Space Program Operations Contract

Shuttle Crew Training Catalog

November 7, 2008

DRD-1.6.1.3-A
Contract NNJ06VA01C

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Shuttle Crew Training Catalog

Prepared by

Original signature obtained
Steven Williams, Manager
USA/Training Integration

This document prepared by the
Training Integration Group
Department 4920

DRD-1.6.1.3-a

Contract NNJ06VA01C
### REVISION LOG

<table>
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<th>Rev. letter</th>
<th>Change no.</th>
<th>Description</th>
<th>Date</th>
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<td>01-BASE-01 Add FLT CONT QUAL 21007</td>
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<td>01-BASE-05 TOXICOLOGY 91001 mandatory</td>
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<td>01-BASE-08 Add CSA-CP 31001</td>
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<td>01-BASE-07 Modify flow chart</td>
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<td>01-BASE/CPN1-1 Add lesson A/E FCS BR 21001, review lesson A/E FCS 21001 and A/E FCS 21006</td>
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<td>02-0020 Replace PGSC H/W 21020 with PGSC INTRO 21195</td>
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<td>02-0001 Add CMO REFR 91001</td>
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<td>02-0007 Add CVIS &amp; HRF OPS 31001</td>
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<td>Replace media from 31001 to 31195 for lesson PGSC MAL</td>
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Lesson Change Requests (LCRs) implemented in Revision B:

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<td>Revise IFM 21001, IFM PIN KIT 21001</td>
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<td>Updated P/L OV 21001</td>
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<td>FLIGHT PLAN 21001</td>
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<td>CREW HAB 21001, ESC EQ/SYS 21001, ESC PROC 21001, REACH &amp; VIS 21020, WATER SURV 21001, WATER SURV 21027</td>
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<td>P/L COM OPS 21001 with P/L COM/OIU OPS 21001</td>
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Revision D

Lesson Change Requests (LCRs) implemented for Revision D: 12/20/2004
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<td>Editorial changes to MPS OV 21001 and Introduction</td>
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<td>2 lessons deleted (OCA/VTS OPS 21195 and PGSC NETWORK OPS 21195) and 1 lesson added (PGSC OPS 21195); changes to flow charts, tables, and lesson numbers</td>
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<td>Objective modifications to P/L &amp; APDS OV 21001</td>
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<td>04-0024</td>
<td>Modified MED EVAL DCS 31001</td>
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<td>04-0025</td>
<td>Added MED EVAL DCS EXP 31001 for experienced crew; reduced duration of class</td>
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<td>04-0043</td>
<td>Added ISIS EQ 31001 and ISIS OPS 31019; changes to tables and flow chart</td>
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<td>04-0040</td>
<td>Deleted ISSUES BR 31001; changes to tables, flow chart, and order of lessons</td>
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<td><strong>RENDZVOUS/PROXIMITY OPERATIONS:</strong></td>
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<td>1 lesson added (DST MAN PH 61025); changed lesson titles and modified hours for SES lessons; changes to flow charts and tables</td>
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<td><strong>ISS ECLSS FOR STS CREW TRAINING:</strong></td>
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<td>04-0023</td>
<td>Deleted section (IUS will no longer be flown). References to IUS deleted from lessons in ORBIT FLIGHT OPERATIONS, RENDEZVOUS/ PROXIMITY OPERATIONS, and INTEGRATED SIMULATIONS. Deletion of acronyms in Appendix D SPACEHAB moved to Section 11.0</td>
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<td><strong>ISS CORE SYS:</strong></td>
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<td>Created new section (CORE STATION SYSTEMS FOR STS CREW TRAINING)</td>
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<td>Removed applicable lessons from ISS ECLSS FOR STS CREW TRAINING and placed into new section</td>
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<td>04-0048</td>
<td>Creation of section (67 shared lessons with ISS) with new flow charts</td>
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<td>04-0027</td>
<td>Changed TRANS FAM 21001 to TRANS FAM 31001; modifications to flow chart and tables</td>
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<td>04-0038</td>
<td>Added Contingency Landing Training; changes to Table A.1</td>
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<td>Deletion of various acronyms in Appendix D and the addition of common acronyms; removal of acronym callouts (synopsis/objectives) for common acronyms in all applicable sections of the Shuttle CTC; editorial changes/updates for the Introduction and Index</td>
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<td>Change in lesson title of IMU 21001 to IMU BR 21001</td>
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<td>Addition of NAV QUAL 21001</td>
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<td>Revised: C&amp;W OV 21001, MECH OV 21001, MECH OPS 21008, APU/HYD MAL 21001, APU/HYD MAL 21004; ECLSS MAL O 21001, and ECLSS MAL O 21004</td>
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<td>Editing changes to DPS HW 21057 and NAV OV BR 21001</td>
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<td>05-0006</td>
<td>Editing changes to IFM PIN KIT 21001</td>
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**ADDENDUM:**

Added flight-specific requirement lessons to contents:
- Crew Equipment Review
- FDF/ODF Pre Simulation Briefing
- Guest List
- Menu Review
- POC REVIEW
- Initial FDF T/U
- Crew Task Panel
- Dental
- Flight IPT
- Flight JOP
- Vision
- FPSR
- Flight Ops Review
- DT/CB T/U
- RANGE SAFETY
- PREFLT MENU
- CB FRR
- ELSA Training
- Annual IT Security Briefing
- TRAINING KICKOFF MTG
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<td>ADDENDUM: (concluded) The following lessons were deleted from the Addendum: • Interviews/Presentation Support • SCUBA Proficiency • Extravehicular Maneuvering Unit (EMU) Proficiency • Military Requirements • Other CB-Related Duties • Lunch/Dinner All tables in Addendum have been changed to SBT format; section has been reorganized to sections based on Flight Support, Aircraft Operations, and Informal lessons Miscellaneous: Insertion of new formatted tables from SBT for PHOTO TV, MOBILE SERVICING SYSTEM FOR STS CREW, TRANSFER OPERATIONS, and INTEGRATED SIMULATIONS sections. Included “Shared – Shuttle” and “Shared – ISS” designation on applicable lessons. Added 1 Appendix (A – Shuttle Budget Team Information) to contents; added acronyms to Appendix E (Acronyms and Abbreviations); updated lesson flows for Appendix D (Payload Specialist Training Flow Chart). Completed editorial changes/updates for the Introduction and Index; added acronym callouts to new lessons; included Shuttle Budget Team information into the LCR process (Introduction)</td>
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<td>Divides the SYS QUAL 21008 lesson into three separate quals</td>
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<td>Updated objectives in E NAV 22006</td>
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<td>Revised Front Matter, ORB SYS TRNG 21001, CREW DUTY 21001, SPOC 21001, NAV QUAL 21001, ENT DP MAL 21006, ORB MAN ATT 21001, OGNC QUAL 21006, and DPS QUAL 21001</td>
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<td>COMM class updates 7 lesson codes replaced with Briefing (BR) lessons AUDIO 21001 split into 2 lessons (plus 1 BR lesson) Adds AUDIO 21001, AUDIO 21006, COMM/IN OPS 21001, CCTV OPS 21001, P/L COM/OIU OPS 21001, and KU OPS 21001</td>
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| F (cont)   | 05-0072    | Revised Tables 1-1 and 1-2  
                  Adds 1.0 hour to ORB SYS 21012  
                  Revised PO INS OPS 21001,  
                  ABORT FAM 21001, A/E BFS 21001,  
                  ORB SYS 21012, A/E SYS 21001,  
                  A/E SYS 21011, PAPER SIM 21001 through  
                  25001, DO PREP BKOT 21001,  
                  ASC SKLS 21001, and E SKL 21001 |  |
|            | 05-0073    | Revised OMS, RCS, MPS, and E GUID lessons.  
                  10 lesson codes replaced with Briefing (BR) lessons.  
                  18 lessons revised |  |
|            | 05-0074    | Revised EPS, APU/HYD, and ECLSS lessons.  
                  10 lesson codes replaced with Briefing (BR) lessons.  
                  10 lessons revised |  |
|            | 05-0129    | Changes EVA OV 21001 with  
                  EVA INTRO 21001 |  |
|            |            | **CORE SYSTEMS REFRESHER:** |  |
|            | 05-0045    | Deleted PL COM/OIU 41001 and  
                  PL COM/OIU RVW 41006 |  |
|            | 05-0081    | Added CONT ABT RVW 21001 |  |
|            | 05-0082    | Added CONT ABT RVW 21011 |  |
|            | 05-0083    | Added MAN ABT 21001 |  |
|            | 05-0084    | Added MAN ABT 21011 |  |
|            | 05-0085    | Added MAN ASC 21001 |  |
|            | 05-0086    | Added MAN ASC 21011 |  |
|            | 05-0106    | A MPS S&C Q 31001 split into two separate  
                  Qual lessons:  
                  MPS QUAL 31006 and  
                  S&C QUAL 31006 |  |
|            |            | **CREW SYSTEMS:** |  |
|            | 05-0069    | Moved ASC/CAP/DES 91020 from Stage 3  
                  to Stage 2 |  |
|            |            | **MEDICAL OPERATIONS:** |  |
|            | 05-0057    | Small text changes for clarity to 8 lessons |  |
|            | 05-0058    | Modified synopsis and objectives for  
                  MED CPR 31001 and SEE OPS 31020 |  |
|            | 05-0059    | Modified synopsis and objectives for  
                  TEPC 31001 |  |
|            |            | **STS PHOTO/TV:** |  |
|            | 05-0065    | Combined APPR&DOCK TV 91020  
                  (PHO/TV) and PDRS LIGHTING 91019 into  
                  one lesson called CCTV LIGHTING 91019 |  |
|            | 05-0107    | Deleted 203 and LIN series, EO PHO, and  
                  RELOAD OPS  
                  Added 760 EVA EQ 31001 and  
                  760 EVA PHO SKL 31031, added  
                  EVA IR CAM REQ 31001 and  
                  EVA IR CAMR SKL 31019, and added  
                  LCS EQ 31001 |  |
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<td>05-0049</td>
<td>Deleted 5 E AUTOLAND lessons.</td>
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<td>Revised notes in CONT ABT 91011,</td>
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<td>Added MAN ASC 41001</td>
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<td>05-0047</td>
<td>Corrected student requirement designations for 8 lessons, indicating R1/R2 versus MS position</td>
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<td>Added note to 20000-level lesson flow chart about observing Generic Int Sim</td>
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<td>Deleted PDRS LIGHTING 31019 and PDRS LIGHTING 91019</td>
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<td>05-0046</td>
<td>Moved APPR &amp; DOCK 31069 from Stage 2 to Stage 3. Revised RNDZ FS-TRAD BR 31001, RNDZ FAM 21012, RNDZ OPS 21012, RNDZ MAL 21006, TI DELAY 31006, and TRAD OV 21195</td>
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<td>MPLM flow added to SPACEHAB section (5 lessons added for MPLM flow)</td>
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<td>Increased durations for SHAB EPSMAL 31029 and SHAB ECS MAL 31029; decreased duration for SVT FAM 31185</td>
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<td>Added the following lessons for the MPLM flow: SHUTTLE MPLM I/F 31001, ASBLY OPS HB 31007, MPLM FACIL 31031, MPLM ROEU/PRS OPS 31029, and MPLM REVIEW 41029</td>
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<td>Deleted ISS SA S/W TOOLS 21178</td>
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<td>05-0050</td>
<td>Adjusted duration for SMALL VOL PRESS OPS 21105</td>
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<td>Reduced duration of ISS UHF OPS/ MAL 21078 by 15 minutes</td>
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<td>Reduced duration for MPLM INTRO 31105. Updated lesson code and synopsis for ISS EMERGENCY OVW (21105 to 11105). Updated prerequisites for RACK INSTAL SKL 21105 and ISS/STS EMER SCEN 31186</td>
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<td>MOBILE SERVICING SYSTEM FOR STS CREW TRAINING:</td>
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<td>05-0052</td>
<td>Redlined synopsis and objectives for MSS SUPT TOOLS 21025</td>
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<td>Decreased duration for MSS SPEC TASK 7 21025</td>
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<td>Decreased duration for ROBOTICS LSN LRND 21001</td>
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<td>Decreased duration for MSS SPN &amp; REF DATA 91001</td>
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<td>Deleted ROBO/MECH I/F SIM 91110 and MRMDF FAM 21175. Added CBM and CAS ROBO INSTALL Sims to lesson flow chart. Changed lesson codes for MSS TPS ORM VIEW 91069 and MSS TPS OBSS H/O 91069. Changed stages for several other lessons</td>
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<td>TRANSFER OPERATIONS: Updated lesson flow chart and table</td>
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<td>INTEGRATED SIMULATIONS: Updated table</td>
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<td>ADDENDUM: Revised all tables</td>
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<td>05-0061</td>
<td>Revised Vision lesson in Flight Support section (FS-14)</td>
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<td>05-0062</td>
<td>Revised Medium for HAT Flights in Flight Support section</td>
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<td>05-0067</td>
<td>Deleted EMU FITCHECK lesson from Flight Support section</td>
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<td>Miscellaneous: Applicable redlines applied to sections to reflect current operating practices.</td>
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<td>Appendix C and D combined into 1 appendix (Appendix C: Payload Specialist Training Information). Updated Appendix D (Acronyms and Abbreviations). Updated tables in all sections to remove the word “sequence” and replace it with “reference.” Reorganized the Introduction and updated all lesson flow charts. Updated the Index. Revised Appendix A with current table information</td>
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<td>Lesson Change Requests (LCRs) implemented for Revision G (including Shuttle Budget Team (SBT) cycle):</td>
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<td>NEW ASTRONAUT:</td>
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<td>06-0007</td>
<td>Replaced two lesson codes (DPS 21005 to DPS 21006, and IMU 21005 to IMU FAM 21006)</td>
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<td>06-0045</td>
<td>Deleted EPS MAL 21057 and C&amp;W/EMERGENCY ALARM SYSTEMS 21057 Objective revisions for MECH MAL 21008 and C&amp;W MAL 21004</td>
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<td>06-0050</td>
<td>Deleted MPS NOM ASC 21057 CBT from Table 1-4</td>
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<td>06-0078</td>
<td>Revised objectives for E DAP SKL BR 21001</td>
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<td>06-0044</td>
<td>Added multi-system lesson SHUTTLE REVIEW 31006</td>
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<td>Replaced lesson code SYSTEMS Q 31004 with three separate qual lessons (EPS QUAL 31004, APU/HYD QUAL 31004, and ECLSS/C&amp;W/MECH QUAL 31008)</td>
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<td>Revised objectives for ASC SKL 34012</td>
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<td>Added review reference to preparation for ASC SKL 35011</td>
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<td>Revised title and objective of ISS EVA MASS OPS 91016; this LCR accompanied LCR 06-0059</td>
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<td>Revised Table 8-3 (EVA Task Operations)  for 5 lesson phase changes</td>
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<td>Moved CREW PRESS CONF from Stage 1 to Stage 2</td>
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**Miscellaneous:** Applicable redlines applied to sections to reflect current operating practices. Stage changes made to various section tables per applicable LCRs. Student designation changes made to various lessons to match applicable tables. Revised Appendix A with current table information. Updated Appendix C (Payload Specialist Training Information) and Appendix D (Acronyms and Abbreviations). Updated all lesson flow charts per applicable LCRs. Updated the Index; the Index changed document location, from before Addendum to after the Appendixes.
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Editorial changes to the Index and Appendix D to reflect current documentation
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<td>(Joint LCR with ORBIT FLIGHT OPS) Added PROX OPS T/L 91012, UNDOCK MAL T/L 91001, and UNDOCK MAL T/L 91012 to contents</td>
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<td>Added CBM OPS PREP 21001, CAS OPS PREP-S 21001, and CAS MAL PREP-S 21001; revised CAS/CBM classes</td>
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<td>Revised O2N2 OPS 21001</td>
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<td>07-0035</td>
<td>Added OnOrbit Crew Email lesson</td>
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<td>Added Postflight Appearances Planning Meeting lesson</td>
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<td>07-0037</td>
<td>Added Range Safety Brief at JSC lesson</td>
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<td>07-0038</td>
<td>Added L - 10 Bench Review lesson</td>
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<td>07-0039</td>
<td>Added MPLM KSC Bench Review lesson</td>
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<td>07-0062</td>
<td>Revised A/C-9 HAT Flight lesson</td>
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<td>Completed redlines to Section and Addendum tables per LCR input; editorial changes made to Orbit Flight Operations Section sources, Introduction, Appendices A, B, and D, and Index per current operating practices</td>
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<td>Lesson Change Requests (LCRs) implemented for Revision J (including Shuttle Budget Team (SBT) cycle):</td>
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<td>08-0019</td>
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<td>08-0020</td>
<td>Revised CO2 31074</td>
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<td>Added Suit IV/Task IV designation to PREBREATHE 31001, CEVIS &amp; HRM OPS 31001, STS TOX OPS 31001, MED EVAL DCS 31001, and MED EVAL DCS EXP 31001</td>
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<td>Added EVA PGT/TM 21001 to EVA Generic flow</td>
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<td>Deleted: PDRS DOCK SJ OBSS 21069</td>
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<td>Revised ECG INTRO 11001</td>
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<td>08-0013</td>
<td>Revised ISS OPS S/W INTRO 21257</td>
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<td>08-0027</td>
<td>Revised and lesson code change from TOOL/REPAIR KITS 21105 to TOOL/REPAIR KITS 21208</td>
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<td>08-0028</td>
<td>Added ISS AUD/VID RVW 21121</td>
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<td>08-0042</td>
<td>Revised ISS AUDIO HW 21105</td>
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<td>08-0051</td>
<td>Revised O2N2 XFER OPS 21105 and O2N2 XFER PROF 41105</td>
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**CORE STATION SYSTEMS: (concluded)**

**MOBILE SERVICING SYSTEMS FOR STS CREW TRAINING:**

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<td>08-0030</td>
<td>Added the SPDM Maintenance flow and lessons: SPDM MAINT1 41025 SPDM MAINT2 42025 SPDM MAINT3 43025 SPDM MAINT4 44025 SPDM MAINT5 45025</td>
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<td>08-0031</td>
<td>Deleted the Additional Element Install flow and the following lessons: ADD EL INSTL1 31025 ADD EL INSTL2 32016 ADD EL VIS MAL 31025 ADD EL TRAJ MOD 91025 ADD EL RVW 31025</td>
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<td>08-0032</td>
<td>Changed the MSS Main Element flow. Deleted lessons: EL UNBRTH1 31025 EL UNBRTTH2 32115 EL TRAJ MOD1 91025 Added lessons: EL NOM INSTL 4 91045 Revised lessons: EL NOM INSTL 1 31025 EL NOM INSTL 2 32115 EL NOM INSTL 3 93016 Revised and lesson code change from EL INST RVW 41025 to EL INSTL RVW 41025 (Stage 1 revision)</td>
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<td>Lesson code change from MSS D&amp;C OV 21065 to SSRMS D&amp;C OV 21065</td>
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<td>08-0034</td>
<td>MOBILE SERVICING SYSTEMS FOR STS CREW TRAINING: (continued)</td>
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<td>08-0034 Changed the MSS TPS Inspection &amp; Repair flow</td>
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<td>Added five lessons for new SPDM Qual flow:</td>
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PREFACE

The Shuttle Crew Training Catalog, prepared by the United Space Alliance (USA) Training Department’s Training Integration Group, documents the formal training requirements for the space shuttle crewmembers.

Questions or comments regarding this document should be addressed to the Training Integration Group, care of:

United Space Alliance
600 Gemini
Houston, Texas 77058-2777
Mail Code: USH-492X
Telephone: (281) 244-2486

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INTRODUCTION

Purpose

This catalog documents and describes the formal training provided by the Mission Operations Directorate (MOD) for flight crews operating the Space Transportation System (STS). It is designed to show trainees the proper sequence and content of their training, and contains the facility and lesson information necessary to conduct this training.

The catalog is also used by instructors to develop lesson plans that ensure continuity and minimize redundancy between lessons. Training managers, team leads, long range planners, and other flight operations support personnel use the lesson and facility information to aid them in conducting their assigned duties. In addition, the catalog may be of value to others interested in the STS training program.

Scope

This catalog lists the formal training requirements for STS flight operations, including lessons currently available and lessons under development. Special training requirements for payloads or technical activities associated with a particular flight may not be included in this catalog, but will be included in the training plan for that particular shuttle flight. This catalog covers all other levels of Flight-Specific STS crew training provided by MOD in detail.

Crew Training Overview

MOD’s crew training program is designed to provide the systems familiarization and flight skills required to effectively, efficiently, and safely control and operate the STS orbiter as well as carry out mission tasks. The training documented in this catalog is structured in a building block format, beginning with workbooks and briefings and progressing to lessons using sophisticated trainers and simulators.

Persons selected as Astronaut Candidates (ASCANs) undergo a year-plus program of training and evaluation. During this time period, the astronaut candidates proceed through the New Astronaut training program documented in this catalog and directed by the Flight Crew Operations Directorate (FCOD), while beginning advanced training from the New Astronaut Training Flow documented and directed by MOD.

New astronaut training introduces new crewmembers to generic shuttle systems and flight operations. A good understanding of this material is essential for new crewmembers in both their technical assignments and their other contributions to the Astronaut Office. This training also prepares a student for training as an assigned crewmember. The lessons included in this flow are all those in the Data Processing System (DPS), Guidance, Navigation, and Control (GNC), Systems and Control/Propulsion, and Communications training courses. Upon completion of this new astronaut training flow, the student should possess a functional knowledge of most of...
the shuttle systems and flight operations procedures. It is intended that the new astronaut lessons be completed prior to flight assignment so that the new crewmember will be ready for the flight-similar flight operations training.

After this first year, candidates continue the advanced training, which may lead, upon completion, to an assignment to a space shuttle flight crew.

While awaiting flight assignment, flown crewmembers and crewmembers who have completed the new astronaut lessons maintain proficiency in shuttle systems and flight operations by taking recurring proficiency (40000-level) lessons at the SMS. These crewmembers may also elect to take Single System Trainer (SST) refresher lessons in various orbiter systems.

**Assigned Crew Training**

Upon assignment to a specific flight, crewmembers progress into the flight-similar flight operations (ascent, orbit, and deorbit/entry) lessons and begin the appropriate mission-specific courses such as: Payload Deployment and Retrieval System (PDRS), Mobile Servicing System (MSS), Rendezvous/and Proximity Operations (Rndz/Prox Ops), Extravehicular Activity (EVA), International Space Station (ISS) Core Systems, and Transfer Training.

Assigned crew training is directed by a Shuttle Budget Team (SBT) which includes representation from MOD and FCOD. The SBT monitors, manages, and approves changes to assigned crew training. It is tasked with managing curriculum loading and distribution, as well as curriculum content.

**Payload Specialist Training**

The Astronaut Office is responsible for outlining the Payload Specialist (PS) training curriculum. Specific training requirements for each PS are determined by the Crew Support Office manager and the crew payload commander. These training requirements are incorporated into the detailed crew training plan developed by the MOD training manager. Training for PSs is composed of generic and flight-specific training. PS training is intended to achieve the following:

- Provide sufficient shuttle systems training so that PS activities onboard the shuttle are conducted in a safe manner.

- Provide sufficient crew interaction and operations training so that the entire crew can operate safely as a disciplined, integrated team.

- Provide sufficient emergency and safety training so that hazardous situations can be handled with speed and skill.

- Provide sufficient time for payload training so that experiment operations proficiency can be maintained.
Lessons which are recommended for PSs are listed throughout the Crew Training Catalog (CTC). Each Crew Training Requirements Table contains crew position columns which define which lessons each crewmember will receive. Payload Specialist lessons will be indicated using the “PS” column. No facility lessons will be scheduled for the backup PS. However, backup PSs are encouraged to attend facility lessons with the prime PS, as an observer, if space is available. Re-designation of the prime PS within 4 months of launch could affect the satisfactory completion of the training requirements.

A list of self study materials and a flow chart depicting the recommended PS training may also be found in the CTC appendix. This flow chart integrates lessons from each CTC section.

Training outlined in the Shuttle CTC will be augmented for a specific mission based on the requirements of the Payload Integration Plan (PIP) Training Annex, and those of the mission Commander, Payload Commander, Simulation Supervisor, and Training Team Lead.

**Timeframe**

The training period for assigned crews is divided into timeframe segments called stages. Stages are broad timeframes, each spanning several L-weeks in which the training is divided. Each activity is associated with a particular training stage.

**Stage Breakdown:**

- **Stage 4 – Training start through L-35**
  Light training, handing over Astronaut Office jobs, finishing Shuttle Mission Simulator (SMS) qualifications

- **Stage 3 – L-34 through L-19**
  Training heavily across all disciplines

- **Stage 2 – L-18 through L-5**
  Start of integrated simulations

- **Stage 1 – L-4 through “T-38 to KSC” (not launch)**
  Protected time, includes Terminal Countdown Demonstration Test (TCDT)

Flight-similar training starts approximately 12 months prior to the published launch date, or at Stage 4. The final phase, load-specific training, typically begins 16-18 weeks before launch (Stage 2), but for a very complex mission, may begin earlier. During this phase, the training facilities are operated with the actual flight software load or mission model.

Integrated training begins approximately 16-18 weeks prior to launch (Stage 2) and brings the flight crew, ground support personnel, and the customer together using the
Shuttle Mission Simulator (SMS), Mission Control Center (MCC), and the customer control facility. Integrated training produces a high-fidelity simulation of the mission and exercises the required coordination between the groups operating and controlling the flight.

**Deviations**

Although some lessons require participation of the entire crew, the lessons may have been designed to emphasize training for one or two specific crew positions. In addition, training requirements for some positions (such as mission specialists) may not require that all lessons in the training flow be taken. These special conditions are detailed in the lesson descriptions. A list of the lessons required for a specific flight is generated by the appropriate Training Division training manager after crew assignment.

The Shuttle CTC was developed as a guideline for Astronaut Training. Preservation of Crew Loading, Crew Experience Levels, Mission Content Changes, etc. may necessitate changes to these guidelines. Deviations to the Shuttle CTC and subsequently the Crew Training Plan may be made with concurrence from the Training Manager, Subject Matter Expert, and the Commander (CDR). These deviations shall be documented appropriately in the Crew Training Plan.

Crewmembers desiring further study in a given area may request additional classes.

**Catalog Organization**

The catalog is divided into sections covering orbiter system ASCAN training, flight operations, specific mission operations, payloads, and integrated simulations. The training courses provide in-depth information on the individual systems and their interactions.

The New Astronaut Flow (Section 1) consists of all lessons required by the Training Division for ASCANs. It contains courses from GNC, the DPS, orbiter systems, propulsion systems, and other crew systems. Section 2 contains the Core Systems Refresher lessons that can be taken to maintain proficiency in orbiter systems. The following sections contain lessons for flight assigned crewmembers. Crew Systems (Section 3) provides knowledge and skills for orbiter habitability and emergency escape. Medical Operations (Section 4) familiarizes the crewmembers with basic medical information for use while onboard the shuttle. Photo/TV (Section 5) teaches the crewmembers how to operate the photo and video equipment onboard the orbiter.

Flight operations courses (Sections 6 and 7) are Ascent/Entry Flight Operations and Orbit Flight Operations. Mission operations courses (Sections 8-10) include Extravehicular Activity (EVA), Payload Deployment and Retrieval System (PDRS), and Rendezvous/Proximity Operations (Rndz/Prox Ops). The Payload course (Section 11) covers the Spacehab and Multipurpose Logistics Module (MPLM) lessons. Courses necessary for shuttle crews visiting the ISS can be found in Section 12 for Core Station Systems, Section 13 for Mobile Servicing Systems (MSS), and Section 14 for Transfer Operations. Integrated simulations are covered in Section 15.
Each catalog section includes lesson and flow information in several different formats which may consist of a course introduction, a lesson flow chart, a training requirements table showing the hours and crew positions to be trained, a summary of crew and facility hours, and a description of each individual lesson.

Not every section includes all formats. For example, the Integrated Simulations Training Course (Section 15) includes only an introduction, a summary of the standard integrated simulation requirements, training objectives, and a series of lesson descriptions.

It should also be noted that ISS-related lessons and flows may deviate from the formatting outlined in this section due to differences between the two training programs.

**Training Level Definition**

Training lessons are designated by levels. Understanding these levels will help the catalog user interpret the lesson coding system. These training level distinctions are necessary to identify training requirements for newly assigned flight crewmembers as well as for those who have previously flown a mission. Training lesson levels are designated as follows:

**Level 1: Basic**
Part of the New Astronaut basic training consists of briefings, lectures, T-38 flying, etc. designed as an introduction to the Space Transportation System (STS) program and to flight operations activities. This training is directed by FCOD.

**Level 2: Advanced**
Lessons in generic STS and ISS operations.

**Level 3: Flight-Similar**
Lessons which require a load or configuration similar to that flight’s actual load or configuration.

**Level 4: Proficiency, Review and Refresher**
Lessons repeated as needed to brush up on or maintain a given level of skills and knowledge in STS operations.

**Level 6: Operational**
The 60000-level code is used for events that are Facility, hardware, or operational prerequisites for training.

**Level 9: Load-Specific**
Lessons which require that flight’s actual load or configuration (software and/or hardware).
Lesson Codes

Lessons are identified by a lesson code consisting of up to nineteen alphanumeric characters. The last six characters describe the training level, session number, facility, and revision code.

![Diagram showing lesson code interpretation]

**Figure 1. Lesson Code Interpretation**

Proficiency, Review, and Refresher Lessons

There are three types of 40000-level lessons in this catalog: proficiency, review, and refresher.

a. Proficiency Lessons

Proficiency lessons within each course are used to maintain a specific level of skills or systems knowledge after a particular phase of training is completed. These lessons are taken on a scheduled, recurring basis as required. The frequency is determined by the individual training course supervisor. The content of the lesson is predefined and is outlined in the lesson descriptions.

The three levels of proficiency lessons correspond with the levels of training: advanced, Flight-Similar (FS), and Load-Specific (LS). Advanced proficiency lessons (designated ‘XXXX PRF ADV,’ where ‘XXXX’ indicates the training course) are taken upon completion of that course’s advanced (20000-level) training. For the
flight operations courses, this is commonly referred to as 'astronaut pool proficiency'. Flight-similar proficiency lessons (XXXX PRF FS) are taken after all flight-similar (30000-level) training is completed and before the load drop. Load-specific proficiency lessons (XXXX PRF LS) are taken after completion of load-specific (90000-level) training and before actual flight. They are also used to round out the load-specific training in the weeks before flight.

b. Review Lessons

Review lessons are the second type of 40000-level lessons offered. They are used to review specific material in a given course or to cover the highlights of a group of lessons. This may happen, for instance, when an experienced crewmember is in training for a subsequent flight. Review lessons (designated ‘XXXXX REVIEW’) may be taken at any appropriate time during the course by crew and/or instructor request, and therefore do not have a specified frequency. The content of review lessons is determined in a pre-lesson meeting between the crewmember(s) and instructor(s).

c. Refresher Lessons

Refresher lessons are the third type of 40000-level training. They are used to brush-up each crewmember’s knowledge of the individual systems, usually prior to the start of 30000-level training. Crewmembers who have been assigned to a flight are required to take these lessons within 12 months of flight unless they have taken the related 20000-level lessons within 2 years of the flight. The content of each lesson is predefined and is outlined in the lesson description. Refresher lessons (designated ‘XXXXXXX REFR’) may also be taken by other crewmembers upon request.
## Table 1. Facility/Media List

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Table 1. Facility/Media List (Continued)

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<td>SSTF with RST and Crew Station</td>
<td>5S</td>
</tr>
<tr>
<td>153</td>
<td>FT</td>
<td>Field Trip</td>
<td>-</td>
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<tr>
<td>154</td>
<td>SSATA</td>
<td>Space Station Airlock Test Article</td>
<td>5S</td>
</tr>
<tr>
<td>155</td>
<td>SMC</td>
<td>Station Management and Control Laboratory</td>
<td>5S</td>
</tr>
<tr>
<td>156</td>
<td>PTT1</td>
<td>Part Task Trainer 1</td>
<td>4S</td>
</tr>
<tr>
<td>157</td>
<td>SSC</td>
<td>Station Support Computer</td>
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<td>PCS</td>
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<td>159</td>
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<td>Galveston IMAX Theater</td>
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<td>160</td>
<td>OLMATS</td>
<td>Online Materials</td>
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<td>161</td>
<td>SSTF USLT</td>
<td>SSTF U.S. Lab Trainer</td>
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<tr>
<td>162</td>
<td>SSTF JEM</td>
<td>SSTF JEM Trainer</td>
<td>5S</td>
</tr>
<tr>
<td>163</td>
<td>SSTF COF</td>
<td>SSTF Columbia Operating/Orbiting Facility</td>
<td>5S</td>
</tr>
<tr>
<td>164</td>
<td>SSTF SATA</td>
<td>SSTF Stand-Alone Training Area</td>
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</tr>
<tr>
<td>165</td>
<td>SSTF RBUA</td>
<td>SSTF Rack Build-Up Area</td>
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</tr>
<tr>
<td>166</td>
<td>SSTF PSSA</td>
<td>SSTF Payload Support Structural Assembly</td>
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<tr>
<td>167</td>
<td>SSMTF SATA</td>
<td>SSMTF Stand-Alone Training Area</td>
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<td>SSMTF FCSL</td>
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<td>EVA Space-to-Space Communication System Trainer</td>
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<tr>
<td>171</td>
<td>DST2</td>
<td>Dynamic Skills Trainer 2</td>
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<td>DST5</td>
<td>Dynamic Skills Trainer 5</td>
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<td>175</td>
<td>OBT/CBT</td>
<td>On-Board Training/Computer Based Trainer</td>
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<tr>
<td>176</td>
<td>CR/TTT</td>
<td>Table Top Trainers in a Classroom</td>
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<tr>
<td>177</td>
<td>VCONF</td>
<td>Video Conference</td>
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<td>SSTF</td>
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</tr>
<tr>
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<td>S1/SSMTF</td>
<td>Space Station Training Facility/Space Station Mock-Up Training Facility</td>
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<td>180</td>
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<td>181</td>
<td>CLR1</td>
<td>Classroom 1</td>
<td>-</td>
</tr>
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<td>182</td>
<td>PTT5</td>
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</tr>
<tr>
<td>184</td>
<td>GITF</td>
<td>GNC Integrated Training Facility</td>
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<tr>
<td>185</td>
<td>SVT</td>
<td>Spacehab Volumetric Trainer</td>
<td>5N</td>
</tr>
<tr>
<td>186</td>
<td>S2/SSMTF</td>
<td>S2/SSMTF Combined Configuration</td>
<td>5S/9N</td>
</tr>
<tr>
<td>187</td>
<td>SVTFB</td>
<td>Spacehab Volumetric Trainer Fixed Base</td>
<td>5N</td>
</tr>
<tr>
<td>188</td>
<td>SVTMB</td>
<td>Spacehab Volumetric Trainer Motion Based</td>
<td>5N</td>
</tr>
<tr>
<td>189</td>
<td>SVTGNS</td>
<td>Spacehab Volumetric Trainer GNS</td>
<td>5N/35</td>
</tr>
<tr>
<td>190</td>
<td>ISVTFB</td>
<td>Integrated Spacehab Volumetric Trainer Fixed Base</td>
<td>30/5N</td>
</tr>
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<td>ISVTMB</td>
<td>Integrated Spacehab Volumetric Trainer Motion Based</td>
<td>30/5N</td>
</tr>
<tr>
<td>192</td>
<td>ISVTGNS</td>
<td>Integrated Spacehab Volumetric Trainer GNS</td>
<td>30/5N/35</td>
</tr>
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<td>193</td>
<td>S3</td>
<td>SSTF – String 3</td>
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<td>195</td>
<td>PGSC</td>
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<td>196</td>
<td>CLR2</td>
<td>Classroom 2</td>
<td>-</td>
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<td>197</td>
<td>FQDT</td>
<td>EVA Fluid QD Trainer</td>
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<td>Evaluation</td>
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<td>201</td>
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<td>Russia Classroom</td>
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<td>Russia Workbook</td>
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<td>RUSS TRNR</td>
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<td>Androgynous Peripheral Docking System Trainer</td>
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<td>Building 9 Suit Room</td>
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<td>Mission Control Center-Moscow</td>
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<td>DT SSC Lab</td>
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<td>Energia</td>
<td>-</td>
</tr>
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<td>292</td>
<td>RS FLT SUP</td>
<td>RS Flight Support</td>
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<tr>
<td>298</td>
<td>RS INFORM</td>
<td>Russia Inform</td>
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<td>299</td>
<td>UG</td>
<td>User Guide</td>
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<td>300</td>
<td>ESA</td>
<td>European Space Agency</td>
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<td>412</td>
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<td>CTF</td>
<td>Canadian Training Facility</td>
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<td>MMLC</td>
<td>Multimedia Learning Center</td>
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<td>514</td>
<td>MOTS</td>
<td>MSS Operations Training Simulator</td>
<td>-</td>
</tr>
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<td>515</td>
<td>SOSC</td>
<td>Space Operations Support Center</td>
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<td>No.</td>
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<td>Media Description</td>
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<td>516</td>
<td>VOTE</td>
<td>Virtual Operations Training Environment</td>
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<tr>
<td>700</td>
<td>SSTF SLAB</td>
<td>SSTF Secondary Lab</td>
<td>5S</td>
</tr>
<tr>
<td>701</td>
<td>ORU</td>
<td>Orbiter Replacement Unit</td>
<td>9N</td>
</tr>
<tr>
<td>703</td>
<td>TPST</td>
<td>Thermal Protection System Trainer</td>
<td>9N</td>
</tr>
<tr>
<td>704</td>
<td>SSMTF and ORU Trainer</td>
<td>Space Station Mock-Up and Training Facility and Orbital Replacement Unit</td>
<td>9N</td>
</tr>
<tr>
<td>705</td>
<td>VR &amp; PABF</td>
<td>Virtual Reality and Precision Air Bearing Floor</td>
<td>9N</td>
</tr>
<tr>
<td>706</td>
<td>TPS &amp; PABF</td>
<td>Thermal Protection System and Precision Air Bearing Floor</td>
<td>9N</td>
</tr>
</tbody>
</table>
Lesson Flow Charts

The flowchart(s) in each section show the preferred sequence of lessons in that course and indicate any mandatory prerequisites to those lessons. All prerequisites should be met before progressing to the next class. This will ensure that the material has been presented in an effective manner.

The Lesson Flow Charts in most training courses (the New Astronaut section is an exception) depict lesson sequence from bottom to top. Below is an example of a Lesson Flow Chart. This flow does not necessarily correspond to any specific training course. Please refer to the examples following to understand how to interpret the different formatting elements used in Lesson Flow Charts.
Typical Lesson
The following example identifies a SST skill development lesson used to teach advanced skills concerning the orbiter electrical power system. It consists of one session lasting 2 hours.

In the flow chart, this lesson would be identified as follows:

All paths to a lesson must be completed before that lesson can be taken. In the example below, a student must complete lessons 1 through 3 before taking lesson 4, 5, or 6. However, lesson 3 could be taken before lessons 1 or 2.

Informational text may be connected to flow charts by a single straight line.

Proficiency, Refresher, Review Lessons
The following example identifies an ascent proficiency lesson used to maintain ascent skills between flight-similar and load-specific training, using the SMS. The example also includes an ascent review lesson which may be used to brush up on ascent skills previously covered. Both lesson codes contain a 40000-level number. The duration and frequency of the proficiency lesson is shown by the numbers before and after the slanted line, respectively. In this example, the lesson lasts 2 hours and should be repeated every week. If it were scheduled on a monthly basis, the number after the
slash would be a 4. The letter F will be used after the slash if training is to be repeated once per flight. The single number shown indicates the lesson length in hours. Both proficiency and review lessons are connected to the flow by dashed lines and are annotated as shown. Refresher lessons are also connected to the flow by dashed lines and are annotated “(AS REQUIRED)”. They do not have a repeat frequency specified.

Supplemental Lessons
When a lesson provides a source of supplemental data, it will be shown and annotated as follows:

Lessons From Another Course
A dashed line box indicates that the lesson is from another course and is a prerequisite to the next lesson above it in this course. The name of the course is annotated under the dashed box.
Lessons From the ISS Crew Training Catalog (CTC)
A dashed parallelogram box indicates that the lesson is from the ISS CTC and is a prerequisite to the next lesson above it in this course.

Mission-Specific Lessons
When a training flow has lessons that result from a particular STS flight’s objective or cargo configuration, lesson flow charts will identify these requirements by lesson(s) and segregate those lesson groups. This will be accomplished using a dashed box or a separate training flow page for each option.

Generic Flight Crew Training Requirements Lesson List
A lesson flow chart is a requirements lesson list in table form. This list is useful as an overview of lessons contained in a training course and for obtaining facility loading baseline data. The table includes the lesson stage, reference number, the lesson code, duration in hours, scheduling code, crew positions to be scheduled, any alternate facility for the lesson, and a comments column.
### SAMPLE TRAINING REQUIREMENTS TABLE

**Non-Crew Rotation**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ref Num</th>
<th>Lesson Code</th>
<th>Media</th>
<th>Hrs</th>
<th>Sched Code</th>
<th>[Suit IV]</th>
<th>[Task IV]</th>
<th>CrewRotation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>P</td>
<td>EV MS1 EV MS2 EV MS3 MS4 PS C</td>
<td>IV P</td>
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<td>2</td>
<td>ISS-EVA 51105</td>
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<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>4</td>
<td>3</td>
<td>ISS-EVA 51105</td>
<td>SSMTF</td>
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<tr>
<td>4</td>
<td>4</td>
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<td>2</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
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<td>5</td>
<td>ISS-EVA 51105</td>
<td>SSMTF</td>
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**Crew Rotation**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ref Num</th>
<th>Lesson Code</th>
<th>Media</th>
<th>Hrs</th>
<th>Sched Code</th>
<th>[Suit IV]</th>
<th>[Task IV]</th>
<th>CrewRotation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>P</td>
<td>EV MS1 EV MS2 EV MS3 MS4 PS C</td>
<td>IV P</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>ISS-EVA 51105</td>
<td>DMVDF</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>4</td>
<td>3</td>
<td>ISS-EVA 51105</td>
<td>SSMTF</td>
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<td>4</td>
<td>ISS-EVA 51105</td>
<td>SSMTF</td>
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<td>2</td>
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</tr>
</tbody>
</table>

**Date Last Modified:** 10/05

Crew task assignments as determined by the SBT for both crew rotation and non-crew rotation scenarios are displayed in the requirements table. These task and lesson assignments allow the SBT to assess and manage crew loading for entire crews, as well as for specific crew positions.

The scheduling code defines how many crewmembers will be scheduled at a time for the lesson. A scheduling code of ‘8’ indicates that the entire crew should be scheduled for the lesson.

The crew position requirements column defines which lessons each crewmember will receive during training.

Proficiency and supplemental lessons, which are not necessarily required, are listed as unsequenced lessons in appropriate positions in the table.

Crew position designators in the crew training requirements tables are as follows:

- **C** = Commander
- **P** = Pilot
- **MS1** = Mission Specialist 1
- **MS2** = Mission Specialist 2-Flight Engineer
- **MS3** = Mission Specialist 3
- **MS4** = Mission Specialist 4
- **PS** = Payload Specialist
- **A** = ASCAN
- **EV1** = EVA Crewmember 1
- **EV2** = EVA Crewmember 2
- **Suit IV** = EVA Suit Support Crewmember
- **Task IV** = EVA Task Support Crewmember
- **M1** = SSRMS Operator 1
- **M2** = SSRMS Operator 2
- **R1** = RMS Operator 1
- **R2** = RMS Operator 2

Positions designated are task-related and are assigned by the commander.

An alternate facility is indicated in case the planned facility is unavailable. For example, the SST 3 is almost functionally equivalent to SST 1 and SST 2 and usually may be substituted for lessons planned for either.

The comments column is primarily used for additional scheduling information appropriate to the lesson. For example, a **Comments reference** in the Sample Training Requirements Table, “As assigned by CDR,” indicates that the crewmembers assigned to this position can be determined by the commander.
Training Requirements Summary Tables

The New Astronaut course has a training requirements summary table included as part of the course description material. This table is used to provide a summary of the training broken out by facility. The Crew Hours column is based on the Highest Loaded Crew Member (HLCM). The Facility Hours column is the length of the class multiplied by the number of times that the class must be taught in the facility (limited by the maximum number of students that can take the class at once).

### SAMPLE TRAINING REQUIREMENTS SUMMARY

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Crew Hours</th>
<th>Facility Hours</th>
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<td>CLASSROOM (001)</td>
<td>285.0</td>
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<tr>
<td>SST (004, 006, 008)</td>
<td>105.5</td>
<td>1055.0***</td>
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<tr>
<td>CST (005)</td>
<td>2.0</td>
<td>40.0</td>
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<tr>
<td>SMS-Motion Base (011)</td>
<td>53.5</td>
<td>374.5**</td>
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<tr>
<td>SMS-Fixed Base (012)</td>
<td>30.0</td>
<td>210.0**</td>
</tr>
<tr>
<td>CCT (020)</td>
<td>22.0</td>
<td>*</td>
</tr>
<tr>
<td>NBL (027)</td>
<td>3.0</td>
<td>*</td>
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<tr>
<td>CBT (057)</td>
<td>12.5</td>
<td>250.0</td>
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<tr>
<td>WCS (065)</td>
<td>1.0</td>
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</tr>
<tr>
<td>DST (025)</td>
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<td>40.0</td>
</tr>
<tr>
<td>PGSC (195)</td>
<td>4.5</td>
<td>*</td>
</tr>
</tbody>
</table>

Based on an ASCAN class of 20.
The non-ASCAN prebriefs are not included in these numbers.
*Facility Hours are not calculated for non-key facilities.
**SMS Facility Hours based on the lesson being taught seven times to account for a class of 20.
***SST Facility Hours based on the lesson being taught 10 times to account for a class of 20.
Lesson Description

Each lesson in a training course has a lesson description consisting of a lesson title, duration, training medium, student position designation, lesson source, effective date, lesson(s) replaced, equipment required, prerequisite lesson(s), preparation, synopsis and lesson objectives. Some descriptions may also include a list of suggested reading. Lesson descriptions are assigned a reference number that corresponds to the number on the lesson flow chart. For example:

![Lesson Flow Chart]

**22 CSI 21057**

Title: Crew Software Interface  
Duration: 1.5 hours  
Medium: CBT  
Student: ASCAN  
Source: DT35/DPS/Navigation and Rendezvous Section  
Date: 02/04  
Lesson(s) Replaced: CSI 21005  
Equipment Required: None  
Prerequisite Lesson(s): DPS OV 21001  
Preparation: Read:
  - CSI 21002; Part 1

Synopsis: This lesson provides an introduction to basic DPS operations. The lesson focuses primarily on the Primary Avionics Software System (PASS) operations, keyboard operations, and display specifications. PASS structure and General Purpose Computer (GPC) software configurations for flight phases are presented. Keyboard practice is accomplished with Operational Sequence (OPS) and major mode transitions, interaction with the onboard clocks, and DPS display reconfiguration.

Objectives:
  - Describe the PASS software structure and GPC configuration for various flight phases.
  - Define the term “unsupported major function.”
  - Identify the function of the Integrated Display Processor (IDP) power, select, and major function switches.
  - Identify the function of each key on the keyboard.
  - Perform OPS and major mode transitions.
  - Identify the standard format of DPS displays.
  - State the significance of special indicators (M, H, L, ↑, ↓, *, ?) and page nomenclature.
CSI 21057 (Concluded)

- Perform item entries with implied item numbering and multiple entries strung together.
- Identify the source of ‘ERR’ and ‘ILLEGAL ENTRY’ messages.
- Explain Fault Summary format and demonstrate page clearing.
- Demonstrate SPEC and Display (DISP) retention.
- Perform onboard clock operations using SPEC 2.

- “Title” identifies the complete lesson title from which the lesson abbreviation code is derived.

- “Duration” is the amount of time required to accomplish the lesson.

- “Medium” identifies the training facility or document used for the lesson. Some lessons can be conducted in an alternate facility. If the planned facility is preferred, then the alternate facility is shown in parenthesis next to the prime training facility [For example: SMS-FB (SMS-MB)]. If the planned facility is not preferred over the alternate facility an ‘or’ is used to separate facilities listed for example: SST 1 or SST 3. Acronyms used for the training mediums are shown in the Facility/Media List (Table 1).

- “Student” designation is used for scheduling purposes. The lesson is scheduled for crewmembers as a group, unless a notation such as “schedule in pairs” or “schedule individually” follows the student listing. The crew position designators are the same as those used in the Sample Training Requirements Table, and are as follows:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Description</th>
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<td>Pilot</td>
</tr>
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</tr>
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<tr>
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<td>Mission Specialist 3</td>
</tr>
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<tr>
<td>PS</td>
<td>Payload Specialist</td>
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</tr>
<tr>
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<td>EVA Crewmember 2</td>
</tr>
<tr>
<td>R1</td>
<td>RMS Operator 1</td>
</tr>
<tr>
<td>R2</td>
<td>RMS Operator 2</td>
</tr>
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<td>MSS Operator 1 (Section 13)</td>
</tr>
<tr>
<td>M2</td>
<td>MSS Operator 2 (Section 13)</td>
</tr>
</tbody>
</table>

- “Source” identifies the section of MOD responsible for developing the lesson material and for conducting the lesson.

- “Date” indicates the effective date of the lesson.

- “Lessons Replaced” lists obsolete lessons which are preempted by the current lesson.

- “Equipment Required” identifies any unique configuration or ancillary equipment required for lesson conduct and is used for scheduling purposes.
• “Prerequisite Lesson(s)” lists the immediate prerequisite lesson(s).

• Lesson “Preparation” lists tasks that must be accomplished before the lesson is taken.

• “Synopsis” provides the student with additional information about the lesson. Included may be one or more scenarios, a summary of points, procedures or rules to be covered, or a discussion of the environment or timeline presented in the lesson.

• “Objectives” indicates what the student is expected to know or be able to do upon completion of the lesson.

Catalog Revisions and LCR Approvals

Changes to the CTC are made via Lesson Change Request (LCR). LCR forms are submitted to the CTC book manager and are reviewed for accuracy and completeness with regard to format, content, and overall curriculum impact by the CTC book manager, lesson group manager, and flow owner. If the LCR includes changes with loading impacts it must be reviewed and approved by the SBT. Figure 2 depicts the LCR submittal process flow.

Each LCR is considered individually and within the scope of the overall budget. The SBT works toward concurrence on the budget, at which point SBT chair and Astronaut Office approvals are obtained for each LCR and for the overall budget.

SBT Conflict Resolution

Every effort must be made to ensure that conflict resolution does not impose undue delay on catalog publication.

Should the conflict resolution process exceed 2 weeks, the LCR approval will be delayed to the next cycle. The SBT Chair may opt at any point in the process to invoke any of the following conflict resolution process options.

• If the issue at hand is strictly a technical issue, then the LCR will be returned to the SBT flow representative for modifications and may then be approved out of board.

• If issues involve loading, the board will re-convene. The flow owner is required to present supporting data or a modified LCR at this time. Every effort shall be made to resolve conflicts within the board. If the issue remains unresolved, then it will be elevated to Spaceflight Training Management at the next Crew Training Control Board meeting. All affected SBT representatives must attend. Final direction will be determined at this forum.
Figure 2. LCR Submittal Process Flow
Flow Owners’ Responsibilities

A course flow owner is responsible and accountable for the content, loading, and lesson time frame information within his flow. Flow owners must review all LCRs for content and loading impacts and are responsible for presenting and providing the SBT with supporting rationale for each LCR written against his section. The flow owner must also inform respective disciplines of changes to the curriculum. In most cases, the flow owner is also the Training Course supervisor, but this task may be delegated to another individual.

Training Course Supervisor Responsibilities

The primary responsibility of the Training Course Supervisor (TCS) is to maintain correct, accurate, and consistent content of a particular training flow. This will include writing LCRs and obtaining the necessary approvals for the LCRs. They will communicate with other TCSs to eliminate gaps and unnecessary repetitions and to maintain content consistency between training flows. A list of the CTC courses and the responsible TCS can be found in Table 2.

Table 2. Training Course Supervisors

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<thead>
<tr>
<th>Introduction</th>
<th>DA7/Peggy Levy</th>
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<tr>
<td><strong>Shuttle Systems</strong></td>
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<tr>
<td>Section 1: New Astronaut Training Flow</td>
<td>DA7/Kelsey Berumen</td>
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<td>Section 2: Core Systems Refresher Training</td>
<td>DA7/Gail Barnett</td>
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<td>Section 3: Crew Systems</td>
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<td>Section 4: Medical Operations</td>
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<td>Section 5: Photo/TV</td>
<td>DX34/David Williams</td>
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<td>DX3/Tracy Snow and Megan Murphey</td>
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<td>Section 9: Payload Deployment and Retrieval System</td>
<td>DX25/Jenny Young</td>
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<td>Section 10: Rendezvous/Proximity Operations</td>
<td>DM34/Alan Fox</td>
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<td>Section 11: Spacehab/MPLM</td>
<td>DO5/Allen Burge</td>
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Table 2. Training Course Supervisors (Concluded)

**ISS Systems and Operations**
Section 12: Core Station Systems for STS Crew Training  DA7/Chris Zajac  
Section 13: Mobile Servicing System for STS Crew Training  DX2/*Paul Williamson*  
Section 14: Transfer Operations for Shuttle Crews  DO55/Matthew Villaverde

**Integrated Simulations**
Section 15: Integrated Simulations  DA7/Gail Barnett  
Addendum  DA7/*Peggy Levy*
SECTION 1.0 NEW ASTRONAUT TRAINING FLOW

The New Astronaut Training courses contain all required Orbiter Systems 20000-level training courses. It does not include 20000-level specialty instruction such as Rendezvous/Proximity Operations, PDRS, Spacehab, or Flight Specific Payload training. Assignments to these courses occur upon completion of the New Astronaut Flow or flight assignment.

The New Astronaut flow is an integrated flow containing lessons from all orbiter systems along with lessons given by the astronaut office and other MOD personnel. It is organized by tiers. The New Astronaut lesson flow chart, Figure 1-1, is read left to right. As the student progresses through the tiers, the difficulty and complexity of the lessons increase.

Tier 1: Introduction to Shuttle Systems
Tier 2: Orbiter Systems Overviews
Tier 3: Flight Operations
Tier 4: Malfunction Training
Tier 5: Advanced Systems Training
Tier 6: Interdisciplinary Malfunction Training
Tier 7: Qualification

Tier Tests

The Astronaut Candidate (ASCAN) will be tested throughout the New Astronaut Training flow. These tests are called Tier Tests. Listed in the New Astronaut flow are five Tier Tests. They are placed in the flow at the points where the tiers listed above conclude. The latter tiers do not have a tier test associated with them. The knowledge obtained in those tiers is tested in the Qualification Lessons.

The ASCANs could have more Tier Tests than listed in this flow. The tests may not necessarily fall at the conclusion of each Tier. From the beginning of the flow, they are scheduled on a monthly basis and will include the lessons completed up to that point since the last Tier Test.

The most important completion standard associated with Orbiter Systems Training is a measure of the student’s understanding of the system and its associated concepts, procedures, and hardware at a “big picture” level. Therefore, these qualification lessons will begin with guided discussions of selected items and, in some cases, without the use of FDF. It is important that the student focus on an overall understanding of the system rather than memorization of the FDF. These lessons are NOT a test of the students’
ability to memorize the FDF. In fact, because procedures are often modified or vary for different phases of flight, memorizing FDF is strongly discouraged.

The primary intent of all qualification lessons is to provide both the instructor and the student with positive feedback that the student is knowledgeable and prepared to begin assigned crew flight specific training. The instructor will use leading questions to help the student focus on the appropriate concepts. FDF will be reviewed in the lesson to tie together the basic concepts discussed in the class and the published procedures.

The following are examples of tasks you may be asked to perform without FDF:

- Configure the DAP to maneuver at a specified rate.
- Configure panel A1 for STDN, TDRS, and SGLS.
- Perform an OMS to RCS interconnect and interconnect return.

Remember that the instructor will provide you with “leads” in performing the task should you need them. We must also clarify that it is not our intention to train you to perform procedures without using FDF. It is imperative to use your checklist when performing tasks or troubleshooting problems onboard the orbiter.

The following are examples of tasks you may be asked to perform with FDF while explaining the major concepts associated with the procedure.

- Perform an IMU reference recovery.
- Perform Ku antenna stow.

You have reached the final tier of your ASCAN training and our intent is for you to recognize your achievements by reviewing the major concepts of orbiter systems through the qualification lessons.

**Lesson Description**

The Lesson Description sheet for each lesson contains very important information including a synopsis of the lesson and performance objectives. These objectives are to be met upon completion of the lesson. The prerequisites and preparation for each lesson are listed, also. Prerequisites are scheduled lessons that must be completed prior to taking the stated lesson. Preparation consists of material that must be read/reviewed prior to beginning that lesson. Preparation material usually consists of training manuals, briefings or Flight Data File. Computer Based Training (CBT) is often used for preparation of a class. Lists of self-study material for preparation and supplemental preparation are included on Table 1-3 and Table 1-4. Table 1-3 lists the lesson(s) associated with each required self study material. It summarizes the information found in the lesson descriptions. Table 1-4 lists the lessons that have supplemental preparation. This supplemental material information is not found in the lesson descriptions.
**Instructor Astronaut (IA) and Instructor Pilot (IP)**

Lessons will sometimes require an IA or IP to be present for the simulation. An IA is an astronaut who has completed new astronaut training previously and who will provide valuable insight into the lesson material. An IA may be either a Mission Specialist or a Pilot/Commander. An IP has the same function, but he or she must be a Pilot or a Commander.

**Flow Diagrams**

The Flow Diagrams depict the ideal way to schedule the lessons. However, classes may be scheduled out of the flow sequence as long as the prerequisite lessons listed in the lesson description are met.

**Non-ASCAN lessons**

The New Astronaut course does contain lessons that are only for non-ASCAN students. These lessons are noted as being Non-ASCAN lessons in Table 1-1 and in the lesson description. ASCANs receive training that has longer and more detailed briefings and higher fidelity trainers. If a non-ASCAN student takes a SST lesson, they typically receive a thirty minute prebrief that covers material that was presented in the ASCAN briefing and is needed prior to taking the SST lesson. Also, the non-ASCAN student might take a lesson in the SST versus a higher fidelity trainer. A non-ASCAN student is defined as an astronaut taking the lesson as a review or other students from MOD and other organizations.

**Training Requirements Summary Table**

The New Astronaut course has a training requirements summary table included as part of the course description material. This table is used to provide a summary of the training broken out by facility. The Crew Hours column is based on the hours per individual ASCAN. The Facility Hours column is the length of the class multiplied by the number of times that the class must be taught in the facility (limited by the maximum number of students that can take the class at once). The non-ASCAN lessons are not included in this table.
Figure 1–1. New Astronaut Lesson Flow Chart (1 of 5)
Figure 1-1. Continued (2 of 5)
Figure 1-1. Continued (3 of 5)
Figure 1-1. Concluded (5 of 5)
# Table 1-1. New Astronaut Crew Training Requirements

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**Date Last Modified:** 04/06
Table 1-1. New Astronaut Crew Training Requirements (Continued)

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Table 1-2. New Astronaut Training Requirements Summary

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Based on an ASCAN class of 20.
The non-ASCAN prebriefs are not included in these numbers.
*Facility Hours are not calculated for non-key facilities.
**SMS Facility Hours based on the lesson being taught seven times to account for a class of 20.
***SST Facility Hours based on the lesson being taught 10 times to account for a class of 20.
SELF STUDY MATERIAL LISTING

The attached listings will serve to document all self study materials such as training manuals, study guides, handbooks, and Computer Based Training (CBT) lessons. This material will be used during 20000-level training. Some self study material is required as part of lesson preparation or homework. Other material is supplemental to your training and should be considered additional or reference material.

The list (Table 1-3) is organized by the self study material code. For each self study material, the source, lesson(s) association, and an estimated number of hours required to complete the entire lesson are also displayed. Keep in mind some lessons only require a portion of the self study material to be completed. Read the lesson description for more information.

The list (Table 1-4) displays what supplemental self-study material is available for various lessons. Not all lessons have supplemental material. Table 1-4 is organized by Lesson Association.
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Table 1-3. New Astronaut Self Study Materials List (Concluded)

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</table>
New Astronaut Lesson Descriptions

1  **ORB SYS TRNG 21001**

Title:  Welcome to Orbiter Systems ASCAN Training Briefing  
Duration:  2.0 hours  
Medium:  Classroom  
Student:  ASCAN  
Source:  *DS24/DPS/Navigation Training Group*  
Date:  10/05  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  None  
Preparation:  None

Synopsis:  This briefing is designed to be an introduction to the ASCAN Orbiter Systems Training to be conducted and coordinated by the Mission Operations Directorate (MOD) Space Flight Training Division. The briefing will review the flow of lessons, the timetable for these lessons, as well as the tools/simulators that the ASCANs will be using throughout their training.

Objectives:  • Describe how the ASCAN Orbiter Systems Training will be conducted.  
• Identify whom to contact if questions/problems arise in the Orbiter Systems Training Flow.  
• Describe the use of the Crew Training Catalog.  
• Describe the “coding” system for lessons.  
• Describe the different facilities that will be used for Orbiter Systems Training.  
• Describe the ASCAN evaluation process.  
• Describe how Orbiter Systems Training flows into flight-specific training.

2  **ORB MECH OV 21001**

Title:  Orbital Mechanics Briefing  
Duration:  3.0 hours  
Medium:  Classroom  
Student:  ASCAN  
Source:  *DM34/Rendezvous Guidance, Procedures and Training*  
Date:  02/04  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  None  
Preparation:  None
New Astronaut Lesson Descriptions

2 ORB MECH OV 21001 (Concluded)

Synopsis: This lesson introduces the student to the terminology of orbital mechanics and provides basic descriptions of the relationships between different orbit characteristics. The lesson describes the effects of orbital maneuvering and provides some basic rules of thumb in this regard. The lesson presents the basic concepts of some orbital transfer maneuvers, emphasizing the utility of each type. The lesson also presents some of the concerns and constraints of orbital mission design. These restrictions include the location of a particular launch site as well as solar beta angle geometry. The lesson presents the basic concepts of launch window. The lesson explains the basic characteristics of orbital ground track. The lesson describes the two most significant orbit perturbations.

Objectives:
• Define the following:
  – Perigee
  – Apogee
  – Ascending/descending nodes
  – Line of apsides
  – Semimajor axis
  – Eccentricity
  – Inclination
  – Orbital period
  – Local vertical/local horizontal reference frame
  – Solar beta angle
• State the relationship between orbital altitude and orbital velocity.
• State the relationship between orbital velocity and apogee/perigee.
• State the effect on orbital velocity, altitude, and orbit orientation caused by posigrade, retrograde, radial in, and radial out orbital burns
• State the premise, restrictions, advantages, and required maneuvers of the following orbital transfers: Hohmann, plane change, and lambert-targeted.
• State the relationship between launch site latitude and achievable orbital inclinations.
• State the relationship between launch azimuth and payload-to-orbit performance.
• State the relationship between launch azimuth and safety concerns.
• Draw a rough sketch of a mission launch window.
• State how orbital motion is perturbed by atmospheric drag and the Earth’s oblateness.
New Astronaut Lesson Descriptions

3  SCOM OV 21001

<table>
<thead>
<tr>
<th>Title:</th>
<th>Shuttle Crew Operations Manual Overview Briefing</th>
</tr>
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<tbody>
<tr>
<td>Duration:</td>
<td>0.5 hours</td>
</tr>
<tr>
<td>Medium:</td>
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<tr>
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</tr>
<tr>
<td>Source:</td>
<td>DA72/Training Execution Branch and CB/Astronaut Office</td>
</tr>
<tr>
<td>Date:</td>
<td>03/95</td>
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<tr>
<td>Lesson(s) Replaced:</td>
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<tr>
<td>Equipment Required:</td>
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<tr>
<td>Prerequisite Lesson(s):</td>
<td>ORB SYS TRNG 21001</td>
</tr>
<tr>
<td>Preparation:</td>
<td>None</td>
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</tbody>
</table>

Synopsis: This lesson provides an introduction to the Shuttle Crew Operations Manual (SCOM). This briefing will review the general purpose of the SCOM, the type of information contained in the SCOM, how it is organized, who is responsible for its upkeep, and how this book will be used throughout ASCAN training.

Objectives:  
- Describe the general purpose of the SCOM.  
- Describe the general types of information contained in the SCOM.  
- State the book manager of the SCOM.

4  SHUTTLE OV 21001

<table>
<thead>
<tr>
<th>Title:</th>
<th>Shuttle Systems Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
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<tr>
<td>Medium:</td>
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<td>ASCAN, PS</td>
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<tr>
<td>Source:</td>
<td>DA72/Training Execution Branch</td>
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<tr>
<td>Date:</td>
<td>03/95</td>
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<tr>
<td>Lesson(s) Replaced:</td>
<td>None</td>
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<tr>
<td>Equipment Required:</td>
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<tr>
<td>Prerequisite Lesson(s):</td>
<td>SCOM OV 21001</td>
</tr>
<tr>
<td>Preparation:</td>
<td>Read:</td>
</tr>
<tr>
<td></td>
<td>• SCOM; Section 1.1, Overview</td>
</tr>
</tbody>
</table>

Synopsis: This lesson is designed to give the student a “big picture” introduction to the orbiter and some general concepts that the student will need to be familiar with before proceeding into more in-depth study of the shuttle systems. The lesson is divided into 3 parts:

- A review of the major shuttle systems – The overall purpose and location of each major shuttle system will be discussed.
New Astronaut Lesson Descriptions

4  **SHUTTLE OV 21001 (Concluded)**

- The concept of “fault-tolerance” and in particular as it pertains to the design of the orbiter.
- A review of some basic acronyms used in the Shuttle Program.

**Objectives:**
- Identify the main shuttle systems and state what their functions are on the orbiter.
- Identify the acronyms for each of the major shuttle systems.
- Explain the concept of “fault-tolerance” and fail operational/fail safe, especially as it pertains to the orbiter design.
- Label the X, Y, Z body axes on the orbiter.
- Define pitch, yaw and roll used on the shuttle to define an attitude.
- Define the terms “attitude” and “state vector.”
- Identify and define the following acronyms: Time of Ignition (TIG), CAPCOM, Line Replaceable Unit (LRU), Primary Avionics Software System (PASS), Backup Flight Software (BFS), MET, GMT, Center of Gravity (c.g.).

5  **CREW HAB 21001**

**Title:** Crew Habitability  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** ASCAN, PS  
**Source:** DX45/Crew Systems Group and CB/Astronaut Office  
**Date:** 08/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** SHUTTLE OV 21001  
**Preparation:** None  

**Synopsis:** This lesson consists of a classroom briefing and slide presentation on Intravehicular stowage, describing the various locations throughout the orbiter that are used to stow loose equipment including payload hardware.

All major stowage areas will be addressed including the flight deck, middeck, airlock, galley, Waste Collection System (WCS), and subfloor. Additionally, provisions for Wet/Dry trash and temporary stowage will be discussed.

**Objectives:**
- Describe the general configuration of the crew station (flightdeck, middeck).
- Demonstrate the ability to locate and describe all the stowage areas associated with the crew module.
INTRO FDF 21001

Title: Introduction to Flight Data File Briefing
Duration: 3.5 hours
Medium: Classroom
Student: ASCAN, PS
Source: DA72/Training Execution Branch
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SHUTTLE OV 21001
Preparation: Read:
• SCOM; Section 1, Location Codes
  Review:
• FDF 21057

Synopsis: This lesson is designed to introduce the student to the shuttle FDF and the panel location coding scheme. The lesson will review the four types of FDF, what they are used for, and when they are used. In addition, the lesson will review the standard FDF format and the nomenclature and symbology that is used. Finally, the lesson will review the differences between the CDR, PLT, and MS copies of the FDF and the differences between these copies and the published copies within Mission Operations Directorate (MOD).

Objectives:
• Identify what items are considered the complement of FDF.
• List the four different types of FDF.
• Identify where the following panels are located in the crewstation:
  – L1
  – 014
  – A1
  – ML86B
• Interpret sample FDF directions that use the standard FDF format, nomenclature, and symbology.
• Identify the general FDF configurations in the cockpit during ascent, orbit, and entry.
• Explain why some pieces of FDF are different between the CDR, PLT, and MSs during ascent and entry.
• Explain the differences between the FDF that is used for training and the bound copies that are actually flown.
New Astronaut Lesson Descriptions

7  STS PROG OV 21001

Title: Shuttle Program Overview
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: MA2/Space Shuttle Program Integration
Date: 03/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SHUTTLE OV 21001
Preparation: None

Synopsis: This lesson is designed to give the student an overview of how the Space Shuttle Program is managed and integrated. It will expose the student to the different NASA centers where the various space shuttle components are produced, managed, and/or integrated. The briefing will also introduce the student to the current issues facing the Space Shuttle Program.

Objectives:
• Identify the various Space Shuttle Program elements.
• Describe the strategic direction of the Space Shuttle Program.
• Describe the current issues facing the Space Shuttle Program.

8  ORB OPS OV 21001

Title: Orbit Operations Overview Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DA72/Training Execution Branch and CB/Astronaut Office
Date: 03/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ORB MECH OV 21001, SHUTTLE OV 21001
Preparation: None

Synopsis: The purpose of this lesson is to discuss some of the nominal operations that occur during the orbit phase of flight. The discussion will include operations pertaining to Post-Insertion, Orbit Ops, Deorbit Prep, as well as orbiter housekeeping and payload operations.

Objectives:
• Identify the three parts of orbit flight operations.
• Define the purpose of the post-insertion phase of flight.
• Discuss nominal post-insertion activities.
New Astronaut Lesson Descriptions

8  **ORB OPS OV 21001 (Concluded)**

- Discuss the various types of payload operations.
- Discuss orbiter housekeeping activities.
- Discuss Earth observation activities.
- Discuss items that will affect mission duration.
- Define the purpose of the Deorbit Prep phase of flight.
- Discuss nominal Deorbit Prep activities.

9  **CREW CAB FAM 21020**

Title:  Crew Cabin Familiarization (Shared – Shuttle)
Duration:  1.0 hour
Medium:  CCT, CCT II, or FFT
Student:  ASCAN, PS (Schedule in groups of 5.)
Source:  *DX45/Crew Systems Group*
Date:  08/04
Lesson(s) Replaced:  CREW CAB FAM 31019
Equipment Required:  None
Prerequisite Lesson(s):  CREW HAB 21001
Preparation:  Read:
  - LOC CODE 21002

Synopsis:  This lesson uses the Building 9A trainers to provide an orientation of the orbiter crew compartment. Emphasis is placed on sleeping accommodations, lockers, Waste Collection System (WCS), and galley.

Objectives:
- Describe the layout of the crew module.
- Identify and discuss major features of the middeck and flightdeck.

10  **ASC OV 21001**

Title:  Ascent Overview Briefing
Duration:  3.0 hours
Medium:  Classroom
Student:  ASCAN, PS
Source:  *DS66/G&C/Propulsion Training Group*
Date:  08/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  INTRO FDF 21001
Preparation:  Read:
  - SCOM;
    - Section 6.6, Abort to Orbit
    - Section 6.5, Abort Once Around (stop at Post MECO Transoceanic Abort Landing)
New Astronaut Lesson Descriptions

10  **ASC OV 21001 (Concluded)**

- Section 6.4, TAL (stop at Abort Dump)
- Section 6.3, Return-to-Launch Site (stop at Post-MECO Dumps)
- Section 6.7, Contingency Abort (stop at Powered Flight)
- Section 6.2, Ascent Aborts
- Section 2.7, Dedicated Display Systems (first paragraph only at Alpha Mach Indicator (AMI) and Altitude Vertical Velocity Indicator (AVVI))

Synopsis: This is an introductory lecture to familiarize astronauts with the types of ascent/abort trajectories the space shuttle is capable of flying. Major events and milestones of each trajectory are presented to promote the astronaut’s ability to monitor the ascent flight phase from the cockpit. The Ascent Checklist (C/L) and cockpit displays are introduced at a very basic level to provide insight on where critical cockpit information is located. This lesson prepares an astronaut to observe trajectory management operations at the SMS.

Objectives:
- State the 2 reasons for performing ascent aborts.
- List, in order of preference, based on performance, the major types of ascent aborts.
- State the purpose of the throttle bucket.
- List the major ascent events.
- Describe the profile for each type of ascent abort.

11  **ENT OV BR 21001**

Title: Entry Overview Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN, PS
Source: DS66/G&C/Propulsion Training Group
Date: 01/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
- SCOM; Section 5.4, Entry

Synopsis: This class covers the basics of turning a spaceship into a glider. The sequence of the major entry events will be presented. The class assumes no prior knowledge of aerodynamics or shuttle entry.
New Astronaut Lesson Descriptions

11  ENT OV BR 21001

Objectives:
- Put the major entry events in correct order given a list.
- State the purpose of the deorbit burn.
- Match the navigation sensor to the altitude where the sensor is first used during entry.
- Name the three guidance algorithms used on entry.
- State the event that causes the transition to the next guidance algorithm.
- Match each of the guidance algorithms to its primary control parameter.

12  TIER TEST 21001

Title: Tier Test
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS/Space Transportation Vehicle Division
Date: 03/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Determined closer to test time
Preparation: Review all lessons up to this time

Synopsis: The test will cover all orbiter systems lessons that have been complete up to this point. It is a graded, closed book test that will last for up to two hours. The questions will be: True/False, Multiple Choice, Short Answer Essay, Matching and Fill In the Blank. A review of the test will be scheduled for the entire class after all tests have been graded. If it is determined that a weakness exists in one subject area, proficiency training on this subject will be covered in the appropriate medium, briefing or facility. The best way to study for the test is to review the lesson objectives from the Crew Training Catalog and to review the handout material from the lessons.

Objectives:
- Emphasize, through questions, some of the most important concepts in the orbiter systems training so far.
- Identify any areas of weakness that may need to be reviewed with the student as an individual.
- Identify any areas of weakness that may need to be reviewed with the whole class.
New Astronaut Lesson Descriptions

13 A/E CL USE 21001

Title: Ascent/Entry Checklist Usage Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DA72/Training Execution Branch
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: ASC C/L, ENT C/L
Prerequisite Lesson(s): INTRO FDF 21001
Preparation: Review:
  • FDF 21057

Synopsis: This lesson is designed to be an introduction to the Ascent Checklist (C/L) and the Entry C/L. It is not intended to be a “line-by-line” review of the procedures but to provide a general overview of what is contained in these C/Ls, when they are used, and how they are used. The different physical configurations and cockpit locations of the C/Ls used by the CDR, PLT, and MS will be discussed as will the format and contents of each C/L.

Objectives:
• Identify the timeframes when the Ascent C/L and the Entry C/L are used.
• Identify what the differences are between the CDR and PLT copies of the Ascent and Entry C/Ls and what is contained in the MS copies of these C/Ls.
• Identify the differences between the Ascent C/L and Entry C/L printed for use as “ground copies” and the copies that fly on the orbiter.
• Explain why there are two different times noted in the prelaunch section in the Ascent C/L.
• Explain how the crew should perform the post-landing procedures in the Entry C/L (i.e., CDR pages versus PLT pages and pages should not be turned until all CDR and PLT procedures are complete).
• Given a sample page of the Ascent and Entry C/Ls, identify which crewmember should perform the procedures, what the CRT configuration should be, and what the procedure is asking the crewmember to do.
• Describe the basic page format (layout) of each C/L (i.e., CRT configuration at top of page, CRT changes called out in boxes, etc.).
New Astronaut Lesson Descriptions

14  **DPS HW 21057**

**Title:** Data Processing System Hardware  
**Duration:** 1.0 hour  
**Medium:** CBT  
**Student:** ASCAN, PS  
**Source:** *DS24/DPS/Navigate* Training Group  
**Date:** 03/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** PC  
**Prerequisite Lesson(s):** None  
**Preparation:** Read:
- SCOM; Section 2.6, DPS
  - Read the initial description.
  - Skim the Data Processing System Interfacing Hardware diagram.
  - Skim through the section’s topic titles and diagrams, especially the following figures:
    - Data Bus Network figure
    - GPC/MDM Interfaces figure
    - MEDS Architecture

**Synopsis:** The DPS Hardware lesson covers all of the major hardware components, such as the following, and their relationship to one another:
- The General Purpose Computers (GPCs)
- The Data Bus Network (DBN)
- Bus Terminal Units and Multiplexers/Demultiplexers (BTUs and MDMs)
- Modular Memory Units (MMUs)
- Multifunction Electronic Display System (MEDS)
- Backup Flight Controller (BFC)
- Master Timing Unit (MTU)

**Objectives:**
- Identify and describe the functions of the DPS components and explain their relationship to each other.
- For each of the major components of DPS hardware (GPCs, DBN, BTUs, MDMs, MMUs, MEDS, BFC, MTU):
  - Describe its purpose.
  - Name the different subcomponents and/or types.
  - Explain its relationship to other parts of the DPS.
- Define the utilities of MEDS.
New Astronaut Lesson Descriptions

15  SSSH 21001

Title: Space Shuttle Systems Handbook Schematics Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): INTRO FDF 21001
Preparation: None

Synopsis: This class will familiarize the trainee with the Space Shuttle Systems Handbook (SSSH). Initially, the trainee will be introduced to the Mission Operations Directorate (MOD) Drafting Standards document as a reference to use in interpreting symbols and nomenclature found in the SSSH. The class will then be familiarized with the breakdown of the SSSH by system/subsystem. Specific examples of symbology, nomenclature, and drawing format common to the drawings found in the SSSH will be presented and discussed.

Objectives:
- State the reference source for symbols and nomenclature for the SSSH.
- Locate a specified system or subsystem within the SSSH.
- Identify drawing notes.
- Interpret technical zone references.
- Identify layout of parallel and/or redundant components (shadowboxing).
- Identify the location of switches and other subsystem components.
- Identify and interpret electrical and mechanical symbols.
- Determine the source of electrical power for a specified subsystem.
- Identify circuit protection.
- Interpret telemetry symbols.
- Determine what data is displayed to the crew, and where it is displayed.

16  NAV OV BR 21001

Title: Navigation Overview Briefing
Duration: 1.5 hours
Medium: Classroom
Student: ASCAN
Source: DS24/DPS/Navigation Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
New Astronaut Lesson Descriptions

16 NAV OV BR 21001 (Concluded)

Prerequisite Lesson(s): ASC OV 21001, ENT OV BR 21001
Preparation: Skim:
- SCOM; Section 2.13, GNC, Description and Navigation Hardware

Synopsis: This briefing is an overview briefing of the space shuttle’s navigation systems. The M50 inertial coordinate system is defined at the beginning of the briefing. The Inertial Measurement Units (IMUs) are introduced and described. The state vector is introduced and it is shown how IMU data is used along with the gravity model to generate the state vector. Orbit navigation is then discussed. The reasons for IMU alignments and the applicable flight rules are explained. The location and the purpose of the Star Trackers, the Crew Optical Alignment System (COAS), and the Heads-Up Display (HUD) are then presented. Entry navigation is then discussed. The three state vector scheme and its purpose is introduced. The different entry navigation aids, when they are used, what data they provide and, in general, how they are used is discussed briefly. The last section of the briefing provides an overview of how Operational Sequence (OPS) is used on the shuttle.

It should be kept in mind that this is just an introductory briefing. It is intended to merely make the student aware of the sensors the orbiter has available and where and how they are used. This briefing is further broken down into individual sections and detailed in later briefings. It is in these detailed briefings that the student will learn how software uses the data, how faults are detected and how redundancy management works on subjects such as IMUs, Star Trackers, COAS, and all of the Entry Navigation sensors.

Objectives:
- Identify the purpose of navigation.
- Explain the purpose of the IMUs and how they work.
- Define what a state vector is and how it is calculated in ascent, entry, and orbit.
- Explain the purpose of the Star Trackers, the COAS, and the HUD for IMU alignment.
- Explain the purpose of Global Positioning System (GPS) as a navigation system.
- Explain the purpose of the 5 entry navigation sensors (Drag H, Tactical Air Navigation (TACAN), Air Data Transducer Assembly (ADTA), Microwave Landing System (MLS), Radar Altimeter (RA)) and when they are used.
New Astronaut Lesson Descriptions

17 **OMS OV 21001**

Title: Orbital Maneuvering System Overview Briefing  
Duration: 4.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: DS66/G&C/Propulsion Training Group and EP4/Propulsion Systems Branch  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ASC OV 21001, ORB OPS 21001, ENT OV BR 21001  
Preparation: Read:  
- SCOM;  
  - Section 1.1, Nominal Mission Profile, Orbit Insertion and Circularization and Deorbit sections only  
  - Section 1.2, OMS/RCS pods  
  - Section 2.18, OMS (omit Fault Detection and Identification)  

Synopsis: This briefing covers the nominal uses of the OMS in all phases of flight, provides an overview of the system hardware along with an introduction to the displays and controls associated with the OMS. Also discussed are the basic mechanics of an OMS burn and the OMS/Reaction Control System (RCS) interface. A detailed discussion of displays and controls and FDF procedures will be covered in the OMS review.  

Objectives:  
- Explain the purpose of the OMS.  
- Identify the subsystems of the OMS (OMS engines, nitrogen, etc.).  
- Explain the purposes of the subsystems.  
- Explain how the OMS is used during a nominal mission.  
- Identify OMS cockpit interfaces (switches, meters, displays).  
- Explain how vehicle flight control is achieved during an OMS burn.  
- Identify OMS/RCS interfaces.  
- State the basics of an OMS burn.  

18 **MB SAFETY BR 21003**

Title: Motion Base Simulator Safety Training  
Duration: 0.5 hours  
Medium: Video (Viewed via the computer.)  
Student: ASCAN, PS (Schedule individually.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 01/04  
Lesson(s) Replaced: None  
Equipment Required: None
New Astronaut Lesson Descriptions

18 MB SAFETY BR 21003 (Concluded)

Prerequisite Lesson(s): None
Preparation: None

Synopsis: This video provides the student with the required safety information necessary prior to motion operation in the motion base simulator.

Objectives:
• State the action required by all occupants before motion is activated in the motion base simulator.
• State the action required if communication between the crew station and instructor/operator station is lost.
• Describe the location of the Motion Inhibit pushbutton (or “Chicken Switch”) and state the conditions under which it should be used.
• Describe the notification procedure for violent motion excursions or other potentially unsafe conditions.

19 APPR/LNDG BR 21001

Title: Approach and Landing Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group and CB/Astronaut Office
Date: 01/04
Lesson(s) Replaced: APPR/LAND BR 21001
Equipment Required: None
Prerequisite Lesson(s): None

Note: Pilots must complete this lesson prior to any Shuttle Training Aircraft (STA) training. It may be taken out of sequence.

Preparation: Read (in this order):
• Flight Procedures Handbook; Approach, Landing, and Rollout
  – Section 4, pages 4-1 through 4-6
  – Section 5, pages 5-1 through 5-13
  – Section 4.8, page 4-41
  – Section 4.13, page 4-50
  – Section 2.11, pages 2-13 through 2-28 (should be a review)
  – Section 2.12, pages 2-29 through 2-35
  – Section 3, pages 3-4 through 3-12
  – Section 5, pages 5-34 through 5-37
• SCOM;
  – Section 5.4, Approach and Landing
  – Section 7.4, Heading Alignment Cone
Take:
• GNC DED DISP 21057 (optional)
• HUD 21057 (optional)
New Astronaut Lesson Descriptions

19  APPR/LNDG BR 21001 (Concluded)

Synopsis: This lesson is an introduction to shuttle landings (approach and land transition through rollout). The students will learn about the landing guidance, procedures, and protocol. A visual orientation to cockpit controls, flight instruments, and landing aids will be provided. The students will learn the techniques for landing the shuttle, meaning the flying characteristics and handling qualities. The briefing will include a “pilot's perspective” presented by a current astronaut.

Objectives:
• Identify the procedures used for landing.
• Describe the functions of the Space Shuttle Systems used for approach, landing, and rollout.
• Explain the purpose of the sub-phases of approach and landing guidance.
• Identify shuttle displays and external landing aids used for approach, landing, and rollout.
• Explain pilot techniques for approach, landing, and rollout.

20  DPS OV 21001

Title: Data Processing System Overview Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN, PS
Source: DS24/DPS/Navigation Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC OV 21001, DPS HW 21057, ENT OV BR 21001
Preparation: Read:
• SCOM; Section 2.6, DPS
  – Read the initial description.
  – Skim through the section’s topic titles and diagrams, especially the Orbiter Flight Computer Software figure and the Major Modes figure.

Synopsis: The DPS Overview Briefing covers the philosophy with which the orbiter computer system was created.

The briefing covers the basics of the orbiter’s software structure and finally a review of some nominal operations particularly corresponding to phases of flight.
New Astronaut Lesson Descriptions

20  DPS OV 21001 (Concluded)

Much of the material in this briefing will be repeated in subsequent CBT and SST lessons (through the DPS FAMs). Also, more of the details and off-nominal situations are then discussed. In this initial briefing the student should get a feel for the “big picture” of the DPS and become familiar with the General Purpose Computer (GPC) software and the nominal GPC configurations.

Objectives:
- State the requirements for and purpose of the orbiter’s DPS.
- Define the subdivisions of orbiter software (System Software, Application Software, Operational Sequence, and Major Mode).
- Define the specific GPC synchronization terms (Redundant Set, Common Set, Simplex).
- State the purpose of the Backup Flight Software (BFS).
- Define a string.
- Describe the nominal GPC configuration and DPS functions throughout each nominal flight phase.

21  OMS TGTING 21001

Title: Orbital Maneuvering System Targeting Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 01/04
Lesson(s) Replaced: None
Equipment Required: ASC C/L
Prerequisite Lesson(s): ASC OV 21001, OMS OV 21001, DPS OV 21001
Preparation: Review:
  - SCOM; Section 1.1, Nominal Mission Profile, Launch, Orbit Insertion and Circularization, and Deorbit only

Synopsis: This lesson instructs the student on the task of OMS Targeting for Insertion, Orbit and Deorbit burns. The lesson has 2 main parts. The first part covers definitions, explanations, and concepts used in OMS Targeting. The second part teaches the actual operations of OMS Targeting and focuses on the use of cockpit cues and available FDF.

Objectives:
- Define each item on the Maneuver Execute display and state its operational function.
- Explain how to use the Maneuver Execute Display to load targets for an orbit insertion, orbit transfer, and deorbit burn.
New Astronaut Lesson Descriptions

21  **OMS TGTING 21001 (Concluded)**

- Locate and define the function of the OMS-1/2 Targeting Card and the OMS Targets section in the Ascent Checklist.
- Perform OMS-1/2 targeting for a nominal OMS-2 direct insertion burn.

22  **CSI 21057**

**Title:** Crew Software Interface

**Duration:** 1.5 hours

**Medium:** CBT

**Student:** ASCAN, PS

**Source:** *DS24/DPS/Navigation Training Group*

**Date:** 02/04

**Lesson(s) Replaced:** CSI 21005

**Equipment Required:** None

**Prerequisite Lesson(s):** DPS OV 21001

**Preparation:** Read:
- CSI 21002; Part 1

**Synopsis:** This lesson provides an introduction to basic DPS operations. The lesson focuses primarily on the Primary Avionics Software System (PASS) operations, keyboard operations, and display specifications. PASS structure and General Purpose Computer (GPC) software configurations for flight phases are presented. Keyboard practice is accomplished with Operational Sequence (OPS) and major mode transitions, interaction with the onboard clocks, and DPS display reconfiguration.

**Objectives:**
- Describe the PASS software structure and GPC configuration for various flight phases.
- Define the term “unsupported major function.”
- Identify the function of the Integrated Display Processor (IDP) power, select, and major function switches.
- Identify the function of each key on the keyboard.
- Perform OPS and major mode transitions.
- Identify the standard format of DPS displays.
- State the significance of special indicators (M, H, L, ↑, ↓, *, ?) and page nomenclature.
- Perform item entries with implied item numbering and multiple entries strung together.
- Identify the source of ‘ERR’ and ‘ILLEGAL ENTRY’ messages.
- Explain Fault Summary format and demonstrate page clearing.
- Demonstrate SPEC and Display (DISP) retention.
- Perform onboard clock operations using SPEC 2.
New Astronaut Lesson Descriptions

23  EPS OV 21001

Title: Electrical Power System Overview Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
  • SCOM, Section 2.8, EPS

Synopsis: This lesson will cover the components and equipment that make up the EPS. The briefing will be divided into three subsystems: Power Reactants Storage and Distribution (PRSD), Fuel Cell Powerplants (FCP), and Electrical Power Distribution and Control (EPDC).

Objectives:
  • Identify the functions of the Cryo, Fuel Cell, and EPDC subsystems during all flight phases.
  • Identify the major components of each EPS subsystem.
  • Describe how the EPS subsystems interface with one another and with other systems.
  • Describe how a Remote Power Controller (RPC) operates.
  • Identify the power sources of the Main, Essential, Control, and AC buses, and what types of equipment they power.
  • Describe how the AC bus sensors function in the Off, Monitor, and Auto Trip switch positions.

24  APU/HYD OV 21001

Title: Auxiliary Power Unit/Hydraulic Overview Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
  • SCOM; Section 2.1, APU/HYD
New Astronaut Lesson Descriptions

24  APU/HYD OV 21001 (Concluded)

Synopsis: This lesson will cover the components, functions, and operations of the Auxiliary Power Unit (APU)/Hydraulic (Hyd) systems throughout a typical mission. It will also include time for viewing actual hardware and asking questions.

Objectives:  
- Identify the functions of the APU and Hyd subsystems during all flight phases.  
- Identify the major components of each APU/Hyd subsystem.  
- Describe how the APU/Hyd subsystems interface with one another.  
- Identify the APU/Hyd system interfaces with other orbiter systems.  
- Identify the main functions of the APU controller.  
- Identify which orbiter subsystems receive hydraulic pressure from the Hyd subsystem.

25  COMM OV 21001

Title: Communications Overview Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN, PS
Source: DS25/Communications/NSS Training Group and CB/Astronaut Office
Date: 01/04
Lesson(s) Replaced: COMM OV BR 21001, INST BR 21001
Equipment Required: None
Prerequisite Lesson(s): DPS OV 21001
Preparation: Read: SCOM
  - Section 2.4, Communications
  - Section 2.3, CCTV

Synopsis: The purpose of this lesson is to introduce the student to the space shuttle and network communications system. Each communication system will be covered, along with a brief statement of its function, purpose, and relationship to other communication subsystems. The voice, command, and telemetry flow between mission control and the shuttle will be described, along with the space communication network that supports this information transfer. Finally, the communications and network system as it relates to the phases of flight will be discussed.

Objectives:  
- State the functions of each of the following communication systems:  
  - Voice  
  - Data  
  - Commanding  
  - Closed Circuit TV
COMM OV 21001 (Concluded)

- Discuss the functions of:
  - Crew Communications Umbilical (CCU)
  - Audio Terminal Unit (ATU)
  - Audio Central Control Unit (ACCU)
- Discuss functions of the Network Signal Processor (NSP).
- Identify the five orbiter Radio Frequency (RF) communications systems and their uses.
- Discuss the capabilities and limitations of the Satellite and Ground Networks.
- State the function of the instrumentation system.
- Discuss the function of the Pulse Code Modulation Master Unit (PCMMU).
- Discuss the function of the Communications Security (COMSEC) system.
- Discuss the function of the Ground Command/Control Interface Logic (GCIL) system.
- Identify the three types of information that are transferred between the orbiter and the MCC.
- Discuss how each of the five communication systems is used during each phase of flight.

ORB FDF USE 21001

Title: Orbit Flight Data File Usage Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DA72/Training Execution Branch
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: PI C/L, D/O PREP C/L, FLT PLN, ORB OPS C/L, REF DATA, DPS Dictionary
Prerequisite Lesson(s): A/E C/L USE 21001
Preparation: Review:
  - FDF 21057

Synopsis: This lesson is designed to provide an introduction to the Post-Insertion Checklist (C/L), De-Orbit (D/O) Prep C/L, and Flight Plan, ORB OPS C/L, DPS Dictionary, and Ref Data.

The lesson will also review when the C/Ls are used, how they are formatted, and the information contained in each. In addition, a short review of the Systems Data Book and Maps Book will be performed.
New Astronaut Lesson Descriptions

26 ORB FDF USE 21001 (Concluded)

Objectives:

- Explain when the Post-Insertion C/L, D/O Prep, and Flight Plan are used.
- Explain when the transitions occur between the three C/Ls.
- Explain how the time is referenced for the three C/Ls (i.e., MET, TIG XX).
- Given a specific time (MET), use the Flight Plan to identify:
  - Flight day number
  - Orbit number
  - CDR and MS2 activities
  - Day or night cycle
  - Tracking and Data Relay Satellite (TDRS) coverage
  - Easy activities block (EZ ACTIVITIES)
  - Orbiter attitude
  - Earth trace
- Explain when the Deorbit Prep Backout procedures are used.
- Explain how the Switch List section of the Post-Insertion and Deorbit Prep should be used (Post-Insertion: look at only boxed switches, D/O Prep: look at ALL switches).
- Explain when the Orbit Ops C/L, Ref Data, and the DPS Dictionary might be used, and the type of information contained in each (i.e., procedures, reference material for bus losses, CRT displays, etc.).

27 DPS 21006

Title: Data Processing System
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule individually.)
Source: DS24/DPS/Navigation Training Group
Date: 04/06
Lesson(s) Replaced: DPS 21005, DPS OPS 22006, DPS OPS 21006
Equipment Required: None
Prerequisite Lesson(s): CSI 21057
Note: This lesson should be scheduled no later than 2 weeks after completing CSI 21057.
Preparation: Read:
- DPS OV 21002; Sections 1-5
Review:
- CSI 21057
New Astronaut Lesson Descriptions

DPS 21006 (Continued)

Synopsis: This lesson provides a review of the DPS software and an introduction to DPS hardware, controls, displays, and concepts. It familiarizes the student with General Purpose Computer (GPC) upper and lower memory, Memory Configurations (MCs), and GPC synchronization. The student is introduced to the function and operation of the GPC switches and talkbacks and performs an Initial Program Load (IPL) of a GPC. The student is also introduced to Multifunction Electronic Display System (MEDS) Hardware including the use of the Multifunction Display Unit (MDU) Edge Keys. The student is introduced to the concept of strings and performs restrings using the Nominal Bus Assignment Table (NBAT). The student performs Operational Sequence (OPS) transitions and a GPC Freeze Dry. The lesson familiarizes the student with the use of the DPS displays: GPC MEMORY, DPS UTILITY, TIME, and GPC/BUS STATUS. The lesson concludes with a demonstration of troubleshooting a basic DPS malfunction and recovery via port moding.

Objectives:

- Define the following terms:
  - Memory configurations
  - GPC upper and lower memory
  - Common set
  - Redundant set
  - Line Replacement Unit (LRU)
  - Bus Terminal Unit (BTU)
  - Multiplexer/Demultiplexer (MDM)
  - Flight-critical data bus
  - Strings
  - GPC commander
  - GPC listener

- Identify the locations and functions of the GPC controls (power, mode, output, IPL Source Select, IPL pushbutton) on Panel O6, and describe their operation and talkback indications.

- State the purpose of an IPL.

- Describe the actions to perform a default option IPL.

- State the purpose of the NBAT.

- Describe the actions necessary to perform Guidance, Navigation, and Control (GNC) and Systems Management (SM) OPS transitions.

- Define the term “GPC Freeze Dry,” and describe the actions to perform one.

- Describe how the GPCs keep time using the Master Timing Unit (MTU).

- Explain the purpose of a restring, and the necessary actions to perform one.
New Astronaut Lesson Descriptions

27  **DPS 21006 (Concluded)**

- State the purpose of the GPC/BUS STATUS display; state the meaning of the status indicators (*, blank, ↓, *↓) on the display.
- State the purpose of port modes and describe the necessary actions to perform one.
- Observe the signature of an MDM port failure and recover it via a port mode.

28  **OMS OPS BR 21001**

**Title:** Orbital Maneuvering System Operations Review  
**Duration:** 2.0 hours  
**Medium:** Classroom  
**Student:** ASCAN (Schedule in groups of up to 15.)  
**Source:** *DS66/G&C/Propulsion Training Group*  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** ASC C/L, ORB OPS C/L, ENT C/L  
**Prerequisite Lesson(s):** OMS OV 21001  
**Preparation:** Review:  
  - SCOM; Section 2.18, OMS, Description through TVC  
Read:  
  - SCOM; Section 2.18, OMS, Fault Detection and Identification through OMS Summary Data  
  - OMS 21002; Sections 1-3 (pay particular attention to the MNVR EXEC display and GNC SYS SUMM 2 display)

**Synopsis:** This lesson will prepare the student for OMS OPS 21006 by reviewing material that was covered in OMS OV 21001 and by introducing material that will be covered in OMS OPS 21006. This lesson will discuss the flow of the FDF as it pertains to OMS procedures.

**Objectives:**  
- Explain the flow of the FDF and the rationale for nominal OMS burn procedures.  
- List the five requirements for an OMS burn.  
- Explain the three operational considerations for interconnects and crossfeeds.  
- Explain the steps and rationale for the FDF procedure for the OMS to Reaction Control System (RCS) interconnect and OMS crossfeed.
New Astronaut Lesson Descriptions

29  **RCS OV 21001**
Title: Reaction Control System Overview Briefing  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: *DS66/G&C/Propulsion Training Group* and EP4/Propulsion Systems Branch  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ASC OV 21001, ORB OPS OV 21001, ENT OV 21001  
Preparation: Read:  
• SCOM; Section 2.23, RCS  
Synopsis: The purpose of the briefing is to describe the purpose of the Reaction Control System (RCS), and its nominal and off-nominal uses in all phases of flight, provide a general physical description of the system, discuss how propellant quantity is calculated, relate the RCS to the OMS, EPS, and DPS, and provide an overview of the displays and controls relating to the RCS. The briefing will also discuss software jet Redundancy Management (RM) and how it relates to the RCS.  
Objectives:  
• State the purpose of the RCS.  
• Identify the subsystems of the RCS.  
• Explain the purpose of each RCS subsystem.  
• State the purpose of RCS Jet Redundancy Management (RM).  
• State the nominal and off-nominal use of the RCS.  
• Identify the displays and controls associated with the RCS.

30  **C&W OV 21001**
Title: Caution and Warning Overview Briefing  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN, PS  
Source: *DS45/Shuttle Systems Training Group*  
Date: 04/06  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CSI 21057  
Preparation: Read:  
• SCOM; Section 2.2, Caution & Warning
New Astronaut Lesson Descriptions

30 C&W OV 21001 (Concluded)

Synopsis: This lesson will cover the major purpose of the Caution & Warning (C&W) system and the crew response to alarms, aural and visual annunciation and crew interfaces associated with each of the following alarm classes:

- Emergency: Smoke Detection and Fire Suppression
- Emergency: Rapid Cabin Depressurization
- Primary Caution and Warning
- Backup Caution and Warning
- Alert
- Limit Sensing

Objectives:

- List the four alarm classes within the C&W system.
- List the two subsystems that Class 1 C&W monitors.
- Describe the Class 1 alarm annunciation (aural and visual cues) for the fire and smoke subsystem.
- Describe the Class 1 alarm annunciation (aural and visual cues) for the dP/dT subsystem.
- Explain the differences between the Primary C&W System and the Backup C&W System.
- Describe the aural and visual cues for a Primary C&W alarm annunciation.
- Describe the aural and visual cues for a Backup C&W alarm annunciation.
- Explain which C&W systems the crew can interface with and how they accomplish this.
- Describe which C&W systems MCC can interface with and how they accomplish this.
- Describe the aural and visual cues for a Class 3 C&W alarm annunciation.
- Define preconditioning for Class 3 C&W.

31 COMM/IN OPS BR 21001

Title: Communication/Instrumentation Operations Review
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN, PS
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: COM/IN OPS 21001, COM/IN OPS 22001
Equipment Required: None
Prerequisite Lesson(s): COMM OV 21001
New Astronaut Lesson Descriptions

31  **COMM/IN OPS BR 21001 (Concluded)**

Preparation: Read:
- S-BD COM/IN 21002; Section 7, S-Band GMM/INST Operations Review
- SCOM; Section 2.4, for additional information on S-Band Phase Modulation (PM), S-Band Frequency Modulation (FM), Instrumentation, and the Audio Distribution System

Take:
- COMM OV 21057
- INST 21057

Synopsis: This briefing consists of an overview of the Communications and Operational Instrumentation systems with an introduction to the nominal procedures and signatures associated with all phases of flight.

Objectives:
- Describe orbiter S-Band PM two-way voice communications with MCC.
- Describe orbiter S-Band PM commanding from MCC to the orbiter.
- Describe orbiter S-Band PM and FM telemetry to MCC.
- Describe basic function and location of orbiter S-Band PM/FM Line Replacement Units (LRUs), displays and controls.
- Describe orbiter S-Band PM/FM system redundancy.
- Describe orbiter S-Band PM/FM site/Tracking and Data Relay Satellite (TDRS) coverage per flight phase.
- Recognize S-Band PM/FM FDF procedures.
- List available S-Band PM/FM displays.
- Describe basic function and location of Operational Instrumentation (OI) LRUs, displays and controls.
- Recognize OI procedures in appropriate FDF.

32  **AUDIO BR 21001**

Title: Audio Operations Briefing
Duration: 1.5 hours
Medium: Classroom

**Note:** Schedule in the Bldg 9A suit room.

Student: ASCAN, PS (Schedule in groups of up to 4.)

**Source:** DS25/Communications/NSS Training Group

Date: 01/04

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): COMM OV 21001
New Astronaut Lesson Descriptions

32 AUDIO BR 21001 (Concluded)

Preparation: Read:
- SCOM; Section 2.4, Communications, Audio Distribution System
- AUD/UHF 21002; Sections 1 and 2
  - Answer questions after Sections 2 and 3.

Synopsis: The intent of this lesson is to introduce the student to the orbiter Audio Distribution System (ADS) and its operation. In addition, the student will be introduced to the loose communications gear used as end items with the ADS.

Objectives:
- Explain the relationship of the orbiter ADS to the voice communications between the orbiter and the MCC.
- Explain the relationship of the orbiter ADS and voice intercommunications in the orbiter.
- Explain the relationship of the orbiter ADS and the Caution and Warning (C&W) system.
- Identify the function of individual loose communications gear.

33A AUDIO 21001

Title: Audio Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
- SCOM; Section 2.4, Communications, Audio Distribution System
- AUD/UHF 21002
  - Answer questions after Sections 2 and 3.

Note: This lesson replaces the AUDIO BR 21001 lesson for non-ASCAN students.

Synopsis: The intent of this lesson is to introduce the student to the orbiter Audio Distribution System (ADS) and its operation. In addition, the student will be introduced to the loose communications gear used as end items with the ADS.
New Astronaut Lesson Descriptions

33A AUDIO 21001 (Concluded)

Objectives:
- Explain the relationship of the orbiter ADS to the voice communications between the orbiter and the MCC.
- Explain the relationship of the orbiter ADS and voice intercommunications in the orbiter.
- Explain the relationship of the orbiter ADS and the Caution and Warning (C&W) system.
- Identify the function of individual loose communications gear.

33B AUDIO 21020

Title: Audio Operations
Duration: 1.5 hours
Medium: CCT/FFT
Student: ASCAN, PS (Schedule in groups of up to 4.)
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): AUDIO BR 21001
Preparation: None

Synopsis: This lesson is a hands-on training exercise utilizing a fully operational, flight configured orbiter prototype audio system installed in the CCT or FFT. Very Lightweight Headsets (VLHSs) handheld microphones, and Battery Powered Speaker Microphone Units (BPSMU) are used to demonstrate interfaces and operational capabilities. This class will also demonstrate the operation of the orbiter audio system to communicate with MCC, EVA crew members, and International Space Station (ISS). Also included in this lesson is the familiarization with the Ultrahigh Frequency (UHF) system operation relative to Air-to-Ground (A/G) and Air-to-Air (A/A) connections to the orbiter audio system made on panel A1R.

Objectives:
- Operate the orbiter audio system from a single audio crew station using a VLHS, handheld microphone/speaker, and BPSMU.
- Operate the orbiter audio system to communicate with EVA crewmembers and to the ISS.
New Astronaut Lesson Descriptions

33C AUDIO 21006
Title: Audio Operations
Duration: 1.0 hour
Medium: SST
Student: Non-ASCAN
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): AUDIO 21001
Preparation: None
Note: This lesson replaces the AUDIO 21020 lesson for non-ASCAN students.

Synopsis: This lesson is a hands-on training exercise utilizing an operational, flight configured orbiter prototype audio system installed in the SST. Very Lightweight Headsets (VLHSs) and handheld microphones will be used to demonstrate interfaces and operational capabilities. Both normal and backup configurations are covered. Also included is familiarization with the UHF system operations.

Objectives:
• Operate the orbiter audio system from a single audio crew station using a VLHS and/or handheld microphone/speaker during various phases of flight.
• Configure the orbiter audio system to communicate with MCC and other crewmembers.

34A OMS OPS 21001
Title: Orbital Maneuvering System Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: ASC C/L, ORB OPS C/L, ENT C/L
Prerequisite Lesson(s): None
New Astronaut Lesson Descriptions

34A  **OMS OPS 21001 (Concluded)**

**Preparation:** 
Review:  
- SCOM; Section 2.18, OMS, Description through TVC  

Read:  
- SCOM; Section 2.18, OMS, Fault Detection and Identification through OMS Summary Data  
- OMS 21002; Sections 1-3 (pay particular attention to the MNVR EXEC display and GNC SYS SUMM 2 display)

**Note:** This lesson replaces the OMS OPS BR 21001 lesson for non-ASCAN students.

**Synopsis:** This lesson will prepare the student for OMS OPS 21006 by reviewing material that was covered in OMS OV 21001 and by introducing material that will be covered in OMS OPS 21006. This lesson will discuss the flow of the FDF as it pertains to OMS procedures.

**Objectives:**  
- Explain the flow of the FDF and the rationale for nominal OMS burn procedures.  
- List the five requirements for an OMS burn.  
- Explain the three operational considerations for interconnects and crossfeeds.  
- Explain the steps and rationale for the FDF procedure for the OMS to Reaction Control System (RCS) interconnect and OMS crossfeed.

34B  **OMS OPS 21006**

**Title:** Orbital Maneuvering System Operations  
**Duration:** 2.0 hours  
**Medium:** SST 1 or SST 2 or SST 3  
**Student:** ASCAN (Schedule in pairs.)  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 04/06  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** OMS OPS BR 21001, CSI 21057, DPS 21006  

**Preparation:** Review:  
- OMS OPS BR 21001 handouts

**Synopsis:** Using the FDF, the student will perform all the nominal procedures associated with the OMS, starting at Main Engine Cutoff (MECO) and ending with the post landing procedures. Throughout the lesson, the student will be required to state the purpose of each procedure and the rationale of the major steps as the procedure is performed.
New Astronaut Lesson Descriptions

34B  **OMS OPS 21006 (Concluded)**

Objectives:
- Know the uses of the OMS, the function of OMS switches, and how to monitor critical system temperatures and pressures.
- Match the schematic diagram in the FDF to panel switches, meters, and DPS displays.
- Describe how the parts of the OMS interact to execute an OMS burn.
- Execute and monitor OMS burns using the appropriate FDF as a reference.
- Verify that the proper targets are loaded.
- Configure the switches for the OMS burns.
- Monitor the vital OMS parameters during the burn.
- Describe the use of the burn monitor card.
- Explain the effect of the burn on the vehicle orbit.
- Perform an OMS crossfeed.
- Configure the switches for a crossfeed using the appropriate FDF.
- Explain the difference between a crossfeed performed preburn and a “hot” crossfeed performed during an OMS burn.
- Set up an OMS-to-Reaction Control System (RCS) interconnect.
- Configure the switches for an interconnect using the appropriate FDF.
- Determine the OMS quantity during an interconnect.

35  **RCS OPS BR 21001**

Title: Reaction Control System Operations Review  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN (Schedule in groups of about 15.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): RCS OV 21001  
Preparation: Review:
- SCOM; Section 2.23
  - RCS – Propellant System
  - RCS Redundancy Management and Operations

Take:
- RCS RM 21057
New Astronaut Lesson Descriptions

35 **RCS OPS BR 21001 (Concluded)**

Synopsis: This briefing prepares the student for the lesson RCS OPS 21006, which exercises nominal Reaction Control System (RCS) operations in the SST. This briefing begins with a review of RCS OV 21001, highlighting the various hardware and software interfaces for the RCS. The briefing then presents the major nominal procedures associated with the RCS and discusses the rationale behind those procedures.

Objectives:
- Explain the rationale behind the RCS switch configuration for ascent, orbit, and entry.
- Explain the function of the RCS during:
  - Forward window protection
  - Mated coast
  - External Tank (ET) separation
- State the points during a nominal entry when the RCS jets are phased out and replaced by aerosurfaces.
- Explain the mechanics of performing and the rationale behind the following RCS-related procedures:
  - ET PHOTO MANEUVER
  - TAIL ONLY CONTROL
  - CONFIGURE VERNIER CONTROL
  - XFEED: R(L) RCS to L(R) RCS
  - RCS REGULATOR RECONFIG
  - ON-ORBIT MULTI AXIS RCS BURN
  - RCS HOT FIRE TEST
  - FORWARD RCS DUMP
  - RCS, OMS SAFING (RJDs)
  - RCS, OMS VALVE TEST

36 **ENG REF OV 21001**

Title: Introduction to Engineering Reference Material
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN
Source: *DS66/G&C/Propulsion Training Group*
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
New Astronaut Lesson Descriptions

36  **ENG REF OV 21001 (Concluded)**

**Synopsis:** This lesson presents the student with the engineering reference documents most commonly used in shuttle training. These reference documents provide invaluable information concerning space shuttle performance data, orbiter subsystem data, and mission operations data. The three types of documents that are addressed during this briefing are orbiter/STS operations, flight software, and mission operations. In addition, the student will be told where these documents can be found, who owns these documents, and how these documents are revised.

**Objectives:**
- Identify the five most commonly used engineering reference documents used in shuttle training.
- Describe briefly what each document contains.
- Identify where to find each of these documents.
- Identify who owns each of these documents.
- Describe how these documents are revised.

37  **FLIGHT RULES 21001**

**Title:**  Flight Rules Overview Briefing
**Duration:**  2.0 hours
**Medium:**  Classroom
**Student:**  ASCAN
**Source:**  DA8/Flight Director Office
**Date:**  02/04
**Lesson(s) Replaced:**  None
**Equipment Required:**  None
**Prerequisite Lesson(s):**  ENG REF OV 21001
**Preparation:**  None

**Synopsis:** This lesson is designed to be an introduction to the STS Operational Flight Rules book. This briefing will discuss the following topics: book organization, major types of topics in the book, how to read a Go/No-Go Criteria table, and the flight rule change approval process. Additionally, key flight determination terms will be defined.

**Objectives:**
- Describe the overall organization of the Flight Rules Book.
- Describe the purpose of the Flight Rules Book.
- Describe the major types of topics discussed in the Flight Rules Book.
- Define the following terms:
  - First Day Primary Landing Site (PLS)
  - PLS
  - Minimum Duration Flight (MDF)
  - Emergency Landing Site (ELS)
New Astronaut Lesson Descriptions

37  **FLIGHT RULES 21001 (Concluded)**

- Given a failure scenario, determine the mission impact using a Go/No-Go Criteria table.
- Discuss the flight rule change approval process.

38  **FDF 21020**

**Title:** Flight Data File  
**Duration:** 1.0 hour  
**Medium:** CCT, CCT II, or FFT  
**Note:** Schedule suit room in Bldg. 9.
**Student:** ASCAN (Schedule in groups of up to 4.)  
**Source:** DX45/Crew Systems Group  
**Date:** 08/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** None
**Prerequisite Lesson(s):** ORB FDF USE 21001  
**Preparation:** None

**Synopsis:** This lesson is designed to familiarize the student with the onboard complement of flight-like FDF. A brief overview of Post-Insertion, Flight Plans, and other FDF documents will be given. Emphasis will be placed on the FDF locations when unstowed/installed and stowed.

**Objectives:**
- Identify the types of FDF flown.
- Discuss the ascent locations and stowage of the FDF.

39  **C&W OPS 21004**

**Title:** Caution and Warning Operations  
**Duration:** 1.5 hours  
**Medium:** SST 2 or SST 1 or SST 3  
**Student:** ASCAN, PS (Schedule in pairs.)  
**Source:** DS45/Shuttle Systems Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** None
**Prerequisite Lesson(s):** C&W OV 21001  
**Preparation:** Read:

- C&W 21002
New Astronaut Lesson Descriptions

39 C&W OPS 21004 (Concluded)

Synopsis: This lesson will present an overview of the Caution and Warning (C&W) system, a description of related panels, displays, and controls, and crew procedures used to operate and interface with the C&W system. The student will also be required to perform certain nominal and off-nominal procedures using the related FDF while explaining the rationale of each step.

Objectives:
- Perform the steps involved in executing certain nominal C&W procedures.
- Identify C&W parameters on the Systems Management (SM) display SPEC 60.
- Locate C&W switches and circuit breakers located on the following panels: C3, R13U.
- Explain the rationale for performing each of the nominal C&W procedures.
- Recognize tones and annunciator lights associated with alarm classes.
- Use the C&W section of Ref Data with panel R13 and SPEC 60 to manipulate hardware and software C&W limits.
- Execute the procedures for extinguishing an avionics bay fire as listed on the Fire/Smoke cue card.

40A COMM/IN OPS 21001

Title: Communication/Instrumentation Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
- S-BD COM/IN 21002; Section 7, S-Band GMM/INST Operations Review
- SCOM; Section 2.4, for additional information on S-Band Phase Modulation (PM), S-Band Frequency Modulation (FM), Instrumentation, and the Audio Distribution System
Preparation: Take:
- COMM OV 21057
- INST 21057

Note: This lesson replaces the AUDIO BR 21001 lesson for non-ASCAN students.
New Astronaut Lesson Descriptions

40A  COMM/IN OPS 21001 (Concluded)

Synopsis: This briefing consists of an overview of the Communications and Operational Instrumentation systems with an introduction to the nominal procedures and signatures associated with all phases of flight.

Objectives:
- Describe orbiter S-Band PM two-way voice communications with MCC.
- Describe orbiter S-Band PM commanding from MCC to the orbiter.
- Describe orbiter S-Band PM and FM telemetry to MCC.
- Describe basic function and location of orbiter S-Band PM/FM Line Replacement Units (LRUs), displays and controls.
- Describe orbiter S-Band PM/FM system redundancy.
- Describe orbiter S-Band PM/FM site/Tracking and Data Relay Satellite (TDRS) coverage per flight phase.
- Recognize S-Band PM/FM FDF procedures.
- List available S-Band PM/FM displays.
- Describe basic function and location of Operational Instrumentation (OI) LRUs, displays and controls.
- Recognize OI procedures in appropriate FDF.

40B  COMM/IN OPS 21006

Title: Communications/Instrumentation Operations SST Lesson
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN, PS (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: COM/IN OPS 22006, COM/IN OPS 21006A
Equipment Required: None
Prerequisite Lesson(s): COMM/IN OPS BR 21001
Preparation: Take:
- COMM SPEC 21057; Segments 1 and 2

Synopsis: This lesson demonstrates the operation, configuration, and redundancy of the S-band Phase Modulation (PM)/Frequency Modulation (FM) and Operational Instrumentation (OI) subsystems. Emphasis is placed on nominal signature recognition, comm coverage, and MCC operation of the subsystem. Students will periodically explain comm configuration and status during the lesson using the displays and controls.

Objectives:
- Describe S-band audio distribution system interface.
- Configure S-band PM/FM subsystems for all phases of flight, including internal versus panel configuration using Ground Command/Control Interface Logic (GCIL) panel/command switches.
New Astronaut Lesson Descriptions

40B  COMM/IN OPS 21006 (Concluded)

• Recognize nominal S-band PM/FM display signatures for all phases of flight.
• Explain S-band PM Stored Program Commands (SPCs) and their effects on the system.
• Describe S-band PM comm coverage for all phases of flight.
• Configure OI subsystems for all phases of flight.
• Perform and explain Telemetry Format Loads (TFLs) using Post Insertion and Orbit Ops checklists.
• Recognize nominal OI display signatures.

41A  RCS OPS 21001

Title: Reaction Control System Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Review:
  • SCOM; Section 2.23
    – RCS – Propellant System
    – RCS Redundancy Management and Operations
Take:
  • RCS RM 21057

Note: This lesson replaces the RCS OPS BR 21001 lesson for non-ASCAN students.

Synopsis: This briefing prepares the student for the lesson RCS OPS 21006, which exercises nominal Reaction Control System (RCS) operations in the SST. This briefing begins with a review of RCS OV 21001, highlighting the various hardware and software interfaces for the RCS. The briefing then presents the major nominal procedures associated with the RCS and discusses the rationale behind those procedures.

Objectives:
• Explain the rationale behind the RCS switch configuration for ascent, orbit, and entry.
• Explain the function of the RCS during:
  – Forward window protection
  – Mated coast
  – External Tank (ET) separation
41A  **RCS OPS 21001 (Concluded)**

- State the points during a nominal entry when the RCS jets are phased out and replaced by aerosurfaces.
- Explain the mechanics of performing and the rationale behind the following RCS-related procedures:
  - ET PHOTO MANEUVER
  - TAIL ONLY CONTROL
  - CONFIGURE VERNIER CONTROL
  - XFEED: R(L) RCS to L(R) RCS
  - RCS REGULATOR RECONFIG
  - ON-ORBIT MULTI AXIS RCS BURN
  - RCS HOT FIRE TEST
  - FORWARD RCS DUMP
  - RCS, OMS SAFING (RJDs)
  - RCS, OMS VALVE TEST

41B  **RCS OPS 21006**

**Title:** Reaction Control System Operations  
**Duration:** 2.0 hours  
**Medium:** SST 1 or SST 2 or SST 3  
**Student:** ASCAN (Schedule in pairs.)  
**Source:** DS66/G&C/Propulsion *Training Group*  
**Date:** 04/06  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** RCS OPS BR 21001, CSI 21057, DPS 21006  
**Preparation:** Review:
  - FDF; Nominal RCS procedures
  - DPS Dictionary; SPEC 23 operation and uses

**Synopsis:**  
The lesson is designed to concentrate on the basic Reaction Control System (RCS) operational procedures that are performed during a typical mission. The main emphasis of the class is on FDF procedures, DPS displays, and proper switch throws. Flight rules and engineering/design aspects of the RCS are not stressed. This lesson begins with a review of the controls and displays in the flight deck. The class continues with switch position rationale and a discussion of operations and procedures for RCS during Ascent, Orbit, Deorbit Preparation and Entry.

**Objectives:**
- Perform the nominal RCS operational procedures during all phases of flight.
- Configure the RCS switches and valves through the ascent, orbit, and entry phases of flight.
New Astronaut Lesson Descriptions

41B  **RCS OPS 21006 (Concluded)**

- Explain the impacts that helium leaks and prolonged jet firings have on the RCS gauging system.
- Use the RCS-related displays and controls to deselect/reselect jets, alter jet firing priorities, and reset jet Redundancy Management (RM).

42A  **DPS FAM 21001**

**Title:** Data Processing System Familiarization 1 Prebrief
**Duration:** 0.5 hours
**Medium:** Classroom
**Student:** ASCAN, PS (Schedule in pairs.)
**Source:** DS24/DPS/Navigation Training Group
**Date:** 04/06
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** DPS 21006

**Note:** This lesson should be scheduled no later than 3 weeks after completing DPS 21006.

**Preparation:** Read:
- DPS FAM 21002

**Synopsis:** This prebrief will start with an overview of the DPS Familiarization (FAM) lessons. The student should have a good understanding of Initial Program Loads (IPLs), Operational Sequence (OPS) transitions, and strings. This lesson will emphasize certain DPS SPECs and the use of the Nominal Bus Assignment Table (NBAT). The information in this prebrief should be a review of DPS 21006. The instructor will show the location and briefly describe the DPS switches. The Backup Flight System (BFS) is then briefly described, including the role of the BFS, BFS tracking, and BFS engage.

**Objectives:**
- Explain the purpose of an IPL.
- Explain the purpose of an OPS transition.
- Describe a string.
- Explain the main DPS functions of SPEC 0, SPEC 6, SPEC 1, and the Systems Summary (SYS SUMM).
- Describe the memory configuration and the use of the NBAT.
- Identify the DPS switches.
- State the role and function of the BFS.
- Identify the locations and names of the Multifunction Display Units (MDUs).
- Describe the Multifunction Electronic Display System (MEDS) databus network.
Title: Data Processing System Familiarization 1

Duration: 2.0 hours

Medium: SST 1 or SST 2 or SST 3

Student: ASCAN, PS (Schedule in pairs.)

Source: DS24/DPS/Navigation Training Group

Date: 02/04

Lesson(s) Replaced: DPS OPS 21006

Equipment Required: None

Prerequisite Lesson(s): DPS FAM 21001

Preparation: None

Synopsis: The overall lesson is done in a semi-chronological order, without real FDF. The purpose is to gain understanding of some basic DPS concepts. The FAM 1 lesson covers operations typically seen prelaunch, on ascent, and during orbit. The first section of the lesson covers switch locations and Initial Program Loads (IPLs) to illustrate some of the DPS operations done prior to crew ingress.

The student should explain the IPL operations as they occur, with instructor assistance. The ascent section will include Operational Sequence (OPS) overlays, Backup Flight Software (BFS) tracking, OUTPUT switch operations, and use of the Computer Annunciation Matrix (CAM). Each of these sections will be taught with diagrams or examples from the ascent phase of flight. The last two sections will include a Post-Insertion DPS reconfiguration and orbit Multifunction Electronic Display System (MEDS) operations. This will prepare the student for further on-orbit operations in FAM 2.

Objectives:

- State the function/purpose of the following DPS controls and displays:
  - General Purpose Computer (GPC)
  - Integrated Display Processor (IDP), Multifunction Display Unit (MDU), and Analog to Digital Converter (ADC)
  - Multiplexer/Demultiplexer (MDM) controls on Panel 06
  - IDP/CRT controls on panel C2
  - Backup Flight Controller (BFC) switches on Panel C3
  - CAM
  - Caution and Warning (C&W) lights

- Perform a default option IPL, aided, and explain its purpose.
- Perform a menu option IPL for Primary Avionics Software System (PASS) and BFS, aided, and explain the purposes for each.
New Astronaut Lesson Descriptions

42B  **DPS FAM 21006 (Concluded)**

- Explain the difference between a Major Function Base and an OPS Overlay.
- Perform the ascent software reconfiguration, aided and without real FDF.
- Explain how the GPC/CRT key overrides the Nominal Bus Assignment Table (NBAT) for IDP assignments.
- Perform a GPC/CRT assignment (PASS versus BFS), unaided.
- Summarize the process by which BFS tracks PASS and identify the signature for BFS Standalone.
- Explain the difference between the three positions for the OUTPUT switch.
- Explain the signatures (including talkbacks, displays, and the CAM) for a GPC failure.
- List the major steps in the Post Insertion DPS Reconfiguration procedure, aided and without real FDF.
- Explain various methods for assigning/deassigning IDPs (NBAT, GPC/CRT key, Major Function switch, BFC CRT DISP, and SEL switch).
- Explain the purpose of the G3 archive and how it is loaded.
- Identify the nominal signature for a BFS engage.
- Review the output and mode switch functions for PASS and BFS.
- Identify the signature for powering off MDUs and an edgekey failed closed.
- Discuss good DPS habits (IDP power on time constraints, Resume SPECs, distribution of IDPs among different Major Functions, Hands Off for OPS transitions, and PASS GPCs to RUN).

43  **MPS OV 21001**

<table>
<thead>
<tr>
<th>Title</th>
<th>Main Propulsion System Overview Briefing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>3.5 hours</td>
</tr>
<tr>
<td>Medium</td>
<td>Classroom</td>
</tr>
<tr>
<td>Student</td>
<td>ASCAN</td>
</tr>
<tr>
<td>Source:</td>
<td><em>DS66</em>/G&amp;C/Propulsion Training Group and <em>DS65</em>/Booster Systems Group</td>
</tr>
<tr>
<td>Date</td>
<td>03/05</td>
</tr>
<tr>
<td>Lesson(s) Replaced:</td>
<td>None</td>
</tr>
<tr>
<td>Equipment Required:</td>
<td>None</td>
</tr>
<tr>
<td>Prerequisite Lesson(s):</td>
<td>ASC OV 21001, ENT OV BR 21001, ORB OPS OV 21001</td>
</tr>
</tbody>
</table>
New Astronaut Lesson Descriptions

43 **MPS OV 21001 (Concluded)**

**Preparation:**
Read:
- SCOM
  - Section 2.16, MPS (disregard information on malfunctions and failures)
  - Section 1.3, External tank
- MPS Workbook 21002, Sections 1 and 2

**Take:**
- MPS INTRO 21057 (Do CBT after reading SCOM)

**Synopsis:** This lesson covers the Main Propulsion System (MPS) hardware and how each respective MPS subsystem works and interfaces with other orbiter systems. For each subsystem, this lesson will cover the controls and displays available on the flight deck, and will introduce how to monitor the subsystem on a nominal ascent.

**Objectives:**
- Identify the 7 MPS subsystems.
- Given a list of the 7 MPS subsystems and their components:
  - State the purpose of each subsystem relative to the overall MPS.
  - Explain how each subsystem works and identify the subsystem interfaces to other orbiter systems.
  - Identify the subsystem controls and displays available on the flight deck.

44 **ECLSS 21057**

**Title:** Environmental Control and Life Support System/Astronaut Path
**Duration:** 4.0 hours
**Medium:** CBT
**Student:** ASCAN
**Source:** DS45/Shuttle Systems Training Group
**Date:** 02/04

**Lesson(s) Replaced:** ECLSS OV 21001
**Equipment Required:** None
**Prerequisite Lesson(s):** None

**Preparation:**
Read:
- SCOM; Section 2.9, Environmental Control and Life Support System (ECLSS)

**Synopsis:** This lesson introduces the student to the concepts and equipment used in the Environmental Control and Life Support Systems (ECLSS) onboard the shuttle. Equipment is identified and generally described.
New Astronaut Lesson Descriptions

44  **ECLSS 21057 (Concluded)**

Objectives:  
- Identify the functions of the ECLSS subsystems during all flight phases.  
- Identify the major components of each ECLSS subsystem.  
- Describe how the ECLSS subsystems interface with each other and with other systems.

45  **MECH OV 21001**

Title:  Mechanical Systems Overview Briefing  
Duration:  3.0 hours  
Medium:  Classroom  
Student:  ASCAN  
Source:  DS45/Shuttle Systems Training Group  
Date:  03/05  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  None  
Preparation:  Read:  
  - SCOM; Section 2.17, Mechanical System  
  Complete:  
  - PLBD 21057 – Nom Ops  

Synopsis:  This lesson will cover the various components and equipment that make up the Mechanical (Mech) Systems. The briefing will discuss the active vent system, external tank umbilical doors, payload bay doors, radiators, and landing/deceleration system.

Objectives:  
- Identify the components of a Power Drive Unit (PDU) and state their functions.  
- Explain how microswitches affect the PDU motors.  
- Explain the difference between single motor drive and dual motor drive.  
- Identify the functions of the Active Vent, External Tank (ET) Doors, Payload Bay Doors, Deployable Radiators, and Landing & Deceleration subsystems.  
- Identify the major components of each Mech subsystem.  
- Describe the vent door configuration during the various mission phases (prelaunch through postlanding).  
- Describe the ET door configuration during the various mission phases (prelaunch through postlanding).  
- State how many latches are in a payload bay door latch gang.  
- Describe the information provided on the Systems Management (SM) displays: SPEC 63 PL BAY DOORS and OPS 202 PL BAY DOORS.
New Astronaut Lesson Descriptions

45 **MECH OV 21001 (Concluded)**

- Describe the sequence of events during payload bay door opening and closing.
- State the purpose of radiator deployment.
- Identify the methods available to release the main landing gear and nose landing gear uplock hooks.

46 **EPS OPS BR 21001**

Title: Electrical Power System Operations Review  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: DS45/Shuttle Systems Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: ASC C/L, PI C/L, ORB OPS C/L, D/O PREP C/L, ENT C/L  
Prerequisite Lesson(s): EPS OV 21001  
Preparation: Read:  
- EPS 21002  
  Complete:  
- EPS OPS 21057  

Synopsis: This lesson will begin with a short review of the EPS subsystems, focusing on the sensors. The EPS-related displays and controls will be discussed, focusing on the operational uses of the R1 panel, R11U panel, O2 and F9 meters, and the Cryo panels on the Aft Flight Deck. The relationship between the displays, subsystem drawings, and controls will also be discussed. The class will then walk through the nominal timeline and discuss the EPS procedures. During these discussions, the EPS displays and controls will be located, the purpose of the procedure will be discussed, and the rationale behind the steps will be discussed.

Objectives:
- Recognize EPS parameters on the following Systems Management (SM) displays: SYS SUMM 1, SYS SUMM 2, SPEC 67, SPEC 68, and SPEC 69.
- Recognize EPS parameters on the panel O2 and F9 meters.
- Recognize EPS switches and circuit breakers located on the following panels: R1, R11U, A11, A15, O14, O15, O16, and MA73C.
- Identify the nominal EPS procedures performed during a mission (prelaunch through postlanding).
- State the rationale for performing each of the nominal EPS procedures.
- Describe the configuration of the EPS subsystems based on the mission timeline.
New Astronaut Lesson Descriptions

46 **EPS OPS BR 21001 (Concluded)**

- Describe the EPS by using the schematic on panel R1.
- Describe dual cryo heater operations.
- Describe the purpose of the Cryo system manifold valves, reactant valves, tank check valves, O2 supply valves, and manifold relief valves.
- Explain how the Cryo heater sensor check causes the heater to trip off.
- Explain the purpose of the fuel cell dual gas regulator.
- Identify the EPS-related reason(s) for a Ground Launch Sequence (GLS) hold prelaunch.
- Explain how to use the Fuel Cell VI (Volts vs. Current) Performance plot.
- Explain the operational constraints for the manual fuel cell purge.
- Describe the significance of the Fuel Cell Stack T, Cool P, and Exit T indications.

47 **APU/HYD OPS BR 21001**

**Title:** Auxiliary Power Unit/Hydraulic Operations Review  
**Duration:** 2.0 hours  
**Medium:** Classroom  
**Student:** ASCAN  
**Source:** DS45/Shuttle Systems Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** ASC C/L, PI C/L, ORB OPS C/L, D/O PREP C/L, ENT C/L  
**Prerequisite Lesson(s):** APU/HYD OV 21001  
**Preparation:**  
- Read:  
  - APU/HYD/WSB 21002  
  - APU/HYD OPS 21057  
**Synopsis:** During this lesson, there will be a review of the Auxiliary Power Unit (APU)/Hydraulic (Hyd) system hardware, cockpit interface, mission timeline, and FDF procedures. The student will be progressed from the detailed technical aspects of the APU/Hyd system, as covered in the overview core briefing, to an operationally oriented familiarization. This lesson will serve as the conversion to “hands-on” operations of the APU/Hyd system.

**Objectives:**  
- Recognize APU/Hyd parameters on Guidance, Navigation, and Control (GNC) SPEC 51 and the following Systems Management (SM) displays: THERMAL, SYS SUMM 2, SPEC 86, SPEC 87, and SPEC 88.
New Astronaut Lesson Descriptions

APU/HYD OPS BR 21001 (Concluded)

- Recognize APU/Hyd parameters on the Multifunction Electronic Display System (MEDS) displays.
- Recognize APU/Hyd switches and circuit breakers located on the following panels: R2, R4, and A12.
- Describe the configuration of the APU, Hyd, and Water Spray Boiler (WSB) subsystems based on the mission timeline.
- Explain the relationship between data seen on the meters and on the displays.
- Identify the nominal APU/Hyd procedures performed during a mission (prelaunch through postlanding).
- State the rationale for performing each of the nominal APU/Hyd procedures.
- Describe how the following functions are supported by the APU/Hyd system:
  - Engine throttling
  - Engine gimballing (ascent)
  - External tank umbilical plate retraction
  - Engine gimballing (entry)
  - Aerosurface actuation
  - Gear deploy
  - Braking
  - Nose wheel steering
- Describe the APU/Hyd system using the APU/Hyd schematic in the Ascent Pocket Checklist.
- Describe the conditions that would call for “Attempt One APU” vs. “Attempt Two APUs” when performing the SINGLE APU START procedure in the Entry Checklist.
- Identify the prelaunch Ground Launch Sequencer (GLS) constraints.

DPS FAM 22001

Title: Data Processing System Familiarization 2 Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: DPS FAM 22001
Equipment Required: None
Prerequisite Lesson(s): COMM/IN OPS 21006, DPS FAM 21006
Note: This lesson should be scheduled no later than 3 weeks after completing DPS FAM 21006.
New Astronaut Lesson Descriptions

48A  **DPS FAM 22001 (Concluded)**

**Preparation:** Review:
- DPS FAM 21002

**Synopsis:** This prebrief will start with an overview of the DPS FAM 2 lesson. The student will then be quizzed about the main objectives from the DPS FAM 1 lesson. With this foundation, the instructor will then lead the student through the five steps of an Operational Sequence (OPS) transition and discuss system redundancy for the Modular Memory Units (MMUs). Redundant set expansions and contractions are defined and the nominal activities associated with them are discussed. Downlist and uplink are also briefly discussed as they relate to orbiter data flow to and from the General Purpose Computers (GPCs). Telemetry Format Loads (TFLs) and the Pulse Code Modulation Master Unit (PCMMU) are also discussed at this time.

**Objectives:**
- Identify the 5 main steps that occur while GPCs are in an OPS transition.
- Identify the major activities associated with a redundant set contraction.
- Identify the major activities associated with a redundant set expansion.
- Describe what TFLs and PCMMUs are and explain their purpose.
- Discuss how a PCMMU gets and sends its data.
- Describe the path of an uplink/downlink from the ground to the orbiter.

48B  **DPS FAM 22006**

**Title:** Data Processing System Familiarization 2  
**Duration:** 2.0 hours  
**Medium:** SST 1 or SST 2 or SST 3  
**Student:** ASCAN (Schedule in pairs.)  
**Source:** DS24/DPS/Navigation Training Group  
**Date:** 02/04  
**Lesson(s) Replaced:** DPS OPS 21006A (last half)  
**Equipment Required:** None  
**Prerequisite Lesson(s):** DPS FAM 22001  
**Preparation:** None
The New Astronaut Lesson Descriptions

48B  DPS FAM 22006 (Concluded)

Synopsis: This lesson will cover various DPS operations using Orbit, Deorbit Prep, Entry, and Post Landing as the chronological basis for the flow. During this lesson, many FAM 1 objectives will be reviewed to better reinforce the concepts and procedures to aid the student in preparation for FAM 3. The first section will cover the power status and commfault indications for Modular Memory Units (MMUs) and Multiplexers/Demultiplexers (MDMs) during powerdown and powerup Input/Output (I/O) recovery. The student will also exercise a redundant set contraction and expansion. While performing the Guidance, Navigation, and Control (GNC) Operational Sequence (OPS) 8 (G8) and GNC OPS 2 (G2) OPS transitions, MMU commanding and assignment logic will be discussed. In the Deorbit Prep section, the student will apply knowledge of the DPS system to produce a Deorbit Prep DPS reconfiguration strategy (with limited instructor assistance) and procedures that will then be executed. In the Entry section, port mode issues will be discussed. The impacts of a General Purpose Computer (GPC) failure on GNC downlist is discussed.

The last section, Post Landing, is optional. This section will be used if there is extra time or if the instructor feels that the student needs another opportunity to review redundant set contractions and GPC operations.

Objectives:
- Perform, aided, a redundant set contraction and a redundant set expansion.
- Explain MMU hardware and its software logic (preposition logic, Modular Memory (MM) bus default logic, and MMU source default logic).
- State examples of various operations requiring MMU access (Telemetry Format Load (TFL), Roll-In SPEC, Systems Management (SM) Checkpoint).
- Perform G2 to G8 and G8 to G2 OPS transitions.
- List the steps in the Deorbit Prep DPS reconfiguration and explain the purpose of each.
- Perform, aided, the Deorbit Prep DPS reconfiguration.
- Perform, aided, a port-mode operation.
- Explain the rationale for the Multifunction Electronic Display System (MEDS) ascent and entry cockpit configuration.
- Explain how the Redundant Set maintains a downlist GPC after a GPC failure.
- Perform, aided, the Post-Landing DPS reconfiguration. (This is optional. Perform, if time permits or as needed, at the end of the class.)
New Astronaut Lesson Descriptions

49A  **APPR/LNDG 21001**

**Title:** Approach and Landing Prebrief  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Note:** Schedule in PILOT simulator room (Flight Planning Room).  
**Student:** ASCAN (Prior to STA: Schedule 1 CB IP, 4 ASCAN PLTs;  
After STA: Schedule 1 ASCAN PLT, 4 MSs.)  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 02/04  
**Lesson(s) Replaced:** APPR & LAND 21001  
**Equipment Required:** None  
**Prerequisite Lesson(s):** APPR/LNDG BR 21001; MB SAFETY BR 21003  
**Preparation:**  
- HUD 21057  
- Review:  
  - APPR/LNDG BR 21001; Cockpit Calls – Procedures  

**Synopsis:** This prebrief is to prepare the student for APPR/LNDG 21011. The flow of APPR/LNDG 21011 will be discussed along with how the class will run. The students will learn basic cockpit resource management and how the tasks are divided among the crewmembers for the landing phase. They will be refreshed on landing aids and instruments used for landing. The students will practice landing on the Portable Inflight Landing Operations Trainer (PILOT) simulators before using the SMS.

Typically, the simulator lesson will be scheduled for 4 hours, with each student receiving one hour of approach and landing training with the instructor pilot. Two students will fly the first two hours of the session; the other two students will fly the last two hours of the session. All four students and the instructor pilot will attend this prebrief.

**Objectives:**  
- State the tasks performed by each crewmember during the landing phase (10K feet to landing rollout and wheel stop).  
- Evaluate orbiter position and attitude from pictures of landing aids and orbiter instruments and state the required correction.  
- State the nominal landing parameters for heavy and lightweight vehicles and for aborts.  
- Use the PILOT simulator to land the shuttle within nominal parameters.
New Astronaut Lesson Descriptions

49B  APPR/LNDG 21011

Title:  Approach and Landing
Duration:  4.0 hours
Medium:  SMS-MB
Student:  ASCAN (Prior to STA:  Schedule 1 CB IP, 4 PLTs; After STA:  Schedule 1 ASCAN PLT, 4 MSs.  The 4 hour SMS session will be split into two 2-hour blocks with two students per block.)
Source:  DS66/G&C/Propulsion Training Group
Date:  02/04
Lesson(s) Replaced:  APPR & LAND 21011
Equipment Required:  None
Prerequisite Lesson(s):  APPR/LNDG 21001
Preparation:  None

Synopsis:  The students will begin by learning how to perform a nominal shuttle landing.  They will learn the different techniques for controlling the vehicle in the air and on the runway during rollout.  Each student will have a chance to do a number of landings (even the MSs will get to land the vehicle during their lesson).  Once the nominal techniques are mastered, the students will then practice landing with a variety of wind conditions, tire fails, and other malfunctions.  All runs will start on the Heading Alignment Cone (HAC), so the students can practice the entire Approach and Landing (A/L) profile from transition on down.

Objectives:  
- Identify the SMS landing data collection sheets and how to read them.
- Perform a nominal landing starting from above the A/L transition through wheel stop.
- Make crew calls within the cockpit and perform all the other landing tasks.
- Execute rollouts with the different steering devices.
- Land with different approach conditions (winds, malfunctions, etc.).

50  MPS OPS BR 21001

Title:  Main Propulsion System Operations Review
Duration:  2.5 hours
Medium:  Classroom
Student:  ASCAN (Schedule in groups of about 15.)
Source:  DS66/G&C/Propulsion Training Group
Date:  10/05
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  MPS OV 21001
New Astronaut Lesson Descriptions

50  **MPS OPS BR 21001 (Concluded)**

**Preparation:**
- Read:
  - MPS Workbook 21002, Section 3

**Review:**
- MPS OV 21001 handout
- Abort Mode Boundaries handout

**Synopsis:** This lesson will very briefly review the 7 Main Propulsion System (MPS) subsystems discussed in MPS OV 21001. The lesson will then focus on the 7 nominal crew tasks for MPS on ascent and will discuss in detail how to perform each of them. Next, the lesson will cover the rationale and execution of the 9 MPS-related FDF procedures. Finally, the lesson will provide a brief discussion of the abort mode boundary calls provided by MCC to the crew on a nominal ascent.

**Objectives:**
- Identify the 7 nominal crew tasks for MPS on ascent and explain how to perform each.
- Given a list of the 9 MPS-related FDF procedures:
  - Locate each procedure in the FDF.
  - Explain the rationale for each procedure.
  - Explain how to perform each procedure.
- Explain, in general terms, what each abort mode boundary call means to the crew given a list of the calls.

51  **SRB OV 21001**

**Title:** Solid Rocket Booster Briefing
**Duration:** 3.0 hours
**Medium:** Classroom
**Student:** ASCAN
**Source:** CB/Astronaut Office
**Date:** 03/95
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** MPS OV 21001

**Preparation:**
- SCOM; Section 1.4, Solid Rocket Boosters
New Astronaut Lesson Descriptions

51  **SRB OV 21001 (Concluded)**

Synopsis: This lesson will review basic elements of the Solid Rocket Boosters (SRBs). The major components, including solid rocket motors, structure, separation system, recovery system, pyrotechnics thrust vector control, and range safety destruct system, the building, shipping, and stacking process, SRB physical characteristics, including weight, thrust and type of propellant, the SRB use profile, including launch, recovery, refurbish, manufacture, ship, and stack, the deceleration system, the SRB crew-related operations, including twang, thrust profile, sep sequence, and reentry sequence, and 51-L.

Objectives:  
- Describe the major components of the SRBs.  
- Discuss the basic operating principles of the SRBs.  
- Describe the reusability of the SRBs (in general terms).  
- Describe the crew interface to the SRBs (in general terms).

52  **ECLSS OPS BR 21001**

Title:  Environmental Control and Life Support Operations Review (Part 1)
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN  
Source:  *DS45/Shuttle* Systems *Training Group*  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: ASC C/L, PI C/L, ORB OPS C/L  
Prerequisite Lesson(s): ECLSS 21057  
Preparation: Read:  
- ECLSS 21002  

Synopsis: The lesson will start with a brief review of Environmental Control and Life Support System (ECLSS) subsystems. Next the lesson will review ECLSS switch panels and displays, focusing on the operational uses of the panels and meters. The nominal subsystem procedures, operations, and configurations will be discussed, from prelaunch through the midpoint of a typical mission timeline. The lesson will conclude with a discussion of the relationship between the displays, subsystem drawings and controls.

Objectives:  
- Identify nominal ECLSS procedures and explain their purpose (from prelaunch to postlanding).  
- Recognize ECLSS parameters on the following Systems Management (SM) displays: THERMAL, SYS SUMM 1, SYS SUMM 2, SPEC 66, and SPEC 88.  
- Recognize ECLSS parameters on the panel O1 meters.
New Astronaut Lesson Descriptions

ECLSS OPS BR 21001 (Concluded)

- Explain the relationship between data seen on the overhead meters (panel O1) and on the displays.
- Recognize ECLSS switches and circuit breakers located on the following panels: L1, L2, L4, C5, C6, C7, R11L, O14, O15, O16, O17, MO10W, MO32M, MO69M, MD44F, ML26C, ML31C, ML86B, and MO51F.
- Identify the nominal ECLSS procedures performed from prelaunch through the midpoint of a typical mission, including:
  - Pre-launch
  - Ascent (liftoff through post OMS-2)
  - Post-Insertion
  - Selected Flight Plan activities [Pressure Control System (PCS) Config, Pre/Post-Sleep Activities, Supply/Waste Water Dump]
- State the rationale for performing each of the nominal ECLSS procedures.
- Explain the difference between the three “dP/dT” values on the displays (hardware, backup, equivalent), and state when each is available.
- Identify the mechanism(s) actively cooling the Freon loops during all phases of flight from prelaunch to mid-mission.
- Identify the two supply water system configurations, and explain why the valves are configured as they are for each configuration.
- Explain the radiator startup sequence in terms of the motion and timing of the radiator flow control and bypass valves.
- Describe the following subsystems of ECLSS by using the schematics on associated switch panels (i.e., panel L1, L2, R11L, ML31C, MO10W):
  - Pressure Control System
  - Atmosphere Revitalization Subsystem (ARS)
  - Active Thermal Control System (ATCS)
  - Supply and Waste H2O System
- Describe ECLSS subsystem configurations, based on the mission timeline.
New Astronaut Lesson Descriptions

53A  MECH OPS 21001

Title: Mechanical Systems Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
• MECH SYS 21002

Note: This lesson replaces the MECH OV 21001 lesson for non-ASCAN students.

Synopsis: The lesson will provide a brief overview of the Mechanical (Mech) Systems. The major components of each subsystem will be described, and various hardware models will be used to demonstrate their functions.

Objectives:
• Identify the components of a Power Drive Unit (PDU) and state their functions.
• Explain how microswitches affect the PDU motors.
• Explain the difference between single motor drive and dual motor drive.
• Identify the functions of the Active Vent, External Tank (ET) Doors, Payload Bay Doors, Deployable Radiators, and Landing & Deceleration subsystems.
• Identify the major components of each Mech subsystem.

53B  MECH OPS 21008

Title: Mechanical Systems Operations
Duration: 1.5 hours
Medium: SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MECH OV 21001
Preparation: Read:
• MECH SYS 21002
New Astronaut Lesson Descriptions

53B    MECH OPS 21008 (Concluded)

Synopsis: This lesson familiarizes the student with the nominal procedures associated with active vent system, external tank umbilical doors, payload bay door system, radiator system, and landing and deceleration systems. The lesson flow follows that of a nominal mission starting at post-Main Engine Cutoff (MECO) and ending at rollout.

Objectives:
- Execute the nominal mechanical system procedures (including radiator deploy/stow procedures) performed during a mission (prelaunch through postlanding).
- Explain the rationale for performing each of the nominal Mechanical system procedures (including radiator deploy/stow procedures).
- Identify Mechanical system parameters on the Guidance, Navigation, and Control (GNC) SPEC 51 OVERRIDE and on the Systems Management (SM) displays: SPEC 63 PL BAY DOORS and OPS 202 PL BAY DOORS.
- Locate Mechanical system switches and circuit breakers located on the following panels: R2, R4, R13L, F6, F8, R14, A12, C3.
- Explain auto mode and manual mode payload bay door operations.
- Explain the purpose of the Payload Bay Door Bulkhead Latch Go/No-Go diagram and state when it is used.
- Explain the purpose of the Centerline Latch Extended Guide Roller Trajectory No Go diagram and state when it is used.
- State how the crew interacts with the active vent system.
- Discuss the three external tank umbilical door closure methods.
- State how many radiator panels are located on each payload bay door.
- State how many radiator panels are deployable.
- Explain how and why procedural actions for single radiator deploy/stow operations differ from procedural actions for dual radiator deploy/stow operations.

54A    EPS OPS 21001

Title: Electrical Power System Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: ASC C/L, PI C/L, ORB OPS C/L, D/O PREP C/L, ENT C/L
Prerequisite Lesson(s): None
New Astronaut Lesson Descriptions

54A  **EPS OPS 21001 (Concluded)**

Preparation: Read:
- EPS 21002

**Note:** This lesson replaces the EPS OPS BR 21001 lesson for non-ASCAN students.

Synopsis: This lesson will provide a brief overview of the EPS. The major components of each subsystem will be described, and the subsystem interfaces will be discussed.

Objectives:
- Identify the major components of each EPS subsystem.
- Identify the functions of the Power Reactants Storage and Distribution (PRSD), Fuel Cell Powerplants (FCP), and Electrical Power Distribution and Control (EPDC) subsystems during all flight phases.
- Describe how the EPS subsystems interface with one another and with other Orbiter systems.
- Identify the power sources of the Main, Essential, Control, and AC buses.

54B  **EPS OPS 21004**

Title: Electrical Power System Operations
Duration: 1.5 hours
Medium: SST 2 or SST 1 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: *DS45/Shuttle Systems Training Group*
Date: 10/05
Lesson(s) Replaced: EPS OPS 21004
Equipment Required: None
Prerequisite Lesson(s): EPS OPS BR 21001
Preparation: Review:
- EPS 21002

Synopsis: This lesson will start by familiarizing the student with the meters, panels, and displays. The student will then work through the EPS portions of FDF according to a nominal mission timeline and perform the procedures. During each procedure, the student and instructor will discuss the rationale behind each procedure. If there is time during the session, the student will be asked to discuss the impact, using onboard displays and functional diagrams, of making switch throws such as holding the Control Bus switch in Reset and letting it go, or disconnecting and reconnecting a phase of AC power.
New Astronaut Lesson Descriptions

54B  EPS OPS 21004 (Concluded)

Objectives:  
• Identify the EPS parameters on the following Systems Management (SM) displays: SYS SUMM 1, SYS SUMM 2, SPEC 67, SPEC 68, and SPEC 69.  
• Identify EPS parameters on the meters on panels O2 and F9.  
• Locate EPS switches and circuit breakers on the following panels: R1, A11, A15, R11U, L4, and C3.  
• Execute the nominal EPS procedures performed during a mission (prelaunch through postlanding).  
• Explain the rationale for each of the EPS nominal procedures.

55A  APU/HYD OPS 21001

Title: Auxiliary Power Unit/Hydraulic Operations Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: Non-ASCAN  
Source: DS45/Shuttle Systems Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: Read:  
• APU/HYD/WSB 21002  

Note: This lesson replaces the APU/HYD OPS BR 21001 for non-ASCAN students.

Synopsis: This lesson will provide a brief overview of the Auxiliary Power Unit (APU)/Hydraulic (Hyd) system. The major components of each subsystem will be described, and the subsystem interfaces will be discussed.

Objectives:  
• Identify the functions of the APU and Hyd subsystems during all flight phases.  
• Identify the major components of each APU/Hyd subsystem.  
• Describe how the APU/Hyd subsystems interface with one another, and with other Orbiter systems.  
• Identify the main functions of the APU controller.
New Astronaut Lesson Descriptions

55B  APU/HYD OPS 21004
Title: Auxiliary Power Unit/Hydraulic Operations  
Duration: 2.0 hours  
Medium: SST 2 or SST 1 or SST 3  
Student: ASCAN (Schedule in pairs.)  
Source: DS45/Shuttle Systems Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): APU/HYD OPS BR 21001  
Preparation: Review:  
- APU/HYD/WSB 21002  
Synopsis: APU/HYD OPS 21004 will require the student to use the classroom skills developed by APU/HYD/WSB 21002 and APU/HYD OPS BR 21001. The objective is to have the student capable of performing all nominal Auxiliary Power Unit (APU)/Hydraulic (Hyd) operations upon completion of the lesson. The student will learn how panels R2, R4, and A12 are used for nominal operations. Additionally, panels F7, F8, and the various displays will be used.

Objectives:  
- Execute the nominal APU/Hyd procedures performed during a mission (prelaunch through postlanding).  
- Identify APU/Hyd parameters on Guidance, Navigation, and Control (GNC) SPEC 51 and the following Systems Management (SM) displays: THERMAL, SYS SUMM 2, SPEC 86, SPEC 87, and SPEC 88.  
- Identify APU/Hyd parameters on the Multifunction Electronic Display System (MEDS) displays.  
- Locate APU/Hyd switches and circuit breakers located on the following panels: R2, R4, and A12.  
- Explain the rationale for performing each of the nominal APU/Hyd procedures.  
- List the 8 uses for hydraulic power.

56A  MPS OPS 21001
Title: Main Propulsion System Operations Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: Non-ASCAN  
Source: DS66/G&C/Propulsion Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None
New Astronaut Lesson Descriptions

56A MPS OPS 21001 (Concluded)

Prerequisite Lesson(s): None
Preparation: Read:
  • MPS Workbook 21002, Section 3

Note: This lesson replaces the MPS OPS BR 21001 lesson for non-ASCAN students.

Synopsis: This lesson will very briefly review the 7 Main Propulsion System (MPS) subsystems discussed in MPS OV 21001. The lesson will then focus on the 7 nominal crew tasks for MPS on ascent and will discuss in detail how to perform each of them. Next, the lesson will cover the rationale and execution of the 9 MPS-related FDF procedures. Finally, the lesson will provide a brief discussion of the abort mode boundary calls provided by MCC to the crew on a nominal ascent.

Objectives: 
  • Identify the 7 nominal crew tasks for MPS on ascent and explain how to perform each.
  • Given a list of the 9 MPS-related FDF procedures:
    – Locate each procedure in the FDF.
    – Explain the rationale for each procedure.
    – Explain how to perform each procedure.
  • Explain, in general terms, what each abort mode boundary call means to the crew given a list of the calls.

56B MPS OPS 21006

Title: Main Propulsion System Operations
Duration: 1.5 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group

Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MPS OPS BR 21001, CSI 21057, DPS 21006
Preparation: Review:
  • MPS OPS BR 21001 handout
  • MPS Workbook 21002, Section 3
New Astronaut Lesson Descriptions

56B MPS OPS 21006 (Concluded)

Synopsis: This lesson will allow the student to practice all of the tasks and procedures discussed in MPS OPS User’s Guide 21002. The 7 nominal ascent crew tasks for Main Propulsion System (MPS) will be practiced during 2 full ascents run from T-25 seconds through External Tank Separation (ET SEP). During these runs, the instructor will provide abort mode boundary calls. The student will also perform all 9 MPS-related FDF procedures.

Objectives: • Perform the 7 nominal crew tasks for MPS on ascent.
• Acknowledge the MCC-provided nominal abort mode boundary calls and explain in general terms what each call means.
• Perform the 9 MPS-related FDF procedures, and explain the rationale for each procedure.

57A ECLSS OPS 21001

Title: Environmental Control and Life Support Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ECLSS 21057
Preparation: Read: • ECLSS 21002

Note: This lesson replaces the ECLSS OPS BR 21001 lesson for non-ASCAN students.

Synopsis: The lesson will provide a brief overview of the Environmental Control and Life Support System (ECLSS) subsystems. The major components of each subsystem will be described, and the subsystem interfaces will be discussed.

Objectives: • Identify the major components of each ECLSS subsystem.
• Describe how the ECLSS subsystems interface with one another and with other Orbiter systems.
New Astronaut Lesson Descriptions

57B  ECLSS OPS 21004

Title:     Environmental Control and Life Support Operations (Part 1)
Duration:  1.5 hours
Medium:   SST 2 or SST 1 or SST 3
Student:  ASCAN (Schedule in pairs.)
Source:    DS45/Shuttle Systems Training Group
Date:      02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ECLSS OPS BR 21001
Preparation: Review:
• ECLSS 21002

Synopsis:  The lesson will start with a very brief review of the switch panels. The student will perform nominal Environmental Control and Life Support System (ECLSS) procedures from prelaunch to the midpoint of a typical mission. Panel O1 meters and onboard display data will be referenced throughout the lesson to monitor subsystem/component signatures as switches are thrown. Throughout the lesson, the student will be asked to identify subsystem diagrams on ECLSS panels and how switch configurations relate to the function of the subsystem.

Objectives:
• Execute the nominal ECLSS procedures performed during a mission, from prelaunch through mid-mission of a typical timeline.
• Identify ECLSS parameters on the following Systems Management (SM) displays: THERMAL, SYS SUMM 1, SYS SUMM 2, SPEC 66, and SPEC 88.
• Locate ECLSS switches and circuit breakers located on the following panels: L1, L2, L4, C5, C6, C7, O14, O15, O16, O17, R11L, MO10W, MD44F, ML26C, ML31C, and ML86B.
• Identify ECLSS parameters on the panel O1 meters.
• Explain the rationale for performing each of the nominal ECLSS procedures.

58  ECLSS OPS BR 22001

Title:     Environmental Control and Life Support Operations Review (Part 2)
Duration:  2.0 hours
Medium:   Classroom
Student:  ASCAN
Source:    DS45/Shuttle Systems Training Group
Date:      10/05
Lesson(s) Replaced: None
Equipment Required: ORB OPS C/L, D/O PREP C/L, ENT C/L
New Astronaut Lesson Descriptions

58  ECLSS OPS BR 22001 (Continued))

Prerequisite Lesson(s):  ECLSS OPS BR 21001
Preparation: Review:
•  ECLSS 21002

Synopsis: The lesson will start with a brief review of Environmental Control and Life Support System (ECLSS) subsystems. Next, the lesson will review ECLSS switch panels and displays, focusing on the operational uses of the panels and meters. The nominal subsystem procedures, operations, and configurations will be discussed, from the midpoint of a typical mission timeline through post-landing. The lesson will conclude with a discussion of the relationship between the displays, subsystem drawings, and controls.

Objectives:
•  Identify nominal ECLSS procedures and explain their purpose (from prelaunch to post-landing).
•  Recognize ECLSS parameters on the following Systems Management (SM) displays: THERMAL, SYS SUMM 1, SYS SUMM 2, SPEC 66, and SPEC 88.
•  Recognize ECLSS parameters on the panel O1 meters.
•  Explain the relationship between data seen on the overhead meters (panel O1) and on the displays.
•  Recognize ECLSS switches and circuit breakers located on the following panels: L1, L2, L4, C5, C6, C7, R11L, O14, O15, O16, O17, MO10W, MO32M, MO69M, MD44F, ML26C, ML31C, ML86B, and MO51F.
•  Identify the nominal ECLSS procedures performed from the midpoint of a typical mission through post-landing, including:
  – Selected Flight Plan activities (mid-mission reconfiguration of various systems)
  – Deorbit Prep
  – Entry
  – Post-Landing
•  State the rationale for performing each of the nominal ECLSS procedures.
•  Identify the mechanism(s) actively cooling the Freon loops during all phases of flight from mid-mission to post-landing.
•  Explain the radiator startup sequence in terms of the motion and timing of the radiator flow control and bypass valves.
New Astronaut Lesson Descriptions

58 ECLSS OPS BR 22001 (Concluded)

- Describe the following subsystems of ECLSS by using the schematics on associated switch panels (i.e., panel L1, L2, R11L, ML31C, MO10W):
  - Pressure Control System (PCS)
  - Atmosphere Revitalization Subsystem (ARS)
  - Active Thermal Control System (ATCS)
  - Supply and Waste H$_2$O System
- Describe ECLSS subsystem configurations, based on the mission timeline.

59 ECLSS OPS 22004

Title: Environmental Control and Life Support Operations (Part 2)
Duration: 1.5 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/ Shuttle Systems Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ECLSS OPS BR 22001, ECLSS OPS 21004
Preparation: Review:
  - ECLSS 21002

Synopsis: The lesson will start with a very brief review of the switch panels. The student will perform nominal Environmental Control and Life Support System (ECLSS) procedures from the midpoint of a typical mission to post-landing. Panel O1 meters and display data will be referenced throughout the lesson to monitor subsystem/component signatures as switches are thrown. Throughout the lesson, the student will be asked to identify subsystem diagrams on ECLSS panels and how switch configurations relate to the function of the subsystem.

Objectives:
- Execute the nominal ECLSS procedures performed during a mission, from mid-mission of a typical timeline through post-landing.
- Identify ECLSS parameters on the following Systems Management (SM) displays: THERMAL, SYS SUMM 1, SYS SUMM 2, SPEC 66, and SPEC 88.
- Locate ECLSS switches and circuit breakers located on the following panels: L1, L2, L4, C5, C6, C7, O14, O15, O16, O17, R11L, MO10W, MD44F, ML26C, ML31C, and ML86B.
- Identify ECLSS parameters on the panel O1 meters.
- Explain the rationale for performing each of the nominal ECLSS procedures.
New Astronaut Lesson Descriptions

60 TIER TEST 22001

Refer to TIER TEST 21001 for description.

61 GALLEY 21020

Title: Galley (Shared – Shuttle)
Duration: 1.0 hour
Medium: CCT II or FFT only
Student: ASCAN, PS (Schedule in groups of 4.)
Source: DX45/Crew Systems Group
Date: 08/04
Lesson(s) Replaced: HAB EQ/PROC 21020
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
  • FOOD SYS 21002

Synopsis: This lesson is designed to familiarize crewmembers with the operations of the orbiter galley. Information on the types of food available and the preparation of the food items will be covered. In addition, a meal will be prepared and eaten by the students.

Objectives:
  • Describe the basic galley operations.
  • Describe how food is prepared using the galley.

62 WCS PROC 21065

Title: Waste Collection System Procedures (Shared – Shuttle)
Duration: 1.0 hour
Medium: WCS Trainer
Student: ASCAN (Schedule in groups of up to 3.)
Source: DX45/Crew Systems Group
Date: 08/04
Lesson(s) Replaced: HAB EQ/PROC 21020
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Take:
  • WCS 21057

Synopsis: This lesson is conducted in the Waste Collection System (WCS) training facility located in building 5. Students are shown the launch configuration of the WCS and the procedure for configuring the WCS for orbit ops. Normal and contingency procedures are discussed and demonstrated.
New Astronaut Lesson Descriptions

62  **WCS PROC 21065 (Concluded)**

Objectives:
- Describe the general configuration and operation of the WCS.
- Identify the equipment and quantities of items stowed in the waste management compartment.
- Perform the post-insertion configuration and WCS setup procedures.

63A  **CCTV OPS BR 21001**

Title: Closed Circuit Television Operations Briefing  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (Schedule in pairs.)  
Source: *DS25/Communications/NSS Training Group*  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): COMM OV 21001  
Preparation: Read:  
- CCTV OPS 21108  
- SCOM; Section 2.3, CCTV  

Synopsis: The intent of this prebrief is to introduce the student to the CCTV system and its associated components.

Objectives:
- Identify the purpose of the CCTV system.
- Identify the CCTV hardware components and two Radio Frequency destinations where CCTV video is routed.
- Identify the major components of the CCTV system, which comprise the Video Control Unit (VCU).
- Identify the five major functions of the Remote Control Unit (RCU) and the six major functions of the Video Switching Unit (VSU).
- Identify the one true Ground Control Interface Logic (GCIL) switch of the CCTV system.
- Locate and identify the circuit breakers and CCTV switches used to configure the CCTV system.
- Identify the two types of cameras, the camera locations, and camera range of movement.
New Astronaut Lesson Descriptions

63B  **CCTV OPS 21001**

Title: Closed Circuit Television Operations Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: Non-ASCAN  
Source: DS25/Communications/NSS Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: Read:  
• CCTV OPS 21108  
• SCOM; Section 2.3, CCTV  
Note: This lesson replaces the CCTV OPS BR 21001 lesson for non-ASCAN students.

Synopsis: The intent of this prebrief is to introduce the student to the CCTV system and its associated components.

Objectives:  
• Identify the purpose of the CCTV system.  
• Identify the CCTV hardware components and two Radio Frequency destinations where CCTV video is routed.  
• Identify the major components of the CCTV system, which comprise the Video Control Unit (VCU).  
• Identify the five major functions of the Remote Control Unit (RCU) and the six major functions of the Video Switching Unit (VSU).  
• Identify the one true Ground Control Interface Logic (GCIL) switch of the CCTV system.  
• Locate and identify the circuit breakers and CCTV switches used to configure the CCTV system.  
• Identify the two types of cameras, the camera locations, and camera range of movement.

63C  **CCTV OPS 21008**

Title: Closed Circuit Television Operations  
Duration: 1.0 hour  
Medium: SST 3  
Student: ASCAN (Schedule in pairs.)  
Source: DS25/Communications/NSS Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CCTV OPS BR 21001
New Astronaut Lesson Descriptions

63C  **CCTV OPS 21008 (Concluded)**

Preparation:  None

Synopsis:  This lesson will introduce the student to the functions and operations of the CCTV system. The student will perform nominal CCTV procedures, which include activating, operating and deactivating the CCTV system using the cue card and associated CCTV panel controls. The lesson will also discuss recorder interfaces to the CCTV system and the basic configuration to record video.

Objectives:
- Activate and deactivate the CCTV system per CCTV cue card.
- Perform the following operations:
  - Locate panel A6 and A7 CCTV switches.
  - Power on and off CCTV cameras and monitors.
  - Route video to monitors and downlink video to Mission Control Center.
  - Generate a multiplexed scene on a monitor.
- Operate the 12 menu options on the Color Television Monitors.
- Describe generic record and playback operations associated with a recorder interface to the CCTV system.

64  **P/L COM/OIU OPS BR 21001**

Title:  Payload Communications/Orbiter Interface Unit Operations Prebrief
Duration:  1.5 hours
Medium:  Classroom
Student:  ASCAN
Source:  *DS25/Communications/NSS Training Group*
Date:  10/05
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  COMM OV 21001
Preparation:  Read:
- P/L COM 21002
- P/L COM 21057

Synopsis:  The purpose of this lesson is to explain the Payload Communications (P/L COM)/Orbiter Interface Units (OIs) operations using Payload Signal Processor (PSP) and Payload Data Interleaver (PDI) Line Replaceable Units (LRUs) of the P/L COM system. The lesson will also cover related procedures for Pulse Code Modulation Master Units (PCMMUs), PDI, and OIU formatting and configurations.
New Astronaut Lesson Descriptions

64  P/L COM/OIU OPS BR 21001 (Concluded)

Objectives:
• Describe the command and telemetry flow to and from generic attached and deployable payloads.
• Explain the basic functions and redundancies of the payload communication/OIU system.
• Review crew procedures and relate the information displayed on SPEC 62 and SPEC 212 to the components of the payload communication/OIU system, for nominal and off-nominal conditions.
• Locate the switches for the payload communication/OIU system.
• Identify the generic and flight-specific FDF books related to payload communications/OIU operations.

65  DPS FAM 23006

Title: Data Processing System Familiarization 3
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): DPS FAM 22006, ORB FDF USE 21001
Preparation: Review:
• DPS FAM 21002
• FDF 21057

Synopsis: This lesson concentrates on the nominal FDF procedures for the DPS. The format of the class is a nominal flight profile. The lesson begins prelaunch, taking the student through Ascent, Post-Insertion, Orbit, Deorbit Prep, and finally Post-Landing. During the lesson, the student will exercise all nominal DPS procedures using FDF. The rationale and concepts discussed in previous Familiarization lessons are brought together in this lesson to demonstrate to the student why the nominal procedures are written as they are. The student is expected to have a basic knowledge of the rationale for the major steps in these procedures.

Objectives:
• Perform, aided, the following prelaunch DPS procedures as specified in the Ascent Checklist (C/L):
  – Post Ingress SW Reconfig
  – PASS/BFS Transfer Prep
  – OPS 1 Load (PASS GPCs to GNC OPS 1)
  – BFS to OPS 1
New Astronaut Lesson Descriptions

65  DPS FAM 23006 (Concluded)

- Perform, aided, the following Post-Insertion DPS procedures:
  - Config GPCs for OPS 2 (Block 1)
  - PLBD OPS GO/NO GO Criteria
- Perform DPS steps in the Group B Powerdown.
- Perform, aided, a set contraction to configure the GPCs for single G2 Operational Sequence (OPS) using the procedure in the Orbit OPS C/L.
- Perform G2 to G8 and G8 to G2 OPS transition associated with the Flight Control System (FCS) Checkout as specified in the Orbit OPS C/L.
- Perform, aided, the following Deorbit Prep C/L DPS procedures:
  - CRT Timer Setup (Block 1)
  - DPS Config for D/O Prep (Block 4a)
  - Ensure BFS GPC can command an Integrated Display Processor (Block 4b)
  - DPS Entry Config (Block 12)
- Perform, aided, the following post-landing DPS procedures:
  - DPS Transition (to OPS 9 – PASS and OPS 0 – BFS)
  - G9 Set Contraction in Extended Power Up (as time permits)

66  UNIV PTG 21001

Title: Universal Pointing Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS24/DPS/Navigation Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): NAV OV BR 21001
Preparation: Read:
  - G&C I/O/D 21002A; Section 5, UNIV PTG Display
  - SCOM
    - Section 2.7, Dedicated Display Systems: ADI subsection (pages 2.7-3 through 2.7-6)
    - Section 2.13, Guidance, Navigation, and Control (GNC): Coordinate Systems subsection (pages 2.13-3 through 2.13-4)
Take:
  - GNC DED DISP 21057 (Primary Flight Display – Attitude Direction Indicator section only)
New Astronaut Lesson Descriptions

66  **UNIV PTG 21001 (Concluded)**

**Synopsis:** This briefing covers topics related to universal pointing. The applicable coordinate systems are introduced at the beginning of this briefing, followed by a discussion of all available targets and body vectors used by Guidance, Navigation, and Control (GNC) software to point the orbiter. The relationship between the Universal Pointing (UNIV PTG) software and the on-orbit Digital Auto Pilot (DAP) will be discussed. Examples are provided on selecting appropriate UNIV PTG commands to establish a desired orbiter attitude in Local Vertical Local Horizontal (LVLH) coordinates. In addition, the student will attempt to visualize each attitude by positioning an orbiter model relative to a predefined LVLH reference frame. The lesson contains additional visual aids, which assist in developing the thought process for orbiter attitude determination.

**Objectives:**

- Describe commonly used coordinate systems (M50 inertial, LVLH, orbiter body) and their application to pointing the orbiter.
- Explain how to read the Attitude Direction Indicator (ADI).
- Explain the basic functions of the DAP (A, B, AUTO, INRTL, LVLH, FREE, PRI, ALT, VERN, DISC RATE, and PULSE (rotation)).
- Identify the GNC software display used for pointing the orbiter (UNIV PTG) and its interface to the DAP.
- Explain how to perform a maneuver (MNVR) to an inertial attitude.
- Explain how to perform a track (TRK), including definition of the target identification (TGT ID), orbiter body vector (BODY VECT), and Omicron (OM).
- Explain how to perform a rotation (ROT).
- Explain the UNIV PTG fields used to monitor vehicle attitude.
- Describe the inputs to the UNIV PTG display and DAP to perform various maneuvers based on a given set of attitude constraints at the present or a future MET.

67  **MAL FDF USE 21001**

**Title:** Malfunction Flight Data File Usage Briefing

**Duration:** 3.0 hours

**Medium:** Classroom

**Student:** ASCAN

**Source:** *DA72/Training Execution Branch*

**Date:** 02/04

**Lesson(s) Replaced:** None

**Equipment Required:** AESP

**Prerequisite Lesson(s):** ORB FDF USE 21001

**Preparation:**

- Review:
  - FDF 21057
New Astronaut Lesson Descriptions

67  MAL FDF USE 21001 (Concluded)

Synopsis: This lesson is designed to provide an introduction to the procedures used when an off-nominal event (malfunction) occurs. The briefing reviews the different types of off-nominal FDF as well as when they are used and how they are formatted. Cockpit configurations for ascent, orbit, and entry are reviewed as they relate to the layout of the off-nominal FDF. Extra time is spent reviewing the peculiarities of the A/E Systems Procedures and Malfunction Procedures. The briefing also includes exercises that demonstrate the use of malfunction FDF.

Objectives:
- Given a pictorial of a mission, label which pieces of off-nominal FDF are used for each mission phase.
- State what malfunction FDF is used during OMS burns.
- State how the Ascent/Entry Systems Procedures book is organized.
- Define the relationship between the Ascent/Entry Systems Procedures and the CDR Window Flip Book, the PLT Overhead and Window Flip Books, and cue cards.
- Define the flight configuration of the Ascent/Entry Systems Procedures for ascent and entry (i.e., which books are the AESP procedures combined with during these 2 flight phases).
- Given a schematic of the cockpit, identify where certain malfunction FDF books are located during ascent and entry.
- State who uses the Ascent/Entry Systems Procedures in the cockpit.
- Define the meaning of the different symbols used in the Ascent/Entry Systems Procedures and pocket checklists.
- Explain when the Malfunction Procedures are used versus when the Orbit Pocket C/L is used.
- Define the term Super Mal.
- Given a copy of a typical procedure in the Mal Procedure, walk through a failure scenario following the blocks until a “conclusion block” is reached.
- Briefly explain the purpose of the SYS AOA book and the Contingency Deorbit Book.

68  E NAV BR 21001

Title: Entry Navigation Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS24/DPS/Navigation Training Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: None
New Astronaut Lesson Descriptions

**E NAV BR 21001 (Continued)**

**Prerequisite Lesson(s):** A/E CL USE 21001, NAV OV BR 21001

**Preparation:** Read:
- NAV 21002; with an emphasis on entry navigation topics
- NAVAIDS 21002; for details on Tactical Air Navigation System (TACANS), Microwave Landing System (MLS), Radar Altimeters (RAs), and Global Positioning System (GPS)
- ADS 21002; for details on Air Data System

**Synopsis:** This briefing is an introduction to the navigation system used by the orbiter during the entry phase of flight, with an emphasis on the crew operations in managing the orbiter navigation state vector (NAV state). The briefing begins with an overview of the Operational Sequence (OPS) 3 Entry navigation scheme: three independent Inertial Measurement Unit (IMU) state vectors, NAV filter, and the combination of sensor measurements the shuttle uses to maintain an accurate onboard NAV state. An overview of the various NAV sensors is presented: Drag Altitude, Tactical Air Navigations (TACANs), Air Data, Microwave Scanning Beam Landing System (MSBLS), GPS, and Radar Altimeters (RAs). Emphasis is placed on the crew management of the sensors and sensor data using cockpit resources (FDF, switches, DPS displays, and tapes) and in coordination with the MCC. The Redundancy Management (RM) of each of the sensors is discussed. Corrections to the onboard NAV state via MCC uplinks and GPS updates are discussed. The nominal signatures of the sensor data and signatures of some of the failure modes are described and shown via video filmed in the SMS.

**Objectives:**
- Explain the concept of the single-state vector scheme and when it is used.
- Explain the concept of the 3-state vector scheme and why it is used in OPS 3.
- Explain the basic function of the General Purpose Computer (GPC) Kalman filter (NAV filter).
- Describe the parameters provided for entry navigation by the various NAVAID sensors: Drag Altitude (DRAG H), TACANS, Microwave Landing System (MLS), Air Data Transducer Assembly (ADTA) units, and RA.
- Discuss GPS and how it is used with respect to navigation.
- Identify the windows of usage for the various NAV sensors (Drag H, TACAN, ADTA, MLS, RA) for a nominal entry profile.
- Explain the use of the NAV filter displays and controls on SPEC 50 (RATIO, Residual (RESID), Auto (AUT), Inhibit (INH), Force (FOR)).
New Astronaut Lesson Descriptions

68  **E NAV BR 21001 (Concluded)**

- Identify the crew actions to evaluate data from the various NAV sensors (Drag H, TACAN, MLS, ADTA, RA).
- Describe the procedure for Air Data Probe deploy and deploy verification.
- Describe the switches and circuit breakers for the various NAV sensors (TACAN, MLS, ADTA, RA).
- Describe the interfaces of the DPS and EPS to the various NAV sensors (TACAN, MLS, ADTA, RA).
- Describe the RM for the various NAV sensors (TACAN, ADTA, MLS).
- Describe the nominal MCC calls concerning NAV sensor management during an entry.
- State the various ways to update the state vector and the order of preference (MCC whole state uplink, GPS update, MCC delta state uplink).
- Describe the use of Primary Avionics Software System (PASS) SPEC 50 and SPEC 55 to perform a state vector update.
- Explain IMU re-anchoring in OPS 3.
- Describe how to perform a PASS-to-Backup Flight Software (BFS) state vector transfer and when it is used.

69  **ENT AERO BR 21001**

Title: Entry Aerodynamics Briefing
Duration: 2.5 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 08/04
Lesson(s) Replaced: E AERO BR 21001
Equipment Required: None
Prerequisite Lesson(s): ENT OV BR 21001
Preparation: Read:
  - SCOM;
    - Section 4.3, Airspeed Limitations
    - Section 4.4, Angle of Attack Limitations
    - Section 4.5, Sideslip Limitations
    - Section 4.6, Landing Weight Limitations
    - Section 4.7, Descent Rate Limitations
    - Section 4.8, Center of Gravity Limitations
    - Section 4.9, Accel. Limitations
New Astronaut Lesson Descriptions

69 ENT AERO BR 21001 (Continued)

Synopsis: This lesson discusses how the orbiter flies and its aerodynamic characteristics starting at Entry Interface (EI) and ending at rollout. The differences between how the orbiter flies and how a conventional aircraft flies will be discussed. This lesson also discusses the limitations of the orbiter, as well as some terms that flight crews need to know.

Objectives:
- Define the following aerodynamic terms used in shuttle entry:
  - Roll
  - Bank
  - Pitch
  - Yaw
  - Beta
  - Alpha
  - Gamma
  - Phi
  - Theta
  - Qbar
  - Knots Equivalent Airspeed (KEAS)
  - Inertial Velocity (VI)
  - Relative Velocity (Vrel)
  - Mach number
- Draw a free body diagram of the orbiter during high-speed entry. State how this diagram is different from a conventional glider.
- Describe the control devices used by the orbiter on entry.
- State which of the 3 rotational axes are always highly coupled.
- Explain why an orbiter with forward center of gravity (c.g.) will have less effective roll/yaw control.
- State what DTOs and Programmed Test Inputs (PTIs) are and explain the relationship between the two.
- Sketch the Normal Acceleration (Nz) versus weight limit.
- Sketch the alpha versus Mach limits for Mach 0 to Mach 2.5.
- State the following orbiter entry limits:
  - Pitch up divergence alpha at Mach 1.5 and Mach 0.6
  - C-N-Beta dynamic alpha (hypersonic)
  - Max airspeed
  - G’s
- Find the maximum lift over drag (L/D) angles of attack given the appropriate FDF. State which max L/D alpha is not in the FDF.
- Describe what happens when any of the following limits are violated:
  - Max Lift-to-Drag Ratio (L/D) alpha
  - Pitch up divergence alpha
  - C-N-Beta dynamics alpha
New Astronaut Lesson Descriptions

69 ENT AERO BR 21001 (Concluded)

- Max airspeed
- G’s
- Y c.g.
- Forward c.g.
- Aft c.g.

70 KU OPS BR 21001

Title: Ku-Band Operations Review
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: ORB OPS C/L
Prerequisite Lesson(s): COMM OV 21001
Preparation: Read:
- KU OPS 21002
Review:
- ORB OPS C/L; Section 2, COMM/INST
  - KU-BD ANT DEPLOY
  - KU-BD ACTIVATION
  - KU-BD ANT STOW

Synopsis: This lesson will discuss the purpose of the Ku-Band system, the Ku-Band components, the Ku-Band displays and switches, and the nominal Ku-Band procedures (KU-BD ANT DEPLOY, ACTIVATION, and ANT STOW procedures in Section 2 of the Orb Ops C/L).

Objectives:
- State the two purposes of the Ku-Band system.
- State what type of information can be in the Ku-Band uplink.
- State the number of Ku-Band channels of downlink.
- Describe the location of the Ku-Band antenna on the orbiter.
- Name the phase of flight in which the Ku-Band antenna can be used.
- Locate all Ku-Band panels switches in the orbiter and state the function of each of the switches.
- Describe the purpose of each of the Ku-Band related parameters and item entries on SM OPS 201, Antenna Display; SM SPEC 76; and GNC SPEC 33.
- State the two reasons Ku-Band maskings are used.
- Explain the purpose of the major steps in the Ku-Band nominal procedures in Section 2 of the Orb Ops C/L.
New Astronaut Lesson Descriptions

71A  P/L COM/OIU OPS 21001

Title: Payload Communications/Orbiter Interface Unit Operations Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
• P/L COM 21002
Take:
• P/L COM 21057
Note: This lesson replaces the P/L COM/OIU OPS BR 21001 lesson for non-ASCAN students.

Synopsis: The purpose of this lesson is to explain the Payload Communications (P/L COM)/Orbiter Interface Units (OIUs) operations using Payload Signal Processor (PSP) and Payload Data Interleaver (PDI) Line Replaceable Units (LRUs) of the P/L COM system. The lesson will also cover related procedures for Pulse Code Modulation Master Units (PCMMUs), PDI, and OIU formatting and configurations.

Objectives:
• Describe the command and telemetry flow to and from generic attached and deployable payloads.
• Explain the basic functions and redundancies of the payload communication/OIU system.
• Review crew procedures and relate the information displayed on SPEC 62 and SPEC 212 to the components of the payload communication/OIU system, for nominal and off-nominal conditions.
• Locate the switches for the payload communication/OIU system.
• Identify the generic and flight-specific FDF books related to payload communications/OIU operations.

71B  P/L COM/OIU OPS 21006

Title: Payload Communications/Orbiter Interface Unit Operations
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: P/L COM OPS 21006
New Astronaut Lesson Descriptions

71B P/L COM/OIU OPS 21006 (Concluded)

Equipment Required: None
Prerequisite Lesson(s): P/L COM/OIU OPS BR 21001
Preparation: Review:
- P/L COM/OIU OPS BR 21001; Handouts
- P/L COM 21002

Synopsis: This lesson introduces the student to the hands-on operation of the Payload Communication (P/L COM)/Orbiter Interface Unit (OIU) system. The student will perform related nominal procedures in the same sequence as in normal flight. The student will review the systems, FDF use and procedures, and equipment configurations.

Objectives:
- Describe the hardline and Radio Frequency (RF) command and telemetry flow, using the payload communication overview diagram in Section 2 of the Malfunction procedures.
- Describe the components and interfaces of the Payload Communication/OIU systems.
- Review crew displays and controls for P/L COM, Pulse Code Modulation Master Unit (PCMMU), and OIU.
- Configure the Payload Comm system for hardline mode and also for RF mode.
- Identify both nominal and off-nominal signatures of the Payload Comm system and OIU.

72 TAEM GUID BR 21001

Title: Terminal Area Energy Management Guidance Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 08/04

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): APPR/LNDG BR 21001, ENT AERO BR 21001
Preparation: Read:
- SCOM; Section 7.4
- GNC DED DISP 21057
- HUD 21057
New Astronaut Lesson Descriptions

72 **TAEM GUID BR 21001 (Concluded)**

**Synopsis:** This lesson covers the Terminal Area Energy Management (TAEM) Guidance algorithm that functions during entry from an earth-relative velocity of 2500 fps to Approach and Landing interface (approximately 10,000 ft altitude). The lesson covers TAEM Guidance outputs, flight instrument and subsystem status displays, and both AUTO and manual techniques of controlling energy.

**Objectives:**
- Define when TAEM guidance starts and when it stops.
- Describe how the TAEM pitch channel command is generated.
- Describe how the TAEM phase-specific roll commands are generated.
- Describe how the TAEM speedbrake commands are generated.
- Describe the flight instrument and subsystem status displays available during the TAEM phases.
- Describe the methods (both AUTO and manual) available for recovering from both high and low energy.
- State three primary differences between OPS 3 and OPS 6 TAEM Guidance.
- Describe two cases where the TAEM pitch command is bad (pitch error needles are erroneous) due to sensor failures.
- Describe Theta Limits and their use.
- Explain the energy and glide slope calls made by the MCC and crew reaction to each.

73A **KU OPS 21001**

**Title:** Ku-Band Operations Prebrief
**Duration:** 0.5 hours
**Medium:** Classroom
**Student:** Non-ASCAN
**Source:** DS25/Communications/NSS Training Group
**Date:** 10/05

**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** None

**Preparation:**
- Read: KU OPS 21002

**Review:**
- ORB OPS C/L; Section 2, COMM/INST
  - KU-BD ANT DEPLOY
  - KU-BD ACTIVATION
  - KU-BD ANT STOW
New Astronaut Lesson Descriptions

73A  **KU OPS 21001 (Concluded)**

**Note:** This lesson replaces the KU OPS BR 21001 lesson for non-ASCAN students.

**Synopsis:** This lesson will discuss the purpose of the Ku-Band system, the Ku-Band components, the Ku-Band displays and switches, and the nominal Ku-Band procedures (KU-BD ANT DEPLOY, ACTIVATION, and ANT STOW in Section 2 of the Orb Ops C/L).

**Objectives:**
- State the two purposes of the Ku-Band system.
- State what type of information can be in the Ku-Band uplink.
- State the number of Ku-Band channels of downlink.
- Describe the location of the Ku-Band antenna on the orbiter.
- Name the phase of flight in which the Ku-Band antenna can be used.
- Locate all Ku-Band panels switches in the orbiter and state the function of each of the switches.
- Describe the purpose of each of the Ku-Band related parameters and item entries on SM OPS 201, Antenna Display; SM SPEC 76; and GNC SPEC 33.
- State the two reasons Ku-Band maskings are used.
- Explain the purpose of the major steps in the Ku-Band nominal procedures in Section 2 of the Orb Ops C/L.

73B  **KU OPS 21006**

**Title:** Ku-Band Operations
**Duration:** 1.5 hours
**Medium:** SST 1 or SST 2 or SST 3
**Student:** ASCAN (Schedule in pairs.)
**Source:** DS25/Communications/NSS Training Group
**Date:** 10/05
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** KU OPS BR 21001
**Preparation:** Review:
- COMM SPEC 21057; Segment 4, Ku-Band
- Orbit Ops C/L
  - KU-BD ANT DEPLOY
  - ACTIVATION
  - ANT STOW
  - KU-BD MANUAL ACQUISITION (COMM)
  - KU-BD ANT JETTISON
- Mal Proc; MECH Section, SSR-5
New Astronaut Lesson Descriptions

73B KU OPS 21006 (Concluded)

Read:
- KU OPS 21002

Synopsis: The lesson will start with a review of panel/switch locations/functions and Ku-Band display information. The Ku-Band antenna heaters will be discussed and activated. The student will perform procedures such as KU-BD ANT DEPLOY, ACTIVATION, and ANT STOW. The student will be required to explain the purpose of each procedure step as it is performed. There will also be a brief review of radar operations and discussion and/or performance of contingency operations (i.e., Ku jettison).

Objectives:
- Perform, aided, and explain the major steps of the following nominal procedures:
  - KU-BD ANT DEPLOY
  - KU-BD ACTIVATION
  - KU-BD ANT STOW
- Perform, aided, COMM and radar mode antenna operations.
- Perform, aided, the following malfunction procedures:
  - KU-BD MANUAL ACQUISITION
  - KU-BD ANT DIRECT STOW
  - KU-BD ANT JETTISON (if time permits)
- State the 2 purposes of Ku-Band in the radar mode.

74 REF DATA USE 21001

Title: Reference Data Usage Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS45/Shuttle Systems Training Group and CB/Astronaut Office
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: REF DATA
Prerequisite Lesson(s): MAL FDF USE 21001
Preparation: None
New Astronaut Lesson Descriptions

74  REF DATA USE 21001 (Concluded)

Synopsis: This lesson is designed to be presented in 3 parts. There is an explanation of the types of information contained in the Reference (Ref) Data Book, an explanation of when Ref Data is used, and the completion of exercises that work all sections of the Ref Data book. In addition, the lesson will review which crewmember is responsible for this book during ascent and entry, and how it is used during each phase of flight.

Objectives:
- State the major sections of the Ref Data Book.
- Use Ref Data to identify equipment lost when given an electrical, databus, and Operational Instrumentation Dedicated Signal Conditioner (OI DSC) failure.
- Use Ref Data to determine how to reset the hardware and software Caution & Warning (C&W) limit for a given parameter.
- Use Ref Data to determine which parameter(s) may be out of limit(s) when provided with a particular fault message or F7 C&W Matrix light.
- Use Ref Data to identify Navigation stars and associated information given a Star ID.
- Use Ref Data to identify various Program Notes, and how and when those Notes apply.
- Use Ref Data to locate a given stowage item (i.e., identify locker that it is stowed in).

75A  E NAV 21001

Title: Entry Navigation 1 Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 07/07

Lesson(s) Replaced: E NAV 21011 (partial)
Equipment Required: None
Prerequisite Lesson(s): E NAV BR 21001, MAL FDF USE 21001

Preparation: Review:
- NAV 21002; with an emphasis on entry navigation topics
- NAVAIDS 21002
- ADS 21002
  Take:
- GNC DED DISP 21057
New Astronaut Lesson Descriptions

75A E NAV 21001 (Concluded)

Read:
- AESP (Glided Flight); COMM/GNC and DPS
  - RM FAIL ADTA
  - RM DLMA ADTA
  - RM FAIL TAC
  - RM DLMA TAC
  - FA/FF MDM I/O ERROR and PORT MODE

Synopsis: This prebrief takes a “what-you-need-to-know-onboard” approach to the entry Navigation Aids (NAVAIDs), with primary emphasis on Tactical Air Navigation Units (TACANs) and air data. Procedures for monitoring the state vector on entry, evaluating sensors, and incorporating them, with MCC concurrence, will be introduced sequentially while talking through a desktop entry simulation. This includes all expected ground calls as well as procedures for deploying the air data probes at the appropriate time. The ENTRY MANEUVERS cue card will be discussed in detail.

Pertinent information on Guidance, Navigation, and Control (GNC) SPECs 50 and 51 will be reviewed for working with the NAVAID data. TACAN and air data systems details and software interface (Redundancy Management (RM) and Fault Detection, Identification, and Reconfiguration (FDIR)) will be reviewed as they pertain to understanding and successfully troubleshooting malfunctions.

Objectives:
- Identify the function and availability of each of the NAVAIDs (Drag Attitude (Drag H), Global Positioning System (GPS), TACAN, air data, Microwave Landing System (MLS), Radar Altimeter (RA)) in a typical entry flight profile.
- Explain procedures for evaluating and/or incorporating NAVAIDs (Drag H, GPS, TACAN, air data, MLS, RA) using onboard instruments and displays.
- Explain SPEC 50 residuals and ratios for DRAG H, TACAN, and Air Data Transducer Assembly (ADTA) Altitude (H).
- Explain TACAN and air data RM and selection filter.
- Identify differences between Primary Avionics Software System (PASS) and Backup Flight Software (BFS) use of TACAN and Air Data.
- Explain each NAVAID callout on the Entry MNVR Cue Card.
New Astronaut Lesson Descriptions

75B  E NAV 21006

Title: Entry Navigation 1
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 07/07
Lesson(s) Replaced: E NAV 21011 (partial)
Equipment Required: None
Prerequisite Lesson(s): E NAV 21001
Preparation: None

Synopsis: This lesson acquaints the student with Navigation Aids (NAVAIDs) management during entry, including coordination with MCC. The student will associate Tactical Area Navigation (TACAN) and Air Data Transducer Assembly (ADTA) Redundancy Management (RM) schemes with various malfunction signatures. Procedures will be executed from both the Entry cue cards and Ascent/Entry Systems Procedures. Backup Flight Software (BFS) actions and indications will be discussed where applicable. The following runs will exercise the objectives listed below:

- Run 1: Nominal 210 Kft to landing.
- Run 2: TACAN RM failures and dilemma with self-test.
- Run 3: TACAN unresolved dilemma.
- Run 4: ADTA RM fail and dilemma.
- Run 5: Probe deploy problem and dilemma.
- Run 6: Combined TACAN and air data malfunction case (210 Kft to landing).

Objectives:

- Exercise all onboard tasks associated with navigation and sensor management in a nominal end-of-mission entry trajectory starting from 210 Kft and using the Entry MNVR Cue Card.
- Identify nominal Global Positioning System (GPS), TACAN, Air Data System (ADS), Microwave Landing System (MLS), and Radar Altimeter (RA) feedback from onboard displays.
- Use the ENTRY MANEUVERS cue card to identify TACAN and air data incorporation boundaries.
- Identify a TACAN/RA Multiplexer/Demultiplexer (MDM) card failure and exercise the appropriate procedure.
- Discuss the interfaces of NAVAIDs with DPS and EPS.
- Identify and resolve a failure to meet the Primary Avionics Software System (PASS) two-lock requirement for TACANs.
New Astronaut Lesson Descriptions

75B  E NAV 21006 (Concluded)

- Identify a TACAN dilemma with PASS auto self-test and exercise the correct procedure.
- Evaluate and troubleshoot an unresolved TACAN dilemma.
- Explain the BFS reasonableness test for TACAN.
- Identify all positions of the TACAN rotary switch on Panel (PNL) O7 and identify SPEC 50 signature.
- Identify a TACAN RM failure and exercise the correct procedure.
- Identify an Air Data Transducer Assembly (ADTA) RM failure and exercise the correct procedure.
- Evaluate and resolve an ADTA RM dilemma.
- Evaluate and resolve an air data probe dilemma.
- Discuss the impacts of an ADTA Built-In Test Equipment (BITE) for PASS and BFS.
- Identify and resolve an air data probe deployment failure.
- Identify the scenarios when flying Theta Limits is required and how to fly them.
- Explain the Flight Rule implications pertaining to a single ADTA.
- Prioritize malfunction procedures with nominal activities in order to execute all entry tasks on time.

76  E DAP BR 21001

Title: Entry Digital Autopilot Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: ENT C/L
Prerequisite Lesson(s): ENT AERO BR 21001
Preparation: Read:
  - SCOM
  - Section 2.13, Aerojet DAP portion only
New Astronaut Lesson Descriptions

76 E DAP BR 21001 (Concluded)

Synopsis: This lesson describes how the DAP flies the orbiter through the atmosphere to a landing. It relies heavily on the information taught in the Entry Aerodynamics class. It is also operator based – DAP issues and concepts that are transparent to flight crews will not be emphasized. The class will focus on how the orbiter is controlled in the pitch, roll, and yaw axes. Flight control system effectors and sensors used by entry DAP to fly the vehicle will be discussed, as well as the cockpit displays and controls available to the crew. Nominal procedures relating to entry DAP will also be presented.

Objectives:
- Define the orbiter stability axes and state their effect on entry DAP.
- For the pitch channel, state the following:
  - On what is the pitch command based.
  - The devices used for control and trim.
  - The two pitch channel features that operationally affect the crew.
  - How the crew can manually trim pitch.
- For the roll/yaw channel, state the following:
  - On what is the roll/yaw command based.
  - The devices used for control and trim.
  - The meaning of “reverse aileron.”
  - The operational differences between Baseline DAP, No Yaw Jet DAP, and Wraparound DAP.
  - How the crew can manually trim roll/yaw.
- State the function of each of the DAP displays and controls.
- Match the significant entry DAP changes to the event that causes the changes.
- State the differences between Primary Avionics Software System (PASS) and Backup Flight System (BFS) entry DAP.

77A TAEM GUID 21001

Title: Terminal Area Energy Management Guidance Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN (Schedule 3 ASCANs.)
Source: DS66/G&C/Propulsion Training Group
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TAEM GUID BR 21001
Preparation: Read:
- ENT GUID 21002; TAEM Guidance Section
New Astronaut Lesson Descriptions

77A  TAEM GUID 21001 (Concluded)

Synopsis: This lesson prepares the student for the SMS class TAEM GUID 21011. Emphasis will be placed on cockpit displays and Space Flight Resource Management (SFRM), while reviewing the cases to be run in the SMS.

Objectives:
• Discuss the impact of a large Heading Alignment Cone (HAC) turn angle – energy dump/pullup maneuver, glide slope and airspeed impacts, and HAC predictor activity.
• Discuss how the energy dump/pullup maneuver, glide slope and airspeed, and HAC predictor activity are impacted by large winds on the HAC.
• Discuss cockpit cues for high energy – Energy Over Weight (EOW) scale, orbiter bug movement, and Terminal Area Energy Management (TAEM) Guidance reaction.
• Discuss the impact of large HAC with no Air Data.
• Discuss how to fly theta limits.
• Discuss the impact of multiple Accelerometer Assembly (AA) failures.
• Discuss techniques of flying Area Navigation by using raw Tactical Air Navigation data.

77B  TAEM GUID 21011

Title: Terminal Area Energy Management Guidance
Duration: 4.0 hours
Medium: SMS-MB
Student: ASCAN (Schedule 3 ASCANs.)
Source: DS66/G&C/Propulsion Training Group
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TAEM GUID 21001
Preparation: None

Synopsis: This is a hands-on flying lesson that teaches crew Space Flight Resource Management (SFRM) and use of the Terminal Area Energy Management (TAEM)-related onboard displays.

Objectives:
• Demonstrate a large Heading Alignment Cone (HAC) turn angle while pointing out the energy dump/pullup maneuver, glide slope and airspeed impacts, and HAC predictor activity.
• Demonstrate how the energy dump/pullup maneuver, glide slope and airspeed, and HAC predictor activity are impacted by large winds on the HAC.
New Astronaut Lesson Descriptions

77B  TAEM GUID 21011 (Concluded)

- Demonstrate cockpit cues for high energy – Energy Over Weight (EOW) scale, orbiter bug movement, and TAEM Guidance reaction.
- Demonstrate cockpit cues for low energy – Energy Over Weight (EOW) scale, orbiter bug movement, and TAEM Guidance reaction.
- Demonstrate the impact of large HAC with no Air Data.
- Demonstrate how to fly theta limits.
- Demonstrate the impact of multiple Accelerometer Assembly (AA) failures.
- Demonstrate flying Area Navigation using raw Tactical Air Navigation (TACAN) data.

78  IMU BR 21001

Title: Inertial Measurement Unit Briefing
Duration: 2.5 hours
Medium: Classroom
Student: ASCAN
Source: DS24/DPS/Navigation Training Group
Date: 03/05
Lesson(s) Replaced: IMU/ST/COAS 21001
Equipment Required: None
Prerequisite Lesson(s): REF DATA USE 21001, UNIV PTG 21001
Preparation: Read:
- SCOM; Section 2.13
- Inertial Measurement Units (IMUs)
- Star Trackers
- Crew Optical Alignment Sight (COAS)

Synopsis: This briefing reviews Inertial Measurement Unit (IMU), Star Tracker, and Crew Optical Alignment Sight (COAS) functions, procedures, and displays. Emphasis is placed on IMU alignment procedures and the associated Orbit Operations (Ops) Checklist (C/L) data. IMU redundancy management will also be reviewed. The Head-Up Display (HUD) calibration will be discussed along with the COAS calibration.

Objectives: 
- Describe the basic IMU, Star Tracker, and COAS/HUD hardware.
- Describe IMU, Star Tracker, and COAS General Purpose Computer (GPC) interface.
- Explain the two modes of operation for an IMU.
- Define the IMU Built-In Test Equipment (BITE) and its impact on Primary Avionics Software System (PASS) and Backup Flight Software (BFS).
New Astronaut Lesson Descriptions

78  **IMU BR 21001 (Concluded)**

- State the operational functions of the IMUs, Star Trackers, and COAS/HUD.
- Summarize the nominal align procedures for the IMUs and Star Trackers.
- Describe the star tracker door hardware and operations.
- Summarize the calibration and sight mode procedures for the HUD.
- Explain the differences between the 3 IMU alignments: Matrix align, IMU/IMU align, and star align.
- State the two ways to move an IMU’s platform.
- Name the three Reference Stable Member Matrices (REFSMMATs) and state their purpose.
- Explain basic IMU attitude and velocity redundancy management schemes for PASS and BFS.
- Explain the purpose of IMU skewing.
- Explain PASS and BFS state vector schemes for ascent, orbit, and entry.

79  **E DAP SKL BR 21001**

Title: Entry Digital Autopilot Skills Briefing  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN (Schedule in groups of about 15.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 04/06  
Lesson(s) Replaced: None  
Equipment Required: ENT C/L  
Prerequisite Lesson(s): E DAP BR 21001  
Preparation: Read:
- Entry Flight Procedures Handbook  
  - 5.1.9, Off-Nominal Procedures  
    - 5.1.9.1, High Frequency Oscillators  
    - 5.1.9.3, Aileron Trim Saturation  
    - 5.1.9.4, RCS Critical Entry  
- SCOM  
  - Section 7.3, Entry Takeover through Backup Flight System  
  - Section 7.4, Handling Qualities
New Astronaut Lesson Descriptions

E DAP SKL BR 21001 (Concluded)

Synopsis: This class covers DAP performance in off-nominal situations. Presented will be Reaction Control System (RCS) and aerosurface failures that impact entry DAP. Rationale of the off-nominal procedures will be discussed, but the student will be expected to perform the procedure only in later lessons. The rationale discussion will build student confidence in the procedures. A list of DAP-related caution and warning messages and crew actions will be presented. A review of the Flight Control System (FCS) airspeed and alpha limitations, with emphasis on the consequences of violating these limitations, will also be presented. Lastly, situations in which entry DAP can contribute to a loss of vehicle control will be discussed.

Objectives:

• State when the No Yaw Jet mode is certified.
• Explain the mechanics of flying the No Yaw Jet mode.
• State the minimum number of RCS jets required for certified flight.
• Explain how to perform the ARCS QTY <10% procedure on the ENTRY CONTROL cue card given a copy of the procedure.
• Explain how to perform the HIGH-FREQ OSC OR SURF/JET CYCLE procedure given a copy of the procedure.
• Explain how to perform the AIL TRIM ≥3° procedure on the ENTRY CONTROL cue card given a copy of the procedure.
• State the expected aileron trim given a Y center of gravity (c.g.).
• State the orbiter angle of attack vs. Mach number limits established by the FCS and the consequences of exceeding these limits.
• State the signature of an adverse aileron trim and what crew actions are required.
• State the adverse impacts the Beta Washout Filter can have on flight control and what crew actions are required.

E DAP 21001

Title: Entry Digital Autopilot Prebrief
Duration: 1.0 hour
Medium: Classroom or DST 6 (Ascent/Entry Trainer)
Student: ASCAN (Schedule 4 ASCANs.)
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E DAP SKL BR 21001
New Astronaut Lesson Descriptions

80A  **E DAP 21001 (Concluded)**

**Preparation:** Review:
- Entry Checklist (C/L)
  - Entry Control cue card
  - Entry Maneuvers cue card

**Synopsis:** This prebrief prepares the student for E DAP 21011. A copy of the SMS script will be provided to the student. Flight demonstrations to be accomplished during the lesson will be discussed. Crew procedures for monitoring nominal DAP performance (Entry DAP Briefing) and actions for DAP-related failures (Entry DAP Skills Briefing) will be reviewed. The prebrief will emphasize recognition and performance of the procedures, not the rationale for the procedure.

**Objectives:** State the crew actions for both nominal and off-nominal entry DAP conditions using an Entry Checklist (C/L).

80B  **E DAP 21011**

**Title:** Entry Digital Autopilot
**Duration:** 2.0 hours
**Medium:** SMS-MB or DST 6 (Ascent/Entry Trainer)
**Student:** ASCAN (Schedule 2 ASCANs. A 4-hour SMS session will be split into two 2-hour blocks with two students per block. A Pilot is not required for each session.)
**Source:** DS66/G&C/Propulsion Training Group
**Date:** 10/05
**Lesson(s) Replaced:** E FCS 22011
**Equipment Required:** None
**Prerequisite Lesson(s):** E DAP 21001

**Preparation:** None

**Synopsis:** This lesson covers nominal and off-nominal DAP performance. Nominal DAP reconfiguration and handling characteristics will be covered. All nominal and off-nominal procedures that are related to DAP will be covered. The student will explore the airspeed and alpha limits of the Flight Control System (FCS) and see the consequence of violating these limits.

**Objectives:**
- While performing a nominal entry, state the major events in DAP reconfiguration.
- Accomplish scripted flight demonstrations and explain the vehicle response to:
  - Zero angle of attack while hypersonic
  - No yaw jet at qbar > 10
New Astronaut Lesson Descriptions

80B  E DAP 21011 (Concluded)

- Wraparound DAP at qbar > 10
- Effect of panel trim switches
- Auto vs. fixed elevon schedule
- Various body flap positions
- Various speed brake positions

- Recognize and respond to the following off-nominal conditions:
  - Aileron trim due to Center of Gravity (c.g.)
  - DAP Caution and Warning (C&W) messages
  - Critical Reaction Control System (RCS) propellant quantity

81  E GUID BR 21001

Title: Entry Guidance Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TAEM GUID 21011
Preparation: Read:
  - SCOM; Section 7.3

Synopsis: This lesson covers the Entry Guidance algorithm that functions from five minutes prior to atmospheric reentry (Entry Interface-5 (EI-5)) to Terminal Area Energy Management (TAEM) interface (earth relative velocity = 2500 fps). Entry Guidance control of downrange and crossrange will be explained. Manual calculations that emulate Entry Guidance will also be introduced. The focus will be on end-of-mission entries, although Transatlantic Abort Landing (TAL) entries will also be covered. The TAL unique aspects of Entry Guidance will be covered in the abort classes.

Objectives:
- Determine desired hdot, reference hdot, desired drag, and current drag given an Entry TRAJ display.
- Identify on an ENTRY TRAJ display the parameters supplied by Entry Guidance.
- Using the ENTRY TRAJ display, determine maximum drag and whether or not Entry Guidance will violate it.
- Define high and low energy states and state how Entry Guidance reacts to each.
- State the two types of prebank and when each is used.
New Astronaut Lesson Descriptions

81  E GUID BR 21001 (Concluded)

- Explain why large bank angles are not necessarily more thermally severe at high Mach numbers.
- Describe how Entry Guidance controls crossrange.
- State the conditions for performing a roll reversal.
- Describe how a Ground Controlled Approach (GCA) is performed during entry.

82  IMU FAM 21006

Title: Inertial Measurement Unit Familiarization
Duration: 2.0 hours
Medium: SST 1 or SST2 or SST 3
Student: ASCAN (Schedule individually.)
Source: DS24/DPS/Navigation Training Group
Date: 04/06
Lesson(s) Replaced: IMU 21005, IMU/ST/CO 21005X
Equipment Required: None
Prerequisite Lesson(s): IMU BR 21001
Preparation: Skim:
  - STRK/HUD/COAS 21002
Read:
  - IMU 21002

Synopsis: This lesson gives the student the opportunity to use an orbiter-type keyboard to perform nominal procedures involving Inertial Measurement Units (IMUs), Star Trackers (STRK), and Crew Optical Alignment Sight (COAS)/Heads-Up Display (HUD). The IMU ALIGN and S TRK/COAS Control (CNTL) Specialist Functions (SPECs) are discussed in detail and are used to perform the procedures. The student will complete a HUD calibration although neither the COAS nor HUD will be available. The student will be able to monitor the effects and results of the above actions on the appropriate DPS displays. The student will also perform a reference recovery for an IMU that has lost its inertial reference, aided and with FDF.

Objectives:
- Describe the purpose of the IMUs, Star Trackers, and HUD/COAS.
- State the location of the IMUs, Star Trackers, and HUD/COAS.
- Identify the control switches for the IMU, Star Trackers, and HUD/COAS.
- Activate the Star Trackers and open the doors using the Post-Insertion FDF.
- Explain the Star Tracker information and star table on SPEC 22.
- Explain the information and options available on SPEC 21.
New Astronaut Lesson Descriptions

82 IMU FAM 21006 (Concluded)

- Perform a nominal IMU ALIGN-S TRK after maneuvering to the required attitude.
- Describe the information and options available for the COAS/HUD on SPEC 22.
- Perform, aided, a nominal HUD Calibration (CAL) after maneuvering to the required attitude.
- Describe the differences between a COAS and HUD CAL.
- Explain the operational differences in the Standby (STBY) and Operate mode for an IMU.
- Perform the IMU reference recovery align procedure when a good IMU reference exists.

83 ENT C/L RVW 21001

Title: Entry Checklist Review Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: ENT C/L, D/O PREP C/L
Prerequisite Lesson(s): E NAV BR 21001
Preparation: Read:
  - SCOM; Sections 5.4 and 5.5, Normal Procedures, Entry and Normal Procedures, Post-landing

Synopsis: This lesson is designed to prepare the student for A/E FAM 21011, and to be a review of the Entry Checklist (C/L) procedures and the cue cards used during entry. The following Entry C/L procedures will be reviewed in detail:
  - Deorbit Burn
  - Deorbit Flight Rules
  - 1-Orbit Late
  - Post Burn
  - Entry No-Go C/L
  - Entry Maneuvers
  - Mach/Alpha
  - Post Landing
New Astronaut Lesson Descriptions

83 ENT C/L RVW 21001 (Concluded)

Objectives:
• Show the flow through the Entry C/L for given scenarios.
• Explain the rationale behind the bolded, capitalized procedures in the Entry C/L.

84 A/E DPS MAL 21001

Title: Ascent/Entry Data Processing System Malfunctions
Duration: 2.5 hours
Medium: Classroom
Student: ASCAN
Source: DS24/DPS/Navigation Training Group
Date: 03/05
Lesson(s) Replaced: DPS I/O BRF 21001
Equipment Required: None
Prerequisite Lesson(s): DPS FAM 23006, REF DATA USE 21001
Preparation: Review:
• SCOM
  – Section 6.8, System Failures, DPS except Set Splits
  – Appendix D, DPS Rules of Thumb
  – Appendix C, DPS Study Notes, except Set Splits
• A/O/E Pocket C/Ls, AESP, and Cue Cards FPH
  – DPS – DATA PROCESSING SYSTEM OVERVIEW, MULTI DATA PATH LOSS, RESTRING (Cue Cards)

Synopsis: This briefing reviews the functional operation of the DPS, presents failure modes and the associated signatures, and discusses specific procedures. This class emphasizes ascent and entry DPS. There will be a general discussion of several DPS procedures and a few will be covered line by line. The Multiplexer/Demultiplexer (MDM) section of Ref Data, Multi Data Path Loss procedure, and Restring Cue Cards will be covered in detail. Exercises for the student are included to emphasize particular points in the material.

Objectives:
• Explain the purpose of each of the seven types of data buses.
• Describe the methods by which the Backup Flight Software (BFS) obtains data from the Primary Avionics Software System (PASS).
• Differentiate the signatures for the various PASS General Purpose Computer (GPC) failures (Fail to Sync (FTS), Fail to Halt (FTH), Power, Quit, Input/Output (I/O) Terminate (Term) B, I/O Term A).
• Differentiate the signatures for the various BFS GPC failures (FTH, Power, Quit, FTH Transient, Power Transient, Standalone, Standby (STBY), I/O Term A).
• Define the functional components of an MDM.
New Astronaut Lesson Descriptions

84  **A/E DPS MAL 21001 (Concluded)**

- Explain the impact of a total and a partial bypass of an MDM and be able to identify the respective signatures.
- Describe how a port mode works, and when Flight Rules will allow one.
- Identify the signature and discuss the implications of a non-universal I/O Error.
- Identify the signature and explain the impact of a Flight Critical (FC) databus failure at the PASS and BFS GPC.
- Identify the losses associated with a total or partial MDM failure using Ref Data.
- Identify DPS failure modes when given various signatures.
- Describe how and when to apply the ascent and entry restrings.
- Identify the impacts of multiple data path losses and explain steps to handle the losses.

85  **ORB DAP 21057**

Title: Orbit Digital Autopilot  
Duration: 2.0 hours  
Medium: CBT  
Student: ASCAN  
Source: DS66/G&C/Propulsion Training Group  
Date: 02/04  
Lesson(s) Replaced: ORB DAP 21064  
Equipment Required: None  
Prerequisite Lesson(s): ORB OPS OV 21001  
Preparation: None

Synopsis: This lesson is designed as an introductory exercise to familiarize the student with the displays, controls, and crew procedures associated with the orbit Reaction Control System (RCS) DAP. After some sections, exercises are provided to review the material presented.

Objectives:  
- Describe the principal DAP functions.  
- Identify the tools used to reconfigure the DAP.  
- Select DAP functions based on flight-specific requirements.
New Astronaut Lesson Descriptions

86  ASC C/L RVW 21001

Title:     Ascent Checklist Review Briefing
Duration:  3.0 hours
Medium:    Classroom
Student:   ASCAN
Source:    DS66/G&C/Propulsion  Training Group
Date:      07/04
Lesson(s) Replaced:  None
Equipment Required:  ASC C/L
Prerequisite Lesson(s):  ENT C/L RVW 21001
Preparation:  None

Synopsis:  This lesson is designed to be a review of the Ascent Checklist (C/L) procedures that are used for a nominal ascent. The review will start with prelaunch and go through post Orbital Maneuvering System-2 (OMS-2). The review will include an in-depth discussion of the following Ascent C/L procedures:
• Prelaunch
• Recycle
• Ascent Procedures
• No COMM Mode Boundary
• Systems Flight Rules
• OMS-1/2 Targeting
• OMS TGTS

In addition, the Landing Site Table and Communication Coverage chart will be briefly discussed. This lesson is designed to prepare the student for A/E FAM 21011. ABORT FDF 21001 will cover the procedures used for abort cases (Return-To-Launch Site (RTLS), Transatlantic Abort Landing (TAL), Abort to Orbit (ATO), and Abort Once Around (AOA)).

Objectives:
• Show the flow through the Ascent C/L for given scenarios.
• Explain the rationale behind the bolded, capitalized procedures in the Ascent C/L.

87  E GUID 21057

Title:     Entry Guidance
Duration:  2.0 hours
Medium:    CBT
Student:   ASCAN (Schedule in pairs or groups of 4.)
Source:    DS66/G&C/Propulsion  Training Group
Date:      10/05
Lesson(s) Replaced:  None
New Astronaut Lesson Descriptions

87  **E GUID 21057 (Concluded)**

**Equipment Required:** None  
**Prerequisite Lesson(s):** E GUID BR 21001  
**Preparation:** None

**Synopsis:** Space Flight Resource Management (SFRM) manual flying techniques and monitoring Entry Guidance will be emphasized. The manual flying techniques taught in this class are designed to teach the student how Entry Guidance works. This CBT is not available for self study. The instructor will lead the student through several cases via the CBT in a classroom.

**Objectives:**
- Fly from the top of TRAJ 1 to Terminal Area Energy Management (TAEM) interface using desired altitude rate.
- Fly the orbiter through TRAJ 1 and TRAJ 2 after delaying the first non-zero roll command (active control will start at an Hdot of + 180 fps).
- Contrast a Transatlantic Abort Landing (TAL) entry trajectory to that of a nominal Entry.
- Fly a low energy/high crossrange entry to demonstrate the difficulty of Delta Azimuth (DEL AZ) control under these conditions.
- Achieve and maintain 2.5 G’s using the Entry Displays and Entry Alpha Cue Card.

88  **A/E FCS BR 21001**

**Title:** Ascent/Entry Flight Control System Briefing  
**Duration:** 3.0 hours  
**Medium:** Classroom  
**Student:** ASCAN  
**Source:** DS66/G&C/Propulsion *Training Group*  
**Date:** 02/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** AESP  
**Prerequisite Lesson(s):** A/E DPS MAL 21001  
**Preparation:** Read:
- FCS/EFF 21002
- SCOM, Section 2.13, Aerosurface Servo Amplifiers through Ascent Thrust Vector Control
New Astronaut Lesson Descriptions

88 A/E FCS BR 21001 (Concluded)

Synopsis: This lesson is designed to prepare students for A/E FCS 21006. This lesson is divided into five basic parts:
- Command/data flow from the General Purpose Computers (GPCs) to the aerosurfaces
- Aerosurface Servo Amplifier (ASA) feedback
- Ascent Thrust Vector Control (ATVC) and ASA hardware components
- Crew interfaces (SYS SUMM 1, GNC SPEC 53 and GNC SPEC 1)
- Failure scenarios

Objectives:
- Trace the flow from the Flight Control System (FCS) command source through the Multiplexer/Demultiplexer (MDM) to the specific actuators.
- Describe the basic components of the ATVC and ASA actuator hardware including servovalve, isolation valve, and bypassing a port.
- Explain the events that cause a port to bypass and the mission impacts of the port bypass.
- Describe the Redundancy Management (RM) scheme of aerosurface actuator feedback.
- Identify malfunctions using the following cockpit signatures SYS SUMM 1, SPEC 53, F7 Caution and Warning (C&W) lights, and GPC Fault messages.
- Describe how the body flap differs from the other actuators.

89 PTG 21006

Title: Pointing
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: DAP 21012
Equipment Required: None
Prerequisite Lesson(s): ORB DAP 21057
Preparation:
- UNIV PTG 21001
New Astronaut Lesson Descriptions

PTG 21006 (Concluded)

Synopsis: During this lesson, the student will exercise every available option for maneuvering the orbiter using the Universal Pointing (UNIV PTG) display. The first maneuvers will stress proper execution of item entries and identify how to monitor a maneuver from start to finish. Each maneuvering option will then be demonstrated along with a realistic mission application. Some exercises require multiple maneuvers in order to achieve a given mission objective or complete a procedure. The student will be asked to perform maneuvers with and without FDF, and to execute more of the maneuvers without instructor assistance as the lesson progresses. An orbiter model will be used in the lesson to visualize each maneuver before it is commanded. As an end-of-lesson quiz, the student will be given a set of constraints and asked to perform the maneuver(s) necessary to satisfy them.

Objectives:

- Describe how to setup, execute, and monitor vehicle maneuvers with the UNIV PTG page for M50 attitudes and for tracking a specified target with a body vector.
- Modify the commanded discrete maneuver rate on the SPEC 20 DAP page.
- Perform, aided, a maneuver to track the center of the Earth with the -Z body axis and an omicron optimized for maintaining air-to-ground communications.
- Perform, aided, an M50 (pitch-yaw-roll) maneuver to an attitude specified in the Orbit Operations Checklist (ORB OPS C/L) STAR PAIRS Preliminary Advisory Data (PAD) for acquiring star data with the Star Trackers.
- Compare inertial and LVLH attitude-hold options using M50 maneuver, target tracking maneuver, and manual DAP.
- Perform additional maneuvers and maneuver sequences, which exercise every other available option on the UNIV PTG display except reboost.
- Identify constant orbital rate while in Earth-center track attitude hold.
- Identify varying orbital rate while in Earth-surface track attitude hold.
- Develop and execute a maneuver sequence for passive thermal control.
- Command a maneuver to be executed at a time in the future.
- Demonstrate different UNIV PTG methods to perform multiple maneuvers for single Star Tracker Inertial Measurement Unit (IMU) align operations.
- Demonstrate UNIV PTG display errors caused by mathematical singularity points.
New Astronaut Lesson Descriptions

90 **SFRM OV 21001**

Title: Space Flight Resource Management Overview  
Duration: 4.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: *DS66/G&C/Propulsion Training Group*  
Date: 01/04  
Lesson(s) Replaced: SFRM 21001  
Equipment Required: None  
Prerequisite Lesson(s): ASC OV 21001  
Preparation: Read:  

Synopsis: This lesson introduces the student to Space Flight Resource Management (SFRM) concepts, and standardizes SFRM vocabulary and methodology. Concepts are defined, including those for SFRM and Windows of Awareness. The six performance elements of SFRM, the skills associated with each element, and the relationships between the elements are discussed. Students then practice identifying SFRM philosophy and methodology, and using a standardized SFRM vocabulary, with selected video clips.

Objectives:  
- Define SFRM.
- Define the concept of Windows of Awareness.
- Explain each of the six SFRM performance elements.
- Identify SFRM skills while observing selected video clips.

91 **E GUID 21011**

Title: Entry Guidance  
Duration: 4.0 hours  
Medium: SMS-MB  
Student: ASCAN (Schedule 2 ASCANs, no CB IA. A Pilot is not required for each session.)  
Source: *DS66/G&C/Propulsion Training Group*  
Date: 07/04  
Lesson(s) Replaced: E GUID 21001  
Equipment Required: None  
Prerequisite Lesson(s): E GUID 21057  
Preparation: None
New Astronaut Lesson Descriptions

91  **E GUID 21011 (Concluded)**

**Synopsis:** This is a hands-on flying lesson. Most cases will be high energy, where the student must take Control Stick Steering (CSS) and fly desired Hdot to avoid over-tempering/over-Ging the vehicle. Emphasis will be placed on good Space Flight Resource Management (SFRM) and monitoring AUTO guidance. A short demonstration of a prebank, the phugoid damper, “ROLL REF” alert, and minimum roll is included.

**Objectives:**
- Fly the orbiter through TRAJ1 and TRAJ 2 after delaying the first non zero roll command (active control to start at an Hdot of +180 fps).
- Achieve and maintain 2 G’s using the Entry Displays and Entry Alpha Cue Card.
- Identify Entry Guidance information on the TRAJ display.
- Fly the phugoid damper successfully.
- Fly a prebank successfully.
- Identify Entry Guidance reaction to a density shear.

92A  **A/E FCS 21001**

**Title:** Ascent/Entry Flight Control Surfaces Prebrief
**Duration:** 0.5 hours
**Medium:** Classroom
**Student:** ASCAN (Schedule in pairs.)
**Source:** DS66/G&C/Propulsion Training Group
**Date:** 02/04
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** A/E FCS BR 21001
**Preparation:** None

**Synopsis:** This prebrief will review the Flight Control System (FCS) operations for the Ascent and Entry flight phases.

**Objectives:**
- Identify FCS channel failures using available DPS displays, GPC Fault messages, master alarm, and Systems Management (SM) alert.
- State when Fault Detection, Identification, and Reconfiguration (FDIR) quits and the selection filter downmodes for FCS position feedback errors.
- Define aerosurface positions and moments.
- Explain when manual port bypassing is necessary.
- Explain prioritization as it relates to FCS channel management.
- Explain FCS channel actions in General Purpose Computer (GPC) and Flight Aft Multiplexer/Demultiplexer (FA MDM) failure scenarios.
- Define bodyflap Caution and Warning (C&W).
New Astronaut Lesson Descriptions

92B  A/E FCS 21006

Title: Ascent/Entry Flight Control System
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group

Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): A/E FCS 21001
Preparation: None

Synopsis: The focus of this lesson is on Flight Control System (FCS) channel management. This lesson will allow students to practice identifying various types of failures using the fault messages, Caution and Warning (C&W) lights and DPS displays. The FCS CH 1 (2,3,4) (2nd FAIL) procedures will be executed, and the associated rationale will be discussed. The instructor will provide a discussion about SPEC 53, allowing students to practice bypassing and resetting aerosurface ports. The instructor will also point out the limited crew insight as compared to mission control. The student will also concentrate on procedures, which involve the FCS. Many of the failures are DPS related, such as the PASS GPC FAIL procedure. The instructor will limit discussion to FCS-related steps of the DPS procedures. In conclusion, various body flap messages will be examined, and differences between the body flap and the other aerosurfaces will be discussed.

Objectives:
- Identify the following FCS Channel signatures for both Aerosurface Servo Amplifier (ASA) and Ascent Thrust Vector Control (ATVC) systems using SPEC 53, SYS SUMM 1, F7 C&W lights, and fault messages:
  - Port bypass
  - Command bias
  - Feedback bias
  - General Purpose Computer (GPC)/Multiplexer/Demultiplexer (MDM) failures
  - ASA/ATVC power failures
- Describe the function of the FCS Channel override switch position.
- Identify why a 2-second delay is required between FCS switch throws.
- Bypass and reset a port using SPEC 53.
- Execute the following procedures and describe the rationale as it concerns FCS:
  - FCS CH 1 (2,3,4) (2nd FAIL)
  - PASS GPC FAIL
New Astronaut Lesson Descriptions

92B  A/E FCS 21006 (Concluded)

- FA/FF MDM I/O ERROR
- POST OPS 3/GRTLS TRANSITION RESTRING
- BCE STRING D (optional)

- Identify the causes of the FCS SAT POS, and the FCS SAT MOM fault messages.
- State the priority between ATVC malfunctions and ASA malfunctions for ascent and entry.
- Describe how an Auxiliary Power Unit (APU) failure affects the body flap.
- Identify the cause of the following body flap fault messages:
  - BODY FLAP FAIL
  - BODY FLAP CYCLE
  - BODY FLAP HOLD

93  SFRM APPL METH 21001

Title: Space Flight Resource Management Applied Methods
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: SFRM 21001
Equipment Required: None
Prerequisite Lesson(s): SFRM OV 21001
Preparation: None

Synopsis: This second lesson in Space Flight Resource Management (SFRM) will stress how the SFRM concepts can be applied to future Shuttle and Station training and missions. The students will practice their SFRM performance observation and critiquing skills during a simulated SMS session. A review of the roles and responsibilities of both the crew and training team with respect to SFRM training will be discussed.

Objectives:
- Explain how the various SFRM performance elements relate to one another.
- Identify SFRM skills while observing two actual flight examples.
- Given the criteria for effective SFRM debriefs, evaluate the SFRM debrief during two training examples.
New Astronaut Lesson Descriptions

94 **G&C SENS BR 21001**

Title: Guidance and Control Sensors and Controllers Briefing  
Duration: 3.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: DS66/G&C/Propulsion *Training Group*  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): A/E FCS BR 21001

Preparation: Read:
- SCOM; Section 2.13, Flight Control System Hardware up to, but not including, Trim Switches

Synopsis: This briefing includes principles of operation, power sources, data flow, and redundancy management for the following sensors and controllers: Orbiter Rate Gyro Assemblies (RGAs), Solid Rocket Booster (SRB) RGAs, Accelerometer Assemblies (AAs), Rotational Hand Controller (RHC), Translational Hand Controller (THC), Rudder Pedal Transducer Assembly (RPTA), Speed Brake Thrust Controller (SBTC). Impacts due to DPS and EPS failures on these sensors and controllers are examined in detail, as well as their impacts on the vehicle’s control capability.

Objectives:
- State the Guidance and Control (G&C) sensors used by flight control.
- Explain how the G&C sensors are used during ascent and entry.
- State the parameter(s) that each G&C sensor supplies, its power source(s), and data bus channelization.
- Describe the Redundancy Management (RM) schemes used for the G&C sensors.
- Describe how the crew interacts with the G&C sensors.
- Describe what happens when the G&C sensor feedback into the General Purpose Computers (GPCs) is bad.
- State the G&C controllers available in the cockpit.
- Describe when each G&C controller is available and how the crew uses them.
- State the G&C controller power sources and data bus channelization for each controller.
- Describe the RM schemes for the G&C controllers.
- Describe the available crew interfaces for the G&C controllers.
- Find the applicable procedure in the FDF given G&C controller failure scenarios.
PAPER SIM 21001

Title: Paper Simulation
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN (Schedule 4 ASCANs.)
Source: DA7/Assigned SMS Team
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SFRM APPL METH 21001
Preparation: Review:
  • Ascent C/L
    – OMS Failures cue card
    – OMS Targeting
  • AESP
    – Glided Flight; DPS Section, Restring Procedures
    – Powered Flight and Glided Flight; DPS Section, Multi Data Path Loss
    – Powered Flight and Glided Flight; EPS Section, Electrical Bus loss procedures
  • Ref Data
    – Electrical Bus Loss Tables
    – MDM Bus Loss Tables

Synopsis: This lesson is designed to prepare the student for multisystem malfunction ascent, abort, and entry cases. This lesson is conducted like a sim, but without the high-fidelity simulator. The student will be presented with an ascent or entry scenario that has a set of failures. The cockpit signatures associated with these failures will be provided to the student. The student is allowed to ask the instructors for any information that would normally be available to the crew at that time. The students will then be required to identify the failure (based on the provided signatures), make the appropriate MCC call, determine the FDF procedure to be worked (if required), and determine the system/mission impacts. In several cases, the students will also be asked to state what the next worst failure would be. This class emphasizes those failures that affect multiple orbiter systems (e.g., EPS, DPS failures).
New Astronaut Lesson Descriptions

95  PAPER SIM 21001 (Concluded)

Objectives:  • Based on the cockpit signature provided by the instructor, perform the following:
  – Identify malfunction.
  – Make the appropriate MCC call.
  – Identify appropriate procedure to be used for the failure (if required).
  – Identify the multi-discipline effects for the given failure.
  – Identify the system/mission impacts of the given failure during the selected phase of flight.
  – Identify the “next worse failure.”

96  ASC GUID BR 21001

Title:  Ascent Guidance Briefing
Duration:  3.0 hours
Medium:  Classroom
Student:  ASCAN
Source:  DS66/G&C/Propulsion Training Group
Date:  08/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  NAV OV BR 21001, G&C SENS BR 21001,
A/E FCS BR 21001
Preparation:  Read:
  • ASC G&C 21002
    – Section 1.0, Overview
    – Section 2.0, First Stage Guidance
    – Section 3.0, Second Stage Guidance
  • Optional reading:
    – Section 6.0, Cockpit Displays and Controls

Synopsis:  This lesson is a functional introduction to the software algorithms of automatic guidance as applied to the operational environment. A discussion of ascent aerodynamics and vehicle limitations as related to guidance is provided to familiarize astronauts with operational nomenclature. Major events and moding of each guidance phase is presented to promote the astronaut’s ability to monitor guidance functions from the cockpit. The Ascent Checklist and cockpit displays are re-introduced to provide insights to guidance-related information in the cockpit. A brief discussion on manual guidance is included. This lesson is one in a series that prepares an astronaut candidate for a Shuttle Avionics Integration Laboratory (SAIL) assignment.
New Astronaut Lesson Descriptions

96  ASC GUID BR 21001 (Concluded)

Objectives:
• Identify guidance functions and moding using observable cockpit cues.
• Identify the vehicle limitations that drive the guidance design.
• State how guidance issues throttle and steering commands for each flight phase.
• Identify the differences between nominal and abort guidance.
• Compare OMS burn guidance to main stage guidance.
• Demonstrate how to initiate and terminate manual guidance.

97A  A/E FAM 21001

Title: Ascent/Entry Familiarization Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN, PS (Schedule 3 ASCANs, 1 CB IA.)
Source: DA7/Assigned SMS Team
Date: 03/05
Lesson(s) Replaced: ASC FAM 21001
Equipment Required: None
Prerequisite Lesson(s): SFRM APPL METH 21001
Preparation:
  Complete: GNC DED DISP 21057
  Review:
    • Ascent C/L
      - Prelaunch, starting at T-9:00
      - ASC
      - POST OMS-1
      - OMS-2 Burn cue cards
      - POST OMS-2
    • Entry C/L
      - D/O BURN
      - Post BURN
      - Entry Maneuvers cue card
      - Post Landing
    • SCOM
      - Section 5.1, Pre-Launch starting at T-9:00
      - Section 5.2, Ascent, through OMS-2
      - Section 5.4, Entry, start at TIG-15 minutes
      - Section 5.5, Post-Landing
New Astronaut Lesson Descriptions

97A  A/E FAM 21001 (Concluded)

Synopsis: This lesson is designed to prepare the student for A/E FAM 21011. Because the students will have had several entry SMS lessons prior to this one, this prebrief will emphasize the ascent phase of flight. This lesson will review the information displayed on the Ascent CRT TRAJ displays. In addition, this lesson will discuss typical CRT/Dedicated Display scan patterns for ascent and entry. An ascent flight deck video will be shown to support a discussion about the responsibilities and tasks of each flight deck position.

Objectives:  
- Recognize and respond to all nominal ascent and entry MCC calls.
- Describe how the Ascent TRAJ displays are used to monitor the orbiter’s performance and guidance.
- Describe how the dedicated displays are used to monitor the orbiter’s performance and guidance.
- Determine crewmember seating assignments, responsibilities, and tasks.

97B  A/E FAM 21011

Title: Ascent/Entry Familiarization
Duration: 4.0 hours
Medium: SMS-MB
Student: ASCAN, PS (Schedule 3 ASCANs, 1 CB IA.)
Source: DA7/Assigned SMS Team
Date: 07/04
Lesson(s) Replaced: ASC FAM 21011
Equipment Required: None
Prerequisite Lesson(s): A/E FAM 21001
Preparation: None

Synopsis: This lesson pulls together information from ascent and entry briefings, entry SMS lessons, and system-specific SST lessons. This lesson provides the opportunity for the students to execute all of the nominal ascent and entry FDF procedures in a realistic cockpit environment. Two ascents will be performed. The first ascent will be performed from T-9 minutes to post OMS-2, and the second ascent will be performed from T-2 through ET SEP. The entry will be performed from D/O-15 minutes through post-landing. The crew should switch seating assignments between runs.
New Astronaut Lesson Descriptions

97B  **A/E FAM 21011 (Concluded)**

Objectives:
- Perform a nominal ascent from T-9 through the OMS-2 burn using the FDF.
- Perform a nominal entry from Deorbit-15 min through the post-landing procedures using the FDF.
- Coordinate the required nominal tasks among the flight deck crewmembers.

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98  **TIER TEST 23001**

Refer to TIER TEST 21001 for description.

99  **ESC EQ/SYS 21001**

Title:  Escape Equipment/Systems Briefing (Shared – Shuttle)
Duration:  2.0 hours
Medium:  Classroom
**Note:**  Schedule suitroom in Bldg. 9, and CCT, CCT II, or FFT for last 30 minutes of lesson.
Student:  ASCAN (Schedule in groups of up to 10.)
Source:  *DX45/Crew Systems Group*
Date:  08/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  CREW CAB FAM 21020
Preparation:  Read:
  - CREW ESCAPE SYSTEMS 21002

Synopsis:  This lesson introduces the student to crew-worn equipment, orbiter equipment, and systems associated with emergency egress. Material presented will include the ACES, helmet, harness, parachute, cabin vent, hatch jettison, escape panel pyrotechnics, escape pole, egress slide, Sky Genie, survival gear, orbiter seats, and egress assists.

In addition to these, a brief discussion of the launch pad egress systems and slidewire baskets is presented. A video will be shown on crew-worn equipment, orbiter equipment, and launch pad equipment and systems. The last 30 minutes of the class will be spent in the CCT, CCT II, or FFT, looking at the orbiter equipment, and deploying the engineering escape pole mockup.
New Astronaut Lesson Descriptions

99 **ESC EQ/SYS 21001 (Concluded)**

Objectives:
- Describe the crew-worn equipment and associated systems, their function, and their purpose.
- Describe the orbiter escape equipment and systems, their function, and their purpose.
- Describe the emergency equipment located at the launch pad, its function, and its purpose.

100 **SWITCH RM BR 21001**

Title: Switch Redundancy Management Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): G&C SENS BR 21001
Preparation: None

Synopsis: This lesson introduces the student to switch Redundancy Management (RM). The lesson will identify the reasons for multiple contact switches and will also describe the common failures that can impact the operation of orbiter switches. Finally, the lesson will identify the General Purpose Computer (GPC) Fault messages that are generated by the aforementioned failure and will discuss the impact of the failure.

Objectives:
- Recognize that some cockpit switches control hardware and some cockpit switches provide input into GPCs.
- Identify the potential impact of control bus failures on switches.
- Identify the potential impact of Multiplexer/Demultiplexer (MDM) failures on switches.
- Identify the impact of the following GPC Fault messages:
  - BDY FLAP SW L(R)
  - DISPLAY SW L(R,A)
  - ET SEP MAN/ET SEP AUTO
  - ME SHDN SW
  - PNL TRIM L(R)
  - G51 RL MODE SW
  - SENSE SW
New Astronaut Lesson Descriptions

100 SWITCH RM BR 21001 (Concluded)

- Identify which GPC Fault message is associated with the term "green dot."
- State why some switches are single contact and some switches have multiple contacts.
- Define the term “switch teasing.”

101 APU/HYD MAL BR 21001

Title: Auxiliary Power Unit/Hydraulic Malfunction Review
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: AESP, ORB PKT C/L
Prerequisite Lesson(s): APU/HYD OPS 21004
Preparation: Review:
- SCOM; Section 2.1

Synopsis: This lesson is a review of Main Propulsion System (MPS) interface, essential nominal operations, cockpit interface, and FDF procedures for the Auxiliary Power Units (APUs) and Hydraulic (Hyd) systems. Also covered is the Flight Rule rationale for critical procedures, and an FDF procedure location exercise is included.

The student will progress from the detailed technical aspects of the APU/Hyd system, as covered in the consolidated core briefing and nominal operations briefing, to operationally identifying and compensating for malfunctions.

Objectives:
- Identify the signatures of the following APU/Hyd malfunctions on ascent and/or entry via displays, meters, and other cockpit cues:
  - APU shift to high speed
  - APU overspeed
  - APU underspeed
  - APU oil overtemp
  - Hyd leak
  - Hyd pump failure
  - WSB leak
- Explain the guidelines, constraints, and rationale associated with the APU/Hyd malfunctions discussed in this class.
New Astronaut Lesson Descriptions

101 APU/HYD MAL BR 21001 (Concluded)

- Use Flight Rule rationale to explain when to shutdown an APU during powered flight.
- Explain the importance of performing the APU Shutdown procedure in the correct sequence.
- Describe the impacts of one and two failed Hyd systems on the MPS on ascent.
- Describe the impacts of one and two Hyd failed systems on gear deploy, braking, and nose wheel steering.
- List the reasons for restarting an APU during glided flight.

102 ABORT FAM BR 21001

Title: Abort Familiarization Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: ABORT BR 21001
Equipment Required: None
Prerequisite Lesson(s): A/E FAM 21001
Preparation: Read:
  - SCOM; Sections 6.1 to 6.6
  - Intact Ascent Aborts 21002

Synopsis: This lesson prepares the student for ABORT FAM 21011 SMS session, where the aborts described in the class will be practiced. The lesson describes the intact abort modes that could occur during the ascent flight phase, including Abort to Orbit (ATO), Abort Once Around (AOA), Transatlantic Abort Landing (TAL), and Return-To-Launch Site (RTLS). High energy TAL is considered a contingency abort, but will be discussed briefly in this class. At the end of the class, the student will be able to recognize, initiate, and assist in executing any of the intact aborts.

Objectives:
- List the four intact aborts.
- Describe the conditions that would cause the various intact aborts to be executed.
- Describe the trajectory of each of the intact aborts.
- Select the proper abort mode for a given set of conditions.
New Astronaut Lesson Descriptions

103 **IFM 21001**

Title: In-Flight Maintenance Overview Briefing  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN, PS  
Source: *DX44*/In-Flight Maintenance Group  
Date: 03/95  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None  

Synopsis: This lesson consists of a classroom briefing on the orbiter In-Flight Maintenance (IFM) capabilities from within the crew module. Photographs and a limited amount of hardware will be utilized to discuss IFM tasks, the location and accessibility of avionics, the tools required, and the IFM C/L procedures.

Objectives:  
- Describe IFM, the responsibilities of the IFM console operators, and the capabilities and constraints for the crew to perform IFM.  
- State the major types of information contained in the IFM C/L (general information, tools, component locations, and IFM procedures).  
- Describe representative IFM procedures from the IFM C/L that illustrate the types of procedures the crew may be expected to perform.  
- Describe some of the more interesting IFM procedures that have been performed in previous missions.

104 **P/L & APDS OV 21001**

Title: Payload and Androgynous Peripheral Docking System Overview Briefing  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: *DS45/Shuttle Systems Training Group and DO5/Cargo Integration and Operations Branch*  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None
New Astronaut Lesson Descriptions

104 P/L & APDS OV 21001 (Concluded)

Synopsis: The purpose of this briefing is to give the student an introduction to different types of payloads flown on the orbiter, interfaces to the payloads, and carriers. Payload operations and use of the FDF are briefly discussed.

In addition, the student will be provided with a top level familiarization of the APDS including hardware, crew interfaces, and nominal operation scenarios.

Objectives:
- State the different types of payloads and their interfaces flown on the orbiter.
- Identify the payload operations FDF documents.
- Explain how crewmembers and ground controllers interface with payloads.
- Describe a nominal docking and undocking sequence.
- Explain how crewmembers and ground controllers interface with the APDS.

105 SENS/CNTL 21006

Title: Sensors and Controllers
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): G&C SENS BR 21001
Preparation: None

Synopsis: During this lesson, the student will have the opportunity to study various malfunctions including Rate Gyro Assembly (RGA), Accelerometer Assembly (AA) and controller failures. In addition, the instructor will discuss controller operations and will provide students with the opportunity to operate the controllers. The runs will allow students to practice identifying various types of failures using the fault messages, Caution and Warning (C&W) lights, and DPS displays. The RM FAIL IMU, RGA, AA and RHC L(R) (2nd FAIL) procedures will be executed, and the associated rationale will be discussed. DPS malfunctions will also be presented, but the discussion will be limited to sensor-related steps of the procedures.
New Astronaut Lesson Descriptions

105 **SENS/CNTL 21006 (Concluded)**

Objectives:
- Identify AA, RGA, and controller malfunctions using SPEC 51, SYS SUMM 1, F7 C&W lights, and fault messages.
- Describe the Redundancy Management (RM) scheme for RGAs, AAs, and controllers in the Primary Avionics Software System (PASS) and Backup Flight System (BFS).
- Demonstrate the ability to operate the controllers by:
  - Using the Speed Brake Thrust Controller (SBTC) to open and close the speedbrake.
  - Taking Control Stick Steering (CSS) using either the CSS pushbuttons or by using a hot stick downmode.
  - Using the SBTC to throttle the main engines.
- Execute the following procedures and describe the rationale as it concerns Flight Control System (FCS):
  - RM FAIL RGA
  - RM FAIL AA
  - RHC L(R) (2nd FAIL)

106 **PDRS OV 21001**

Title: Payload Deployment and Retrieval System Overview Briefing
Duration: 1.5 hours
Medium: Classroom
Student: ASCAN
Source: *DX25/Robotics Shuttle Training Group*, CB/Astronaut Office, and ER3/Flight Robotics Systems Branch
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

**Synopsis:** This briefing will be presented in a Flight Plan format. The Summary Timeline will give the introduction and outline, and the Detailed Timeline will cover all RMS activities that occur prelaunch through post-landing inspection, including details on crew training, how the RMS works, RMS support equipment, and applications of the RMS in space flight.

The Ref Data section will cover specifics on the design of the RMS and safety considerations. The lesson will conclude with questions and answers and a video of past flights.
New Astronaut Lesson Descriptions

106 **PDRS OV 21001 (Concluded)**

Objectives:
- State the possible applications of the RMS in shuttle operations.
- Identify the RMS activities in each phase of flight (prelaunch to post-landing).
- Describe the need for different RMS modes of operation.
- Recall high-level design characteristics and safety considerations for the RMS.

107A **CCTV MAL 21001**

Title: Closed Circuit Television Malfunction Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: ASCAN (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 01/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CCTV OPS 21008
Preparation: Review:
  - SCOM; Section 2.3, CCTV

Synopsis: This prebrief will introduce the student to some basic troubleshooting techniques for the CCTV system as well as the use of FDF to aid in resolving the malfunctions. The briefing will begin with an operations review of the CCTV system and will allow the students to concentrate on malfunction recognition and resolution of failures in the SST.

Objectives:
- List the major steps involved in activating the CCTV system per the cue card.
- Identify the procedures corresponding to given CCTV signatures.
- Identify cues to assist in determining the location of the failure (e.g., nominal configuration, monitor, panel A7, and alert messages).
CCTV MAL 21008

Title: Closed Circuit Television Malfunction
Duration: 1.0 hour
Medium: SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 01/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CCTV MAL 21001
Preparation: None

Synopsis: This lesson introduces the student to CCTV malfunction procedures while configuring for nominal operations. The student will be required to recognize and resolve CCTV monitor, camera, and power failures affecting the CCTV system using FDF.

Objectives: • Perform the following for each malfunction listed below:
  – Identify the associated signatures.
  – Perform the applicable malfunction procedure.
  – Explain the rationale for each step and the impact of the failure.
• Malfunctions:
  – Monitor failures
  – Camera overtemp
  – Loss of exterior camera video
  – Sync generator failure
  – Main power failure
New Astronaut Lesson Descriptions

108 RNDZ OV 21001
Title: Rendezvous and Proximity Operations Overview Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DM34/Rendezvous Guidance, Procedures and Training and CB/Astronaut Office
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PTG 21006
Preparation: Take:
  • RNDZ Concepts 21057
  • ORB MECH 21057
  • ORB DAP 21057

Synopsis: The purpose of this lesson is to introduce the student to the principles of Rendezvous and Proximity Operations. This lesson is designed to be a solid introduction to the basic profile, the use of onboard targeting, the use of sensors, and ultimately the manual phase, which culminates in either grapple of the target or docking to ISS. This lesson will also include a brief history of Rendezvous missions and some examples of future rendezvous missions.

Objectives:
• Define Rendezvous (RNDZ) terms.
  – Describe the roles of the chaser and target vehicles.
  – Describe the two types and two phases of RNDZ.
• Define Proximity Operations (Prox Ops) terms.
  – Describe the following Prox Ops tasks: manual phase, approach, docking, grappling, station-keeping, separations, flyaround, and transition.
• Know the standard RNDZ profile.
  – Read a relative motion plot.
  – Describe the basic burn types and how they shape the orbit.
  – Describe the placement of burns in the standard profile.
  – Describe the three RNDZ sensors and the data they provide.
  – Describe the three RNDZ state vectors.
  – Describe the placement of sensor passes in the standard profile.
  – Discuss Lambert targeting and which burns use it.
New Astronaut Lesson Descriptions

108  **RNDZ OV 21001 (Concluded)**

- Know the standard Prox Ops profile.
  - Describe the timeline of manual takeover/manual phase.
  - Describe the basic Prox Ops piloting task.
  - Describe the three main Prox Ops approaches and orbital mechanics effects of each.
  - Describe the onboard tools used during Prox Ops.

109  **P/L COM/OIU MAL 21006**

Title: Payload Communications/Orbiter Interface Unit Malfunction
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 08/03
Lesson(s) Replaced: P/L COM MAL 21006
Equipment Required: None
Prerequisite Lesson(s): P/L COM/OIU OPS 21006
Preparation: Review:
- Payload Communication Workbook; PL COM 21002, Sections 6, 7, and 8
- Malfunction Procedures: Sections 2.4, 2.5, and 5.5A
- Systems Operations Data File (SODF) Assembly Ops: Comm Malfunction Points Diagram; OIU Malfunction Procedures

Synopsis: In this lesson, the student will be introduced to the Malfunction Procedures pertaining to the payload communications system and the Assembly Operations Procedures pertaining to Orbiter Interface Unit (OIU) fault messages. The student will practice these procedures in response to P/L Comm system Line Replaceable Unit (LRU) and OIU failures.

Objectives: Given malfunctions to the P/L Comm system and OIU.
- Identify the associated signatures and confirming cues.
- Perform the applicable malfunction procedure and explain the rationale behind the steps of the procedure.
- Explain the impact of the failure.
New Astronaut Lesson Descriptions

110  **EVA INTRO 21001**

Title: Extravehicular Activity Introduction  
Duration: 4.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: DX32/EVA Task Group, DX35/EVA Systems Group  
Date: 05/03  
Lesson(s) Replaced: None  
Equipment Required: EVA Tools and Equipment  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: A historical overview of EVA will be discussed, highlighting accomplishments in the Gemini, Apollo, and Skylab programs. The history of EVA will be presented in a short video, then EVA requirements and constraints will be discussed. An introduction to the EMU, SAFER, and airlocks will be given. Some generic EVA tools will be demonstrated, and the flow of mission EVA events will be discussed. Finally, the EVA training facilities and EVA training flow for the ASCANs will be presented.

Objectives:  
- Identify the reasons for conducting an EVA, and the role that EVA has played in previous and current space programs.  
- Identify the types of EVAs that are trained and may be performed on orbit.  
- Identify the roles that the EMU, SAFER, airlock, external airlock, and Station airlock accomplish in EVA operations.  
- Identify the roles that different equipment and tools fulfill during an EVA.  
- Identify the purpose of pre-EVA, EVA, and post-EVA operations.  
- Identify the role that different training facilities play in EVA training, and comprehend the EVA training flow.

111  **RANGE SAFETY 21001**

Title: Range Safety Briefing  
Duration: 2.0 hours  
Medium: Classroom  
Student: ASCAN  
Source: CB/Astronaut Office  
Date: 03/95  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None
New Astronaut Lesson Descriptions

111 RANGE SAFETY 21001 (Concluded)

Preparation: Read:
- SCOM; Section 1.4, Range Safety System paragraph and General Overview
  - Solid Rocket Boosters

Synopsis: This lesson will review the basics of the Eastern Range at Cape Canaveral Air Force Station. The organization and responsibilities of the Eastern Range will be discussed as they relate to the Shuttle Program as well as other programs. In addition, the following topics will be reviewed:
- Role of the Range Safety Officer (RSO)
- Range clearance
- Range tracking (hardware, software, displays)
- Flight Termination System (FTS)
  - Philosophy
  - Significance to crew
  - Launch Commit Criteria
  - Flight rules
- Current issues

Objectives:
- Explain the function of the Eastern Range as it applies to the shuttle and other programs.
- Explain what the FTS is.
- Explain the operational significance to the crew of the FTS.

112 CREW DUTY 21001

Title: Crew Duties Briefing
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: CB/Astronaut Office
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
New Astronaut Lesson Descriptions

112  **CREW DUTY 21001 (Concluded)**

Synopsis: CB representative will provide the students with descriptions and insight into crew assignments, both onboard the orbiter and within the astronaut office. This class can be broken down into two separate briefings. One where representatives from the different branches discuss what jobs within their branches are like. The other class would have crew members discuss the roles and responsibilities for the pilot and mission specialists in the cockpit.

Objectives: Objectives provided by CB office.

113  **HAB EQ/PROC 21020**

Title: Habitability Equipment and Procedures  
Duration: 3.5 hours  
Medium: CCT (CCT II or FFT)  
Student: ASCAN (Schedule in groups up to 4.)  
Source: DX45/Crew Systems Group  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CREW CAB FAM 21020, WCS PROC 21065  
Preparation: None

Synopsis: During this lesson, the student will perform the procedures related to orbiter habitability in a flight-configured trainer with the appropriate equipment. The equipment used and the procedures performed include those associated with sleep, exercise, crew personal clothing, trash management, trash overboard vent, atmospheric samples, acoustic measurements, crew compartment cleaning, restraints/mobility aids, and window shades/filters. The crew will remove the equipment from launch stowage locations, perform on-orbit operations, and restow the equipment in the entry configuration.

Objectives:  
- Become familiar with the operational use of all nominal crew equipment.  
- Be able to determine the locations of the wet and dry trash.  
- Become familiar with the on-board exercise equipment.
New Astronaut Lesson Descriptions

114 MECH MAL BR 21001

Title: Mechanical Malfunction Review
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MECH OPS 21004
Preparation: Review:
  • MECH SYS 21002, Section 4 (PLBD System)
  Complete:
  • PLBD 21057 – Basic malfunctions

Synopsis: This lesson is designed to prepare the student for MECH MAL 21004. The lesson begins with a review of the Payload Bay Doors display and nominal payload bay door operations. The lesson discusses the malfunctions that cause “PBD CONFIG” and “PBD SEQ FAIL” fault messages during auto payload bay door operations. It also discusses microswitch configurations that can cause a dilemma during payload bay door operations.

Objectives:
  • Define the terms “active group” and “end of travel” in relation to the Payload Bay Doors.
  • Describe how payload bay door auto mode operations work in the Primary Avionics Subsystem Software (PASS) and Backup Flight Software (BFS).
  • Describe the malfunctions that will cause a “PBD CONFIG” fault message.
  • Describe the malfunctions that will cause a “PBD SEQ FAIL” fault message.
  • Describe the malfunctions that will cause a dilemma.
  • Given specific microswitch malfunctions, identify what, if any, fault messages will be generated.
New Astronaut Lesson Descriptions

115  ECLSS MAL A/E BR 21001

Title:  Ascent/Entry Environmental Control and Life Support System Malfunction Review

Duration:  3.0 hours
Medium:  Classroom
Student:  ASCAN
Source:  DS45/Shuttle Systems Training Group
Date:  12/06

Lesson(s) Replaced:  None
Equipment Required:  ASC PKT C/L, ENT PKT C/L, AESP
Prerequisite Lesson(s):  ECLSS OPS 22004
Preparation:  Review:
  • SCOM; Section 2.9, ECLSS

Synopsis:  The lesson will start with a review of Environmental Control and Life Support System (ECLSS) subsystems and their respective configurations for ascent and entry. Next, subsystem redundancy and mission impact of ECLSS malfunctions will be discussed. The signatures of selected ECLSS component failures will be covered, using ECLSS ascent/entry displays and panel O1 meters. Malfunction prioritizing will follow, with discussion on probable cause of selected malfunctions. Next, FDF malfunction procedure flow will be covered, with a focus on transition from powered flight to unpowered flight procedures. The lesson will conclude with a discussion of operational guidelines and the steps involved in selected ECLSS ascent/entry malfunctions.

Objectives:
  • Identify the signatures of the following ECLSS malfunctions on ascent and/or entry via displays, meters, and other cockpit cues:
    – Avionics bay fan degrade
    – Cabin leak
    – H₂O loop pump failure
    – Flash Evaporator System freeze-up
    – Internal N₂ leak
    – Freon loop leak
    – Freon loop blockage
    – NH₃ leak onto Freon loops
    – H₂O loop leak
    – Avionics bay fire
  • Describe the sequence of FDF usage for the above ECLSS ascent/entry malfunctions.
  • Explain the guidelines/constraints and rationale associated with the procedures for the above ECLSS ascent/entry malfunctions.
New Astronaut Lesson Descriptions

115  **ECLSS MAL A/E BR 21001 (Concluded)**

- Identify how ECLSS malfunctions are prioritized, and given a series of malfunctions from the list above, determine which procedures should be worked immediately and which can be delayed.
- Determine whether or not an ascent abort is required for a given ECLSS malfunction (using FDF).
- State the mission impacts of losing the following systems during the ascent/entry time frame: cabin pressure, single or both Freon loops, single or both water coolant loops, single or multiple Flash Evaporator System controllers.

116  **DPS MAL 21006**

**Title:** Data Processing System Malfunctions  
**Duration:** 2.0 hours  
**Medium:** SST 1 or SST 2 or SST 3  
**Student:** ASCAN (Schedule in pairs.)  
**Source:** DS24/DPS/Navigation Training Group  
**Date:** 02/04  
**Lesson(s) Replaced:** DPS OPS 21006A  
**Equipment Required:** None  
**Prerequisite Lesson(s):** A/E DPS MAL 21001  
**Preparation:** Review:  
- MAL PROC; Section 5, DPS; Table of Contents  

**Synopsis:** This lesson exercises the nominal timeline from post-OMS-1 through the entry configuration with DPS malfunctions. Malfunctions in General Purpose Computers (GPCs), Multiplexer/Demultiplexers (MDMs), and Modular Memory Units (MMUs) are presented to show expected annunciations and other indications (e.g., GPC status matrix, Caution and Warning (C&W) light matrix, Systems Maintenance (SM) alert light and tone, master alarm, and GPC fault message line). FDF recovery procedures and rationale are presented. At the conclusion of the lesson, the student will be given the Major GPC Failures Summary and the MDM Failure Recognition prebrief text handouts to review prior to taking DPS MAL 21057.

**Objectives:**  
- Perform, aided, the appropriate procedures to safe and recover from a GPC 4 Fail to HALT malfunction during Major Mode (MM)104.  
- Perform, aided, the Post-Insertion DPS reconfiguration with GPC 4 failed.  
- Perform, aided, the appropriate procedures to recover GPC 4, including a software dump, a hardware dump, and an Initial Program Load (IPL) of GPC 4.
New Astronaut Lesson Descriptions

116  **DPS MAL 21006 (Concluded)**

- Perform, aided, the appropriate procedures to recover from an Flight Forward (FF) 1 primary port failure on orbit, by moding flight-critical string 1 to secondary ports.
- Perform, aided, the appropriate procedures to recover from an MMU 1 power failure during an orbit Operational Sequence (OPS) transition.
- Perform, aided, the appropriate procedures to safe and recover from a GPC 1 Fail to Sync malfunction during the entry time-frame.
- List the short and long range impacts of a GPC failure during MM104.
- Describe the impacts and Flight Rule implications for an MMU failure.
- Explain the Radiator/Payload Bay Door (RAD/PLBD) NO-GO criteria and Flight Rule impacts of the GPC and MDM failures.
- Identify and recover from the failure of an Integrated Display Processor (IDP) and understand the In-Flight Maintenance (IFM) impacts.
- Identify and recover from an edge key failure.
- Describe the impacts of a GPC failure Pre-Time of Ignition (TIG) and Post Burn.

117  **PGSC INTRO 21195**

**Title:** Payload and General Support Computer Orbiter Communication Adapter Familiarization

**Duration:** 2.5 hours

**Medium:** PGSC Lab

**Student:** ASCAN, PS (Schedule in groups of 2.)

**Source:** *DO5/Cargo Integration and Operations Branch*

**Date:** 10/01

**Lesson(s) Replaced:** PGSC H/W 21020

**Equipment Required:** PGSC Lab

**Prerequisite Lesson(s):** None

**Preparation:** None

**Synopsis:** The purpose of this class is to introduce the student to PGSC hardware and applications that they will use for Orbit simulations at the SMS. The lesson will require the latest flown flight-specific configuration, flight software, usage chart, Chapter 12 “ORB OPS,” late-updates, sample web, and messages. After this class, the student will be able to use the generic PGSC load for any orbit sim, and configure the PGSC network accordingly.

**Objectives:**

- Set up a flight-specific PGSC configuration with the ORB OPS Checklist and flight-specific usage chart.
- Understand the IBM 760 XD and the Selectadock I hardware and ports use.
New Astronaut Lesson Descriptions

117  **PGSC INTRO 21195 (Concluded)**

- Perform and understand the PGSC late-update procedure.
- Understand the high-level use of all the cables, and PC cards: quatech, Etherlink III, RFLan, Manipulator Controller Interface Unit (MCIU), and hard disk.
- Understand and verify the peer-to-peer network with Pingmaster and Windows Explorer.
- Perform EPSON Network printer procedures.
- Launch and understand the following apps: WorldMap, WinDecom, RMS Situational Awareness Display (RSAD), Dynamic Onboard Ubiquitous Display (DOUG).

118  **ESC PROC 21001**

**Title:** Escape Procedures Briefing (Shared – Shuttle)
**Duration:** 1.0 hour
**Medium:** Classroom
**Student:** ASCAN (Schedule in groups of up to 7; 2 PLTs and 5 MSs.)
**Source:** DX45/Crew Systems Group
**Date:** 12/06
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** ESC EQ/SYS 21001

**Note:** ESC PROC 21001 should be no more than 2 days before ESC PROC 21020. Suit Fit Check is required before this lesson may be scheduled.

**Preparation:** Review:
- CREW ESCAPE SYSTEMS 21002; Section 4

**Synopsis:** This lesson introduces the student to procedures associated with the different emergency egress modes. Material presented will include the following:
- Launch pad emergencies
  - Emergency egress Modes 1 through 4
- Post-landing emergencies
  - Modes 5 through 7
- Bailout
  - Mode 8

A video will be shown on emergency egress procedures.
New Astronaut Lesson Descriptions

118 ESC PROC 21001 (Concluded)

Objectives: • Describe the following emergency egress Modes:
   – Mode 1 – Unassisted Pad Egress.
   – Modes 2 through 4 – Assisted Pad Egress.
   – Mode 5 – Unassisted Postlanding Egress.
   – Modes 6 and 7 – Assisted Postlanding Egress.
   – Mode 8 – Bailout.
   • Describe orbiter egress and escape from the launch pad.
   • Describe egress slide deployment (both hatch on and hatch jettisoned modes).
   • Describe the backup procedure if the slide fails to deploy.
   • Describe the procedures of the escape panel and Sky Genie usage.
   • Describe the deployment of the escape pole, hook up, and bailout.

119 APU/HYD MAL 21004

Title: Auxiliary Power Unit/Hydraulic Malfunction
Duration: 2.0 hours
Medium: SST 2 or SST 1 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: AP/HY MAL 21004
Equipment Required: None
Prerequisite Lesson(s): APU/HY MAL BR 21001
Preparation: None

Synopsis: This lesson will take the student beyond nominal operations to the level of minimum proficiency in off-nominal operations of the Auxiliary Power Unit (APU)/Hydraulic (Hyd) systems. As a minimum, the student will be exposed to cases requiring the shutting down of the APU during both powered and glided flight. Discussion of the impacts will be incorporated into these procedures. Additionally, the critical skills of cooling and restarting the APU will be performed. Additional malfunctions listed above, or otherwise, will be included as permitted by student performance.

Objectives: • Identify the following APU/Hyd malfunctions on ascent and/or entry via displays, meters, and other cockpit cues:
   – APU 10.5 second timer fail
   – APU fuel/H₂O line heater fail
   – APU oil overtemp
   – APU overspeed
   – APU speed control shift
   – APU underspeed
New Astronaut Lesson Descriptions

119  **APU/HYD MAL 21004 (Concluded)**
- Hyd Pressure sensor
- Hyd pump degrade
- Hyd reservoir leak
- Water Spray Boiler (WSB) tank pressure sensor fail
  - Execute the appropriate FDF procedure for each of the malfunctions listed above.
  - Explain the rationale for the FDF procedures associated with each of the malfunctions listed above.
  - State the mission impact for each of the APU/Hyd malfunctions discussed in this class.

120  **ABORT FDF 21001**
Title: Abort Flight Data File Review Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: ASC C/L, ENT C/L
Prerequisite Lesson(s): ABORT FAM BR 21001
Preparation: None
Synopsis: This lesson is designed to be a line-by-line review of the Ascent Checklist (C/L) procedures used to perform a Return-To-Launch Site (RTLS), a Transatlantic Abort Landing (TAL) (pre- and post-Main Engine Cut-off (MECO)), an Abort to Orbit (ATO), and an Abort Once Around (AOA) abort.

An in-depth review of OMS 1/2 TGTING, OMS1 BRN, OMS2 TGTING, RTLS, TAL, TAL Redesignate, ABORT DUMPS, AOA, POST D/O BURN, and OMS TGTS will be performed. While each procedure is reviewed, the major events of the abort and the crew tasks required for each abort will be discussed. This lesson is designed to prepare the student for ABORT FAM 21011 and ABORT FAM 22011.
New Astronaut Lesson Descriptions

120 ABORT FDF 21001 (Concluded)

Objectives: • Identify where the procedures for the following aborts are located in both the CDR/PLT C/Ls and the MS C/Ls.
  – RTLS
  – TAL/TAL Delay
  – ATO
  – AOA
• Identify the abort required, using the Orbital Maneuvering System – 1/2 (OMS-1/2) targeting page, the ATO page, the OMS Targets section, and the OMS-2 targeting page given a set of post-MECO conditions.
• Using the appropriate procedures, state how to initiate an RTLS, a TAL, an ATO, and an AOA.

121 IFM PIN KIT 21001

Title: In-Flight Maintenance Pin Kit Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN (Schedule in groups of up to 4.)
Source: DX44/In-Flight Maintenance Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): IFM 21001
Preparation: None

Synopsis: This lesson includes a detailed study of each element of the In-Flight Maintenance (IFM) pin kit (such as cables, pins, alligator clips, sockets, minigrabbers, crimping tools, strippers, etc.) and how to use each. Instruction on the use of the IFM Digital Multimeter (DMM), circuit breaker (cb) retention device, transducer modules, and IFM Breakout Box (BOB) will also be provided. Emphasis is on hands-on practical application, and involves actual manufacturing of cables as might be done in flight.

Objectives: • Identify the different types of electrically related IFM procedures.
• Describe orbiter electrical components and be familiar with how they are labeled/identified.
• Describe and understand IFM C/L electrical schematics.
New Astronaut Lesson Descriptions

121 **IFM PIN KIT 21001 (Concluded)**

- Describe the purpose, basic function, and stowage location of the following items:
  - cb retention device
  - IFM DMM
  - Temperature and pressure transducer modules
  - IFM BOB and DC cable
  - IFM Pin Kit and its contents
- Perform, aided, the setup and demonstrate use of the DMM, transducer modules, IFM BOB, and cable.
- Demonstrate the use of the IFM pin kit to manufacture a typical jumper wire/cable that might be used in flight, including wire stripping, attaching pins and sockets, and splicing.

122 **FLIGHT PLAN 21001**

**Title:** Flight Planning Overview Briefing  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** ASCAN  
**Source:** DO4/Flight Planning *Branch*  
**Date:** 05/03

**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** P/L & APDS OV 21001

**Preparation:** None

**Synopsis:** This lesson is designed to familiarize the student with the flight planning process. The briefing will review the development process by which a mission-specific Flight Plan is developed. Some of the topics to be discussed are parties involved with the development process, crew scheduling constraints, payload and orbiter constraints, and how real-time mission replanning is accomplished.

**Objectives:**
- Describe the development process that is used to design and create a mission-specific Flight Plan.
- Identify the different parties that contribute to the development of a Flight Plan.
- Identify some of the general scheduling rules that are must be adhered to when designing a Flight Plan (crew, payload, and orbiter-related).
- Describe the role and responsibilities of the Flight Activities Officer (FAO) in the MCC.
- Explain how replanning is performed real time.
- Familiarization with products produced by FAO team.
New Astronaut Lesson Descriptions

123  FCS C/O 21006

Title:  Flight Control System Checkout  
Duration:  2.0 hours  
Medium:  SST 1 or SST 2 or SST 3  
Student:  ASCAN (Schedule in pairs.)  
Source:  DS66/G&C/Propulsion Training Group  
Date:  02/04  
Lesson(s) Replaced:  VEH UTIL 21002  
Equipment Required:  None  
Prerequisite Lesson(s):  SENS/CNTL 21006  
Preparation:  Read:  
  • SCOM; Section 5.3  
    – Last Full Day On-Orbit  
  • FCS/EFF 21002; Section 10, Surface Drive Checks and Hydraulic Warmup  

Synopsis:  This lesson will focus on performing the FCS CHECKOUT crew procedures. The student is expected to already have a basic understanding of the FCS equipment. The student will perform the FCS Checkout procedure with the exception of Auxiliary Power Unit (APU) start/shutdown, which is covered in APU/HYD OPS 21004. Simple malfunctions will give the student practice in malfunction identification and reconfiguration. Translational Hand Controller (THC) and Rotational Hand Controller (RHC) Redundancy Management (RM) will be discussed during the controller checkout. This class will have an operational focus and provide inputs to the student about expected noises, vibrations, and movements that may occur during the checkout.

Objectives:  
  • State the purpose of the procedure.  
  • State when the procedure is performed during the mission.  
  • Locate the procedure in the FDF.  
  • State what OPS mode is required and why.  
  • List basic equipment tested in Parts 1 and 2 of procedure.  
  • Explain what occurs during the Aerosurface Drive Test.  
  • Identify the noise associated with the secondary actuator check.  
  • Perform the FCS CHECKOUT crew procedures as listed in the FDF.  
  • Identify malfunctions and work the applicable FCS CHECKOUT procedures to resolve them.  
  • Explain the difference between THC and RHC RM.  
  • Explain the procedure differences if Secondary Actuator Checkout is performed with a circulation pump.
New Astronaut Lesson Descriptions

124A  PO INS OPS 21001
Title: Post-Insertion Operations Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN (Schedule 3 ASCANs, 1 CB IA.)
Source: DA7/Assigned SMS Team
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): A/E FAM 21011, PGSC INTRO 21195
Preparation: Review:
• Post-Insertion C/L; Overview Timeline Section
Synopsis: This prebrief is designed to prepare the student for PO INS OPS 21012. The prebrief will review the Post-Insertion timeline, identifying parallel and serial procedures and the rationale for each of the major steps. The prebrief also provides the students with an opportunity to define their individual roles as crewmembers and determine the procedures for which each person will be responsible in PO INS OPS 21012.
Objectives:
• Identify the three sections of the Post-Insertion C/L.
• Identify the major events of Post-Insertion using the annotated Summary Timeline.
• Identify the tasks that must be performed in serial and which ones can be performed in parallel.
• Identify which crewmembers are responsible for each of the major activities.
• Discuss the purpose of the “PLBD Open Go/No-Go” block of the Post Insertion.
• Discuss the criteria required to activate the vernier RCS jets.
• Identify each student’s roles and responsibilities for PO INS OPS 21012.

124B  PO INS OPS 21012
Title: Post-Insertion Operations
Duration: 4.0 hours
Medium: SMS-FB
Student: ASCAN (Schedule 3 ASCANs, 1 CB IA.)
Source: DA7/Assigned SMS Team
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
New Astronaut Lesson Descriptions

124B  **PO INS OPS 21012 (Concluded)**

Prerequisite Lesson(s):  PO INS OPS 21001
Preparation:  None

Synopsis:  This lesson provides the first opportunity for the students to exercise all of the Post-Insertion activities per the timeline in full cockpit environment. The lesson pulls together many of the nominal procedures that have been exercised individually in SST lessons, and allows the students to work each of them together in a nominal timeline. The lesson consists of one run starting at L/O-9 minutes and continuing through the first part of the Flight Plan. The students will be required to perform all of the nominal ascent, Post-Insertion, and Flight Plan activities as well as unstow and stow the appropriate FDF.

Objectives:

- Perform the nominal ascent and post-insertion procedures.
- Identify which procedures can be performed in parallel and which must be performed in serial and execute accordingly.
- Perform an IMU align using the Star Trackers and Star Pairs PAD.
- Set up and activate the PGSC to run the WorldMap program Space Operations Computing (SpOC).
- Perform the following Flight Plan activities from the Orbit Ops C/L:
  - PCS Config
  - LAMP TEST
  - SMOKE DETN CKT TEST
  - CRYO O2 CURRENT SENSOR TEST
  - Ku deploy/activation
  - CCTV activation and checkout

125A  **D/O PREP 21001**

Title:  Deorbit Preparation Operations Prebrief
Duration:  1.0 hour
Medium:  Classroom
Student:  ASCAN (Schedule 3 ASCANs, 1 CB IA.)
Source:  DA7/Assigned SMS Team
Date:  07/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  PO INS OPS 21012
Preparation:  Review:
  - Deorbit Prep C/L; Overview Timeline
New Astronaut Lesson Descriptions

125A  **D/O PREP 21001 (Concluded)**

**Synopsis:** This prebrief is designed to prepare the student for D/O PREP 21012. The prebrief will review the D/O Prep timeline, identifying parallel and serial procedures, and the rationale for each of the major steps. The prebrief also provides the students with an opportunity to define their individual roles as crewmembers and determine the procedures for which each person will be responsible in D/O PREP 21012.

**Objectives:**
- Identify the purpose of the seven sections of the D/O Prep C/L.
- Using the Nominal Deorbit Prep Summary Timeline, identify the purpose of each major timeline activity and which crewmember is normally responsible for executing the activity.
- Identify which activities must be performed serially and which can be performed in parallel.
- Identify each student’s roles and responsibilities for D/O PREP 21012.

125B  **D/O PREP 21012**

**Title:** Deorbit Preparation Operations
**Duration:** 4.0 hours
**Medium:** SMS-FB
**Student:** ASCAN (Schedule 3 ASCANs, 1 CB IA.)
**Source:** DA7/Assigned SMS Team
**Date:** 07/04
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** D/O PREP 21001
**Preparation:** None

**Synopsis:** This lesson provides the first opportunity for the students to exercise all of the Deorbit Preparation activities per the timeline in a full cockpit environment. The lesson pulls together many of the nominal procedures that have been exercised individually in SST lessons and allows the students to work each of them together in a nominal timeline. The lesson consists of one run starting at D/O-4 hours and continuing through at least D/O-15 minutes. The students will be required to perform all of the Deorbit Prep and deorbit burn preparation activities as well as unstowing and stowing the appropriate FDF. Lastly, the students will use the Space Operations Computing (SpOC) program to determine the deorbit burn targets to burn.
New Astronaut Lesson Descriptions

125B  D/O PREP 21012 (Concluded)

Objectives:
• Perform the nominal Deorbit Prep and deorbit burn preparation procedures.
• Identify which procedures must be performed serially and which can be performed in parallel and execute accordingly.
• Using the SpOC, determine the deorbit burn target set to be burned.

126  MECH MAL 21008

Title: Mechanical Malfunction
Duration: 2.0 hours
Medium: SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/Shuttle Systems Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MECH MAL BR 21001
Preparation: Review:
• PLBD 21057 – Basic malfunctions

Synopsis: This lesson introduces the student to off-nominal procedures associated with the external tank umbilical doors, payload bay door system, and radiator system. For each failure, the following will be reviewed: cockpit cues, procedures to be performed and the rationale for major steps, and the impacts of the failure on the system itself, the other orbiter systems, and the mission.

Objectives:
• Identify the following Mechanical system malfunctions via displays and other available cockpit cues:
  – Two external tank (ET) umbilical door ready-to-latch microswitches failed off
  – Microswitch failure(s) which cause a PBD CONFIG or PBD SEQ FAIL message or a dilemma
  – Payload bay door jam in the Open direction
  – Radiator talkback failure
• Execute the appropriate FDF procedure for each of the malfunctions discussed in this class.
• Explain the rationale for the FDF procedures associated with each of the malfunctions discussed in this class.
• State the mission impact for each of the malfunctions discussed in this class.
• Explain the purpose of the Payload Bay Door Bulkhead Latch Go/No-Go diagram and state when it is used.
New Astronaut Lesson Descriptions

126 MECH MAL 21008 (Concluded)

- Explain the purpose of the Centerline Latch Extended Guide Roller Trajectory No-Go diagram and state when it is used.
- Recognize when the Emergency Payload Bay Door Opening procedure is required, and execute the procedure.
- Execute the procedure to deploy a single radiator panel.

127 ECLSS MAL A/E 21004

Title: Ascent/Entry Environmental Control and Life Support System Malfunction
Duration: 2.0 hours
Medium: SST 2 or SST 1 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/Shuttle Systems Training Group
Date: 12/06
Lesson(s) Replaced: ECLSS MAL A 21004, ECLSS MAL E 21004
Equipment Required: None
Prerequisite Lesson(s): ECLSS MAL A/E BR 21001
Preparation: None

Synopsis: The lesson will start with a brief review of the Environmental Control and Life Support System (ECLSS) subsystems and their configurations for ascent/entry (using ECLSS panel schematics). The lesson will consist of three runs. Two will start at prelaunch in the mission timeline and end at post OMS-1, and one will start at post deorbit burn and end after rollout. A variety of ECLSS malfunctions will be shown and the student will be required to identify and confirm the failure, execute malfunction recovery procedures using appropriate FDF, explain rationale for steps in the procedures, and state the system/mission impact of failures.

Objectives:

- Identify the following ECLSS malfunctions during the ascent/entry timeframe via displays and other available cockpit cues:
  - Avionics bay fan degrade
  - Avionics bay fire
  - Avionics bay signal conditioner
  - Cabin fan degrade
  - Cabin leak
  - Flash Evaporator System freeze-up
  - Freon loop leak
  - Freon loop pump failure
  - H2O loop leak
  - H2O loop pump failure
  - Internal N2 leak
New Astronaut Lesson Descriptions

127  **ECLSS MAL A/E 21004 (Concluded)**

- NH$_3$ leak onto Freon loops
- O$_2$/N$_2$ controller failure
- Radiator undertemp sensor failure
- Execute the appropriate FDF procedure for each of the malfunctions listed above.
- Explain the rationale for the FDF procedures associated with each of the malfunctions listed above.
- State the mission impact for each of the malfunctions listed above.

128  **DPS MAL 21057**

**Title:** Data Processing System Failure Recognition  
**Duration:** 2.0 hours  
**Medium:** CBT  
**Student:** ASCAN  
**Source:** DS24/DPS/Navigation *Training Group*  
**Date:** 02/04  
**Lesson(s) Replaced:** DPS MAL 22006  
**Equipment Required:** None  
**Prerequisite Lesson(s):** DPS MAL 21006  
**Preparation:** Review:
  - DPS MAL 21006  
  - Major GPC Failure Handout  
  - MDM Failure Recognition Handout  
  - MAL PROC; Section 5, DPS, 5.1a, Block 4

**Synopsis:** This lesson stresses the differing indications and causes for various single-point General Purpose Computer (GPC), Multiplexer/Demultiplexer (MDM), Multifunction Electronic Display System (MEDS), Modular Memory Unit (MMU), and Line Replaceable Unit/Bus Terminal Unit (LRU/BTU) failure modes. Many single-point failure cases are presented to reinforce DPS failure recognition. No multiple-layer-deep failure scenarios are discussed because each malfunction is presented one at a time. This lesson is primarily failure signature recognition and diagnosis of probable causes, and no procedures will be worked by the student. Some discussion of the probable causes will be presented after the student has correctly diagnosed the failure mode. The students may be directed to take certain diagnostic steps if they are having problems with a particular failure diagnosis or to reinforce the effects of a particular failure. There will be an option available to see a subset of the available failure indications in a random order for review purposes after the student has taken the lesson for credit.
New Astronaut Lesson Descriptions

128 DPS MAL 21057 (Concluded)

Objectives:
- Identify selected failures within the DPS during the orbit and the ascent/entry timeframe by:
  - Monitoring display cues.
  - Monitoring panels.
- State the probable cause and mission impacts of a given DPS malfunction.

129 IMU 21006

Title: Inertial Measurement Unit
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 05/07
Lesson(s) Replaced: IMU/ST/COAS 21006, IMU/ST/COAS 21012
Equipment Required: None
Prerequisite Lesson(s): DPS MAL 21006, PTG 21006
Preparation: Review:
- Orbit Ops C/L; GNC
  - IMU Align – S TRK
  - IMU Alignment – IMU/IMU
- Mal Procs; GNC
  - FRP 2, IMU Reference Recovery
  - FRP 3, IMU Recovery with at least one IMU as good reference

Synopsis: During this lesson the student will follow a standard Flight Plan, Post Insertion, and Orbit Ops Checklist (C/L) to perform nominal Inertial Measurement Unit (IMU) and Star Tracker (STRK) actions. The student will be required to perform three different types of IMU aligns (star align, IMU/IMU align, and matrix align), aided and with FDF. To bring out some points about how the system operates, several malfunctions will be introduced which should direct the student to the Orbit Pocket C/L and Malfunction Procedures (Mal Proc). During this process, the instructor will be able to help the student develop troubleshooting skills.

Objectives:
- Activate the star trackers and open the doors.
- Identify and recover from the loss of IMU 3 and the -Y star tracker data path due to a Flight Forward (FF) 3 Multiplexer/Demultiplexer (MDM) primary port failure.
- Identify and recover from the loss of the -Z STRK power source.
- Identify the loss of power to an IMU and recognize that this IMU will be caged upon recovery of power.
New Astronaut Lesson Descriptions

129  **IMU 21006 (Concluded)**

- Perform the IMU Reference Recovery with at least one IMU as a good reference procedure for the caged IMU.
- Identify a biased star tracker and perform a single star tracker align.
- Identify an IMU Built-In Test Equipment (BITE) and mask that BITE.
- Identify an IMU Redundancy Management (RM) failure due to attitude misalignment.
- Identify an IMU dilemma due to an accelerometer problem.
- Perform an IMU reference recovery given no inertial reference.

130  **PGSC OPS 21195**

**Title:** Payload General Support Computer Operations  
**Duration:** 2.0 hours  
**Medium:** Payload General Support Computer (Building 5 PGSC Lab)  
**Student:** ASCAN (Schedule no more than 2 students per class.)  
**Source:** DO5/Cargo Integration and Operations Branch  
**Date:** 08/04  
**Lesson(s) Replaced:** OCA/VTS OPS 21195 and PGSC NETWORK OPS 21195  
**Equipment Required:** Latest PGSC flight load and hardware  
**Prerequisite Lesson(s):** PGSC INTRO 21195  
**Preparation:** None  

**Synopsis:** The purpose of this class is to configure the Orbiter Communication Adapter (OCA) router for use with Modem File Transfer (MFX) Operations and Ku-Band File Transfer (KFX) Operations, as well as to setup the network using the latest PGSC usage chart. Upon completion of the class, the student will be able to use the generic PGSC load for any orbit simulation, configure the PGSC network accordingly, and perform a video teleconference. In addition, the student will be able to understand data flow to the different applications being used.

**Objectives:** Upon the completion of the lesson, the student(s) should be able to:
- Understand the purpose of the OCA router and how to configure it for MFX Operations and KFX Operations.
- Assemble the network using the PGSC usage chart.
- Setup the Network printer and perform a warm-up and self-test.
- Understand the capabilities and the limitations associated with using Outlook.
- Understand the PGSC’s ProShare unique features for Video Teleconferencing System (VTS).
- Perform a video teleconference.
- Launch and understand Windows DeCommutator (WinDecom).
New Astronaut Lesson Descriptions

131  **ECLSS MAL O BR 21001**

Title:  Orbit Environmental Control and Life Support System
       Malfunction Review
Duration:  3.0 hours
Medium:  Classroom
Student:  ASCAN
Source:  *DS45/Shuttle* Systems Training Group
Date:  12/06
Lesson(s) Replaced:  None
Equipment Required:  ORB PKT C/L, MAL PROC (Volume 1)
Prerequisite Lesson(s):  ECLSS OPS 21004, PGSC INTRO 21195
Preparation:  Review:
   • SCOM; Section 2.9, ECLSS

Synopsis:  The lesson will start with a review of Environmental Control and Life Support System (ECLSS) subsystems and their respective configurations for orbit. Next, subsystem redundancy and mission impact of ECLSS malfunctions will be discussed. The signatures of selected ECLSS component failures will be covered using ECLSS orbit displays and meters. Malfunction prioritizing will follow, with discussion on probable cause of selected malfunctions. Next, malfunction procedure flow will be covered, with a focus on Orbit Pocket Checklist and Malfunction procedures. The lesson will conclude with a discussion of constraints/guidelines and rationale of the steps involved in selected ECLSS orbit malfunctions.

Objectives:
   • Identify the signatures of the following ECLSS malfunctions on orbit via displays, meters, and other cockpit cues:
      – Freon loop leak
      – Cabin leak
      – Partial Pressure of Oxygen (PPO₂) sensor failure
      – Supply water leak
      – H₂O loop pump failure
   • State the mission impacts for the ECLSS orbit malfunctions discussed in this class.
   • Describe the sequence of FDF usage for selected ECLSS orbit malfunctions.
   • Explain the constraints/guidelines and rationale associated with the procedures for the ECLSS orbit malfunctions discussed in this class.
   • Identify how ECLSS malfunctions are prioritized, and given a series of malfunctions, determine which procedures should be worked immediately and which can be delayed.
New Astronaut Lesson Descriptions

132 ESC PROC 21020

Title: Escape Procedures
Duration: 4.0 hours
Medium: CCT or CCT II and FFT
Student: ASCAN (Schedule in groups of up to 7; 2 PLTs and 5 MSs.)
Source: DX45/Crew Systems Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: ACES required
Prerequisite Lesson(s): ESC PROC 21001
Note: Suited. Notify medical and safety. This lesson should be scheduled no later than 2 days after completing ESC PROC 21001.
Preparation: None

Synopsis: This lesson provides hands-on experience for a suited bailout and post-landing emergency egress. All aspects of bailout will be simulated, including cabin vent, side hatch jettison, seat egress, escape pole deployment, and bailout. Students will also perform a post-landing egress using the emergency egress slide system, and escape through the emergency escape panel (window 8) using the Sky Genie descent device. The students will have an opportunity to practice descent procedures over a mattress prior to exiting from window 8 and the side hatch. All of the above activities are performed in the ACES.

Objectives:
- Perform seat ingress and strap in the horizontal position with and without assistance from the suit technician.
- Perform egress procedures for Mode 8 bailout.
- Perform egress procedures for Mode 5 slide egress (hatch on).
- Perform contingency egress procedures for slide failure.
- Perform egress procedures for Mode 5 escape panel egress (window 8) using the Sky Genie descent device.

133 MPS MAL BR 21001

Title: Main Propulsion System Malfunctions 1 Review
Duration: 2.5 hours
Medium: Classroom
Student: ASCAN (Schedule in groups of up to 15.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: ASC C/L, ASC PKT C/L, and AESP
Prerequisite Lesson(s): APU/HYD MAL 21004, MPS OPS 21006, SWITCH RM BR 21001
New Astronaut Lesson Descriptions

133  **MPS MAL BR 21001 (Concluded)**

**Preparation:**
- Review:
  - MPS OPS BR 21001 handouts

**Read:**
- MPS Workbook 21002, Sections 4.1 – 4.4

**Synopsis:** This lesson will present a general problem-solving strategy model and specific guidelines for using the FDF procedures for Main Propulsion System (MPS) malfunctions. The malfunction cases covered in the class re:
- Space Shuttle Main Engine (SSME) Fail/Shutdown
- SSME Redline Limits and the Limit Switch
- Hydraulic or Electric Lockup
- Command Path Fail
- Data Path Fail
- Main Engine Helium Leak
- Pneumatic Helium Leak
- External Tank (ET) SEP Inhibit
- Low ET LH2 Ullage Pressure

This lesson will cover the following for the malfunction cases listed:
- The cause of each malfunction.
- Recognition of each malfunction.
- Locating the applicable procedure.
- Rationale for each procedure.

**Objectives:** Given MPS-related malfunctions:
- Explain the cause of each malfunction.
- State the cues to identify each malfunction.
- Locate the applicable procedure.
- Explain the rationale for each procedure.
- Explain the steps of the problem solving strategy.

134  **OMS TGTING 22001**

**Title:** Orbital Maneuvering System Targeting Briefing, Part 2

**Duration:** 3.0 hours

**Medium:** Classroom

**Student:** ASCAN

**Source:** *DS66/G&C/Propulsion Training Group*

**Date:** 02/04

**Lesson(s) Replaced:** None

**Equipment Required:** ASC C/L
New Astronaut Lesson Descriptions

134 OMS TGTING 22001 (Concluded)

Prerequisite Lesson(s): A/E FAM 21011, OMS TGTING 21001, ABORT FDF 21001

Preparation: Read:
- SCOM
  - Section 6.5, Abort Once Around (AOA)
  - Section 6.7, Abort to Orbit (ATO)
- G&C I/O/D 21002, Section 4

Synopsis: The emphasis of this lesson is on Orbital Maneuvering System – 1/2 (OMS-1/2) Targeting. The lesson is composed of two parts. The first part covers the definitions, rationale, and philosophies applied to OMS-1/2 Targeting and, specifically, the definitions and limitations of the FDF used to perform OMS-1/2 Targeting. The second part develops the student’s ability to determine targets and evaluate solutions by prioritizing targeting data, cross checking solutions, and applying rules of thumb. The second part of the lesson is focused on crew operations and has hands-on exercises for the student to practice OMS-1/2 targeting for a variety of performance and systems cases.

Objectives:
- Describe all the boundaries on the OMS-1/2 Targeting Card and state their importance.
- Demonstrate the use of the:
  - OMS-1/2 Targeting Card
  - OMS-2 Targeting Card
  - ATO Card
  - OMS Targets
- Utilize and prioritize the use of all the cockpit resources used for OMS-1/2 Targeting.
- Determine and explain how to correctly load OMS-1/2 targets for a variety of cases.

135 FLT CONT QUAL 21006

Title: Flight Control Qualification
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule individually.)
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SENS/CNTL 21006
New Astronaut Lesson Descriptions

135 FLT CONT QUAL 21006 (Concluded)

Preparation: Review:
- A/E FCS BR 21001 Handout
- G&C SENS BR 21001 Handout
- AESP; FCS CH (2nd FAIL)
- AESP; RM FAIL RGA, AA
- AESP; FA/FF MDM I/O ERROR (FCS Steps)
- AESP; FA/FF PORT MODE (FCS, RGA, AA Steps)
- AESP; Powered, OPS 1/6/TAL TRANSITION RESTRING
- AESP; Glided, POST OPS 3/GRTLS TRANSITION RESTRING (FCS Steps)

Synopsis: This lesson will verify completion of the Ascent/Entry Flight Control System (A/E FCS) and Sensors and Controllers flow by testing the student’s operational knowledge of the FCS and Guidance and Control Sensors and Controllers. The lesson tests the student’s ability to identify a problem via cockpit signatures, locate the correct procedure, and to evaluate the impact of the failure. The instructor will question the student to test knowledge of system operation, including rationale for procedures and functioning of redundancy management. The lesson also tests the student’s ability to determine the impacts of a DPS failure on the FCS, Sensors, and Controllers.

The instructor will play MCC and answer questions and direct the student as necessary. Initially, the student will configure the Orbiter for ascent and monitor the FCS, Sensors, and Controllers. The student will perform all nominal procedures as well as malfunction identification, resolution, and evaluation for the ascent and entry runs. The student will use FDF and cockpit displays to identify problems and take actions.

Objectives:
- Recognize failures in the FCS and flight control sensors and controllers.
- Demonstrate familiarity with the SPEC 53 and BFS SPEC 51 displays.
- Perform FDF procedures for FCS, Accelerometer Assembly (AA), Rate Gyro Assembly (RGA), and controller failures and explain the rationale for these procedures.
- Configure FCS channels per the OPS 1/6/TAL Transition Restring Cue Card and explain the rationale for the configuration.
- Manually bypass an aerosurface port.
- Manually deselect an AA, RGA, and FCS surface feedback.
- Perform the FCS, AA, and RGA steps in PASS GPC FAIL and FA/FF MDM I/O ERROR FDF procedures.
- Demonstrate an understanding of Redundancy Management (RM) for FCS, AAs, RGAs, and controllers.
New Astronaut Lesson Descriptions

136   PI 21020

Title: Post Insertion Timeline in Shuttle Mockup
Duration: 4.0 hours
Medium: CCT (CCT II or FFT)
Student: ASCAN (Schedule in groups of up to 3.)
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: ACES
Prerequisite Lesson(s): HAB EQ/PROC 21020

Note: This lesson should be taught the day prior to DO PREP 21020. These lessons will be covered over a consecutive two-day period. The first session, PI 21020, will be covered in a 4-hour period on the afternoon of day 1, and the second session, DO PREP 21020, will be covered in a 4-hour period in the morning of day 2.

Preparation: None

Synopsis: During this lesson, the student will perform the integrated crew station post-insertion and on-orbit procedures. The activities performed during this lesson include all nominal crew actions required to configure the crew station for orbit operations. (Includes crew worn equipment, specialist seat operations, communications equipment, FDF, and miscellaneous loose equipment.)

Objectives:
• Exercise the Post-Insertion timeline focusing on switch configuration, reconfiguration of the middeck for on-orbit operations, and stowage.
• Locate the fire extinguishers and practice donning the Quick Don Masks (QDMs).

137   DO PREP 21020

Title: Deorbit Prep Timeline in Shuttle Mockup
Duration: 4.0 hours
Medium: CCT (CCT II or FFT)
Student: ASCAN (Schedule in groups of up to 3.)
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: ACES
Prerequisite Lesson(s): PI 21020, HAB EQ/PROC 21020
New Astronaut Lesson Descriptions

137  DO PREP 21020 (Concluded)

Note: This lesson should be taught the day after PI 21020. These lessons will be covered over a consecutive two-day period. The first session, PI 21020, will be covered in a 4-hour period on the afternoon of day 1, and the second session, DO PREP 21020, will be covered in a 4-hour period in the morning of day 2.

Preparation: None

Synopsis: During this lesson, the student will perform the integrated crew station deorbit procedures. The activities performed during this lesson include all nominal crew actions required to configure the crew station for entry. (Includes crew worn equipment, specialist seat operations, communications equipment, FDF, and miscellaneous loose equipment.)

Objectives: Exercise the Deorbit Prep timeline focusing on switch configuration, seat setup, and donning of the ACES.

138  ECLSS MAL O 21004

Title: Orbit Environmental Control and Life Support System Malfunction

Duration: 2.0 hours
Medium: SST 2 or SST 1 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/Shuttle Systems Training Group
Date: 12/06
Lesson(s) Replaced: ECLSS MAL O 21004, ECLSS MAL 21004
Equipment Required: None
Prerequisite Lesson(s): ECLSS MAL O BR 21001, PGSC INTRO 21195
Preparation: None

Synopsis: The lesson will start with a brief review of the Environmental Control and Life Support System (ECLSS) subsystems and their configurations for orbit (using ECLSS panel schematics). The lesson will consist of 2 runs, both in an orbit configuration. A variety of ECLSS malfunctions will be shown and the student will be required to identify and confirm the failure, execute malfunction recovery procedures using appropriate FDF, explain rationale for steps in the procedures, and state the system/mission impact of failures.

Objectives: Identify the following ECLSS malfunctions during the orbit timeframe via displays and other available cockpit cues:
- Cabin leak
- Freon loop leak
- H₂O loop controller fail
- H₂O loop pump fail
New Astronaut Lesson Descriptions

138  **ECLSS MAL O 21004 (Concluded)**

- O₂ regulator shift
- PPO₂ sensor bias
- Radiator controller fail
- Supply water leak

- Execute the appropriate FDF procedure for each of the ECLSS orbit malfunctions discussed in this class.
- Explain the rationale for the FDF procedures associated with each of the ECLSS orbit malfunctions discussed in this class.
- State the mission impact for each of the ECLSS orbit malfunctions discussed in this class.

139  **OFF-NOM EG 21116**

Title: Off-Nominal Egress
Duration: 1.25 hours
Medium: CCTII
Student: ASCAN (Schedule in groups of up to 7; 2 PLTs and 5 MSs.)
Source: DX45/Crew Systems Group
Date: 12/06
Lesson(s) Replaced: None
Equipment Required: CCTII in nose-down orientation
Prerequisite Lesson(s): ESC PROC 21020
Preparation: None

Synopsis: This lesson discusses the procedures associated with the different off-nominal egress procedures such as a Launch Scrub, Space Shuttle Main Engine (SSME) shutdown, Break-up/Loss of Control, and Crew Worn/Carry-On contingencies. Additionally, the student has the opportunity to experience the crew module environment in the nose-down attitude. Students will be allowed to crawl around in the CCTII and strap-in to the seats (if desired) to help comprehend the actions necessary to egress the vehicle in the event of an in-flight vehicle breakup.

Objectives:
- Describe the major steps in the procedures for a launch scrub and a SSME shutdown.
- Describe the egress procedures associated with the vehicle Break-up/Loss of Control scenario.
- Describe post-landing loss of COMM procedures (including light signals).
- Describes the procedures for Crew Worn/Carry-On equipment contingencies.
New Astronaut Lesson Descriptions

WATER SURV 21001

Title: Water Survival Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN (Schedule in groups of 5.)
Source: DX45/Crew Systems Group
Date: 05/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ESC PROC 21020

Note: WATER SURV 21027 should be scheduled no later than 2 days after WATER SURV 21001.

Preparation: Review:
- CREW ESCAPE SYSTEMS 21002
  - Section 2.5
  - Section 2.6
  - Section 3.6
  - Section 4.7

Synopsis:
- The parachute, harness, raft, and survival equipment are discussed in great detail.
- Inflation of the Life Preserver Unit (LPU) and life raft are performed.
- A full complement of survival gear will be available for the students to see and handle.
- The procedures for using the parachute, LPU, raft and survival equipment are discussed. Included in the discussion are: capabilities and limitation of the equipment, recommended procedures, and Search and Rescue (SAR) operations.
- The procedures for the NBL session are discussed, including safety precautions.

Objectives:
- Describe both automatic and manual parachute operation.
- Describe under-canopy/LPU-inflation and water-entry techniques.
- Describe survival equipment and its usage.
- Describe Search and Rescue (SAR) operations.
- Describe procedures for NBL session.
New Astronaut Lesson Descriptions

141  REACH & VIS 21020

Title: Reach and Visibility
Duration: 2.0 hours
Medium: CCT or CCT II
Student: ASCAN, PS (Schedule in groups of 4, preferably 2 PLTs and 2 MSs, suited.)
Source: DX45/Crew Systems Group
Date: 08/04
Lesson(s) Replaced: REACH & VIS 31020
Equipment Required: ACES required
Prerequisite Lesson(s): ESC PROC 21020
Preparation: Review:

- CREW ESCAPE SYSTEMS 21002
  - Section 2.2
  - Section 2.3
  - Section 3.2
  - Section 3.3
  - Section 4.3

Synopsis: This lesson is designed to familiarize the students with orbiter ingress and egress in the vertical position while suited. It allows each crewmember to know his or her limitations for reach and visibility envelopes, while in the ACES. In addition, it provides information on techniques that will compensate for these limitations. The reach and visibility portion of the lesson will be performed both pressurized and unpressurized. While the ACES is at a “hard press,” the crewmembers will experience a decrease in their reach and visibility envelopes. This information can then be used in their SMS exercises, where crew coordination is developed. Time is allotted to the suit technicians so that they can document specific crew-worn equipment that is necessary to improve crew comfort, reach, and visibility. At the end of the lesson, a Mode 1 egress will be performed.

Objectives:
- Perform seat ingress and strap-in while vertical.
- Describe the limitations to reach and visibility while the suit is pressurized and unpressurized.
- Describe various techniques of improving the personal reach and visibility envelopes while in the vertical.
- Describe techniques that will enhance coordination of procedures during powered flight.
- Perform Mode 1 egress.
New Astronaut Lesson Descriptions

142A  MPS MAL 21001

Title:  Main Propulsion System Malfunctions Prebrief  
Duration:  0.5 hours  
Medium:  Classroom  
Student:  Non-ASCAN  
Source:  DS66/G&C/Propulsion Training Group  
Date:  10/05  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  APU/HYD MAL 21004, MPS OPS 21006  
Preparation:  Read:  
  MPS Workbook 21002, Sections 4.1 – 4.4  
Note:  This lesson replaces the MPS MAL BR 21001 lesson for non-ASCAN students.

Synopsis:  This lesson will present a general problem-solving strategy model and specific guidelines for using the FDF procedures for Main Propulsion System (MPS) malfunctions. The malfunction cases covered in the class are:  
  • Space Shuttle Main Engine (SSME) Fail/Shutdown  
  • SSME Redline Limits and the Limit Switch  
  • Hydraulic or Electric Lockup  
  • Command Path Fail  
  • Data Path Fail  
  • Main Engine Helium Leak  
  • Pneumatic Helium Leak  
  • External Tank (ET) SEP Inhibit  
  • Low ET LH2 Ullage Pressure  

This lesson will cover the following for the malfunction cases listed:  
  • The cause of each malfunction.  
  • Recognition of each malfunction.  
  • Locating the applicable procedure.  
  • Rationale for each procedure.  

Objectives:  Given MPS-related malfunctions:  
  • Explain the cause of each malfunction.  
  • State the cues to identify each malfunction.  
  • Locate the applicable procedure.  
  • Explain the rationale for each procedure.  
  • Explain the steps of the problem solving strategy.
New Astronaut Lesson Descriptions

142B  MPS MAL 21006
Title: Main Propulsion System Malfunctions 1
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MPS MAL BR 21001
Preparation: Review:
  • MPS Workbook 21002, Sections 4.1 – 4.4

Synopsis: This lesson will provide 5-6 ascent runs for the student to practice resolving the Main Propulsion System (MPS) malfunctions listed below. Following each run, the instructor will review with the student the cause of each malfunction, the recognition cues, and the rationale for each procedure.

Objectives: • Apply the problem solving strategy to resolve the following malfunctions in the MPS system:
  – Space Shuttle Main Engine (SSME) Fail/Shutdown
  – SSME Redline Limits and the Limit Switch
  – Hydraulic or Electric Lockup
  – Command Path Failure
  – Data Path Failure
  – Main Engine Helium Leak
  – Pneumatic Helium Leak
  – Low External Tank (ET) LH2 Ullage Pressure

143A  ABORT FAM 21001
Title: Abort Familiarization 1 Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN, PS (Schedule 3 ASCANs, 1 CB IP.)
Source: DA7/Assigned SMS Team
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ABORT FDF 21001, PAPER SIM 21001
New Astronaut Lesson Descriptions

143A  **ABORT FAM 21001 (Concluded)**

**Preparation:**
- Review:
  - Ascent C/L
    - OMS1/2 TGTING
    - OMS1 BURN
    - OMS2 TGTING
    - RTLS
    - TAL/TAL Delay
    - AOA
    - POST D/O BURN
    - OMS TGTS

**Synopsis:** This prebrief will prepare the student for ABORT FAM 21011. During the prebriefing, the major events and FDF flow of an Abort to Orbit (ATO), an Abort Once Around (AOA), a 2-engine Return-To-Launch Site (RTLS), and a Transatlantic Abort Landing (TAL)/TAL Delay will be reviewed. In addition, the students will review the cockpit indications that should be monitored during each of the abort cases and the crewmember(s) responsible for the monitoring task.

**Objectives:**
- Identify the flow of the FDF associated with each abort case.
- Identify the major tasks associated with each abort case and the crewmember responsible for the task.
- Identify the cockpit indications that should be monitored during each major event of each abort case.

143B  **ABORT FAM 21011**

**Title:** Abort Familiarization 1
**Duration:** 4.0 hours
**Medium:** SMS-MB
**Student:** ASCAN, PS (Schedule 3 ASCANs, 1 CB IP.)
**Source:** DA7/Assigned SMS Team
**Date:** 02/04
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** ABORT FAM 21001
**Preparation:** None

**Synopsis:** This lesson is designed to introduce the students to several intact abort scenarios in a cockpit environment. During each abort case, the students will be required to follow the appropriate FDF procedures, perform the tasks called out in the FDF, and identify the cockpit indicators that each crewmember is monitoring throughout the abort.
New Astronaut Lesson Descriptions

143B  **ABORT FAM 21011 (Concluded)**

Objectives:
- Using the FDF, perform the following intact aborts:
  - Abort to Orbit (ATO) to OMS 2 targeting
  - Abort Once Around (AOA) to landing (systems)
  - 2-engine Return-To-Launch Site (RTLS) to landing
  - Transatlantic Abort Landing (TAL)/TAL Delay to landing (landing optional)
- Perform the appropriate monitoring tasks associated with each of the abort cases.
- Debrief the major cockpit cues (aural, visual, etc.) associated with each abort case.

144  **EPS MAL A/E BR 21001**

Title: Ascent/Entry Electrical Power System Malfunction Review
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: *DS45/Shuttle Systems Training Group*
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: ASC PKT C/L, ENT PKT C/L, AESP, REF DATA
Prerequisite Lesson(s): EPS OPS 21004
Preparation:
- Review:
  - SCOM; Section 2.8, EPS

Synopsis: Using materials from previous EPS lessons, this review class will begin with a brief overview of the EPS subsystems and then an overview of the FDF, including the Ascent/Entry Systems Procedures, Ascent Pocket Checklist, Entry Pocket Checklist, and Reference Data from an EPS point of view. Next, there will be a discussion of the fuel cell shutdown and bus tie procedures. The remainder of the class will be working through the malfunctions listed in the performance objectives using the display, meter, and panel information with the FDF to identify the problem, confirm the problem, safe the system, reconfigure the system, and determine the impact of the problem on the remainder of the mission.

Objectives:
- Identify the signatures of the following EPS malfunctions on ascent and/or entry via displays, meters, and other cockpit cues:
  - 3 phase motor stop
  - AC single phase inverter fail
  - AC single phase volts high
  - Essential Bus (ESS) short
  - Forward Power Controller (FPC)
New Astronaut Lesson Descriptions

144  **EPS MAL A/E BR 21001 (Concluded)**

- Fuel Cell pH
- Main bus or Fuel Cell short
- O₂ manifold leak
- Reactant valve fail closed

- Describe the sequence of FDF usage for the EPS ascent/entry malfunctions discussed in this class.
- Explain the guidelines/constraints and rationale associated with the procedures for the EPS ascent/entry malfunctions discussed in this class.
- State the mission impact for each of the EPS ascent/entry malfunctions discussed in this class.
- Explain the difference between the long and short form bus tie, and when each would be used.
- Identify the difference in signatures between a fuel cell short and a main bus short.
- Describe the function of the AC bus sensors on ascent/entry.
- Explain the failure that leads to a 3-phase motor shop.

145  **EPS MAL O BR 21001**

**Title:** Orbit Electrical Power System Review  
**Duration:** 3.0 hours  
**Medium:** Classroom  
**Student:** ASCAN  
**Source:** DS45/Shuttle Systems Training Group  
**Date:** 04/06  
**Lesson(s) Replaced:** None  
**Equipment Required:** ORB PKT C/L, MAL PROC (Volume 2), REF DATA, IFM C/L  
**Prerequisite Lesson(s):** EPS OPS 21004, IFM PIN KIT 21001  
**Preparation:** Review:  
  - SCOM; Section 2.8, EPS

**Synopsis:** Using materials from previous EPS classes, this review class will begin with a brief overview of the EPS subsystems and then an overview of the FDF (Orbit Pocket Checklist, Malfunction Procedures) from an EPS point of view. Next, there will be a detailed discussion of the Fuel Cell Shutdown and Bus Tie procedures. The remainder of the class will be working through the malfunctions listed in the performance objectives using the onboard display, meter, and panel information with the FDF to identify the problem, confirm the problem, safe the system, reconfigure the system, and determine the impact of the problem on the remainder of the mission.
New Astronaut Lesson Descriptions

145 **EPS MAL O BR 21001 (Concluded)**

Objectives:
- Identify the signatures of the following EPS malfunctions on orbit via displays and other available cockpit cues:
  - AC Inverter Failure
  - AC Single Phase Short
  - Control Bus Short
  - Cryo O₂ Tank Heater Trip
  - Forward Power Controller (FPC) Short
  - Fuel Cell Coolant Pump Delta P Sensor Failure
  - Fuel Cell H₂ Pump Failure
  - Fuel Cell pH Indication
- State the mission impact for each of the EPS orbit malfunctions discussed in this class.
- Explain the guidelines, constraints, rationale, and FDF sequence associated with EPS orbit malfunction procedures.
- Explain the concept of “induced voltage.”
- Identify when “bus isolation” steps in the Malfunction procedures are needed, and when they are not needed.
- Explain how a short on a control bus will fail part (but not all) of the bus.
- Explain the concept of the AC Transfer Cable.
- Describe the function of the AC bus sensors on orbit.

146 **WATER SURV 21027**

Title: Water Survival
Duration: 3.0 hours
Medium: Neutral Buoyancy Lab
Student: ASCAN (Schedule in groups of up to 5.)
Source: DX45/Crew Systems *Group*
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: ACES required
Prerequisite Lesson(s): WATER SURV 21001

**Note:** Swim Test required before this lesson may be scheduled. This lesson should be scheduled no later than 2 days after WATER SURV 21001.

**Preparation:**
- CREW ESCAPE SYSTEMS 21002
  - Section 2.5
  - Section 2.6
  - Section 3.6
  - Section 4.7
New Astronaut Lesson Descriptions

146 WATER SURV 21027 (Concluded)

Synopsis: This lesson enables the crewmembers to experience bailout, water entry, and survival techniques. It is in 2 parts.

- **Part 1:**
  - Each of the crewmembers will hang from parachute risers, inflate their Life Preserver Unit (LPU), close and lock their visor, and pull their green apple.
  - They will then be released and enter the water.
  - Divers will place the crewmember under the canopy and they will extricate themselves from underneath it.
  - The student will experience a back drag and a front drag to practice proper body positioning and Frost fitting release.
  - They will then enter the raft and perform survival procedures, including radio ops using the PRC-112 and Search and Recovery Satellite Aided Tracking (SARSAT), signaling equipment, and bailing devices.
  - The student will perform the procedures associated with the Forest Penetrator rescue seat.

- **Part 2:**
  - They will enter a mockup of the orbiter side hatch, attach themselves to the escape pole, and perform a bailout into the pool.
  - A video will be replayed to show how well they have performed.
  - Additional bailouts can be performed to improve technique.

Objectives: Perform parachute descent techniques and water entry procedures.
Perform parachute drag and canopy extraction.
Perform life raft entry and reentry procedures.
Perform survival equipment use, radio protocol, and signaling techniques.
Perform rescue hoist operations.
Perform orbiter side hatch bailout procedures into pool.

147 OMS MAL BR 21001

Title: Orbital Maneuvering System Malfunction Review
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN (Schedule in groups of up to 15.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
OMS MAL BR 21001 (Concluded)

Prerequisite Lesson(s): OMS OPS 21006
Preparation: Read:
  • OMS 21002; Chapter 4

Synopsis: This lesson will prepare the students for OMS MAL 21006, and will be the foundation for all future OMS troubleshooting operations. The lesson will begin with a review of the OMS and its nominal operations. A discussion of OMS failure modes and resolution techniques will be the main component of the briefing. Malfunction troubleshooting methods and use of the FDF will be covered. The OMS leaking Propellant/Helium procedures on orbit will be covered in detail.

Objectives:
  • Use OMS cockpit cues and FDF to identify single-failure-deep OMS malfunctions and determine the appropriate actions required to place the system in a safe configuration.
  • The types of malfunctions covered will include:
    – Transducer failures (temperature, pressure)
    – Leaks (helium, propellant, nitrogen)
    – Regulator failures (helium, nitrogen)
    – Gimbal failures
    – Probe failures
    – Switch and valve failures
    – Thermal failures

OMS MAL 21001

Title: Orbital Maneuvering System Malfunction Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): OMS OPS 21006
Preparation: Read:
  • OMS 21002; Chapter 4

Note: This lesson replaces the OMS MAL BR 21001 lesson for non-ASCAN students.
New Astronaut Lesson Descriptions

148A  **OMS MAL 21001 (Concluded)**

Synopsis: This lesson will prepare the students for OMS MAL 21006, and will be the foundation for all future OMS troubleshooting operations. The lesson will begin with a review of the OMS and its nominal operations. A discussion of OMS failure modes and resolution techniques will be the main component of the briefing. Malfunction troubleshooting methods and use of the FDF will be covered. The OMS leaking Propellant/Helium procedures on orbit will be covered in detail.

Objectives:
- Use OMS cockpit cues and FDF to identify single-failure-deep OMS malfunctions and determine the appropriate actions required to place the system in a safe configuration.
- The types of malfunctions covered will include:
  - Transducer failures (temperature, pressure)
  - Leaks (helium, propellant, nitrogen)
  - Regulator failures (helium, nitrogen)
  - Gimbal failures
  - Probe failures
  - Switch and valve failures
  - Thermal failures

148B  **OMS MAL 21006**

Title: Orbital Maneuvering System Malfunction
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): OMS MAL BR 21001
Preparation: Review:
  - OMS 21002; Section 4

Synopsis: This lesson is designed to allow the student to practice malfunctions discussed in OMS MAL BR 21001. The lesson will present one-failure-deep OMS malfunctions from the Ascent, Orbit, and Entry phases of flight. The class is designed to reinforce basic OMS subsystem knowledge, teach the use of FDF, and form the basis of analytical thinking in troubleshooting subsystem problems. Students will be actively involved and are encouraged to engage their instructors with questions. Students will work an OMS Helium tank leak on-orbit to completion.
New Astronaut Lesson Descriptions

148B  OMS MAL 21006 (Concluded)

Objectives:  
- Perform the following actions for given one-failure-deep OMS malfunctions:
  - Recognize (identify) that a malfunction has occurred with primary and secondary cues.
  - Identify the FDF procedure to be worked.
  - Notify MCC and perform the actions required.
  - Correctly identify the malfunction on the appropriate FDF schematic.
  - Evaluate if the actions were effective and determine the impacts to the system/mission.

149A  ABORT FAM 22001

Title:  Abort Familiarization 2 Prebrief
Duration:  1.0 hour
Medium:  Classroom
Student:  ASCAN (Schedule 3 ASCANs, 1 CB IP.)
Source:  DA7/Assigned SMS Team
Date:  03/95
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  ABORT FAM 21011
Preparation:  Review:
  - Ascent C/L
    - OMS 1/2 TGTING, Look specifically at ATO OMS1 burn required portion of the card
    - OMS1 BURN
    - OMS2 TGTING
    - TAL, Look specifically at Post-MECO TAL steps
    - TAL Redesignate cue card

Synopsis:  This prebrief will prepare the student for ABORT FAM 22011. During the prebrief, the major events and FDF flow of the following aborts will be reviewed:

  - ATO with OMS-1
  - Post-MECO TAL
  - 3-ENG RTLS
  - TAL Redesignate

In addition, the students will review the cockpit indications that should be monitored during each of the abort cases and the crewmember(s) responsible for the monitoring task.
New Astronaut Lesson Descriptions

149A  **ABORT FAM 22001 (Concluded)**

Objectives:
- Identify the major tasks associated with each abort case.
- Identify the flow of FDF associated with each abort case.
- Identify the cockpit indications that should be monitored during each major event of each abort case.

149B  **ABORT FAM 22011**

Title: Abort Familiarization 2  
Duration: 4.0 hours  
Medium: SMS-MB  
Student: ASCAN (Schedule 3 ASCANs, 1 CB IP.)  
Source:  
Date: 03/95  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ABORT FAM 22001  
Preparation: None  

Synopsis: This lesson is designed to introduce the students to several intact abort scenarios in a cockpit environment. During each abort case, the students will be required to follow the appropriate FDF procedure, perform the tasks called out in the FDF, and identify the cockpit indicators that each crewmember is monitoring throughout the abort.

Objectives:  
- Using the FDF, perform the following intact aborts:  
  - ATO with OMS-1 burn required  
  - Post-MECO TAL  
  - 3-engine RTLS to landing  
  - TAL Redesignate through OPS 3 (landing optional)  
- Perform the appropriate monitoring tasks associated with each of the abort cases.  
- Discuss the major cockpit cues (aural, visual, etc.) associated with each abort case.

150  **EPS MAL A/E 21004**

Title: Ascent/Entry Electrical Power System Malfunction  
Duration: 2.0 hours  
Medium: SST 2 or SST 1 or SST 3  
Student: ASCAN (Schedule in pairs.)  
Source:  
Date: 04/06  
Lesson(s) Replaced: EPS MAL 21004
New Astronaut Lesson Descriptions

150  **EPS MAL A/E 21004 (Concluded)**

Equipment Required:  None  
Prerequisite Lesson(s):  EPS MAL A/E BR 21001  
Preparation:  None

Synopsis:  This lesson will present the student with a variety of malfunctions in the Power Reactants Storage and Distribution (PRSD) subsystem, fuel cell, and Electrical Power Distribution and Control (EPDC) subsystem. The students will use their EPS knowledge with the onboard displays, meter, panel information, and FDF to identify the problem, confirm the problem, safe the system, reconfigure the system, and determine the impact of the problem on the remainder of the mission.

Objectives:

- Identify the following EPS malfunctions during the ascent/entry timeframe via displays and other available cockpit cues:
  - 3 phase motor stall
  - AC inverter failure
  - AC inverter shift
  - Bus tie switch failure
  - Cryo manifold leak
  - Essential bus short
  - Forward Power Controller (FPC) short
  - Fuel cell pH sensor fail
  - Fuel cell reactant valve failed closed
  - Fuel cell short
  - Main bus short

- Execute the appropriate FDF procedure for each of the EPS ascent/entry malfunctions discussed in this class.
- Explain the rationale for the FDF procedures associated with each of the EPS ascent/entry malfunctions discussed in this class.
- State the mission impact for each of the EPS ascent/entry malfunctions discussed in this class.

151  **EPS MAL O 21004**

Title:  Orbit Electrical Power System Malfunction  
Duration:  2.0 hours  
Medium:  SST 2 or SST 1 or SST 3  
Student:  ASCAN (Schedule in pairs.)  
Source:  DS45/Shuttle Systems Training Group  
Date:  04/06  
Lesson(s) Replaced:  EPS OPS 21004  
Equipment Required:  None
New Astronaut Lesson Descriptions

151    EPS MAL O 21004 (Concluded)

Prerequisite Lesson(s): EPS MAL O BR 21001
Preparation: None

Synopsis: This lesson will present the student with a variety of malfunctions in the Power Reactant Storage and Distribution (PRSD) subsystem, Fuel Cell, and Electrical Power Distribution and Control (EPDC) subsystem. The students will use their EPS knowledge with the onboard displays, meter, panel information, and FDF to identify the problem, confirm the problem, safe the system, reconfigure the system, and determine the impact of the problem on the remainder of the mission.

Objectives:

• Identify the following EPS malfunctions during the orbit timeframe via displays and other available cockpit cues:
  – AC inverter failure
  – AC overload
  – Control bus short
  – Cryo O₂ heater current sensor trip
  – FPC short
  – Fuel cell H₂ pump
  – Fuel cell delta-P sensor failure
  – Fuel cell pH sensor

• Execute the appropriate FDF procedure for each of the EPS orbit malfunctions discussed in this class.

• Explain the rationale for the FDF procedures associated with each of the EPS orbit malfunctions discussed in this class.

• State the mission impact for each of the EPS orbit malfunctions discussed in this class.

152    SPOC 21001

Title: SpOC Familiarization Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN, PS (Schedule in groups of up to 4.)
Source: MS4/Flight Software Office
Date: 10/05

Lesson(s) Replaced: SpOC/HP48SX 21001
Equipment Required: ORB OPS C/L, ORB PKT C/L
Prerequisite Lesson(s): ECLSS MAL O 21004, PGSC INTRO 21195
Preparation: Review:
  • Orbit Ops C/L; PGSC section
New Astronaut Lesson Descriptions

152  **SPOC 21001 (Concluded)**

Synopsis: This lesson is designed to familiarize the students with the standard Space Operations Computing (SpOC) software applications flown on the PGSC for every mission. This class is a “hands-on” software and hardware class. The students will learn how to use and interface with the SpOC applications. Additionally, students will be presented with the overall ops concepts for PGSC software (i.e., how each application affects the suite of tools on the PGSC). Students will be given operational scenarios and asked to respond using the software to generate solutions.

Objectives:
- Describe the functions provided by the SpOC software.
- Demonstrate effective uses of the SpOC software and PGSC hardware.
- Describe the relationships (i.e., cause and effect) of data to the software suite.
- Describe the operational concept of the PGSC as it relates to Shuttle ops.

153A  **E NAV 22001**

Title: Entry Navigation 2 Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: ASCAN (Schedule in pairs.)  
Source: DS24/DPS/Navigation Training Group  
Date: 02/04  
Lesson(s) Replaced: E NAV 21011  
Equipment Required: None  
Prerequisite Lesson(s): E NAV 21006, IMU 21006  
Preparation: Review:  
- NAV 21002; with an emphasis on entry navigation topics  
Read:  
- AESP (Glided Flight); COMM/GNC and DPS  
  - RM FAIL IMU  
  - RM DILEMMA IMU  
  - POST BFS ENGAGE  

Synopsis: This prebrief will review entry Inertial Measurement Unit (IMU) and state vector management and introduce associated FDF. Differences between Primary Avionics Software System (PASS) and Backup Flight Software (BFS) usage of Tactical Air Navigation (TACAN) and air data sensors will be reviewed as well. This will include a detailed discussion of the BFS probe deployment and verification procedures. The Microwave Landing System (MLS) and its use during landing phase will be discussed, including identification of failure modes.
New Astronaut Lesson Descriptions

153A  E NAV 22001 (Concluded)

Objectives:
• Discuss the IMU attitude and velocity selection filter for PASS and BFS.
• Discuss entry state vector management for PASS and BFS, including the procedure for PASS-to-BFS state vector transfer.
• Explain how TACAN and air data sensor management is different in PASS versus BFS.
• Discuss elements of the POST BFS ENGAGE procedure pertaining to IMUs and air data.
• Describe BFS air data probe deploy and verification.
• Discuss the MLS and its management during entry.
• Summarize the method for troubleshooting MLS Redundancy Management (RM) dilemmas.
• Discuss IMU re-anchoring in PASS Operational Sequence (OPS) 3.

153B  E NAV 22006

Title: Entry Navigation 2
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: E NAV 21011 (partial)
Equipment Required: None
Prerequisite Lesson(s): E NAV 22001
Preparation: None

Synopsis: This lesson, a continuation of E NAV 21006, concentrates on entry Inertial Measurement Unit (IMU) and state vector management, including identification, safing, and recovery, when possible. Flight-critical Multiplexer/Demultiplexer (MDM) problems will be used to demonstrate the effects of DPS problems on IMU and state vector selection in both the Primary Avionics Software System (PASS) and Backup Flight Software (BFS). On one run, the BFS will be engaged and BFS-unique entry procedures will be performed. The evaluation and resolution of a Microwave Landing System (MLS) malfunction will be performed at the end of an entry run. The following runs will be used to exercise the training objectives:

• Run 1: Tactical Air Navigation (TACAN), air data, and MLS case from 210K to landing.
• Run 2: IMU management (Redundancy Management (RM) and data paths).
New Astronaut Lesson Descriptions

153B  E NAV 22006 (Concluded)

- Run 3: IMU management (IMU/IMU align).
- Run 4: BFS-engage entry (TACAN and air data procedures).
- Run 5: Bad onboard NAV/incorporate Global Positioning System (GPS).

Objectives:
- Identify TACAN and air data failures and execute recovery/safing procedures.
- Identify and resolve an MLS dilemma using the Horizontal Situation Indicator (HSI).
- Identify and resolve IMU RM fail and dilemma using the appropriate procedures.
- Describe PASS and BFS IMU RM.
- Explain IMU re-anchoring in PASS Operational Sequence (OPS) 3.
- Identify the impact of DPS failures on PASS and BFS IMU selection.
- Identify the signature of an IMU power failure.
- Perform the IMU/IMU align procedure to recover a caged IMU.
- Perform a PASS/BFS state vector transfer.
- Perform a BFS engage and work the post-engage procedures.
- Identify a silent TACAN dilemma in the BFS.
- Perform BFS probe deploy and verification.
- Identify and resolve an Air Data Transducer Assembly (ADTA) malfunction while BFS-engaged.
- Discuss onboard evaluation of bad nav.
- Discuss GPS and its usage.
- Incorporate GPS to correct a bad NAV state.

154  NAV QUAL 21001

Title:  Navigation Qualification
Duration:  1.0 hour
Medium:  Classroom
Student:  ASCAN (Schedule individually.)
Source:  DS24/DPS/Navigation Training Group
Date:  10/05
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  E NAV 22006, A/E BFS 21011
Preparation:  None

Synopsis:  This lesson will verify completion standards of Navigation (NAV) training by having the student answer some general questions about NAV operations.
New Astronaut Lesson Descriptions

154  **NAV QUAL 21001 (Concluded)**

Objectives:  
- Describe the data that the sensor provides to the software, the timeframes used, the Redundancy Management (RM) (selection filter and downmode conditions) for Primary Avionics Software System (PASS) and Backup Flight System (BFS), and the procedures for RM failures and dilemmas, as applicable, for the following sensors: Inertial Measuring Unit (IMU), Tactical Air Navigation (TACAN), the air data system, Microwave Landing System (MLS), and Radar Altimeters (RAs).
- Describe the IMU failure signatures (Fail, Dilemma (DLMA), Power) and the actions required for each, as applicable.
- Describe IMU reanchoring and when it will occur.
- Describe air data probe deployment and verification for PASS and BFS.
- Describe residual, ratio, and the filter controls (Auto, Inhibit, Force) as seen on PASS and BFS SPEC 50.
- Describe the single-state and three-state vector schemes, when they are used, and their advantages/disadvantages.

155  **RCS MAL BR 21001**

Title: Reaction Control System Malfunction Review  
Duration: 2.5 hours  
Medium: Classroom  
Student: ASCAN (Schedule in groups of about 15.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: AESP, ASC PKT C/L, ORB PKT C/L  
Prerequisite Lesson(s): OMS MAL 21006  
Preparation: Review:  
- SCOM; Section 2.20  
- RCS OV 21001 materials  

Synopsis: This lesson is a refresher on the Reaction Control System (RCS), including nominal operations, relevant DPS displays, switch, and meter locations. This lesson is also an introduction into malfunction recognition and resolution. This will include schematic references, FDF selection and manipulation, and techniques for crewmembers. FDF procedures will be examined in a generic overview fashion. Line by line reviews, when required, are reserved for the SST. This lesson leads directly into RCS MAL 21006. The RCS leaking Propellant/Hehelium procedures will be covered in detail.
New Astronaut Lesson Descriptions

155 **RCS MAL BR 21001 (Concluded)**

Objectives:
- State the four steps in resolving a malfunction.
- Determine the appropriate FDF book and procedure title for given RCS failures based on the phase of flight and message annunciated.
- Identify the technique for “securing” the RCS.
- Identify the technique used to reopen a secured RCS.
- Identify on an FDF schematic the bounded location of the following:
  - A helium tank leak
  - A helium line leak
  - A propellant tank leak
  - A propellant leg leak
  - A manifold leak
  - A crossfeed line leak
- Define the following malfunctions and state how each is monitored:
  - Jet Fail LEAK
  - Jet Fail ON
  - Jet Fail OFF

156A **RCS MAL 21001**

Title: Reaction Control System Malfunction Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: Non-ASCAN  
Source: DS66/G&C/Propulsion Training Group  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): OMS MAL 21006  
Preparation: Review:  
  - SCOM; Section 2.20  
  - RCS 21002  

**Note:** This lesson replaces the RCS MAL BR 21001 lesson for non-ASCAN students.

**Synopsis:** This lesson is a refresher on the Reaction Control System (RCS), including nominal operations, relevant DPS displays, switch, and meter locations. This lesson is also an introduction into malfunction recognition and resolution. This will include schematic references, FDF selection and manipulation, and techniques for crewmembers. FDF procedures will be examined in a generic overview fashion. Line by line reviews, when required, are reserved for the SST. This lesson leads directly into RCS MAL 21006. The RCS leaking Propellant/Helium procedures will be covered in detail.
New Astronaut Lesson Descriptions

156A  **RCS MAL 21001 (Concluded)**

Objectives:

- State the four steps in resolving a malfunction.
- Determine the appropriate FDF book and procedure title for given RCS failures based on the phase of flight and message annunciated.
- Identify the technique for “securing” the RCS.
- Identify the technique used to reopen a secured RCS.
- Identify on an FDF schematic the bounded location of the following:
  - A helium tank leak
  - A helium line leak
  - A propellant tank leak
  - A propellant leg leak
  - A manifold leak
  - A crossfeed line leak
- Define the following malfunctions and state how each is monitored:
  - Jet Fail LEAK
  - Jet Fail ON
  - Jet Fail OFF

156B  **RCS MAL 21006**

Title: Reaction Control System Malfunction

Duration: 2.0 hours

Medium: SST 1 or SST 2 or SST 3

Student: ASCAN (Schedule in pairs.)

Source:  *DS66/G&C/Propulsion Training Group*  

Date: 10/05

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): RCS MAL BR 21001

Preparation: Review:

- RCS 21002; Chapter 4
- SCOM; Section 6.8, OMS, RCS

Synopsis: This lesson will present malfunctions from Ascent, Orbit, and Entry phases of flight. The lesson is designed to reinforce basic Reaction Control System (RCS) subsystem knowledge, teach the use of FDF, and form the basis of analytical thinking in troubleshooting subsystem problems. A majority of procedures from each checklist (C/L) will be exercised. The lesson will allow hands-on practice for the student. Students will be actively involved, and are encouraged to engage their instructors with questions. Student will work through the orbit leaking Helium burn procedures.
New Astronaut Lesson Descriptions

156B  **RCS MAL 21006 (Concluded)**

Objectives:  
- Demonstrate an ability to use the appropriate FDF to correctly identify, confirm, and reconfigure in response to single failures of the RCS subsystem.
- Use instrumentation cross checks to identify real and false failure annunciations.
- Perform isolation/securing of the leaking system from the bottom to the top.
- Identify, on a schematic, the following:
  - A helium tank leak
  - A helium leg leak
  - A propellant tank leak
  - A manifold leak
  - A tank leg leak
- Define, for both Primary Avionics Software System (PASS) and Backup Flight Software (BFS), the causes and signatures of the following:
  - Jet Fail OFF
  - Jet Fail ON
  - Jet Fail LEAK
- Execute the RCS He tank leak procedure on-orbit to completion.

157  **TIER TEST 24001**

Refer to TIER TEST 21001 for description.

158  **MAN MNVR 21025**

Title: Orbit Manual Maneuvers  
Duration: 2.0 hours  
Medium: Dynamic Skills Trainer 1  
Student: ASCAN (Schedule individually.)  
Source: **DM34/Rendezvous Guidance, Procedures and Training**  
Date: 02/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PTG 21006  
Preparation:  
- Review:
  - ORB DAP 21057
New Astronaut Lesson Descriptions

158 MAN MNVR 21025 (Concluded)

Synopsis: This lesson contains exercises for developing the skills required to manually maneuver the shuttle (translation and rotation) on orbit. The emphasis of the lesson is on configuration of the orbit DAP using both the Guidance, Navigation, and Control (GNC) SPEC 20 DAP CONFIG display and the DAP pushbuttons (located on either Panel C3 or A6). The lesson will also allow the student to observe the effects of rotational and translational cross-coupling on the orbiter from the visuals, Attitude Direction Indicator (ADI), and the Universal Pointing (UNIV PTG) display. The exercises will contain maneuvers to both M50-stabilized and LVLH-stabilized attitudes, and will require the student to execute them in the +X orbiter body sense.

Objectives:
- State the function of each DAP pushbutton.
- State the function of all reconfigurable DAP parameters on SPEC 20.
- Perform a DAP EDIT reconfiguration and a temporary DAP change on SPEC 20.
- Describe and observe the cross-coupling effects in each axis for rotational and translational maneuvers.
- Perform INRTL and LVLH manual maneuvers with various orbiter body axes in Discrete (DISC) (attitude hold) and PULSE (free drift).
- Describe the information provided by the ADI and the four switches that affect this information.

159 MPS MAL BR 22001

Title: Main Propulsion System Malfunction Review 2
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN (Schedule in groups of about 15.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: ASC C/L, ASC PKT C/L, and AESP
Prerequisite Lesson(s): MPS MAL 21006, ABORT FAM 22011
Preparation: Read:
- MPS Workbook 21002, Section 4.5
Review:
- MPS MAL BR 22001 handouts
- MPS Workbook 21002, Sections 4.1 – 4.4
New Astronaut Lesson Descriptions

159 MPS MAL BR 22001 (Concluded)

Synopsis: This lesson builds on MPS MAL 21006, and will first review the general problem-solving strategy model and the specific guidelines for using the FDF cue cards for Main Propulsion System (MPS) malfunctions. The malfunction cases covered in the class are:

- 2 Stuck Throttles
- 2 Hydraulic Systems Failed
- Space Shuttle Main Engine (SSME) Stuck in the Bucket
- Single SSME Completion (2 SSMEs Failed/Shutdown)
- Multiple SSME Data Path Failures
- SSME Pushbuttons
- Main Engine He Leak and Aft Load Controller (ALC) Bus Failed
- DPS and EPS Fail Impacts to SSME Powered Flight
- MPS Helium Leak (Post External Tank Separation (ET SEP))
- ET SEP MAN/AUTO
- MPS Dump Inhibit
- Single DPS or EPS Fail: Impacts to MPS Dump/Vacuum Inerting
- DPS Multi-Data Path Loss Impacts to MPS
- High LH₂/LO₂ Manifold Pressure (Post-Main Engine Cut-off (MECO))
- MPS Helium Regulator Fail During Entry

This lesson will cover the following for the malfunction cases listed:

- The cause of each malfunction.
- Recognition of each malfunction.
- Locating the applicable procedure.
- The rationale for each procedure.

Objectives:

- Given MPS-related malfunction:
  - Explain the cause of each malfunction.
  - State the cues to identify each malfunction.
  - Locate the applicable procedure.
  - Explain the rationale for each procedure.

160 CONT ABT BR 21001

Title: Contingency Abort Briefing
Duration: 4.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
New Astronaut Lesson Descriptions

160 CONT ABT BR 21001 (Concluded)

Prerequisite Lesson(s): ABORT FAM 22011
Preparation: Read:
  - CONT ABT 21007

Synopsis: The briefing describes what contingency aborts are, when they are required, and how to fly them. At the end of the briefing, the student will have a basic understanding of contingency aborts, and will be able to use and understand the contingency abort cue card. The student will be prepared to practice contingency abort procedures in the SMS. Due to time constraints, not all contingency abort procedures on the cue card will be taught in this lesson. More contingency abort training occurs early in the assigned crew training flow.

Objectives:
  - State when a contingency abort is required.
  - Describe the basic maneuvers and events that occur during contingency aborts.
  - State where the generic contingency aborts black zones are located.
  - Explain how the automated contingency guidance is engaged.
  - Explain how the following orbiter features are used in contingency aborts: Control Stick Steering (CSS) flight controls; max throttles; SPEC 51 OMS dump; fast External Tank (ET) separation; single engine roll control; flight instruments and displays; speed brake and body flap; bailout autopilot.
  - Describe the suggested Space Flight Resource Management (SFRM) and cockpit techniques for flying contingency aborts, including the typical division of responsibilities among crewmembers.
  - Explain the basic differences between the two engine out and three engine out procedures.
  - State how the crew uses the droop guidance display in the cockpit.
  - Explain the format and use of the contingency abort cue card.
  - Explain how to execute selected contingency abort procedures, using the contingency abort cue card.
    - Contingency 2 out blue
    - Contingency 3 out blue
    - Return-To-Launch Site (RTLS) 2 out yellow
    - RTLS 3 out orange
    - Bermuda/East Coast Abort Landing (ECAL)
    - Stuck procedures
New Astronaut Lesson Descriptions

161A ASC DPS MAL 21001

Title: Ascent Data Processing Systems Malfunction Procedures Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: ASC DPS 21001
Equipment Required: None
Prerequisite Lesson(s): A/E DPS MAL 21001
Preparation: Review:
  • AESP (Powered Flight); DPS FDF procedures
Skim:
  • Ascent Pocket C/L; DPS FDF procedures
Read:
  • Flight Rules
    – Ascent String Reassignment (Section 2)
    – Regain RCS Jets for RTLS ET Separation (Section 2)
    – PASS DPS Failure (Section 7)
    – Redundant Set Failure (Section 7)
    – Redundant Set Split (Section 7)
    – GPC Failure (Section 7, Paragraph A)
    – Data Path Failure (Section 7, Paragraph A)
    – PASS Data Bus Assignment Criteria (Section 7)
    – MDM Port Moding (Section 7)

Synopsis: This prebrief will introduce the student to various DPS failure signatures and procedures used during ascent. It will also be a review of the material presented in A/E DPS MAL 21001. The discussion will center on the malfunctions that will be introduced in ASC DPS MAL 21006. It is intended to ensure that the student has a good understanding of the procedures prior to exercising them in the SST.

Objectives: Identify signatures and the procedures to be run during ascent for the following DPS situations:
  – Flight Aft (FA) and Flight Forward (FF) Multiplexer/Demultiplexer (MDM) failure (either at the General Purpose Computer (GPC) or at the MDM)
  – Partial FA or FF MDM failure (A/B or C/D)
  – Backup Flight Software (BFS) Engage
  – Multi Data Path Loss
  – Explain the rationale for ascent restring and port mode cases.
New Astronaut Lesson Descriptions

161B  ASC DPS MAL 21006

Title: Ascent Data Processing System Malfunction Procedures
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: ASC DPS 21011
Equipment Required: None
Prerequisite Lesson(s): ASC DPS MAL 21001
Preparation: None

Synopsis: In this lesson, the student will practice exercising the procedures and signature recognition associated with ascent DPS failures. Procedures will be executed from both the Ascent/Entry Systems Procedures (AESP) (Powered and Glided) and Ascent Pocket (ASC PKT) Checklist (C/L). Backup Flight Software (BFS) actions will be discussed where applicable. Four runs will be used to exercise the following procedures:
• BCE STRG X
• PASS GPC FAIL
• MULTI-DATA PATH
• BFS GPC FAIL
• I/O ERROR CRT/DPS DISPLAY ANOMALY
• FA/FF MDM I/O ERROR
• FA/FF MDM PORT MODE
• PL MDM I/O ERROR
• POST BFS ENGAGE
• RESTRING CUE CARD

Objectives:
• Identify the DPS failure based on cockpit cues.
• Perform appropriate procedures in the AESP and/or the ASC PKT C/L.
• Explain the steps and rationale behind each procedure worked.
• Optimize final DPS configuration for ascent.
• Identify mission impacts of the failures.
New Astronaut Lesson Descriptions

162 BFS FAM BR 21001

Title: Backup Flight System Familiarization Briefing
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN
Source: DS24/DPS/Navigation Training Group and DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Review:
  • SCOM; Section 2.6, Software, Backup Flight System
  • DPS HW/SW 21002; Section 4, Backup Flight Software
  • IMU 21002; Section 5, Differences in the BFS
  • NAV 21002; Section 5.8, BFS Differences
  • OMS 21002; Section 5, Differences in the BFS
  • RCS 21002; Section 5, Differences in the BFS
  • Ascent/Abort FPH; Section 5, Backup Flight System
  • ASC G&C 21002; Section 7, BFS Differences
  • CONT 21002; Section 7, Backup Flight System Controllers
  • G&C I/O/D 21002; BFS portions of Sections 3, 4, 5, 6, 7, and 8
  • Flight Rules
    – Data Path Fail/Engine-On Limit Shutdown Control (Section 5)
    – PASS/BFS Redundancy (Section 7)
    – GNC GPC Reactivation Priority (Section 7)
    – BFS DPS Failure (Section 7)
    – GPC Major Function Configuration (Section 7, Paragraph A, D, E)
    – Constraints on Port Moding or I/O Resets (Section 7)
    – Loss of BFS (Section 8)

Synopsis: This briefing explains the hardware and software aspects of the Backup Flight System (BFS). It will discuss the primary purpose of the BFS, its limitations and its uses during various phases of flight. The briefing also discusses when and how to engage the BFS. Flight Rules pertaining to the management of the BFS will also be discussed. The briefing also focuses on the operational difference between the Primary Avionics Software System (PASS) and BFS (pre and post BFS engage).

Objectives: • Explain the primary purpose of the BFS and its major limitations.
  • Explain how the BFS is normally used for the various phases of flight.
  • Explain how to perform a successful BFS engage.
New Astronaut Lesson Descriptions

162 **BFS FAM BR 21001 (Concluded)**

- Differentiate the requirements for PASS and BFS to recognize a BFS engage.
- Identify situations which may/will require a BFS engage.
- Identify situations when the BFS is no-go for engage.
- Identify situations when the BFS is suspect for engage.
- Describe a BFS self-engage and its signature.
- Explain the operational differences between PASS and BFS (pre and post BFS engage).

163 **OM/RC BURNS BR 21001**

**Title:** Orbital Maneuvering/Reaction Control System Burns Review  
**Duration:** 2.0 hours  
**Medium:** Classroom  
**Student:** ASCAN (Schedule in groups of about 15.)  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** OMS MAL 21006, RCS MAL 21006, OMS TGTING 22001  
**Preparation:** Review:  
- OMS 21002  
  - Section 4, Engine Failures, Leaks and other Propellant System Failures; Nitrogen System Failures, and Gimbal Failures  
- SCOM  
  - Section 2.19, Fault Detection and Identification  

**Synopsis:** This lesson will provide the student the background for diagnosing failures during OMS and Reaction Control System (RCS) burns and prepare the student for OM/RC BURNS 21006 SST lessons. The procedures on the OMS BURN and OMS BURN MONITOR cards, and the fundamental concepts of OMS “engine failures” and “propellant failures” will be discussed. The prebrief will define OMS engine and propellant failures and teach how to diagnose engine fail and propellant fail during an OMS burn. This lesson will explain the rationale of the OMS ENG FAIL and OMS PRPLT FAIL procedures for OMS 2 and On Orbit OMS burns, during which the student will resolve malfunctions that occur during the OMS 1, OMS 2, and Orbit burns. This lesson will also introduce the “hot” OMS XFEED and other burn specific propellant management procedures. Lastly, this class will introduce the Space Flight Resource Management (SFRM) associated with monitoring burns, diagnosing failures, and working procedures.
New Astronaut Lesson Descriptions

163  **OM/RC BURNS BR 21001 (Concluded)**

Objectives:  
- Use OMS and RCS cockpit cues and OMS BURN MONITOR card to diagnose OMS engine and propellant failures due to propellant blockages, He line blockages, He leaks, propellant leaks, and Nitrogen leaks.
- Diagnose an OMS ENG FAIL due to gimbal failures.
- State the cockpit cue and system impact differences between an OMS engine fail and an OMS propellant fail.
- Explain the rationale of the OMS ENG FAIL and OMS PRPLT FAIL procedure on the OMS 2/ORBIT OMS BURNS card.

164  **C&W MAL 21004**

Title:  Caution & Warning Malfunction 2  
Duration:  2.0 hours  
Medium:  SST 2 or SST 1 or SST 3  
Student:  ASCAN (Schedule in pairs.)  
Source:  **DS45/Shuttle** Systems Training Group  
Date:  04/06  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  C&W OPS 21004  
Preparation:  None  

Synopsis:  Review the Caution & Warning (C&W) hardware systems, learn to recognize failures in these systems, and diagnose the problem using crew procedures.

Objectives:  
- Identify the following C&W malfunctions during the orbit timeframe via displays and other cockpit cues:
  - Power supply A fail
  - Power supply B transient
  - Primary C&W memory fail
  - C&W systems self-test failure
  - C&W parameter inhibited inadvertently
  - C&W multiplexer (MUX) failure
  - Smoke detection/fire suppression circuitry failure
  - C&W system A klaxon trigger circuit fail
- Execute the appropriate FDF procedure for each of the C&W malfunctions discussed in this class.
- Explain the rationale for the FDF procedures associated with each of the C&W malfunctions discussed in this class.
- State the mission impact for each of the C&W malfunctions discussed in this class.
New Astronaut Lesson Descriptions

ORB EPS 21004

Title: Orbit Electrical Power System Advanced Malfunction
Duration: 2.0 hours
Medium: SST 2 or SST 1 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS45/Shuttle Systems Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EPS MAL O 21004
Preparation: None

Synopsis: This lesson will cover Orbit EPS malfunctions. These malfunctions are more complicated than those presented in EPS MAL O 21004. The students will use their EPS systems knowledge with the FDF, onboard display, meter, and panel information to identify and confirm the problem, safe and reconfigure the system, and determine the impact of the problem on the remainder of the mission.

Objectives:

• Identify the following EPS malfunctions during the orbit timeframe via displays and other available cockpit cues:
  – Fuel Cell H₂ Pump Stall
  – Fuel Stack Temp transducer bias
  – Fuel Cell Internal Cryo Leak
  – Cryo Tank heater fail on
  – Cryo Tank Controller Pressure sensor fail Off Scale Low
  – AC False Overload
  – Forward Power Controller (FPC) Failure
  – Essential Bus Loss
  – Partial Control Bus Loss

• Execute the appropriate FDF procedure for each of the EPS orbit malfunctions discussed in this class.

• Explain the rationale for the FDF procedures associated with each of the EPS orbit malfunctions discussed in this class.

• State the mission impact for each of the EPS orbit malfunctions discussed in this class.

• Explain the concept and limitations of the AC Transfer Cable.
New Astronaut Lesson Descriptions

166A ORB DPS MAL 21001

Title: Orbit Data Processing System Malfunction Procedures Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): A/E DPS MAL 21001
Preparation: Review:
  • Flight Rules
    – DPS Redundancy Requirements (Section 7)
    – Transient GPC (Section 7)
    – GPC Failure (Section 7)
    – GPC Major Function Configuration (Section 7)
    – Powered Off GPC Action (101S) (Section 7)
    – GNC 3 Archive Management (Section 7)
    – GNC GPC Reactivation Requirements (Section 7)
    – PASS/BFS Redundancy (Section 7)
    – DPS GO/NO-GO Matrix (Section 7)
  • OOCL
    – PRE-SLEEP ACTIVITY, Step 8
  • OPCL
    – PASS GNC GPC (1st FAIL)
    – PASS SM GPC FAIL
  • MALFUNCTION PROCEDURE
    – GPC, 5.1a, CS SPLIT
    – MMU/MTU, 5.2a, I/O ERROR MMU, 5.2b, OFF/BSY MMU
    – DPS, SSR-8, GPC IPL-PASS

Synopsis: This briefing is designed to prepare the student for ORB DPS MAL 21006. The failures in this lesson are designed to exercise the associated procedures and to examine the operational impacts of the failures.

This briefing familiarizes the student with the following On-Orbit DPS failures and malfunction procedures. The briefing focuses on the failure signatures, the operational and flight rule impacts, the recovery procedures, and the procedural philosophies.
New Astronaut Lesson Descriptions

166A  ORB DPS MAL 21001 (Concluded)

Objectives: • Identify signatures and the procedures to be run during orbit for the following DPS situations:
  – Common Set (CS) split with single G2 configuration
  – Integrated Display Processor (IDP) Critical Built-In Test Equipment (BITE)
  – Modular Memory Unit (MMU) Power Failure
  – Operational Sequence (OPS) transition with both MMUs failed and stuck in OPS 0
  – Multifunction Display Unit (MDU) Anomaly (if time permits)

• Discuss the Multifunction Electronic Display System (MEDS) actions in the Pre-sleep procedure of the Orbit Operations (OPS) Checklist (if time permits).

166B  ORB DPS MAL 21006

Title: Orbit Data Processing System Malfunction Procedures 1
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ORB DPS MAL 21001
Preparation: None

Synopsis: The lesson begins with a single G2 configuration, and is designed to expose the student to on-orbit DPS failures. The failures are designed to have the student exercise the appropriate procedures and examine the operational impacts of the failures.

Objectives: • For the malfunctions listed below:
  – Identify the failure (primary cue).
  – Confirm the failure (secondary cue).
  – Make appropriate call to MCC.
  – Execute the appropriate FDF procedure.
  – Explain the steps and rationale behind the procedure.
  – Identify system/mission impacts.
  – Optimize final DPS configuration for orbit or entry, as required.
  – Configure Operational Sequence (OPS) for single G2.
New Astronaut Lesson Descriptions

166B  ORB DPS MAL 21006 (Concluded)

- Malfunctions to be exercised:
  - Common Set (CS) split with single G2 config
  - Critical Integrated Display Processor (IDP) Built-In Test Equipment (BITE)
  - Modular Memory Unit (MMU) Power Failure
  - OPS transition with both MMUs failed and stuck in OPS 0
  - Multifunction Display Unit (MDU) Built-In Test (BIT) Error (if time permits)
- Perform the Multifunction Electronic Display System (MEDS) portion of Pre-Sleep procedure (if time permits)

167  ORB SKL COMM 21008

Title: Orbit Communication Skills
Duration: 1.5 hours
Note: Schedule 30 minutes for setup.
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PGSC INTRO 21195
Preparation: REVIEW:
  - COMM SPEC 21057; Segments 1, 2, and 4
Synopsis: The lesson will develop the students’ skill in recognizing both nominal and off-nominal communication signatures. This will be performed with the aid of S/Ku-Band signal strength meters, orbiter SPEC 201 (ANTENNA), SPEC 76 (COMMUNICATIONS), and the WorldMap program.
Objectives: Identify orbiter communication status using the displayed signatures.
  - Determine if COMM LOST situations require application of malfunction procedures (no malfunction procedures are done in this lesson).
New Astronaut Lesson Descriptions

168 MPS MAL 22006

Title: Main Propulsion System Malfunctions 2
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05

Lesson(s) Replaced: MPS MAL A 21006
Equipment Required: None
Prerequisite Lesson(s): MPS MAL BR 22001
Preparation: Review:
• MPS MAL BR 22001 handouts
• MPS Workbook 21002, Section 4

Synopsis: This lesson will provide five to six ascent runs for the student to practice resolving the Main Propulsion System (MPS) malfunctions listed. Following each run, the instructor will review with the student the cause of each malfunction, the recognition cues, and the rationale for each procedure.

Objectives:
• Apply the problem-solving strategy to resolve the following malfunctions in the MPS:
  – 2 Stuck Throttles
  – 2 Hydraulic Systems Failed
  – Space Shuttle Main Engine (SSME) Stuck in the Bucket
  – Single SSME Completion (2 SSMEs Failed/Shutdown)
  – Multiple SSME Data Path Failures
  – SSME Pushbuttons
  – Main Engine He Leak and Aft Load Controller (ALC) Bus Failed
  – MPS Helium Leak (Post External Tank Separation (ET SEP))
  – ET SEP MAN/AUTO
  – MPS Dump Inhibit
  – MPS Helium Regulator Fail During Entry
• Apply the problem-solving strategy to resolve DPS and EPS failures that impact the MPS.
New Astronaut Lesson Descriptions

169A  **CONT ABORT 21001**

Title: Contingency Abort Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (2 PLTs, 2 MSs)  
Source: DS66/G&C/Propulsion Training Group  
Date: 02/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CONT ABT BR 21001  
Preparation: Review:
- Ascent Checklist Contingency Abort cue card;
  - Contingency 2 out blue
  - Contingency 3 out blue
  - RTLS 2 out yellow
  - RTLS 3 out orange
  - Bermuda/ECAL
  - Stuck RTLS and DROOP

Synopsis: This prebrief is designed to prepare the student for CONT ABORT 21011. All procedures listed below under Performance Objectives will be discussed. The prebrief will consist of a brief review of contingency abort principles, a discussion of the steps involved in each of the procedures to be flown, and answers to specific questions.

Objectives: Given the contingency abort cue card, identify what each of the following procedures steps means, who performs the step, and why it is done:
- Contingency 2 out blue
- Contingency 3 out blue
- RTLS 2 out yellow
- RTLS 3 out orange
- Bermuda/East Coast Abort Landing (ECAL)
- Stuck RTLS and DROOP

169B  **CONT ABORT 21011**

Title: Contingency Abort  
Duration: 4.0 hours  
Medium: SMS-MB  
Student: ASCAN (2 PLTs, 2 MSs)  
Source: DS66/G&C/Propulsion Training Group  
Date: 02/04  
Lesson(s) Replaced: None
New Astronaut Lesson Descriptions

169B    **CONT ABORT 21011 (Concluded)**

**Equipment Required:** None  
**Prerequisite Lesson(s):** CONT AB 21001  
**Preparation:** None  

**Synopsis:** In this lesson, the student will perform contingency abort procedures.  
Proficiency is not required. Students are encouraged to see the procedures multiple times during the lesson, time permitting. Students may elect to fly the procedures from different cockpit positions, as desired.

**Objectives:**
- Perform, aided, the following contingency abort procedures:
  - Contingency 2 out blue  
  - Contingency 3 out blue  
  - RTLS 2 out yellow  
  - RTLS 3 out orange  
  - Bermuda/ECAL  
  - Stuck RTLS and DROOP

170A    **ENT DPS MAL 21001**

**Title:** Entry Data Processing System Malfunction Procedures Prebrief  
**Duration:** 0.5 hours  
**Medium:** Classroom  
**Student:** ASCAN (Schedule in pairs.)  
**Source:** DS24/DPS/Navigation Training Group  
**Date:** 02/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** ASC DPS MAL 21006  
**Preparation:** Review:  
- AESP (Glided Flight); DPS FDF procedures  
  Skim:  
- Entry Pocket C/L; DPS FDF procedures  
  Read:  
- Flight Rules  
  - Entry String Reassignment (Section 2)  
  - I/O Reset (Section 7)  
  - PASS GPC BCE Failure Management (Section 7)  
  - Non-universal I/O Error Action (Section 7)
New Astronaut Lesson Descriptions

170A  ENT DPS MAL 21001 (Concluded)

Synopsis: This prebrief will introduce the student to various DPS failure signatures and procedures used during entry. It will also be a review of the material presented in A/E DPS MAL 21001. The discussion will center around the malfunctions that will be introduced in ENT DPS MAL 21006. It is intended to ensure that the student has a good understanding of the procedures prior to exercising them in the SST.

Objectives:
• Identify signatures and the procedures to be run prior to the Deorbit (D/O) burn Time to Ignition (TIG) for the following DPS situations:
  – Primary Avionics Software System (PASS) General Purpose Computer (GPC) failure
  – Flight Aft (FA) Multiplexer/Demultiplexer (MDM) failure
  – Backup Flight Software (BFS) GPC failure
• Discuss the DPS portions of the D/O Burn Monitor Cue Card.
• Explain the rationale for entry restring and port mode cases.

170B  ENT DPS MAL 21006

Title: Entry Data Processing System Malfunction Procedures
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS24/DPS/Navigation Training Group
Date: 10/05
Lesson(s) Replaced: E DPS 21011A
Equipment Required: None
Prerequisite Lesson(s): ENT DPS MAL 21001
Preparation: None

Synopsis: In this lesson, the student will practice exercising the procedures and signature recognition associated with Entry DPS failures. Procedures will be exercised from both the Entry Pocket (ENT PK) Checklist (C/L) and the Ascent/Entry Systems Procedures (AESP). Backup Flight Software (BFS) actions will be discussed where applicable. Four runs will be used to exercise the following procedures:
• BCE STRG X
• PASS GPC FAIL
• MULTI-DATA PATH LOSS
• BFS GPC FAIL
• I/O ERROR CRT/DPS DISPLAY ANOMALY
• FA/FF MDM I/O ERROR
• FA/FF MDM PORT MODE
New Astronaut Lesson Descriptions

170B  ENT DPS MAL 21006 (Concluded)

- DEORBIT BURN MONITOR CUE CARD
- SUBSYSTEM STATUS DISPLAY ANOMALY
- FF/FA MDM OUTPUT

Objectives:
- Identify the DPS failure based on cockpit cues.
- Perform appropriate procedures in the ENT PKT C/L or the AESP.
- Explain the steps and rationale behind each procedure worked.
- Optimize final DPS configuration for entry.
- Identify the signature and actions to be performed for a non-universal Input/Output (I/O) error and an Analog to Digital Converter (ADC) failure.

171A  OM/RC BURNS 21001

Title: Orbital Maneuvering/Reaction Control System Burns Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: Non-ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): OMS MAL 21006, RCS MAL 21006
Preparation: Review:
- OMS 21002
  - Section 4, Engine Failures, Leaks and other Propellant System Failures; Nitrogen System Failures, and Gimbal Failures
- SCOM
  - Section 2.19, Fault Detection and Identification

Note: This lesson replaces the OM/RC BURNS BR 21001 lesson for non-ASCAN students.

Synopsis: This lesson will provide the student the background for diagnosing failures during OMS and Reaction Control System (RCS) burns and prepare the student for OM/RC BURNS 21006 SST lessons. The procedures on the OMS BURN and OMS BURN MONITOR cards, and the fundamental concepts of OMS "engine failures" and "propellant failures" will be discussed. The prebrief will define OMS engine and propellant failures and teach how to diagnose engine fail and propellant fail during an OMS burn. This lesson will explain the rationale of the OMS ENG FAIL and OMS PRPLT FAIL procedures for OMS 2 and On-Orbit OMS burns, during which the student will resolve malfunctions that occur during the
New Astronaut Lesson Descriptions

171A  OM/RC BURNS 21001 (Concluded)

OMS 1, OMS 2, and Orbit burns. This lesson will also introduce the “hot” OMS XFEED and other burn specific propellant management procedures. Lastly, this class will introduce the Space Flight Resource Management (SFRM) associated with monitoring burns, diagnosing failures, and working procedures.

Objectives:
- Use OMS and RCS cockpit cues and OMS BURN MONITOR card to diagnose OMS engine and propellant failures due to propellant blockages, He line blockages, He leaks, propellant leaks, and Nitrogen leaks.
- Diagnose an OMS ENG FAIL due to gimbal failures.
- State the cockpit cue and system impact differences between an OMS engine fail and an OMS propellant fail.
- Explain the rationale of the OMS ENG FAIL and OMS PRPLT FAIL procedure on the OMS 2/ORBIT OMS BURNS card.

171B  OM/RC BURNS 21006

Title: Orbital Maneuvering/Reaction Control System Burns
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): OM/RC BURNS BR 21001
Preparation: None

Synopsis: This lesson will prepare the student for diagnosing failures that occur during an OMS or Reaction Control System (RCS) burn using the Burn Monitor Card, and following the appropriate procedures on the Burn Card. It will concentrate on malfunctions during OMS 1, OMS 2, and On-Orbit burns. The student will be given the opportunity to resolve failures including, OMS engine failures, OMS propellant failures, sensors failures, Helium blockages, Helium regulator failures, OMS gimbal failures, and RCS jet failures.

Objectives:
- Set up and perform OMS burns (OMS 1, OMS 2, and On-Orbit burns).
- Diagnose OMS engine, OMS propellant, and OMS Sensor failures using system signatures and BURN MONITOR criteria.
- Perform appropriate Burn Card procedures based on failure diagnosis.
New Astronaut Lesson Descriptions

171B  OM/RC BURNS 21006 (Concluded)

- Correctly identify the malfunction on the FDF OMS schematic.
- Evaluate if the actions were effective and determine system/mission impacts.

172  COM/IN MAL BR 21001

Title: Communications/Instrumentation Malfunction Procedures Review
Duration: 1.5 hours
Medium: Classroom
Student: ASCAN
Source: DS25/Communications/NSS Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ORB SKL COMM 21008

Preparation:
- S-Bd Comm/Inst. 21002, Section 1-6
- AESP (Ascent Comm and DPS); APCL, COMM LOST (Multi-pnls)
- OPCL, COMM Procedures
- MALF PROC, Section 2.1-2.4; COMM Drawing; SSR-1 and 12
- IFM, ACCU Bypass procedure

Complete:
- S-Bd Comm/Inst. 21002, Section 7

Synopsis: This lesson will review the communication cockpit cues and procedures to identify communication capabilities and troubleshooting techniques for ascent and orbit phases of a Shuttle flight.

Objectives:
- Identify the communication cockpit cues used to determine and monitor voice and data communications with MCC-H.
- Troubleshoot and correct communication problems using cockpit cues and appropriate FDF procedures: AESP, APCL, OPCL, MALF PROC, etc.
- Explain basic philosophy/rationale for communication pocket checklist procedures using the APCL or OPCL as an example.
- Explain basic steps in the MAL PROC Comm SSR-1 (LOSS OF ALL VOICE COMM) and IFM (ACCU BYPASS CONNECTOR INSTALLATION) – to be continued in SST.
New Astronaut Lesson Descriptions

173 COM/IN MAL 21006

Title: Communications/Instrumentation Malfunction Procedures
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule in pairs.)
Source: DS25/Communications/NSS Training Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): COM/IN MAL BR 21001
Preparation: Review:
• S-Bd Comm/Inst. 21002, Section 1-6
• AESP (Ascent Comm and DPS); APCL, COMM LOST (Multi-Pnls)
• OPCL, Comm Procedures
• MALF PROC, Section 2.1-24, Comm Drawing; SSR-1 and 12
• IFM, ACCU Bypass Procedure
Complete:
• S-Bd Comm/Inst. 21002, Section 7

Synopsis: This lesson will practice using the communication cockpit cues and procedures to identify communication capabilities and troubleshooting techniques for ascent and orbit phases of a Shuttle flight.

Objectives:
• Use cockpit cues and perform appropriate steps in FDF, as necessary, to regain voice and/or command/data with MCC. Specifically:
  – ASCENT PHASE:
    – S-Band PM LRU failure
    – NSP problem
    – Audio System problem, including SSR and IFM review
  – ORBIT PHASE:
    – GCIL problem
    – PCMMU failure(s)
    – S-Band PM system failure
    – RTC practice
    – S-Band PM Antenna select problem
    – COMSEC problem
    – Use MALF PROC Comm drawing to trace forward link and return link for High Power Mode through appropriate LRUs, using COMM related displays and controls
New Astronaut Lesson Descriptions

174A  **ORB MAN ATT 21001**

Title: Orbit Manual Attitude Control Techniques Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (Schedule ASCAN PLTs in pairs, no CB IA.)  
Source: *DM34/Rendezvous Guidance, Procedures and Training*  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): IMU 21006, MAN MNVR 21025  
Preparation: Review:  
- UNIV PTG 21001  
- ORB DAP 21057  
- ORB OPS C/L  
  - HUD CAL  

Synopsis: This prebrief will cover orbit manual attitude control procedures as well as techniques that will be practiced in ORB MAN ATT 21012. It will start with a review of Universal Pointing (UNIV PTG) and the DAP. Several manual flying techniques will also be discussed.

Objectives:  
- Describe the options for the DAP available on SPEC 20.  
- Discuss how each parameter of the attitude monitor section of the UNIV PTG display is used to monitor the attitude of the orbiter.  
- Explain the rationale associated with Manual Minimum Impulse (MMI).  
- Describe how to fly Manual Minimum Impulse.  
- Describe the rationale for each step of the Heads-Up Display (HUD) calibration procedure.  
- Discuss the two maneuvering techniques available for the HUD calibration.  
- Describe how to read the Attitude Direction Indicator (ADI).  
- Discuss the four rules of thumb for maneuvering to an M50 burn attitude using Velocity to Go (VGOs).

174B  **ORB MAN ATT 21012**

Title: Orbit Manual Attitude Control Techniques  
Duration: 4.0 hours  
Medium: SMS-FB, GNS  
Student: ASCAN (Schedule ASCAN PLTs in pairs, no CB IA.)  
Source: *DM34/Rendezvous Guidance, Procedures and Training*  
Date: 07/04  
Lesson(s) Replaced: IMU/ST/COAS 21012  
Equipment Required: None
New Astronaut Lesson Descriptions

174B  **ORB MAN ATT 21012 (Concluded)**

Prerequisite Lesson(s):  ORB MAN ATT 21001  
Preparation:  None  

Synopsis:  The student will perform a number of manual piloting procedures in order to demonstrate attitude control techniques and orbiter handling qualities under a variety of on-orbit conditions. The procedures include a Heads-Up Display (HUD) calibration, Manual Minimum Impulse (MMI) maneuver, and a manual vernier Reaction Control System (RCS) maneuver, all requiring Rotational Hand Controller (RHC) input. Possible scan patterns, control inputs and 3-D situational awareness should be emphasized over specific procedures or rationale.

Objectives:  
• Perform MMI maneuvers using Primary (PRI) and VERN DAP.  
• Calibrate the HUD.  
• Perform maneuver using Translational (TRANS) DAP.  
• Perform maneuver using aft RHC and Attitude Direction Indicator (ADI) in both the -x and -z sense.  
• Perform maneuver to M50 attitude using ADI.  
• Perform maneuver to M50 attitude using Velocity to Go (VGOs).  
• Perform maneuver using RHC Accelerated (ACCEL) mode.

175  **MPS QUAL 21006**

Title:  Main Propulsion System Qualification  
Duration:  2.0 hours  
Medium:  SST 1 or SST 2 or SST 3  
Student:  ASCAN (Schedule individually.)  
Source:  DS66/G&C/Propulsion Training Group  
Date:  03/05  
Lesson(s) Replaced:  MPS QUAL 21001  
Equipment Required:  None  
Prerequisite Lesson(s):  MPS MAL 22006  
Preparation:  Review:  
• MPS Workbook 21002

Synopsis:  This lesson will present a series of scenarios for the student. Each scenario presents both nominal or malfunction conditions that the student must analyze and then determine what crew actions are required based on FDF procedures.
New Astronaut Lesson Descriptions

175  MPS QUAL 21006 (Concluded)

Objectives:  
- Demonstrate the ability to perform the 7 nominal crew tasks for the Main Propulsion System (MPS) on ascent.
- Demonstrate the ability to identify malfunctions, locate the appropriate FDF procedures, and perform the required actions on ascent.
- Explain the cause of the malfunctions observed and the rationale for the actions taken for each scenario presented.

176A  A/E BFS 21001

Title:  Ascent/Entry Backup Flight Software Prebrief  
Duration:  1.0 hour  
Medium:  Classroom  
Student:  ASCAN (Schedule 3 ASCANs, 1 CB IA.)  
Source:  DA7/Assigned SMS Team  
Date:  10/05  
Lesson(s) Replaced:  ASC BFS 21001, E BFS 21001  
Equipment Required:  None  
Prerequisite Lesson(s):  BFS FAM BR 21001, ENT DPS MAL 21006, E NAV 22006  
Preparation:  Review:  
- BFS FAM BR 21001  
Synopsis:  During this prebrief, the differences between PASS and BFS will be reviewed. This prebrief should prepare the student to perform the ascents and entries in A/E BFS 21011.

Objectives:  
- Identify the major differences between PASS and BFS.  
- Identify the major limitations of the BFS.

176B  A/E BFS 21011

Title:  Ascent/Entry Backup Flight Software  
Duration:  4.0 hours  
Medium:  SMS-MB  
Student:  ASCAN (Schedule 3 ASCANs, 1 CB IA.)  
Source:  DA7/Assigned SMS Team  
Date:  07/04  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  A/E BFS 21001  
Preparation:  None  
Synopsis:  During this lesson, the students will perform several ascents and entries. They will be required to complete each of the runs and consider the health of the PASS and the BFS after various malfunctions.
New Astronaut Lesson Descriptions

176B  A/E BFS 21011 (Concluded)

Objectives:  
- Identify conditions that warrant BFS engage and perform the engage.  
- Perform an entry while BFS engaged.  
- Identify the major differences between the PASS and BFS.  
- Perform appropriate flight techniques under BFS engage conditions.

177  PROP DUMPS BR 21001

Title:  Propellant Dumps Briefing  
Duration:  2.0 hours  
Medium:  Classroom (Schedule in groups of up to 30.)  
Student:  ASCAN  
Source:  DS66/G&C/Propulsion Training Group  
Date:  10/05  
Lesson(s) Replaced:  ASC PROP 21001  
Equipment Required:  None  
Prerequisite Lesson(s):  ABORT FAM 22011, OM/RC BURNS 21006  
Preparation:  Read:  
- SCOM; Section 6.8-15, OMS Engine/Propellant Failure  
Review:  
- Flight Procedures Handbook; Ascent/Orbit/Entry Systems  
  Procedures, and Cue Cards with Rationale  
  - OMS Pc LOW  
  - OMS TEMP  
  - OMS He TK P LOW, AESP  
  - OMS TK P (FU or OX) LOW, ASC PKT C/L  
Synopsis:  The purpose of this prebrief is to review abort dumps, and to discuss  
engine failures during abort dumps.  
Objectives:  
- Identify the DPS display used to control ascent abort dumps.  
- Explain the purpose of smart interconnect.  
- State the impact of an OMS engine and/or prop failure.  
- Identify the procedures required for an engine or prop failure during an  
  abort dump.  
- Explain the major steps in the Ascent portion of the Ascent/Entry  
  Systems Procedure (AESP) for the OMS He Tank P Low and OMS  
  Tank P Low procedures.
**New Astronaut Lesson Descriptions**

178A  **PROP DUMPS 21001**

**Title:** Propellant Dumps Prebrief  
**Duration:** 0.5 hours  
**Medium:** Classroom  
**Student:** Non-ASCAN  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** OM/RC BURNS 21006  
**Preparation:** Read:  
- SCOM; Section 6.8-15, OMS Engine/Propellant Failure  
  Review:  
- Flight Procedures Handbook; Ascent/Orbit/Entry Systems Procedures, and Cue Cards with Rationale  
  - OMS Pc LOW  
  - OMS TEMP  
  - OMS He TK P LOW, AESP  
  - OMS TK P (FU or OX) LOW, ASC PKT C/L  
**Note:** This lesson replaces the PROP DUMP BR 21001 lesson for non-ASCAN students.

**Synopsis:** The purpose of this prebrief is to review abort dumps, and to discuss engine failures during abort dumps.

**Objectives:**  
- Identify the DPS display used to control ascent abort dumps.  
- Explain the purpose of smart interconnect.  
- State the impact of an OMS engine and/or prop failure.  
- Identify the procedures required for an engine or prop failure during an abort dump.  
- Explain the major steps in the Ascent portion of the Ascent/Entry Systems Procedure (AESP) for the OMS He Tank P Low and OMS Tank P Low procedures.

178B  **PROP DUMPS 21006**

**Title:** Propellant Dumps SST  
**Duration:** 2.0 hours  
**Medium:** SST 1  
**Student:** ASCAN (Schedule in pairs.)  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** ASC PROP 21011  
**Equipment Required:** Special FDF provided by instructor
New Astronaut Lesson Descriptions

178B PROP DUMPS 21006 (Concluded)

Prerequisite Lesson(s): PROP DUMPS BR 21001
Preparation: None

Synopsis: This lesson will prepare the student for subsequent standalone and integrated ascent and entry training in the SMS. The goal of the lesson is to strengthen the student’s skill in leak resolution and failures during ascent propellant dumps.

Objectives:

• Using SPEC 51 and the Ascent Checklist (ASC C/L), determine the total percent OMS propellant to be dumped during a given abort dump and estimate the time and percent OMS propellant to be dumped.
• Given an ascent run with all OMS quantity gauging failed, estimate post-Main Engine Cut-off (MECO) the amount of OMS propellant dumped during an Abort to Orbit (ATO) dump.
• Identify and perform the procedure required for OMS engine failures, propellant failures, and injector temperature biases during abort dumps.
• Identify a smart interconnect reconfiguration.
• Perform the leaking OMS He propellant dump.
• Perform the leaking OMS propellant out-of-plane burn (ASC C/L).
• Perform leaking OMS Perigee adjust burn on-orbit.

179 OM/RC DP/EPS BR 21001

Title: Orbital Maneuvering/Reaction Control System Data Processing System/Electrical Power System Review
Duration: 2.0 hours
Medium: Classroom
Student: ASCAN (Schedule in groups of about 15.)
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): OMS MAL 21006, RCS MAL 21006, EPS MAL A/E 21004, EPS MAL O 21004, DPS MAL 21006
Preparation: Review:

• OMS 21002; Section 4, Electrical and Data Path Failures
• RCS 21002; Section 4, Electrical and Data Path Failures
New Astronaut Lesson Descriptions

179  **OM/RC DP/EPS BR 21001 (Concluded)**

**Synopsis:** This lesson will prepare the student for OM/RC DP/EPS 21006. The review will include a discussion of Reference Data, the OMS Failures cue card, and the OMS and Reaction Control System (RCS) Configuration Screen (ORCS).

**Objectives:**
- State the generic impacts of the EPS, DPS, and Instrumentation (INST) systems on the OMS and RCS.
- Use Ref Data to determine the capabilities of the OMS and RCS after DPS and EPS failures.
- Use the OMS Failures cue card to determine the capability of the OMS engines with DPS and EPS failures.
- Use the ORCS program to determine the capability of the OMS/RCS valves after the occurrence of DPS and EPS failures.
- Explain OMS and RCS callouts in the EPS, DPS, and INST malfunction procedures.

180A **ORB SYS 21001**

**Title:** Orbit Systems Prebrief
**Duration:** 1.0 hour
**Medium:** Classroom
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA.)
**Source:** DA7/Assigned SMS Team
**Date:** 07/04
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** ORB EPS 21004
**Preparation:** None

**Synopsis:** This prebrief is designed to prepare the student for ORB SYS 21012 and includes a discussion of priority powerdowns on orbit (numbered and lettered), control bus shorts and powerdowns, and the AC transfer cable In-Flight Maintenance (IFM) procedure.

**Objectives:**
- Explain when and why a priority powerdown is to be performed (nominally and off-nominally).
- Explain the difference between the numbered and lettered priority powerdown procedures.
- Identify where the kilowatt usage of certain equipment is located in the FDF.
New Astronaut Lesson Descriptions

180A  **ORB SYS 21001 (Concluded)**

- Identify the FDF procedure that can be used to confirm a control bus short.
- Explain how a shorted control bus is unpowered using the IFM procedure.
- Identify failures that would result in the crew having to perform the AC Power Transfer Cable IFM.
- Identify the major steps performed in the AC Power Transfer Cable IFM.
- Identify the limitations and the capabilities recovered once the AC power transfer cable has been installed.

180B  **ORB SYS 21012**

**Title:** Orbit Systems  
**Duration:** 4.0 hours  
**Medium:** SMS-FB, GNS  
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA.)  
**Source:** DA7/Led Assigned SMS Team  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** ORB SYS 21001  
**Preparation:** None

**Synopsis:** This lesson provides a hands-on environment for the student to perform the following tasks:

- Priority Group B Powerdown and Powerup.
- Shorted control bus powerdown.
- AC Power Transfer Cable installation.

Throughout the lesson, the student will be required to explain the rationale of the major steps of each procedure while performing the procedure.

**Objectives:**

- Perform a Priority Group B Powerdown and Powerup.
- Identify the signature of a control bus short.
- Perform the “CNTL BUS V LOW/CNTL BUS RPC” (Orbit Pocket Checklist) procedure while stating the rationale for each major step.
- Perform the In-Flight Maintenance (IFM) procedure “AC Power Transfer Cable” (Malfunction Checklist, EPS SSR-200) while stating the rationale for each major step.
New Astronaut Lesson Descriptions

181  **EPS QUAL 21004**

Title: Electrical Power Systems Qualification  
Duration: 2.0 hours  
Medium: SST 1 or SST 2 or SST 3  
Student: ASCAN (Schedule individually.)  
Source: *DS45/Shuttle Systems Training Group*  
Date: 10/05  
Lesson(s) Replaced: SYS QUAL 21008  
Equipment Required: None  
Prerequisite Lesson(s): Completion of all 20000-level EPS, ECLSS, MECH, C&W, and APU/HYD SST lessons  
Preparation: Review FDF and EPS reference materials to prepare for the objectives listed below.

Synopsis: This lesson will verify that the student meets the required standards for systems knowledge and FDF usage for the Shuttle EPS. This lesson tests the student’s ability to recognize signatures and execute the appropriate FDF procedure for various EPS malfunctions. In addition to off-nominal procedures, the student will perform selected nominal procedures (including starred blocks when applicable). Throughout the lesson, the instructor will ask questions in order to test the student’s knowledge of hardware, operations, procedure rationale, and concepts associated with EPS.

Objectives:

- Identify various EPS malfunctions during the ascent/entry and orbit timeframes via displays and other available cockpit cues.
- Execute the appropriate FDF procedure for each of the malfunctions presented.
- Explain the rationale for the FDF procedures associated with each of the malfunctions presented.
- State the power sources for the Main, Essential, Control, and AC buses.
- Describe how the AC bus sensors function in the Off, Monitor, and Auto Trip switch positions.
- Explain the “two finger trick” associated with Control buses.
- Recognize which buses require a fuel cell shutdown when lost, and explain why.
- Explain the difference between a fuel cell shutdown and fuel cell safing.
- Explain how to confirm if a fuel cell has been “safed.”
- Recognize which fuel cell malfunctions cause the fuel cell stack temperature reading to be invalid.
- Explain the difference between the long and short form bus tie, and state when each should be used.
- Perform a back door bus tie, when required.
New Astronaut Lesson Descriptions

181  **EPS QUAL 21004 (Concluded)**

- Explain the difference in signatures between a fuel cell short and a main bus short.
- Explain the purpose of performing a fuel cell purge.
- Explain the operational constraints for the manual fuel cell purge.
- Perform the manual fuel cell purge procedure, including starred blocks (when applicable).

182  **APU/HYD QUAL 21004**

**Title:** Auxiliary Power Unit/Hydraulic Qualification  
**Duration:** 2.0 hours  
**Medium:** SST 1 or SST 2 or SST 3  
**Student:** ASCAN (Schedule individually.)  
**Source:** DS45/Shuttle Systems Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** SYS QUAL 21008  
**Equipment Required:** None  
**Prerequisite Lesson(s):** Completion of all 20000-level EPS, ECLSS, MECH, C&W, and APU/HYD SST lessons.  
**Preparation:** Review FDF and APU/Hyd reference materials to prepare for the objectives listed below.

**Synopsis:** This lesson will verify that the student meets the required standards for systems knowledge and FDF usage for the Shuttle Auxiliary Power Unit (APU)/Hydraulic (Hyd) Systems. This lesson tests the student's ability to recognize signatures and execute the appropriate FDF procedure for various APU/Hyd malfunctions. In addition to off-nominal procedures, the student will perform selected nominal procedures (including starred blocks when applicable). Throughout the lesson, the instructor will ask questions in order to test the student's knowledge of hardware, operations, procedure rationale, and concepts associated with the APU/Hyd Systems.

**Objectives:**
- Identify various Auxiliary Power Unit (APU)/Hydraulic (Hyd) malfunctions during the ascent and/or entry timeframes via displays and other available cockpit cues.
- Execute the appropriate FDF procedure for each of the malfunctions presented.
- Explain the rationale for the FDF procedures associated with each of the malfunctions presented.
- When required, report the F7 APU Underspeed or Overspeed light to MCC correctly.
New Astronaut Lesson Descriptions

APU HYD QUAL 21004 (Concluded)

- Describe how the following functions are supported by the APU/Hyd system:
  - Engine throttling
  - Engine gimballing (ascent and entry)
  - Landing gear deploy
  - Braking
  - Nose Wheel Steering

- Locate the Systems Flight Rules in FDF.

- Determine whether an ascent abort is required for a given APU/Hyd malfunction scenario (using FDF).

- Locate the APU ready-to-start criteria in FDF.

- Perform the APU Pre Start and APU Start procedures in the Ascent Checklist, and explain the procedure rationale.

- Perform the APU Pre Start and Single APU Start procedures in the Entry Checklist, and explain the procedure rationale.

- Describe the conditions that would call for “Attempt One APU” versus “Attempt Two APUs” when performing the Single APU Start procedure in the Entry Checklist.

- Describe how the APU primary and secondary control valves operate.

- Describe what happens when the APU Speed Select switch is taken to High.

- State the four reasons for restarting an APU.

- Recognize when an APU that has been shutdown is a candidate for a cooldown and/or a restart.

- Given an APU/Hyd malfunction scenario, determine impacts on the landing gear, brakes, and Nose Wheel Steering (NWS) systems (using the Landing Gear diagram).

- Given an APU/Hyd malfunction scenario, determine impacts to main engine throttling and gimballing (using cue card).

- Describe WSB spray mode and pool mode, and state when each mode is used.

- Explain why the WSB controllers are not swapped prior to Main Engine Cutoff (MECO).

- Explain Priority Rate Limiting (PRL).

- State where each of the three hydraulic pressure sensor readings can be seen in the cockpit.
New Astronaut Lesson Descriptions

183  **ECLSS/C&W/MECH QUAL 21008**

**Title:** Environmental Control and Life Support Systems/Caution & Warning/Mechanical Qualification

**Duration:** 2.0 hours

**Medium:** SST 3 only

**Student:** ASCAN (Schedule individually.)

**Source:** *DS45/Shuttle Systems Training Group*

**Date:** 10/05

**Lesson(s) Replaced:** SYS QUAL 21008

**Equipment Required:** None

**Prerequisite Lesson(s):** Completion of all 20000-level EPS, ECLSS, MECH, C&W, and APU/HYD SST lessons.

**Preparation:** Review FDF and ECLSS, C&W, and Mechanical Systems reference materials to prepare for the objectives listed below.

**Synopsis:** This lesson will verify that the student meets the required standards for systems knowledge and FDF usage for the Shuttle Environmental Control and Life Support Systems (ECLSS), Caution and Warning (C&W), and Mechanical Systems. This lesson tests the student’s ability to recognize signatures and execute the appropriate FDF procedure for various ECLSS and Mechanical malfunctions. In addition to off-nominal procedures, the student will perform selected nominal procedures (including starred blocks when applicable) for each system. Throughout the lesson, the instructor will ask questions in order to test the student’s knowledge of hardware, operations, procedure rationale, and concepts associated with the ECLSS, C&W, and Mechanical Systems.

**Objectives:**
- Identify various Environmental Control and Life Support Systems (ECLSS) malfunctions during the ascent/entry and orbit timeframes via displays and other available cockpit cues.
- Execute the appropriate FDF procedure for each of the malfunctions presented.
- Explain the rationale for the FDF procedures associated with each of the malfunctions presented.
- Locate the Systems Flight Rules in FDF.
- Determine whether an ascent abort is required for a given ECLSS malfunction scenario (using FDF).
- Explain why alternating current (AC) powered equipment is not swapped prior to Main Engine Cutoff (MECO).
- Locate the PCS diagram in FDF.
- Describe the PCS configuration during ascent, entry, and orbit.
- Explain how to distinguish between an oxygen (O2) and nitrogen (N2) leak into the cabin.
• Explain the difference between the three “dP/dT” values on the displays (hardware, backup, equivalent), and state when each is available.
• Explain the Av Bay temperature signature associated with an Av Bay fan that has been turned off (or is completely failed).
• Describe the H₂O loop configuration during ascent, entry, and orbit.
• Explain the difference in signature between an external H₂O loop leak, internal H₂O loop leak, and a H₂O loop pump failure.
• State what the Panel L4 H₂O Loop Pump 1A/2 circuit breakers power.
• Recognize when the Panel L4 H₂O Loop Pump 1A/2 circuit breakers should be pushed in.
• State the mechanism(s) actively cooling the Freon loops during all phases of flight from pre-launch through post-landing.
• Explain the differences between the FES primary controllers and the FES secondary controller.
• State the temperature control point for the FES controllers (primary and secondary), radiator controllers (in norm and high), and NH₃ controllers.
• Explain the purpose of a FES core flush.
• Explain the Freon loop radiator isolation hardware.
• Explain the radiator startup sequence in terms of the motion and timing of the radiator flow control and bypass valves.
• Explain the purpose of the radiator controller startup sequence.
• Explain the rule for configuring NH₃ systems according to Freon flow rates.
• Perform the supply water dump procedure, including starred blocks (when applicable), and explain the procedure rationale.
• Explain the differences between the Primary Caution and Warning (C&W) System and the Backup C&W System.
• Given a parameter name, locate the software identification number in Reference (Ref) Data.
• Given a parameter name, locate the hardware channel number in Ref Data or on the C&W Cue Card.
• Demonstrate how to use the Primary to Backup C&W Analog Parameter Calibration table to change a hardware limit for a given parameter.
• Explain how the state of microswitches affects the operation of a mechanism.
• Execute the procedures for a manual and/or auto mode payload bay door opening and/or closing.
• Describe the malfunctions that will cause a “PBD SEQ FAIL” fault message during payload bay door opening/closing.
• Describe the malfunctions that will cause a “PBD CONFIG FAIL” fault message during payload bay door opening/closing.
New Astronaut Lesson Descriptions

183  ECLSS/C&W/MECH QUAL 21008 (Concluded)

• Describe the malfunctions that will cause a dilemma during payload bay door opening/closing.
• Given a microswitch malfunction, identify what, if any, fault messages will be generated during payload bay door opening/closing.
• Explain the purpose of the Centerline Latch Extended Guide Roller Trajectory No-Go diagram.

184  OGNC QUAL 21006

Title: Orbit Guidance Navigation and Control Qualification
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule individually.)
Source: DS24/DPS/Navigation Training Group
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): IMU 21006, MAN MNVR 21025, ORB MAN ATT 21012 (PLTs only)
Preparation: Review:
• Post Insertion; Star Tracker Activation/Door Open
• Orbit OPS
  – IMU Align – STRK, GNC 201, 202, 301
  – IMU/IMU ALIGNMENT
  – HUD Calibration
  – DAP Tables
• Mal Proc, Vol. II
  – GNC FRP-3, IMU Recovery with at least one IMU as good reference
  – GNC FRP-2, IMU Reference Recovery
New Astronaut Lesson Descriptions

OGNC QUAL 21006 (Concluded)

Synopsis: This lesson will verify completion standards of orbit Guidance, Navigation, and Control (GNC) training by executing some GNC orbit operations with limited use of FDF. The student should have a basic understanding of the systems in order to perform the operations. There is no need to memorize FDF. The student will start the class by configuring the star trackers for orbit. Nominal orbit operations are then performed, including an Inertial Measurement Unit (IMU) alignment and a Heads-Up Display (HUD) calibration. Several different pointing maneuvers are also performed to exercise the Universal Pointing (UNIV PTG) display. A manual flying exercise will be performed to demonstrate comprehension of the relationship between the DAP and UNIV PTG functions.

The student will also exercise the IMU Reference Recovery procedure as a review of the three different types of alignments. This exercise is optional and is not evaluated for the Qual.

Objectives:

- Configure the DAP to maneuver at a specified rate.
- Perform nominal star tracker activation and door opening, without FDF.
- Perform a dual star tracker IMU align using only the Star Pairs Preliminary Advisory Data (PAD) (located in the Orbit Operations (OPS) Checklist (C/L), Flight Supplement (Flt Supp)) and the Flight Plan.
- Perform the steps for a HUD calibration, without FDF.
- Perform a single star tracker IMU align using the Star Pair PAD, without FDF.
- Perform various pointing maneuvers using the UNIV PTG display.
- Maneuver manually by flying a single axis while the other axes maintain LVLH attitude hold.
- Recover an IMU that has lost its inertial reference with an IMU/IMU alignment, without FDF.
- Identify the bad IMU in a velocity dilemma situation.
- Perform the tasks for a total IMU Reference Recovery; i.e., loss of on orbit attitude reference using FDF (optional).
New Astronaut Lesson Descriptions

185  **OM/RC DP/EPS 21006**

Title: Orbital Maneuvering/Reaction Control System, and Data Processing/Electrical Power System

Duration: 2.0 hours

Medium: SST 1 or SST 2 or SST 3

Student: ASCAN (Schedule in pairs.)

Source: DS66/G&C/Propulsion *Training Group*

Date: 10/05

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): OM/RC DP/EPS BR 21001

Preparation: None

Synopsis: This lesson will prepare the student for multi-discipline and multi-failure work in subsequent training at the SMS. The goal of the lesson is to strengthen the student’s knowledge of the OMS and Reaction Control System (RCS) and introduce the student to the impacts of DPS and EPS failures on these systems. Ref Data, the OMS Failures cue card, and the OMS and RCS Configuration Screen (ORCS) will be used by the student to determine failure impacts. Another goal of the lesson is to build on the student’s ability to prioritize malfunction resolution.

Objectives:

- Use the FDF, including the OMS Failures cue card, Reference Data, and the ORCS to resolve two failure deep OMS and RCS malfunctions of the following types:
  - Leaks with an Multiplexer/Demultiplexer (MDM) or EPS bus down
  - OMS burn anomalies with MDMs and EPS buses failed
  - Jet failures with MDMs or EPS buses failed
- Given a combination of OMS and RCS failures, assess their priorities and resolve them according to this prioritization.

186  **OM/RC QUAL O 21006**

Title: Orbital Maneuvering System/Reaction Control Systems for Orbit Qualification

Duration: 2.0 hours

Medium: SST 1 or SST 2 or SST 3

Student: ASCAN (Schedule individually.)

Source: DS66/G&C/Propulsion *Training Group*

Date: 10/05

Lesson(s) Replaced: BURN QUAL 21006

Equipment Required: None

Prerequisite Lesson(s): OM/RC QUAL A/E 21006
New Astronaut Lesson Descriptions

OM/RC QUAL O 21006 (Concluded)

Synopsis: Review the FDF and related reference materials to prepare for the objectives listed below.

Synopsis: This lesson will verify the completion of the OM/RC flow by testing the student’s operational knowledge of the OMS and Reaction Control System (RCS). The lesson tests the student’s ability to configure the orbiter for nominal orbit operations and to perform nominal on orbit procedures. The lesson also tests the student’s ability to locate and work orbit malfunction procedures and to evaluate the impact of the failure on the mission. Lastly, this lesson tests the student’s ability to determine the big picture impacts of an EPS, DPS, or Instrumentation (INST) failure on the OMS and RCS.

The class is composed of one continuous run. The instructor will play MCC and answer questions and direct the student as necessary. The student will configure the orbiter for on orbit OPS then sit in the right seat and monitor the RCS and OMS systems. The student will have available to them the use of all FDF and tools which are typically available in the cockpit.

Objectives:
- Configure the OMS and RCS switches for orbit.
- Perform OMS and RCS callouts in the Post Insertion Checklist.
- Perform the Group B powerdown.
- Perform an OMS to RCS Interconnect.
- Monitor the OMS and RCS on orbit.
- Perform an OMS orbit adjust burn.
- Distinguish the required actions for the following MCC calls:
  - Deselect Jet XXX
  - Reselect Jet XXX
  - Reprioritize Jet XXX
  - Reset Redundancy Management (RM)
  - Toggle RM on Jet XXX
- Use available tools to evaluate impacts of a DPS, EPS or INST failures.
- Determine when you are Loss of Verns and work the procedure.
- Perform failure identification, resolution and evaluation for failures in the OMS and RCS.
New Astronaut Lesson Descriptions

187A ORB OPS/COMM 21001

Title: Orbit Operations/Communication Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)
Source: DA7/Assigned SMS Team
Date: 07/04
Lesson(s) Replaced: ORB EVA/COMM 21001
Equipment Required: None
Prerequisite Lesson(s): COM/IN MAL 21006, ORB DPS MAL 21006
Preparation: Review:
  - DPS Dictionary
    - SM SPEC 76
    - SM OPS 201, Antenna Display

Synopsis: This prebrief is designed to prepare the student for ORB OPS/COMM 21012, where the student will be required to perform nominal on-orbit procedures while dealing with malfunctions. This prebrief covers a review of the process for diagnosing loss of COMM situations, the cockpit signatures, diagnostic process, and reconfiguration for various Pulse Code Modulation Master Unit (PCMMU) failures, and cockpit signatures and system impacts for Operational Instrumentation Dedicated Signal Conditioner (OI DSC) and Operational Instrumentation Multiplexer/Demultiplexer (OI MDM) failures.

Objectives:
  - Describe the process that should be used when diagnosing a loss of COMM situation.
  - Describe the signatures and recovery steps associated with various PCMMU failures.
  - Describe the cockpit signatures of an OI DSC failure and an OI MDM failure.
  - Identify the cockpit interfaces for the Payload General Support Computers (PGSCs) that are used to run the WinDecom and WorldMap applications.
New Astronaut Lesson Descriptions

187B  **ORB OPS/COMM 21012**

**Title:** Orbit Operations/Communication  
**Duration:** 4.0 hours  
**Medium:** SMS-FB, GNS  
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA.)  
**Source:** DA7/Assigned SMS Team  
**Date:** 07/04  
**Lesson(s) Replaced:** ORB EVA/COMM 21012  
**Equipment Required:** None  
**Prerequisite Lesson(s):** ORB OPS/COMM 21001  
**Preparation:** None

**Synopsis:** This lesson is designed to exercise both nominal and off-nominal orbit procedures. The student will be provided with a simulated flight plan. While performing the nominal procedure, the student will be exposed to a variety of failures that may require changes to the nominal procedure and/or timeline. This lesson also emphasizes the effect of certain DPS failures on the communications system. Lastly, signatures and malfunction procedures for Operational Instrumentation Dedicated Signal Conditioner (OI DSC) and Operational Instrumentation Multiplexer/Demultiplexer (OI MDM) failures will be reviewed.

**Objectives:**
- Follow a simulated on-orbit timeline and perform the following nominal procedures at the specified time:
  - Ku Deploy and Activation
  - PGSC ACT, WinDecom OPS and WorldMap Initialization
  - CCTV Activation
  - Supply H₂O Dump using the FES and using the supply dump line
  - Fuel Cell Purge (manual)
  - RCS Regulator Reconfiguration
  - Heater Reconfiguration
  - L OMS to RCS Interconnect
- Identify, safe, and reconfigure from the following failures while performing the above procedures:
  - Ku TB problems during deploy
  - CCTV camera failure
  - Pulse Code Modulation Master Unit (PCMMU) failure at the SM GPC
  - Fuel cell purge valve failure
  - Supply H₂O dump valve problem
  - PL MDM failure
  - S-Band component failure
  - DSC failure
  - OI MDM failure
New Astronaut Lesson Descriptions

188A  **A/E SYS 21001**

Title: Ascent/Entry Systems Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)  
Source: *DA7/Assigned SMS Team*  
Date: 04/06  
Lesson(s) Replaced: ASC SYS 21001, E SYS 21001  
Equipment Required: None  
Prerequisite Lesson(s): MPS MAL 22006, OM/RC DP/EPS 21006, EPS MAL A/E 21004  
Preparation: None  

Synopsis: In order to prepare the student for A/E SYS 21012, this prebrief will discuss electrical bus loss signatures during ascent/entry and aborts, the effects of electrical bus loss on critical equipment, and the landing gear and nose wheel steering systems.

Objectives:  
- Identify the primary cockpit signatures for various electrical bus losses.  
- Using Reference Data, identify what critical equipment and instrumentation for ascent/entry is lost with certain electrical bus failures.  
- Explain how the landing gear is deployed with and without hydraulics.  
- Explain the impacts on the landing gear system (gear deploy, braking, and nose wheel steering) from Auxiliary Power Unit (APU)/Hydraulic failures and from various electrical and flight critical data bus failures.

188B  **A/E SYS 21011**

Title: Ascent/Entry Systems  
Duration: 4.0 hours  
Medium: SMS-MB  
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)  
Source: *DA7/Assigned SMS Team*  
Date: 10/05  
Lesson(s) Replaced: ASC SYS 21011, E SYS 21011  
Equipment Required: None  
Prerequisite Lesson(s): A/E SYS 21001  
Preparation: None  

Synopsis: This lesson consists of the following 5 runs:  
- Uphill through OMS 2 burn – Electrical bus loss signature review.  
- Uphill – Reaction Control System (RCS) fuel leak with electrical bus failure.  
- Return-To-Launch Site (RTLS) – Loss of Main C during ascent.
New Astronaut Lesson Descriptions

188B  A/E SYS 21011 (Concluded)

- RTLS – Manage Auxiliary Power Units (APUs) to maintain landing gear deploy redundancy.

Objectives: At the end of this lesson, the student will be able to:

- Identify the electrical buses lost, based on cockpit cues.
- Identify the impact of the electrical bus losses on the main engines, OMS engines, RCS jets, and landing gear deploy redundancy.
- Isolate an RCS fuel leak that is complicated by an electrical bus failure.
- Work through the nominal RTLS procedures while also working the loss of Main C.
- Perform an APU restart to maintain landing gear deploy redundancy.
- Discuss the secondary cues (other than onboard displays) that can be used to diagnose an electrical bus loss, APU/Hydraulic failure, and a Freon cooling loop failure.

189  OM/RC QUAL A/E 21006

Title: Orbital Maneuvering System/Reaction Control System for Ascent and Entry Qualification
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: ASCAN (Schedule individually.)
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: OM/RC QUAL 21006
Equipment Required: None
Prerequisite Lesson(s): PROP DUMPS 21006, OM/RC DP/EPS 21006
Preparation: Review:

- ASC C/L; Nominal procedures
- ASC PKT C/L; RCS LEAK ISOL
- AESP, Ascent; AFT RCS LEAK
- AESP, Ascent; OMS HE Tk P LOW
- AESP, Entry; AFT RCS LEAK (304/305/GRTLS)
- ENT C/L; 2 Engine Deorbit Burn and Burn Monitor Card
- ENT C/L FORWARD RCS DUMP
**OM/RC QUAL A/E 21006 (Concluded)**

**Synopsis:** This lesson will verify completion of the Orbital Maneuvering/Reaction Control (OM/RC) flow by testing the students' operational knowledge of the OMS and Reaction Control System (RCS). The lesson tests the student’s ability to perform nominal OMS and RCS procedures, the ability to identify a problem via cockpit signatures, locate the correct procedure, and to evaluate the impact of the failure. The lesson also tests the student’s ability to determine the big picture impacts of an EPS, DPS, or Instrumentation (INST) failure on the OMS and RCS.

The class is composed of three runs, two ascents and one entry. The instructor will play MCC and answer questions and direct the student as necessary. The student will configure the orbiter for ascent then sit in the right seat and monitor the RCS and OMS systems. The student will perform all nominal procedures as well as malfunction identification, resolution and evaluation for the ascent and entry runs. The student will have available to them the use of all FDF and tools which are typically available in the cockpit.

**Objectives:**
- Configure the OMS and RCS switches for ascent and entry.
- Monitor the OMS and RCS on ascent and entry.
- Perform OMS 1/2 Targeting.
- Perform an Insertion Burn.
- Perform a Deorbit (D/O) Burn.
- Perform a Forward Reaction Control System (FRCS) Dump.
- Secure and Reopen the RCS.
- Diagnose an engine or propellant failure during a burn and work the appropriate procedure.
- Use the Burn Monitor and OMS Failure Cue Cards.
- Manage Jet Availability and Redundancy Management (RM) via SPEC 23.
- Use the D/O burn Flight Rules.
- Perform a ‘hot’ crossfeed or interconnect.
- Use available tools to evaluate impacts of DPS, EPS and INST failures on the OMS and RCS.
- Perform failure identification, resolution, and evaluation for failures in the OMS and RCS.
New Astronaut Lesson Descriptions

190A  **ORB OPS/FCS 21001**

Title: Orbit Operations and Flight Control System Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)  
Source: *DA7/Assigned SMS Team*  
Date: 07/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ORB OPS/COMM 21012  
Preparation: Review:  
  - Orbit OPS C/L  
     - G2 to G8 transition  
     - G8 to G2 transition  
     - RCS HOT FIRE  
     - FCS checkout parts 1 and 2  
     - PRE- and POST-Sleep activities (single shift)  
     - PGSC activation  
     - Aft controller checkout  

Synopsis: The purpose of this prebrief is to review several of the Orbit Ops C/L procedures that will be performed in ORB OPS/FCS 21012.  
Objectives:  
  - State the purpose of the RCS Hot Fire Test, aft controller checkout, FCS checkout, and pre- and post-sleep activities.  
  - State when each of the above procedures is nominally performed.  
  - Identify the two major parts of the FCS checkout.

190B  **ORB OPS/FCS 21012**

Title: Orbit Operations and Flight Control System Checkout  
Duration: 4.0 hours  
Medium: SMS-FB, GNS  
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)  
Source: *DA7/Assigned SMS Team*  
Date: 07/04  
Lesson(s) Replaced: CAP 21012  
Equipment Required: None  
Prerequisite Lesson(s): ORB OPS/FCS 21001  
Preparation: None  

Synopsis: This purpose of this lesson is to introduce the student to some of the Orbit OPS C/L procedures, as well as to the importance of staying on a timeline.
New Astronaut Lesson Descriptions

190B ORB OPS/FCS 21012 (Concluded)

Objectives: • Perform the following Orbit Ops C/L procedures, using the FDF, and staying on the provided timeline:
  – G2 to G8 transition
  – G8 to G2 transition
  – RCS HOT FIRE
  – FCS Checkout, parts 1 and 2
  – PRE- and POST-Sleep activities
  – PGSC activation
  – Aft controller checkout
  – IMU align
• Activate WorldMap and manually enter time and vector data.

191 COMM/IN QUAL 21008

Title: Communication/Instrumentation Qualification
Duration: 2.0 hours
Medium: SST 3
Student: ASCAN (Schedule individually.)
Source: DS25/Communications/NSS Training Group
Date: 01/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Completion of all 20000-level COMM lessons
Preparation: Review:
  • FDF procedures related to the objectives
  • DPS displays related to the objectives

Synopsis: This lesson will verify completion standards of orbiter communication training. The student will be asked to explain the major concepts of each operation. Then the student will be asked to execute these communication operations.

Objectives: • Perform the following tasks, and be able to explain concepts related to these tasks:
  – Configure the orbiter communication systems for on-orbit operations including Telemetry Format Load (TFL)/Decommutator Format Load (DFL) loading and speaker/handheld microphone operations.
  – Configure Panel A1 for Spaceflight Tracking and Data Network (STDN), Space Ground Link System (SGLS), and Tracking and Data Relay Satellite (TDRS) operations.
  – Deploy, activate, and stow the Ku-Band.
  – Activate and operate the Closed Circuit TV system.
New Astronaut Lesson Descriptions

191   **COMM/IN QUAL 21008 (Concluded)**

   - Use available resources to analyze and explain communication situations.
   - Use available resources to identify communication system failures.
   - Set up orbiter communication systems for entry.

192   **DPS QUAL 21001**

Title: Data Processing System Qualification  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (Schedule individually.)  
Source: [DS24/DPS/Navigation Training Group](#)  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ENT DPS MAL 21006, ORB DPS MAL 21006, A/E BFS 21011  
Preparation: None  

Synopsis: This lesson will verify completion standards of DPS training by having the student answer some general questions about DPS operations with limited use of FDF. After this lesson, the student and instructor will determine if any additional study or lessons are required.

Objectives:  
- During this lesson, the student will be asked to:
  - Describe the nominal DPS configuration during ascent, orbit, and entry.
  - Describe the main differences between a Menu Option Initial Program Load (IPL) and a Default Option IPL.
  - Describe the signatures of the different PASS General Purpose Computer (GPC) failures (Halt, Power, Quit, Fail to Sync, Input/Output (I/O) Terminate (Term) B, I/O Term A).
  - Describe the signature of a BFS failure (Halt, Power, Quit, Power and Halt Transients, Standalone, Fail to Standby, I/O Term A).
  - Explain the signatures of Multiplexer/Demultiplexer (MDM) (at the GPC and at the MDM) failures.
  - Identify scenarios that require a restring and explain how to perform a restring.
  - Discuss BFS engage scenarios, how to verify a successful engage, and identify the post engage procedure.
  - List good DPS habits.
  - Explain the “big picture” DPS actions during Post Insertion.
  - Explain how to perform a redundant set expansion.
New Astronaut Lesson Descriptions

192 DPS QUAL 21001 (Concluded)

- Describe the two methods of contracting the redundant set and how each method impacts the Rendezvous (RNDZ) Navigation (NAV) software.
- Explain the “big picture” actions required for an SM GPC failure on-orbit (Orbit Pocket Checklist (OPCL) and Malfunction Procedures (MAL PROC) procedures), using FDF.

193 D/O BURN BR 21001

Title: Deorbit Burn Briefing 1
Duration: 3.0 hours
Medium: Classroom
Student: ASCAN
Source: DS66/G&C/Propulsion Training Group
Date: 10/05
Lesson(s) Replaced: D BURN BR 21001, D/O BURN BR 23001
Equipment Required: ENT C/L, D/O BURN BR 21001
Prerequisite Lesson(s): A/E SYS 21011, DPS MAL 21006, OM/RC DP/EPS 21006
Preparation: Read:
  - D/O BURN BR 21001 (This briefing handout will be supplied 2 weeks prior to the briefing. The student is not expected to understand all of the materials but to have a basic knowledge of the terminology and rationale.)

Synopsis: This briefing demonstrates how the information on the maneuver (MNVR) Preliminary Advisory Data (PAD), Deorbit, Entry, and Landing (DEL) PAD, and Propellant (PRPLT) PAD is relayed between MCC and the crew. It also defines the deorbit entries of the DEL PAD and PRPLT PAD, defines the use of the Deorbit (D/O) Burn Flight Rules cue card, reviews how to diagnose engine and propellant failures, explains the procedures on the Deorbit Burn Monitor card and 2 Engine burn card, and reviews the use of the OMS Failures card. Definition and Methods of the Deorbit Burn and burn rules of thumb are also discussed.

Objectives:
  - Enter the information read by the instructor into the appropriate blocks on the MNVR PAD, DEL PAD, and PRPLT PAD.
  - Transfer the information on the DEL PAD and PRPLT PAD to the appropriate blocks on the 2 Engine burn card.
  - State the burn completion methods for failures that occur at the different milestones on the DEL PAD.
  - Determine if a waveoff is required using the D/O Burn Flight Rules cue card given a failure.
New Astronaut Lesson Descriptions

193 D/O BURN BR 21001 (Concluded)

- State the signatures of an oxidizer/fuel blockage upstream and downstream of the inlet pressure sensor.
- Define the effect of an engine failure (ENG FAIL) and propellant failure (PRPLT FAIL) on oxidizer and fuel inlet pressures.
- Define the rationale for the procedures on the Deorbit Burn Monitor card.
- Define the rationale for the nominal procedures on the 2 Engine burn card.
- Determine the corresponding Reaction Control System (RCS) burn time using the OMS He PRESS/V/BURN TIME table given an OMS quantity.
- Given a failure, identify if an ignition path still exists, what additional failures would take the ignition path (what failure the system is critical to), and if a manual shutdown is required, using the OMS Failures cue card (Deorbit Burn).
- State the two conditions required to generate the OMS down arrow.
- State the three conditions required to mode guidance.

194A D/O FLT TECH 21001

Title: Deorbit Burn Flight Techniques Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN (Schedule ASCANs in groups of 2 or 3, no CB IA, no more than 2 PLTs per group. MS are optional. May schedule 2 groups for same prebrief.)
Source: DS66/G&C/Propulsion Training Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: ENT C/L
Prerequisite Lesson(s): D/O BURN BR 21001, ORB MAN ATT 21012
Preparation:
- SCOM; Page 7.3-1 to 7.3-6, Deorbit Burn Monitoring, Takeover and Manual Control

Synopsis: This prebrief will review the techniques and cockpit indications required to fly with no OMS guidance downmode, monitor and perform the Patterson maneuver, and monitor and perform the Forward Reaction Control System (FRCS) completion.

Objectives:
- State the proper VGO x,y,z ratios for a 2 OMS, 1 OMS, AFT RCS, and FRCS burn.
- State the software requirements for OMS guidance downmode.
New Astronaut Lesson Descriptions

194A  D/O FLT TECH 21001 (Concluded)

- State cockpit indications and effects on flight control for:
  - An 1 OMS engine burn, when guidance thinks 2 OMS are burning
  - An RCS burn, when guidance thinks an OMS engine is burning
- State the purpose of the Patterson maneuver.
- Explain how to perform and monitor the Patterson maneuver from the flight deck, including:
  - Applicable FDF
  - Maneuvering rate and techniques of using the Rotational Hand Controller (RHC)
  - Vehicle dynamics during the burn
  - Vehicle attitude at maneuver completion
- Explain how to perform and monitor a FRCS completion from the flight deck, including:
  - Applicable FDF
  - Pre-maneuver attitude
  - Maneuvering rate and techniques of using the RHC
  - Maneuver completion indications (prior to burn)
  - Vehicle dynamics during the burn

194B  D/O FLT TECH 21012

Title: Deorbit Burn Flight Techniques
Duration: 2.0 hours
Medium: SMS-FB, SMS-MB, GNS
Student: ASCAN (Schedule ASCANs in groups of 2 or 3, no CB IA, no more than 2 PLTs per group. PLTs only.)
Source: DS66/G&C/Propulsion Training Group
Date: 08/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): D/O FLT TECH 21001
Preparation: None

Synopsis: This lesson will allow the students to practice skills required for advanced deorbit burns. Each student will practice manual flying for a 2 OMS burn, performing the Patterson maneuver, flying 4+X with no OMS guidance downmode, and Forward Reaction Control System (FRCS) completion.

Objectives:
- Perform a manual 2 OMS burn from the flight deck, including:
  - Maneuvering rate and techniques of using the Rotational Hand Controller (RHC)
  - Vehicle dynamics during the burn
New Astronaut Lesson Descriptions

194B  **D/O FLT TECH 21012 (Concluded)**

- Monitor an OMS engine failure with no guidance downmode from 2 OMS to 1 OMS from the flight deck.
- Perform and monitor the Patterson maneuver from the flight deck, including:
  - Maneuvering rate and techniques of using the RHC
  - Vehicle dynamics during the burn
  - Vehicle attitude at maneuver completion
- Perform and monitor a 4+X RCS burn with no OMS guidance downmode from the flight deck, including:
  - Maneuvering rate and techniques of using the RHC
  - Vehicle dynamics during the burn
- Perform and monitor a FRCS completion from the flight deck, including:
  - Pre-maneuver attitude
  - Maneuvering rate and techniques of using the RHC
  - Maneuver completion prior to burn
  - Vehicle dynamics during the burn

195A  **D/O BURN 21001**

- **Title:** Deorbit Burn 1 Prebrief
- **Duration:** 1.0 hour
- **Medium:** Classroom
- **Student:** ASCAN (Schedule 3 ASCANs, no CB IA; at least 1 ASCAN PLT.)
- **Source:** DS66/G&C/Propulsion Training Group
- **Date:** 07/04
- **Lesson(s) Replaced:** None
- **Equipment Required:** ENT C/L
- **Prerequisite Lesson(s):** D/O FLT TECH 21012
- **Preparation:** Review:
  - D/O BURN BR 21001 handouts
    - Section on Pages 5-8, DEL PAD definitions
    - Section on Pages 15-18, Deorbit burn monitor rationale
    - Section on Pages 25-38, Deorbit Burn (2 Eng) cue card rationale

**Synopsis:** The purpose of this prebrief is to prepare the student to diagnose deorbit burn failures and work the proper procedures using the DEORBIT BURN MONITOR card and DEORBIT BURN (2 ENG) cue card. This lesson will also review how to transfer the data from the Deorbit, Entry, and Landing (DEL) Preliminary Advisory Data (PAD) and Propellant (PRPLT) PAD to the Deorbit Burn (2 Eng) cue card.
New Astronaut Lesson Descriptions

195A  **D/O BURN 21001 (Concluded)**

Objectives:
- Transfer the information on the DEL and PRPLT PADS to the D/O Burn 2 Eng cue card.
- State the difference between an engine failure (ENG FAIL) and a propellant failure (PRPLT FAIL) relating to availability of the engine and propellant.
- State the implications of a PRPLT FAIL.
- Identify the type of failure, ENG or PRPLT, given the loss of an OMS engine and loss of the associated OX or FU IN P.
- Using the training video, diagnose an ENG FAIL, PRPLT FAIL, and sensor failures.
- Identify and describe the appropriate off-nominal procedures to perform (PRPLT FAIL, ENG FAIL, 2nd OMS FAIL, and RCS COMPLETION procedures on the burn cue card) given a failure scenario.

195B  **D/O BURN 21011**

**Title:** Deorbit Burn  
**Duration:** 4.0 hours  
**Medium:** SMS-MB  
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA; at least 1 ASCAN PLT.)  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 07/04  
**Lesson(s) Replaced:** D/O BURN 21010  
**Equipment Required:** None  
**Prerequisite Lesson(s):** D/O BURN 21001  
**Preparation:** None  

**Synopsis:** The intent of the lesson is to exercise all nominal and off-nominal procedures on the DEORBIT BURN (2 ENG) cue card and to use the DEORBIT BURN MONITOR and OMS FAILURES cue cards to recognize and resolve the various malfunctions. This lesson consists of 8 runs with the first run starting at Deorbit (D/O) -15 minutes and the remaining runs starting from D/O -4 minutes. The landing site is KSC with One Orbit Late available.

**Objectives:**
- Transfer the information from the Deorbit, Entry, and Landing (DEL) Preliminary Advisory Data (PAD) and Propellant (PRPLT) PAD to the appropriate blocks on the 2 Engine burn card.
- Perform the procedures for a nominal 2 engine deorbit burn.
- Identify an engine failure (ENG FAIL) versus a propellant failure (PRPLT FAIL), using the Deorbit Burn Monitor cue card.
- Identify and resolve the various failures covered on the Deorbit Burn Monitor cue card.
195B  **D/O BURN 21011 (Concluded)**

- Determine if a waveoff is required using the D/O Burn Flight Rules cue card given a failure before ignition.
- Perform the proper actions for completing the burn using the Deorbit Burn 2 Eng cue card given the following failures or combination of failures:
  - ENG FAIL
  - PRPLT FAIL
- Identify manual shutdown requirements using the OMS FAILURES cue card.
- Given an EPS or DPS failure, identify if an ignition path still exists and what additional failures would take the remaining ignition path (what failure the system is critical to) using the OMS Failures cue card.
- Perform all required manual flight techniques for Reaction Control System (RCS) completion and Prebank/Forward Reaction Control System (FRCS) completion (PLTs only).

196  **D/O BURN BR 22001**

**Title:** Deorbit Burn 2 Briefing  
**Duration:** 3.0 hours  
**Medium:** Classroom  
**Student:** ASCAN (Schedule in groups of about 15.)  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 10/05  
**Lesson(s) Replaced:** D BURN BR 22001  
**Equipment Required:** ENT C/L  
**Prerequisite Lesson(s):** D/O BURN 21011  
**Preparation:** Review:  
  - D/O BURN BR 21001  
**Read:**  
  - D/O BURN BR 22001 (This handout will be supplied 2 weeks prior to the briefing. The student is not expected to understand all of the material but to have a basic knowledge of the terminology and rationale. Bring this handout to the briefing.)

**Synopsis:** This briefing defines the entries of the Propellant (PRPLT) Preliminary Advisory Data (PAD) for the 4 off-nominal types of burns, reviews the diagnosis of engine and propellant failures, and explains the procedures on the 1 Engine, Reaction Control System (RCS), Unbalanced, and Mixed Crossfeed burn cards.
New Astronaut Lesson Descriptions

196  **D/O BURN BR 22001 (Concluded)**

Objectives:
- Transfer the information from the Deorbit, Entry, Landing (DEL) PAD and PRPLT PAD to the 1 Engine, RCS, Unbalanced, and Mixed Crossfeed burn cards.
- Determine which burn card should be used given an initial condition.
- Define the rationale for the nominal procedures on the four off-nominal burn cards.
- Describe how the burn will be completed as stated in the steps of the burn cards given an engine or propellant failure.

197A  **D/O BURN 22001**

Title:  Deorbit Burn 2 Prebrief  
Duration:  1.0 hour  
Medium:  Classroom  
Student:  ASCAN (Schedule 3 ASCANs, no CB IA; at least 1 ASCAN PLT.)  
Source:  DS66/G&C/Propulsion Training Group  
Date:  07/04  
Lesson(s) Replaced:  None  
Equipment Required:  ENT C/L  
Prerequisite Lesson(s):  D/O BURN BR 22001  
Preparation:  Complete:  
- D/O BURN BR 22001; Burn Monitor Failure Diagnosis Quiz  
Review:  
- D/O BURN BR 22001 handout  

Synopsis:  This lesson is a continuation of D/O BURN 21001 and D/O BURN 21011. This prebrief will prepare the student for exercising 1 engine, Reaction Control System (RCS), Unbalanced, and Mixed Crossfeed deorbit burns in D/O BURN 22011. First, the Burn Monitor Failure Diagnosis Quiz will be reviewed. The remainder of the prebrief will be conducted like a paper sim in which the student will be given a set of initial conditions and will have to determine what type of burn to execute. In addition, a subsequent failure scenario will be given and the student will be required to identify and describe the appropriate procedures to perform, using the chosen burn card and the Deorbit Burn Monitor cue card. Also, the student will be required to transfer the information on the Propellant (PRPLT) and Deorbit, Entry, and Landing (DEL) Preliminary Advisory Data (PAD) to the appropriate burn cue card.
New Astronaut Lesson Descriptions

197A  **D/O BURN 22001 (Concluded)**

Objectives:  
- Transfer the information from the DEL and PRPLT PADs to the DEORBIT BURN (1 ENG, RCS, UNBALANCED, MIXED XFEED) cue cards.  
- Given an initial condition and subsequent failure scenario, identify which burn card should be used and then identify and describe the appropriate procedures to perform based on the failures presented.

197B  **D/O BURN 22011**

Title:  Deorbit Burn 2  
Duration:  4.0 hours  
Medium:  SMS-MB  
Student:  ASCAN (Schedule 3 ASCANs, no CB IA; at least 1 ASCAN PLT.)  
Source:  *DS66/G&C/Propulsion Training Group*  
Date:  07/04  
Lesson(s) Replaced:  D/O BURN 22010  
Equipment Required:  None  
Prerequisite Lesson(s):  D/O BURN 22001  
Preparation:  None

Synopsis:  The intent of this lesson is to exercise all nominal and off-nominal procedures on the DEORBIT BURN (1 ENG, RCS, UNBALANCED, and MIXED XFEED) cue cards, and to use the DEORBIT BURN MONITOR and OMS FAILURES cue cards to recognize and resolve the various malfunctions. This lesson consists of 8 runs and 1 optional run, using the 4 off-nominal deorbit burn cue cards. The first run of each card will be a nominal run; the second run of each card will present various failures.

Objectives:  
- Transfer the information on the Deorbit, Entry, and Landing (DEL) Preliminary Advisory Data (PAD) and Propellant (PRPLT) PAD to the appropriate blocks on the DEORBIT BURN (1 ENG, RCS, UNBALANCED, and MIXED XFEED) cue cards.  
- Perform the procedures for a nominal 1 engine, RCS, Unbalanced, and Mixed Xfeed deorbit burn.  
- Perform Malfunction Procedures OMS SSR-1 MIXED XFD: OMS PRPLT FAILURE in order to establish the desired OMS configuration for the Mixed Xfeed Deorbit Burn.  
- Identify an ENG FAIL versus a PRPLT FAIL using the Deorbit Burn Monitor cue card.  
- Identify and resolve the various failures covered on the Deorbit Burn Monitor cue card.
New Astronaut Lesson Descriptions

197B D/O BURN 22011 (Concluded)

- Determine if a waveoff is required using the Deorbit (D/O) Burn Flight Rules cue card given a failure before ignition.
- Given the following failures or combination of failures, perform the proper actions for completing the burn using the given Deorbit Burn cue card:
  - ENG FAIL
  - PRPLT FAIL
- Given an EPS or DPS failure, identify if an ignition path still exists and what additional failures would take the ignition path (what failure the system is critical to), using the OMS Failures cue card.
- Perform all required manual flight techniques for RCS completion and Forward Reaction Control System (FRCS) completion (PLTs only).

198 TIER TEST 25001

Refer to TIER TEST 21001 for description.

199 D/O BURN QUAL 21011

Title: Deorbit Burn Qualification
Duration: 2.0 hours
Medium: SMS-MB, SMS-FB
Student: ASCAN (Schedule 4 ASCANs; at least 1 ASCAN PLT.)
Source: DS66/G&C/Propulsion Training Group
Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Completion of all 20000-level OMS, RCS and D/O BURN lessons.
Preparation: Review:
  - Entry Checklist Deorbit Burn (2 Eng) cue card
  - Entry Checklist Deorbit Burn Monitor cue card
Synopsis: The purpose of this lesson is to verify that the student can complete a 2 engine deorbit burn using the appropriate procedures for the given failures. The FDF will be used during the lesson, and any manual flying required will be performed by the instructor unless otherwise requested by the student (PLTs only). Manual flying is not considered a performance objective of the lesson.
New Astronaut Lesson Descriptions

199  D/O BURN QUAL 21011 (Concluded)

Objectives:  
- Perform a 2-engine deorbit burn.
- With the given failures, perform and explain the steps required to complete the burn.
- Determine the amount of prebank (if required) that is needed to reach the landing site.
- Explain when and how a prebank is performed.

200A  SYS ABT 21001

Title: Systems Aborts Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)  
Source: DA7/Assigned SMS Team  
Date: 07/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PAPER SIM 25001  
Preparation: None

Synopsis: This prebrief will review “systems aborts,” including reasons for performing the abort based on ascent Flight Rules and the rationale for each of those criteria.

Objectives:  
- Define the term “systems abort” and explain how a systems abort differs from a performance abort.
- State the type of abort that should be selected for a systems failure that occurs in the overlap between 2 Engine (2-ENG) Transoceanic Abort Landing (TAL) capability and Negative Return, and the rationale for choosing that abort.
- State the type of abort that should be selected for a performance problem when in the overlap between 2-ENG TAL capability and negative return, and the rationale for choosing that abort.
- Discuss some of the failures that require a pre-Main Engine Cut-Off (MECO) abort.
- Discuss some of the failures that require a post-MECO abort.
- Explain why a TAL is not performed for a thermal window pane failure.
- Explain the FDF flow for Loss of 2 H2O Loops when an Abort Once Around (AOA) has been declared.
New Astronaut Lesson Descriptions

### 200B  SYS ABT 21011

**Title:** Systems Aborts  
**Duration:** 4.0 hours  
**Medium:** SMS-MB  
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA.)  
**Source:** DA7/Assigned SMS Team  
**Date:** 07/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** SYS ABT 21001  
**Preparation:** None

**Synopsis:** This lesson consists of 5 ascent runs, each exercising a different type of systems abort. The cases to be exercised are the following:  
- Transoceanic Abort Landing (TAL) for cabin leak  
- Return-To-Launch Site (RTLS) for loss of two Freon loops  
- Abort Once Around (AOA) for impending loss of cryo  
- TAL for two Auxiliary Power Units (APUs) down and one failing  
- TAL for one oxidizer and one fuel tank leak (different pods)

**Objectives:**  
- Identify the malfunction, determine if an abort is required, and if so, what type of abort to perform for each failure scenario presented.  
- Perform the nominal procedures for each abort case while simultaneously performing the appropriate malfunction procedure/powerdown.  
- Describe the impact of the loss of two Freon loops procedure on the DPS, COMM, and Guidance, Navigation, and Control (GNC) systems.  
- Describe the impact of the loss of two Auxiliary Power Units (APUs) on the main engines, landing gear systems, body flap, brakes, and nose wheel steering systems.

### 201  PAPER SIM 22001

**Title:** Paper Simulation 2  
**Duration:** 2.0 hours  
**Medium:** Classroom  
**Student:** ASCAN (Schedule 4 ASCANs.)  
**Source:** DA7/Assigned SMS Team  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** A/E SYS 21011, D/O BURN 22011, A/E BFS 21011
New Astronaut Lesson Descriptions

201 PAPER SIM 22001 (Concluded)

Preparation: Review:
- Ascent C/L
  - OMS Failures cue card
  - OMS Targeting
- AESP
  - Glided Flight; DPS Section, Restring Procedures
  - Powered Flight and Glided Flight; DPS Section, Multi Data Path Loss
  - Powered Flight and Glided Flight; EPS Section, Electrical Bus loss procedures
- Ref Data
  - Electrical Bus Loss Tables
  - MDM Bus Loss Tables

Synopsis: This lesson is designed to prepare the student for multisystem malfunction ascent, abort, and entry cases. This lesson is conducted like a sim, but without the high-fidelity simulator. The student will be presented with an ascent or entry scenario that has a set of failures. The cockpit signatures associated with these failures will be provided to the student. The student is allowed to ask the instructors for any information that would normally be available to the crew at that time. The students will then be required to identify the failure (based on the provided signatures), make the appropriate MCC call, determine the FDF procedure to be worked (if required), and determine the system/mission impacts. In several cases, the students will also be asked to state what the next worst failure would be. This class emphasizes those failures that affect multiple orbiter systems (e.g., EPS, DPS failures).

Objectives: Based on the cockpit signature provided by the instructor, perform the following:
- Identify malfunction.
- Make the appropriate MCC call.
- Identify appropriate procedure to be used for the failure (if required).
- Identify the multi-discipline effects for the given failure.
- Identify the system/mission impacts of the given failure during the selected phase of flight.
- Identify the “next worse failure.”
New Astronaut Lesson Descriptions

202 PAPER SIM 23001

Refer to PAPER SIM 22001 for description.

203A DO PREP BKOT 21001

Title: Deorbit Preparation Backout Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)
Source: DA7/Assigned SMS Team
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): D/O BURN 22011
Preparation: Review:
• D/O Prep C/L; D/O Prep Backout Section

Synopsis: This lesson will familiarize the student with the timeline and procedures in the Deorbit Prep Backout section of the D/O Prep C/L. It will review when this procedure is used and the FDF paths leading up to the procedure. In addition, the deorbit burn flight rules card will be discussed.

Objectives:
• Locate the D/O Prep Backout section of the C/L.
• Define the elapsed time concept of the C/L.
• Describe the FDF path to the D/O Prep Backout procedure.
• Review the annotated timeline in preparation for DO PREP BKOT 21012.
• Review the GO-NO GO cue card.
• Describe the events that would cause a D/O Prep backout.
• Describe the philosophy difference between a 1 orbit and a 1 day waveoff and when each is used.
• Identify the powerdown that is usually required following a waveoff.

203B DO PREP BKOT 21012

Title: Deorbit Preparation Backout
Duration: 4.0 hours
Medium: SMS-FB, GNS
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)
Source: DA7/Assigned SMS Team
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
New Astronaut Lesson Descriptions

203B  DO PREP BKOT 21012 (Concluded)

Prerequisite Lesson(s):  DO PREP BKOT 21001
Preparation:  None

Synopsis:  This lesson will familiarize the students with the timeline and allow them to perform the procedures in the D/O Prep Backout section of the D/O Prep C/L.  This lesson will start at D/O -15 minutes with all systems nominal. Due to particular events, the D/O Burn will not be performed and a 1 day waveoff will be required. The students will perform the D/O Prep Backout procedures, including a Priority Group C powerdown.

Objectives:
• Identify when a deorbit burn should not be performed, based on a given failure.
• Use the D/O Prep Backout procedure to perform the D/O Prep Backout Timeline.
• Identify the tasks in the D/O Backout procedure that should be delayed due to earlier failures.

204  PAPER SIM 24001

Refer to PAPER SIM 22001 for description.

205  PAPER SIM 25001

Refer to PAPER SIM 22001 for description.

206A  ASC SKL 21001

Title:  Ascent Skills Prebrief
Duration:  1.0 hour
Medium:  Classroom
Student:  ASCAN (Schedule 3 ASCANs, no CB IA.)
Source:  DA7/Assigned SMS Team
Date:  10/05
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  DO PREP BKOT 21012
Preparation:  None

Synopsis:  This prebrief is run in a paper sim format. The paper sim that is exercised in this prebrief is performed in ASC SKL 21011. The paper sim emphasizes 2-failure-deep malfunction scenarios and failures that affect multiple orbiter disciplines.
New Astronaut Lesson Descriptions

206A  **ASC SKL 21001 (Concluded)**

Objectives: Complete the following tasks for each failure:
- Identify the failure.
- Make the correct MCC call.
- Identify the FDF procedure to be performed.
- Discuss the general purpose of the FDF procedure.
- Identify the mission/system impacts.

206B  **ASC SKL 21011**

Title: Ascent Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: ASCAN (Schedule 3 ASCANs, no CB IA.)
Source:  *DA7/Assigned SMS Team*
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 21001
Preparation: None

Synopsis: This SMS lesson is designed to expose the students to a multi-discipline malfunction environment. The students will be required to work through failure scenarios while performing nominal ascent/abort procedures. The failures presented are multi-discipline in nature, and are often more than 1-failure-deep. It is very important that the students understand the impact of each failure on the other orbiter systems and its priority compared to other failures and nominal tasks. This lesson contains 2 uphill runs, 1 RTLS, and 1 TAL.

Objectives: Perform the following tasks for the malfunctions presented for each of the required ascent runs:
- Identify the failure.
- Make the appropriate MCC call.
- Execute the correct FDF procedure.
- State the mission/system impact.
- Adjust nominal and/or subsequent malfunction procedures to account for the failure.
- Prioritize the malfunctions to be worked, and divide the tasks among the appropriate crewmembers.
- Perform the nominal procedures on time.
New Astronaut Lesson Descriptions

207A  **E SKL 21001**

**Title:** Entry Skills Prebrief  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA.)  
**Source:** *DA7/Assigned SMS Team*  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** ASC SKL 21011  
**Preparation:** None

**Synopsis:** This prebrief is run in a paper sim format. The paper sim that is exercised in this prebrief is performed in E SKL 21011. The paper sim emphasizes 2-failure-deep malfunction scenarios and failures that affect multiple orbiter disciplines.

**Objectives:**
- Identify the failure.  
- Make the correct MCC call.  
- Identify the FDF procedure to be performed.  
- Discuss the general purpose of the FDF procedure.  
- Identify the mission/system impacts.

207B  **E SKL 21011**

**Title:** Entry Skills  
**Duration:** 4.0 hours  
**Medium:** SMS-MB  
**Student:** ASCAN (Schedule 3 ASCANs, no CB IA.)  
**Source:** *DA7/Assigned SMS Team*  
**Date:** 07/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** E SKL 21001  
**Preparation:** E SKL 21001
New Astronaut Lesson Descriptions

207B  E SKL 21011 (Concluded)

Synopsis: This lesson is designed to expose the students to a multi-discipline malfunction environment. The students will be required to work through failure scenarios while performing nominal entry procedures. The failures presented are multi-discipline in nature and are often more than 1-failure-deep. It is very important that the students understand the impact of each failure on the other orbiter systems and its priority compared to other failures and nominal tasks. This lesson contains 1 D/O - 15 to landing run, and 2 200K to landing runs, with post-landing procedures exercised on the last 200K run.

Objectives:• Perform the following tasks for the malfunctions presented for each of the required entry runs:
  – Identify the failure.
  – Make the appropriate MCC call.
  – Execute the correct FDF procedure.
  – State the mission/system impact.
  – Adjust nominal and/or subsequent malfunction procedures to account for the failure.
• Prioritize the malfunctions to be worked, and divide the tasks among the appropriate crewmembers.
• Perform the nominal procedures on time.
SECTION 2.0  CORE SYSTEMS REFRESHER TRAINING

The Core Systems Refresher Training Section contains lessons that may be requested by the student or instructor as part of proficiency training. These lessons are often used to refamiliarize the assigned crewmember with systems knowledge prior to beginning 30000-level training.

The Core Systems Refresher Training Course also contains the Qualification (Qual) lessons which selected crewmembers must successfully complete in order to begin the 30000-level Ascent/Entry training flow. The assigned crewmember should review their position-specific sections of the Assigned Crew Study Guide prior to taking the Qual lessons. The concept of completing the Assigned Crew Study Guide and passing the Qual lessons was designed to eliminate the “every 12 month” requirement for all Refresher lessons and to ensure that all crewmembers were at the same knowledge-base level prior to starting their 30000-level Ascent/Entry training flow. The student should avoid using the Refresher lessons as a substitute for the Assigned Crew Study Guide lessons in preparation for the Quals. The Assigned Crew Study Guide lessons are procedure-based whereas the Qual lessons are primarily knowledge-based. Satisfactory Qual lesson completion will be determined by the Instructor/Team Lead. If minimum knowledge is not demonstrated, the Instructor/Team Lead will determine the appropriate remedial instruction required to bring the student to the appropriate level and retaking of the entire Qual is not necessary. A crewmember who is not required to take a specific Qual lesson per Table 2-1 may take the lesson at their discretion. Upon completion of all required Qual lessons, 30000-level training may begin.
# Table 2-1. Core Systems Refresher Training Requirements

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Sub Total for Stage Stage Totals Per Crewmember:

|       | 60.5 | 60.5 | 60.5 | 46.5 | 60.5 | 46.5 | 60.5 | 46.5 | 0   | 0   | 60.5 | 60.5 | 46.5 | 60.5 |

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7. Please note the prerequisites for this class.
Core Systems Refresher Training Lesson Descriptions

1  **MPS QUAL 31006**

Title: Main Propulsion System Qualification
Duration: 2.0 hours
Medium: SST
Student: COMMANDER, MS 2, PILOT (MS 1 optional.)
Source: *DS66/G&C/Propulsion Training Group*
Date: 10/05
Lesson(s) Replaced: A MPS S&C Q 31001
Equipment Required: None
Prerequisite Lesson(s): Completion of ASCAN MPS Training Flow
Preparation: Read:
- Main Propulsion System Workbook; Section 4
- Assigned Crew Study Guide; Section 2.8 MPS

Synopsis: This lesson will present a series of scenarios for the student. Each scenario presents both nominal or malfunction conditions that the student must analyze and then determine what crew actions are required based on FDF procedures.

Objectives:
- Demonstrate the ability to perform the 7 nominal crew tasks for the Main Propulsion System (MPS) on ascent.
- Demonstrate the ability to identify malfunctions, locate the appropriate FDF procedures, and perform the required actions on ascent.
- Explain the cause of the malfunctions observed and the rationale for the actions taken for each scenario presented.

2  **S&C QUAL 31006**

Title: Sensors and Controllers Qualification
Duration: 1.0 hour
Medium: SST
Student: COMMANDER, MS 2, PILOT (MS 1 optional.)
Source: *DS66/G&C/Propulsion Training Group*
Date: 10/05
Lesson(s) Replaced: A MPS S&C Q 31001
Equipment Required: None
Prerequisite Lesson(s): Completion of ASCAN FCS and Sensors & Controllers Training Flows
Preparation: Assigned Crew Study Guide; Section 2.12 Sensors and Controllers
Core Systems Refresher Training Lesson Descriptions

2 S&C QUAL 31006 (Concluded)

Synopsis: This lesson will test the student’s operational knowledge of the flight control sensors and controllers. The lesson tests the student’s ability to identify a problem via cockpit signatures, locate the correct procedure, and to evaluate the impact of the failure. The instructor will question the student to test knowledge of the system operation, including rationale for procedures and functioning of redundancy management. The lesson also tests the student’s ability to determine the impacts of DPS failures on the flight control sensors and controllers.

The class is composed of two runs, one entry and one orbit. The instructor will play MCC and answer questions and direct the student as necessary. Initially, the student will configure the orbiter for entry and monitor the flight control sensors and controllers. The student will perform all nominal procedures as well as malfunction identification, resolution, and evaluation for the entry and orbit runs. The student will use FDF and cockpit displays to identify problems and take actions.

Objectives:
- Recognize failures in the flight control sensors and controllers.
- Demonstrate familiarity with displays containing flight control sensor and controller information.
- Perform flight data file procedures with flight control sensors’ and controllers’ steps and explain the rationale for the steps.
- Manually deselect flight control sensors and controllers.
- Explain flight control sensors and controllers redundancy management.
- Demonstrate proper operation of controllers.

3 EPS QUAL 31004

Title: Electrical Power Systems Qualification
Duration: 2.0 hours
Medium: SST
Student: COMMANDER, MS 2, PILOT (Schedule individually.) MS 1, MS 3 optional.
Source: DS45/Shuttle Systems Training Group
Date: 04/06
Lesson(s) Replaced: SYSTEMS Q 31004
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Review FDF and EPS reference materials to prepare for the objectives listed below.
Core Systems Refresher Training Lesson Descriptions

3  EPS QUAL 31004 (Concluded)

Synopsis: This lesson will verify that the student meets the required standards for systems knowledge and FDF usage for the Shuttle EPS. This lesson tests the student’s ability to recognize signatures and execute the appropriate FDF procedure for various EPS malfunctions. In addition to off-nominal procedures, the student will perform selected nominal procedures (including starred blocks when applicable). Throughout the lesson, the instructor will ask questions in order to test the student’s knowledge of hardware, operations, procedure rationale, and concepts associated with EPS.

Objectives:

• Identify various EPS malfunctions during the ascent/entry and orbit timeframes via displays and other available cockpit cues.
• Execute the appropriate FDF procedure for each of the malfunctions presented.
• Explain the rationale for the FDF procedures associated with each of the malfunctions presented.
• State the power sources for the Main, Essential, Control, and AC buses.
• Describe how the AC bus sensors function in the Off, Monitor, and Auto Trip switch positions.
• Explain the “two finger trick” associated with Control buses.
• Recognize which buses require a fuel cell shutdown when lost, and explain why.
• Explain the difference between a fuel cell shutdown and fuel cell safing.
• Explain how to confirm if a fuel cell has been “safed.”
• Recognize which fuel cell malfunctions cause the fuel cell stack temperature reading to be invalid.
• Explain the difference between the long and short form bus tie, and state when each should be used.
• Perform a back door bus tie, when required.
• Explain the difference in signatures between a fuel cell short and a main bus short.
• Explain the purpose of performing a fuel cell purge.
• Explain the operational constraints for the manual fuel cell purge.
• Perform the manual fuel cell purge procedure, including starred blocks (when applicable).
Core Systems Refresher Training Lesson Descriptions

4 APU/HYD QUAL 31004

Title: Auxiliary Power Unit/Hydraulic Qualification
Duration: 2.0 hours
Medium: SST
Student: COMMANDER, MS 2, PILOT (Schedule individually.) MS 1, MS 3 optional.
Source: DS45/Shuttle Systems Training Group
Date: 04/06
Lesson(s) Replaced: SYSTEMS Q 31004
Equipment Required: None
Prerequisite Lesson(s): None

Preparation: Review FDF and APU/Hyd reference materials to prepare for the objectives listed below.

Synopsis: This lesson will verify that the student meets the required standards for systems knowledge and FDF usage for the Shuttle Auxiliary Power Unit (APU)/Hydraulic (Hyd) Systems. This lesson tests the student’s ability to recognize signatures and execute the appropriate FDF procedure for various APU/Hyd malfunctions. In addition to off-nominal procedures, the student will perform selected nominal procedures (including starred blocks when applicable). Throughout the lesson, the instructor will ask questions in order to test the student’s knowledge of hardware, operations, procedure rationale, and concepts associated with the APU/Hyd Systems.

Objectives:

- Identify various Auxiliary Power Unit (APU)/Hydraulic (Hyd) malfunctions during the ascent and/or entry timeframes via displays and other available cockpit cues.
- Execute the appropriate FDF procedure for each of the malfunctions presented.
- Explain the rationale for the FDF procedures associated with each of the malfunctions presented.
- When required, report the F7 APU Underspeed or Overspeed light to MCC correctly.
- Describe how the following functions are supported by the APU/Hyd system:
  - Engine throttling
  - Engine gimballing (ascent and entry)
  - Landing gear deploy
  - Braking
  - Nose Wheel Steering
- Locate the Systems Flight Rules in FDF.
- Determine whether an ascent abort is required for a given APU/Hyd malfunction scenario (using FDF).
Core Systems Refresher Training Lesson Descriptions

4  APU/HYD QUAL 31004 (Concluded)

- Locate the APU ready-to-start criteria in FDF.
- Perform the APU Pre Start and APU Start procedures in the Ascent Checklist, and explain the procedure rationale.
- Perform the APU Pre Start and Single APU Start procedures in the Entry Checklist, and explain the procedure rationale.
- Describe the conditions that would call for “Attempt One APU” versus “Attempt Two APUs” when performing the Single APU Start procedure in the Entry Checklist.
- Describe how the APU primary and secondary control valves operate.
- Describe what happens when the APU Speed Select switch is taken to High.
- State the four reasons for restarting an APU.
- Recognize when an APU that has been shutdown is a candidate for a cooldown and/or a restart.
- Given an APU/Hyd malfunction scenario, determine impacts on the landing gear, brakes, and Nose Wheel Steering (NWS) systems (using the Landing Gear diagram).
- Given an APU/Hyd malfunction scenario, determine impacts to main engine throttling and gimballing (using cue card).
- Describe Water Spray Boiler (WSB) spray mode and pool mode, and state when each mode is used.
- Explain why the WSB controllers are not swapped prior to Main Engine Cutoff (MECO).
- Explain Priority Rate Limiting (PRL).
- State where each of the three hydraulic pressure sensor readings can be seen in the cockpit.

5  PRL 21057

Title: Priority Rate Limiting CBT
Duration: 1.0 hour
Medium: CBT
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Personal Computer; access to NASA CBT Web site
Prerequisite Lesson(s): None
Preparation: None
Core Systems Refresher Training Lesson Descriptions

5  **PRL 21057 (Concluded)**

**Synopsis:** This CBT lesson provides the student with Priority Rate Limiting (PRL) background information, as well as student practice with basic PRL exercises and PRL case studies. It allows the student to choose which information or exercises are presented.

**Objectives:** To receive credit for the lesson, the student must successfully complete at least 5 of the 7 case studies.

6  **ECLSS/C&W/MECH QUAL 31008**

**Title:** Environmental Control and Life Support Systems/Caution & Warning/Mechanical Qualification

**Duration:** 2.0 hours

**Medium:** SST 3

**Student:** COMMANDER, MS 2, PILOT (Schedule individually.) MS 1, MS 3 optional.

**Source:** DS45/Shuttle Systems Training Group

**Date:** 04/06

**Lesson(s) Replaced:** SYSTEMS Q 31004

**Equipment Required:** None

**Prerequisite Lesson(s):** None

**Preparation:** Review FDF and ECLSS, C&W, and Mechanical Systems reference materials to prepare for the objectives listed below.

**Synopsis:** This lesson will verify that the student meets the required standards for systems knowledge and FDF usage for the Shuttle Environmental Control and Life Support Systems (ECLSS), Caution and Warning (C&W), and Mechanical Systems. This lesson tests the student’s ability to recognize signatures and execute the appropriate FDF procedure for various ECLSS and Mechanical malfunctions. In addition to off-nominal procedures, the student will perform selected nominal procedures (including starred blocks when applicable) for each system. Throughout the lesson, the instructor will ask questions in order to test the student’s knowledge of hardware, operations, procedure rationale, and concepts associated with the ECLSS, C&W, and Mechanical Systems.

**Objectives:**
- Identify various ECLSS malfunctions during the ascent/entry and orbit timeframes via displays and other available cockpit cues.
- Execute the appropriate FDF procedure for each of the malfunctions presented.
- Explain the rationale for the FDF procedures associated with each of the malfunctions presented.
Core Systems Refresher Training Lesson Descriptions

ECLSS/C&W/MECH QUAL 31008 (Continued)

- Locate the Systems Flight Rules in FDF.
- Determine whether an ascent abort is required for a given ECLSS malfunction scenario (using FDF).
- Explain why Alternating Current (AC) powered equipment is not swapped prior to Main Engine Cutoff (MECO).
- Locate the Portable Computer System (PCS) diagram in FDF.
- Describe the PCS configuration during ascent, entry, and orbit.
- Explain how to distinguish between an oxygen ($O_2$) and nitrogen ($N_2$) leak into the cabin.
- Explain the difference between the three “dP/dT” values on the displays (hardware, backup, equivalent), and state when each is available.
- Explain the av bay temperature signature associated with an av bay fan that has been turned off (or is completely failed).
- Describe the $H_2O$ loop configuration during ascent, entry, and orbit.
- Explain the difference in signature between an external $H_2O$ loop leak, internal $H_2O$ loop leak, and a $H_2O$ loop pump failure.
- State what the Panel L4 $H_2O$ Loop Pump 1A/2 circuit breakers power.
- Recognize when the Panel L4 $H_2O$ Loop Pump 1A/2 circuit breakers should be pushed in.
- State the mechanism(s) actively cooling the Freon loops during all phases of flight from pre-launch through post-landing.
- Explain the differences between the Flash Evaporator System (FES) primary controllers and the FES secondary controller.
- State the temperature control point for the FES controllers (primary and secondary), radiator controllers (in norm and high), and $NH_3$ controllers.
- Explain the purpose of the FES core flush.
- Explain the Freon loop radiator isolation hardware.
- Explain the radiator startup sequence in terms of the motion and timing of the radiator flow control and bypass valves.
- Explain the purpose of the radiator controller startup sequence.
- Explain the rule for configuring $NH_3$ systems according to Freon flow rates.
- Perform the supply water dump procedure, including starred blocks (when applicable), and explain the procedure rationale.
- Explain the differences between the Primary Caution and Warning (C&W) System and the Backup C&W System.
- Given a parameter name, locate the software identification number in Reference (Ref) Data.
- Given a parameter name, locate the hardware channel number in Ref Data or on the C&W cue card.
Core Systems Refresher Training Lesson Descriptions

6 ECLSS/C&W/MECH QUAL 31008 (Concluded)

- Demonstrate how to use the Primary to Backup C&W Analog Parameter Calibration table to change a hardware limit for a given parameter.
- Explain how the state of microswitches affects the operation of a mechanism.
- Execute the procedures for a manual and/or auto mode payload bay door opening and/or closing.
- Describe the malfunctions that will cause a “PBD SEQ FAIL” fault message during payload bay door opening/closing.
- Describe the malfunctions that will cause a “PBD CONFIG FAIL” fault message during payload bay door opening/closing.
- Describe the malfunctions that will cause a dilemma during payload bay door opening/closing.
- Given a microswitch malfunction, identify what, if any, fault messages will be generated during payload bay door opening/closing.
- Explain the purpose of the Centerline Latch Extended Guide Roller Trajectory No-Go diagram.

7A APU REFR 41001

Title: Auxiliary Power Unit/Hydraulic Systems Operations Refresher Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PRL 21057
Preparation: None

Synopsis: This prebrief will include a review of nominal and off-nominal Auxiliary Power Unit/Hydraulic (APU/HYD) and Water Spray Boiler (WSB) systems operations. Recent APU/HYD and WSB procedure and hardware/software changes will also be discussed.

Objectives:  
- Review the hydraulically driven components, and identify their location throughout the vehicle.
- Show illustrations/pictures to identify and locate the APUs, fuel tanks, water spray boiler, and other miscellaneous equipment.
Core Systems Refresher Training Lesson Descriptions

7A  APU REFR 41001 (Concluded)

- Review the APU/HYD schematic shown in the PKT Checklists (C/Ls) and MAL PROC. As a minimum, review the following:
  - APU fuel tank and plumbing system
  - APU hardware
  - APU controllers, including caution & warning, and auto shutdown features
  - HYD pump and plumbing
  - Accumulator/bootstrap system and purpose
  - HYD circ pump package and operation
  - WSB equipment and operation
  - Gas Generator (GG) bed injector cooling equipment and operation
- Review the hydraulic scheme for nose wheel steering and main & nose gear deployment.
- Review appropriate malfunction scenarios, based upon student requirements (i.e., flight-specific details).
- Time permitting, review the Backup Flight System (BFS) and Primary Avionic Software System (PASS) CRT displays that are available.

7B  APU REFR 41004

Title: Auxiliary Power Unit Refresher
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): APU REFR 41001
Preparation: None

Synopsis: This lesson provides refresher training in Auxiliary Power Unit/ Hydraulic/Water Spray Boiler (APU/HYD/WSB) components and their functions, and provides insight into recent FDF procedural and hardware/software changes. Several scenarios are presented to provide hands-on training in nominal and off-nominal APU/HYD/WSB operations.

Objectives:
- Identify all controls and displays related to the APU/HYD/WSB systems for each flight phase.
- Explain the rationale behind the nominal and off-nominal APU/HYD/WSB systems procedures.
- Perform quick recognition of nominal and off-nominal system signatures in all flight phases.
Core Systems Refresher Training Lesson Descriptions

7B APU REFR 41004 (Concluded)

- Perform APU/HYD/WSB system management during all flight phases including Priority Rate Limiting (PRL), APU start and shutdown.
- Identify calls that need to be made by both crew and ground.
- Determine and state the rationale behind malfunction impact on the APU/HYD/WSB systems and flight duration.
- Describe basic APU operation of the following:
  - APU controller logic
  - Ready-to-start talkback
  - Start sequence
  - Speed control logic
  - Auto shutdown
- Describe basic HYD operation of the following:
  - HYD main pump operation
  - Circ pump operation
  - System redundancy
  - Accumulator system
  - Switching valves
- Describe basic WSB operation of the following:
  - WSB controller logic
  - Pool mode
  - Spray mode
  - Bypass valve logic
  - Ready indicators
- Explain the interfaces between the APU/HYD systems and the following:
  - Space Shuttle Main Engines (SSMEs)
  - Aerosurfaces
  - Landing gear
  - Brakes
  - Nose Wheel Steering (NWS)

8 APU REVIEW 41004

Title: Auxiliary Power Unit/Hydraulic Systems Review
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: AP/HY REVIEW 41004
Equipment Required: None
Prerequisite Lesson(s): PRL 21057
Core Systems Refresher Training Lesson Descriptions

8  APU REVIEW 41004 (Concluded)

Preparation: None

Synopsis: This lesson provides the medium for an in-depth discussion or review of the system and/or associated FDF procedures. It is primarily tailored to a crewmember's individual needs, and is scheduled as desired.

Objectives: Discuss specific topics predetermined by the instructor and student.

9  C&W REFR 41004

Title: Caution & Warning Refresher
Duration: 1.0 hour
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: FDF
Prerequisite Lesson(s): C&W MAL 21004
Preparation: None

Synopsis: This lesson provides practice in system configuration, panel R13 and F7 functions, Systems Management (SM) TABLE MAINT SPEC operations, fault summary display operations, and fire and smoke systems switch operations.

Objectives:
- Recognize visual and aural cues for hardware and software Caution and Warning (C&W).
- Recognize visual and aural cues for an SM alert.
- Utilize primary C&W matrix cue card to locate parameters and/or channel numbers.
- Inhibit and enable hardware C&W parameter using panel R13 and the reference data book.
- Read and change limits for a hardware C&W parameter using panel R13 and the Reference Data book.
- Perform lamp test for hardware C&W light matrix.
- Inhibit and enable software C&W parameter using SPEC 60.
- Change software C&W parameter limit using SPEC 60.
- Utilize fault messages to recognize failures.
- Change the SM tone duration using SPEC 2.
- Write checkpoint using SPEC 60.
- Identify location of fire holes in cabin.
Core Systems Refresher Training Lesson Descriptions

9  C&W REFR 41004 (Concluded)

- Identify location of smoke detectors.
- Perform SMOKE DETN CKT TEST using Orbit Ops Checklist (C/L).
- Identify and perform the correct procedure for an avionics bay fire.
- Recognize the signatures that indicate cabin depressurization.

10A  CCTV REFR 41001

Title: Closed Circuit Television Refresher Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS25/Shuttle Comm Training
Date: 08/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CCTV MAL 21008
Preparation: None

Synopsis: This lesson is to strengthen the student’s knowledge of the CCTV system. The CCTV system, associated components, TV Cue Card, and the appropriate FDF procedures will be discussed.

Objectives:
- Identify the five major functions of the Remote Control Unit (RCU) and the six major functions of the Video Switching Unit (VSU).
- Identify the two types of cameras, the camera locations, and camera range movement.
- Identify the one true Ground Control Interface Logic (GCIL) switch of the CCTV system.
- List the major steps involved in activating the CCTV system.
- Identify the procedures corresponding to given CCTV signatures.
- Identify cues to assist in determining the location of the failure (e.g., nominal configuration, monitor and panel A7 and Systems Management (SM) alert message).
Core Systems Refresher Training Lesson Descriptions

**10B CCTV REFR 41008**

<table>
<thead>
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<td>Source:</td>
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<td>Lesson(s) Replaced:</td>
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<tr>
<td>Equipment Required:</td>
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<td>Prerequisite Lesson(s):</td>
<td>CCTV REFR 41001</td>
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<td>Preparation:</td>
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**Synopsis:** This lesson reinforces the student’s knowledge of the CCTV system. The student will perform nominal CCTV procedures that include activating, operating, and deactivating the CCTV system with the TV cue card and associated panel controls. The student will also be required to troubleshoot CCTV malfunctions using FDF.

**Objectives:**
- Operate the CCTV system by activating, operating, and deactivating.
- Locate, explain, and use CCTV monitor controls and Panel A6 and A7 CCTV switches to operate the system.
- Demonstrate downlinking a video scene and viewing the downlinked video on a Color Television Monitor.
- Recognize and resolve a CCTV monitor, a camera, and an overtemp failure using FDF, if applicable.

**11 CCTV REVIEW 41008**

<table>
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<th>Title:</th>
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<td>CCTV MAL 21008</td>
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<td>Preparation:</td>
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</tbody>
</table>

**Synopsis:** This lesson is primarily tailored to a crewmember’s individual needs; therefore, it is recommended that the student coordinate the subject areas to be reviewed with the assigned instructor. This lesson is to be scheduled as desired.
Core Systems Refresher Training Lesson Descriptions

11 CCTV REVIEW 41008 (Concluded)

Objectives:
- Operate the CCTV system by activating, operating, and deactivating.
- Employ the students requested CCTV activities.

12 COMM/IN QUAL 31008

Title: Communication/Instrumentation Qualification
Duration: 2.0 hours
Medium: SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (CDR optional.)
(Schedule individually.)
Source: DS25/Shuttle Comm Training
Date: 04/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Complete all Comm Study Guides
Preparation: Review:
- FDF procedures related to the objectives
- CRT displays related to the objectives

Synopsis: This lesson will verify completion standards of orbiter communication training. The student will be asked to explain the major concepts of each operation. The student will then be asked to execute these communication operations.

Objectives:
- Perform the following tasks, and be able to explain concepts related to these tasks:
  - Load Telemetry Format Loads (TFLs) and Decom Format Loads (DFLs).
  - Deploy, activate, and stow the Ku-band.
  - Configure panel A1 for Space Flight Tracking and Data Network (STDN), Tracking and Data Relay Satellite (TDRS), and Space-Ground Link System (SGLS).
  - Use available resources (displays and controls) to identify COMM coverage.
  - Use available resources to analyze and explain comm situations.
  - Use available resources to identify comm failures.
  - Configure audio system for speaker/handheld microphone operations.
  - Perform CCTV activation and operation.
Core Systems Refresher Training Lesson Descriptions

13 COM/IN RVW 41008

Title: Communications/Instrumentation Review
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually or as requested by CDR.)
Source: DS25/Shuttle Comm Training
Date: 04/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): New Astronaut Training Flow completed
Preparation: S-BD COMM/IN 21002

Synopsis: This lesson provides the medium for basic or in-depth discussion or review of the Shuttle communications, instrumentation, and/or the associated cockpit cue/FDF procedures. It is tailored to a crewmember's individual or 'flight crews' need(s); therefore, it is recommended that the student(s) coordinate the subject areas to be reviewed with the assigned instructor. This lesson is to be scheduled as desired.

Objectives:
• Familiarize the student with the appropriate communications signatures during the Ascent and Post Insertion phases of flight.
• Familiarize the student with appropriate SPEC displays, Ku-Band system, and CCTV system while on-orbit.
• Familiarize the student with nominal and off-nominal Ground Control Interface Logic (GCIL) signatures.
• Identify selected off-nominal communications and Operational Instrumentation (OI) signatures while in an orbit configuration.
• Identify appropriate FDFs for use by student during ascent, orbit, and entry phases of flight.

14 DPS REVIEW 41006

Title: Data Processing System Review
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
DS24/DPS/Navigation Training Group
Date: 05/99
Lesson(s) Replaced: DPS REFR 41006
Equipment Required: None
Prerequisite Lesson(s): ORB DPS MAL 21006
Preparation: None
Core Systems Refresher Training Lesson Descriptions

14  DPS REVIEW 41006 (Concluded)

Synopsis: This lesson provides the medium for an in-depth discussion or review of the DPS and FDF procedures. The student should coordinate with the DPS/Navigation (NAV) instructor about the subject areas to be reviewed. This lesson is to be scheduled as desired. If the student desires a 30 minute prebrief prior to the lesson, they can coordinate this with the DPS/NAV instructor.

Objectives: Objectives will be determined by the instructor and/or student.

15  DPS Q 31001

Title: Data Processing System Qualification
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Schedule in groups of up to 3.)
Source: *DM34/Rendezvous Guidance, Procedures and Training*
*DS24/DPS/Navigation Training Group*

Date: 02/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
  - Assigned Crew Study Guide Orbiter Systems; Section 3: DPS

Synopsis: This lesson will verify completion standards of DPS training by having the student answer some general questions about DPS operations. The CDR, PLT, and MS2 will each take this qual prior to the start of 30000-level training. This lesson can be scheduled either individually or as a group, crew choice. There will be limited FDF use. At the completion of this lesson, the student and the instructor will determine if any additional studying or lessons are required.

Objectives:
  - Describe the nominal DPS configuration during ascent, orbit, and entry.
  - Describe the operational differences between Primary Avionics Software System (PASS) and Backup Flight System (BFS).
  - Describe the signatures of a BFS engage, BFS self-engage, and BFS disengage.
  - Describe the signature of a BFS failure (Halt, Power, Quit, Power and Halt Transients, Standalone, Fail to Standby, Input/Output Terminate A (I/O TERM A)) and identify the procedure that should be worked.
Core Systems Refresher Training Lesson Descriptions

15  **DPS Q 31001 (Concluded)**

- Explain the “big picture” rationale for the steps in nominal DPS procedures (Post Insertion, Deorbit Prep, Post Landing, Redundant Set (RS) Contraction, RS Expansion, Pre/Post Sleep Activities, Systems Management (SM) Checkpoint).
- Describe the main differences between a Menu Option Initial Program Load (IPL) and a Default Option IPL.
- Describe the signature of a Flight Critical (FC) Multiplexer/Demultiplexer (MDM) (at the MDM, at the General Purpose Computer (GPC), Card).
- Describe the signatures of the different PASS GPC failures (Halt, Power, Quit, Fail to Sync, I/O TERM B, I/O TERM A).
- Identify the scenarios that allow a restring and explain how to perform a restring.
- Discuss good DPS habits.
- Explain how to troubleshoot basic Multifunction Electronic Display Subsystem (MEDS) failures.

16A  **ECLSS REFR 41001**

**Title:** Environmental Control and Life Support Systems Operations Refresher Prebrief

**Duration:** 0.5 hours

**Medium:** Classroom

**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)

**Source:** DS45/Shuttle Systems Training Group

**Date:** 05/99

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** ECL 10.2 ATM 21004, ECLSS MAL AE 21004, ECLSS MAL O 21004

**Preparation:** None

**Synopsis:** This prebrief will include a review of nominal and off-nominal Environmental Control and Life Support System (ECLSS) operations.

**Objectives:**
- Identify flight rules for ECLSS systems aborts in the Ascent Checklist (C/L).
- Identify major points for LOSS OF CABIN PRESSURE, LOSS OF 2 WATER LOOPS, and LOSS OF 2 FREON LOOPS procedures.
- Identify and explain recent ECLSS-related hardware/software and procedural changes.
Core Systems Refresher Training Lesson Descriptions

16B  ECLSS REFR 41004
Title: Environmental Control and Life Support Systems Refresher
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ECLSS REFR 41001
Preparation: None

Synopsis: This lesson provides refresher training in Environmental Control and Life Support System (ECLSS) components and their functions, and provides insight into recent FDF hardware/software and procedural changes. Several scenarios are presented to provide hands on training in nominal/off-nominal ECLSS operations.

Objectives:
- Explain the rationale behind the nominal/off-nominal ECLSS system procedures.
- Perform quick recognition of nominal/off-nominal system signatures in all flight phases.
- Configure and explain switch and display configuration for all flight phases.
- Describe the Supply H₂O system and perform appropriate leak isolation procedures.
- Identify a cabin leak and perform associated procedures in a timely manner.
- Explain the Active Thermal Control System (ATCS) and Atmosphere Revitalization System (ARS) cooling systems and their relation to the various flight phases.
- Discuss the rationale for ECLSS-driven aborts.

17  ECLSS REVIEW 41004
Title: Environmental Control and Life Support System Review
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: ECLSS MAL 21004
Equipment Required: FDF
Core Systems Refresher Training Lesson Descriptions

17 ECLSS REVIEW 41004 (Concluded)
Prerequisite Lesson(s): ECL 10.2 ATM 21004, ECLSS MAL AE 21004, ECLSS MAL O 21004
Preparation: None
Synopsis: This lesson is designed for the crewmember as a review of the Environmental Control and Life Support System (ECLSS) in order to cover items in question and to maintain proficiency in the FDF procedures. This session is primarily tailored to a crewmember's individual needs, and is to be scheduled as desired.
Objectives: Discuss specific topics predetermined by the instructor and student.

18A EPS REFR 41001
Title: Electrical Power System Refresher Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EPS MAL A/E 21004
Preparation: None
Synopsis: This prebrief will include a review of nominal and off-nominal EPS operations.
Objectives: Review systems schematics for Power Reactants Storage and Distribution (PRSD) and fuel cell subsystems. Discuss recent vehicle hardware changes, as applicable. Discuss appropriate vehicle-specific information. Discuss recent Primary Avionics Software System (PASS) and Backup Flight System (BFS) software changes that pertain to EPS. Review any significant changes in nominal and malfunction procedures, and discuss the rationale for the changes.
Core Systems Refresher Training Lesson Descriptions

18B      EPS REFR 41004

Title:   Electrical Power System Refresher  
Duration:  2.0 hours  
Medium:  SST 1 or SST 2 or SST 3  
Student:   COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)  
Source:   DS45/Shuttle Systems Training Group  
Date:   05/99  
Lesson(s) Replaced: None  
Equipment Required: FDF  
Prerequisite Lesson(s): EPS REFR 41001  
Preparation: None

Synopsis:   This lesson allows the student to practice EPS-related nominal and off nominal procedures. The student will configure EPS switches for various flight phases using the FDF. During this lesson, EPS-related malfunctions will be presented, and the student will have an opportunity to recognize the malfunctions and perform corrective procedures.

Objectives:
- Configure Cryogenic (CRYO) heaters for various flight phases.
- Perform O₂ heater current sensor test using the Orbit Ops Checklist (C/L).
- Configure AC bus sensors and essential (ESS) buses for various phases of flight.
- Perform manual and auto fuel cell purge using the cue card and plot fuel cell amps and volts on the back of the cue card.
- Utilize F7 panel, CRT displays, panel meters, and fault messages to identify various EPS malfunctions.
- Recognize AC bus failures, understand their effect on other systems, and reconfigure the orbiter.
- Perform the correct procedure for AC bus failures using the Orbit Pocket C/L and the malfunction procedures.
- Recognize an AC phase shift and utilize the Orbit Pocket C/L to identify the phase, which caused the failure.
- Distinguish between AC overload and AC over/under voltage condition.
- Identify and perform the correct procedure for a Forward Power Controller (FPC) bus loss.
- Identify and perform the correct procedure for a main bus undervolt.
- Distinguish between a Fuel Cell (FC) short and a main bus short.
- Identify an O₂ or H₂ reactant valve fail closed, and perform the correct procedure for an O₂ reactant valve failure within 2 minutes, or, for an H₂ reactant valve, within 30 seconds.
- Identify an ESS bus failure and perform the correct procedure.
Core Systems Refresher Training Lesson Descriptions

18B EPS REFR 41004 (Concluded)

- Identify a FC PUMP failure and perform the correct procedure within 6 minutes.
- Utilize the fuel cell shutdown cue card whenever it is necessary to shut down the fuel cell, or to bus tie.
- Identify a cryo O₂ or H₂ leak in a tank, manifold, or fuel cell, and perform the correct procedure.

19 EPS REVIEW 41004

Title: Electrical Power System Review
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: EPS MAL 21004
Equipment Required: None
Prerequisite Lesson(s): EPS MAL A/E 21004
Preparation: None

Synopsis: This lesson provides the medium for an in-depth discussion or review of the system and/or associated FDF procedures. It is primarily tailored to a crewmember’s individual needs; therefore, it is recommended that the student coordinate with the assigned instructor regarding the subject areas to be reviewed. This lesson is to be scheduled as desired.

Objectives: Discuss specific topics predetermined by the instructor and student.

20A MECH REFR 41001

Title: Mechanical Systems Operations Refresher Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MECH MAL 21004
Preparation: None

Synopsis: This prebrief will include a review of nominal and off-nominal mechanical systems operations, utilizing actual hands-on manipulation of mechanical component models in the mechanical model classroom.
Core Systems Refresher Training Lesson Descriptions

20A  MECH REFR 41001 (Concluded)

Objectives:
- Discuss the payload bay door display (OPS 202 base page, or SPEC 63) in detail.
- Describe the opening and closing of the Payload Bay Doors (PLBDs), and the associated FDF/figures in detail.
- Explain the meaning of 3 possible software malfunction indications.
- Construe the difference between auto and manual PLBD operations.

20B  MECH REFR 41004

Title:  Mechanical Refresher
Duration:  2.0 hours
Medium:  SST 3 only
Student:  COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source:  DS45/Shuttle Systems Training Group
Date:  05/99
Lesson(s) Replaced:  None
Equipment Required:  FDF
Prerequisite Lesson(s):  MECH REFR 41001
Preparation:  None

Synopsis:  This lesson allows the student to demonstrate knowledge of the various mechanical systems. This lesson will cover External Tank (ET) umbilical door, Payload Bay Door (PLBD), and landing gear deploy operations. These operations will include various malfunctions.

Objectives:
- Identify configuration of vent doors during prelaunch, ascent, orbit, entry, and post-landing.
- Perform the ET umbilical door opening/closing procedures.
- Recognize and perform actions associated with a failed ET door.
- Perform the emergency PLBD opening procedures.
- Recognize and perform actions for PLBD SEQ FAIL and PLBD CONFIG messages.
- Perform an off-nominal PLBD closing.
- Locate and explain PLBD visual aids.
- Perform landing gear deployment.
Core Systems Refresher Training Lesson Descriptions

21 MECH REVIEW 41004
Title: Mechanical Review
Duration: 2.0 hours
Medium: SST 3 only
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS45/Shuttle Systems Training Group
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: FDF
Prerequisite Lesson(s): MECH MAL 21004
Preparation: None

Synopsis: This lesson provides the medium for an in-depth discussion or review of the basic mechanical systems, Payload Bay Door (PLBD), External Tank (ET) doors, vent doors, the landing deceleration system, and/or FDF procedures. This lesson is primarily tailored to a crewmember's individual needs and is to be scheduled as desired.

Objectives: Discuss specific topics predetermined by the instructor and student.

22 MPS REFR 41006
Title: Main Propulsion System Refresher
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 01/95
Lesson(s) Replaced: None
Equipment Required: FDF
Prerequisite Lesson(s): MPS MAL 22006
Preparation: None

Synopsis: This lesson is designed to ensure that the student completely understands all nominal actions involving the Main Propulsion System (MPS). It will also cover a variety of problems involving the MPS in order to ensure that the student understands their nature and all appropriate actions involved therein.

Objectives: • Monitor the MPS.
• Perform nominal and off nominal MPS procedures in the checklists and cue cards.
• Resolve (Identify, Solve, and Discuss) selected MPS-related problems caused by both MPS and orbiter system failures.
Core Systems Refresher Training Lesson Descriptions

23 MPS REVIEW 41006

Title: Main Propulsion System Review  
Duration: 2.0 hours  
Medium: SST 1 or SST 2 or SST 3  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DS66/G&C/Propulsion Training Group  
Date: 05/92  
Lesson(s) Replaced: MPS MAL A 21006  
Equipment Required: FDF  
Prerequisite Lesson(s): MPS MAL 21006  
Preparation: None

Synopsis: Refer to MPS MAL 21006, New Astronaut Flow, for synopsis. More malfunctions will be used per run, and the overall problems are more complex. This lesson is to be scheduled as desired.

Objectives: Refer to MPS MAL 21006, New Astronaut Flow, for objectives, with particular emphasis upon malfunctions requested by the crewmember.

24 NAV REVIEW 41006

Title: Navigation Review  
Duration: 2.0 hours  
Medium: SST 1 or SST 2 or SST 3  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)  
Source: DM34/Rendezvous Guidance, Procedures and Training DS24/DPS/Navigation Training Group  
Date: 05/99  
Lesson(s) Replaced: OGNC REFR 41006, OGNC REVIEW 41006  
Equipment Required: None  
Prerequisite Lesson(s): E NAV 22006, IMU 21006  
Preparation: None

Synopsis: This lesson provides the medium for an in-depth discussion or review of the shuttle navigation systems and FDF procedures. The student should coordinate with the DPS/Navigation (NAV) instructor about the subject areas to be reviewed. This lesson is to be scheduled as desired. If the student desires a 30-minute prebrief prior to the lesson, they can coordinate this with the DPS/NAV instructor.

Objectives: Objectives will be determined by the instructor and/or student.
### NAV Q 31001

**Title:** Navigation Qualification  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** COMMANDER, MS 2, PILOT (Schedule in groups of up to 3.)  
**Source:** DM34/Rendezvous Guidance, Procedures and Training  
DS24/DPS/Navigation Training Group  
**Date:** 02/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** None  
**Preparation:** Read:  
- Assigned Crew Study Guide Orbiter Systems; Sections 3: NAV – Air Data System, Dedicated Displays, Entry NAVAIDs Overview, Inertial Measurement Units (IMUs), MLS/RA, Nav Overview, Tactical Air Navigations (TACANs)  

**Synopsis:** This lesson will verify completion standards of Navigation (NAV) training by having the student answer some general questions about NAV operations. The CDR, PLT, and MS2 will each take this qualification lesson prior to the start of 30000-level training. This lesson can be scheduled either individually or as a group, crew choice. There will be limited FDF use. At the completion of this lesson, the student and the instructor will determine if any additional study or lessons are required.  

**Objectives:**  
- Describe the data the sensor provides to the navigation software, the Redundancy Management (RM) (selection filter and downmode conditions) for Primary Avionics Software System (PASS) and Backup Flight System (BFS), and the procedures for RM failures and dilemmas for the following sensors: IMUs, TACANs, the air data system, Microwave Landing System (MLS), and Radar Altimeters (RAs).  
- Describe air data probe deployment and verification for PASS and BFS.  
- Describe the Heads-Up Display (HUD) data bus selection switch.  
- Describe residual, ratio, and the filter controls (Auto, Inhibit, Force) as seen on PASS and BFS SPEC 50.  
- Describe what data the IMUs provide the General Purpose Computer (GPC) software.  
- Describe the IMU failure signatures (Fail, Dilemma (DLMA), H/W and S/W Built-In Test Equipment (BITE), Power) and the actions required for each.  
- Describe the single-state and three-state vector schemes, when they are used, and their advantages/disadvantages.
Core Systems Refresher Training Lesson Descriptions

OGNC QUAL 31006

Title: Orbit Guidance Navigation and Control Qualification
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 2, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
        DS24/DPS/Navigation Training Group
Date: 05/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read:
    • Assigned Crew Study Guide Orbiter Systems; Sections 3:
      NAV – IMUs, Nav Overview, Nominal Nav Procedures, Star
      Tracker
    Review:
    • Post-Insertion; Star Tracker Activation/Door Open
    • Orbit Ops C/L;
      – IMU Align – STRK
      – GNC 201, 202, 301
      – IMU/IMU ALIGNMENT
      – HUD Calibration
    • Mal Proc, Vol. II;
      – GNC FRP-3, IMU Recovery with at least one IMU as good
        reference
      – GNC FRP-2, IMU Reference Recovery

Synopsis: This lesson will verify completion standards of orbit Guidance, Navigation, and Control (GNC) training by executing some GNC orbit operations with limited use of FDF. The student should have a basic understanding of the systems in order to perform the operations. There is no need to memorize the FDF. The student will start the lesson by configuring the star trackers for orbit. Nominal orbit operations are then performed, including an Inertial Measurement Unit (IMU) alignment and a Heads-Up Display (HUD) calibration. Several different pointing maneuvers are also performed to exercise the Universal Pointing (UNIV PTG) display. A manual flying exercise will be performed to demonstrate comprehension of the relationship between the DAP and UNIV PTG functions. The student will also exercise the IMU Reference Recovery procedure as a review of the three different types of alignments.
Core Systems Refresher Training Lesson Descriptions

26 OGNC QUAL 31006 (Concluded)

Objectives:
- Configure the DAP to maneuver at a specified rate.
- Perform nominal star tracker activation and door opening, without FDF.
- Perform a dual star tracker IMU align using only the Star Pairs Preliminary Advisory Data (PAD) (Orbit Ops Checklist (C/L), Flt Supp) and the Flight Plan.
- Perform the steps for a HUD calibration, without FDF.
- Perform a single star tracker IMU align using the Star Pairs PAD, without FDF.
- Perform various pointing maneuvers using the UNIV PTG display.
- Manually maneuver by flying a single axis while the other axes maintain LVLH attitude hold.
- Recover an IMU that has lost its internal reference with an IMU/IMU alignment, without FDF.
- Identify the bad IMU in a velocity dilemma situation.
- Perform the tasks for a total IMU Reference Recovery; i.e., loss of on orbit attitude reference using FDF.

27 OM/RC A/E Q 31006

Title: Orbital Maneuvering/Reaction Control System Ascent/Entry Qualification
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: MS 2, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 04/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Study Guide
Preparation: Review:
- FDF and related reference materials

Synopsis: This lesson tests the crew’s ability to perform nominal OMS and Reaction Control System (RCS) procedures, identify a problem via cockpit signatures, locate the correct procedure, evaluate the impact of the failure, and determine the big picture impacts of an EPS, DPS, or Instrumentation (INST) failure on the OMS and RCS. The crew is expected to verbalize their actions and thoughts regarding the procedures and malfunctions as much as possible during this lesson.
Core Systems Refresher Training Lesson Descriptions

27 OM/RC A/E Q 31006 (Concluded)

This lesson is composed of 2 ascent runs and 1 entry run. The instructor will assume the role of MCC by answering questions and directing the student as necessary. The crew will configure the orbiter for ascent. The crew will perform all nominal procedures and will identify, evaluate, and resolve malfunction scenarios for the ascent and entry runs. The FDF and other tools which are typically available in the cockpit will be available for use during this lesson.

Objectives:
- Configure the OMS and RCS switches for ascent and entry.
- Monitor the OMS and RCS on ascent and entry.
- Perform OMS-1/2 Targeting.
- Perform an Insertion Burn.
- Perform a Deorbit (D/O) Burn.
- Perform a Forward Reaction Control System (FRCS) Dump.
- Secure and Re-Open the RCS.
- Diagnose an Engine (ENG) or Propellant (PRPLT) failure during a burn and work the appropriate procedure.
- Use the Burn Monitor and OMS Failure Cue Cards.
- Manage Jet Availability and Redundancy Management (RM) via SPEC 23.
- Use the D/O burn Flight Rules.
- Perform a hot XFEED or INCNCT.
- Use available tools to evaluate impacts of DPS, EPS and INST failures on the OMS and RCS.
- Perform failure identification, resolution, and evaluation for failures in the OMS and RCS.

28 OM/RC REVIEW 41008

Title: Orbital Maneuvering/Reaction Control System Review
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Source: DS66/G&C/Propulsion Training Group
Date: 08/84
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Core Systems Refresher Training Lesson Descriptions

28  **OM/RC REVIEW 41008 (Concluded)**

Synopsis: This lesson provides the medium for an in-depth discussion or review of the OMS, Reaction Control System (RCS), and/or FDF procedures. The student should coordinate with the assigned instructor about subject areas to be reviewed. This lesson is to be scheduled as desired.

Objectives: Discuss specific topics predetermined by the instructor and student.

29  **OMRC REFR 41008**

Title: Orbital Maneuvering/Reaction Control System Refresher
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually or in pairs.)
Source: DS66/G&C/Propulsion Training Group
Date: 09/89
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides the student with practice in performance of the OMS and Reaction Control System (RCS) procedures associated with normal and malfunction system operations through the ascent and entry flight phases.

Objectives: • Identify and use the proper procedures for OMS and RCS. Propellant or gas leaks in any part of the system(s) during ascent and entry phases of flight.
• Understand the use of the FDF to target or re-target and perform an OMS or RCS burn for any reason.
• Be able to recognize and work with system sensor failures.
• Understand the OMS/RCS Redundancy Management (RM) system, how it works, and the use of the SPEC displays and FDF associated with it.
• Learn to recognize OMS engine and RCS jet failures, both real and false, and take the necessary corrective action.
• Understand the use of the SPECs and their OPS modes used to operate and troubleshoot the OMS and RCS systems.
Core Systems Refresher Training Lesson Descriptions

30  **OMRC REFR 42008**

Title: Orbital Maneuvering/Reaction Control System Refresher  
Duration: 2.0 hours  
Medium: SST 1 or SST 2 or SST 3  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually or in pairs.)  
Source: *DS66/G&C/Propulsion Training Group*  
Date: 09/89  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None  

Synopsis: This lesson provides the student with practice in performance of the OMS and Reaction Control System (RCS) procedures associated with normal and malfunction system operations through the orbit phase of flight.

Objectives:
- Identify and use the proper procedures for OMS and RCS propellant or gas leaks in any part of the system(s) during the orbit phase of flight.
- Understand the use of the FDF to target or re-target and perform an OMS or RCS burn for any reason.
- Be able to recognize and work with system sensor failures.
- Understand the OMS/RCS Redundancy Management (RM) system, how it works, and the use of SPECs and the FDF associated with it.
- Learn to recognize OMS engine and RCS jet failures, both real and false, and take the necessary corrective action.
- Understand the use of the SPECs and their OPS modes used to operate and troubleshoot the OMS and RCS systems.

31  **OMRC Q O 31006**

Title: Orbital Maneuvering System and Reaction Control System Qualification for Orbit  
Duration: 2.0 hours  
Medium: SST 1 or SST 2 or SST 3  
Student: MS 2, PILOT (Schedule individually.)  
Source: *DS66/G&C/Propulsion Training Group*  
Date: 04/96  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): Study Guide  
Preparation: Review:  
- FDF and related reference materials
Core Systems Refresher Training Lesson Descriptions

31 OM/RC Q O 31006 (Concluded)

Synopsis: This lesson will verify the student’s operational knowledge of the OMS and Reaction Control System (RCS). The lesson tests the student’s ability to configure the Orbiter for nominal orbit operations and to perform nominal on-orbit procedures. This lesson also tests the student’s ability to locate and work orbit malfunction procedures and to evaluate the impact of the failure on the mission. Lastly, this lesson tests the student’s ability to determine the big picture impacts of an EPS, DPS, or Instrumentation (INST) failure on the OMS and RCS. The student is expected to verbalize their actions and thinking with regards to procedures/malfunctions. The instructor will assume the role of MCC and answer questions and direct the crew as necessary. The student will configure the orbiter for on orbit OPS, and monitor the RCS and OMS systems. The FDF and all standard cockpit tools will be available during this lesson.

Objectives:

- Configure the OMS and RCS switches for orbit.
- Perform OMS and RCS callouts in the Post-Insertion Checklist (C/L).
- Perform the Group B powerdown.
- Perform an OMS to RCS Interconnect.
- Monitor the OMS and RCS on orbit.
- Perform an OMS orbit adjust burn.
- Distinguish the required actions for the following MCC calls:
  - Deselect Jet XXX.
  - Reselect Jet XXX.
  - Reprioritize Jet XXX.
  - Reset Redundancy Management (RM).
  - Toggle RM on Jet XXX.
- Use available tools to evaluate impacts of a DPS, EPS, or INST failures.
- Determine if you are “Loss of Vorns,” and work the procedure.
- Perform failure identification, resolution, and evaluation for the OMS and RCS.

32 ECL 10.2 ATM 41004

Title: Environmental Control Life Support System 10.2 Atmosphere
Duration: 1.5 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually.)
Note: This lesson is optional for crewmembers with a scheduled, shuttle-based EVA.
Source: DS45/Shuttle Systems Training Group
Date: 12/03
Core Systems Refresher Training Lesson Descriptions

32     **ECL 10.2 ATM 41004 (Concluded)**

Equipment Required:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  None  
Preparation:  Review 10.2 psia Cabin section of ECLSS 21002.  Review PCS instrumentation diagram in ECLSS 21002.

Synopsis:  The lesson will start with a nominal 14.7 psia Pressure Control System (PCS) configuration and have the student perform the nominal EVA Checklist procedures for 10.2 psia depress, maintenance, and repress.  Rationale for PCS configuration changes will be discussed throughout the lesson.  The lesson will conclude with a review of PCS configurations for 14.7 psia operations, cabin depress, 10.2 psia maintenance, and cabin repress.

Objectives:  
- Perform the steps involved in executing nominal Environmental Control and Life Support System (ECLSS) 10.2 atmosphere procedures.
- Explain the rationale and constraints associated with 10.2 psia operations.
- Describe the PCS configuration for 14.7 psia operations during cabin depress, during 10.2 psia maintenance, and during cabin repress using a PCS schematic.
- Explain the rationale of the PCS configurations during cabin depress, 10.2 psia maintenance, and cabin repress.

33A     **MAN ASC 21001**

Title:  Manual Ascent Prebrief  
Duration:  2.0 hours  
Medium:  Classroom  
Student:  Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, **DS66** Instructors  
Source:  **DS66**/Ascent Procedures Specialists  
Date:  10/05  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  None  
Preparation:  None  

Synopsis:  This briefing is the first in a series of 2 briefings.  They are both designed to review the cockpit indications and techniques used to fly the nominal, Abort To Orbit (ATO), and Transatlantic Abort Landing (TAL) trajectories manually.  A discussion of cockpit indications and techniques used during manual control is discussed to prepare for Manual Ascent 21011.  A review of guidance anomaly recognition, manual control, flight
Core Systems Refresher Training Lesson Descriptions

33A  MAN ASC 21001 (Concluded)

instruments, CRT displays, FDF, and flight techniques is presented. This
lesson covers trajectories similar in nature to normal insertions to orbit,
and includes manual entry techniques for TAL aborts. The following
trajectories are discussed: nominal ascent, ATO caused by Space Shuttle
Main Engine (SSME) failure, dual simultaneous SSME failure during
ascent with Single Engine Roll Control (SERC), and a two-engine out-of-
plane TAL to landing.

Objectives:
• Develop the crews skills to recognize when a manual takeover is
  required.
• Be able to fly the vehicle to Main Engine Cutoff (MECO) conditions,
  using navigation-derived information only:
  – Allow for orbital insertion and/or a runway landing without structural
    exceedances.

33B  MAN ASC 21011

Title: Manual Ascent Introduction
Duration: 4.0 hours
Medium: SMS/MB
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew
Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MAN ASC 21001 or MAN ASC BR 31001 or
MAN ASC 41001
Preparation: None

Synopsis: This lesson reinforces the material covered in MAN ASC 21001 through
practical application in the SMS.

Objectives: At the end of this lesson, the student will be able to perform the following
objectives:
• Recognize when a manual takeover is required.
• Establish manual control.
• Use navigation-derived information to fly the vehicle to Main Engine
  Cutoff (MECO) conditions:
  – Allow for orbital insertion and/or a runway landing without structural
    exceedances.
Core Systems Refresher Training Lesson Descriptions

**34A  MAN ABT 21001**

Title: Manual Abort Prebrief  
Duration: 2.0 hours  
Medium: Classroom  
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, **DS66** Instructors  
Source: **DS66**/Ascent Procedures Specialists  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MAN ASC 21011 or MAN ASC 31011 or MAN ASC 41011  
Preparation: None  
Synopsis: This lecture is the second in a series of 2. These lessons are designed to review cockpit indications and techniques used flying Transatlantic Abort Landing (TAL) and Return-To-Launch Site (RTLS) trajectories manually. A discussion of cockpit indications and techniques used during manual control is provided to prepare for MAN ABORT 21011. Topics to be reviewed: TAL redesignation, low energy TAL, post-MECO TAL, high energy TAL, high energy YQX, and RTLS flight techniques. Included is a discussion of abnormal entry energy management techniques for TAL and RTLS. The following are discussed: TAL Redesignation to low energy flight techniques, post-MECO TALs leading to high energy TAL to in-plane and out of plane sites flight techniques, two-engine RTLS including TAEM flight techniques, and three-engine RTLS including TAEM flight techniques.

Objectives:  
- Develop skills required to recognize when a manual takeover is required.  
- Be able to fly the vehicle to MECO conditions, using navigation-derived information only:  
  - Allow for orbital insertion and/or a runway landing without structural exceedances.

**34B  MAN ABT 21011**

Title: Manual Abort Introduction  
Duration: 4.0 hours  
Medium: SMS/MB  
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, **DS66** Instructors  
Source: **DS66**/Ascent Procedures Specialists  
Date: 10/05  
Lesson(s) Replaced: None
Core Systems Refresher Training Lesson Descriptions

34B MAN ABT 21011 (Concluded)

Equipment Required: None
Prerequisite Lesson(s): MAN ABT 21001 or MAN ABT BR 31001 or MAN ABT 41001
Preparation: None
Synopsis: This lesson reinforces the material covered in MAN ABT 21001 through practical application in the SMS.
Objectives: At the end of this lesson, the student will be able to perform the following objectives:
- Recognize when a manual takeover is required.
- Establish manual control.
- Use navigation-derived information to fly the vehicle to acceptable Main Engine Cutoff (MECO)/External Tank (ET) Separation (SEP) conditions.
- Fly the vehicle on entry to allow for a runway landing without structural exceedances.

35A CONT ABT RVW 21001

Title: Contingency Abort Review Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MAN ABT 21011 or MAN ABT BR 31001 or MAN ABT 41011
Preparation: None
Synopsis: This lecture will discuss contingency abort procedures in preparation for the CONT ABT RVW 21011 SMS lesson. Crews will receive instruction on contingency abort maneuvering and trajectory profiles, cockpit indications, procedural rationale and execution, techniques, displays, controls, and cockpit resources used to initiate contingency abort maneuvering. The instruction will address both powered flight and entry procedures to either landing or bailout. A review of flight software capability and relevant orbiter hardware limitations is also provided. The lesson covers all of the Ascent Checklist (C/L) procedural regions for two and three engine failure scenarios occurring in either OPS 1 (contingency
Core Systems Refresher Training Lesson Descriptions

35A CONT ABT RVW 21001 (Concluded)

abort) or OPS 6 (Return-To-Launch Site (RTLS) contingency abort). A representative sampling of contingency abort maneuvers (not regions) are presented during this lesson.

Objectives: To develop crew skills to:
- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions, when intact abort capability is nonexistent.
- Locate and execute the published procedure applicable to the contingency abort region in which the engine malfunctions occurred.

35B CONT ABT RVW 21011

Title: Contingency Abort Review
Duration: 4.0 hours
Medium: SMS/MB
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT ABT RVW 21001 or CONT ABT 31001 or CONT ABT RVW 41001
Preparation: None

Synopsis: This lesson reinforces the material discussed in CONT ABT RVW 21001 through practical application using flight software at the SMS. A representative sampling of contingency abort maneuvers (not regions) are presented during this lesson.

Objectives: The crew will:
- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions where intact abort capability is nonexistent.
- Locate the published procedure in FDF applicable to the contingency abort region in which the engine malfunctions occurred.
- Execute published contingency abort procedures without exceeding structural limitations (or to the most benign conclusion).
- Recognize and avoid specific flight envelopes that will cause a loss of control or vehicle overstress (where applicable).
## SHUTTLE REVIEW 41006

**Title:** Shuttle Multidiscipline Systems Review  
**Duration:** 2.0 hours  
**Medium:** SST 1 or SST 2 or SST 3  
**Student:** COMMANDER, MS 2, PILOT (Schedule in groups of up to 3.)  
**Source:** DS12/Shuttle Training  
**Date:** 12/06  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** None  
**Preparation:** None  

**Synopsis:** This lesson provides the medium for an in-depth discussion or review of the shuttle multidiscipline systems and FDF procedures. The student(s) should coordinate with the instructors about the phase of flight. This lesson is to be scheduled as desired.  

**Objectives:** Objectives will be determined by the instructor and/or student.
SECTION 3.0 CREW SYSTEMS TRAINING COURSE

The Crew Systems Training Course provides the flight crew and selected flight operations support personnel the knowledge and skills necessary for activation, operation, and deactivation of the onboard crew systems equipment. Using these systems, the crew maintains a viable living environment on the orbiter, and performs in flight maintenance and emergency egress from the orbiter.

Upon completion of the Crew Systems Training Course, the student will be able to:

- Perform crew systems pre-launch operations and emergency egress
- Operate crew systems during on-orbit activities
- Perform procedures for crew station lighting
- Perform orbiter habitability procedures (waste collection, dining, personal hygiene, sleep, trash management, etc.)
- Perform stowage operations for orbiter loose equipment
- Respond to emergencies (loss of cabin pressure, fire/smoke, contaminated atmosphere, etc.)
- Perform crew and crew station preparation for post insertion and de-orbit
- Perform post-landing normal and emergency egress

The trainer media/facilities used for the Crew Systems Training Course include classroom, workbooks, the mock ups (CCT, CCTII, FFT) and other facilities as necessary to conduct ingress/egress and survival training.
Figure 3-1. Crew Systems Lesson Flow Chart
**Table 3-1. Crew Systems Training Requirements**

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**Note:**

1. Should be scheduled before TCDT and, if possible, in conjunction with PRL PROC 91920. PRL PROC 91920 may be waived if student has supported launch within a year.
2. A dry run is required for this lesson for PSs within one week of the full-crew lesson. Astronaut crewmembers who have not previously flown may request a dry run.
3. Applies to crewmember responsible for IFM support.
4. Prior to taking PLD EG 91919 and BAILOUT 91920, PSs and APS must take ESC EQ/SYS 21001, ESC PROC 21001, and ESC PROC 21020.
# Table 3-1. Crew Systems Training Requirements

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**NOTE:**
1. Should be scheduled before TCDT and, if possible, in conjunction with PRL PROC 91020. PRL PROC 91020 may be waived if student has supported launch within a year.
2. A dry run is required for this lesson for PSs within one week of the full-crew lesson. Astronaut crewmembers who have not previously flown may request a dry run.
3. Applies to crewmember responsible for IFM support.
4. Prior to taking PLD EG 91019 and BAILOUT 91020, PSs and APS must take ESC EQ/SYS 21001, ESC PROC 21001, and ESC PROC 21020.
Crew Systems Lesson Descriptions

1  WCS PROC 31065
Title: Waste Collection System Procedures
Duration: 1.0 hour
Medium: WCS Trainer
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, MS 5, PILOT, PS 1
(Schedule full Shuttle crew for ISS missions.)
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): New Astronaut Flow
Preparation: None
Synopsis: This lesson is conducted in the Waste Collection System (WCS) training facility located in building 5. Students are shown the launch configuration of the WCS and the procedure for configuring the WCS for orbit ops. Normal and contingency procedures are discussed and demonstrated.
Objectives: 
• Describe the general configuration and operation of the WCS.
• Identify the equipment and quantities of items stowed in the Waste Management Compartment.
• Perform the Post-Insertion configuration and WCS setup procedures.

2A  EDO WCS 91002
Title: Extended Duration Orbiter Waste Collection System
Duration: 1.0 hour
Medium: Workbook
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule individually.)
Source: DX45/Crew Systems Group
Date: 10/01
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Note: EDO flights only.
Synopsis: This workbook contains information on the major components of the Extended Duration Orbiter (EDO) Waste Collection System (WCS) hardware as well as the controls, restraints, and accessories used in conjunction with this system.
Objectives: Become familiar with the operations and the components of the EDO WCS.
Crew Systems Lesson Descriptions

2B  EDO WCS PROC 91074

Title: Extended Duration Orbiter Waste Collection System Procedures
Duration: 1.5 hours
Medium: NASA (EDO WCS Flight Unit)
Note: Since a training unit is currently not available, this class will be conducted during times when the flight unit is available.
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule individually or in pairs.)
Source: DX45/Crew Systems Group
Date: 10/01
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EDO WCS 91002
Preparation: None
Note: EDO flights only.

Synopsis: This lesson covers the major components of the Extended Duration Orbiter (EDO) Waste Collection System (WCS), procedures for activation and deactivation, and instructs the student on the procedures for urination and defecation. In addition, a briefing on consumables used in conjunction with the EDO WCS, trash stowage, and potential malfunctions are discussed.

Objectives: Become familiar with the components and operation of the EDO WCS.

3A  WATER OPS 91001

Title: Water Operations
Duration: 0.75 hours
Medium: Classroom
Student: As assigned by CDR.
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: See Facility Utilization Request.
Prerequisite Lesson(s): N ASTRO (ASCAN) flow
Preparation: None

Synopsis: This lesson will utilize training hardware to familiarize the student with each component. Emphasis will be placed on nomenclature and technical function of each component. Galley Iodine Removal Assembly (GIRA) water transfer equipment, FDF procedures, protocol, training schedule, and mission-specific game plans will be discussed. Additional on-orbit activities (Contingency Water Dispense set up, DSO/DTO ops, etc.) may be performed at crew request.
Crew Systems Lesson Descriptions

3A  WATER OPS 91001 (Concluded)

Objectives:  
• Review all the procedures and hardware associated with transferring water from the shuttle to the ISS.  
• Review all FDF procedures related to nominal Water Operations.  
• Review stowage, setup, and operation of all Water Transfer hardware.

3B  WATER OPS 91020

Title:  Water Operations  
Duration:  0.75 hours  
Medium:  CCTII or FFT  
Student:  As assigned by CDR.  
Source:  DX45/Crew Systems Group  
Date:  03/05  
Lesson(s) Replaced:  None  
Equipment Required:  See Facility Utilization Request.  
Prerequisite Lesson(s):  WATER OPS 91001  
Preparation:  None

Synopsis:  This lesson will utilize training hardware, mock-ups, and FDF procedures to familiarize the student with each component and how they interface with the galley, Condensate Quick Disconnect (QD), and Contingency Cross Tie. A step-by-step review of FDF procedures will be performed. Additional on-orbit activities (Contingency Water Dispense set up, DSO/DTO ops, etc.) may be performed at crew request.

Objectives:  
• Review all water transfer hardware and procedures. Actual installation of hardware will be performed. Filling and dumping of Contingency Waste Container (CWC) and Payload Water Reservoirs (PWRs) will be demonstrated, as well as condensate collection procedures. Review temporary CWC stowage locations and hands-on training for the student.  
• Proficiency performing Galley Iodine Removal Assembly (GIRA) setup and configuration.  
• Proficiency executing CWC and PWR filling procedures.  
• Proficiency executing consecutive CWC and PWR dumping procedures.  
• Proficiency performing Condensate Collection setup.
Crew Systems Lesson Descriptions

4  HAB/EQ PROC 91020
Title:  Habitability Equipment and Procedures
Duration:  3.5 hours (Schedule 4.0 hours for ISS crew rotation mission)
Medium:  CCT, CCTII, or FFT
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source:  DX45/Crew Systems Group
Date:  03/05
Lesson(s) Replaced:  HAB EQ/PROC 31020
Equipment Required:  See Facility Utilization Request
Prerequisite Lesson(s):  CREW CAB FAM 21020
Preparation:  None
Synopsis:  This lesson consists of the performance of procedures in a flight-configured trainer with equipment related to orbiter habitability. The equipment used, and the procedures performed include those associated with sleep, exercise, crew personal clothing, trash management, trash overboard vent, atmospheric samples, acoustic measurements, crew compartment cleaning, restraints/mobility aids, and window shades/filters. The equipment is removed from launch stowage locations, on-orbit operations are performed, and the equipment is restowed in the entry configuration.
Objectives:
• Become familiar with the operational use of all nominal crew equipment.
• Be able to determine the locations of the wet and dry trash.
• Become familiar with the on-board exercise equipment.

5  ISS HW FAM 21105
Title:  ISS Hardware Familiarization (Shared – Shuttle)
Duration:  2.0 hours
Medium:  SSMTF
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source:  DX45/Crew Systems Group
Date:  03/05
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  None
Preparation:  None
Synopsis:  This lesson is targeted for those who are unfamiliar with the internal and external configuration of the ISS modules and the internal hardware associated with day-to-day ISS activities. A description of each module will be provided to the students, with emphasis on basic internal hardware locations and operations.
Crew Systems Lesson Descriptions

5  ISS HW FAM 21105 (Concluded)

Objectives:
- Be able to identify individual ISS elements through the most current flight configuration.
- Understand ISS internal location coding and module internal layout.
- Know where internal light controls are located and their function.
- Become familiar with basic loose hardware locations and functions.
- Become familiar with Russian segment locations, layout, and basic loose hardware.
- Comprehend the layout of the ISS internal volume.

6  ISS HAB HW 31105

Title: ISS Habitability Hardware
Duration: 2.0 hours
Medium: SSMTF
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Note: Lesson not needed for crewmembers who have had ISS HAB EQ & PROC 21105.

Equipment Required: None
Prerequisite Lesson(s): ISS HW FAM 21105
Preparation: None

Synopsis: This lesson utilizes the SSMTF to introduce ISS Habitability hardware and procedures to the student. Upon lesson completion, the student will be familiar with the functionality, operational use, and location of selected hardware and habitability items, such as Restraints & Mobility Aids (R&MA), trash management, stowage hardware, internal lighting, crew support and loose equipment, racks, and nominal hatch operations. The student will also receive general information about related Russian hardware.

Objectives:
- Understand ISS internal location coding and module internal layout.
- Understand and conduct the procedures associated with the nominal operations of selected U.S. habitability items.
- Understand locations of Portable Emergency Provisions (PEPs).
- Understand trash management procedures.
- Understand and conduct stowage operations and comprehend stowage constraints.
- Conduct nominal hatch operations.
Crew Systems Lesson Descriptions

7  ODS TNL OPS 91020

Title: Orbiter Docking System Tunnel Operations
Duration: 1.0 hour
Medium: CCTII or FFT
Student: As assigned by CDR (Schedule individually.)
Note: Spacehab missions only. (Prime and backup as assigned.)
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: Tunnel (TNL) Adapter mockup with Tunnel
Prerequisite Lesson(s): HAB/EQ PROC 91020
Preparation: None

Synopsis: This lesson begins with a briefing to familiarize the student with all hardware associated with the tunnel extension, airlock, tunnel adapter, tunnel, and hatch types. Hands-on training in the mockup using the appropriate FDF procedures will follow the briefing.

Objectives:

- Become familiar with the flight configurations for the tunnel extension, airlock, tunnel adapter, and the tunnel.
- Perform nominal operations for configuring the ducting, stowage hardware, centerline-camera/bracket, docking lights, cross-hairs, target/baseplate; for the launch/post-insertion/docking/undocking and entry phases of a mission will be reviewed.
- Perform the Spacehab Activation and Entry Preparation procedures that include tunnel configuration operations, if Spacehab flown.

8  PI/DO PREP 91020

Title: Post-Insertion/De-orbit Preparation Timeline
Duration: 8.0 hours
Note: This lesson is to be covered over a consecutive two-day period. The first session, Post-Insertion, will be covered in a 4-hour period on the afternoon of day 1, and the second session, Deorbit Prep, will be covered in a 4 hour period in the morning of day 2.
Note: Schedule with the Expedition crew if crew rotation mission.
Note: A dry run of this lesson may be held for all PS and first time fliers if Commander deems necessary. Contact Crew Systems Mission Lead for duration required.
Medium: CCT, CCTII, or FFT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: PI/DO PREP 31020
Crew Systems Lesson Descriptions

8  PI/DO PREP 91020 (Concluded)

Equipment Required: See Facility Utilization Request, ACES
Note: This is a suited run.
Prerequisite Lesson(s): HAB/EQ PROC 91020
Preparation: None

Synopsis: This lesson consists of the performance of integrated crew station post-insertion, on-orbit, and deorbit procedures. The activities performed during this lesson include all nominal crew actions required to configure the crew station for orbit operations or entry. (Includes crew worn equipment, specialist seat operations, communications equipment, flight data file, and miscellaneous loose equipment.)

Objectives: • Become more proficient with the Post-Insertion timeline concentrating on switch configuration, reconfiguration of the middeck for on-orbit operations, and stowage.
• Be able to exercise the Deorbit Prep timeline focusing on switch configuration, seat setup, and donning of the ACESs.
• Be able to locate the fire extinguishers and practice donning the Quick Don Masks.

9  ERGOMETER 91020

Title: Ergometer Operations
Duration: 1.0 hour
Medium: CCT, CCTII, or FFT
Student: As assigned by CDR.
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: Ergometer with Accessory Bag and Frame from USA
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson outlines the assembly and installation of the Ergometer and associated exercise equipment. Instruction is given for both powered and manual operations as well as malfunction recovery. Locations for on-orbit use are covered, as well as the proper configuration for launch and return. Flight procedures are utilized where necessary.

Objectives: • Familiarity with Ergometer assembly.
• Familiarity of exercise options associated with the Ergometer.
• Familiarity with most common malfunctions and their recovery.
Crew Systems Lesson Descriptions

9  ERGOMETER 91020 (Concluded)

- Ability to successfully assemble and operate the Ergometer in both manual and powered modes.
- Ability to recognize Ergometer malfunction conditions and recover operations.

10  CABLE ROUTE 91001

Title:  Cable Routing  
Duration:  1.5 hours  
Medium:  Classroom  
Student:  As assigned by CDR.  
Source:  DX45/Crew Systems Group  
Date:  03/05  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  New Astronaut Flow  
Preparation:  None  

Synopsis:  The crew and other personnel will discuss pre-routing and labeling of photo/TV, PGSC, and secondary cables for launch. This meeting will be followed by CCT, CCTII, or FFT exercise which will route all pre-routed cables for the crew to review.

Objectives:  Discuss pre-routing PGSC, photo/TV, secondary, and other miscellaneous cables prior to flight.

11  CABLE/STOW 91020

Title:  Cable Routing and Stowage Review  
Duration:  2.0 hours  
Medium:  CCT, CCTII, or FFT  
Student:  As assigned by CDR.  
Source:  DX45/Crew Systems Group  
Date:  03/05  
Lesson(s) Replaced:  None  
Equipment Required:  See Facility Utilization Request (FUR)  
Prerequisite Lesson(s):  CABLE ROUTE 91001  
Preparation:  None  

Synopsis:  All Photo/TV, PGSC, secondary, and other miscellaneous cables will be pre-routed and labeled for the crew to review. In addition, stowage as currently baselined will be discussed so any changes can be made to the manifest prior to Crew Compartment Configuration Review (CCCR).
Crew Systems Lesson Descriptions

11  CABLE/STOW 91020 (Concluded)

Objectives:  
• Review flight deck and middeck pre-routed cables.  
• Review stowage configuration prior to L-60 day CCCR.

12  ASC/CAP/DES 91020

Title:  Ascent/Crew Activity Plan/Descent Timeline Walkthrough  
Duration:  8.0 hours (Schedule in 4 hour blocks over two consecutive days)  
Medium:  CCT, CCTII, or FFT  
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  
Source:  DX45/Crew Systems Group  
Date:  09/02  
Lesson(s) Replaced:  ASC/CAP/DES 31020  
Equipment Required:  See Facility Utilization Request; ACES required.  
Note:  This is a suited run.  
Prerequisite Lesson(s):  PHO/TV PROC 92020, PI/DO PREP 91020  
Preparation:  None  
Synopsis:  This lesson consists of a fast-time walkthrough of timeline activity covering the period between launch and landing. Display and control functions will be exercised for reach, visibility, and sequence familiarity only (Crew Compartment Trainer does not respond to control inputs). While the major highlights of the on-orbit timeline will be exercised in its entirety, major emphasis will be placed on crew systems-related activities. DSOs requiring loose equipment within the cabin will be exercised, if available.  
Objectives:  
• Become proficient with the activities covered in the Post Insertion and Deorbit Prep timeline, concentrating on the middeck activities that cannot be performed realistically in the SMS.  
• Review setup, stowage, and operation of the Secondary Payloads and DSOs.  
• Review photo/TV equipment and setup procedures.

13  IN/EG TIMELINE 91105

Title:  Ingress/Egress Timeline (Shared – Shuttle)  
Duration:  4.0 hours  
Medium:  SSMTF and CCTII  
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, MS 5, PILOT, PS 1  
(Schedule full Shuttle crew for ISS missions.)  
Source:  DX45/Crew Systems Group  
Date:  03/05  
Lesson(s) Replaced:  None  
Equipment Required:  See Facility Utilization Request.
Crew Systems Lesson Descriptions

13 IN/EG TIMELINE 91105 (Concluded)

Prerequisite Lesson(s): ISS HAB HW 31105
Preparation: None

Synopsis: This lesson will allow assigned Shuttle flight crews to practice performing all nominal Shuttle-to-ISS and ISS-to-Shuttle egress operations using procedures found in the flight-specific ISS/Shuttle Joint Operations Book, JSC-48503. The lesson includes a discussion of the Shuttle Arrival configuration, the on-orbit configurations, and the orbiter departure configurations of the ISS, and a general overview of the ISS ingress timeline. Using the CCTII and the SSMTF, the students will configure middeck, airlock, and Orbiter Docking System (ODS) hardware into the appropriate configurations and work through the procedures associated with their mission.

In addition to the ingress and egress activities, the students have the opportunity to review hardware transfer procedures and any other flight-specific Shuttle/ISS operations requested by the crew.

**The length of the lesson will vary depending on the number and complexity of operations conducted during the specific mission.

Objectives:
- Conduct flight-specific Shuttle-to-ISS ingress and egress operations including:
  - Nominal ODS, Pressurized Mating Adapter (PMA), and Lab hatch operations.
  - Shuttle-to-ISS vent configuration.
  - N₂ and O₂ transfer hose configuration.
  - Review and/or practice hardware transfer protocol and procedures.
  - Review and/or practice vestibule ops and procedures (as required for MPLM).
  - Review and/or practice Photo TV ops and procedures.

14 WCS REFR 91065

Title: Waste Collection System Procedures Refresher (Shared – Shuttle)
Duration: 0.5 hours
Medium: WCS Trainer
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in groups of up to 3.)
Source: DX45/Crew Systems Group
Date: 10/01
Lesson(s) Replaced: WCS REFR 41065
Equipment Required: WCS System
Prerequisite Lesson(s): WCS PROC 21065
Crew Systems Lesson Descriptions

14  **WCS REFR 91065 (Concluded)**

Preparation: None

Synopsis: Refer to WCS PROC 21065, New Astronaut Flow, for synopsis.

Objectives:  
- Review general configuration and operation of the Waste Collection System (WCS).
- Review equipment and quantities of items stowed in the waste management compartment.
- Review post-insertion configuration and WCS setup procedures.

15  **EDO WCS REFR 41065**

Title: Extended Duration Orbiter Waste Collection System Refresher

Duration: 1.0 hour

Medium: EDO WCS Flight Unit @ KSC (during CEIT)

Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule individually or in pairs.)

Source: DX45/Crew Systems Group

Date: 10/01

Lesson(s) Replaced: None

Equipment Required: EDO WCS

Prerequisite Lesson(s): New Astronaut Flow

Preparation: None

Note: EDO flights only.

Synopsis: An Extended Duration Orbiter (EDO) Waste Collection System (WCS) refresher will be conducted on the flight unit during the Crew Equipment Interface Test (CEIT). This review will include reviewing the components of the EDO WCS, as well as the In-Flight Maintenance (IFM) procedures and malfunctions.

Objectives: Become refamiliarized with the EDO WCS and the procedures.

16  **STOW REVIEW 91020**

Title: Stowage Review (Shared – Shuttle)

Duration: 2.0 hours

Medium: CCT, CCTII, or FFT

Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1

Source: DX45/Crew Systems Group

Date: 02/04

Lesson(s) Replaced: None

Equipment Required: Full stowage complement for each flight

Prerequisite Lesson(s): ASC/CAP/DES 91020
Crew Systems Lesson Descriptions

16 **STOW REVIEW 91020 (Concluded)**

**Preparation:** None

**Synopsis:** This class will be given to the flight crew while they are in quarantine. It is a flight-specific stowage review of all middeck and flight deck lockers. In addition, cable routing will be addressed.

**Objectives:**
- Be able to locate and configure all locker-stowed items.
- Review cable routing and switch configuration.
- Review fire/smoke procedures and equipment.

17 **IFM PROC 91020**

**Title:** In-Flight Maintenance Procedures

**Duration:** 3.5 hours

**Medium:** CCT or CCTII

**Student:** As assigned by CDR.

**Source:** DX44/In-Flight Maintenance Group

**Date:** 03/05

**Lesson(s) Replaced:** IFM PROC 31020

**Equipment Required:** See Facility Utilization Request.

**Prerequisite Lesson(s):** New Astronaut Flow

**Preparation:** None

**Synopsis:** This lesson is a hands-on exercise using the In-Flight Maintenance (IFM) tools in a vehicle environment. Component location/access and removal/installation procedures are reviewed (and performed where possible).

**Objectives:**
- Become familiar with IFM tools.
- Become familiar with IFM procedures within a flight-configured environment.
- Gain knowledge of orbiter hardware accessibility.
- Gain hands-on experience with tools and procedures.

18 **IFM KSC W/T 91031**

**Title:** In-Flight Maintenance Kennedy Space Center Walkthrough

**Duration:** 3.0 hours

**Medium:** KSC

**Note:** Schedule in the Orbiter Processing Facility (OPF).

**Student:** As assigned by CDR.

**Source:** DX44/In-Flight Maintenance Group

**Date:** 05/03

**Lesson(s) Replaced:** IFM KSC W/T 31031
Crew Systems Lesson Descriptions

18  **IFM KSC W/T 91031 (Concluded)**

Equipment Required:  None  
Prerequisite Lesson(s):  IFM PROC 91020  
Preparation:  None  

Synopsis: This lesson familiarizes the student with detailed configurations of In-Flight Maintenance (IFM)-related hardware and vehicle-specific constraints on IFM tasks. The required degree of fidelity is available only in the flight vehicle. Selected closeout panels will be removed to provide the necessary access to hardware (generally done by KSC personnel prior to lesson conduct). Although actual hardware changeout/modification will not be performed, IFM procedures will be simulated and tool fit checks will be performed.

Objectives:  
- Fit-check tools to vehicle.  
- Become more familiar with IFM procedures.

19  **PLD EG 91019**

Title: Post-landing Egress (Shared – Shuttle)  
Duration:  4.0 hours  
Medium:  FFT  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  

Note: Alternate Payload Specialists will observe the full crew exercise. PSs and APSs must take ESC EQ/SYS 21001, ESC PROC 21001, and ESC PROC 21020 before taking this lesson.

Source:  DX45/Crew Systems Group  
Date:  03/05  

Lesson(s) Replaced:  None  
Equipment Required:  See Facility Utilization Request; ACES required.  

Note: This is a suited run.  
Prerequisite Lesson(s):  ESC PROC 21020  
Preparation:  None  

Synopsis: Assigned flight crews will practice crew coordination and skills required for post-landing emergency egress. Crew skills will include seat egress, and emergency egress slide configuration for hatch on and hatch jettison scenarios. The crew will master sky genie descent device technique for self rescue exit through the side hatch and through the Window 8 overhead escape panel. The crew will demonstrate proper emergency egress slide descent technique.

Objectives:  
- Practice crew egress coordination for post-landing emergencies.  
- Conduct proper Emergency Egress Slide (EES) configuration and inflation.  
- Demonstrate proficiency in sky genie descent techniques.
Crew Systems Lesson Descriptions

19 **PLD EG 91019 (Concluded)**

- Demonstrate proficiency in EES descent techniques.
- Discuss post-landing emergency scenarios and actions.

20 **BAILOUT 91020**

Title: Bailout System (Shared – Shuttle)
Duration: 3.0 hours
Medium: CCT or CCTII
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: BAILOUT 31020
Equipment Required: See Facility Utilization Request; ACES required.
Note: This is a suited run.
Prerequisite Lesson(s): New Astronaut Flow
Note: PSs and APS must take ESC EQ/SYS 21001, ESC PROC 21001 and ESC PROC 21020 before taking this lesson. APS should observe full crew exercise.
Preparation: None

Synopsis: This lesson provides a more detailed experience on procedures used for in-flight bailout emphasizing teamwork. All aspects of the bailout will be simulated including cabin vent, side hatch jettison, seat egress, escape pole deployment and bailout. Two “runs” will be performed; one simulating a bailout during ascent and another during entry. During the second run, the G-suits will be inflated and the emergency oxygen system used.

Objectives:
- Become familiar with in-flight bailout procedures.
- Understand and experience seat egress techniques during bailout.
- Become familiar with the operation of cabin vent and hatch jettison system.
- Practice pole deployment techniques.

21 **OFF-NOM EG 91020**

Title: Off-Nominal Egress (Shared – Shuttle)
Duration: 1.25 hours
Medium: CCTII
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1
Source: DX45/Crew Systems Group
Date: 02/07
Lesson(s) Replaced: None
Note: This is not a suited lesson.
Crew Systems Lesson Descriptions

21  **OFF-NOM EG 91020 (Concluded)**

**Equipment Required:** Computer and projector  
**Prerequisite Lesson(s):** PLD EG 91019, BAILOUT 91020  
**Preparation:** None

**Synopsis:** The lesson begins with a classroom session discussing several off-nominal egress conditions. These include launch scrub, main engine shut-down, loss of comm post-landing, and vehicle break up/loss of control. After the classroom session, the crew will perform a shirt-sleeve walkthrough with the CCTII in a nose-down configuration.

**Objectives:**
- Discuss launch scrub  
- Discuss main engine shut-down on launch pad  
- Discuss loss of comm post-landing  
- Discuss loss of control/break-up dynamics  
- Discuss egress procedures during loss of control/break-up

22  **PRL IN/EG 91020**

**Title:** Prelaunch Ingress/Egress (Shared – Shuttle)  
**Duration:** 4.0 hours  
**Medium:** CCT or CCTII  
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  
**Note:** The Payload Specialist (PS) will perform this lesson twice. Optimum separation between the PS run and the full-crew run is one week. Alternate PSs will observe the full crew exercise. This lesson is required prior to TCDT.

**Source:** DX45/Crew Systems Group  
**Date:** 03/05  
**Lesson(s) Replaced:** PRL IN/EG 31020  
**Equipment Required:** Refer to Facility Utilization Request, ACES  
**Note:** This is a suited run.  
**Prerequisite Lesson(s):** New Astronaut Flow, PRL PROC 91020 (ASP only)  
**Preparation:** None

**Synopsis:** With the CCT/CCTII in the vertical position, students perform nominal ingress procedures assisted by the Astronaut Support Personnel (ASP) and suit technicians. A Mode I Egress is performed allowing the crew to practice an unaided egress on the pad. Included in this lesson are the crew, NASA Test Director (NTD), and Orbiter Test Conductor (OTC) and MCC COMM checks. This class is performed in conjunction with PRL PROC 91020 in which the ASP practices configuring the Orbiter for crew ingress.
Crew Systems Lesson Descriptions

22 PRL IN/EG 91020 (Concluded)

Objectives:
- Become familiar with best technique for egressing the orbiter prelaunch.
- The ASP and crew will become proficient with the prelaunch ingress procedures.

23 ESC SYS REFR 91020

Title: Escape System Refresher (Shared – Shuttle)
Duration: 2.0 hours
Note: Schedule 3 hours, if suited.
Medium: CCT, CCTII, or FFT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX45/Crew Systems Group
Date: 03/99
Lesson(s) Replaced: BAILOUT 32020
Note: This is not a suited lesson, but the crew may request it.
Equipment Required: Video: Escape Systems Review
Prerequisite Lesson(s): BAILOUT 91020, PLD EG 91019, PRL IN/EG 91020
Preparation: None

Synopsis: This is the last egress lesson the crew performs prior to launch. The lesson begins with a classroom session which covers the major escape systems and procedures for prelaunch, bailout and post-landing emergencies. Discussions will stress the procedures needed to successfully deploy and operate the various crew worn and orbiter systems. Procedures to egress the vehicle during a break up/Loss of Control, and some in-flight maintenance/repair of suit equipment and systems will be presented. Launch commit criteria and minimum equipment items will be monitored as they relate to escape equipment and systems. After the classroom session, the crew will perform a shirt-sleeve walkthrough in the CCT, CCTII, or FFT and review the egress systems/equipment. If requested, crewmembers may deploy the escape pole mockup.

Objectives:
- Review and practice in-flight bailout procedures.
- Review and practice seat egress techniques during bailout.
- Review and practice the operation of cabin vent and hatch jettison system.
- Review and practice pole deployment techniques.
- Review and discuss bailout procedures during loss of control.
Crew Systems Lesson Descriptions

WATER SURV 41001
Title: Water Survival (Shared – Shuttle)
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in groups of up to 5.)
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): New Astronaut Flow
Preparation: None
Note: This lesson should be scheduled no later than 2-3 days after WATER SURV 41027.
Synopsis: This classroom lesson is a review of WATER SURV 21001. Discussion includes more detail of the Mode VIII in-flight bailout procedures including parachute operations, survival/rescue gear usage, and the Search and Rescue (SAR) posture. A full complement of survival gear will be available for the students to see and handle. The procedures for the NBL session are discussed, including safety precautions. Emphasis will be placed on techniques and what to-expect situations.
Objectives:
• Review both automatic and manual parachute operation.
• Review under-canopy/Life Preserver Unit (LPU)-inflation and water-entry techniques.
• Review survival equipment and its usage.
• Review SAR operations.
• Review procedures for NBL session.

WATER SURV 41027
Title: Water Survival (Shared – Shuttle)
Duration: 3.0 hours
Medium: Neutral Buoyancy Lab
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in groups of up to 5.)
Source: DX45/Crew Systems Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: ACES required
Note: This is a suited lesson in the water. This lesson must be scheduled within 2-3 days of WATER SURV 41001.
Prerequisite Lesson(s): New Astronaut Flow, WATER SURV 41001
Crew Systems Lesson Descriptions

WATER SURV 41027 (Concluded)

Preparation: None

Synopsis: This lesson is a review of WATER SURV 21027. It is performed at the NBL to enable the crewmembers to experience bailout and water entry and survival techniques. It is in 2 parts.

- Part 1:
  - Each of the crewmembers will hang from parachute risers, inflate their Life Preserver Unit (LPU), close and lock their visor, and pull their green apple.
  - They will then be released and enter the water.
  - Divers will place the crewmember under the canopy and they will extricate themselves from underneath it.
  - The student will experience a back drag and a front drag to practice proper body positioning and Frost fitting release.
  - They will then enter the raft and perform survival procedures, including radio ops using the PRC-112 and Search and Recovery Satellite Aided Tracking (SARSAT), signaling equipment, and bailing devices.
  - The student will perform the procedures associated with the Forest Penetrator rescue seat.

- Part 2:
  - They will enter a mockup of the orbiter side hatch, attach themselves to the escape pole, and perform a bailout into the pool.
  - A video will be replayed to show how well they have performed.
  - Additional bailouts can be performed to improve technique.

Objectives:
- Perform parachute descent techniques and water entry procedures.
- Perform parachute drag and canopy extraction.
- Perform life raft entry and reentry procedures.
- Perform survival equipment use, radio protocol, and signaling techniques.
- Perform rescue hoist operations.
- Perform orbiter side hatch bailout procedures into the pool.
Crew Systems Lesson Descriptions

IFM REV 41001

Title: In-Flight Maintenance Review
Duration: 2.0 hours
Note: This lesson is recommended at L-14 weeks and at L-1 week.
Medium: Classroom
Student: IFM Crewmembers as assigned by CDR.
Source: DX44/In-Flight Maintenance Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: See instructor lesson plan
Prerequisite Lesson(s): New Astronaut Flow, IFM PROC 91020, IFM KSC W/T 91031
Preparation: None

Synopsis: This lesson is a review of pilot pool In-Flight Maintenance (IFM) training, with emphasis on recent changes to the IFM checklist, recent flight history, and electrical IFM procedures.

Objectives:
- Review IFM checklist procedures.
- Become proficient in the use of the following IFM electrical equipment:
  - Pin Kit
  - Digital Multimeter
  - Thermal Temp Module
  - Pressure Sensor Module
  - IFM Breakout Box

PRL PROC 91020

Title: Pre-launch Procedures
Duration: 3.0 hours
Note: Contact ASP to verify the amount of time required. Some setups do not require the full time.
Medium: CCT or CCTII
Student: ASP
Source: DX45/Crew Systems Group
Date: 11/02
Lesson(s) Replaced: None
Equipment Required: See Facility Utilization Request
Note: This is not a suited lesson.
Prerequisite Lesson(s): None
Preparation: Read and Review:
- Astronaut Support Personnel (ASP) book, JSC-20392; Procedures
Crew Systems Lesson Descriptions

PRL PROC 91020 (Concluded)

Synopsis: With the CCT/CCTII in the vertical position, the Astronaut Support Personnel (ASP) and the students (if any) perform nominal pre-crew ingress procedures. These procedures include installation of FDF, installation of window shades (as appropriate), MS bags at seats, installation of headrest cushion, performing loose item inspection, performing air sample of crew module, removing Rotational Hand Control (RHC) covers, and verifying location of crew preference switch guards, yellow booties, decals, etc.

Objectives:
- Review pre-launch orbiter preparation and perform switch configuration.
- Practice locking/unlocking side hatch.
SECTION 4.0 MEDICAL OPERATIONS TRAINING COURSE

The Medical Operations training curriculum familiarizes crewmembers with the medical support available to them while onboard the space shuttle. The information presented in these lessons includes space physiology, onboard medical equipment, onboard environmental-monitoring hardware, flight surgeon support, and toxicological concerns.

Two crewmembers per mission will receive training as a Crew Medical Officer (CMO). The CMOs begin their training with Medical Diagnostics 31001, scheduled at L-16 weeks.

Upon completion of their training, the CMOs will be able to:

- Perform physical examination procedures
- Perform medical diagnostic procedures, including
  - Vital Signs
  - Eye/ear/nose/throat examination
  - Heart and lung examination
  - Abdominal, musculoskeletal, and neurological examination
- Perform medical therapeutic procedures, including
  - Eye foreign body removal
  - Nosebleed treatment
  - Medications administration
  - Airway Management
  - Intravenous fluid infusion
  - Wound management
  - Urinary catheterization
- Perform basic diagnostic and therapeutic dental procedures

The trainer/facilities used for the Medical Operations training curriculum include classroom, Crew Compartment Trainer (CCT), and the JSC clinic.
Figure 4-1. Medical Operations Lesson Flow Chart
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**NOTE:** 1. The exercise portion of this lesson must be repeated if more than 9 months have elapsed between PEAK CYCLE TEST 31001 or SUBMAX CYCLE TEST 31001 course completion (whichever is appropriate) and flight. Repeat of the lecture portion of this lesson will be at the discretion of the crew flight surgeon and the crewmembers.

2. Required if more than 6 months but less than 8 months have elapsed between MED DIAG 31001, MED THER 31001, and MED THER 32001 completion dates and flight.
### Table 4-1. Medical Operations Training Requirements (Concluded)

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**NOTE:**

1. The exercise portion of this lesson must be repeated if more than 9 months have elapsed between PEAK CYCLE TEST 31001 or SUBMAX CYCLE TEST 31001 course completion (whichever is appropriate) and flight. Repeat of the lecture portion of this lesson will be at the discretion of the crew flight surgeon and the crewmembers.

2. Required if more than 6 months but less than 8 months have elapsed between MED DIAG 31001, MED THER 31001, and MED THER 32001 completion dates and flight.
Medical Operations Lesson Descriptions

1 PEAK CYCLE TEST 31001

Title: Peak Cycle Test
Duration: 1.0 hour
Medium: Classroom
Student: Shuttle EVA crewmembers that will use the ISS Airlock (Schedule individually.)
Source: SK/HACO
Date: 03/04
Lesson(s) Replaced: None
Equipment Required: EXL (B 261/room 122), LODE Electronic Cycle Ergometer, Three-lead EKG, Metabolic Gas Analyzer (accessories and consumables) and Defibrillator.
Prerequisite Lesson(s): None
Preparation: It is recommended that no strenuous exercise occur 24 hours prior to testing; no NBL training within 48-72 hours prior to testing; no meals permitted 2 hours prior to testing, no alcohol or other vasoactive substances or medications 24 hours prior to testing; and no caffeine or nicotine 8 hours prior to testing.

Note: This lesson must be repeated if more than 36 months have elapsed between course completion and flight. This class may be repeated at an earlier date if requested by the flight surgeon.

Synopsis: Crewmembers will receive a brief introduction to the EVA Exercise Prebreathe Protocol testing and training process. A measure of crewmember peak exercise capacity for use in the development of the exercise prescription will be obtained during PEAK CYCLE TEST 31001 for the EVA Exercise Prebreathe Protocol. One individual training session will be scheduled per EVA crewmember trained for the exercise EVA Exercise Prebreathe Protocol.

Objectives:
• To obtain a measure of crewmember exercise capacity.
• Be familiar with the EVA Exercise Prebreathe Protocol testing and training.
Medical Operations Lesson Descriptions

2  CO2 31074
Title: Carbon Dioxide Exposure Training
Duration: 0.4 hours
Medium: NASA/Schedule in JSC Clinic Cardiopulmonary Laboratory, Bldg. 8, Rm. 150
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS1
Note: Schedule students individually, one after another.
Source: SD2/Medical Operations
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Cardiopulmonary Laboratory
Prerequisite Lesson(s): None
Preparation: None
Note: This lesson has a validation period of 36 months.
Synopsis: Crewmembers are exposed to increased levels of CO₂ gas in order to experience their unique symptoms of hypercapnia. Crewmembers are monitored for oxygen status and concentration of inhaled CO₂ and O₂. Testing ceases when the crewmember experiences symptoms or when levels reach a certain concentration, whichever comes first. Crewmember symptoms are recorded and given to the crew surgeon as a reference while on console.
Objectives:
• Experience individual responses/symptoms to hypercapnia in a controlled environment.
• Document individual symptoms to be used on console by the Flight Surgeon.
• Be able to recognize a potential CO₂ contingency.

3  PREBREATHE 31001
Title: EVA Prebreathe Familiarization and Exercise Prescription Verification (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: Shuttle EVA crewmembers that will use the ISS Airlock, Suit IV
Note: Schedule EVA pairs together with the IV.
Source: SK/HACO
Date: 03/04
Lesson(s) Replaced: PREBREATHE C 31001
Equipment Required: EXL (B261/122), LODE Electronic Cycle Ergometer, Heart Rate Monitor or EKG, Metabolic Gas Analyzer Accessories and Consumables, Defibrillator.
Prerequisite Lesson(s): PEAK CYCLE TEST 31001 for STS EVA crewmembers
3 PREBREATHE 31001 (Concluded)

Preparation: It is recommended that no strenuous exercise occur 24 hours prior to testing; no NBL training within 48-72 hours prior to testing; no meals permitted 2 hours prior to testing; no alcohol or other vasoactive substances or medications 24 hours prior to testing; no caffeine or nicotine 8 hours prior to testing.

Note: The exercise portion of this lesson must be repeated if more than 9 months have elapsed between PEAK CYCLE TEST 31001 or SUBMAX CYCLE TEST 31001 course completion (whichever is appropriate) and flight. Repeat of the lecture portion of this lesson will be at the discretion of the crew flight surgeon and the crewmembers.

Synopsis: This lesson covers the procedures and exercise hardware for the EVA Exercise Prebreathe Protocol. The background and history of the prebreathe protocol are discussed followed by performance of the protocol to verify each crewmember’s in-flight prescription. Crewmembers will also receive an introduction to the procedures for the Cycle Ergometer with Vibration Isolation System (CEVIS) and Heart Rate Monitor (HRM).

Objectives:
- Explain the prebreathe exercise countermeasure and procedures.
- Perform and verify the exercise prescription (EV crewmember).
- Perform exercise intensity on CEVIS appropriate for exercise prescription and proactive heart rate monitoring to ensure safety controls.

4 CEVIS & HRM OPS 31001

Title: Cycle Ergometer with Vibration Isolation System and Heart Rate Monitor Operations

Duration: 1.0 hour

Medium: Classroom

Student: Shuttle EVA crewmembers that will use ISS Airlock, Suit IV

Source: SD2/Medical Operations

Date: 03/05

Lesson(s) Replaced: None

Equipment Required: HRM and CEVIS

Prerequisite Lesson(s): PEAK CYCLE TEST 31001, PREBREATHE 31001

Preparation: None

Note: This lesson must be repeated if more than 12 months have elapsed between course completion and flight.
Medical Operations Lesson Descriptions

4  **CEVIS & HRM OPS 31001 (Concluded)**

Synopsis: This lesson introduces crewmembers to the Cycle Ergometer with Vibration Isolation System (CEVIS) and Heart Rate Monitor (HRM). The information obtained in the lesson will be used as part of the EVA Exercise Prebreathe Protocol. The first part of the lesson concentrates on the purpose and operation of the components. This is followed by hands-on procedures using the hardware.

Objectives:
- Explain HRM and CEVIS hardware operation procedures.
- Identify the location of the hardware.
- Explain EV and IV crewmember responsibilities in regards to the protocol.
- Operate the HRM and CEVIS without instructor assistance.

5  **FIRST AID 31001**

Title: Basic First Aid
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: SD37/Occupational Health
Date: 03/04
Lesson(s) Replaced: FIRST AID 21001
Equipment Required: Videotape player
Prerequisite Lesson(s): None
Preparation: None

Note: This lesson will need to be repeated if more than 12 months have elapsed between course completion and flight.

Synopsis: The lesson will demonstrate how to administer basic first aid. The course emphasizes the four priorities of first aid:

1. Get the victim away from the source of danger.
2. Check for breathing.
3. Give CPR if necessary.
4. Control bleeding and treat for shock.

Objectives: Be able to perform basic first aid procedures.
Medical Operations Lesson Descriptions

6  MED CPR 31001
Title: Medical Cardiopulmonary Resuscitation
Duration: 3.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: SD37/Occupational Health
Date: 03/04
Lesson(s) Replaced: MED CPR 21001
Equipment Required: CPR training mannequin(s)
Prerequisite Lesson(s): None
Preparation: None
Note: This lesson will need to be repeated if more than 12 months have elapsed between course completion and flight as the Crew Medical Officer (CMO).

Synopsis: The Medical Cardiopulmonary Resuscitation (CPR) course will train crewmembers in one- and two-rescuer CPR according to the American Heart Association standards. Use of the in-flight patient restraint system will be demonstrated. Emergency treatment of a choking victim will also be covered. The crewmembers will practice correct CPR technique on training mannequin(s).

Objectives: • Be able to perform CPR and airway obstruction procedures.
• Be able to use the shuttle restraint systems.

7  TOXICOLOGY 91001
Title: Toxicology
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: SD2/Medical Operations
Date: 03/05
Lesson(s) Replaced: TOXICOLOGY 31001
Equipment Required: CCK, Medical Checklist, HazMat Database
Prerequisite Lesson(s): None
Preparation: None
Note: This lesson must be repeated if more than 12 months have elapsed between course completion and flight.
Medical Operations Lesson Descriptions

7  TOXICOLOGY 91001 (Concluded)

Synopsis: Crewmembers will be instructed in the protocols and equipment required
to clean and contain any hazards associated with an orbiter toxicological
contingency. Specific topics include medical procedures for
decontamination, the contents and usage of the Contaminant Cleanup
Kit (CCK), and utilizing the Hazardous Material (HazMat) Online
Database.

Objectives:
• Be able to use the Medical Checklist and the contents of the CCK.
• Understand the uses of the HazMat Database.
• Be able to treat medical problems that result from a toxicological
  contingency.
• Become familiar with mission-specific toxicological concerns, and the
  procedures associated with their containment, cleanup, and treatment.
• Be familiar with the post-flight exposure limits for orbit egress.

8  STS TOX OPS 31001

Title: Shuttle Toxicology Operations
Duration: 0.75 hours
Medium: Classroom
Student: EV, Suit IV, and as assigned by CDR.
Source: SD2/Medical Operations
Date: 07/07
Lesson(s) Replaced: CSA-CP 31001
Equipment Required: CSA-CP, CSA-O2, CDM, IVA Ammonia Detection Kit,
GSC & FMK trainer units, and Operating Procedures
Prerequisite Lesson(s): TOXICOLOGY 91001
Preparation: None
Note: This lesson must be repeated if more than 12 months have elapsed
between course completion and flight.

Synopsis: This lesson introduces the crewmembers to the Compound Specific
Analyzer-Combustion Products (CSA-CP), Compound Specific Analyzer-
Oxygen (CSA-O2), Carbon Dioxide Monitor (CDM), Grab Sample
Container (GSC), Intravehicular Activity (IVA) Ammonia Detection Kit, and
Formaldehyde Monitoring Kit (FMK) (when flown on shuttle flights)
hardware and procedures. The location and function of the CSA-CP,
CSA-O2, CDM, IVA Ammonia Detection Kit, GSC, and FMK (if flown) are
discussed, followed by hands-on training of the individual units.
Medical Operations Lesson Descriptions

8  STS TOX OPS 31001 (Concluded)

Objectives:

• Summarize the purpose of the CSA-CP, CSA-O2, CDM, GSC, IVA Ammonia Detection Kit, and FMK.
• Understand what the CSA-CP, CSA-O2, CDM, GSC, IVA Ammonia Detection Kit, and FMK are monitoring.
• Identify the location of the CSA-CP, CSA-O2, CDM, GSC, IVA Ammonia Detection Kit, and FMK.
• Perform sampling and monitoring procedures without instructor assistance for the CSA-CP, CSA-O2, CDM, and IVA Ammonia Detection Kit.
• Perform sampling procedures without instructor assistance for the GSC and FMK.

9  TEPC 31001

Title: Tissue Equivalent Proportional Counter
Duration: 0.5 hours
Medium: Classroom
Student: As assigned by CDR.
Source: SD2/Medical Operations
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: CPDs, HRDs, and RAM training units and the TEPC flight unit and Operating Procedures
Prerequisite Lesson(s): None
Preparation: None
Note: This lesson must be repeated if more than 12 months have elapsed between course completion and flight.

Synopsis: The crewmember will be taught the procedures for powering up the Tissue Equivalent Proportional Counter (TEPC) unit. The crewmember will be taught to recognize the normal operating displays on the TEPC. The TEPC is a passive device and nominally requires a “Power On” and “Power Off” procedure to be completed by the crewmember on-orbit. Malfunction procedures will be covered with the crewmember during the class as well as contingency procedures for recording readings from the TEPC in the case of a solar event. Current solar activity/space weather is covered with the crewmember and radiation dose projections for the mission are discussed. The crew is taught the procedure to deploy the Radiation Area Monitors (RAMs) as well as the importance of always wearing the Crew Personal Dosimeter (CPD). The crew is taught procedures for the High Rate Dosimeters (HRDs).
Medical Operations Lesson Descriptions

9  TEPC 31001 (Concluded)

Objectives:
• Identify the important switches and interfaces on the TEPC.
• Power up and power down the TEPC using procedures.
• Using the malfunction procedures, perform tasks in the event of a hardware failure.
• Obtain information on current solar activity and projected conditions for the mission.
• Perform monitoring procedures for RAM hardware.
• Perform monitoring procedures for the HRD hardware.

10  MED PROC 31001

Title:  Medical Procedures
Duration:  2.5 hours
Medium:  Classroom
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source:  SD2/Medical Operations
Date:  03/05
Lesson(s) Replaced:  MED PROC 21001A
Equipment Required:  SOMS Hardware and MED C/L
Prerequisite Lesson(s):  New Astronaut Flow
Preparation:  None
Note:  This lesson must be repeated if more than 10 months have elapsed between course completion and flight.

Synopsis:  This lesson provides a detailed briefing on the medical aspects of spaceflight, medical equipment, and checklist procedures associated with diagnosis and treatment on orbit. This lesson also covers the spaceflight medical training program, operational counter measures, and post-flight readaptation. The Shuttle Orbiter Medical System (SOMS) and the Medical Checklist are presented.

Objectives:
• Become familiar with space medicine, physiology, and medical support for the shuttle.
• Issues covered include the following:
  – Emergency Medical Services (EMS) at launch and landing
  – Health Stabilization Program (HSP)
  – Preflight medical support
  – In-flight medical concerns
  – Medical equipment onboard the Shuttle and FDF review
  – In-flight environmental concerns
  – Post-flight medical issues
Medical Operations Lesson Descriptions

11 MED DIAG 31001

Title: Medical Diagnostics
Duration: 1.5 hours
Medium: Classroom
Student: CMOs as assigned by CDR (Schedule in pairs.)
Source: SD2/Medical Operations
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MED PROC 31001
Preparation: None

Note: MED PROF 41001 will be required if more than 6 months and less than 8 months have elapsed between MED DIAG 31001 course completion and flight as the crew medical officer(s).

Synopsis: The Crew Medical Officers (CMOs) will be instructed in the use of the diagnostic equipment available in the Shuttle Orbiter Medical System (SOMS). Techniques of evaluating and recording blood pressure and heart rate, as well as lung and bowel sounds will be covered. Eye and ear examination techniques will be demonstrated.

Objectives:
• Be able to recognize simple medical problems which may develop in flight.
• Be able to use the Medical Checklist and the SOMS.
• Be able to obtain vital signs and perform a physical exam.
• Be able to recognize medical problems with the assistance of the MCC Surgeon during the Private Medical Conference (PMC).

12 MED EVAL DCS 31001

Title: Medical Evaluation of Decompression Sickness
Duration: 1.0 hour
Medium: Classroom
Student: CMO, EV1, EV2, Suit and Task IV
Source: SD2/Medical Operations
Date: 04/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): BTA OPS 31001 (EVA SYS OPS),
EMU RESIZE 31209 (EVA SYS OPS),
MED DIAG 31001 (CMOs ONLY)
Medical Operations Lesson Descriptions

12  MED EVAL DCS 31001 (Concluded)

Preparation:  None

Note:  This lesson is given to inexperienced crewmembers, and it will need to be repeated if more than 36 months have elapsed between course completion and flight.

Synopsis:  Inexperienced crewmembers are introduced to the Decompression Sickness (DCS) Cuff Classifications, including symptoms and classification criteria. A brief overview of DCS physiology, symptoms, and risks included is given. The techniques required to perform the in-suit and out-of-suit physical examinations are presented.

Objectives:
• Explain DCS physiology, symptoms, and risk.
• Define the symptoms and criteria for distinguishing DCS Cuff Class 1, 2, 3, and 4.
• Explain the decision process for following DCS Treatment protocols.
• Demonstrate the in-suit physical exam.
• Explain the out-of-suit physical examination.
• Explain post-symptomatic treatment and care.

13  MED EVAL DCS EXP 31001

Title:  Medical Evaluation of Decompression Sickness Cuff for Experienced Crewmembers

Duration:  0.5 hours

Medium:  Classroom

Student:  CMOs, EV1, EV2, Suit and Task IV

Source:  SD2/Medical Operations

Date:  04/04

Lesson(s) Replaced:  None

Equipment Required:  None

Prerequisite Lesson(s):  BTA OPS 31001 (EVA SYS OPS)
                       EMU RESIZE 31209 (EVA SYS OPS),
                       MED DIAG 31001 (CMO ONLY)

Preparation:  None

Note:  This lesson is given to experienced crewmembers and will need to be repeated if more than 36 months have elapsed between course completion and flight.

Synopsis:  Crewmembers are given a brief overview of Decompression Sickness (DCS) Cuff Classifications, including symptoms and classification criteria. DCS physiology, symptoms, and risks are also given in a brief overview. This class is conducted by a NASA Flight Surgeon.
Medical Operations Lesson Descriptions

13 MED EVAL DCS EXP 31001 (Concluded)

Objectives:
• Review DCS physiology, symptoms, and risk.
• Define the symptoms and criteria for distinguishing DCS Cuff Class 1, 2, 3, and 4.
• Cover the decision process for following the DCS Treatment Protocol.
• Review post-symptomatic treatment and care.
• Review the in-suit and out-of-suit physical examinations.

14 MED THER 31001

Title: Medical Therapeutics
Duration: 2.0 hours
Medium: Classroom
Student: CMOs as assigned by CDR (Schedule in pairs.)
Source: SD2/Medical Operations
Date: 03/05
Lesson(s) Replaced: MED THER 21001
Equipment Required: None
Prerequisite Lesson(s): MED PROC 31001
Preparation: None
Note: MED PROF 41001 will be required if more than 6 months and less than 8 months have elapsed between MED THER 31001 course completion and flight as the crew medical officer(s).

Synopsis: The Crew Medical Officers (CMOs) will be instructed in the treatment of routine and emergency in flight illnesses and injuries including lacerations, burns, eye trauma, fractures, and airway trauma. The dosing of oral, intramuscular, and intravenous medications as well as the indications for their use will be covered. Routine medications for common in-flight illnesses will be emphasized. Airway management and intubation will be practiced.

Objectives:
• Be able to perform intramuscular and subcutaneous injections.
• Be able to gain IV access, treat eye injuries, and treat simple and complex nosebleeds.
• Be able to perform various airway management techniques:
  - Oral Airway
  - Intubating Laryngeal Mask Airway (ILMA)
  - Endotracheal (ET) Intubation
  - Cricothyrotomy
• Be able to perform a needle thoracentesis to treat a collapsed lung.
Medical Operations Lesson Descriptions

15  **MED THER 32001**

Title: Medical Therapeutics  
Duration: 2.0 hours  
Medium: Classroom  
Student: CMOs as assigned by CDR (Schedule in pairs.)  
Source: SD2/Medical Operations  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MED THER 31001  
Preparation: None  
**Note:** MED PROF 41001 will be required if more than 6 months and less than 8 months have elapsed between MED THER 32001 course completion and flight as the crew medical officer(s).

Synopsis: Refer to MED THER 31001 for synopsis.

Objectives:  
- Be able to perform available wound closure techniques.  
- Be able to perform evaluation and treatment of the following musculoskeletal injuries:  
  - Sprains/Strains  
  - Fractures/Dislocations  
- Be able to treat urinary retention through urinary catheterization using straight and Foley catheters.

16  **DENTAL 31001**

Title: Dental  
Duration: 0.5 hours  
Medium: Classroom  
**Note:** Schedule in the Bldg. 8 Dental Office.  
Student: CMOs as assigned by CDR (Schedule in pairs.)  
Source: SD32/Space Medicine  
Date: 03/04  
Lesson(s) Replaced: None  
Equipment Required: EENT Subpack  
Prerequisite Lesson(s): MED PROC 31001  
Preparation: None  
**Note:** This lesson must be repeated if more than 8 months have elapsed between course completion and flight.

Synopsis: This lesson will demonstrate the equipment and the techniques to be used in the treatment of in-flight dental emergencies.
Medical Operations Lesson Descriptions

16  **DENTAL 31001 (Concluded)**

Objectives:  
- Become familiar with the use of the items contained in the dental portion of the Eye, Ear, Nose, and Throat (EENT) Subpack.  
- Become familiar with the intra-oral injection technique.  
- Be able to place a temporary filling.  
- Be able to re-cement dislodged crowns.  
- Be able to treat chipped/fractured teeth or fillings.

17  **SEE OPS 31020**

Title:  Shuttle Emergency Eyewash Operations  
Duration:  0.5 hours  
Medium:  CCT II, FFT  
Student:  CMOs as assigned by CDR (Schedule in pairs.)  
Source:  SD2/Medical Operations  
Date:  03/05  
Lesson(s) Replaced:  None  
Equipment Required:  Contaminant Cleanup Kit, Shuttle Resuscitator, and Operational Bioinstrumentation System (OBS)  
Prerequisite Lesson(s):  None  
Preparation:  None  

**Note:** This lesson must be repeated if more than 8 months have elapsed between course completion and flight.

Synopsis:  This lesson will provide the Crew Medical Officers (CMOs) with Shuttle Emergency Eyewash (SEE) deployment procedures and the procedures needed to activate water flow through the SEE, which will enable a crewmember to flush the eyes in the event of exposure to toxins and irritants. Connection ports and procedures for utilizing the Operational Bioinstrumentation System (OBS) and the Shuttle Resuscitator will also be covered.

Objectives:  
- Be able to perform emergency eyewash procedures in the Shuttle.  
- Using the Cardiac Monitoring procedures, perform a mock setup of the OBS for Intravehicular Activity (IVA) monitoring.  
- Identify O₂ connection ports for the Shuttle Resuscitator.
Medical Operations Lesson Descriptions

18 **SUBMAX CYCLE TEST 31001**

Title: Submaximal Cycle Test  
Duration: 1.0 hour  
Medium: Classroom  
Student: Shuttle EVA crewmembers who will use the ISS Airlock (Schedule individually.)  
Source: SK/HACO  
Date: 03/04  
Lesson(s) Replaced: None  
Equipment Required: EXL (B 261/room 122), LODE Electronic Cycle Ergometer, Three-lead EKG, Metabolic Gas Analyzer (accessories and consumables), and Defibrillator.  
Prerequisite Lesson(s): CEVIS & HRM OPS 31001, PEAK CYCLE TEST 31001, PREBREATHE 31001  
Preparation: It is recommended that no strenuous exercise occur 24 hours prior to testing; no NBL training within 48-72 hours prior to testing; no meals permitted 2 hours prior to testing; no alcohol or other vasoactive substances or medications 24 hours prior to testing; and no caffeine or nicotine 8 hours prior to testing.  
Note: This lesson must be repeated if more than 3 months have elapsed between course completion and flight.  
Synopsis: A measure of crewmember exercise capacity for use in the possible modification of the exercise prescription will be obtained during SUBMAX CYCLE TEST 31001 for the EVA Exercise Prebreathe Protocol. One individual training session will be scheduled per EVA crewmember trained for the EVA Exercise Prebreathe Protocol.  
Objectives:  
- Measure crewmember exercise capacity prior to flight to determine need to modify exercise prescription.  
- Review EVA Exercise Prebreathe Protocol procedures as necessary.

19 **MED REFR 91001**

Title: Medical Procedures Refresher  
Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  
Note: Schedule any support personnel requiring this lesson separately from the prime crew.  
Source: SD2/Medical Operations  
Date: 03/04  
Lesson(s) Replaced: None  
Equipment Required: SOMS Hardware and MED C/L
Medical Operations Lesson Descriptions

19  MED REFR 91001 (Concluded)

Prerequisite Lesson(s):  CO2 31074, DENTAL 31001, FIRST AID 31001,
MED CPR 31001, MED DIAG 31001, MED THER 32001,
SEE OPS 31020, TOXICOLOGY 91001

Preparation:  None

Synopsis:  This lesson will be given at approximately L-10 days. A review of the Shuttle Orbiter Medical System (SOMS), physical examination and treatment procedures, shuttle propellant toxicology, exposure to environmental temperature extremes, and emergency treatment procedures will be covered. In addition, space motion sickness, private medical communications, and EVAs will be discussed. This lesson is given to prime crews with instructor and flight surgeons present.

Objectives:  • Review the following:
  – Emergency Medical Services (EMS) at launch and landing
  – Health Stabilization Program (HSP)
  – Preflight medical support
  – In-flight medical concerns
  – Medical equipment onboard shuttle
  – In-flight environmental issues
  – Expected radiation exposure rates
  – Post-flight medical issues

20  SOMS CMO REFR 41001

Title:  Shuttle Orbiter Medical System Crew Medical Officer Refresher
Duration:  1.0 hour
Medium:  Classroom
Student:  CMOs as assigned by CDR (Schedule in pairs.)
Source:  SD2/Medical Operations
Date:  03/04

Lesson(s) Replaced:  None

Equipment Required:  SOMS

Prerequisite Lesson(s):  MED THER 31001, MED THER 32001

Preparation:  None

Note:  This lesson is CMO request only.

Synopsis:  Same as for MED THER 31001 and MED THER 32001.

Objectives:  Same as for MED THER 31001 and MED THER 32001.
Medical Operations Lesson Descriptions

21  MED PROF 41001

Title: Medical Proficiency
Duration: 3.0 hours
Medium: Classroom
Student: CMOs as assigned by CDR (Schedule in pairs.)
Source: SD2/Medical Operations
Date: 03/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MED DIAG 31001, MED THER 31001, MED THER 32001
Preparation: None

Note: This course will be given to the CMOs if more than 6 months and less than 8 months have elapsed between MED DIAG 31001, MED THER 31001, and MED THER 32001 completion dates and flight. This class will validate the CMOs for 4 months from the date of course completion.

Synopsis: The Crew Medical Officers (CMOs) will review treatments of routine and emergency in-flight illnesses and injuries, including lacerations, burns, eye trauma, and fractures. The dosing of oral, intramuscular, and intravenous medications as well as the indications for their use will be reviewed. Airway management and intubation will be practiced. Routine medications for common in-flight illnesses will also be emphasized.

Objectives:
• Be able to demonstrate skills learned in training sessions.
• Be able to use the Medical Checklist and the Shuttle Orbiter Medical System (SOMS).
• Be able to treat medical problems, which are likely to develop in-flight.
• Be able to treat more difficult medical problems under the guidance of the MCC Surgeon.
• Be able to perform advanced therapeutic procedures, including airway management during emergencies using endotracheal intubation and cricothyrotomy, and intravenous technique using insertion of intracatheter needle with intravenous fluids.
• Be able to perform alternate methods of laceration closure.
• Be able to discuss medical scenarios that could occur during flight, and how they would be managed.
SECTION 5.0 STS PHO/TV TRAINING COURSE

Throughout the U.S. Space Program, photos, film and video have played an important role in preserving history and documenting technological advances. The STS PHO/TV Training Course applies techniques developed throughout the years of manned space flight to Space Shuttle scenarios using modern photographic and video technologies.

The STS PHO/TV Training Course provides the flight crew with the knowledge necessary to operate the Orbiter integrated TV system, video devices, film cameras, still cameras and associated photographic accessories. In addition to hardware training, courses are included that provide photography and video skills unique to daily life on orbit. Classes are also provided for highly specialized phases of flight that utilize Photo/TV devices such as ascent/entry, External Tank (ET) separation, ISS docking and EVA.
Figure 5–1. PHOTO/TV Lesson Flow Chart
USA002960
Rev. J
Table 5-1. STS PHO/TV Crew Training Requirements
Date Last Modified: 06/08
Non-Crew Rotation
Stage

Ref
Num

4
4
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4

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7

BASIC PHOTO 31001
D2XS EQ 31001
D2XS EQ 32001
F5 EQ 31001
INT PHO SKL 31020

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EXT PHO SKL 31153
D2XS EVA EQ 31001
G1 CAMC EQ 31001
PAO CAMC 31001
CCTV OPS 31019
IR CAMR EQ 31001
IR CAMR SKL 31001

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PAO CAMC SKL 31019
PAO VID REV 31001
CCTV OPS 32019

FFT
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18

ET EQ 31001

CLR

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ET PHO SKL 31001
MINICAM EQ 31001
MINICAM PHO SKL 31019
WVS EQ 31001

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WVS OPS 31019

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Lesson Code

Crew Rotation

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P

MS1

MS2

MS3

MS4

PS

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MS1

MS2

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CCTII/FFT

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As assigned by CDR

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LDRI EQ 31001

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25

LCS EQ 31001

CLR

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CCT

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Comments

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As assigned by CDR

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Required when OBSS
manifested

As assigned by CDR.
Required when OBSS
manifested

3

26

LDRI OPS 31012

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27

C/L CAMR OPS 91019

FFT

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As assigned by CDR

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28

CCTV LIGHTING 91019

FFT

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Lights out session; as
assigned by CDR

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3

31
32

SPECIAL PHOTO 31001
PHO/TV PROC 31019

CLR
FFT

1
2

8
2-3

1
2

1
2

1
2

1
2

1
2

1
2

1
2

1
2

1
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3
3
3

33

ISS EXT SRVY 91001

CLR
Sub Total for Stage

1

1

1

1

1

1

1

1

1

1

25.0

25.0

14.5

14.5

10.0

12.5

9.5

20.0

20.0

25.0

1
2

1
2

8
1
1
Stage Totals Per Crewmember:
14.5
14.5

5-5

CCT

CCT
Attendance per CDR


### Table 5-1. STS PHO/TV Crew Training Requirements (Concluded)

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Date Last Modified: 06/08
STS PHO/TV Lesson Descriptions

1  **LDRI EQ 21001**

Title: Laser Dynamic Range Imager Equipment  
Duration: 1.5 hours  
Medium: Classroom  
Student: R1, R2  
Source: DX46/Photo/TV Section  
Date: 04/06  
Lesson(s) Replaced: None  
Equipment Required: Computer, Projector  
Prerequisite Lesson(s): CCTV OPS 21008  
Preparation: None  

Synopsis: This lesson will introduce the crew to the Laser Dynamic Range Imager (LDRI) instruments used on the Orbiter Boom Sensor System (OBSS) for Shuttle Thermal Protection System (TPS) inspection. LDRI is mounted on the end of the OBSS boom. Discussed topics will include sensor design, power requirements, system control, data transfer and storage, shuttle integration and inspection method/timeline. This lesson will prepare the crew to operate the LDRI hardware in the subsequent PDRS OBSS SURVEY 21069, 22069, 23069 lessons.

Objectives:  
• Understand the LDRI instrument design and capabilities.  
• Understand the power and data interfaces between LDRI and the Shuttle.  
• Understand how LDRI is controlled.  
• Understand how to collect and downlink LDRI instrument video.  
• Understand how LDRI will be used with the Shuttle RMS for TPS inspection.

2  **BASIC PHOTO 31001**

Title: Basic Photo  
Duration: 2.0 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  
Source: DX46/Photo/TV Section  
Date: 02/01  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): New Astronaut Flow, LDRI EQ 21001  
Preparation: None
STS PHO/TV Lesson Descriptions

2 BASIC PHOTO 31001 (Concluded)

Synopsis: This lesson is the first in the series of photo classes given to the crewmembers. This lesson will prepare students to better comprehend the information contained in classes to follow. The class will be presented with a multi-projector slide program as the primary source of visuals. The instructor will provide real-time narration for the class during the slide presentation.

Objectives:
• Gain basic understanding of fundamental photographic principles needed prior to hardware classes.
• Become familiar with the following:
  – Photo subjects
  – Cameras
  – Lenses
  – Film
  – Light
  – Filters
  – Exposure concepts
  – Exposure problems
  – Composition

3 D2XS EQ 31001

Title: Nikon D2Xs Equipment
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)
Source: DX46/Photo/TV Section
Date: 06/08
Lesson(s) Replaced: 760 EQ 31001
Equipment Required: Nikon D2Xs Hardware
Prerequisite Lesson(s): BASIC PHOTO 31001
Preparation: None

Synopsis: During the two hour lesson, the student will be briefed on the Nikon D2Xs camera displays and controls, lenses, flash, nominal operation and related Generic Photo/TV information.

Objectives:
• Upon completion, the student will be familiar with the Nikon D2Xs camera and be able to correctly operate the Nikon D2Xs camera for nominal operations.
• Prepare the camera for operation and take a photograph using existing light.
• Prepare the camera for operation and take a photograph using flash.
### STS PHO/TV Lesson Descriptions

#### D2XS EQ 32001

<table>
<thead>
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<td>Date:</td>
<td>06/08</td>
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<td>Equipment Required:</td>
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<tr>
<td>Preparation:</td>
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</table>

**Synopsis:** During the 1.5 hour lesson, the student will be briefed on the Nikon D2Xs menu system, camera configuration and use of the A31p laptop.

**Objectives:**
- Upon completion, the student will be able to correctly operate the Nikon D2Xs camera menus and digital features as well as the viewing software on the A31p.
- Prepare the camera for operation and take a photograph using flash.
- Quick format the card.
- View images with the computer viewing software.
- Save a compressed image file.

#### D2XS OV 31001

<table>
<thead>
<tr>
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<td>Date:</td>
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<td>Preparation:</td>
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</table>
STS PHO/TV Lesson Descriptions

5  **D2XS OV 31001 (Concluded)**

Synopsis: This class is an overview of *D2XS* EQ 31001 and 32001. Normal camera operations and malfunction diagnosis will be covered.

Objectives:
- Overview of the *Nikon D2Xs* camera system.
- Gain camera proficiency.

6  **F5 EQ 31001**

Title: Nikon F5 Equipment

Duration: 1.0 hour

Medium: Classroom

Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)

Note: Schedule if manifested.

Source: *DX46/Photo/TV Section*

Date: 04/06

Lesson(s) Replaced: None

Equipment Required: Nikon F5 35mm Camera System

Prerequisite Lesson(s): *D2XS* EQ 32001, *D2XS* OV 31001 (Experienced crewmembers only)

Preparation: None

Synopsis: This lesson is a hands-on training exercise that familiarizes crewmembers with the operation and usage of the Nikon F5 35mm camera system. Nominal camera operations and malfunction diagnosis will be discussed.

Objectives:
- Understand the Nikon F5 35mm camera system.
- Gain the ability to operate the F5 camera.

7  **INT PHO SKL 31020**

Title: Interior Photo Skills

Duration: 2.0 hours

Medium: CCT, CCTII or FFT

Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)

Source: *DX46/Photo/TV Section*

Date: 04/06

Lesson(s) Replaced: 760 PHO SKL 31020

Equipment Required: *Nikon D2Xs* Hardware, Nikon F5 Hardware (If manifested)

Prerequisite Lesson(s): *D2XS* EQ 32001, *D2XS* OV 31001 (Experienced crewmembers only), F5 EQ 31001 (If manifested)

Preparation: None
STS PHO/TV Lesson Descriptions

7  INT PHO SKL 31020 (Concluded)

Synopsis: This lesson will provide an opportunity for hands-on operation of the camera hardware in a flight-like environment with training supervision. The images will be reviewed with each crewmember.

Objectives:
- Obtain a reinforced understanding of the still camera system.
- Practice advanced operational techniques with flight cameras.
- Gains hands-on experience with the camera.
- Review lessons objectives utilizing images obtained in the orbiter mock up.
- Critique images obtained in the orbiter mock-up.

8  EXT PHO SKL 31153

Title: Exterior Photo Skills
Duration: 2.0 hours
Medium: Outside (JSC Mall Area)
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)
Source: DX46/Photo/TV Section
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: Nikon D2Xs Hardware
Prerequisite Lesson(s): INT PHO SKL 31020
Preparation: None

Synopsis: This lesson will provide an opportunity for hands-on operation of the digital still camera hardware outside. The images will be reviewed with each crewmember at the end of the class.

Objectives:
- Know and understand operations for the Nikon D2Xs system.
- Demonstrate an understanding of the digital still camera system.
- Perform advanced operational techniques with the digital still camera system.
### D2XS EVA EQ 31001

- **Title:** *Nikon D2Xs* EVA Equipment
- **Duration:** 2.0 hours
- **Medium:** Classroom
- **Student:** EVA and IVA crewmembers
- **Source:** DX46/Photo/TV Section
- **Date:** 06/08
- **Lesson(s) Replaced:** 760 EVA EQ 31001
- **Equipment Required:** *D2Xs* EVA camera, flash, brackets and associated hardware
- **Prerequisite Lesson(s):** *D2XS* EQ 32001 or *D2XS* OV 31001 (experienced crewmembers only)
- **Preparation:** None

**Synopsis:** This lesson instructs the crewmembers on how to properly configure and use the *Nikon D2Xs* camera for EVA use. The crewmembers will learn how to configure the camera for existing light and flash photography.

**Objectives:**
- Understand the *Nikon D2Xs* EVA camera hardware.
- Properly assemble the *Nikon D2Xs* camera for EVA use with and without the flash.
- Understand the *Nikon D2Xs* EVA camera FDF procedures.

### D2XS EVA PHO SKL 31031

- **Title:** *Nikon D2Xs* EVA Photo Skills
- **Duration:** 1.5 hours
- **Medium:** KSC (during Crew Equipment Interface Test (CEIT))
- **Student:** EVA and IVA crewmembers
- **Source:** DX46/Photo/TV Section
- **Date:** 06/08
- **Lesson(s) Replaced:** 760 EVA PHO SKL 31031
- **Equipment Required:** *Nikon D2Xs* camera, EVA flash, EVA camera accessories, Shuttle TPS, floodlight, laptop computer
- **Prerequisite Lesson(s):** *D2XS* EVA EQ 31001
- **Preparation:** None

**Synopsis:** This lesson teaches the crew how to properly use the *Nikon D2Xs* EVA camera to photograph the Thermal Protection System (TPS) on the real vehicle under different lighting conditions.

**Objectives:**
- Configure the camera for EVA operations.
- Photograph the different types of Shuttle TPS under various lighting conditions.
- Review imagery at the end of the lesson.
STS PHO/TV Lesson Descriptions

11  **G1 CAMC EQ 31001**

Title:  *Canon G1* Camcorder Equipment  
Duration:  2.0 hours  
Medium:  Classroom  
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)  
Source:  *DX46*/Photo/TV Section  
Date:  **06/08**  
Lesson(s) Replaced:  *PD100 CAMC EQ 31001*  
Equipment Required:  *Canon G1 Camcorder and accessories*  
Prerequisite Lesson(s):  BASIC PHOTO 31001  
Preparation:  None  
Synopsis:  This lesson is a hands-on training exercise that familiarizes crewmembers with the operation and usage of the camcorder. Normal operations and diagnosis of problems will be explained.  
Objectives:  • Become familiar with and understand the entire camcorder system, including the operation and the malfunction procedures.  
• Gain the ability to independently operate the camcorder system.

12  **G1 CAMC OV 31001**

Title:  *Canon G1* Camcorder Overview  
Duration:  1.0 hour  
Medium:  Classroom  
Student:  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule in pairs.)  
**Note:**  Schedule experienced crewmembers only.  
Source:  *DX46*/Photo/TV Section  
Date:  **06/08**  
Lesson(s) Replaced:  *PD100 CAMC OV 31001*  
Equipment Required:  *Canon G1 Camcorder and accessories*  
Prerequisite Lesson(s):  *G1 CAMC EQ 31001*  
Preparation:  None  
Synopsis:  This lesson is a hands-on review of the camcorder equipment. Normal operations and diagnosis of problems will be explained.  
Objectives:  • Obtain a review on camcorder system operations.  
• Gain camcorder proficiency through independent use of the camcorder system.
STS PHO/TV Lesson Descriptions

13 PAO CAMC 31001

Title: Public Affairs Office Camcorder Skills
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: PAO CAMCORD 91001
Equipment Required: Camcorder hardware
Prerequisite Lesson(s): G1 CAMC EQ 31001, G1 CAMC OV 31001 (Experienced crewmembers only)
Preparation: None

Synopsis: This lesson is a hands-on training exercise that familiarizes crewmembers with the operation and usage of the camcorder video/audio systems. This lesson goes beyond the standard camcorder lesson, concentrating on advanced video techniques.

Objectives:
• Obtain a reinforced understanding of camera controls, as well as audio controls.
• Obtain a basic understanding of the general types of Public Affairs Office (PAO) video and corresponding hardware considerations.
• Obtain an understanding of scene, personal, prop and wardrobe preparations/considerations.
• View video from past missions.

14 CCTV OPS 31019

Title: Closed Circuit Television Operations
Duration: 2.5 hours
Medium: FFT or CCT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: CCTV OPS 21020
Equipment Required: See Facility Utilization Request.
Prerequisite Lesson(s): PAO CAMC 31001
Preparation: None
STS PHO/TV Lesson Descriptions

14  **CCTV OPS 31019 (Concluded)**

Synopsis: This lesson is a hands-on training exercise utilizing a fully functional, flight prototype television system. The student will be briefed on system operation, including activation/deactivation, display and control functions, camera features, Video Tape Recorder (VTR) operation, system limitations and constraints, and any necessary assembly/disassembly of equipment.

Utilizing the appropriate FDF checklists, television procedures will be performed and the proper responses to scene variables will be demonstrated and discussed.

Objectives:
- Understand CCTV/Orbiter system configuration, operations, and malfunction procedures.
- Be able to exercise Photo/TV FDF checklist procedures for CCTV, VTR, and Camcorder.
- Gain the ability to operate the CCTV system.

15  **PAO CAMC SKL 31019**

Title: Public Affairs Office Camcorder Skills
Duration: 2.0 hours
Medium: FFT or CCT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: PAO CAMCORD 91019
Equipment Required: Camcorder hardware
Prerequisite Lesson(s): CCTV OPS 31019
Preparation: None

Synopsis: This lesson will provide an opportunity for hands-on operation of the camcorder hardware in a flight-like environment with training supervision. Normal operations and diagnosis of problems will be covered.

Objectives:
- Obtain a reinforced understanding of the individual flight system via hands-on camcorder operations.
- Practice the different types of on-orbit video situations related to Public Affairs Office (PAO) situations.
STS PHO/TV Lesson Descriptions

16  **PAO VID REV 31001**

Title: Public Affairs Office Camcorder Video Review  
Duration: 0.5 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  
Source: DX46/Photo/TV Section  
Date: 02/01  
Lesson(s) Replaced: VID REV 31001  
Equipment Required: None  
Prerequisite Lesson(s): PAO CAMC SKL 31019  
Preparation: None  

Synopsis: This lesson is a review of videotape footage taken by each crewmember during PAO CAMC SKL 31019. Video and audio tracks will be critiqued by lead instructor and crewmembers for proper techniques and hardware operations.  

Objectives:  
- Identify problems and solutions within the video footage.  
- Review lesson objectives of PAO CAMC 31001 and PAO CAMC SKL 31019 utilizing video obtained in the orbiter mock-up.

17  **CCTV OPS 32019**

Title: Closed Circuit Television Operations  
Duration: 1.5 hours  
Medium: FFT or CCT  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in pairs.)  
Source: DX46/Photo/TV Section  
Date: 06/05  
Lesson(s) Replaced: None  
Equipment Required: See Facility Utilization Request.  
Prerequisite Lesson(s): PAO VID REV 31001  
Preparation: None  

Synopsis: This lesson will serve as Part 2 of CCTV OPS 31019 to cover Digital Television (DTV), Sequential Still Video (SSV), and video routing/recording/playback utilizing the Shuttle TV system and in-cabin hardware.
STS PHO/TV Lesson Descriptions

17 **CCTV OPS 32019 (Concluded)**

Objectives:  
- Understand the DTV hardware components and their functions.  
- Configure and route a video signal through the DTV system.  
- Configure the SSV hardware for on-orbit operations.  
- Configure and record video with the DTV VTR, the Sony V10 VTR, and the *Canon G1* camcorder.  
- Configure and play back video with the DTV VTR, the Sony V10 VTR, and the *Canon G1* camcorder for on-board viewing and analog/digital downlink to MCC.

18 **ET EQ 31001**

Title: External Tank Photography Equipment  
Duration: 1.5 hours  
Medium: Classroom  
Student: As assigned by CDR.  
Source: *DX46*/Photo/TV Section  
Date: 04/06  
Lesson(s) Replaced: None  
Equipment Required: *Canon G1* Camcorder, *Nikon D2Xs* Digital Still Camera, IEEE 1394 converter and cables, *A31p* PGSC  
Prerequisite Lesson(s): *D2XS* EQ 32001, *G1* CAMC EQ 31001, *D2XS* OV 31001 (Experienced crewmembers only), *G1* CAMC OV 31001 (Experienced crewmembers only)  
Preparation: None  
Synopsis: This lesson familiarizes the crewmember(s) with the External Tank (ET) photographic requirements as presented by a representative of the Imaging Science and Analysis Group (IS&AG). The related hardware to be used for the task will be presented and configured per procedures. The umbilical well ET Thermal Protection System (TPS) camera system and imagery downloading will also be discussed.

Objectives:  
- Understand ET photography objectives, techniques, and configuration procedures.  
- Configure the camera hardware per procedures to obtain ET images.  
- Understand the umbilical well ET TPS camera system and image downloading hardware, software, and procedures.
STS PHO/TV Lesson Descriptions

19  ET PHO SKL 31001
Title: External Tank Photo Skills
Duration: 1.0 hour
Medium: Classroom
Student: As assigned by CDR.
Source: DX46/Photo/TV Section
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: Canon G1 camcorder, Nikon D2Xs digital still camera, IEEE 1394 converter and cables, A31p PGSC
Prerequisite Lesson(s): ET EQ 31001
Preparation: None
Synopsis: This lesson will provide an opportunity for hands-on operation of the camera configurations for External Tank (ET) photography. Once the cameras are configured, the crewmembers will go outside to practice focusing and shooting assorted moving targets. The images and video will be reviewed back in the classroom at the end of the session as part of a critique. Computer software to download the umbilical well ET Thermal Protection System (TPS) camera images will be exercised during the critique portion of the class.
Objectives: • Configure the camera hardware per procedures to obtain ET images.
• Take pictures and video of various targets to practice focus and exposure techniques required for ET photography.
• Use the Kodak Camera Manager software to download images from a DCS 760 camera.

20  MINICAM EQ 31001
Title: Minicam Equipment
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: None
Equipment Required: Mini-cam camera system
Prerequisite Lesson(s): CCTV OPS 31019
Preparation: None
STS PHO/TV Lesson Descriptions

20 MINICAM EQ 31001 (Concluded)

Synopsis: This lesson is a hands-on training exercise that familiarizes crewmembers with the operation and usage of the mini-cam camera system. Ascent, entry and on-orbit camera configurations will be discussed. Mini-cam video from past missions will be reviewed.

Objectives: • Understand the entire mini-cam camera system, including camera mounting options.
• Gain the ability to operate the camera.

21 MINICAM PHO SKL 31019

Title: Minicam Photo Skills
Duration: 1.0 hour
Medium: FFT or CCT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule in groups of 3.)
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: None
Equipment Required: Minicam camera system
Prerequisite Lesson(s): MINICAM EQ 31001
Preparation: None

Synopsis: This lesson is a hands-on training exercise in a flight-like environment that familiarizes crewmembers with the minicam camera system integrated into the Orbiter CCTV system. Ascent, entry and on-orbit camera configurations will be rehearsed.

Objectives: • Obtain a reinforced understanding of the minicam camera system.
• Gain hands-on experience with the minicam system.
• Obtain an understanding of minicam system configuration as determined by phase of flight.

22 WVS EQ 31001

Title: Wireless Video System Equipment
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: None
Equipment Required: PGSC, Overhead projector
STS PHO/TV Lesson Descriptions

22  **WVS EQ 31001 (Concluded)**

Prerequisite Lesson(s): CCTV OPS 31019  
Preparation: None  

Synopsis: This one-hour lesson will cover the overall design of the Wireless Video System (WVS), components, and basic operations of the PGSC-based software.

Objectives:  
- Know the main components of the Orbiter WVS.  
- Understand the main function that each Orbiter WVS component performs.  
- Understand how commands and telemetry/video are routed through the WVS components.  
- Know the crew interfaces to the Orbiter WVS.  
- Know how to configure and start the WVS PGSC and software.  
- Understand the WVS PGSC software information page layout design.  
- Know how to activate and deactivate the Orbiter WVS.  
- Understand how the WVS PGSC software is to be used.  
- Activate the Orbiter WVS PGSC software.  
- Maneuver through the WVS PGSC software displays.

23  **WVS OPS 31019**

Title: Wireless Video System Operations  
Duration: 2.0 hours  
Medium: FFT  
Student: As assigned by CDR.  
Source: DX46/Photo/TV Section  
Date: 02/01  
Lesson(s) Replaced: None  
Equipment Required: See Facility Utilization Requirement.  
Prerequisite Lesson(s): WVS EQ 31001  
Preparation: None  

Synopsis: This two-hour lesson will cover Wireless Video System (WVS) Intravehicular Activity (IVA) hardware setup and operations. Fully integrated system test, operation, malfunctions, and deactivation utilizing available crew procedures will be the main goal of the lesson.
STS PHO/TV Lesson Descriptions

23 WVS OPS 31019 (Concluded)

Objectives:
- Know the flight-specific video hardware configuration for WVS support.
- Understand the purpose of WVS switches and PGSC commands and telemetry.
- Understand the purpose of the WVS checkout and nominal activation.
- Understand how to determine what camera is being sent to the V10 recorders.
- Understand how to troubleshoot WVS problems based on signal conditions and error messages.
- Configure the WVS PGSC and video hardware to conduct WVS operations.
- Perform WVS checkout utilizing crew procedures.
- Perform WVS nominal activation utilizing crew procedures.
- Perform nominal WVS camera image improvement based on varying lighting conditions.
- Perform WVS malfunction procedures based on given problems.
- Conduct task monitoring, closeout documentation, and problem resolution via IVA/EVA communication and camera selection.
- Route and record WVS video signals to PL3/monitor and V10s for recording.
- Record and playback WVS video.
- Properly deactivate the WVS.

24 LDRI EQ 31001

Title: Laser Dynamic Range Imager Equipment
Duration: 1.5 hours
Medium: Classroom
Note: This lesson required only if OBSS is manifested.
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DX46/Photo/TV Section
Date: 06/05
Lesson(s) Replaced: ISIS EQ 31001
Equipment Required: Computer, projector
Prerequisite Lesson(s): CCTV OPS 32019
Preparation: None
STS PHO/TV Lesson Descriptions

24  **LDRI EQ 31001 (Concluded)**

Synopsis: This lesson will introduce the crew to the Laser Dynamic Range Imager (LDRI) instruments used on the Orbiter Boom Sensor System (OBSS) boom for Shuttle Thermal Protection System (TPS) inspection. LDRI is mounted on the end of the OBSS boom. Discussed topics will include sensor design, power requirements, system control, data transfer and storage, Shuttle integration and inspection method/timeline. This lesson will prepare the crew to operate the LDRI hardware in the subsequent LDRI OPS 31012 lesson.

Objectives:
- Understand the LDRI instrument design and capabilities.
- Understand the power and data interfaces between LDRI and the Shuttle.
- Understand how LDRI is controlled.
- Understand how to collect and downlink LDRI instrument video.
- Understand how LDRI will be used with the Shuttle RMS for TPS inspection.

25  **LCS EQ 31001**

| Title: Laser Camera System Equipment |
| Duration: 2.0 hours |
| Medium: Classroom |
| **Note:** This lesson only req'd if OBSS manifested. |
| Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT |
| Source: **DX46/Photo/TV Section** |
| Date: 06/05 |
| Lesson(s) Replaced: None |
| Equipment Required: Computer, projector, A31p laptop with LCS software |
| Prerequisite Lesson(s): LDRI EQ 31001 |
| Preparation: None |

Synopsis: This lesson will introduce the crew to Sensor Package 2 used on the OBSS boom for Shuttle Thermal Protection System (TPS) inspection. Sensor Package 2 is the Laser Camera System (LCS) with Integrated Sensor Inspection System (ISIS) Digital Camera (IDC) and is statically mounted on the end of the OBSS boom. Discussed topics will include sensor design, power requirements, system control, data transfer and storage, shuttle integration, inspection method/timeline and IDC operations. This lesson will prepare the crew to operate Sensor Package 2 from the A31p laptop in subsequent inspection training sessions in the SMS.
STS PHO/TV Lesson Descriptions

25 **LCS EQ 31001 (Concluded)**

Objectives:
- Understand the Sensor Package 2 instrument design and capabilities.
- Understand the power and data interfaces between Sensor Package 2 and the Shuttle.
- Understand how Sensor Package 2 is controlled.
- Understand how to collect and downlink Sensor Package 2 data.
- Understand how Sensor Package 2 will be used with the Shuttle RMS for TPS inspection.

26 **LDRI OPS 31012**

Title: Laser Dynamic Range Imager Operations  
Duration: 2.0 hours  
Medium: FFT or CCT or SMS FB or SMS GNS  
Note: This lesson required only if OBSS is manifested.  
Student: As assigned by CDR.  
Source: DX46/Photo/TV Section  
Date: 04/06  
Lesson(s) Replaced: LDRI OPS 31019  
Equipment Required: See Facility Utilization Request.  
Prerequisite Lesson(s): LCS EQ 31001, PDRS UNDOCK SURVEY 91069  
Preparation: None  

Synopsis: This lesson will give the crew a chance to perform hands-on procedures with the actual or simulated Laser Dynamic Range Imager (LDRI) hardware while in the flight deck environment of the FFT. This will allow them to understand the panel interfaces to LDRI hardware and be able to properly route video as required within the flight deck.

Objectives:
- Understand the flight deck panel interfaces to LDRI hardware.
- Identify individual LDRI system switches and understand their function.
- Understand the procedures involved with LDRI and the inter-relationships between checklists.
- Perform LDRI activation, operation, and deactivation procedures.
- Understand LDRI malfunction procedures.
Title: Centerline Camera Operations
Duration: 2.0 hours
Medium: FFT
Student: As assigned by CDR.
Source: DX46/Photo/TV Section
Date: 02/01

Lesson(s) Replaced: None
Equipment Required: See Facility Utilization Request.
Prerequisite Lesson(s): CCTV OPS 31019
Preparation: None

Synopsis: During this two-hour lesson, the student will perform the setup and operation of the Battery Speaker Microphone (BPSMU), Camcorder, and Centerline camera. The lesson will conclude with a setup and operation of Video Switching Unit (VSU) failure associated hardware to perform Centerline camera operations.

Objectives:
- Understand the H/W and signal routing required to perform BPSMU audio-only operations.
- Understand the H/W and signal routing required to perform BPSMU with Camcorder operations.
- Understand the H/W and signal routing required to perform Centerline camera operations.
- Understand the H/W and signal routing required to control the Centerline camera with a VSU Failure configuration.
- Configure and operate the BPSMU in an audio-only configuration from the Orbiter Docking System (ODS).
- Configure and operate the BPSMU and Camcorder from the ODS.
- Configure and operate the Centerline camera. Perform Centerline camera alignment verification.
- Configure the flight deck for VSU failure operation. Operate the Centerline camera with the VSU Failure H/W.
CCTV LIGHTING 91019

Title: CCTV Lighting
Duration: 2.0 hours
Medium: FFT
Student: As assigned by CDR.
Note: This lesson may be performed out of sequence in preparation for integrated simulations if deemed necessary. Lesson must be scheduled after hours for lights-out operation.
Source: DX46/Photo-TV Section
Date: 10/05
Lesson(s) Replaced: APPR&DOCK TV 91020
Equipment Required: See Facility Utilization Request.
Prerequisite Lesson(s): C/L CAMR OPS 91019
Preparation: None

Synopsis: In this lights-out lesson, the crewmember will start off looking at centerline camera views of a docking target under various lighting conditions. They will learn what camera settings work best for each situation and understand what auxiliary lighting options work best. A simulated docking to the target will be performed. The crewmember will then learn to control and evaluate the capabilities of Videoinspection and Payload Bay Camera illuminator lights while also learning about the low light capabilities of the different cameras.

Objectives:
• Properly mount the centerline camera monitor overlay.
• Understand centerline camera exposure settings for video of a docking target under a range of lighting conditions.
• Change the camera focus in a timely fashion to maintain a sharp picture of the docking target during the final phases of the docking.
• Understand auxiliary lighting configurations for a range of different lighting conditions.
• Know how to activate/deactivate the payload bay camera and Videoinspection camera illuminators.
• Understand the low light capabilities of the payload bay cameras.
• Understand the capabilities of the camera illuminators under different lighting conditions.
STS PHO/TV Lesson Descriptions

29  **IR CAMR EQ 31001**

Title: Infrared Camera Equipment  
Duration: 2.0 hours  
Medium: Classroom  
Student: EVA and IVA crewmembers  
Source: DX46/Photo/TV Section  
Date: 06/08  
Lesson(s) Replaced: EVA IR CAMR EQ 31001  
Equipment Required: IR camera, computer, projector  
Prerequisite Lesson(s): BASIC PHOTO 31001  
Preparation: None  

Synopsis: This lesson will introduce the crew to the Infrared (IR) camera that will be used for Thermal Protection System (TPS) or other thermal related inspections. The topics will cover camera assembly and operations.

Objectives:  
• Understand basic thermography concepts and applications.  
• Understand the Infrared (IR) camera design and capabilities.  
• Understand the Remote Control Unit (RCU) keypad and menus.  
• Understand how movies are collected and transferred to a PGSC.  
• Understand how the camera will be used for TPS inspection.

30  **IR CAMR SKL 31001**

Title: Infrared Camera Skills  
Duration: 2.0 hours  
Medium: Classroom  
Student: EVA and IVA crewmembers  
Source: DX46/Photo/TV Section  
Date: 06/08  
Lesson(s) Replaced: EVA IR CAMR SKL 31209  
Equipment Required: IR camera, TPS samples, PGSC  
Prerequisite Lesson(s): IR CAMR EQ 31001  
Preparation: None  

Synopsis: This lesson will allow the crewmembers to use the camera to image Reinforced Carbon Carbon (RCC) targets and practice techniques for capturing the desired imagery. The topics will cover camera assembly, operations and imagery downloading to the laptop.

Objectives:  
• Understand the Infrared (IR) camera hardware.  
• Understand how to operate the camera.  
• Record movies and transfer them from Random Access Memory (RAM) to the Compact Flash (CF) card.
STS PHO/TV Lesson Descriptions

30  IR CAMR SKL 31001 (Concluded)

- Understand how the camera will be used for Thermal Protection System (TPS) inspection.
- Understand how movies are collected and transferred to a PGSC.

31  SPECIAL PHOTO 31001

Title: Special Photo Operations
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX46/Photo/TV Section
Date: 04/06
Lesson(s) Replaced: SPECIAL PHO 31001
Equipment Required: Camera system hardware, slide projector, FDF
Prerequisite Lesson(s): EXT PHO SKL 31153
Preparation: None

Synopsis: The crew will receive a briefing including a slide presentation for special photographic opportunities. The unique photographic situations during EVA, payload deploy, OMS burns, lighting, night operations, etc., will be discussed.

Objectives:
- Gain an in-depth understanding of various pieces of specialized hardware such as night scopes, nocturnal lenses, and high speed emulsions.
- Gain basic knowledge needed to photograph a multitude of space images.

32  PHO/TV PROC 31019

Title: Generic Photo/Television Procedures
Duration: 2.0 hours
Medium: FFT or CCT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (Schedule in groups of 2-3.)
Source: DX46/Photo/TV Section
Date: 04/06
Lesson(s) Replaced: PHO/TV PROC 21020
Equipment Required: See Facility Utilization Request, FDF
Prerequisite Lesson(s): EXT PHO SKL 31153, CCTV OPS 31019
Preparation: None
STS PHO/TV Lesson Descriptions

32 PHO/TV PROC 31019 (Concluded)

Synopsis: This lesson consists of the performance of integrated photo and CCTV procedures including unstowage, assembly, operation, disassembly, and stowage using the appropriate FDF documents. Flight-specific documentation is desirable, but not required.

After a short classroom briefing on Photo/TV Checklist organization, the students will set up typical scenes involving the use of in-cabin photo and CCTV cameras as well as payload bay CCTV cameras. Student performance using the CCTV system can be evaluated by observing the onboard monitors. In the case of photo, film may be exposed during the lesson and used to evaluate student performance.

Objectives:

- Gain a basic understanding of Photo and TV systems in relation to specific flight scene requirements within the orbiter environment.
- Be able to utilize the generic FDF procedures to setup and activate Photo/TV scene requirements.

33 ISS EXT SRVY 91001

Title: International Space Station (ISS) External Survey
Duration: 1.0 hours
Medium: Classroom
Student: COMMANDER, Pilot, MS 1, MS 2, MS 3, MS 4, MS 5, ISS Crewmember Going Up (Attendance per CDR.)
Source: KX/Image Science and Analysis Group (IS&AG)
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Computer, projector, screen, photographs
Prerequisite Lesson(s): PHO/TV PROC 31019
Preparation: Review Photo/TV checklist listed ISS external survey requirements and procedures.

Synopsis: During this 1.0 hour lesson, the student will be instructed on the acquisition of ISS external still and video imagery through a review by KX personnel of previous mission imagery acquired during the various phases of a Shuttle flight to the ISS (approach, docking, docked, backaway, and fly-around). The usefulness of various lighting conditions will be reviewed along with a brief overview of how ISS External Survey imagery has been used to access the condition of ISS external surfaces. DX personnel will review the sections of the P/TV Checklist associated with ISS External Survey imagery acquisition. In addition to instruction on the collection of still and video imagery of the ISS external surfaces, there will be instruction by KX on the procedures for video acquisition of ISS appendage motion during dedicated structural dynamics tests or other
ISS EXT SRVY 91001 (Concluded)

opportunities such as Reboost or Collision Avoidance maneuvers. There will also be a review of the ISS Exterior Images CD which is flown as a reference in the FDF. This lesson will prepare the crew to meet the ISS External Survey imagery requirements listed in IDRD Annex 3 tables.

Objectives:

- Understand the ISS external survey photographic and video requirements.
- Understand the importance of the ISS external survey imagery for change detection and trouble-shooting through review of existing areas of concern on the ISS external surface.
- Understand the types of debris that can be seen through Shuttle windows by reviewing previous anomalies and be sensitized that much of this debris is expected and usually not of major concern.
- Understand proper camera settings for acquisition of imagery of any anomalous debris seen through the windows.
- Understand the periods in which ISS survey targets should be acquired.
- Understand proper camera configurations and lighting situations for photographing or video taping ISS.
- Know where the ISS external survey procedures and requirements are listed in the Photo/TV checklist.
- Understand the video set-up for the Structural Dynamics tests.
- Understand where the ISS Exterior Images CD is stowed and what images are available on the CD.
- Understand the major components of the ISS configuration for their mission.

PHO/TV PROC 91019

Title: Flight-Specific Photo/Television Procedures
Duration: 2.0 hours
Medium: FFT or CCT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule in groups of up to 4.)
Source: DX46/Photo/TV Section
Date: 04/06
Lesson(s) Replaced: PHO/TV PROC 21020
Equipment Required: See Facility Utilization Request, Flight-specific Photo/TV Checklist
Prerequisite Lesson(s): MINICAM PHO SKL 31019, PHO/TV PROC 31019, SPECIAL PHOTO 31001, LDRI OPS 31012, WVS OPS 31019, CCTV LIGHTING 91019, ET PHO SKL 31001, IR CAMR SKL 31001, D2XS EVA PHO SKL 31031
STS PHO/TV Lesson Descriptions

34 PHO/TV PROC 91019 (Concluded)
Preparation: None
Synopsis: This lesson consists of the performance of photo and TV procedures in a flight-configured trainer. The student will set up selected flight-specific in-cabin photo and TV scenes utilizing flight-specific Photo/TV Checklist. Additionally, the payload bay will be properly configured with payload mockups allowing the student to evaluate CCTV camera fields-of-view, blockages, etc.
Objectives:
• Gain understanding of photo and TV systems in support of scene requirements in the flight-configured orbiter environment.
• Be able to use the flight-specific FDF procedures to set up and activate the photo/TV hardware.

35 PHO/TV PROC 92019
Title: Flight-Similar Photo/Television Procedures
Duration: 2.0 hours
Medium: FFT or CCT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule in groups of up to 4.)
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: None
Equipment Required: See Facility Utilization Requirement, Flight-specific Photo/TV checklist
Prerequisite Lesson(s): PHO/TV PROC 91019
Preparation: None
Synopsis: Refer to PHO/TV PROC 91019 for synopsis.
Objectives: Refer to PHO/TV PROC 91019 for objectives.
STS PHO/TV Lesson Descriptions

36 PHO/TV PROC 93019
Title: Flight-Similar Photo/Television Procedures
Duration: 1.0 hour
Medium: FFT or CCT
Note: This is an optional session.
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule is groups of up to 4.)
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: PHO/TV PROC 33020
Equipment Required: See Facility Utilization Request; flight-specific Photo/TV checklist
Prerequisite Lesson(s): PHO/TV PROC 92019
Preparation: None
Synopsis: This is a final photo/TV procedures lesson covering late hardware and procedure changes.
Objectives: Refer to PHO/TV PROC 91019 for objectives.

37 CAMR REVIEW 41001
Title: Camera Review
Duration: 2.0 hours
Medium: Classroom
Note: This class may be scheduled in crew quarters during quarantine.
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DX46/Photo/TV Section
Date: 02/01
Lesson(s) Replaced: None
Equipment Required: Camera systems manifested, FDF
Prerequisite Lesson(s): All PHOTO/TV lessons deemed necessary for the specific mission. This should be the last PHOTO/TV class prior to flight.
Preparation: None
Synopsis: This lesson will provide the student with a review of the hands-on operation of any camera hardware system with instructor supervision.
Objectives: • Obtain a reinforced understanding of any camera system.
• Obtain a briefing on last minute updates and changes to hardware and/or procedures.
SECTION 6.0 ASCENT/ENTRY FLIGHT OPERATIONS TRAINING COURSE

Ascent/Entry Flight Operations training prepares orbiter crewmembers for flight operations for the period from crew ingress to orbital insertion and deorbit burn through landing. The majority of this training is accomplished in the SMS. All necessary 20000-level lessons, including Qual lessons for all required crewmembers, must be completed prior to starting Ascent/Entry Flight Operations Training.

30000-level lessons are intended for assigned crews. All these lessons would be taken by assigned crews once before their flight and some might be repeated prior to subsequent flights. The number of lessons to be repeated depends on the time elapsed since the crew’s last flight and on the time required for a new combination of experienced crewmembers to achieve an adequate level of cockpit coordination.

Those lessons with code numbers beginning with a 9 are intended for assigned crews and require the use of a simulator software load that closely resembles the flight software and vehicle configuration to be used by the crew on their assigned flight. These lessons are repeated by a crew prior to each flight regardless of previous flight assignments. The 30000-level and 90000-level lessons should be conducted with the CDR, PLT, MS 2, and any other crewmembers, who will have an active role in the ascent or entry phase.

Manual flying techniques are covered in several lessons. All CDRs should be proficient in manual skills for nominal ascents, aborts, and entries, at the beginning of assigned crew training. Proficiency in manual control during first stage is not a requirement for this training course.

Prior to each SMS lesson the crew may meet with the instructors for an informal briefing as necessary. Also, there are several briefings, which are a formal part of the ascent/entry course. The purpose of these briefings is to discuss what will be occurring during the subsequent lessons and to cover any questions, which the crewmembers may have. The lesson descriptions list all reading material and checklists, which should be reviewed prior to the briefing.

Space Flight Resource Management (SFRM) lessons are included in this course to enhance team effectiveness and to ensure mission safety and success. A flow chart diagram depicting the entire SFRM flow may be found in Appendix B of the catalog.

Detailed descriptions of the objectives for each of the lessons along with information on the conduct of these lessons are included in this section of the catalog.
Figure 6-1. Ascent/Entry Flight Operations Lesson Flow Chart (Sheet 1 of 3)
Figure 6-1. Ascent/Entry Flight Operations Lesson Flow Chart (Sheet 2 of 3)
Figure 6-1. Ascent/Entry Flight Operations Lesson
Flow Chart (Sheet 3 of 3)
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Suited: Entry MS opt'l
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Sub Total for Stage: 33.5
Stage Totals Per Crewmember: 33.5 8.5 33.5 0 0 0 33.5 33.5 8.5 33.5
Ascent/Entry Flight Operations Lesson Descriptions

Additional Objective Content for 30000-Level Extra Runs &
40000-90000-Level Ascent Skills, Entry Skills, and Proficiency Lessons

The purpose of this objective list is to document those objectives deemed important for
crew training, but that are not covered in the scripted 30000-level Ascent and Entry
Skills lessons. The new QUEST training philosophy deems it unnecessary to train
every documented procedure/failure, and this list complies with that philosophy. This
philosophy presumes that a trained crew will still be able to perform all procedures,
including all nominal mission success activities, even though they may not have seen all
of those procedures during training. At no time should safety be compromised. An
adequate margin of safety (both in the scripts themselves and during the sims), as
defined by the combined experience of all participants, should be maintained.

These objectives are to be used by the Team Lead and SMS Team to develop scripts,
as needed, for any 30000-level extra runs, as well as any 40000-level/90000-level
Ascent Skills, Entry Skills and Proficiency lessons. Some training templates will include
as few as zero 40000-level lessons (this is an acceptable level). All objectives listed
can be accomplished in the 30000-level and 90000-level lessons. Multiple-discipline
systems and crew interaction should be built into the scripts in order to exercise Space
Flight Resource Management (SFRM). SFRM interaction is inherent in the 30000-level
scripted cases. Individual SMS Teams are responsible for SFRM training, utilizing
opportunities as they present themselves.

It is the responsibility of the Team Lead and SMS Team to script runs to cover all of the
additional objectives listed here, as well as any missed objectives from the 30000-level
scripted lessons. Any listed objective with the “{x times}” notation following it is to be
scripted the number of times listed in order to maintain proficiency. All other objectives
are to be scripted at least once.

30000-Level Skills:

Four runs have been scripted for each of the Ascent and Entry Skills 30000-level
lessons. In some lessons (with a very proficient crew, where runs went extremely well
with short debriefs, with no simulator problems, etc.), there may be extra time available
to perform an additional run. Thus, the Team Lead and SMS Team should plan for and
script an additional run for each of the 30000-level skills lessons. Objectives from this
list should be scripted into any extra run developed.

40000/90000-Level Ascent Skills, Entry Skills, and Proficiency Lessons:

The Team Lead and SMS Team will use these objectives to script all 40000-level (if any) and 90000-Level Ascent Skills, Entry Skills, and Proficiency Lessons. The SMS Team should also periodically introduce failures (first utilizing objectives from the available list, then adding supplementary objectives, if necessary) in all systems to
Ascent/Entry Flight Operations Lesson Descriptions

stress crew understanding of vehicle-specific problems and Launch Commit Criteria (LCC) for both GO and NO-GO scenarios.

DPS/NAV Objectives

DPS
1. Crew-initiated Launch Hold (Discussion only)
2. DK bus fail at a PASS GPC
3. Dual commanders
4. SUMWORD ICC message on a TAL
5. BFS power transient
6. BFS fail to STBY (for COMM)*
7. One failure away from BFS self-engage
8. BFS self-engage
9. BFS disengage
10. Engage for RS split close to MECO
11. Engage for no Roll Program
12. Pad Abort with BFS in MM102
13. Post-Landing procedures

NAV
1. IMU reanchoring
2. NAV DELTA ZERO around 200K (reanchoring conditions not met)
3. BFS silent TACAN dilemma
4. MLS RM FAIL
5. MLS RM DLMA in elevation

* Denotes an objective listed in multiple disciplines. Scripting the objective once will accomplish that objective for all disciplines.
Ascent/Entry Flight Operations Lesson Descriptions

Systems Objectives

APU/HYD/MECH
1. APU Shift to High Speed
2. Late APU Start
3. NWS Loss*
4. Water Spray Boiler Leak
5. Manual/Software ET Door Closure
6. Hydraulic Accumulator Leak
7. APU Fuel Leak – unisolatable/isolatable
8. Gearbox Friction

EPS
1. FC Coolant Pump Fail
2. FC Stack T High
3. Reac Valve Fail Closed
4. Essential Bus with Main Controller circuit breaker popped
5. Main Bus Disconnect (recoverable)
6. 3-Phase Motor failure
7. CRYO Leaks

ECLSS
1. RTLS for Cabin Leak
2. No FES Command due to PL Bus Loss
3. False Fire
4. O₂/N₂ Leak into the cabin
5. Fan Degrades
6. H₂O Loop Controller Fail
7. Use of the GPC position of the H₂O Loop switch

* Denotes an objective listed in multiple disciplines. Scripting the objective once will accomplish that objective for all disciplines.
Ascent/Entry Flight Operations Lesson Descriptions

**COMM Objectives**

**Audio/UHF**
1. ICOM loss
2. Loss of all voice with command capability
3. Loss of all voice without command (Rev 2)
4. UHF power filter - - exercise guard frequency
5. UHF pwr amp

**Antenna Management**
1. BFS fail to STBY*

**S-band PM/GCIL**
1. Loss of uplink voice and command (Pre-Amp)
2. Loss of downlink voice and data (Pwr Amp)
3. Transponder mode with OF 3 before TDRS

**FDF Procedures**
1. Comm Lost (multi-pnls) all the way through Mal Proc
2. Post-Landing (Loss of Comm)

**Post-Landing**
1. No S-band Comm, use UHF
2. No command (ant. pointing and Ops Recorders)

* Denotes an objective listed in multiple disciplines. Scripting the objective once will accomplish that objective for all disciplines.
Ascent/Entry Flight Operations Lesson Descriptions

CONTROL Objectives

Ascent
1. Launch Abort/Recycle
2. TAL Redesignation
3. Post-MECO TAL
4. Alternate TAL Site
5. FRCS OMS-2
7. OMS Helium Tank P Low (either a Sensor Fail, Prop Tk Lk, He Tk Lk, or He Line Lk)
8. APUs failed, ATVC Impact
9. BFS No-Go (either no SERC, 2 SRB RGAs failed, or BFS RM actions not complete)
10. Off-nominal Bucket (hot/cold SRBs) {2 times}

Ascent or Entry
1. Select Short Field Speedbrake
2. Crosswind Limits (calm to 15 kts) {2 times}
3. Tailwinds/Headwinds
4. Select Close-In aimpoint
5. NWS fail*
6. Visibility/Clouds {2 times}
7. Tire Failure {2 times}
8. Expedited Powerdown due to OMS/RCS Fu Leak
9. Green Dot
10. Uncommanded Drag Chute Deploy/Jettison {2 times}
11. Single APU Landing

* Denotes an objective listed in multiple disciplines. Scripting the objective once will accomplish that objective for all disciplines.
Entry
1. NWS Fail light at WONG {2 times}
2. Lakebed Required
Ascent/Entry Flight Operations Lesson Descriptions

1A  **SFRM ACT 31001**

**Title:** Space Flight Resource Management Assigned Crew Training  
**Duration:** 3.0 hours  
**Medium:** Classroom  
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1 (CB IA recommended)  
**Note:** Training Team members encouraged to attend.  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 07/99  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** Ascent/Entry Quals (CORE SYS), SFRM Training Strategy Mtg (Addendum)  
**Preparation:** None  

**Synopsis:** This interactive course is designed as an introduction to the philosophies and application of Space Flight Resource Management (SFRM). It briefly covers the definition of SFRM, Windows of Awareness, and the six Performance Elements. A video tape is shown to the crew demonstrating poor performance in these elements. The crew is introduced to observable skills relating to the Performance Elements. They are then given an opportunity to assess the performance of a Shuttle crew in a Return-To-Launch Site (RTLS) simulation utilizing the SFRM Crew Debrief Facilitation Guide. They are shown a second RTLS and are allowed to compare and contrast crew actions with that of the first. Finally, recent SFRM-related events are discussed.

**Objectives:** Following this course, the crew will understand the basic philosophies of SFRM and the application to the training and operational environments. They will be familiar with the SFRM Crew Debrief Facilitation Guide and how it will be applied.

1B  **ASC/ABT SFRM 31001**

**Title:** Ascent Trajectory/Abort Space Flight Resource Management Prebrief  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** COMMANDER, MS 1, MS 2, PILOT  
**Source:** DS66/G&C/Propulsion Training Group  
**Date:** 12/06  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** SFRM ACT 31001
Ascent/Entry Flight Operations Lesson Descriptions

1B  ASC/ABT SFRM 31001 (Concluded)

Preparation: Review:
- Crew-Specific Cockpit responsibilities
- Abort Mode Boundary definitions

Synopsis: This prebrief is designed to allow a new crew to determine their
crewmember roles as would be utilized during the Ascent flight phase. In
addition, the definitions of all abort mode boundary calls are included in
handout material, and Space Flight Resource Management (SFRM)
elements are reviewed.

Objectives: At the end of this prebrief, the student will be able to perform the following
objectives:
- Determine the crew roles, both prime and backup SFRM, with respect to:
  - Nominal uphill
  - Abort To Orbit (ATO) (OMS 1 required)
  - Transatlantic Abort Landing (TAL)
  - Return-To-Launch Site (RTLS)
- Identify crew-specific preferences during ascent (i.e., Integrated Display
  Processor (IDP) Display management, Space Shuttle Main Engine
  (SSME) shutdown, abort verification, etc.).
- Discuss the chain of command for the execution of abort decisions.
- List the Abort Mode Boundary Calls, in the proper sequence, for each
  abort scenario.
- Discuss the immediate actions following an engine failure in relation to
  each Abort Mode Boundary Call.
- Identify the expected nominal trajectory/guidance cues for the above
  listed runs.
- Identify the various timeframes for nominal Global Positioning System
  (GPS) incorporation.

1C  ASC/ABT SFRM 31011

Title: Ascent Trajectory/Abort Space Flight Resource Management
Duration: 4.0 hours
Medium: SMS-MB (SMS-FB, GNS)
Student: COMMANDER, MS 1, MS 2, PILOT (Schedule ascent MSs only.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC/ABT SFRM 31001
Preparation: None
Ascent/Entry Flight Operations Lesson Descriptions

1C ASC/ABT SFRM 31011 (Concluded)

Synopsis: This lesson is designed to allow a new crew to exercise (and adjust to, if needed) their crewmember roles, as would be utilized during the Ascent flight phase. The CDR, PLT, and the ascent MS will experience Ascent/Abort scenarios in the Ascent flight phase, during which they will be able to facilitate Crew coordination and recognition of trajectory cues for each Ascent/Abort scenario.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:

- Coordinate the performance of crew roles, both prime and backup Space Flight Resource Management (SFRM), with respect to:
  - Nominal uphill
  - Abort To Orbit (ATO) (OMS 1 required)
  - Transatlantic Abort Landing (TAL)
  - Return-To-Launch Site (RTLS)
- Exercise crew-specific preferences during ascent (i.e., Integrated Display Processor (IDP) DPS Display management, Space Shuttle Main Engine (SSME) shutdown, abort verification, etc.).
- Demonstrate crew coordination and execution of abort decisions (chain of command).
- Make each Abort Mode Boundary Call.
- Identify nominal trajectory/guidance cues for an Uphill, ATO with OMS 1, TAL and RTLS.
- Demonstrate usage of appropriate FDF (Nominal & Off-Nominal).

2A A/E FCS 31001

Title: Ascent/Entry Flight Control Surfaces Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Ascent/Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 04/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC/ABT SFRM 31011
Preparation: None

Synopsis: This prebrief will review the Flight Control System (FCS) operations for the Ascent and Entry flight phases.
Ascent/Entry Flight Operations Lesson Descriptions

2A  A/E FCS 31001 (Concluded)

Objectives: At the end of this prebrief, the student will be able to perform the following objectives:
- Identify FCS channel failures using available CRT displays, CRT messages, master alarm and Systems Management (SM) alert.
- State when Fault Detection, Isolation, and Recovery (FDIR) quits and the selection filter downmodes for FCS position feedback errors.
- Define aerosurface positions and moments.
- Explain when manual port bypassing is necessary.
- Explain prioritization as it relates to FCS channel management.
- Explain FCS channel actions in General Purpose Computer (GPC) and Flight Aft Multiplexer/Demultiplexer (FA MDM) failure scenarios.
- Define body flap caution and warning.

2B  A/E FCS 31006

Title: Ascent/Entry Flight Control Surfaces
Duration: 2.0 hours
Medium: SST 1
Student: COMMANDER, MS 2, PILOT (Ascent/Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 04/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): A/E FCS 31001
Preparation: None

Synopsis: This lesson covers the operation of the Flight Control System (FCS) for the Ascent and Entry phases of flight as well as the associated FDF procedures. The crewmembers will be expected to monitor the FCS system throughout the lesson and respond to system failures as they occur.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
- Identify FCS channel failures using available CRT displays, CRT messages, master alarm and Systems Management (SM) alert.
- State when Fault Detection, Isolation, and Recovery (FDIR) quits and the selection filter downmodes for FCS position feedback errors.
- Define aerosurface positions and moments.
- Explain when manual port bypassing is necessary.
- Explain prioritization as it relates to FCS channel management.
Ascent/Entry Flight Operations Lesson Descriptions

2B  
A/E FCS 31006 (Concluded)

- Explain FCS channel actions in General Purpose Computer (GPC) and Flight Aft (FA) Multiplexer/Demultiplexer (MDM) failure scenarios.
- Define bodyflap caution and warning.

3A  
APPR/LNDG 31001

Title: Approach and Landing Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 03/96  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ASC/ABT SFRM 31011  
Preparation: None  
Synopsis: This prebrief is a discussion of Space Flight Resource Management (SFRM) for approach and landing, landing-specific Flight Rules, and orbiter systems-related failures.  
Objectives: At the end of this prebrief, the student will be able to perform the following objectives:  
- Identify the crew-specific responsibilities required for approach and landing related to the nominal landing timeline duties.  
- Describe the impacts to landing with respect to the following:  
  - Single Auxiliary Power Unit (APU) landings  
  - Braking  
  - Short field speedbrake  
  - Backup Flight System (BFS) landings  
  - Off-nominal wind profiles  
  - Drag chute deploys  
- Describe expected landing parameters.

3B  
APPR/LNDG 31011

Title: Approach and Landing  
Duration: 2.0 hours  
Medium: SMS-MB  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 12/95  
Lesson(s) Replaced: None
Ascent/Entry Flight Operations Lesson Descriptions

3B  APPR/LNDG 31011 (Concluded)

Prerequisite Lesson(s): None
Prerequisite Lesson(s): APPR/LNDG 31001
Preparation: None

Synopsis: This lesson consists of runs that exercise landing Flight Rules and systems failures.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
  • Perform nominal landing timeline duties associated with assigned cockpit position.
  • Perform single Auxiliary Power Unit (APU) landings, steering tasks, and drag chute deploys.
  • Perform a safe landing given any of the following situations:
    – Crosswinds
    – Backup Flight System (BFS) landings
    – Short field speedbrake
    – Tire failures

4A  TAEM GUID 31001

Title: Terminal Area Energy Management Guidance Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 04/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): A/E FCS 31006, APPR/LNDG 31011
Preparation: None

Synopsis: This prebrief will review the basics of Terminal Area Energy Management (TAEM) guidance including cockpit cues, energy downmode/upmode options, and hardware requirements for TAEM guidance. Other issues relative to TAEM guidance such as high winds and large Heading Alignment Cone (HAC) turns are also discussed.

Objectives: At the end of this prebrief, the student will be able to perform the following objectives:
  • Recognize and explain the following issues associated with large HAC turn angles:
    – Horizontal Situation Indicator (HSI) HAC errors
    – Energy dump, pull-up, and pull-up recovery maneuvers
Ascent/Entry Flight Operations Lesson Descriptions

4A TAEM GUID 31001 (Concluded)

- Recognize and explain the effect of high winds on the HAC.
- Recognize automatic energy downmodes and upmodes.
- Recognize the need for and execute manual energy downmodes and upmodes.
- Recognize the situation where theta limits must be used for pitch reference in lieu of TAEM guidance, and configure the system accordingly.
- Safely fly throughout TAEM using the theta limits for a pitch reference.
- Safely fly throughout TAEM with a loss of normal Z accelerometer redundancy.

4B TAEM GUID 31011

Title: Terminal Area Energy Management Guidance
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 04/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TAEM GUID 31001
Preparation: None

Synopsis: This lesson is designed to demonstrate large Heading Alignment Cone (HAC) turns, high winds on the HAC, a high energy case, a low energy case, loss of Accelerometer Assembly (AA) redundancy, loss of air data redundancy, and the use of Horizontal Situation Indicator (HSI) HAC for bad nav state.

Each run will start at approximately Mach 2.6 and be flown to approach and landing interface. Both CDR and PLT will be given the opportunity to fly each scenario.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
- Recognize the effects of a large HAC turn angle on Terminal Area Energy Management (TAEM) guidance.
- Safely fly TAEM with an abnormally high energy state.
- Safely fly TAEM with an abnormally low energy state.
- Safely fly TAEM with no AA redundancy.
Ascent/Entry Flight Operations Lesson Descriptions

4B  **TAEM GUID 31011 (Concluded)**

- Reconfigure the system as required and safely fly TAEM using theta limits, with the loss of air data redundancy.
- Fly the Area Navigation HAC using the HSI for reference.

5A  **ASC SKL 31001**

**Title:** Ascent Skills Prebrief  
**Duration:** 2.0 hours  
**Medium:** Classroom  
**Student:** COMMANDER, MS 2, PILOT (Ascent MS optional.)  
**Source:** DA72/QUEST  
**Date:** 01/96

**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** TAEM GUID 31011

**Preparation:** Read:
- APU Cooldowns/Restarts Prebrief
- S-Band PM Nominal Comm Coverage Prebrief
- OMS Targeting Prebrief
- 3-phase Motors Stopped Handout
- IMU & Entry NAVAID Failures Handout

**Synopsis:** This is a 3-part prebrief. The topics are OMS Targeting, S-Band Phase Modulation (PM) Nominal COMM Coverage, and Auxiliary Power Unit (APU) Cooldowns/Restarts. This prebrief allows a new crew to determine and develop their crewmember roles and coordination of activities regarding OMS-1/2 Targeting. Secondary emphasis will be placed on the management of OMS-1/2 target determination. The S-Band PM Nominal COMM Coverage Prebrief reviews the nominal ascent COMM coverage along with the high/low freq and high/low data rate relationship. The APU Cooldowns/Restarts prebrief reviews the APU COOLDOWN and RESTART procedures, as well as the reasons/justification for performing an APU Restart.

**Objectives:** At the end of each discipline-specific prebrief, the student will be able to perform the following objectives:
- OMS Targeting Prebrief:
  - Determine the prime and backup crewmember responsible for performing OMS-1/2 Targeting.
  - State what priority OMS-1/2 Targeting will take in the event of a failure scenario.
Ascent/Entry Flight Operations Lesson Descriptions

5A ASC SKL 31001 (Concluded)

- State which other nominal activities will be performed simultaneously with OMS-1/2 Targeting.
- Walk through the post-Main Engine Cutoff (MECO) procedures, given the post-MECO conditions and the required FDF, and practice crew-specific Space Flight Resource Management (SFRM) plan for OMS-1/2 Targeting.

- S-Band PM Nominal COMM Coverage Prebrief:
  - Determine Orbiter COMM coverage per the Ascent Checklist (ASC C/L).
  - Discuss the COMM system configuration (panel A1) per expected COMM coverage.
  - Discuss failure indications associated with the Network Signal Processor (NSP), Transponder, and Communications Security (COMSEC) systems.
  - Explain contingency COMM coverage utilized during a Transatlantic Abort Landing (TAL) and Return-To-Launch Site (RTLS).

- APU Cooldowns/Restarts Prebrief:
  - State why a cooldown is required before restarting a hot APU.
  - Discuss how much cooling time is available.
  - Explain how to verify that a cooldown is working properly.
  - Discuss APU failures that would require a cooldown.
  - Identify those situations where an attempted restart is appropriate.
  - State when the COOLDOWN and RESTART should take place for an APU that:
    - Has suffered an oil overtemp.
    - Is “suspect.”
    - Has suffered an unexplained underspeed.
    - Has picked up an unisolable fuel leak.
  - Discuss when a Diagnostic Restart is required.
  - Discuss the likelihood of a successful restart for the above types of failures.

5B ASC SKL 31011

Title: Ascent Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DA72/QUEST
Date: 01/96
Lesson(s) Replaced: None
Equipment Required: None
Ascent/Entry Flight Operations Lesson Descriptions

5B ASC SKL 31011 (Concluded)

Prerequisite Lesson(s): ASC SKL 31001
Preparation: None

Synopsis: This is the first 30000-level Ascent Skills lesson in a series of 5 and it is designed to allow a new crew to determine and develop their crewmember roles and coordination of activities. Primary emphasis is on crew coordination of ascent calls, abort determination and initiation activities, and OMS targeting tasks. Secondary emphasis is on management of basic EPS, DPS, and Main Propulsion System (MPS) failures. Auxiliary Power Unit/Hydraulic (APU/HYD) system management, communication coverage, and Flight Control System (FCS) channel management are also emphasized.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:

- Coordinate performance of crew roles with respect to the following:
  - Nominal ascent procedures (from liftoff through OMS-2 burn)
  - Performance boundary calls
  - Abort determination
  - Abort procedures (Abort To Orbit (ATO), Transatlantic Abort Landing (TAL), Return-To-Launch Site (RTLS))
- Identify electrical bus losses without aid from MCC.
- Demonstrate proficiency in the use of Reference Data by identifying equipment losses associated with AC/DC bus losses.
- Select and perform actions necessary to support External Tank (ET) Separation (SEP) following Reaction Control System (RCS) jet failures.
- Configure orbiter COMM systems for nominal ascent.
- Identify and recover from S-band Phase Modulation (PM) (voice/telemetry/command) COMM value based on expected COMM coverage as identified in the Ascent (ASC) Checklist (C/L).
- Manage the following failures to maintain critical systems and capabilities:
  - Space Shuttle Main Engine (SSME) failures
  - Data path failures
  - MPS He leaks
  - Electrical bus failures
  - Fuel cell failures
  - Selected General Purpose Computer (GPC) and Multiplexer/Demultiplexer (MDM) failures (identify and manage with limited MCC help)
  - APU/HYD system failures
  - Reaction Control System (RCS) leaks and jet failures (identify and manage)
  - FCS channel failures (identify and manage)
Ascent/Entry Flight Operations Lesson Descriptions

6A  ASC SKL 32001

Title: Ascent Skills Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DA72/QUEST
Date: 03/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 31011
Preparation: Read:
- Ascent/Entry Restring Rules of Thumb Prebrief
- ET Umbilical Door Prebrief
- Abort Dump Failures Prebrief
- Flight Critical & GPC DPS Failures Handout
- IMU & Entry NAVAID Failures Handout
- Audio System Handout
- Ascent/Entry Restringing Handout
- Abort Dump Failures Handout
- Av Bay Fires Handout

Synopsis: This is a 3-part prebrief. The topics cover Ascent/Entry Restring Rules of Thumb, External Tank (ET) Umbilical Doors, and Abort Dump Failures. The Ascent/Entry Restring Rules of Thumb Prebrief reviews the restring flight rules and FDF procedures for ascent and entry, and examines the “Rules of Thumb” for the best way to approach restringing. The ET Umbilical Door Prebrief reviews the nominal operations of the ET doors during the different ascent trajectories, and the actions required to correct malfunctions that may affect them. The Abort Dump Failures Prebrief discusses the failures that may occur during abort dumps and the rationale for the OMS/Reaction Control System (RCS) procedures pertaining to them.

Objectives: At the end of each discipline-specific prebrief, the student will be able to perform the following objectives:
- Ascent/Entry Restring Rules of Thumb Prebrief:
  - Identify the times and reasons when a restring is allowed per the flight rules.
  - Summarize the rationale for choosing a particular Nominal Bus Assignment Table (NBAT).
  - Discuss the rationale for the steps of the ascent and entry restring FDF procedures.
Ascent/Entry Flight Operations Lesson Descriptions

6A  ASC SKL 32001 (Concluded)

- ET Umbilical Door Prebrief:
  - Identify the different operations of the ET doors based on the ascent trajectory.
  - Identify crew actions needed when malfunctions occur during ET door operations.
- Abort Dump Failures Prebrief:
  - Explain the purpose of an Abort To Orbit (ATO) dump.
  - Identify the SPEC used to control and time ascent abort dumps.
  - Explain the purpose of smart interconnect.
  - Explain the purpose of mirror image logic.
  - Determine impacts of the following failures during an abort dump:
    - EPS
    - DPS
    - OMS
    - RCS

6B  ASC SKL 32011

Title:  Ascent Skills
Duration:  4.0 hours
Medium:  SMS-MB
Student:  COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source:  DA72/QUEST
Date:  01/96
Lesson(s) Replaced:  None
Equipment Required:  ACESs
Prerequisite Lesson(s):  ASC SKL 32001
Preparation:  None

Synopsis:  This is the second 30000-level Ascent Skills lesson in the series of 5. The crewmembers will be suited for this lesson. The primary goal of the lesson is to familiarize the crewmembers with the limitations of the suits, primarily the gloves and helmets. By having a suited lesson early in the ascent/entry training flow, the crew will be able to make informed decisions about performance capabilities during the remainder of their training, due to the understood limitations of the suits. The lesson emphasis focuses on crew coordination of ascent and abort tasks including the performance of an OMS-1 burn, the application of restring flight rules, and Auxiliary Power Unit (APU) management. Secondary emphasis is placed on Flight Control System (FCS) management, resolution of abort dump failures, and COMM system failures (mainly audio) during aborts.
Ascent/Entry Flight Operations Lesson Descriptions

6B ASC SKL 32011 (Concluded)

Objectives: At the end of this lesson, the student will be able to perform the following objectives:

- Coordinate performance of crew roles with respect to the following:
  - Nominal ascent procedures (liftoff through targeting), and performance of an OMS-1 Burn
  - Performance boundary calls
  - Abort determination
  - Abort procedures (Abort To Orbit (ATO), Transatlantic Abort Landing (TAL), and Return-To-Launch Site (RTLS))

- Given the following selected scenarios:
  - Identify General Purpose Computer (GPC) and Multiplexer/Demultiplexer (MDM) failure modes for the given signatures.
  - Determine whether a restring is allowed per the flight rules.
  - Using ascent & entry restring procedures, set up and execute a restring at the appropriate time.

- Given hot and cold Solid Rocket Booster (SRB) scenarios, analyze throttle settings and differentiate among nominal, shallow, and two stage buckets.

- Given selected OMS failures during abort dumps, do the following:
  - Diagnose the failure.
  - Perform the appropriate procedure.

- Given selected FCS Channel failures in combination with DPS failures, manage the FCS system.

- Given restring configuration and up to one additional FCS channel failure, determine appropriate FCS configuration, verify planned FCS actions with MCC, and perform.

- Given selected abort scenarios, analyze available cockpit data to do the following:
  - Diagnose loss of data and voice communication.
  - Determine source of loss.
  - Select and perform appropriate procedures to regain or maintain capabilities.

- Manage the following failures to maintain critical systems and capabilities:
  - APU/Hydraulic (HYD) System failures
  - Main Propulsion System (MPS) He leaks
Ascent/Entry Flight Operations Lesson Descriptions

7  E GUID BR 31001

Title: Entry Guidance Briefing
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 12/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 32011
Preparation: Read:
  • SCOM; Section 7.3

Synopsis: This lesson covers the guidance algorithm that functions from very high in the atmosphere (Entry Interface) to Mach 2.5 (Terminal Area Energy Management (TAEM) Interface). The orbiter aerodynamic characteristics are reviewed to better understand Entry Guidance. Detailed discussions on how to use the cockpit displays are included. Entry Guidance during a Transatlantic Abort Landing (TAL) abort will be covered very briefly. The TAL-unique aspects of Entry Guidance will be covered in the abort lessons.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
  • Determine desired altitude rate using Trajectory (TRAJ) Displays.
  • Describe how Entry guidance controls cross-range.
  • Given a TRAJ display, explain which information is derived by Guidance versus the information derived by navigation.
  • Use a TRAJ display to identify conditions where the orbiter is violating a high drag boundary.
  • Define a high and a low energy, and state what Guidance does in each case.
  • State the two different situations where prebank is required.
  • State which prebank case is worse, thermally, and explain why.
  • Explain why large bank angles are not an aggressive maneuver in early Entry.
Ascent/Entry Flight Operations Lesson Descriptions

8  E GUID 31057

Title: Entry Guidance
Duration: 2.0 hours
Medium: CBT
Student: COMMANDER, MS 2, PILOT (Schedule in groups of 2-4, including instructor, entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/95
Lesson(s) Replaced: None
Equipment Required: Computer with joystick highly desirable
Prerequisite Lesson(s): E GUID BR 31001
Preparation: None

Synopsis: This CBT is taught with an instructor and at least 2 students. Space Flight Resource Management (SFRM) techniques and manual entry flying will be emphasized. The manual flying techniques taught in this class are designed to explain how Entry Guidance works.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
• Fly from the top of Trajectory (TRAJ) 1 to Terminal Area Energy Management (TAEM) interface using desired altitude rate.
• Fly through TRAJ 1 and TRAJ 2 after an “accidental” downmode to Control Stick Steering (CSS) at the first roll command (active control will start at an H_dot of +180fps).
• Use a TRAJ display to determine when the orbiter is violating a high drag boundary.
• Fly low energy TRAJ 2 with high DEL AZ (22 deg).
• From the top of TRAJ 2, fly max. NZ and Knots Equivalent Airspeed (KEAS) to TAEM interface. State when this skill is needed.

9  E GUID 31011

Title: Entry Guidance
Duration: 2.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 03/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E GUID 31057
Preparation: None
Ascent/Entry Flight Operations Lesson Descriptions

9  **E GUID 31011 (Concluded)**

Synopsis: This is a hands-on lesson for a CDR and his/her crew. Most runs will be high-energy cases, where the crew must take Control Stick Steering (CSS) and fly the desired Altitude Rate (H_dot) to avoid over-temping the vehicle. The emphasis will be placed on good Space Flight Resource Management (SFRM), and monitoring AUTO guidance. The crew will get a chance to fly the phugoid damper in this class.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
- Successfully fly, under the following conditions, from 350K feet to Terminal Area Energy Management (TAEM) interface, using desired altitude rate:
  - Nominal energy
  - High energy
  - Low energy
- Successfully fly the orbiter through TRAJ 1 and TRAJ 2 after an "accidental" downmode to CSS at the first roll command.
- Monitor the guidance on the Trajectory (TRAJ) displays.
- Use the TRAJ display to determine the following:
  - If the orbiter is violating a high drag boundary
  - If the desired drag is violating a high drag boundary
- Identify when guidance is commanding a minimum bank angle.
- Identify a density shear while in AUTO.
- Successfully fly the phugoid damper.

10  **MAN ASC BR 31001**

Title: Manual Ascent Techniques Briefing
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E GUID 31011
Preparation: Read:
- MAN ASC BR 31001 handout; received 2 days prior to briefing
Ascent/Entry Flight Operations Lesson Descriptions

10 MAN ASC BR 31001 (Concluded)

Synopsis: This briefing is the first in a series of 2 briefings. They are both designed to review the cockpit indications and techniques used to fly nominal, Abort To Orbit (ATO), and Transatlantic Abort Landing (TAL) trajectories manually. A discussion of cockpit indications and techniques used during manual control is provided to prepare an assigned crew for Manual Ascent 31011. A review of guidance anomaly recognition, manual control, flight instruments, Integrated Display Processor (IDP) DPS Displays, FDF, and flight techniques is presented. This lesson covers trajectories similar in nature to a normal insertion to orbit, and includes manual entry techniques for TAL aborts. The following trajectories are discussed: Nominal ascent, without use of the Ascent Attitude Direction Indicator (ADI) Cue Card, ATO caused by Space Shuttle Main Engine (SSME) failure, Dual simultaneous SSME failure during ascent Single Engine Roll Control (SERC), and Two engine out-of-plane TAL to landing.

Objectives:

- Develop the crew skills to recognize when a manual takeover is required.
- Be able to fly the vehicle to Main Engine Cutoff (MECO) conditions, using navigation-derived information only:
  - Allow for orbital insertion and/or a runway landing without structural exceedances.

11 MAN ASC 31011

Title: Manual Ascent Techniques
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MAN ASC BR 31001
Preparation: None

Synopsis: This lesson reinforces the material covered in MAN ASC BR 31001 through practical application in the SMS.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:

- Recognize when a manual takeover is required.
- Establish manual control.
Ascent/Entry Flight Operations Lesson Descriptions

11 **MAN ASC 31011 (Concluded)**

- Use navigation-derived information to fly the vehicle to Main Engine Cutoff (MECO) conditions:
  - Allow for orbital insertion and/or a runway landing without structural exceedances.

12 **MAN ABT BR 31001**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Manual Abort Techniques Briefing</th>
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<tr>
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<td>Preparation:</td>
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<td>• MAN ABT BR 31001 handout; received 2 days prior to briefing</td>
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**Synopsis:**
This lecture is the second in a series of 2. These lessons are designed to review the cockpit indications and techniques used to fly Transatlantic Abort Landing (TAL) and Return-To-Launch Site (RTLS) trajectories manually. A discussion of cockpit indications and techniques used during manual control is provided to prepare an assigned crew for MAN ABORT 31011. The following topics are reviewed: TAL redesignation, low energy TAL, post-Main Engine Cutoff (MECO) TAL, high energy TAL, and RTLS flight techniques.

Included in this lesson is a discussion of abnormal entry energy management techniques for TAL and RTLS aborts. The following trajectories are discussed: TAL Redesignation leading to low energy flight techniques, post-MECO TAL leading to high energy TAL flight techniques, two-engine RTLS, including Terminal Area Energy Management (TAEM) flight techniques, and three-engine RTLS, including TAEM flight techniques.

**Objectives:**
- Develop the crew skills to recognize when a manual takeover is required.
- Be able to fly the vehicle to MECO conditions, using navigation-derived information only:
  - Allow for orbital insertion and/or a runway landing without structural exceedances.
Ascent/Entry Flight Operations Lesson Descriptions

13  MAN ABORT 31011
Title: Manual Abort Techniques
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MAN ABT BR 31001
Preparation: None

Synopsis: This lesson reinforces the material covered in MAN ABT BR 31001 through practical application in the SMS.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:
• Recognize when a manual takeover is required.
• Establish manual control.
• Use navigation-derived information to fly the vehicle to acceptable Main Engine Cutoff (MECO)/External Tank (ET) Separation (SEP) conditions.
• Fly the vehicle on entry to allow for a runway landing without structural exceedances.

14  CONT ABT BR 31001
Title: Contingency Abort Briefing (Part 1)
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 02/97
Lesson(s) Replaced: None
Equipment Required: Overhead slides, overhead projector, space shuttle model, inclination-specific FDF, dry erase markers and board, Horizontal Situation Indicator (HSI) training aid, 5 extra handouts, Contingency Abort videotape, charts, recent 482s
Prerequisite Lesson(s): MAN ABT 31011
Preparation: Read:
• CONT ABT BR 31001 handout (handed out a minimum of 2 days prior to scheduled briefing date)
Ascent/Entry Flight Operations Lesson Descriptions

14  CONT ABT BR 31001 (Concluded)

Synopsis: This lecture is the first in a series of 2 briefings to discuss crew and inclination-specific aspects of contingency abort procedures in preparation for CONT ABT 31011 SMS lesson. Assigned flight crews will receive instruction on contingency abort maneuvering and trajectory profiles, cockpit indications, procedural rationale and execution, techniques, displays, controls, and cockpit resources used to initiate contingency abort maneuvering. The instruction will address both powered flight and entry procedures to either landing or bailout. A review of flight software capability and relevant orbiter hardware limitations is also provided. The lesson covers roughly half of the Ascent Checklist (C/L) procedural regions for two and three engine failure scenarios occurring in either OPS 1 (contingency abort) or OPS 6 (Return-To-Launch Site (RTLS) contingency abort). The remaining regions are covered during the second half of this series of briefing and SMS training. A representative sampling of 10 out of the 69 major contingency abort maneuvers (not regions) is presented during this lesson. The rationale for this sampling is explained at the end of this section. The following regions will be discussed:

- TWO OUT FIRST-BLUE
- TWO OUT SECOND-GREEN
- RTLS TWO OUT COLOR-BLUE
- RTLS TWO OUT COLOR-YELLOW
- THREE OUT FIRST-BLUE
- THREE OUT SECOND-GREEN
- RTLS THREE OUT COLOR-GREEN
- 2 Engine Out (E/O) and 3 E/O Bermuda or East Coast Abort Landing (ECAL), RTLS ECAL (Particular emphasis is placed on Bermuda or ECAL procedures to develop the manual crew skills necessary to avoid bailout.)

Objectives: To develop crew skills to:

- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions, where intact abort capability is nonexistent.
- Locate and execute the published procedure applicable to the contingency abort region in which the engine malfunctions occurred.
Ascent/Entry Flight Operations Lesson Descriptions

15 CONT ABT 31011

Title: Contingency Aborts Familiarization (Part 1)
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 02/97
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT ABT BR 31001
Preparation: Review:
  • CONT ABT BR 31001 notes and handout

Synopsis: This lesson reinforces the material discussed in CONT ABT BR 31001 through practical application using the flight software at the SMS. The following contingency abort regions are mandatory for lesson completion:
  • TWO OUT FIRST-BLUE
  • RTLS TWO OUT COLOR-YELLOW
  • THREE OUT FIRST-BLUE
  • 2 Engine Out (E/O) Bermuda or East Coast Abort Landing (ECAL)
  • 3 E/O Bermuda or ECAL (For inclinations not allowing a ECAL, a THREE OUT SECOND-GREEN must be performed instead of Bermuda)
  • RTLS THREE OUT COLOR-GREEN (Post-Power Pitch Around (PPA), pre Vrel 0)
  • THREE OUT FIRST-BLUE demonstrating marginal flight control
  • Three out downmode from two out second stage green (pre-mode 2 maneuver) demonstrating stagger capability for almost any abort

Time permitting, the following optional regions should be demonstrated:
  • Paperwork verification where one engine is failed at 30 seconds MET and the remaining engines fail before RTLS abort declaration
  • Three out at RTLS PPA to demonstrate software capability with rates on the vehicle as well as what the signature of a black zone might look like
  • RTLS THREE OUT COLOR-GREEN (Post Vrel 0)

Objectives: The crew will:
  • Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions where intact abort capability is nonexistent.
  • Locate the published procedure in the FDF, which is applicable to the contingency abort region in which the engine malfunctions occurred.
Ascent/Entry Flight Operations Lesson Descriptions

15 CONT ABT 31011 (Concluded)

- Execute published contingency abort procedures without exceeding structural limitations.
- Recognize and avoid specific flight envelopes that will cause a loss of control or vehicle overstress.

16A ASC SKL 33001

Title: Ascent Skills Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DA72/QUEST
Date: 01/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E GUID 31011
Preparation: Read:
- Ascent Powerdowns Prebrief
- BFS Engage Prebrief
- ATVC Prebrief
- Flight Critical & GPC DPS Failures Handout
- IMU & Entry NAVAID Failures Handout
- High/Low COMM Handout
- Payload Powerdowns Handout

Synopsis: This is a 3-part prebrief. The topics covered are Ascent Powerdowns, Backup Flight System (BFS) Engages, and the Ascent Thrust Vector Control (ATVC) system. The Ascent Powerdowns Prebrief covers the powerdown steps associated with the Loss of 2 Freon Loops and the Loss of 2 Fuel Cells during ascent. The BFS Engage Prebrief reviews some of the more common scenarios that require a BFS engage, those times when the BFS is NO-GO for engage, and the signature of a self-engage. The ATVC Prebrief familiarizes the students with the ascent thrust vector control system.

Objectives: At the end of each discipline-specific prebrief, the student will be able to perform the following objectives:

- Ascent Powerdowns Prebrief:
  - Identify the procedures required to safe the systems, given the Loss of 2 Freon Loops or the Loss of 2 Fuel Cells malfunctions.
  - Discuss the rationale behind the major steps in the Loss of 2 Freon Loops and the Loss of 2 Fuel Cells procedures.
Ascent/Entry Flight Operations Lesson Descriptions

16A ASC SKL 33001 (Concluded)

- BFS Engage Prebrief:
  - Identify the times when a BFS engage is required or desired.
  - Discuss crew preferences for a 2-on-2 set split and a 2-on-1-on-1 set split.
  - Identify the times when the BFS is NO-GO for engage.
  - Discuss the signature of a successful engage.
  - Discuss the signature of a self-engage, and describe the appropriate actions.
  - Explain the rationale for the steps in the POST BFS ENGAGE procedure.

- ATVC Prebrief:
  - State names of the 10 ATVC actuators by memory.
  - Use SPEC 53 to identify bypassed Space Shuttle Main Engine (SSME) ports.
  - State the proper action to take for 2 port bypasses on the same ATVC actuator during ascent or entry.
  - Given 2 hydraulic system failures, use the Main Propulsion System (MPS) cue card to identify the non-gimballing SSME and shut down the non-gimballer at the proper time (if required).

16B ASC SKL 33011

Title: Ascent Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Ascent MS optional. CB Instructor Astronaut (IA) attendance mandatory.)
Source: DA72/QUEST
Date: 01/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 33001
Preparation: None

Synopsis: This is the third 30000-level Ascent Skills lesson in a series of 5. The primary emphasis of this lesson is the crew coordination that is associated with both the performance of Powerdown Procedures, and the determination of the need for BFS Engage. “Loss of Two Freon Coolant Loops” and “Loss of Two Fuel Cells” procedures will be performed. Performance of the ascent and entry phases of flight with the Backup Flight System (BFS) engaged will also be exercised. This lesson is more
challenging than the previous ascent skills lessons, as it involves advanced single system failures, as well as a greater amount of multiple system failures.

Objectives:

- Given the added complication of a Loss of 2 Fuel Cells Powerdown, a Loss of 2 Freon Coolant Loops Powerdown, or a BFS Engage, coordinate performance of crew roles with respect to the following:
  - Nominal ascent procedures from liftoff through OMS-2
  - Performance boundary calls
  - Abort determination
  - Abort procedures (Abort To Orbit (ATO), Transatlantic Abort Landing (TAL), and Return-To-Launch Site (RTLS))
  - Procedures modified for the Powerdowns
- Given the Loss of 2 Freon Loops, Loss of 2 Fuel Cells, or a Cabin Fire, perform the following actions during powered flight:
  - Safe the system.
  - Perform the associated Powerdown procedures, including all DPS reconfigurations (on MCC call for 2 Freon Loops down).
  - Status other crewmembers as to the remaining equipment and capabilities.
  - Recover from any critical system impacts.
- Identify the situations that make the BFS suspect or NO-GO for engage.
- Identify a situation that requires an engage of the BFS.
- Then, coordinate and execute the engage at the appropriate time.
- Given a BFS engage, and selected failures:
  - Determine and perform appropriate actions regarding Flight Control System (FCS) management.
  - Perform actions regarding Rate Gyro Assembly (RGA) and Accelerometer Assembly (AA) management on MCC call.
- Manage Space Shuttle Main Engine (SSME) stuck throttle cases to maintain critical systems and capabilities.
- Given selected Reaction Control System (RCS) leaks, manage the RCS system.
- Given a “no command” scenario, manage the COMM system, and maintain good voice and data with MCC.
Ascent/Entry Flight Operations Lesson Descriptions

17 CONT ABT BR 32001

Title: Contingency Abort Briefing (Part 2)
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 02/97
Lesson(s) Replaced: None
Equipment Required: Overhead slides, overhead projector, space shuttle model, inclination-specific FDF, dry erase markers and board, Horizontal Situation Indicator (HSI) training aid, 5 extra handouts, Contingency Abort videotape, charts, recent 482s
Prerequisite Lesson(s): ASC SKL 33011, CONT ABT 31011
Preparation: Read:
• CONT ABT BR 32001 handout (handed out a minimum of 2 days prior to the scheduled briefing date)

Synopsis: This lecture is the second in a series of two briefings to discuss crew and inclination-specific aspects of contingency abort procedures in preparation for CONT ABT 32011. Assigned flight crews will receive instruction on contingency abort maneuvering and trajectory profiles, cockpit indications, procedural rationale and execution, techniques, displays, controls, and cockpit resources used to initiate contingency abort maneuvering. The instruction will address both powered flight and entry procedures to either landing or bailout. A review of flight software capability and relevant orbiter hardware limitations is also provided. This lesson covers the remaining Ascent Checklist (C/L) procedural regions for two and three engine failure scenarios occurring in either OPS 1 (contingency abort) or OPS 6 (Return-To-Launch Site (RTLS) contingency abort). A representative sampling of 12 out of the 69 major contingency abort maneuvers (not regions) is presented during this lesson. The rationale for this sampling is explained at the end of this section. The following regions will be discussed:
• TWO OUT DROOP
• STUCK THROTTLE contingency abort procedures
• RTLS TWO OUT COLOR-ORANGE
• RTLS TWO OUT COLOR-GREEN
• RTLS TWO OUT COLOR-RED
• RTLS THREE OUT COLOR-ORANGE
• RTLS THREE OUT COLOR-YELLOW
• RTLS THREE OUT COLOR-RED
• THREE OUT BLANK & RTLS THREE OUT BLANK
Objectives: To develop the crew skills to:

- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions where intact abort capability is nonexistent.
- Locate and execute the published procedure applicable to the contingency abort region in which the engine malfunctions occurred.

**CONT ABT 32011**

Title: Contingency Abort Familiarization (Part 2)

Duration: 4.0 hours

Medium: SMS-MB

Student: COMMANDER, MS 1, MS 2, PILOT

Source: DS66/G&C/Propulsion Training Group

Date: 02/97

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): CONT ABT BR 32001

Preparation: Review:
- CONT ABT BR 32001, notes and handout

Synopsis: This lesson reinforces the material discussed in CONT ABT BR 32001 through practical application using the flight software at the SMS. The following contingency abort regions are mandatory for lesson completion:

- TWO OUT DROOP
- TWO OUT DROOP back-out to TWO OUT SECOND-GREEN
- STUCK FIRST
- STUCK RTLS and STUCK DROOP if applicable
- RTLS TWO OUT COLOR-ORANGE
- RTLS THREE OUT COLOR-ORANGE
- RTLS TWO OUT COLOR-GREEN
- RTLS THREE OUT COLOR-YELLOW
- RTLS THREE OUT COLOR-RED
- RTLS TWO OUT COLOR-RED
- RTLS THREE OUT BLANK
- THREE OUT BLANK

Time permitting, the following optional regions should be demonstrated:

- Bermuda or East Coast Abort Landing (ECAL) review
- STUCK DROOP
- Items requiring additional proficiency
Ascent/Entry Flight Operations Lesson Descriptions

18  **CONT ABT 32011 (Concluded)**

- Any of the remaining 47 contingency abort maneuvers not exercised during the contingency abort series of lessons
- Black zone demonstration

**Objectives:** The crew will:
- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions where intact abort capability is nonexistent.
- Locate the published procedure in the FDF, which is applicable to the selected contingency abort region in which the engine malfunctions occurred.
- Execute published contingency abort procedures without exceeding structural limitations.
- Recognize and avoid specific flight envelopes that will cause a loss of control or vehicle overstress.

19  **PWDN BR 31001**

**Title:** Powerdown Briefing  
**Duration:** 2.0 hours  
**Medium:** Classroom  
**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT  
**Source:** DA72/QUEST  
**Date:** 02/96  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** ASC SKL 33011  
**Preparation:** Read/Review:
- SYSTEMS AOA book;
  - “LOSS OF 2 FREON LOOPS” procedure
  - “LOSS OF 2 H2O LOOPS” procedure
  - ASC SKL 33001 prebrief  
**Establish:**
- Cockpit management plan, with regards to the above listed procedures, assigning specific procedural actions to each crewmember.

**Synopsis:** This briefing is designed to supplement ASC SKL 34001. A detailed review of the “LOSS OF 2 FREON LOOPS” and “LOSS OF 2 H2O LOOPS” procedures in the SYSTEMS Abort Once Around (AOA) book will be conducted. The flight-specific SMS team will be present during this prebrief to answer technical and procedural questions. Procedural rationale and major differences between the two procedures will also be discussed.
Ascent/Entry Flight Operations Lesson Descriptions

19  **PWDN BR 31001 (Concluded)**

Objectives: At the end of this prebrief, the student will be able to:
- Refine crew-specific roles and responsibilities that will make each procedure go more smoothly.
- Identify areas within the two procedures where crew actions must be performed serially, and when they can be completed in parallel.
- Discuss the rationale behind the two procedures.

20  **FCS C/O 31006**

Title: Flight Control System Checkout  
Duration: 2.0 hours  
Medium: SST 1  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 04/96  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: Read:
- Orbit Operations Checklist FCS Checkout Procedure

Synopsis: Emphasis in this lesson is on malfunction resolution during the Flight Control System (FCS) checkout. The FCS checkout procedures are contained in the ORBIT Operations (OPS) Checklist (C/L). Guidance, Navigation, and Control (GNC) procedures will be followed.

Objectives: At the end of this lesson, the student will be able to perform the following:
- State the purpose of the FCS checkout.
- Identify, evaluate, and resolve malfunctions that may occur during FCS checkout.
- Explain the differences between Rotational Hand Controller (RHC) and Translation(al) Hand Controller (THC) redundancy management.

21A  **ASC SKL 34001**

Title: Ascent Skills Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)  
Source: DA72/QUEST  
Date: 01/96  
Lesson(s) Replaced: None  
Equipment Required: None
Ascent/Entry Flight Operations Lesson Descriptions

21A  **ASC SKL 34001 (Concluded)**

Prerequisite Lesson(s):  CONT ABT 32011, PWDN BR 31001

Preparation:  Read:
- Ascent Systems Flight Rules Prebrief
- AOA Deorbit Burns Prebrief
- Flight Critical & GPC DPS Failures Handout
- IMU & Entry NAVAID Failures Handout
- Systems Secondary Cockpit Cues Handout

Synopsis:  This is a 2-part prebrief.  The topics to be covered are Ascent Systems Flight Rules and Abort Once Around (AOA) Deorbit Burns.  The Ascent Systems Flight Rules Prebrief reviews the systems failures that require an abort declaration pre Main Engine Cutoff (MECO) or pre-OMS-2.  The AOA Deorbit Burns Prebrief discusses the differences between nominal End of Mission (EOM) deorbit burns, OMS 1 required AOA deorbit burns, and direct insertion AOA deorbit burns.

Objectives:  At the end of each discipline-specific prebrief, the student will be able to perform the following objectives:
- **Ascent Systems Flight Rules Prebrief:**
  - Identify the systems failures that require an abort, and the type of abort that is required.
  - Discuss how systems aborts differ from performance aborts.
- **AOA Deorbit Burns Prebrief:**
  - Describe the effect of a retrograde burn on the perigee.
  - Describe the effect of a radial burn on the line of apsides.
  - Use the computed PEG 7 targets to determine if the deorbit burn will be primarily retrograde, radial, or out-of-plane.
  - Describe the impact of an over-burn or under-burn during a radial deorbit burn.
- Given an AOA deorbit burn and flight profile, identify the correct completion cue (Height of perigee (HP) or DV).

21B  **ASC SKL 34012**

Title:  Ascent Skills
Duration:  5.0 hours
Medium:  SMS-FB or GNS
Student:  COMMANDER, MS 1, MS 2, MS 3, PILOT (MS1 and MS3 required for first two hours.)
Source:  DA72/QUEST
Date:  01/96
Lesson(s) Replaced:  None
Equipment Required:  None
Ascent/Entry Flight Operations Lesson Descriptions

21B ASC SKL 34012 (Continued)

Prerequisite Lesson(s): ASC SKL 34001
Preparation: None

Synopsis: This is the fourth 30000-level Ascent Skills lesson in a series of 5. The primary emphasis of this lesson is the crew coordination associated with the performance of systems aborts. The fixed base will be used to allow the crew to perform aft cockpit and middeck powerdown procedures. The crew will be required to analyze cockpit signatures and determine the need to abort for cabin leaks, Freon loops, and OMS leaks.

The performance of the above tasks are further complicated by multiple system failures, exercising the applications of the “Multi-Data Path Fail” cue card, Main Propulsion System (MPS) He anomalies, and Backup Flight System (BFS) failures.

Objectives:

- Coordinate performance of crew roles with respect to:
  - Nominal ascent procedures from liftoff through OMS targeting
  - Performance boundary calls
  - Abort determination
  - Abort procedures (Transatlantic Abort Landing (TAL), Return-To-Launch Site (RTLS), and Abort Once Around (AOA))
- Given a cabin leak or loss of 2 freon loops:
  - Select the appropriate FDF.
  - Select and perform the appropriate abort.
  - Determine the leak magnitude (cabin leak only).
- Given selected conditions, use the OMS-2 targeting card to determine the appropriate off-nominal OMS-2 targets and burn cutoff conditions.
- Manage MPS He leaks and Space Shuttle Main Engine (SSME) failures in conjunction with EPS failures to maintain critical systems and capabilities.
- Manage DPS failures to maintain critical MPS dump and vacuum inert capabilities.
- Given selected OMS and Reaction Control System (RCS) leaks:
  - Manage the OMS and RCS systems.
  - Orally status crew and MCC.
  - State the mission impacts.
- Given selected DPS and EPS failures and the OMS Failures Cue Card, determine the impacts to OMS ignition and take appropriate actions.
- Perform the DPS and Navigation (NAV) reconfiguration associated with a major electrical powerdown.
- Identify and manage a partial failure of the BFS.
Ascent/Entry Flight Operations Lesson Descriptions

21B  **ASC SKL 34012 (Concluded)**

- Identify and manage selected DPS and Inertial Measurement Unit (IMU) failures without MCC help.
- Discriminate among probable causes of loss of signal strength, and perform recovery procedures as appropriate.
- Given selected DPS failures, predict the possible loss of S-band antenna selection, and maintain pointing when necessary.
- Coordinate antenna management activities with MCC and other crewmembers.
- Coordinate a COMM Plan with MCC before all COMM is powered down.

22A  **E SKL 31001**

Title: Entry Skills Prebrief  
Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DA72/QUEST  
Date: 12/06  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): E GUID 31011  
Preparation: Read:
  - SSME Repositioning Prebrief
  - D/O APU Start Prebrief
  - Entry IMU Aligns Prebrief
  - Entry COMM Handout
  - Drag Chute Handout
  - Post-Landing Powerdowns
  - Flight-Critical & GPC DPS Failures Handout
  - IMU & Entry NAVAID Failures Handout

Synopsis: This is a 3-part prebrief, which will cover Space Shuttle Main Engine (SSME) Repositioning, Deorbit (D/O) Auxiliary Power Unit (APU) Start, and Entry Inertial Measurement Unit (IMU) Aligns. The SSME Repositioning Prebrief reviews the potential problems with SSME repositioning for the drag chute deploy. The D/O APU Start Prebrief reviews the 2 SINGLE APU START procedures and the rationale for selecting the correct procedure. The Entry IMU Aligns prebrief reviews scenarios that require an IMU align during entry, and the steps to take should one be required (no procedures exist in the entry FDF).
Ascent/Entry Flight Operations Lesson Descriptions

22A  E SKL 31001 (Concluded)

Objectives: At the end of each discipline-specific prebrief, the student will be able to perform the following objectives:

- SSME Repositioning Prebrief:
  - Identify Mach window for SSME repositioning.
  - Explain constraints associated with the restart of the SSME repositioning sequence.
  - Identify the 2 reasons for an “SSME REPOS FAIL” message, and the impact of this message.
  - Identify the impact of a failed Flight Aft (FA) Multiplexer/Demultiplexer (MDM) on SSME repositioning.
  - Identify the reasons to perform a drag chute deploy without the SSMEs repositioned.
  - State the name for this type of drag chute deploy.

- D/O APU Start Prebrief:
  - Identify why only 1 APU is to be started prior to the deorbit burn.
  - Explain why 2 procedures exist for starting a single APU prior to deorbit burn, and recognize that only 1 of the 2 procedures is used.
  - Explain the criteria used to decide when it is correct to select the ATTEMPT 1 APU procedure.
  - Explain the criteria used to decide when it is correct to select the ATTEMPT 2 APUs procedure.

- Entry IMU Aligns Prebrief:
  - Identify the times during entry when an IMU align is desired.
  - Identify the method for performing an IMU align.
  - Define IMU reanchoring.

22B  E SKL 31011

Title: Entry Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DA72/QUEST
Date: 12/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E SKL 31001
Preparation: None

Synopsis: This is the first 30000-level Entry Skills lesson in a series of 2. Its primary emphasis is the crew coordination of entry activities from Deorbit (D/O) - 15 through wheel stop. The lesson also emphasizes Post-Landing Powerdown procedures (Expedited and Emergency), as well as Inertial
Measurement Unit (IMU) and Navigation Aid (NAVAID) management. Secondary topics include Flight Control System (FCS) and Reaction Control System (RCS) management, as well as Space Shuttle Main Engine (SSME) repositioning.

Objectives:

- Coordinate performance of crew roles, with respect to nominal entry procedures:
  - From D/O - 15 through wheel stop
  - From 200K through wheel stop
- Identify the loss of power to an IMU and recover this IMU with an IMU/IMU align.
- Identify a Redundancy Management (RM) failed IMU and safe the Backup Flight System (BFS).
- With limited MCC help, manage the navigation sensors for various failures, including the following:
  - Sensor biases
  - No-lock cases
  - No-deploy cases
- Given selected electrical bus losses, perform the following steps:
  - Identify communication hardware loss.
  - Reconfigure to regain communication capabilities.
  - Select and perform appropriate procedures to regain or maintain capabilities.
- Given selected entry scenarios, analyze available cockpit data to do the following tasks:
  - Diagnose loss of data and voice communication.
  - Determine source of loss.
- Given wind, weather, energy, runway, and vehicle landing hardware conditions, determine impacts to vehicle landing, select a responsive technique, and perform landing and roll-out.
- Given the failure of a single Auxiliary Power Unit (APU) before, during, or after D/O burn, select and perform appropriate response.
- Given selected FCS Channel failures in combination with DPS failures, manage the FCS system.
- Following a restring and up to one additional FCS channel failure, perform the following actions:
  - Determine appropriate FCS configuration.
  - Verify planned FCS actions with MCC.
  - Perform planned actions.
- Given selected RCS jet failures and leaks, manage the RCS system, and select and perform the appropriate post-landing actions.
Ascent/Entry Flight Operations Lesson Descriptions

22B E SKL 31011 (Concluded)

- Given an APU leak, select and perform the appropriate post-landing actions.
- Given intolerable cabin conditions post-landing, select and perform the appropriate powerdown.
- Given an MCC call, inhibit or enable SSME repositioning, and perform appropriate drag chute deploy.
- Identify an Rotational Hand Controller (RHC) failure, state fault tolerance of the system after the failure, and perform the procedure in the Ascent/Entry Systems Procedure (AESP).
- Configure orbiter COMM system for nominal entry.
- Analyze vehicle performance indications and available cockpit data to:
  - Identify situations, which require flying theta limits.
  - Fly theta limits as appropriate.

23 D/O BURN 31001

Title: Deorbit Burn Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E SKL 31011
Preparation: Review:
  - D/O BURN 31001 handout
    - SMS load description
    - Lesson outline
    - MNVR PAD
    - DEL PAD
    - PRPLT PAD

Synopsis: This lesson is a review of nominal and off-nominal procedures on the 5 deorbit burn cue cards (2 Engine, 1 Engine, Reaction Control System (RCS), Unbalanced, and Mixed Xfeed), definitions of the entries on the Propellant (PRPLT) and Deorbit, Entry, and Landing (DEL) Preliminary Advisory Data (PADs), transfer of information from the PRPLT PAD and DEL PAD to each card, PRPLT FAIL and ENG FAIL diagnosis, manual flight techniques for RCS completion and forward RCS completion, rationale for procedures on the Deorbit Burn Monitor cue card, use of the OMS Failures cue card, and use of the Deorbit Burn Flight Rules cue card.
Ascent/Entry Flight Operations Lesson Descriptions

23  **D/O BURN 31001 (Concluded)**

This briefing will also establish crewmember responsibilities and crew-specific Space Flight Resource Management (SFRM).

Objectives:
- Transfer the information on the PRPLT PAD and DEL PAD to the appropriate blocks on the 5 burn cards; 2 Engine, 1 Engine, RCS, Unbalanced, and Mixed Xfeed.
- State the burn completion methods for failures that occur at the different milestones on the DEL PAD.
- Given a failure, determine if a waveoff is required using the Deorbit (D/O) Burn Flight Rules cue card.
- State the signatures and the type of failure (ENG or PRPLT) of an oxidizer/fuel blockage upstream and downstream of the inlet pressure sensor.
- Define the rationale for the procedures on the Deorbit Burn Monitor cue card.
- Define the rationale for the nominal and off-nominal procedures on the 5 deorbit burn cue cards; 2 Engine, 1 Engine, RCS, Unbalanced, and Mixed Xfeed.
- Given an OMS quantity, determine the corresponding RCS burn time using the OMS He PRESS/Delta V/BURN TIME table.
- Given a failure, identify if an ignition path still exists, what additional failure would take the ignition path (what failure the system is critical to), and if a manual shutdown is required, using the OMS Failures cue card.
- State the 2 conditions required to generate the OMS down arrow on the Maneuver (MNVR) display.
- State the 3 conditions required to mode guidance.
- Define the role of each crewmember during the deorbit burn.

24  **D/O BURN 31011**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Deorbit Burn</th>
</tr>
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<tbody>
<tr>
<td>Duration:</td>
<td>4.0 hours</td>
</tr>
<tr>
<td>Medium:</td>
<td>SMS-MB</td>
</tr>
<tr>
<td>Student:</td>
<td>COMMANDER, MS 2, PILOT (Entry MS optional.)</td>
</tr>
<tr>
<td>Source:</td>
<td>DS66/G&amp;C/Propulsion Training Group</td>
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<tr>
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</tr>
<tr>
<td>Prerequisite Lesson(s):</td>
<td>D/O BURN 31001</td>
</tr>
<tr>
<td>Preparation:</td>
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</tr>
</tbody>
</table>
Ascent/Entry Flight Operations Lesson Descriptions

D/O BURN 31011 (Concluded)

Synopsis: The intent of this lesson is to exercise all nominal and a few off-nominal procedures on the Deorbit Burn 2 Engine, 1 Engine, Unbalanced, and Mixed Xfeed cue cards. The lesson will also exercise the use of the Deorbit Burn Monitor and OMS Failures cue cards to recognize and resolve various malfunctions. The Deorbit Burn Flight Rules cue card will be used to determine if a waveoff is required due to a failure that occurs preburn. Finally, this lesson will reinforce the crewmember responsibilities and Space Flight Resource Management (SFRM) that was established in the deorbit burn briefing.

Objectives:

• Transfer the information on the Propellant (PRPT) Preliminary Advisory Data (PAD) and Deorbit, Entry, and Landing (DEL) PAD to the appropriate blocks on the Deorbit Burn 2 Engine, 1 Engine, Unbalanced, and Mixed Xfeed cue cards.
• Perform the procedures for a nominal 2 Engine, 1 Engine, Unbalanced, and Mixed Xfeed burn.
• Identify an ENG FAIL and a PRPT FAIL.
• Identify and resolve the various failures covered on the Deorbit Burn Monitor cue card.
• Given a failure before ignition, determine if a waveoff is required using the Deorbit (D/O) Burn Flight Rules cue card.
• Given the following failures or combination of failures, perform the proper actions for completing the burn using the given burn card (2 Engine, 1 Engine, Unbalanced, or Mixed Xfeed):
  – ENG FAIL
  – PRPT FAIL
• Determine the amount of prebank (if required) that is needed to reach the landing site, also stating the required prebank maneuver time and rate.
• Identify and perform appropriate actions for manual shutdown requirements using the OMS Failures cue card.
• Identify when guidance has not downmoded.
• Given an EPS or DPS failure, identify if an ignition path still exists, and what additional failures would take the ignition path (what failure the system is critical to) using the OMS Failures cue card.
• Perform all required crewmember responsibilities.
Ascent/Entry Flight Operations Lesson Descriptions

25A  ENT DAP SK 31001

Title: Entry Digital Autopilot Skills Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 04/00
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E SKL 31011
Preparation: None

Synopsis: This lesson covers DAP performance in both nominal operations and off nominal situations. A review of Entry DAP operational modes will be presented. Reaction Control System (RCS) and aerosurface failures that impact entry DAP will be presented. Rationale of the off-nominal procedures will be discussed. Lastly, situations in which entry DAP can contribute to a loss of vehicle control will be discussed.

Objectives:
- State the primary control effectors, RCS or aerosurfaces, for each Entry DAP operational mode.
- State the transition points for RCS to aerosurface control, when applicable for the DAP mode selected.
- Explain the impacts of RCS failures on entry DAP, including:
  - 3 yaw jets failed on the same pod
  - No Yaw Jet (NYJ) entry mode
- State the minimum number of yaw jets required for certified flight.
- Given a copy of the following procedures, explain how to perform them:
  - AFT Reaction Control System (ARCS) QTY (L+R) < 10% cue card procedures
  - High Frequency Oscillation or Surface/Jet Limit Cycle procedure
  - Aileron Trim ³ 3° procedure
- Given a Y Center of Gravity (c.g.), state the expected aileron trim.
- Identify ascent/abort situations in which entry DAP may cause loss of control.
Ascent/Entry Flight Operations Lesson Descriptions

25B ENT DAP SK 31011

Title: Entry Digital Autopilot Skills  
Duration: 2.0 hours  
Medium: SMS-MB  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 04/00  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): ENT DAP SK 31001  
Preparation: None

Synopsis: This lesson covers nominal and off-nominal DAP performance. Nominal DAP reconfiguration and handling characteristics will be covered. All nominal and off-nominal procedures that are related to DAP will be covered. The student will explore airspeed and alpha limits of the Flight Control System (FCS), and see the consequence of violating these limits.

Objectives: At the end of this lesson, the student will be able to perform the following objectives:

- State the major events in DAP reconfiguration while performing a nominal entry.
- Accomplish scripted flight demonstrations and explain the vehicle response to:
  - Zero angle of attack while hypersonic
  - No Reaction Control System (RCS) at q-Bar < 10
  - No Yaw Jet (NYJ) at q-Bar < 10
  - Aileron trim due to Center of Gravity (c.g.)
  - Effect of panel trim switches
  - Body flap cycling
  - Speedbrake cycling
  - Auto versus Fixed elevon schedule
- Identify and respond to the following off-nominal conditions:
  - 3-yaw jets failed on the same side
  - RCS propellant quantity critical
  - Aileron Trim Saturation
- Explain how the Backup Flight System (BFS) Entry DAP differs from the Primary Avionics Software System (PASS) Entry DAP.
Ascent/Entry Flight Operations Lesson Descriptions

26  E SKL 32011

Title: Entry Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional. CB Instructor Astronaut (IA) attendance mandatory.)
Source: DA72/QUEST
Date: 12/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 34012, D/O BURN 31011, ENT DAP SK 31011
Preparation: None

Synopsis: This is the second 30000-level Entry Skills lesson in a series of 2. The first run of the lesson provides the crew with the opportunity to practice the coordination of entry tasks from Deorbit (D/O) - 30 minutes to wheel stop. Advanced entry cases, including an incorporation of Global Positioning System (GPS), a Backup Flight System (BFS) entry, no yaw jet flying, theta limits, and stuck speedbrake, will be performed during this lesson. The class will also emphasize D/O Auxiliary Power Unit (APU) starts, Inertial Measurement Unit (IMU) alignments, management of Navigation Aids (NAVAIDs), and entry command configuration.

Objectives:
• With or without the BFS engaged, coordinate performance of crew roles with respect to:
  – Nominal entry procedures from D/O - 30 through wheel stop
  – Nominal entry procedures from 200K through wheel stop
• Identify the need for a state vector update, and perform an incorporation of GPS.
• Given wind, weather, energy, runway, and vehicle landing hardware conditions, determine their impact to the vehicle landing, select a responsive technique, and perform landing and roll-out.
• Given selected yaw jet and Accelerometer Assembly (AA) failure scenarios, determine and take appropriate actions.
• Given failures of multiple landing gear deploy methods, keep track of remaining redundancy level, and maintain at least 1 method of gear deploy.
• Identify OMS anomalies during the deorbit burn, and manage the OMS system to maintain system and vehicle control.
Ascent/Entry Flight Operations Lesson Descriptions

26  E SKL 32011 (Concluded)

- Analyze vehicle performance indications and available cockpit data to:
  - Identify a Rotational Hand Control(ler) (RHC) failure.
  - State the fault tolerance of the system after the failure.
  - Perform the procedure in the Ascent/Entry Systems Procedure (AESP).
  - Determine whether to handover/takeover.
  - Coordinate handover/takeover.
  - Perform piloting functions.
- Given selected Reaction Control System (RCS) leaks complicated by DPS and/or EPS failures, select and perform appropriate procedures in response, and orally status the crew and MCC.
- Given an MCC call concerning wind shears, select a responsive technique, perform landing, and describe how guidance is responding to the shears.
- Without an MCC call, identify a high altitude density shear, select a responsive technique, and perform landing.
- Given an MCC call of required runway (i.e., NO item entries), use the Entry Checklist (ENT C/L) to redesignate to the correct runway.
- Identify an Nose Wheel Steering (NWS) failure and take corrective actions during rollout.
- Given failure of single APU before, during, or after D/O burn, select and perform the appropriate response.
- Manage the navigation sensors for various failures without MCC help (including the determination to fly theta limits).
- Recover from the loss of S-band communications as a result of selected EPS failures.
- Identify and coordinate recovery steps from selected Audio Terminal Unit failures with MCC and other crewmembers.

27  ASC SKL 35011

Title:  Ascent Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DA72/QUEST
Date: 09/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): E SKL 32011
Ascent/Entry Flight Operations Lesson Descriptions

ASC SKL 35011 (Continued)

Preparation: Review: Ascent Skills 35001 Handout (USA008316)
- Essential Bus and Main Controller
- Flight Critical & GPC DPS Failures
- IMU & Entry NAVAID Failures

Synopsis: This is the fifth 30000-level Ascent Skills lesson in a series of 5. This lesson provides the crew with the opportunity to practice crew roles and coordination of activities during aborts and contingency aborts that are complicated with multiple system failures. The runs are designed to be highly challenging, and involve complex cases as well as combinations of many malfunctions. This lesson emphasizes performance of single main engine completion ascents and advanced DPS and EPS failure cases.

Objectives:
- Coordinate performance of crew roles with respect to:
  - Nominal ascent procedures from liftoff through OMS targeting and performance of an OMS-1 burn
  - Performance boundary calls
  - Abort determination
  - Abort procedures (DROOP, East Coast Abort Landing (ECAL), and Return-To-Launch Site (RTLS))
- Manage the failure of 2 Space Shuttle Main Engines (SSMEs), and take appropriate abort moding, throttling, and Single Engine Roll Control (SERC) actions.
- Given selected OMS failures during abort dumps, diagnose the failures and perform the appropriate procedures.
- Following a restring, and up to 1 additional Flight Control System (FCS) channel failure:
  - Determine the appropriate FCS configuration.
  - Verify planned FCS actions with MCC.
  - Perform the planned actions.
- Given a total loss of the Flash Evaporator System (FES), manage orbiter cooling.
- Manage EPS and multi-system Auxiliary Power Unit (APU)/Hydraulics failures to maintain system and vehicle control.
- Given the loss of multiple Multiplex/Demultiplex (MDM) data paths, coordinate the performance of "Multi Data Path Failure" Cue Card actions with other crewmembers.
- Manage data system to maintain critical data.
- Identify the need for and perform an Initial Program Load (IPL) of the Backup Flight System (BFS) post-Main Engine Cutoff (MECO).
- Identify and recover from prelaunch non-Launch Commit Criteria (LCC) violation failures.
Ascent/Entry Flight Operations Lesson Descriptions

27  ASC SKL 35011 (Concluded)

- Maintain a good state vector in the BFS, following various failures.
- Given selected DPS failures, determine and perform corrective action to regain voice/telemetry/commands.
- Manage the S-band Phase Modulation (PM) system to maintain voice/telemetry/command.
- Identify and recover from a keyboard failing to two Integrated Display Processors (IDPs)/Display Electronics Units (DEUs) (Critical Items List (CIL) mitigation).

28  E DTO BR 91001

Title: Entry Detailed Test Objectives Briefing
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DA7/Assigned SMS team
Date: 11/89
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): FCS C/O 31006
Preparation: None

Note: This class is optional. It is required only if any of the following ENTRY DTOs are scheduled: 251, 252, 254, 517, or 521. This lesson requires concurrence of the Ascent/Entry Flight Operations Course Supervisor.

Synopsis: This briefing informs the crew of what they must do to meet the requirements of any DTOs for their flight, to include Programmed Test Inputs (PTIs). Emphasis will also be placed on the special procedures and conditions that require abandonment of the DTOs for flight safety. The team lead or the appropriate instructor should seek assistance from outside DT (DF, DM, EH, DTO Sponsor, etc.), if required.

Objectives:
- Understand the objectives of the DTOs.
- Understand the nominal procedures for the DTOs.
- Understand the malfunction procedures for the DTOs (if any).
- Understand the flight rules involving the DTOs, especially those requiring abandonment of them for flight safety.
- Understand backout procedures (if any).
Ascent/Entry Flight Operations Lesson Descriptions

**E DTO 91056**

Title: Entry Detailed Test Objectives  
Duration: 2.0 hours  
Medium: SES FWD  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DS66/G&C/Propulsion Training Group  
Date: 06/93  
Lesson(s) Replaced: None  
Equipment Required: DTO FDF Procedures  
Prerequisite Lesson(s): E DTO BR 91001  
Preparation: None  

**Note:** This is an optional lesson. It is required only if any of the following ENTRY DTOs are scheduled: 251, 252, 254, 517, or 521. This lesson requires the concurrence of the Ascent/Entry Flight Operations Course Supervisor.

Synopsis: This lesson should only be scheduled if the SMS team and/or the crew desires to practice entry DTO/Programmed Test Input (PTI) procedures prior to flight cycle training in the SMS. Required runs and content will be determined by team and crew. Recommend DTO sponsor and appropriate flight controller(s) be invited by the team/crew to support this lesson.

Objectives:  
- Practice DTO/PTI nominal procedures.  
- Practice DTO/PTI malfunction procedures (if any).  
- Apply appropriate flight rules to DTO/PTI operations (if any).  
- Review other procedures and information as required.

**ENT PRF FS 41011**

Title: Flight-Similar Entry Proficiency  
Duration: 2.0 hours/biweekly  
**Note:** Schedule 1 hour weekly in conjunction with ASC PRF FS 41011.  
Medium: SMS-MB  
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)  
Source: DA7/Assigned SMS team  
Date: 11/89  
Lesson(s) Replaced: ENT PRF ADV 41011  
Equipment Required: None  
Prerequisite Lesson(s): FCS C/O 31006  
Preparation: None
Ascent/Entry Flight Operations Lesson Descriptions

30 ENT PRF FS 41011 (Concluded)

Synopsis: Lesson maintains proficiency in entry operations for assigned crews until their flight software load is delivered for training. The lesson should cover those procedures that the crew has not seen for some time or that they have not seen in their 30000-level E SKL sessions. Completion of E SKL 3X011 or an integrated generic entry simulation fulfills the proficiency requirement.

Objectives: The student will be able to:
- Correctly perform all nominal procedures.
- Understand the required malfunction procedures.
- Understand the ramifications of the malfunctions.
- Prioritize and coordinate crewmember actions during malfunctions.
- Safely land or perform bailout procedures.

31 ASC PRF FS 41011

Title: Flight-Similar Ascent Proficiency
Duration: 3.0 hours/week
Note: Schedule in conjunction with 1 hour of ENT PRF FS 41011.
Medium: SMS-MB (SMS-FB)
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DA7/Assigned SMS team
Date: Prepare as needed
Lesson(s) Replaced: ASC PRF ADV 41011
Equipment Required: None
Prerequisite Lesson(s): FCS C/O 31006
Preparation: None

Synopsis: The purpose of this lesson is to maintain proficiency in ascent flight operations for crews who have completed all ascents except those that are load-specific. Cases should utilize the failures from the additional objectives list preceding 30000-level lesson descriptions. Each lesson should include a variety of ascent scenarios and include Control Stick Steering (CSS) control and a variety of winds and weather as desired. This lesson is not required if the crew has participated in any ascent integrated sim or a 30000-level Ascent Skills within the past week.

Objectives: Demonstrate proficiency in ascent flight operations.
Ascent/Entry Flight Operations Lesson Descriptions

32 CONT ABT PRF 41056

Title: Contingency Abort Proficiency
Duration: 2.5 hours
Medium: SES FWD
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 02/97
Lesson(s) Replaced: None
Equipment Required: Load-specific MS1 and MS2 Ascent Checklists (C/Ls), all 4 contingency abort cue cards, Transatlantic Abort Landing (TAL) Redesignation cue cards, lesson plan, writing utensil, notebook, instructor's copy of FDF
Prerequisite Lesson(s): FCS C/O 31006
Preparation: None
Synopsis: This optional lesson is requested by individual astronauts or assigned flight crews to allow review and practice of contingency abort procedures.
Objectives:
• To increase contingency abort procedural proficiency for non-assigned astronauts.
• To improve crew coordination of contingency abort procedures and techniques to realize proficiency by the time CONT ABT 91011 is scheduled.

33 MPS BSE FLT BRF 31001

Title: Main Propulsion System Booster Systems Engineer Flight Briefing
Duration: 1.0 hour
Medium: Classroom
Student: FLIGHT DIRECTOR, COMMANDER, PILOT, MS 2, CAPCOM, and assigned Booster Flight Controller (BSE)
Source: DS66/G&C/Propulsion Training Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC/ABT SFRM 31011
Preparation: None
Synopsis: This lesson will serve as a forum for the crew, CAPCOM, Booster, and Flight to review procedure changes and to discuss flight-specific details. The lesson will be led by the assigned Booster Flight Controller.
Ascent/Entry Flight Operations Lesson Descriptions

33 **MPS BSE FLT BRF 31001 (Concluded)**

Objectives: The crew, *Flight Director*, BSE, and CAPCOM discuss malfunction scenarios, focusing on the Main Propulsion System (MPS) system alone. *This lesson* also establishes communication and builds a relationship between the BSE, CAPCOM, and the crew, and answers any flight-specific questions prior to integrated training.

34 **E SKL 91011**

Title: Entry Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DA7/Assigned SMS team
Date: 10/92
Lesson(s) Replaced: None
Equipment Required: Advanced Crew Escape Suits (ACESs)
Prerequisite Lesson(s): MPS BSE FLT BRF 31001
Preparation: None

Synopsis: Lesson exercises the crewmembers’ knowledge of malfunction procedures, their ability to prioritize, and their ability to understand the impacts that a malfunction (in one area) has on the other shuttle systems. This lesson will be suited.

Objectives: The student will be able to:
- Correctly perform all nominal procedures.
- Understand the ramifications of the malfunctions.
- Prioritize and coordinate crewmember actions during malfunctions.
- Safely land or perform bailout procedures.
- Practice nominal and off-nominal procedures while suited.
- Correctly perform Payload/Spacehab Entry off-nominal procedures (if applicable).

35 **E SKL 92011**

Title: Entry Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DA7/Assigned SMS team
Date: 11/89
Lesson(s) Replaced: None
Equipment Required: None
Ascent/Entry Flight Operations Lesson Descriptions

35  **E SKL 92011 (Concluded)**

Prerequisite Lesson(s):  E SKL 91011  
Preparation:  None

Synopsis:  Lesson exercises the crewmembers’ knowledge of malfunction procedures, their ability to prioritize, and their ability to understand the impacts that a malfunction (in one area) has on the other shuttle systems. Cases stressing flying theta limits with off-nominal energy and/or high tailwinds or headwinds on the Heading Alignment Cone (HAC) will be emphasized on E SKL 92011.

Objectives:  The student will be able to:
- Correctly perform all nominal procedures.
- Understand the required malfunction procedures.
- Understand the ramifications of the malfunctions.
- Prioritize and coordinate crewmember actions during malfunctions.
- Safely land or perform bailout procedures.

36  **ASC SKL 91011**

Title:  Ascent Skills  
Duration:  4.0 hours  
Medium:  SMS-MB  
Student:  COMMANDER, MS 2, PILOT (Ascent MS optional.)  
Source:  DA7/Assigned SMS team  
Date:  01/96  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  MPS BSE FLT BRF 31001  
Preparation:  None

Synopsis:  This is the first of two required flight-specific ascent lessons. These lessons concentrate on flight-specific ascent procedures, new Operational Instrumentation (OI) updates, flight-specific model updates to the SMS, new 482s approved for this flight, payload-unique requirements, and areas requiring additional proficiency as noted from prior ascent training. Specific cases are not listed for these lessons, but cases from the Ascent Skills or Ascent Proficiency contents list can be used. The Team Lead will check with the Commander prior to scripting these lessons to get his or her input into the content of these lessons.
Ascent/Entry Flight Operations Lesson Descriptions

36  **ASC SKL 91011 (Concluded)**

Objectives: The student will be able to:

- Correctly perform all nominal ascent procedures.
- Understand the required malfunction procedures.
- Understand the ramifications of the malfunctions.
- Prioritize and coordinate crewmember actions during malfunctions.
- Safely go to orbit or perform the correct abort scenario.

37  **ASC SKL 92011**

Title: Ascent Skills
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: **DA7**/Assigned SMS team
Date: 01/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 91011
Preparation: None

Synopsis: This is the second of two required flight-specific ascent lessons. These lessons concentrate on flight-specific ascent procedures, new Operational Instrumentation (OI) updates, flight-specific model updates to the SMS, new 482s approved for this flight, payload-unique requirements, and areas requiring additional proficiency as noted from prior ascent training. Specific cases are not listed for these lessons, but cases from the Ascent Skills or Ascent Proficiency contents list can be used. The Team Lead will check with the Commander prior to scripting these lessons to get his or her input into the content of these lessons.

Objectives: The student will be able to:

- Correctly perform all nominal procedures.
- Understand the required malfunction procedures.
- Understand the ramifications of the malfunctions.
- Prioritize and coordinate crewmember actions during malfunctions.
- Safely go to orbit or perform the correct abort scenario.
D/O BURN 91011

Title: Flight-Specific Deorbit Burn
Duration: 2.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DS66/G&C/Propulsion Training Group
Date: 12/95

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ASC SKL 92011
Preparation: None

Synopsis: This lesson is a review of the nominal and off-nominal procedures on the Deorbit Burn 2 Engine, 1 Engine, and Unbalanced cue cards using the flight-specific load. Some of the basic failures covered on the Deorbit Burn Monitor cue card will also be exercised. This lesson is also intended to allow the crew to get a feel for what their flight-specific deorbit burn will possibly look like, including expected propellant quantities, propellant wasting, and targets.

Objectives:

- Transfer the information on the Propellant (PRPLT) Preliminary Advisory Data (PAD) and Deorbit, Entry, and Landing (DEL) PAD to the appropriate blocks on the Deorbit Burn 2 Engine, 1 Engine, and Unbalanced cue cards.
- Perform a 2 Engine, 1 Engine, and Unbalanced deorbit burn.
- Identify an ENG FAIL and a PRPLT FAIL.
- Identify and resolve the various failures covered on the Deorbit Burn Monitor cue card.
- Given a failure before ignition, determine if a waveoff is required using the Deorbit (D/O) Burn Flight Rules cue card.
- Given various failures, perform the steps required to complete the burn with each crewmember performing their specific duties.
- Determine the amount of prebank (if required) that is needed to reach the landing site, also stating the required prebank maneuver time and rate.
Ascent/Entry Flight Operations Lesson Descriptions

CONT ABT 91011

Title: Contingency Abort Refresher
Duration: 4.0 hours
Medium: SMS-MB
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DS66/G&C/Propulsion Training Group
Date: 02/97
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): D/O BURN 91011
Preparation: Exposure to at least one contingency abort procedure during all ascent flight operations training prior to this lesson.

Synopsis: This lesson is a contingency abort refresher to be conducted in the SMS within two weeks of flight. This lesson concentrates on flight-specific contingency abort procedures not exercised within the last 60 days, BDA (Bermuda)/East Coast Abort Landing (ECAL) procedures, and areas requiring additional proficiency as noted from prior ascent training. Upon crew arrival at the SMS, the commander will be asked if there are any specific procedures they wish to exercise; if not already planned, contingency abort scenarios will be added to the lesson plan to exercise the requested procedures. Assuming black zones are avoided by the instructor, it is mandatory that the following scenarios be performed without overstressing the vehicle:

- Two BDA or ECAL aborts (a high energy and a nominal energy trajectory)
  - Inclination allowing, one ECAL must be a two out scenario.
  - Inclination allowing, the other ECAL must be a Canadian ECAL.
- A high energy Transatlantic Abort Landing (TAL) until automatic nominal energy has been established in OPS 3.
- A two out contingency abort.
- A three out contingency abort.
- A two out Return-To-Launch Site (RTLS) contingency abort.
- A three out RTLS contingency abort.
- Avoidance of the transonic pitch-up divergence.
- Avoidance of the alpha trap logic (manual calculation and verification of target Nz).

Note: For efficient simulation, the last two bulletized items may be incorporated into bullets 3 through 6. Bullets 3 through 6 should encompass procedures requiring additional proficiency or that have not been exercised within the last 60 days.
Ascent/Entry Flight Operations Lesson Descriptions

39  CONT ABT 91011 (Concluded)

Objectives: In a coordinated crew effort, the crew will:
- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions where intact abort capability is nonexistent.
- Locate the published procedure in the FDF that is applicable to the selected contingency abort region in which the engine malfunctions occurred.
- Execute published contingency abort procedures without exceeding structural limitations.
- Recognize and avoid specific flight envelopes that will cause a loss of control or vehicle overstress.

40  ENT PRF LS 41011

Title: Load-Specific Entry Proficiency
Duration: 2.0 hours/biweekly
Note: Schedule 1 hour/weekly in conjunction with ASC PRF LS 41011.
Medium: SMS-MB
Student: COMMANDER, MS 2, PILOT (Entry MS optional.)
Source: DA7/Assigned SMS team
Date: 11/89
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT ABT 91011
Preparation: None

Synopsis: Lesson maintains proficiency in entry operations for assigned crews until they leave for their flight. The lesson should cover those procedures that they have not seen for some time or have not seen in 30000-level or 90000-level E SKL sessions. Completion of E SKL 9X011 or an integrated load-specific entry simulation fulfills the proficiency requirement.

Objectives: The student will be able to:
- Correctly perform all nominal procedures.
- Understand the required malfunction procedures.
- Understand the ramifications of the malfunctions.
- Prioritize and coordinate crewmember actions during malfunctions.
- Safely land or perform bailout procedures.
- Correctly perform Payload/Spacehab Entry off-nominal procedures (if applicable).
Ascent/Entry Flight Operations Lesson Descriptions

41  ASC PRF LS 41011

Title: Load-Specific Ascent Proficiency
Duration: 3.0 hours/week
Note: Schedule in conjunction with 1 hour of ENT PRF LS 41011.
Medium: SMS-MB (SMS-FB)
Student: COMMANDER, MS 2, PILOT (Ascent MS optional.)
Source: DA7/Assigned SMS team
Date: Prepare as needed
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT ABT 91011
Preparation: None

Synopsis: The lesson is load-specific ascent proficiency training which will be utilized, when necessary, in the time period between completion of all previous ascent training and flight. It is similar to ASC PRF FS 41011, except that it should use a simulator software load and FDF which is identical to the flight software and vehicle configuration to be used by the crew on their assigned flight. Specific cases are not listed for this lesson, but cases from the Ascent Skills or Ascent Proficiency content list can be used. This lesson is not required if the crew has participated in a load-specific integrated ascent sim or a 90000-level Ascent Skills lesson within the last week.

Objectives: The student should maintain proficiency in the following:
• Ascent procedures
• Abort mode selection
• Response to system failures
• Flying techniques

MAN ASC 41001

Title: Manual Ascent Proficiency Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 12/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Ascent/Entry Flight Operations Lesson Descriptions

MAN ASC 41001 (Concluded)

Synopsis: This briefing is the first in a series of 2 briefings. They are both designed to review the cockpit indications and techniques used to fly nominal, Abort To Orbit (ATO), and Transatlantic Abort Landing (TAL) trajectories manually. A discussion of cockpit indications and techniques used during manual control is discussed to prepare for MAN ASC 41011. A review of guidance anomaly recognition, manual control, flight instruments, Integrated Display Processor (IDP) DPS Displays, FDF, and flight techniques is presented. This lesson covers trajectories similar in nature to normal insertions to orbit, and includes manual entry techniques for TAL aborts. The following trajectories are discussed: Nominal ascent, ATO caused by Space Shuttle Main Engine (SSME) failure, Dual simultaneous SSME failure during ascent Single Engine Roll Control (SERC), and Two engine out-of-plane TAL to landing.

Objectives: Develop the crew skills to recognize when a manual takeover is required.
- Be able to fly the vehicle to Main Engine Cutoff (MECO) conditions, using navigation-derived information only:
  - Allow for orbital insertion and/or a runway landing without structural exceedances.

MAN ASC 41011

Title: Manual Ascent Proficiency
Duration: 4.0 hours
Medium: SMS/MB
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MAN ASC 21001 or MAN ASC BR 31001 or MAN ASC 41001
Preparation: None

Synopsis: This lesson reinforces the material covered in MAN ASC BR 41001 through practical application in the SMS.
Ascent/Entry Flight Operations Lesson Descriptions

MAN ASC 41011 (Concluded)

Objectives: At the end of this lesson, the student will be able to perform the following objectives:

- Recognize when a manual takeover is required.
- Establish manual control.
- Use navigation-derived information to fly the vehicle to Main Engine Cutoff (MECO) conditions:
  - Allow for orbital insertion and/or a runway landing without structural exceedances.

MAN ABT 41001

Title: Manual Abort Proficiency Prebrief
Duration: 2.0 hours
Medium: Classroom
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MAN ASC 21011 or MAN ASC 31011 or MAN ASC 41011
Preparation: None

Synopsis: This lecture is the second in a series of 2. These lessons are designed to review cockpit indications and techniques used flying Transatlantic Abort Landing (TAL) and Return-To-Launch Site (RTLS) trajectories manually. A discussion of cockpit indications and techniques used during manual control is provided to prepare for MAN ABT 41011. Topics to be reviewed: TAL redesignation, low energy TAL, post-MECO TAL, high energy TAL, high energy YQX, and RTLS flight techniques. Included is a discussion of abnormal entry energy management techniques for TAL and RTLS. The following are discussed: TAL Redesignation to low energy flight techniques, post-MECO TALs leading to high energy TAL to in-plane and out-of-plane sights, flight techniques, two-engine RTLS, including TAEM flight techniques, and three-engine RTLS, including TAEM flight techniques.

Objectives:

- Develop skills required to recognize when a manual takeover is required.
- Be able to fly the vehicle to Main Engine Cutoff (MECO) conditions, using navigation-derived information only:
  - Allow for orbital insertion and/or a runway landing without structural exceedances.
Ascent/Entry Flight Operations Lesson Descriptions

**MAN ABT 41011**

Title: Manual Abort Proficiency  
Duration: 4.0 hours  
Medium: SMS/MB  
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, *DS66* Instructors  
Source: *DS66*/Ascent Procedures Specialists  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MAN ABT 21001 or MAN ABT BR 31001 or MAN ABT 41001  
Preparation: None  
Synopsis: This lesson reinforces the material covered in MAN ABT BR 41001 through practical application in the SMS.  
Objectives: At the end of this lesson, the student will be able to perform the following objectives:  
- Recognize when a manual takeover is required.  
- Establish manual control.  
- Use navigation-derived information to fly the vehicle to acceptable Main Engine Cutoff (MECO)/External Tank (ET) Separation (SEP) conditions.  
- Fly the vehicle on entry to allow for a runway landing without structural exceedances.

**CONT ABT RVW 41001**

Title: Contingency Abort Proficiency Prebrief  
Duration: 2.0 hours  
Medium: Classroom  
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, *DS66* Instructors  
Source: *DS66*/Ascent Procedures Specialists  
Date: 10/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MAN ABT 21011 or MAN ABT 31011 or MAN ABT 41011  
Preparation: None  
Synopsis: This lecture will discuss contingency abort procedures in preparation for the CONT ABT RVW 41011 SMS lesson. Crews will receive instruction on contingency abort maneuvering and trajectory profiles, cockpit indications, procedural rationale and execution, techniques, displays,
Ascent/Entry Flight Operations Lesson Descriptions

CONT ABT RVW 41001 (Concluded)

controls, and cockpit resources used to initiate contingency abort maneuvering. The instruction will address both powered flight and entry procedures to either landing or bailout. A review of flight software capability and relevant orbiter hardware limitations is also provided. The lesson covers all of the Ascent Checklist (C/L) procedural regions for two and three engine failure scenarios occurring in either OPS 1 (contingency abort) or OPS 6 (Return-To-Launch Site (RTLS) contingency abort). A representative sampling of contingency abort maneuvers (not regions) are presented during this lesson.

Objectives: To develop crew skills to:
- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions, where intact abort capability is nonexistent.
- Locate and execute the published procedure applicable to the contingency abort region in which the engine malfunctions occurred.

CONT ABT RVW 41011

Title: Contingency Abort Proficiency
Duration: 4.0 hours
Medium: SMS-MB
Student: Post ASCAN and pre-assigned Crew Members, Proficiency Crew Members, DS66 Instructors
Source: DS66/Ascent Procedures Specialists
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT ABT RVW 21001 or CONT ABT 31001 or CONT ABT RVW 41001
Preparation: None

Synopsis: This lesson reinforces the material discussed in CONT ABT RVW 41001 through practical application using flight software at the SMS. A representative sampling of contingency abort maneuvers (not regions) are presented during this lesson.
Ascent/Entry Flight Operations Lesson Descriptions

CONT ABT RVW 41011 (Concluded)

Objectives: The crew will:

- Recognize and recover from multiple Space Shuttle Main Engine (SSME) malfunctions where intact abort capability is nonexistent.
- Locate the published procedure in FDF applicable to the contingency abort region in which the engine malfunctions occurred.
- Execute published contingency abort procedures without exceeding structural limitations (or to the most benign conclusion).
- Recognize and avoid specific flight envelopes that will cause a loss of control or vehicle overstress (where applicable).
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

Listed below are the 66 different major types of contingency abort maneuvers that create unique training concerns. Other maneuvers can occur; however, they are considered remote for window of exposure and/or failure timing reasons. All of the following are two failure scenarios (or less) with the exception of three out downmodes from two out and one of the stuck throttle maneuvers.

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<th>CONTINGENCY ABORT MANEUVERS</th>
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<td>21. Two out second stage ECAL site overlap</td>
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<td>2. Late three out blue (MM601 maneuver)</td>
<td>22. Droop simultaneous failures</td>
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<td>3. Early three out green (pre heads-up roll)</td>
<td>23. Droop staggered failures (TAL rendez procedures)</td>
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<td>5. Three out green Canadian ECAL</td>
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<td>6. Three out orange from two out simultaneously</td>
<td>26. Late droop (TAL result)</td>
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<td>7. Three out orange from two out staggered</td>
<td>27. Stuck first where good engine fails in first stage</td>
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<tr>
<td>8. Three out orange change to green</td>
<td>28. Stuck first where good engine fails in second stage</td>
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<tr>
<td>9. Three out yellow from two out simultaneously</td>
<td>29. Stuck first blue</td>
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<tr>
<td>10. Three out yellow from two out staggered</td>
<td>30. Stuck first green</td>
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<td>31. Early stuck RTLS (wait for ADI PPA indication)</td>
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<td>12. Three out yellow heads up</td>
<td>32. Late stuck RTLS (past ADI PPA indication)</td>
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<td>13. Two out first stage blue</td>
<td>33. “N/A” stuck RTLS</td>
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<tr>
<td>14. Two out first stage green (rare, but possible)</td>
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<td>15. Two out second stage blue</td>
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<td>18. Two out second stage BDA/ECAL</td>
<td>38. Low energy post-MECO TAL</td>
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<td>19. Two out second stage BDA no yaw</td>
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</tr>
<tr>
<td>20. Two out second stage BDA/ECAL no site (bailout)</td>
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</table>
### RTLS CONTINGENCY ABORT MANEUVERS

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<tr>
<th>No.</th>
<th>Maneuver Description</th>
<th>Maneuver Description</th>
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<td>RTLS two out green early (x-sonic pitch-up demo)</td>
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<td>RTLS three out green (post Vrel 0), (x-sonic pitch up)</td>
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<td>45.</td>
<td>RTLS three out orange early (x-sonic pitch-up demo)</td>
<td>Black zone demonstration (LOC, g’s, or EAS)</td>
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<td>46.</td>
<td>RTLS three out orange late (x-sonic pitch-up demo)</td>
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<td>47.</td>
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<td>Bail-out DAP engagement difficulty</td>
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<tr>
<td>49.</td>
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<td>RTLS three out yellow/red stagger vs. simo failures (trap demo)</td>
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<td>RTLS three out blank staggered failures trap demo)</td>
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<td>56.</td>
<td>RTLS two out orange early (x-sonic pitch-up demo)</td>
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<td>57.</td>
<td>RTLS two out orange late (immediate MECO)</td>
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</table>
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

Only 22 of the maneuvers listed previously are presented during the CONT ABT 31001, 31011, 32001, and 32011 series of assigned crew lessons. This representative sample along with ascent skills and 91011 contingency abort training optimizes maneuver/procedural exposure. This is the absolute minimum training in preparation for a safe STS mission.

RATIONALE FOR THE CONT ABT 31011 SCENARIOS

The first three scenarios must start at T-2 minutes to develop crew procedural cadence. Other data stores/reset points can be used once the first three scenarios have been completed. Discussed below is additional rationale for each of the mandatory scenarios exercised during this lesson:

1. Contingency 2 out blue
   Simultaneous dual engine failure around 1 minute MET. This is a relatively simple first run allowing the crew time to exercise the procedures in a methodical fashion.

2. RTLS 2 out yellow
   Staggered dual engine failure scenario. First engine fails around 1 minute MET to verify the crew's management of procedural paperwork. The second engine fails well past PPA to demonstrate two out automated maneuvering while the vehicle is traveling backwards. This scenario allows the crew ample time to prepare for a staggered engine failure scenario. A pre PPA maneuver is not required because it is nearly identical to two out second stage green.

3. Contingency 3 out blue
   Staggered triple engine failure scenario. One-second stagger simulates a single failure scenario and prevents MECO confirmed, forcing the crew to take action to initiate three out automated maneuvering. Failure timing is chosen to avoid a black zone and force a MM601 maneuver to entry attitude such that all procedural steps are exercised.

4. BDA/ECAL
   Simultaneous dual engine failure within the BDA*/ECAL window. This is the most simplistic BDA/ECAL scenario for the crew’s first attempt at this procedure. If ECAL, and Otis scenario is presented because a moderate amount of time is available to exercise the procedure. Multiple BDA/ECAL scenarios follow as they require more training because of the lack of software automation.

* There is no choice but to stagger the engine failures for 28.45° inclination BDA aborts. The first 28.45° BDA is performed off of a previous BEN TAL declaration.
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

<table>
<thead>
<tr>
<th>Lesson Description</th>
<th>Description</th>
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</thead>
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<tr>
<td>5. BDA/ECAL</td>
<td>Staggered dual engine failure within the BDA/ECAL window. A stagger is chosen because it exercises all additional FDF required for successful BDA/ECAL aborts if ECAL, a Cherry Point RTLS scenario is presented to demonstrate time compression associated with an earlier abort. If 28.45_ BDA, the abort is performed off of a previous MRN TAL to allow the crew to correlate entry energy conditions as a function of TAL trajectory differences.</td>
</tr>
<tr>
<td>6. BDA/Canadian ECAL</td>
<td>If BDA, any dual engine failure scenario is presented to further practice BDA techniques. If high inclination, all three engines fail nearly simultaneously within the Shearwater Canadian ECAL window. Timing for the triple engine failure scenario only allows Shearwater capability to simplify complexity for a first Canadian attempt. The Canadian ECAL provides an opportunity to further practice MM602 energy management techniques while exercising the unique procedures to Canadian sites.</td>
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<tr>
<td>7. Three out green/ Canadian ECAL</td>
<td>A nearly simultaneous failure of all three engines to exercise three out green procedures for low and mid inclination flights. For high inclination a Canadian ECAL is performed in a region where the crew is forced to decide which of three sites to fly towards. This is the most complicated Canadian ECAL, requiring the highest degree of situational awareness and crew coordination.</td>
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</tbody>
</table>

Engine failure timing for all BDA/ECALs above will vary to present high, nominal, and low energy situations in MM602. This will allow exposure to off-nominal energy management techniques for runway capability.

<table>
<thead>
<tr>
<th>Lesson Description</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>8. RTLS three out green</td>
<td>A left engine failure forcing RTLS followed by post PPA – pre Vrel 0 failures of the remaining engines one second apart. Pre PPA RTLS green is not required because the maneuver is nearly identical to the three out green scenarios in 6 and 7 above. The second and third engine failure timing is chosen to demonstrate a maximum yaw around maneuver to entry attitude.</td>
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<tr>
<td>9. Contingency three out blue</td>
<td>A nearly simultaneous failure of all three engines with relatively high q to demonstrate limitations of the 3 out automated software. This is a recoverable loss of control scenario. This develops crew ability to discriminate between commanded and uncommanded maneuvering to know when to stay out of the control loop.</td>
</tr>
</tbody>
</table>
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

10. Three out from two out The last engine is failed during a two out second stage green maneuver to demonstrate automated contingency abort software switching capability from two out to three out with low q. This develops crew confidence to stay out of the control loop. A downmode from two out second stage green (pre mode 2) allows exposure to this maneuver prior to failure of the last engine.

The RTLS two out blue maneuver is not performed during any training because the window of exposure is too narrow. Lack of training should not be a problem if this region is experienced in flight because it is nearly identical to the contingency two out blue maneuver.

Facility time permitting, three optional scenarios will be added:

a) A paperwork verification scenario
b) Three out at RTLS PPA
c) RTLS three out green post Vrel 0.

The paperwork verification scenario ensures the crew has developed good FDF habit patterns. A three out scenario during PPA further demonstrates three out automation capability with rates on the vehicle at low q, thereby developing the crew’s FCS decision-making capability. A black zone signature may result as well. The RTLS three out green post Vrel 0 further develops the crew's ability to read the cue card in this region.
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

RATIONALE FOR THE CONT ABT 32011 SCENARIOS

1. Droop A staggered dual engine failure scenario. The first engine is failed within the TAL window followed by a second engine failure at SE OPS 3. This forces maximum FDF utilization and develops insights to the assumptions comprising the SE OPS 3 boundary.

2. Droop back-out A simultaneous dual engine failure scenario wherein the minimum droop altitude is violated, necessitating a downmode to two out second stage green. This will develop the ability to follow the cue card flow and provide exposure to the droop simultaneous failure scenario. A slight insight to SE OPS 3 assumptions may be realized as well.

3. Stuck first A one and two-thirds scenario in second stage. This provides exposure to the subtle and unique procedures of stuck throttle contingency aborts in regions where runway capability is non-existent. Additionally, this scenario demonstrates that this procedure applies to failures occurring in second stage as well as first stage.

4. Stuck RTLS A one and two-thirds scenario within the one and two-thirds RTLS window. This provides exposure to the completely unique stuck RTLS procedures.

5. RTLS two out orange A second engine failure shortly after Vrel 0 after a previous engine failure forcing the RTLS trajectory. This demonstrates an almost immediate MECO along with the techniques associated with avoiding a powered flight LOC and transonic pitch-up divergence during entry. This scenario increases procedural execution speed and accuracy. This scenario includes a SERC toggle procedure.

6. RTLS three out orange A two-second stagger of the remaining engines shortly after Vrel 0 after a previous engine failure forcing the RTLS trajectory. Exposure to this region further increases three engine out proficiency, allowing practice of techniques and procedural execution speed. The engine failure stagger develops contingency abort SFRM.

7. RTLS two out green A second engine failure after a previous engine failure forcing the RTLS trajectory. This provides exposure to the RTLS green region as well as further procedural, technique and SFRM practice.
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

8. RTLS three out yellow A 1 second stagger of the remaining engines after a previous engine failure forcing the RTLS trajectory. This provides exposure to the marginally controllable RTLS three out yellow region. Further procedural, technique, and SFRM practice is realized. This scenario includes a decision not to toggle SERC.

9. RTLS three out yellow/red A high q simultaneous failure of the remaining engines after a previous engine failure forcing the RTLS trajectory. This provides exposure to the completely unique and marginally controllable RTLS three out red maneuver. An alpha trap situation may develop forcing the crew to use all of the techniques previously practiced in an extremely timely fashion. This is the most confusing and dangerous contingency abort maneuver requiring the utmost SFRM.

10. RTLS two out red A second engine failure after a previous engine failure forcing the RTLS trajectory. This provides exposure to unique procedures associated with this marginally controllable region. Further procedural, technique, and SFRM practice is realized. A decision to toggle SERC is included in this scenario.

11. RTLS three out blank A simultaneous failure of the remaining engines after the color field has blanked on the RTLS Traj display. This provides exposure to the unique and undocumented techniques to safely complete the RTLS trajectory.

12. Contingency three out blank Either a failure of the last remaining engine after two previous engine failures or a nearly simultaneous failure of all three engines after the color field has blanked on the Traj display. This provides exposure to the unique and undocumented techniques to safely complete the RTLS trajectory.

Facility time permitting, optional scenarios will be added to:

a) Review BDA/ECAL techniques
b) Increase proficiency in any area observed to be deficient
c) Exercise a stuck droop procedure
d) Perform any of the remaining 46 major contingency abort maneuvers.
e) Demonstrate a black zone signature.

The rationale for b and d above is self-explanatory. BDA/ECAL maneuver may require review because of the extensive manual techniques involved. The stuck droop procedure is exercised to provide exposure to erroneous display of droop altitude as well as the subtle and unique procedural differences. A black zone demonstration is desirable to complete the crew’s knowledge of the contingency abort trajectory such that its signature can be recognized for situational awareness.

Note: Different combinations/sequences of engine failures are provided throughout this training for maximum exposure to unique aerodynamic asymmetry issues. Data path, red-line limit exceedance, or system failure situations can be added to any scenario above; however, this should be the exception rather than the rule to allow full concentration on contingency abort procedures, maneuvering, techniques, and SFRM.
Ascent/Entry Flight Operations Lesson Descriptions

CONTINGENCY ABORT SAMPLING RATIONALE

RATIONALE FOR THE CONT ABT 91011 SCENARIOS

The rationale for this 90K level lesson is straightforward. The intent of this lesson is to provide flight specific contingency abort review emphasizing:

1. Procedures not performed during recent ascent simulation (or have never been performed during simulation)
2. Procedures requiring manual intervention
3. Areas requiring additional proficiency as noted from previous ascent simulations
SECTION 7.0 ORBIT FLIGHT OPERATIONS TRAINING COURSE

The primary goal of the Orbit Flight Operations Training Course (see Figure 7-1) is to ensure that the student has been exposed to those Flight Data File (FDF) items related to on-orbit orbiter operations, which can be exercised at the SMS. These FDF items include:

- Post-Insertion Checklist
- Flight Plan
- Orbit OPS Checklist
- Orbit Pocket Checklist
- EVA OPS Checklist
- STS Systems Malfunction Procedures
- Reference Data Book

Although the FDF and Flight Plan include flight specific activities, certain aspects are standard. These will be emphasized and include the nominal, Primary Avionics Software System (PASS), General Purpose Computer (GPC), failed, and Backup Flight System (BFS) post-insertion activities. It also includes PGSC computer with Space Operations Computing (SpOC) software use, site coverage, stowage, Orbit Operations (Orb Ops) Checklist (C/L) activities, attitude maneuvers, alignments and minimum Reaction Control System (RCS) usage procedures. Orbit Pocket C/L activities are emphasized. Due to time constraints, all long-form malfunction procedures will not be exercised at the SMS. Single System Trainers (SSTs) are used in the Systems, COMM, Control/Propulsion (PROP), and DPS training flows to cover many of these procedures. The Orbit Flight Operations Training Course also includes part-task training in Star Tracker Crew Optical Alignment Sight (ST/COAS) star sightings, Inertial Measurement Unit (IMU) alignments, and the orbit DAP (as used for orbit manual attitude control), as well as the Electrical Power System (EPS) and COMM systems.

Through the non-load specific (20000-level and 30000-level) orbit training, the crew is prepared to enter integrated orbit simulations or to begin orbit skills training in which they will be exposed to multiple systems failures. The orbit skills lessons will be coordinated by the crew-assigned SMS team lead and SST instructors to cycle the students through FDF items previously covered. In addition, some major powerdowns leading to contingency deorbit preps will be covered. (These procedures were originally taught as part of the Deorbit and Entry Flight Operations Training Course.) The orbit skills lessons may also be utilized by a crew for timeline operations.

Load specific (90000-level) training for a crew begins when the FDF and simulator training load are correct for the assigned flight. This training includes one post-insertion run. Major payload and PDRS activities are covered in their respective training flows.

When each member of a crew has previously flown within 2 years, training will begin at the 30000-level. The specific 30000-level lessons required for an experienced crew are a function of how recently the crew has flown.
Load Specific (90000-Level) RNDZ/PDRS missions:

There are 4 different flows for PDRS depending on the mission tasks: Unloaded, Loaded, Deploy, Retrieve. These flows are only required for Deploy and Retrieve missions, NOT ISS flights, as the PDRS flow will cover all required PDRS objectives.

The Loaded flow will be required if there are excessive loaded operations in the Flight Plan. Minimal Loaded operations may be timelined before the deploy or after the retrieve lessons.

For a Deploy and Retrieve mission, both the Deploy and Retrieve flows will be required.

Not all lessons in each flow may be required. For example, the Single Joint and Contingency lessons will be required only if Single Joint and Contingency procedures are published.

Load Specific (90000-Level) Deploy or Retrieve missions:

PROX OPS T/L 91012 will be required to support any proximity operations that may be required for a Deploy or Retrieve mission.

Load Specific (90000-Level) Docking missions:

UNDOCK MAL T/L 91012 and PROX OPS T/L 91012 will be required to support docking and undocking operations.
Figure 7-1. Orbit Flight Operations Lesson Flow Chart
(Sheet 1 of 3)
Figure 7-1. Orbit Flight Operations Lesson Flow Chart
(Sheet 2 of 3)
Figure 7-1. Orbit Flight Operations Lesson Flow Chart (Sheet 3 of 3)
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# Table 7-1. Orbit Flight Operations
## Crew Training Requirements

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### Non-Crew Rotation
- 4.15
- 40.0  40.0  38.5  35.5  32.5  0  9  40.0  40.0  38.5  35.5

### Crew Rotation
- 4.15
- 40.0  40.0  38.5  35.5  32.5  0  9  40.0  40.0  38.5  35.5

### Sub Total for Stage
- 4.15
- 40.0  40.0  38.5  35.5  32.5  0  9  40.0  40.0  38.5  35.5

### Stage Totals Per Crewmember:
- 4.15
- 40.0  40.0  38.5  35.5  32.5  0  9  40.0  40.0  38.5  35.5

### Comments
- See Notes 4 and 5
- See Note 1
- Others designated by CDR
- See Note 2
- As assigned by CDR
- As assigned by CDR
- Docking flights only. As assigned by CDR
- As assigned by CDR
- As assigned by CDR
- As assigned by CDR
- See Note 6; as assigned by CDR
- 1.0 hour for missions on OV-104

### Date Last Modified:
- 06/08

### Notes:
1. Schedule in pairs from crew CDRs list of crew duty assignments. Schedule the prime and backup crewmembers together in one of the following SST lessons. Instructors should be selected from the SMS team assigned to the flight, if possible. (Contact the instructor or SMS team lead before scheduling.)
2. This lesson should be scheduled a minimum of 2 weeks after FLT COMM PLN BRF 31001.
3. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC or photo/TV setups or Flight Day 1 deploy.
4. If dual shift flight, this should be scheduled separately for the RED Shift Crew and the BLUE Shift Crew.
5. Commander may request other MS to take the lesson. Only C, P, and MS2 required. At the discretion of the CDR/crew, this lesson can be scheduled with the entire crew listed at the same time or in multiple classes.
6. If MPLM is on-board the flight, disregard PRS OPS 31029 and enter MPLM flow.
Table 7-1. Orbit Flight Operations
Crew Training Requirements (Continued)

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Sub Total for Stage | Stage Totals Per Crewmember: 31.5 | 30.5 | 29 | 30.5 | 29 | 0 | 4 | 30.5 | 30.5 | 29 | 30.5 |

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Sub Total for Stage | Stage Totals Per Crewmember: 5.75 | 4 | 4 | 5.75 | 4 | 5.75 | 4 | 5.75 | 4 |

NOTE: 1. Schedule in pairs from crew CDRs list of crew duty assignments. Schedule the prime and backup crewmembers together in one of the following SST lessons. Instructors should be selected from the SMS team assigned to the flight, if possible. (Contact the instructor or SMS team lead before scheduling.) ORB SKL SYS 31004 ORB SKL COMM 31006
2. This lesson should be scheduled a minimum of 2 weeks after FLT COMM PLN BRF 31001.
3. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC or photo/TV setups or Flight Day 1 deploy.
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<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>GNS</td>
<td>Only required if launch slips by minimum of one month</td>
</tr>
</tbody>
</table>

Sub Total for Stage: 62

NOTE: 1. Schedule in pairs from crew CDRs list of crew duty assignments. Schedule the prime and backup crewmembers together in one of the following SST lessons.
   (Contact the instructor or SMS team lead before scheduling.)
   ORB SKL SYS 31004         ORB SKL COMM 31008
2. This lesson should be scheduled a minimum of 2 weeks after FLT COMM PLN BRF 31001.
3. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC or photo/TV setups or Flight Day 1 deploy.
4. If dual shift flight, this should be scheduled separately for the RED Shift Crew and the BLUE Shift Crew.
5. Commander may request other MS to take the lesson. Only C, P, and MS2 required. At the discretion of the CDR/crew, this lesson can be scheduled with the entire crew listed at the same time or in multiple classes.
6. If MPLM is on-board the flight, disregard PRS OPS 31029 and enter MPLM flow.
Orbit Flight Operations Lesson Descriptions

1  **SPOC 31001**

- Title: Space Operations Computing Software Briefing
- Duration: 2.0 hours
- Medium: Classroom
- Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule in groups of 3.)
- Source: MS4/Flight Software Office
- Date: 04/95
- Lesson(s) Replaced: None
- Equipment Required: PGSC per student with generic flight load
- Prerequisite Lesson(s): New Astronaut Flow
- Preparation: None

**Synopsis:** This briefing covers the basic operations of Space Operations Computing (SpOC) PGSC applications primarily focusing on WorldMap and Deorbit Manager. Additional applications covered during the class include 3D Orbiter, Capture Master, Hazardous Materials (HazMat), Locker Stow, OMS Reaction Control System (RCS), Packet Display Program, Portable Onboard Computer (POC) Plot, and Time Utilities. Class includes discussion of SpOC data updates via orbiter telemetry and ground sources.

**Objectives:**
- Demonstrate proficiency in using the SpOC software and PGSC hardware for each of the programs listed above.
- Demonstrate an understanding of the onboard PGSC telemetry distribution system.

2  **ORB SKL DPS 31006**

- Title: Orbit Data Processing System Skills
- Duration: 2.0 hours
- Medium: SST 1, SST 2, or SST 3
- Student: COMMANDER, MS 2, PILOT (If dual shift flight, schedule Red Shift and Blue Shift separately. Commander may request other MS to take the lesson. Only C, P, and MS2 required. At the discretion of the CDR/crew, this lesson can be scheduled with the entire crew listed at the same time or in multiple classes.)
- Source: DS24/DPS/Navigation Training Group
- Date: 02/04
- Lesson(s) Replaced: ORB SKL 32012, ORB SKL 33012
- Equipment Required: None
- Prerequisite Lesson(s): DPS Q 31001
- Preparation: None
2 **ORB SKL DPS 31006 (Concluded)**

**Synopsis:** This lesson covers nominal and malfunction DPS procedures. It will be used to prepare the astronauts (prime and backup) who were selected by the CDR to be responsible for DPS.

**Objectives:** This lesson covers the following objectives:
- Recognize all Primary Avionics Software System (PASS) Guidance, Navigation and Control (GNC) General Purpose Computers (GPCs) failing and work GNC Recovery via G2FD GPC activate procedures
- Recognize and recover from loss of PASS Multifunction Electronic Display System (MEDS) interface via:
  - Systems Management (SM) GPC fail
  - Freeze Dried (FD) GPC activate
  - DPS, MAL PROC, GPC FRP-1 (optional)
  - Modular Memory Unit (MMU) failure during IPL process (optional)
- Recognize and recover from a Flight Critical (FC) X at GPC Y transmitter problem
- Recognize and recover from a Redundant set split with an off-nominal string assignment
- Perform the Operational Sequence (OPS) 2 to OPS 8 transition with MMU problems
- Recognize and recover from a critical Built-In Test Equipment (BITE) in the MEDS
- Discuss pertinent Operations Program System (OPS) notes and good DPS practices

3 **ORB SKL SYS 31004**

**Title:** Orbit Systems Skills  
**Duration:** 2.0 hours  
**Medium:** SST 2  
**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule in pairs as assigned by CDR.)  
**Source:** DS45/Shuttle Systems Training Group  
**Date:** 01/94  
**Lesson(s) Replaced:** ORB SKL 32012, ORB SKL 33012  
**Equipment Required:** None  
**Prerequisite Lesson(s):** New Astronaut Flow  
**Preparation:** None  

**Synopsis:** This lesson covers nominal and malfunction procedures in the subject area. It will be used to prepare the astronauts (prime and backup) who were selected by the CDR to be responsible for these systems.
Orbit Flight Operations Lesson Descriptions

3  **ORB SKL SYS 31004 (Concluded)**

Objectives: The following malfunctions will be resolved using the appropriate FDF.

- Environmental Control and Life Support System (ECLSS):
  - Avionics (AV) Bay smoke detector failure
  - Humidity separator speed sensor failure
  - Cabin fan delta P high
  - Inertial Measurement Unit (IMU) fan delta P low
  - Pressure Control System (PCS) Partial Pressure of Oxygen (PPO₂) controller failure
  - Freon loop evap out temp high
  - Freon flow low
  - H₂O loop accumulator quantity low

- EPS:
  - Cryo O₂ current sensor failure
  - Fuel cell stack sensor failure
  - Fuel cell pH indication
  - Cryo leak

- Auxiliary Power Unit (APU):
  - APU fuel line heater failure
  - Hydraulic accumulator leak with circ pump failure
  - Water Spray Boiler (WSB) leak
  - Hydraulic temperature sensor failure

4  **FLT COMM PLN BRF 31001**

Title: Flight Communications Plan Briefing
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 2, PILOT and other crewmembers designated by CDR
Note: MSs should be designated COMM specialists.
Source: *DS25/Shuttle Comm Training*
Date: 02/03
Lesson(s) Replaced: AUDIO 31001
Equipment Required: None
Prerequisite Lesson(s): New Astronaut Flow
Preparation: None
Orbit Flight Operations Lesson Descriptions

4  **FLT COMM PLN BRF 31001 (Concluded)**

Synopsis: This lesson is required to discuss the use of the audio and communications systems during on-orbit activities. Different options for the audio configurations will be discussed, and the agreed upon audio configurations will be evaluated with the whole crew in the flight-specific COMM lesson FLT COMM PLN 31020.

Objectives:
- Discuss flight-specific requirements and crew preferences for each on-orbit activity audio configuration.
- Finalize Flight-Specific Audio Plan for each activity discussed.

5  **FLT COMM PLN 31020**

Title: Flight Communication Plan
Duration: 2.0 hours
Medium: CCT
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DS25/Shuttle Comm Training
Date: 02/03
Lesson(s) Replaced: AUDIO 31020
Equipment Required: See Facility Utilization Request.
Prerequisite Lesson(s): FLT COMM PLN BRF 31001
Note: This lesson should be scheduled a minimum of 2 weeks after FLT COMM PLN BRF 31001.
Preparation: None

Synopsis: This lesson will enable the crew to set up and use the flight-similar audio equipment for each phase of flight and for flight-specific on orbit activities per the Flight-Specific Audio Plan established during the FLT COMM PLN BRF.

Objectives: Configure the flight-similar Audio equipment for each flight-specific activity per the Flight-Specific Audio Plan.

6  **ORB SKL COMM 31008**

Title: Orbit Communication Skills
Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule in pairs as assigned by CDR.)
Source: DS25/Shuttle Comm Training
Date: 01/94
Lesson(s) Replaced: ORB SKL 32012, ORB SKL 33012
Equipment Required: None
Orbit Flight Operations Lesson Descriptions

6  ORB SKL COMM 31008 (Concluded)

Prerequisite Lesson(s):  FLT COMM PLN 31020
Preparation:  None

Synopsis:  This lesson covers nominal and malfunction procedures in the subject area. It will be used to prepare the astronauts (prime and backup) that were selected by the CDR to be responsible for these systems for their flight assignments.

Objectives:  • Identify and perform the proper steps, per FDF, to recover from the following:
  – COMM SKL 31006
  – AUDIO problems (Audio Central Control Unit (ACCU), Audio Terminal Unit (ATU))
  – Load Telemetry Format Loads (TFLs)/fail
  – Pulse Code Modulation Master Unit (PCMMU) fail
  – PAYLOAD COMM system problems (Payload Data Interleaver (PDI), Payload Signal Processor (PSP))
  – Network Signal Processor (NSP) failure
  – PF #1 Multiplexer/Demultiplexer (MDM) failure
  – MS/PLT ATU failure
  – K-band problems (overtemp, single motor, direct stow, man acq)
  – Manual antenna
  – Downlink playback/realtime CCTV
  – R15 MNC
  – SPEC 76 familiarization (encryption bypass, loss 1 Air-to-Ground (A/G) voice, Panel (PNL)/Command (CMD))

  • Recognize that the loss of COMM between crewmembers, and between crew and MCC, is due to AUDIO system problems.

7  WLES FAM BRF 31001

Title:  Wing Leading Edge Sensor Familiarization Briefing
Duration:  2.0 hours
Medium:  Classroom
Student:  COMMANDER, MS 1, MS 2, MS 3, PILOT
Source:  DO5/EB
Date:  07/07
Lesson(s) Replaced:  None
Equipment Required:  Classroom, Projector, Computer
Prerequisite Lesson(s):  None
Preparation:  None
Orbit Flight Operations Lesson Descriptions

7  WLES FAM BRF 31001 (Concluded)

Synopsis: Build familiarization to the Wing Leading Edge (WLE) System. This briefing will be co-instructed by DO5 and EB personnel to give the entire Shuttle crew an overview to the Wing Leading Edge Sensor (WLES) system.

Objectives: Provide the complete crew with an understanding to the Wing Leading Edge Sensor system.

8  WLES OPS I 91001

Title: Wing Leading Edge Sensor Operations I
Duration: 1.0 hour
Medium: Classroom (Building 49 Wireless Instrumentation System Lab)
Student: As assigned by CDR.
Source: DO5
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: A31p laptop
Prerequisite Lesson(s): WLES FAM BRF 31001
Preparation: None

Synopsis: Provide a hands-on lesson with the Wing Leading Edge Sensor (WLES) software and representative hardware.

Objectives: Familiarize prime WLES crew with the WLES procedures and hardware, including the A31p laptop that the software is resident upon.

9A  PO INS MAL 31001

Title: Post-Insertion Malfunction Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA72/QUEST
Date: 01/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): New Astronaut Flow
Preparation: None
Orbit Flight Operations Lesson Descriptions

9A  PO INS MAL 31001 (Concluded)

Synopsis: This prebrief covers the Post Insertion Checklist (C/L) that will be worked during PO INS MAL 31012. Roles and responsibilities of each crewmember will be discussed.

Objectives: Obtain advanced information required to successfully complete the objectives listed in PO INS MAL 31012.

9B  PO INS MAL 31012

Title: Post-Insertion Malfunction
Duration: 4.0 hours
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA72/QUEST
Date: 01/95
Lesson(s) Replaced: PO INS OPS 22012 (partial)
Equipment Required: Stowage, hardline COMM connected for use by crew, wireless headsets, MS seats installed, PGSC/SpOC, Crew Optical Alignment Sight (COAS)
Prerequisite Lesson(s): PO INS MAL 31001
Preparation: None

Synopsis: This lesson goes through the post-insertion timeframe, beginning at L/O-2 minutes with one General Purpose Computer (GPC) failed during the Operations (OPS) transition. Additional malfunctions included will be limited to the starred block in the Post Insertion Checklist.

Objectives:
• Exercise the post-insertion timeline while successfully working the starred block procedures.
• Resolve all problems and achieve stable orbit configuration that would allow continued mission success.

10A  D/O PREP 31001

Title: Deorbit Preparation Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1 optional (Highly desirable.)
Source: DA72/QUEST
Date: 07/00
Lesson(s) Replaced: D/O N-NOM BR 31001
Equipment Required: None
Orbit Flight Operations Lesson Descriptions

10A  **D/O PREP 31001 (Concluded)**

Prerequisite Lesson(s):  D/O BURN 31011 (A/E FO), New Astronaut Flow  
Preparation:  None

Synopsis:  This briefing details the nominal deorbit preparation procedures from Time of Ignition (TIG) minus 4 hours through deorbit TIG, then backout for a 24 hour stay on-orbit. The major and critical procedures will be pointed out, along with an explanation of the purpose of the procedures. The CDR can also use this lesson to work on crew coordination, timing, and responsibilities.

Objectives:
- Understand the sequence of events during deorbit prep.
- Understand the responsibilities of the crewmembers and how to coordinate them.
- Understand the major timeline events (Payload Bay Door (PLBD) closure, DPS reconfiguration, stowage, etc.).

10B  **D/O PREP 31012**

Title:  Deorbit Preparation  
Duration:  4.0 hours  
Medium:  SMS-FB  
Student:  COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1 optional  
(Highly desirable.)  
Source:  DA72/QUEST  
Date:  07/00  
Lesson(s) Replaced:  None  
Equipment Required:  Stowage, MS seats installed, wireless headsets, standard Deorbit and entry FDF stowed, orbit FDF setup  
Prerequisite Lesson(s):  D/O PREP 31001  
Preparation:  None

Synopsis:  This lesson exercises the nominal End of Mission (EOM) deorbit preparation procedures beginning with the start of the Deorbit (D/O) Prep Checklist (C/L) through the D/O burn Time of Ignition (TIG). The crew should also work on coordination, timing, and responsibilities. All Preliminary Advisory Data (PAD) should be available. Malfunctions that do not distract from the timeline may be input.

Objectives:
- Be able to complete the deorbit preparation procedures according to the timeline in the D/O Prep C/L.
- Exercise the Deorbit Burn Flight Rules cue card.
Orbit Flight Operations Lesson Descriptions

11 APDS MAL 21029
Title: Androgynous Peripheral Docking System Malfunctions (1 of 3)
Duration: 2.0 hours
Medium: PYLD Trainer
Student: COMMANDER, MS 1, PILOT
Note: Schedule for Docking Flights only.
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: APDS MAL 31029
Equipment Required: None
Prerequisite Lesson(s): APDS OPS 21029
Preparation: Review APDS Nominal Procedures in Rendezvous Checklist
Synopsis: This lesson provides a detailed description of Androgynous Peripheral Docking System (APDS) malfunction operations. Emphasis will be placed on star block procedures located in the Rendezvous Checklist.
Objectives: Upon completion of the lesson, the student will be able to:
- Perform docking and undocking procedures, including: Docking Mechanism Initialization, Docking Mechanism Powerup, Docking Ring Extension, Docking Mechanism Powerdown, Docking Prep, Approach Cue Card, Docking Sequence Cue Card, and Undocking.
- Recognize and respond to malfunctions using appropriate starred blocks in the above procedures.
- Demonstrate understanding of rationale for starred blocks.
- Identify and explain switches and circuit breaker capabilities on panel A7L and panel A6U.

12 APDS MAL 22029
Title: Androgynous Peripheral Docking System Malfunctions (2 of 3)
Duration: 2.0 hours
Medium: PYLD Trainer
Student: COMMANDER, MS, PILOT
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: APDS MAL 32029
Equipment Required: None
Prerequisite Lesson(s): APDS MAL 21029
Preparation: Review APDS Off-Nominal Procedures in Rendezvous Checklist
Synopsis: This lesson introduces and implements Androgynous Peripheral Docking System (APDS) malfunction procedures. Emphasis will be placed on off-nominal procedures located in the Rendezvous Checklist.
APDS MAL 22029 (Concluded)

Objectives: Upon completion of this lesson, the student will be able to:

- Perform docking and undocking sequences, including: Docking Mechanism Powerup, Docking Ring Extension, Docking Mechanism Powerdown, Docking Prep, Approach Cue Card, Docking Sequence Cue Card, and Undocking with the addition of malfunctions.
- Recognize and respond to anomalies within 30 ft and review Go/No-Go scenarios in the Docking Sequence Cue Card.
- Recognize and respond to malfunctions using appropriate off-nominal procedures, including the PMA 2/3 HOOKS CLOSE procedure.
- Demonstrate understanding of the rationale for off-nominal procedures.

APDS MAL 23029

Title: Androgynous Peripheral Docking System Malfunctions (3 of 3)
Duration: 2.0 hours
Medium: PYLD Trainer
Student: COMMANDER, MS, PILOT
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: APDS MAL 33029
Equipment Required: None
Prerequisite Lesson(s): APDS MAL 22029
Preparation: Review Off-Nominal Procedures in the Rendezvous Checklist

Synopsis: This lesson introduces and implements Androgynous Peripheral Docking System (APDS) malfunction procedures. Emphasis will be placed on off-nominal procedures located in the Rendezvous Checklist.

Objectives: Upon completion of this lesson, the student will be able to:

- Perform docking and undocking sequences, including: Docking Mechanism Powerup, Docking Mechanism Powerdown, Docking Prep, Approach Cue Card, Docking Sequence Cue Card, and Undocking with the addition of malfunctions.
- Recognize and respond to anomalies within 30 ft and review Go/No-Go scenarios in the Docking Sequence Cue Card.
- Recognize and respond to malfunctions with appropriate off-nominal procedures, including Failed Capture, Force Ring Alignment procedure, and the ODS HOOKS-OPEN contingency procedure.
- Demonstrate understanding of the rationale for off-nominal procedures.
**Title:** Orbiter Communications Adapter/Video Teleconference System Operations  

**Duration:** 2.0 hours  

**Medium:** Payload General Support Computer  

**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1 (Schedule individually or in pairs.)  

**Source:** DO5/Cargo Integration and Operations Branch  

**Date:** 03/02  

**Lesson(s) Replaced:** OCA/VTS OPS 31001  

**Equipment Required:** 2 IBM 760 ThinkPads on expansion chassis with Orbiter Communications Adapter (OCA) and ProShare cards, 1 OCA-to-OCA cable, 2 video mini cameras and cables, 1 VTS audio cable with headset, 2 Direct Current (DC) utility power cables, Epson Printer  

**Prerequisite Lesson(s):** PGSC INTRO 21195  

**Preparation:** Know:  
  - Basic PGSC hardware  
  - Ku-Band and Audio system knowledge  

**Synopsis:** The purpose of this class is to properly configure the Orbiter Communications Adapter (OCA) router for use with Modem File Transfer (MFX) ops and Ku-Band File Transfer (KFX) ops.  

**Note:** Schedule PGSC INTRO 21195 only if requested by crewmember.  

**Objectives:** After this lesson, the student will be able to:  
  - Locate appropriate OCA and Video Teleconference System (VTS) procedures.  
  - Identify an Expansion chassis configured with OCA ProShare cards.  
  - Identify an OCA cable and explain its different uses.  
  - Identify proper OCA software after PGSC boot-up.  
  - Understand Outlook limitations.  
  - Use KFX and MFX.  
  - Launch the OCA and ProShare applications.  
  - Initiate a Video Teleconference.  
  - Launch applications to share with MCC.  
  - Understand the OCA router purpose and how to configure it for MFX ops and KFX ops.  
  - Understand the ProShare PGSC’s unique features for VTS and Outlook.  
  - Set up the Network printer and perform a warm-up and self-test.  
  - Perform a video teleconference.
Orbit Flight Operations Lesson Descriptions

14  **OCA/VTS OPS 31195 (Concluded)**

- Understand KFX and view demonstration of uplink.
- Understand the directory structure as it applies to uplinking and downlinking files.
- Understand MFX and view demonstration of uplink.

15  **PGSC NETWORK OPS 31195**

**Title:** Payload General Support Computer Network Operations  
**Duration:** 2.0 hours  
**Medium:** Payload General Support Computer  
**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1 (Schedule individually or in pairs.)  
**Source:** DO5/Cargo Integration and Operations Branch  
**Date:** 03/02  
**Lesson(s) Replaced:** NETWORK OPS 31001  
**Equipment Required:** Standard PGSC Lab equipment  
**Prerequisite Lesson(s):** OCA/VTS OPS 31195  
**Preparation:** None

**Synopsis:** The purpose of this class is to introduce the student to PGSC network and procedures that can be used to verify a “good” network connection. The lesson will require the latest flown flight-specific configuration, flight software, usage chart, Chapter 12 “ORB OPS,” and late-updates. After this class, the student will be able to use the generic PGSC load for any orbit sim, and configure the PGSC network accordingly.

**Objectives:** After this lesson, the student will be able to:
- Locate appropriate network procedures.
- Identify all associated network equipment.
- Set up, activate, and deactivate a PGSC network.
- Verify a proper network connection and configuration.
- Change PGSC network names.
- Use Explorer to verify drive mapping.
- Set up the WinDecom Ops-Network and serial cable ops.
- Perform Time-Vector (TV) server operations.
- Perform Telemetry server operations.
- Identify and understand Space Operations Computing (SpOC) updates.
- Verify a successful network has been established via Pingmaster and Windows Explorer.
- Understand how to recover possible network malfunctions: Loss of drive mapping, bad network card, or a loss of the Radio Frequency (RF) access point.
Orbit Flight Operations Lesson Descriptions

16  SYS PGSC 31195

Title: Systems Payload General Support Computer Applications  
Duration: 1.5 hours  
Medium: Payload General Support Computer  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule in groups of no more than 4.)  
Source: DS45/Shuttle Systems Training Group  
Date: 02/03  
Lesson(s) Replaced: None  
Equipment Required: Standard PGSC Lab equipment  
Prerequisite Lesson(s): PGSC NETWORK OPS 31195  
Preparation: None  
Synopsis: This lesson is designed to introduce students to the PGSC applications that relate to subject matter covered by the DS45 Shuttle Systems section.  
Objectives: After this lesson, the student(s) will be able to:  
• Locate and operate the following PGSC applications. The optional applications are at crew discretion.  
  – 10.2 Depress (Optional)  
  – Cabin Leak  
  – Fuel Cell Monitoring System (FCMS)  
  – Water Dump (Optional)  

17  PGSC MAL 31195

Title: PGSC Malfunctions  
Duration: 2.0 hours  
Medium: Payload General Support Computer  
Student: As assigned by CDR.  
Source: DO5/Cargo Integration and Operations Branch  
Date: 03/02  
Lesson(s) Replaced: PGSC MAL 31001  
Equipment Required: Standard PGSC Lab equipment  
Prerequisite Lesson(s): SYS PGSC 31195  
Preparation: None  
Synopsis: The purpose of this class is to train crews to recover from potential PGSC malfunctions and identify malfunction signatures. The class will cover Complementary Metal Oxide Semi-conductor (CMOS) settings loss, network connectivity problems, Hard disk swap out, PGSC software recovery, and Operations (OPS) notes.
Orbit Flight Operations Lesson Descriptions

17  PGSC MAL 31195 (Concluded)

Objectives: After this lesson, the student will be able to:

- Perform the Orbiter Communications Adapter (OCA) internal and external loop back test. Demonstrate the use of the Windows NT event viewer.
- Review off nominal Network procedures.
- Review off nominal PGSC operations.
- Perform (aided) appropriate FDF procedures depending on malfunction.
- Review In-Flight Maintenance (IFM) PGSC data card changeout procedures.
- Perform an Auto check/boot up.
- Use AUTO XD floppy to recover CMOS settings.
- Swap bad/unseated network card.
- Swap bad hard drive.
- Understand International Business Machines (IBM) post error codes 174, 163, 161, and 301.
- Review ops notes.
- Understand how a corrupted CMOS impacts Windows 98.
- Reload software via reload Compact Disk (CD).
- Configure for serial cable ops (if Local Area Network (LAN) failure).

18  PRS OPS 31029

Title: Payload Retention System Operations
Duration: 1.5 hours
Medium: PYLD Trainer
Student: As assigned by CDR.
Source: DS45/Shuttle Systems Training Group
Date: 04/94
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides a detailed description of the Payload Retention System (PRS), including the Payload Retention Latch Assembly (PRLA) and the Active Keel Actuator (AKA). The class will explain the PRS equipment, logic, crew interfaces, operating procedures, malfunctions, and generic flight rules.
Orbit Flight Operations Lesson Descriptions

18 PRS OPS 31029 (Concluded)

Objectives:
• State the purpose of the PRS.
• Identify the different types of PRLAs and explain their purpose, plus the AKA.
• Describe the payload retention latch talkbacks, payload retention logic power, Motor Controller Assembly (MCA) logic circuit breakers, and payload mech power.
• Explain the latch, release, and ready-to-latch indications displays on SPEC 97.
• Given the appropriate FDF, perform the following procedures:

<table>
<thead>
<tr>
<th>SETUP FOR UNBERTH</th>
<th>SETUP FOR BERTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activate latches</td>
<td>Activate latches</td>
</tr>
<tr>
<td>AKA release</td>
<td>AKA latch</td>
</tr>
<tr>
<td>PRLA release</td>
<td>PRLA latch</td>
</tr>
<tr>
<td>Deactivate latches</td>
<td>Deactivate latches</td>
</tr>
</tbody>
</table>

• Recognize and resolve payload retention system malfunctions using the appropriate PRLA/AKA malfunction procedures.
• State the rationale for the generic PRLA and AKA Flight Rules.

19A ORB NOM OPS 31001

Title: Orbit Nominal Operations Prebrief
Duration: 1.5 hours for missions on OV-103/105, 1.0 hour for missions on OV-104
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Note: Taught twice for dual shift flights.
Source: DA72/QUEST
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): APDS MAL 31029 (Docking Flights Only), D/O PREP 31012, ORB SKL COMM 31008, ORB SKL DPS 31006, ORB SKL SYS 31004, PGSC MAL 31195, PO INS MAL 31012, FCS C/O 31006
Preparation: None

Synopsis: During this lesson, the Team Lead will review the flight plan for ORB NOM OPS 31012. This will allow the students an opportunity to discuss tasks and get answers to questions on the procedures identified for this lesson.
Orbit Flight Operations Lesson Descriptions

19A  ORB NOM OPS 31001 (Concluded)

Objectives:
• Review the timeline to be used during ORB NOM OPS 31012.
• Review the procedures identified in the timeline.
• Assign crew tasks when required.
  • Locate and configure Station to Shuttle Power Transfer System (SSPTS) and Assembly Power Converter Unit (APCU) switches and displays per procedures.
  • Explain how power is transferred from the ISS to the Shuttle and from the Shuttle to the various payloads. (OV-103/105 flights only)

19B  ORB NOM OPS 31012

Title:  Orbit Nominal Operations
Duration:  4.0 hours
Note:  Schedule twice for dual shift flights.
Medium:  SMS-FB
Student:  COMMANDER, MS 1, MS 2, MS 3, PILOT
Source:  DA72/QUEST
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  Stowage, Standard PGSC setup
Prerequisite Lesson(s):  ORB NOM OPS 31001
Preparation:  None

Synopsis:  This lesson allows the students to practice the nominal procedures found in the Orbit Ops Checklist (C/L) without the distraction of major malfunctions. These procedures include hydraulic thermal conditioning, Ku-Band antenna deploy and activation, Ku-Band cable positioning and stow, Ku-Band manual acquisition, all pre-sleep and post-sleep activity, supply water dump using Flash Evaporator System (FES), Station to Shuttle Power Transfer System (SSPTS) and Assembly Power Converter Unit (APCU) activation, lamp & fire suppression test, manual fuel cell purge, Inertial Measurement Unit (IMU) alignment, Flight Control System (FCS) checkout (parts 1 and 2), and Reaction Control System (RCS) hot fire test.

Objectives:
• Practice and become familiar with nominal orbit operations and procedures.
• Complete the scripted nominal procedures in a timely manner.
• Coordinate crew actions during the execution of multiple nominal orbit procedures.
• Use Windows DeCommutator (WinDecom) to initialize Time and State vector applications to enable auto feed of vector and time to required applications.
Orbit Flight Operations Lesson Descriptions

19B ORB NOM OPS 31012 (Concluded)

- Activate and use the PGSC applications Fuel Cell Monitoring System (FCMS) and Water Dump during the appropriate procedure.
- Perform SSPTS and APCU activation as appropriate.

20A ORB SKL 31001

Title: Orbit Skills Prebrief
Duration: 1.0 hour
Note: Schedule twice for dual shift flights.
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 04/93
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ORB NOM OPS 31012
Preparation: None

Synopsis: This prebrief covers Orbiter-only procedures that will be worked during ORB SKL 31012.

Objectives: Refer to ORB SKL 31012 for objectives.

20B ORB SKL 31012

Title: Orbit Skills
Duration: 6.0 hours
Note: Scheduled as two 6-hour sessions for dual shift flight, with crew handover at the 3-hour point of each session. Schedule red team to blue team, then blue team to red team.
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA72/QUEST
Date: 07/00
Lesson(s) Replaced: ORB SKL 32012, ORB SKL 33012
Equipment Required: Wireless headsets, stowage, Standard PGSC setup and COAS
Prerequisite Lesson(s): ORB SKL 31001
Preparation: None
**Orbit Flight Operations Lesson Descriptions**

20B  **ORB SKL 31012 (Concluded)**

**Synopsis:** The purpose of this orbit skills lesson is to increase crew awareness of orbiter system interfaces by interweaving nominal and malfunction procedures learned in previous lessons in the Orbit Training Flow. Orbit skills lessons will contain scenarios that concentrate on the impacts of interacting multiple system failures, but still have a good mix of nominal procedures from the Orbit Ops Checklist (C/L).

**Note:** These lessons will be run against the timeline found in the standard lesson plan. Standard scripts can be obtained from QUEST script file. Payload and PDRS-related activities are not present in the generic scripts.

**Objectives:** Work the following nominal procedures:

- Post-sleep
- CCTV activation
- Ku-band deploy and activation
- Teleprinter activation
- Orbiter Communications Adapter (OCA) setup
- Group B powerdown
- Presleep
- PGSC use
- COAS/Heads-up Display (HUD) Calibration (CAL)
- Systems Management (SM) checkpoint
- Star tracker align (single star tracker)
- Aft controller checkout
- DTO: Fuel cell shutdown and restart
- Handover (dual shift only)
- Perform Cabin depress to 10.2 PSI using 10.2 Depress PGSC application as an aid. (If EVA scheduled only.)
- Use Orbit data to manually initialize Time and State vector applications to enable auto feed of vector and time to required applications.

21A  **CONT D/O 31001**

**Title:** Contingency Deorbit Preparation Prebrief

**Duration:** 2.0 hours

**Medium:** Classroom

**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT

**Source:** DA72/QUEST

**Date:** 05/99

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** ORB SKL 31012
Orbit Flight Operations Lesson Descriptions

21A CONT D/O 31001 (Concluded)

Preparation: Establish:
- Preliminary crew task assignments to execute the Loss of 2 H₂O Loops procedure.

Synopsis: During this prebrief, the Team Lead will give an overview of the failures that would require a crew to enter the Contingency Deorbit (D/O) Checklist (C/L). The FDF path for the Loss of 2 H₂O Loops failure will be reviewed with the primary emphasis being placed on the procedural flow.

Objectives: At the end of this lesson, the student will be able to:
- Identify failures (and aborts) that require the use of the Contingency D/O Prep C/L.
- Identify the major impacts caused by each of the failures.
- Describe orbiter powerdown and cooling requirements based on equipment location.
- For each procedure, describe the following:
  - When the procedure would be used.
  - The mission phase, assumptions, and time to deorbit.
  - The orbiter configuration after the procedure has been executed.
- Perform the LOSS OF 2 H₂O LOOPS and AV BAY FIRE procedures.
- Outline the FDF flow through the associated checklists.
- Determine which portions of the FDF should be performed in parallel, and which should be performed in series.
- State the rationale for the steps in the procedures.

21B CONT D/O 31012

Title: Contingency Deorbit Preparation
Duration: 5.0 hours
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA72/QUEST
Date: 05/99
Lesson(s) Replaced: D/O N-NOM 31012
Equipment Required: None
Prerequisite Lesson(s): CONT D/O 31001
Preparation: Review:
- CONT D/O 31001

Synopsis: During this lesson, the crew will exercise the LOSS OF 2 H₂O LOOPS procedures.
Orbit Flight Operations Lesson Descriptions

21B CONT D/O 31012 (Concluded)

Objectives: At the end of this lesson, the student will be able to:
- Demonstrate an understanding of the FDF flow associated with the loss of two H2O loops failure.
- Perform the LOSS OF 2 H2O LOOPS procedure including the on-orbit wait and on-orbit wait back-out steps through Entry Interface (EI).
- Use Windows DeCommutator (WinDecom) to initialize Time and State vector applications to enable auto feed of vector and time to required applications.
- Time permitting, use Orbit data to manually initialize Time and State vector applications to enable auto feed of vector and time to required applications.
- Use Deorbit/Center of Gravity (c.g.) application to generate deorbit targets.

The CDR will coordinate the execution of these procedures. The crew will inform the CDR when each step has been completed.

22A CONT D/O 32001

Title: Contingency Deorbit Preparation Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA72/QUEST
Date: 05/99
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT D/O 31001, CONT D/O 31012
Preparation: Review:
- CONT D/O 31001
Establish:
- Preliminary crew task assignments to execute the AV BAY FIRE procedure.

Synopsis: During this prebrief, the FDF paths for the AV BAY FIRE failure will be reviewed with the primary emphasis being placed on the procedural flow.

Objectives: At the end of this lesson, the student will be able to:
- Perform the AV BAY FIRE procedure.
- Outline the FDF flow through the associated checklists.
- Determine which portions of the FDF should be performed in parallel, and which should be performed in series.
- State the rationale for the steps in the procedures.
**Orbit Flight Operations Lesson Descriptions**

### 22B  CONT D/O 32012

**Title:** Contingency Deorbit Preparation  
**Duration:** 2.0 hours  
**Medium:** SMS-FB  
**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT  
**Source:** DA72/QUEST  
**Date:** 05/99  
**Lesson(s) Replaced:** D/O N-NOM 31012  
**Equipment Required:** PGSC with WORLD MAP and DEORBIT Manager Applications, Compound Specific Analyzer-Combustion Products (CSA-CP), Quick Don Masks (Quick Don Mask equipment is based on hardware availability), Contingency Hose Kit  
**Prerequisite Lesson(s):** CONT D/O 32001  
**Preparation:** Review:  
- CONT D/O 31001, CONT D/O 32001  
**Synopsis:** During this lesson, the crew will exercise the AV BAY FIRE procedure.  
**Objectives:** At the end of this lesson, the student will be able to:  
- Demonstrate an understanding of the FDF flow associated with the AV BAY FIRE failure.  
- Perform the AV BAY FIRE procedure through Contingency D/O Prep.  
- Use Windows DeCommutator (WinDecom) to initialize Time and State vector applications to enable auto feed of vector and time to required applications.  
- Time permitting, use Orbit data to manually initialize Time and State vector applications to enable auto feed of vector and time to required applications.  
- Use Deorbit/Center of Gravity (c.g.) application to generate deorbit targets.  

The CDR will coordinate the execution of these procedures. The crew will inform the CDR when a step has been completed.
WLES OPS II 91020

Title: Wing Leading Edge Sensor Operations II
Duration: 0.75 hours
Medium: CCT
Student: As assigned by CDR.
Source: DO5
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): To save Facility and crew time, this lesson should be scheduled to immediately follow CABLE/STOW 91020.
Preparation: None

Synopsis: In a “flight like” environment, the crew will setup the Wing Leading Edge Sensor (WLES) hardware in the crew cable as it will occur during the post insertion portion of their flight. The crew will also perform WLES activation steps required for the hardware setup. Flight history lessons learned, including off-nominal procedures, will be discussed.

Objectives:
• Complete unassisted Setup and Activation of the WLES crew cabin hardware and software by the crew.
• Discuss off-nominal events associated with the WLES system.
• Discuss recent WLES flight experiences.

PASS RECOV 31001

Title: Primary Avionics Software System Recovery after Backup Flight System Engage Prebrief
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS 2, PILOT (If dual shift flight, this should be scheduled separately for the RED Shift Crew and the BLUE Shift Crew. Commander may request other MS to take the lesson. Only C, P, and MS2 required. At the discretion of the CDR/crew, this lesson can be scheduled with the entire crew listed at the same time or in multiple classes.)
Source: DS24/DPS/Navigation Training Group
Date: 05/95
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ORB SKL 31012
Preparation: None
Orbit Flight Operations Lesson Descriptions

24A  PASS RECOV 31001 (Concluded)

Synopsis: The crew will be familiarized with the FDF used in PASS RECOVERY and IMU REFERENCE RECOVERY.

Objectives: • Review the General Purpose Computer (GPC) FRP-4 procedure.
• Review the annotated timeline for the big picture events.

24B  PASS RECOV 31006

Title: Primary Avionics Software System Recovery after Backup Flight System Engage

Duration: 2.0 hours
Medium: SST 1 or SST 2 or SST 3
Student: COMMANDER, MS 2, PILOT (If dual shift flight, this should be scheduled separately for the RED Shift Crew and the BLUE Shift Crew. Commander may request other MS to take the lesson. Only C, P, and MS2 required. At the discretion of the CDR/crew, this lesson can be scheduled with the entire crew listed at the same time or in multiple classes.)

Source: DS24/DPS/Navigation Training Group

Date: 05/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PASS RECOV 31001
Preparation: None

Synopsis: Student(s) will engage Backup Flight System (BFS) in Operational Sequence (OPS) 301 and work the Primary Avionics Software System (PASS) Recovery procedure, General Purpose Computer (GPC) FRP-4.

Objectives: • Recover the PASS set using FRP-4.
• Recover the Inertial Measurement Unit (IMU) reference using simulated MCC uplinks.

25  PO INS MAL 32012

Title: Post Insertion Malfunction

Duration: 4.0 hours
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1, CB Instructor Astronaut (IA) attendance mandatory

Source: DA7/Assigned SMS Team

Date: 03/05
Lesson(s) Replaced: PO INS OPS 91012
**Orbit Flight Operations Lesson Descriptions**

### 25 PO INS MAL 32012 (Concluded)

**Equipment Required:** Middeck stowage, PGSC/SpOC, Advanced Crew Escape Suit (ACES), MS seats installed

**Prerequisite Lesson(s):** CONT D/O 31012, ORB SKL 31012, PASS RECOV 31006

**Preparation:** None

**Synopsis:** This lesson will be scripted by the assigned SMS training team and covers the first 4 hours of flight. Orbiter operations and their effects on payload-related activities should be stressed as appropriate.

**Note:** This lesson may be credited with Team Lead and CDR concurrence.

**Objectives:**
- Gain proficiency exercising the post-insertion timeline.
- Reinforce crew reach limitations while in the suits.
- Review payload/orbiter interface procedures and restrictions such as Ku-Band, Payload bay flood lights.
- Practice crew coordination.

### 26A ORB SKL 32001

**Title:** Orbit Skills Prebrief

**Duration:** 1.0 hour

**Note:** Do not schedule on the same day as ORB SKL 32012, but schedule within a week of completion of this prebrief.

**Medium:** Classroom

**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT

**Source:** DA72/QUEST

**Date:** 03/05

**Lesson(s) Replaced:** ORB SKL 91001

**Equipment Required:** Standard PGSC setup

**Prerequisite Lesson(s):** CONT D/O 32012

**Preparation:** Review:
- CONT D/O BR 31001 handout
- ORB SKL 32001 handout

**Establish:**
- Preliminary crew task assignments to execute the Loss of Cabin Pressure Deorbit (D/O) preparation.

**Synopsis:** During this prebrief, the FDF paths for the Loss of Cabin Pressure and the Quick Response Jettison will be reviewed, with the primary emphasis being placed on the procedural flow. If an ISS flight, the FDF paths for the Joint Expedited Undocking and Separation (JEUS) and the Loss of Cabin Press D/O Prep will be reviewed, with the primary emphasis on procedural flow and coordination.
Orbit Flight Operations Lesson Descriptions

26A  ORB SKL 32001 (Concluded)

Objectives: At the end of this prebrief, the student will be able to:
- Activate and use the Cabin Leak PGSC application.
- Perform the Loss of Cabin Pressure and Quick Response/Jettison procedures in the SMS.
- Outline the FDF flow through the associated checklists.
- Determine which portions of the FDF should be performed in parallel, and which should be performed in series.
- State the rationale for the steps in the procedures.
- Review the JEUS procedure, if an ISS flight.

26B  ORB SKL 32012

Title: Orbit Skills
Duration: 4.0 hours
Note: Do not schedule on the same day as ORB SKL 32001, but schedule within a week following completion of the prebrief.
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA72/QUEST
Date: 03/05
Lesson(s) Replaced: ORB SKL 91012
Equipment Required: None
Prerequisite Lesson(s): ORB SKL 32001
Preparation: Review:
- CONT D/O OV 31001

Synopsis: During the first part of this session, the crew will exercise malfunction procedures determined by the SMS Team. The CDR will coordinate the execution of procedures with the crew utilizing solid Space Flight Resource Management (SFRM) habits. The majority of the lesson will be devoted to performing a Contingency Deorbit (D/O) Prep for a Cabin leak.

Objectives: At the end of this lesson, the student will be able to:
- Demonstrate an understanding of the FDF flow associated with the Loss of Cabin Pressure deorbit preparation procedures.
- Perform the Loss of Cabin Pressure procedure, including the Quick Response/Jettison steps through bailout.
- Perform the phugoid damping technique as required.
- The CDR will coordinate the execution of these procedures. The crew will inform the CDR when each step has been completed.
Orbit Flight Operations Lesson Descriptions

26B  **ORB SKL 32012 (Concluded)**
- Use PGSC application Cabin Leak to calculate maximum on-orbit time before the Deorbit burn.
- Use Windows DeCommutator (WinDecom) to initialize Time and State vector applications to enable auto feed of vector and time to required applications.
- Use Deorbit/Center of Gravity (c.g.) application to generate deorbit targets.

27A  **UNLD MAL T/L 91001**

Title: Unloaded Malfunction Timeline Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DA7/Assigned SMS Team  
Date: 07/00  
Lesson(s) Replaced: UNL ORB SKL 91012 (partial)  
Equipment Required: None  
Prerequisite Lesson(s): PDRS UL SJ 91069 (PDRS flow), PO INS OPS 91012  
Preparation: None  

Synopsis: This lesson will provide the students with the timeline to be executed during the UNLD MAL T/L 91012. Malfunctions and actions for recovery will be discussed.

Objectives: The following will be discussed during this prebrief:
- Nominal unloaded timeline with malfunctions
- Flight Plan:  
  - RMS Powerup  
  - Unloaded operations  
  - RMS Powerdown
Orbit Flight Operations Lesson Descriptions

27B **UNLD MAL T/L 91012**

Title: Unloaded Malfunction Timeline  
Duration: 3.0 hours  
**Note:** As required the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.  
Medium: SMS-FB  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DA7/Assigned SMS Team  
Date: 07/00  
Lesson(s) Replaced: UNL ORB SKL 91012 (partial)  
Equipment Required: Standard PGSC setup  
Prerequisite Lesson(s): UNLD MAL T/L 91001  
Preparation: None  
Synopsis: This lesson will allow the students to exercise the timeline previously discussed in UNLD MAL T/L 91001 while dealing with various malfunctions.  
Objectives: - The following events in the flight plan will be covered during this lesson:  
  - RMS Powerup  
  - Unloaded operations  
  - RMS Powerdown  

28A **LOAD NOM T/L 91001**

Title: Loaded Nominal Timeline Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DA7/Assigned SMS Team  
Date: 07/00  
Lesson(s) Replaced: PDRS LD NOM 91012 (partial)  
Equipment Required: None  
Prerequisite Lesson(s): PDRS LD INT 91012 (PDRS flow), PO INS OPS 91012  
Preparation: None  
Synopsis: This lesson will provide the students with the timeline to be executed during the following lesson, LOAD NOM T/L 91012.
Orbit Flight Operations Lesson Descriptions

28A **LOAD NOM T/L 91001 (Concluded)**

Objectives: The following will be discussed during this prebrief:
- Nominal loaded timeline
- Flight Plan:
  - Payload powerup/activation/checkout
  - Pre-release payload commanding
  - Payload grapple
  - Umbilical demate
  - Payload unberth
  - Loaded operations (critical parts)
  - Payload commanding
  - Payload berthing
  - Umbilical mate
  - Post-berth payload commanding
  - Payload powerdown/deactivation

28B **LOAD NOM T/L 91012**

Title: Loaded Nominal Timeline
Duration: 4.0 hours
Note: Schedule 6 hours if integrated with the NBL. As required the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.
Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: PDRS LD NOM 91012 (partial)
Equipment Required: PGSC
Prerequisite Lesson(s): LOAD NOM T/L 91001
Preparation: None
Synopsis: This lesson will allow the students to exercise the timeline previously discussed in LOAD NOM T/L 91001 for nominal payload and RMS activities.
Orbit Flight Operations Lesson Descriptions

28B  LOAD NOM T/L 91012 (Concluded)

Objectives:
• Perform nominal loaded timeline.
• Exercise the following events in the flight plan:
  – Payload powerup/activation/checkout
  – Pre-release payload commanding
  – Payload grapple
  – Umbilical demate
  – Payload unberth
  – Loaded operations (critical parts)
  – Payload commanding
  – Payload berthing
  – Umbilical mate
  – Post-berth payload commanding
  – Payload powerdown/deactivation

29A  DPLY NOM T/L 91001

Title: Deploy Nominal Timeline Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: PDRS DEP NOM 91012
Equipment Required: None
Prerequisite Lesson(s): SEP/TRANS 31069 (RNDZ PO flow), PO INS OPS 91012,
PDRS DEP INT 91012 (PDRS flow), or
PDRS D&R INT 91012 (PDRS flow)
Preparation: None

Synopsis: This lesson will provide the students with the timeline to be executed during the following lesson, DPLY NOM T/L 91012.

Guidelines for coordination between crewmembers should be discussed. Secondary tasks are prioritized as to not interfere with the primary task. Review the RMS/Rendezvous (RNDZ) DAP constraints for this timeline.
Object Flight Operations Lesson Descriptions

29A DPLY NOM T/L 91001 (Concluded)

Objectives: Discuss the following:
- Nominal deploy timeline
- Flight Plan:
  - Payload powerup/activation/checkout
  - Pre-release payload commanding
  - Payload grapple
  - Umbilical demate
  - Payload unberth
  - Loaded operations required prior to deploy
  - Payload release
  - Separation (SEP) 1 (SEP 2, as time permits.)
  - Post-release payload commanding

29B DPLY NOM T/L 91012

Title: Deploy Nominal Timeline
Duration: 4.0 hours
Note: Schedule 6 hours if integrated with the NBL.
Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: DPLY ORB SKL 91012, DPLY ORB SKL 92012
Equipment Required: PGSC, COAS
Prerequisite Lesson(s): DPLY NOM T/L 91001
Preparation: None

Synopsis: This lesson exercises the deploy/separation timeline, integrating all Rendezvous (RNDZ), PDRS, and Payloads tasks, as the crew will perform them in flight.

Special attention should be paid to coordination between crewmembers and prioritization of tasks. The CDR should coordinate the flight deck activities to establish a proper balance between command and crewmember participation, and act decisively when the situation requires.
Orbit Flight Operations Lesson Descriptions

29B  **DPLY NOM T/L 91012 (Concluded)**

Objectives:
- Perform deploy timeline with selected malfunctions:
  - Payload (PL) Power interface problem
  - Loss of safety inhibits
  - Standard Switch Panel (SSP) Malfunctions
  - Loss of VERNs
  - Systems Management (SM) General Purpose Computer (GPC) Failure
  - RMS Handcontroller failure
  - CCTV Failure
  - End Effector (EE) Malfunctions

- Cover the following events in the Flight Plan:
  - Payload powerup/activation/checkout
  - Pre-release payload commanding
  - Payload grapple
  - Umbilical demate
  - Payload unberth
  - Loaded operations required prior to deploy
  - Payload release
  - Separation (SEP) burn 1 (SEP 2 as time permits)
  - Post-release payload commanding

30A  **RETR NOM T/L 91001**

Title: Retrieve Nominal Timeline Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: PDRS RET NOM 91012 (partial)
Equipment Required: None
Prerequisite Lesson(s): APPR & F/A 31069 (RNDZ/PO flow), PO INS OPS 91012, PDRS RET INT 91012 (PDRS flow) or PDRS D&R INT 91012 (PDRS flow)
Preparation: None
Synopsis: This lesson will provide the students with the timeline to be executed during the following lesson, RETR NOM T/L 91012.
Orbit Flight Operations Lesson Descriptions

30A RETR NOM T/L 91001 (Concluded)

Special attention should be paid to coordination between crewmembers and prioritization of tasks. The Tools for Rendezvous and Docking (TRAD) system should effectively be used to increase situational awareness. If working with the TRAD system interferes with the primary task, its use should be discontinued. The CDR should coordinate the flight deck activities to establish a proper balance between command and crewmember participation, and act decisively when the situation requires.

Objectives:
- Review the nominal retrieve timeline
- Review the following events in the Flight Plan:
  - Initial Condition: RMS is poised for capture
  - Initial Condition: 400 foot approach
  - Pre-capture payload commanding
  - Payload capture
  - Loaded operations required prior to berthing
  - Payload commanding
  - Payload berthing
  - Umbilical mate
  - Post-berth payload commanding
  - Payload powerdown/deactivation

30B RETR NOM T/L 91012

Title: Retrieve Nominal Timeline
Duration: 4.0 hours
Note: Schedule 6 hours if integrated with the NBL. As required the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.

Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: PDRS RET NOM 91012 (partial)
Equipment Required: COAS, PGSC
Prerequisite Lesson(s): RETR NOM T/L 91001
Preparation: None
Orbit Flight Operations Lesson Descriptions

30B  RETR NOM T/L 91012 (Concluded)

Synopsis: This lesson exercises the proximity operations (prox ops) and retrieve timeline, integrating all Rendezvous (RNDZ), PDRS, and Payload tasks, as the crew will perform them in flight.

Special attention should be paid to coordination between crewmembers and the prioritization of tasks. The CDR should coordinate the flight deck activities to establish a proper balance between command and crewmember participation, and acts decisively when the situation requires.

Objectives:

• Perform nominal retrieve timeline.
• Cover the following events in the Flight Plan:
  – Initial Condition: RMS is poised for capture
  – Initial Condition: 400 foot approach
  – Pre-capture payload commanding
  – Payload capture
  – Loaded operations required prior to berthing
  – Payload commanding
  – Payload berthing
  – Umbilical mate
  – Post-berth payload commanding
  – Payload powerdown/deactivation

31  LOAD MAL T/L 91012

Title: Loaded Malfunction Timeline
Duration: 4.0 hours
Note: Schedule 6 hours if integrated with the NBL. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.

Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: LOAD ORB SKL 91012 and LOAD ORB SKL 92012 (partial)
Equipment Required: PGSC
Prerequisite Lesson(s): LOAD NOM T/L 91012
Preparation: None

Synopsis: This lesson will allow the students to execute the loaded timeline while dealing with various payload and RMS malfunctions.
Orbit Flight Operations Lesson Descriptions

31 LOAD MAL T/L 91012 (Concluded)

Objectives:
- Perform nominal loaded timeline with the following malfunctions:
  - Payload Thermal Issues
  - Payload COMM Problems
  - Payload Retention Latch Assembly (PRLA) System Failures
  - PGSC Loss
  - End Effector (EE) Malfunction
  - Hand Controller Failures
  - CCTV Failures
  - Systems Management (SM) General Purpose Computer (GPC) Failure

- Cover the following events in the Flight Plan:
  - Payload powerup/activation/checkout
  - Pre-release payload commanding
  - Payload grapple
  - Umbilical demate
  - Payload unberth
  - Loaded operations (critical parts)
  - Payload commanding
  - Payload berthing
  - Umbilical mate
  - Post-berth payload commanding
  - Payload powerdown/deactivation

32 DPLY MAL T/L 91012

Title: Deploy Malfunction Timeline
Duration: 4.0 hours
Note: Schedule 6 hours if integrated with the NBL. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.
Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (CB Instructor Astronaut (IA) attendance optional.)
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: DPLY ORB SKL 91012 and DPLY ORB SKL 92012
Equipment Required: PGSC, COAS
Prerequisite Lesson(s): DPLY NOM T/L 91012
Preparation: None
Orbit Flight Operations Lesson Descriptions

32 DPLY MAL T/L 91012 (Concluded)

Synopsis: This lesson will allow the students to execute the deploy timeline while dealing with various payload, RMS, and Rendezvous (RNDZ) malfunctions.

Special attention should be paid to coordination between crewmembers and prioritization of tasks. This lesson exercises the Deploy/Separation timeline, integrating all RNDZ, PDRS, and Payload tasks, as the crew will perform them in flight. The CDR should coordinate the flight deck activities to establish a proper balance between command and crewmember participation, and act decisively when the situation requires.

Objectives:

- Perform deploy timeline with the following malfunctions:
  - Payload (PL) Power interface problem
  - Loss of safety inhibits
  - Standard Switch Panel (SSP) Malfunctions
  - Loss of VERNs
  - Systems Management (SM) General Purpose Computer (GPC) Failure
  - RMS Hand Controller Failure
  - CCTV Failure
  - End Effector (EE) Malfunctions

- Cover the following events in the Flight Plan:
  - Payload powerup/activation/checkout
  - Pre-release payload commanding
  - Payload grapple
  - Umbilical demate
  - Payload unberth
  - Loaded operations required prior to deploy
  - Payload release
  - Separation (SEP 1 (SEP 2 as time permits))
  - Post-release payload commanding
Orbit Flight Operations Lesson Descriptions

33  RETR MAL T/L 91012

Title: Retrieve Malfunction Timeline  
Duration: 4.0 hours  
Note: Schedule 6 hours if integrated with the NBL. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.  
Medium: SMS-FB (NBL/FB, as requested.)  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (CB Instructor Astronaut (IA) attendance optional.)  
Source: DA7/Assigned SMS Team  
Date: 07/00  
Lesson(s) Replaced: RETR ORB SKL 92012, RETR ORB SKL 93012  
Equipment Required: PGSC, COAS  
Prerequisite Lesson(s): RETR NOM T/L 91012  
Preparation: None  
Synopsis: This lesson will allow the students to execute the retrieve timeline while dealing with various payload, RMS, and Rendezvous (RNDZ) malfunctions. Special attention should be paid to coordination between crewmembers and prioritization of tasks. This lesson exercises the PROX OPS retrieve timeline, integrating all RNDZ, PDRS, and Payload tasks, as the crew will perform in flight. The CDR should coordinate the flight deck activities to establish a proper balance between command and crewmember participation, and act decisively when the situation requires.  
Objectives: Perform retrieve timeline with selected malfunctions:  
- Systems Management (SM) General Purpose Computer (GPC) Failure  
- RMS Handcontroller Failure  
- CCTV Failure  
- End Effector (EE) Malfunctions  
- Payload Attitude Control problem  
- Flyaround  
- Payload Communication problem  
- Loss of PGSC  
- Standard Switch Panel (SSP) Malfunction  
- RADAR Fail  
- Post-berth payload commanding powerdown/deactivation
LOAD SJ T/L 91012

Title: Loaded Single Joint Timeline
Duration: 4.0 hours

Note: Schedule 6 hours if integrated with the NBL. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.

Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00

Lesson(s) Replaced: LOAD ORB SKL 92012 (partial), LOAD ORB SKL 93012
Equipment Required: PGSC
Prerequisite Lesson(s): LOAD MAL T/L 91012, PDRS LD SJ 92069 (PDRS flow)
Preparation: None

Synopsis: This lesson will allow the students to execute the nominal loaded timeline while dealing with malfunctions forcing use of RMS Single Joint (SJ) operations.

Objectives:

• Perform nominal loaded timeline, using RMS Single Joint operations, with the following malfunctions:
  – Standard Switch Panel (SSP) Problems
  – Loss of Safety Inhibits
  – Umbilical Malfunctions
  – Manipulator Positioning Mechanism (MPM)/Manipulator Restraint Latch (MRL) Problems
  – Manipulator Controller Interface Unit (MCIU) Built-In Test Equipment (BITE)
  – Panel A8 Problem
  – RMS Arm-Based Electronics (ABE) Failure

• Cover the following events in the Flight Plan:
  – Payload powerup/activation/checkout
  – Pre-release payload commanding
  – Payload grapple
  – Umbilical demate
  – Payload unberth
  – Loaded operations (critical parts)
  – Payload commanding
  – Payload berthing
  – Umbilical mate
  – Post-berth payload commanding
  – Payload powerdown/deactivation
35  **DPLY SJ T/L 91012**

**Title:** Deploy Single Joint Timeline  
**Duration:** 4.0 hours  
**Note:** Schedule 6 hours if integrated with the NBL. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys. 

**Medium:** SMS-FB (NBL/FB, as requested.)  
**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT  
**Source:** **DA7/Assigned SMS Team**  
**Date:** 07/00  
**Lesson(s) Replaced:** DPLY ORB SKL 93012, DPLY ORB SKL 92012 (partial)  
**Equipment Required:** PGSC, COAS  
**Prerequisite Lesson(s):** DPLY MAL T/L 91012, PDRS DEP SJ 92069 (PDRS flow), or PDRS D&R SJ 94069 (PDRS flow)  
**Preparation:** None  

**Synopsis:** This lesson will allow the students to execute the deploy timeline while dealing with malfunctions, forcing use of RMS Single Joint (SJ) operations.  

**Objectives:**  
- Perform nominal loaded timeline using RMS Single Joint operations, with the following malfunctions:  
  - RMS Arm-Based Electronics (ABE) Failure (to achieve Single Joint (SJ) ops)  
  - Manipulator Positioning Mechanism (MPM)/Manipulator Retention Latch (MRL) Power Problem (System Mal)  
  - Manipulator Controller Interface Unit (MCIU) Built-In Test Equipment (BITE)  
  - End Effector (EE) Talkback Failure  
  - Panel A8 Switch Failure  
  - Payload (PL) Multiplexer/Demultiplexer (MDM) Fail (Total or Recoverable)  
  - Umbilical Malfunction  
  - Thermal Issue  
  - LOW Z Problem (e.g., jet thrust degrade)  

- Cover the following events in the Flight Plan:  
  - Payload powerup/activation/checkout  
  - Pre-release payload commanding  
  - Payload grapple  
  - Umbilical demate  
  - Payload unberth
Orbit Flight Operations Lesson Descriptions

35  **DPLY SJ T/L 91012 (Concluded)**
- Loaded operations required prior to deploy
- Payload release
- Separation (SEP) 1 (SEP 2 as time permits)
- Post-release payload commanding

36  **RETR SJ T/L 91012**

**Title:** Retrieve Single Joint Timeline  
**Duration:** 4.0 hours  
**Note:** Schedule 6 hours if integrated with the NBL. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC and/or photo/TV setups or those with Flight Day 1 deploys.

**Medium:** SMS-FB (NBL/FB, as requested.)  
**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT  
**Source:** DA7/Assigned SMS Team  
**Date:** 07/00  
**Lesson(s) Replaced:** RETR ORB SKL 92012 (partial), RETR ORB SKL 93012 (partial)  
**Equipment Required:** PGSC, COAS  
**Prerequisite Lesson(s):** RETR MAL T/L 91012, PDRS RETR SJ 92069 (PDRS flow) or PDRS D&R SJ 94069 (PDRS flow)  
**Preparation:** None  
**Synopsis:** This lesson will allow the students to execute the retrieve timeline while dealing with malfunctions forcing the use of RMS Single Joint (SJ) operations.

**Objectives:**  
- Perform retrieve timeline, using RMS SJ operations, with the following malfunctions:  
  - RMS Arm-Based Electronics (ABE) Failure (to achieve single joint ops)  
  - Manipulator Positioning Mechanism (MPM)/Manipulator Retention Latch (MRL) Power Problem (System Mal)  
  - Manipulator Controller Interface Unit (MCIU) Built-In Test Equipment (BITE)  
  - End Effector (EE) Talkback Failure  
  - Panel A8 Switch Failure  
  - Backoff and Approach  
  - Orbiter Translational Hand Controller (THC) Problem  
  - Power Interface Problem  
  - Hardline COMM Problem
Orbit Flight Operations Lesson Descriptions

36 RETR SJ T/L 91012 (Concluded)

- Payload Retention Latch Assembly (PRLA) System Problem
- Loss of VERNs
- Guidance, Navigation, and Control (GNC) General Purpose Computer (GPC) Fail

• Cover the following events from the Flight Plan:
  - Initial Condition: RMS is poised for capture
  - Initial Condition: 400 foot approach
  - Pre-capture payload commanding
  - Payload capture
  - Loaded operations required prior to berthing
  - Payload commanding
  - Payload berthing
  - Umbilical mate
  - Post-berth payload commanding
  - Payload powerdown/deactivation

37 RMS/PL CONT 91012

Title: Remote Manipulator System/Payload Contingencies
Duration: 4.0 hours
Note: Schedule 6 hours integrated with the NBL.
Medium: SMS-FB (NBL/FB, as requested.)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 07/00
Lesson(s) Replaced: PDRS LD CON 91012, PDRS DEP CON 91012, PDRS RET CON 91012
Equipment Required: PGSC, COAS
Prerequisite Lesson(s): LOAD SJ T/L 91012, DPLY SJ T/L 91012, UNLD MAL T/L 91012, RETR SJ T/L 91012, PDRS XXX CON 92069 (XXX = LD, DPLY, RETR, D&R) (PDRS flow)
Preparation: None

Synopsis: During this lesson, the crew will execute a RMS/Payload (PL) contingency timeline agreed to in advance. Emphasis shall be placed on overall crew coordination aspects as well as RMS/EVA/IV/Payload Coordinator.

Objectives:
• This lesson may include Loaded, Deploy or Retrieve operations.
  Objectives will be determined based on mission-planned contingencies.
• Perform contingency retrieve timeline with malfunctions:
Orbit Flight Operations Lesson Descriptions

37  **RMS/PL CONT 91012 (Concluded)**

EXAMPLES:
- EVA assisted retrieve
- Back-away deploy
- EVA assisted deploy (Prebrief)
- Jettison (Emergency Deploy)
- EVA rescue (tool chasing)
- Unplanned deploy
- Equipment jettison

38  **WLES RVW 91001**

Title: Wing Leading Edge Sensor Review  
Duration: 1.0 hour  
Medium: Building 30 PGSC Lab  
Student: As assigned by CDR.  
Source: DO5  
Date: 07/07  
Lesson(s) Replaced: None  
Equipment Required: A31p laptop  
Prerequisite Lesson(s): WLES OPS II 91020  
Preparation: None  

Synopsis: Review previously provided Wing Leading Edge Sensor (WLES) training. This is a hands-on lesson with the WLES software and representative hardware.

Objectives:
- Provide crew with any last minute updates to the WLES system.
- Activate the WLES system again and answer any final questions prior to flight.

39  **PO INS OPS 91012**

Title: Post Insertion Operations  
Duration: 4.0 hours  
Medium: SMS-FB  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DA7/Assigned SMS Team and DF/Crew Systems Representative  
Date: 07/00  
Lesson(s) Replaced: PO INS OPS 92012  
Equipment Required: Middeck stowage, Wireless headsets stowed on table in middeck, Complete mission stowage, Advanced Crew Escape Suits (ACESs), PGSC/SpOC, MS seats installed; Reset point: T-2
Orbit Flight Operations Lesson Descriptions

39 PO INS OPS 91012 (Concluded)

Prerequisite Lesson(s):  RMS/PL CONT 91012
Preparation:  None

Synopsis:  This lesson covers the first 4 hours of flight on the flight-specific training load.  It should cover all nominal procedures during the launch and post-insertion phases of flight.  This includes FDF configuration, suit doffing, and setup of stowed equipment appropriate for this phase of flight.  Malfunctions should be minimized to allow a nominal rehearsal of this timeline.  For RMS flights, RMS checkout must be completed.

Objectives:  • Complete the first 4 hours of the flight timeline.
• Complete all nominal procedures through post-insertion.
• Complete suit doffing.
• Complete setup of stowed equipment.
• Complete RMS checkout, for RMS flights.

PGSC REVIEW 41195

Title:  Payload General Support Computer Review
Duration:  2.0 hours
Note:  Duration will vary depending on objectives predetermined by student(s) and instructor.
Medium:  Payload General Support Computer
Student:  COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually or in pairs.)
Source:  DO5/Cargo Integration and Operations Branch
Date:  08/02
Lesson(s) Replaced:  PGSC REVIEW 41001
Equipment Required:  Standard PGSC Lab equipment
Prerequisite Lesson(s):  OCA/VTS OPS 31195, PGSC MAL 31195, PGSC NETWORK OPS 31195
Preparation:  None

Synopsis:  The crew will setup and activate a complete PGSC configuration.

Objectives:  • Perform a complete PGSC setup.
• Configure for different operations:  Propulsion (Prop) and RMS.
• The student will drive the direction of the class and may ask any questions.
Orbit Flight Operations Lesson Descriptions

APDS REVIEW 41029

Title: Androgynous Peripheral Docking System Review
Duration: 2.0 hours
Medium: PYLD Trainer
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Schedule individually or in pairs.)

Note: Schedule for Docking Flights only.
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): APDS MAL 23029
Preparation: Review APDS Nominal and Off-Nominal procedures as required.

Synopsis: This lesson provides a detailed review of APDS operations, both nominal and with malfunctions. Emphasis will be placed on areas selected by the student.

Objectives: Upon completion of this lesson, the student will be able to understand and perform docking and undocking sequences, both nominal and with malfunctions.

ORB PRF FS 41012

Title: Flight-Similar Orbit Proficiency
Duration: 4.0 hours/week
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA7/Assigned SMS Team
Date: 02/93
Lesson(s) Replaced: ORB PRF ADV 41012
Equipment Required: Wireless headsets, HP48SX, COAS, full stowage, PGSC/SpOC
Prerequisite Lesson(s): ORB SKL 31012
Preparation: None

Synopsis: This lesson is a continuation of ORB SKL 31012. It can be taken after credit for PASS RECOV 31006 is received, and may be used by a crew for crew flight plan development of orbit skills proficiency. This lesson may be scheduled prior to delivery of the crew’s flight-specific training load. The assigned SMS team will determine the content of this lesson.

Note: This lesson is not included in the amount of mandatory orbit standalone SMS training for a crew.
Orbit Flight Operations Lesson Descriptions

ORB PRF FS 41012 (Concluded)

Objectives: • Maintain orbit proficiency. • Practice following flight plan. • Use Windows DeCommutator (WinDecom) to initialize Time and State vector applications to enable auto feed of vector and time to required applications. • Use Deorbit/Center of Gravity (c.g.) application to generate deorbit targets.

ORB PRF LS 41012

Title: Load-Specific Orbit Proficiency Duration: 4.0 hours/week Medium: SMS-FB Student: COMMANDER, MS 1, MS 2, MS 3, PILOT Source: DA7/Assigned SMS Team Date: 02/93 Lesson(s) Replaced: ORB PRF FS 41012 Equipment Required: Wireless headsets, COAS, PGSC/SpOC stowage Prerequisite Lesson(s): RMS/PL CONT 91012 Preparation: None

Synopsis: This lesson may be used by a crew for flight plan development or orbit skills proficiency. It is scheduled after the crew’s load-specific training has been completed. This could happen, for example, if a launch slips. The assigned SMS team will determine the content of this lesson.

Note: This lesson is not included in the amount of mandatory orbit standalone SMS training for a crew.

Objectives: • Develop proficiency with crew flight plan. • Practice following flight plan.
Orbit Flight Operations Lesson Descriptions

PO INS PRF 41012

Title: Post-Insertion Operations Proficiency
Duration: 4.0 hours
Medium: SMS-FB
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT, PS 1
Source: DA7/Assigned SMS Team
Date: 12/93
Lesson(s) Replaced: None
Equipment Required: Middeck stowage, Wireless headsets stowed on table in middeck, Complete mission stowage, PGSC/SpOC, MS seats installed
Prerequisite Lesson(s): RMS/PL CONT 91012
Preparation: None

Synopsis: This lesson covers the first 4 hours on the flight-specific training load. It should cover all nominal procedures during the launch and post-insertion phases of flight. This includes FDF configuration and setup of stowed equipment appropriate for this phase of flight. Malfunctions should be minimized to allow a nominal rehearsal of this timeline. For RMS flights, RMS checkout must be completed.

Objectives:
• Complete the first 4 hours of the flight timeline.
• Complete all nominal procedures through post-insertion.
• Complete setup of stowed equipment.
• Complete RMS checkout for RMS flights.
• Maintain proficiency in post-insertion operations.
SECTION 8.0 EXTRAVEHICULAR ACTIVITY (EVA) OPERATIONS TRAINING COURSE

The Extravehicular Activity (EVA) Operations Training Course presents the training required to prepare future EVA crewmembers for a flight. The EVA training course instructs not only system functions and processes, but techniques and the skills to use them. Performing an EVA is more than executing procedures; knowledge and skill is required. It requires development and practice and is payload and task-specific. Techniques practiced early on may be used differently as timelines are refined throughout the mission training flow progression.

The EVA training course is sub-divided into three sections:

- **Generic** – Crewmembers are trained given a foundation in both EVA Systems and EVA Task classes.
- **Systems** – Crewmembers are trained to understand and use the EMU and associated interfaces.
- **Task** – Crewmembers are trained to perform the necessary EVA tasks for a particular mission.

EVAs are categorized as the following:

- **Contingency**: EVA required affecting the safe return of the crew and vehicle.
- **Unscheduled**: EVA not included in the nominal scheduled mission activities but which may be required to achieve mission success.
- **Scheduled**: EVA scheduled prior to launch and included in the nominal mission timeline.

The EVA training course is divided between the systems and task disciplines. Within each discipline, the flows are further defined between generic and flight-specific training.

The flow types are:

- Generic/ASCAN
- Pilot/ASCAN
- Orbiter Contingency
- Payload Contingency
- EVA Assembly (with Shuttle Airlock)
- EVA Assembly (with Station Airlock)
- Station Expedition Crewmember

At the NBL, Sonny Carter Training Facility, NBL events are also conducted to satisfy hardware and development evaluations and EVA proficiency or EVA skills review training. The EVA skills-based training program provides crewmembers the excellent opportunity to practice EVA skills in a part-task setting or in a timeline-specific configuration based on the pool configuration at the time of the NBL event.
The EVA crewmember assignments are based on several factors, and designators are assigned as follows: Extravehicular 1 (EV1), EV2, and Intravehicular (IV) crewmember. When missions require more than one EVA team, designators will also be assigned for the other EVA team as: EV3, EV4, and IV crewmember (generally EV1 or EV2). A SRMS and/or a SSRMS operator(s) for the EVAs are also assigned.

Upon completion of the EVA Operations Training Course, the crewmember will be able to perform the following in support of an EVA for both payload and orbiter operations:

- Don/doff and operate the EMU.
- Evaluate and respond to EMU malfunctions.
- Operate the airlock systems and orbiter interfaces.
- Perform orbiter contingency, unscheduled payload, and scheduled EVA procedures.
- Be familiar with EVA tools and stowage locations.
- Be familiar with EVA documentation.

The main facilities used for EVA training are:

- NBL
- CCT and CCTII
- FFT
- Virtual Reality (VR) Lab
- PABF
- Bldg. 7/Environmental Test Article (ETA)
- Bldg. 7/Space Station Airlock Test Article (SSATA)
- United Space Alliance/Flight Crew Equipment (USA/FCE)

For scheduled EVA training flows, CB or DA may also require wet integrated simulations, with SMS/NBL. The Crew Equipment Interface Test (CEIT) at KSC, and the Bench Review at USA/FCE are valuable informal training sessions. (See Crew Training Catalog Addendum for informal session descriptions.)

EVA training flows are reviewed periodically throughout the crew training cycle. Some training may be added or not required due to crew’s skill, procedural or requirements changes, and/or flight launch slips or flight manifest changes.
Figure 8-1. EVA Systems Operations Training Flow (Generic)
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## Table 8-1. EVA Generic Operations Training Requirements

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**Date Last Modified:** 06/08

Sub Total for Stage Stage Total Per Crewmember:

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|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|       | 118.5 | 0     | 2     | 70.5  | 115.5 | 0     | 2     | 70.5  | 115.5 | 0     | 2     | 70.5  | 115.5 | 0     | 2     | 70.5  | 115.5 | 0     | 2     | 70.5  | 115.5 |
EVA Generic Operations Lesson Descriptions

1  **EMU SYS 21057**

Title: Extravehicular Mobility Unit Systems and Components (Shared – ISS)
Duration: 2.0 hours
Medium: CBT
Student: COMMANDER, EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 06/08
Lesson(s) Replaced: EMU SYS 21002
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This CBT includes training on all subsystems and components of the EMU. It provides an overview of the EMU including the primary and secondary life support systems, the electrical system, the communications system, and the Caution and Warning System (CWS).

Objectives:
- Become familiar with the EMU Space Suit Assembly (SSA) and ancillary equipment.
- Understand the operations of the Life Support System (LSS) subsystems and Secondary Oxygen Package (SOP).
- Understand the EMU CWS and interfaces.

2  **CONT OPS 21002**

Title: Extravehicular Activity Payload Bay Contingency Operations
Duration: 2.0 hours
Medium: Workbook
Student: EV1, EV2, IV (Schedule individually.)
Source: DX32
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson includes a description of the entire contingency EVA support equipment and orbiter EVA hardware available to the EVA crewmember, a description of each orbiter contingency EVA task, and its related hardware. This lesson will also include EVA mission rules related to orbiter contingency EVAs and training hardware configurations.

Objectives: Become familiar with generic EVA tools and orbiter contingency tasks.
EVA Generic Operations Lesson Descriptions

3  EVA SKILLS 21003
Title: Extravehicular Activity Skills (Shared – ISS)
Duration: 1.5 hours
Medium: Video Tape
Student: EV1, EV2, IV
Source: DX32
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides the student with a detailed overview briefing on acceptable EVA skills related to EVA operations.

Objectives:
• Become familiar with airlock operations.
• Become familiar with translation techniques.
• Become familiar with various EVA hardware operations.
• Become familiar with the proper techniques and skills of conducting EVA Operations.

4  SAFER OPS 21002
Title: Simplified Aid for Extravehicular Activity Rescue Operations
(Shared – Shuttle)
Duration: 1.0 hour
Medium: Workbook
Student: EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This training manual provides an overview of SAFER functions and operations. The student will learn the basic operations and controls of SAFER including SAFER checkout, software, and donning and doffing.

Objectives:
• Comprehend the functionality of SAFER:
  – Describe the functions of SAFER subsystems.
  – Define the component of SAFER.
EVA Generic Operations Lesson Descriptions

4  SAFER OPS 21002 (Concluded)

- Know SAFER controls and operations:
  - Describe the systems operations.
  - Describe checkout operations.
  - Describe maintenance operations such as battery replacement.
  - Describe rescue operations.

5  EVA OV 21001

Title: Extravehicular Activity Overview
Duration: 3.0 hours
Medium: Classroom
Student: EV1, EV2, IV
Source: DX32
Date: 10/04
Lesson(s) Replaced: None
Equipment Required: EMU, EVA tools and equipment
Prerequisite Lesson(s): EMU SYS 21057, CONT OPS 21002, EVA SKILLS 21003, SAFER OPS 21002
Preparation: None

Synopsis: This is a classroom setting with a mixture of hands-on tools, overview presentations, hardware briefing, and open discussions. The goal of this class is to orient the student with the big picture world of EVA. The class will give a brief overview of the Shuttle and Station EVA interfaces and why these interfaces are important to EVA. An EMU suit overview will be given, combined with a hands-on briefing of the use of general EVA tools. After this session the student should have a big picture overview of the complexity involved with planning, training, and executing an EVA.

Objectives:
- Become familiar with Shuttle EVA interfaces
- Become familiar with Station EVA interfaces
- Become familiar with EMU
- Become familiar with EVA tools
- Become familiar with Shuttle contingency tasks
- Become familiar with Station maintenance tasks
EVA Generic Operations Lesson Descriptions

6  EVA OV 22001

Title: Extravehicular Activity Overview
Duration: 3.0 hours
Medium: Classroom
Student: EV1, EV2, IV
Source: DX32
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: EMU, EVA tools and equipment
Prerequisite Lesson(s): EVA OV 21001
Preparation: None

Synopsis: This is a continuation of EVA OV 21001 including a mixture of hands-on tools, overview presentations, hardware briefing, and open discussions. The goal of this class is to orient the student with the big picture world of EVA. The class will give a brief overview of the Shuttle and Station EVA interfaces and why these interfaces are important to EVA. An EMU suit overview will be given, combined with a hands-on briefing of the use of general EVA tools. After this session the student should have a big picture overview of the complexity involved with planning, training, and executing an EVA.

Objectives:
• Continue familiarization with Shuttle and Station EVA interfaces
• Continue familiarization with EMU and EVA tools
• Continue familiarization with Shuttle contingency and Station maintenance tasks
• Become familiar with potential EMU injuries during EVA training

7  NITROX TRNG 61001

Title: Nitrox Training (Shared – ISS)
Duration: 2.5 hours
Medium: Classroom
Student: Required of anyone prior to SCUBA or suited run at NBL
(Schedule individually or in pairs.)
Source: DX12
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
EVA Generic Operations Lesson Descriptions

7  **NITROX TRNG 61001 (Concluded)**

Synopsis: This event will provide the student with information regarding use of breathing Nitrox gas during NBL SCUBA and suited operations. The student will receive a facility orientation, receive a classroom briefing, and must take a written exam after the briefing.

Objectives: Become familiar with use of Nitrox gas at the NBL facility.

8  **EVA FLUID QD OPS 21197**

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Synopsis: The lesson provides the student with a detailed knowledge of EVA fluid connector operations. The student will operate the connectors under pressurized conditions.

Objectives: • Become familiar with proper operations of an EVA fluid connector.  
• Become familiar with EVA tools used to operate EVA fluid connector functions.

9  **SCUBA QUAL 21027**

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EVA Generic Operations Lesson Descriptions

9 SCUBA QUAL 21027 (Concluded)

Preparation: None

Note: This lesson is nominally scheduled same day as NITROX TRNG 61001.

Synopsis: This lesson provides the student with an overview of the NBL safety procedures and review of SCUBA gear and its use. The student then performs proper SCUBA skills in the water. (Refer to NBL Training Plan, DX12-0003, for currency requirements.)

The student must take a written SCUBA test and Nitrox class prior to this lesson, approximately 6 hours at NBL.

Objectives:
• Know NBL Facility safety procedures.
• Demonstrate familiarity with SCUBA gear.
• Perform SCUBA skills in water (as required by NBL Training Plan).

10 CLS III MEAS 61001

Title: Class III Measurements (Shared – ISS)
Duration: 1.5 hours
Medium: Classroom
Student: EV1, EV2, IV1 (Schedule individually.)
Source: DX35 (USA/FCE)
Date: 03/02

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This event will provide Flight Crew Equipment (FCE) EMU suit measurements necessary to build up an EMU for a particular student. This event must be done prior to an EMU Class III Fit Check. The crewmember will report to the FCE facility for detailed measurements that are obtained by the FCE EMU engineer. The data will be used to determine the sizing requirements. Nominally, Mission Operations Directorate (MOD) personnel do not attend this activity.

Objectives: None
EVA Generic Operations Lesson Descriptions

11  **CLS III GLOVE FITCK 61001**

Title: Class III Glove Fit Check  
Duration: 2.0 hours  
Medium: Classroom  
Student: EV1, EV2, IV1 (Schedule individually.)  
Source: DX35 (USA/FCE)  
Date: 03/02  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: This event will provide Flight Crew Equipment (FCE) a fit check verification, as required, of the student's Class III EMU gloves. The Class III gloves (no other suits, or hardware required) are provided at the FCE facility with student and engineer using the FCE Glove Box for verification of proper fit.

Objectives: None

12  **CLS III FITCK 61001**

Title: Class III Fit Check (Shared – ISS)  
Duration: 2.5 hours  
Medium: Classroom  
Student: EV1, EV2, IV1 (Schedule individually.)  
Source: DX35 (USA/FCE)  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: This event will provide Flight Crew Equipment (FCE) a fit check verification of the student’s Class III EMU suit and Class III gloves. Two EMUs (baseline and enhanced) will be provided for the fit check so that FCE will have correct sizing information to build up for either an enhanced or baseline unit for the student's upcoming EVA lessons. This event will provide FCE a fit check verification of the student's Class III EMU gloves. The class III gloves are provided at the FCE facility with student and engineer using the FCE Glove Box for verification of proper fit. The crewmember will report to the FCE facility for the fit checks with the assistance of the FCE suit technician.

Objectives: None
EVA Generic Operations Lesson Descriptions

13 JNT AL MANUAL 21002
Title: ISS Joint Airlock Systems Training Manual (Shared – ISS)
Duration: 2.0 hours
Medium: Workbook
Student: EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This workbook provides an overview of the ISS Joint Airlock modules, their nominal configuration, capabilities, functions, and EMU interfaces.

Objectives: As listed in each chapter of the workbook.

14 EVA SOP 21007
Title: Extravehicular Activity Standard Operating Procedures
(Shared – Shuttle)
Duration: 1.0 hour
Medium: Text
Student: EV1, EV2, IV (Schedule individually.)
Source: DX32 (CB)
Date: 03/02
Lesson(s) Replaced: EVA LSN LRND 21007
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides students the opportunity to benefit from the accumulated experience of present and past EVA crewmembers, flight controllers, and engineers. It presents valuable insight to facilitate activities related to EMU operations, EVA task techniques, safety, EVA hardware, etc. This will also be required during flight-specific training.

Objectives:
• Become familiar with acceptable EVA techniques.
• Become familiar with EVA hardware operational constraints.
• Become familiar with various EVA operational concepts.
EVA Generic Operations Lesson Descriptions

15  EVA SSCS 21002

Title: Extravehicular Activity Space-to-Space Communication System (Shared – ISS)
Duration: 2.0 hours
Medium: Workbook
Student: EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This workbook will provide the student with a complete overview of the Space-to-Space Communication System (SSCS) as it pertains to EVA on Shuttle and on ISS. Topics include: controls of the Space-to-Space EMU Radio (SSER), the Space-to-Space Orbiter Radio (SSOR), and the Space to-Space Station Radio (SSSR); configuration of these controls for hardline and Radio Frequency (RF) EVA communication; and flight rules associated with EVA communication.

Objectives:
• Identify the SSER and the Communications Carrier Assembly (CCA).
• Identify the controls associated with the SSER, SSOR, and SSSR.
• Explain the nominal and back-up communications configurations.
• State the flight rules associated with the SSER.
• Summarize the EVA communication procedures for Shuttle and ISS.
• Respond to malfunctions of the SSCS.

16  ISS EMU 21105

Title: ISS Extravehicular Mobility Unit Familiarization (Shared – ISS)
Duration: 2.0 hours
Medium: Space Station Mock-Up And Training Facility
Student: EV1, EV2, IV (Schedule individually or in pairs.)
Source: DX35
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: EMU and ancillary equipment
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This EMU familiarization lesson provides a description of, and hands-on experience with the major EMU components, configuration/procedures, and ancillary EVA equipment.
EVA Generic Operations Lesson Descriptions

16 **ISS EMU 21105 (Concluded)**

Objectives:

- Know and identify EMU physical features.
- Be familiar with and identify physical features with which the crewmember interfaces during EVA operations (switches, airlock panels, valves, umbilicals, display locations, and hatch configurations).
- Perform component mating/demating procedures.
- Perform airlock hatch operations and launch/on-orbit/re-entry stowage of EVA equipment.
- Know stowage locations of ancillary EVA hardware.

17 **ISS EVA SMALL TOOLS 21001**

Title: ISS Extravehicular Activity Small Tools (Shared – ISS)

Duration: 2.5 hours

Medium: Classroom (at NBL)

Student: EV1, EV2, IV

Source: DX32

Date: 02/07

Lesson(s) Replaced: EVA ST TOOLS C 21001

Equipment Required: EVA tools and equipment, EMU gloves

Prerequisite Lesson(s): EVA SOP 21007

Preparation: None

Synopsis: This lesson includes a description of the EVA tools used during ISS EVA operations. This lesson consists of a classroom briefing and hands-on applications of the EVA hardware.

Objectives:

- Be familiar with and operate EVA tools.
- Be familiar with EVA tool operational constraints.

18 **EVA PGT/TM 21001**

Title: Extravehicular Activity Piston Grip Tool/Torque Multiplier Operations (Shared – ISS)

Duration: 1.5 hours

Medium: Classroom

Student: EV1, EV2, IV (Schedule in groups of up to 3.)

Source: DX32

Date: 06/08

Lesson(s) Replaced: None

Equipment Required: EVA tools and equipment

Prerequisite Lesson(s): ISS EVA SMALL TOOLS 21001

Preparation: None
EVA Generic Operations Lesson Descriptions

18  **EVA PGT/TM 21001 (Concluded)**

**Synopsis:** This lesson provides the student with a detailed description of the Pistol Grip Tool (PGT) and Torque Multiplier (TM) operations. The student gets hands-on application of the EVA hardware.

**Objectives:**
- Become familiar with PGT operations.
- Become familiar with TM operations.
- Become familiar with re-programming capability of the PGT software using a computer.

19  **EVA SCUBA 21027**

**Title:** Extravehicular Activity Scuba  
**Duration:** 4.0 hours  
**Medium:** Neutral Buoyancy Lab  
**Student:** EV1, EV2, IV  
**Source:** DX32  
**Date:** 10/05  
**Lesson(s) Replaced:** None  
**Equipment Required:** Swimming suit, EVA tools and equipment  
**Prerequisite Lesson(s):** ISS EVA SMALL TOOLS 21001  
**Preparation:** None

**Synopsis:** This lesson will provide the students with their first exposure to Shuttle and Station EVAs prior to their upcoming suited runs. This class includes a pre-brief, 2 hours on SCUBA, and debrief while waiting for the 1-hour medical observation period to pass. The student will gain general Shuttle EVA knowledge and EVA skills such as translation and foot restraint operations while being exposed to Shuttle and Station. It is highly recommended that the instructor use Surface Supplied Diving System (SSDS) to communicate with the students and the utility divers.

**Objectives:**
- Review Shuttle coordinate system
- Practice various translation techniques
- Review Shuttle A/L operations
- Translate to a few contingency worksites and on Station
- Review Station coordinate system
- While swimming, point out all of the Station trusses and elements
- Review Station A/L
EVA Generic Operations Lesson Descriptions

20  ISS SUIT QUAL 1G 21001

Title: ISS Suit Qualification 1G (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: EV1, EV2, IV
Source: DX32
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson is a walk-through/briefing on the objectives and techniques involved with the ISS SUIT QUAL 21027 NBL run.

Objectives:
• Discuss schedule of NBL day.
• Step through suit qualification tasks.
• Review tools and hardware utilized.
• Brief students on NBL general tips and safety concerns.

21  ISS SUIT QUAL 21027

Title: ISS Suit Qualification (Shared – ISS)
Duration: 6.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, IV
Source: DX32
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): ISS SUIT QUAL 1G 21001
Preparation: None

Synopsis: This lesson instructs the students of suit qualification and translation objectives.

The lesson begins with a physical, prebrief and EMU donning. The lesson concludes with EMU doffing and a lesson debrief. (The student must remain at the Neutral Buoyancy Laboratory one hour post-run for safety/medical requirements.)
EVA Generic Operations Lesson Descriptions

21  **ISS SUIT QUAL 21027 (Concluded)**

Objectives:

- Perform translation adaptation on ISS.
- Perform Body Restraint Tether (BRT) Operations.
- Perform reach limitations evaluation and Mini-Workstation (MWS) activities.
- Perform Pistol Grip Tool (PGT) Operations.
- Perform Articulating Portable Foot Restraint (APFR) and Translational Foot Restraint (TFR) on Crew Equipment Translation Aid (CETA) cart operations.
- Perform EMU glove pop.
- Become familiar with Neutral Buoyancy Lab (NBL) general tips.
- Become familiar with applicable hardware Operational Control Agreement Document (OCADs – Ops Constraints).

22  **ISS JNT AL INTRO 21105**

Title: ISS Joint Airlock Introduction (Shared – ISS)
Duration: 3.0 hours
Medium: Space Station Mock-Up And Training Facility
Student: EV1, EV2, IV
Source: DX35
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): JNT AL MANUAL 21002
Preparation: None

Synopsis: This lesson provides an overview of the Joint Airlock and the EVA support equipment contained therein. It provides a hands-on opportunity for the student to operate Joint Airlock Systems including the Service, Performance and Checkout Equipment (SPCE).

Objectives:

- Know and describe the Joint Airlock including the SPCE.
- Understand the function of each SPCE component.
- Understand the interfaces between the Joint Airlock and the EMU.
- Exercise Joint Airlock hardware and controls.
EVA Generic Operations Lesson Descriptions

23  **ISS ECWS INTRO 21014**

Title:  ISS Extravehicular Mobility Unit Caution and Warning System
       Introduction (Shared – ISS)
Duration:  2.0 hours
Medium:  EMU Mal Sim
Student:  EV1, EV2, IV (Schedule individually.)
Source:  DX35
Date:  03/02
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  ISS EMU 21105
Preparation:  None

Synopsis:  This lesson provides an overview of the ISS EMU Caution and Warning
System (CWS) operational procedures and introduces the student to the
operation of the EMU Malfunction Simulator.

Objectives:
•  Know the EMU and Joint Airlock fluid/electrical systems (EMU
   Schematic Review).
•  Be familiar with the EMU CWS and the ISS Airlock flight procedures.
•  Exercise EMU and ISS Airlock interfaces and controls.

24  **ISS ECWS MALS 21014**

Title:  ISS Extravehicular Mobility Unit Caution and Warning System
        Malfunctions (Shared – ISS)
Duration:  2.0 hours
Medium:  EMU Mal Sim
Student:  EV1, EV2, IV (Schedule individually.)
Source:  DX35
Date:  03/02
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  ISS ECWS INTRO 21014
Preparation:  None

Synopsis:  This lesson provides an exercise of nominal and malfunction procedures
in the EMU Caution and Warning System (CWS) simulator. The student,
aided by the instructor, will walk through standard procedures displayed in
the simulator. The instructor will insert malfunctions for the student to
resolve.
EVA Generic Operations Lesson Descriptions

24  **ISS ECWS MALS 21014 (Concluded)**

Objectives:
- Review EMU and airlock support systems.
- Exercise the EMU CWS and the ISS EMU/Joint Airlock flight procedures.
- Perform limited EMU malfunction procedures.

25  **SAFER INTRO 21016**

Title: Simplified Aid for EVA Rescue Introduction (Shared – ISS)
Duration: 2.0 hours
Medium: Virtual Reality Trainer
Student: EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SAFER OPS 21002
Preparation: None

Synopsis: This lesson familiarizes the student with SAFER systems and controls. The student will be instructed on basic piloting procedures and techniques, and then be asked to incorporate the information by performing unaided simple rescue scenarios.

Note: For crewmembers, pupil measurement is highly desired prior to taking this class, and can be completed at the JSC Clinic. It takes approximately 5-10 minutes.

Objectives:
- Know SAFER systems and controls.
- Perform unaided basic piloting procedures.
- Perform unaided simple rescue scenarios.

26  **ISS EVA LARGE TOOLS 21028**

Title: ISS EVA Large Tools (Shared – ISS)
Duration: 2.0 hours
Medium: AB Table
Student: EV1, EV2, IV
Source: DX32
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): None
Preparation: None
EVA Generic Operations Lesson Descriptions

26 ISS EVA LARGE TOOLS 21028 (Concluded)

Synopsis: This lesson includes a description of the large EVA tools used during ISS EVA assembly and maintenance operations. This lesson consists of a briefing and hands-on application of the EVA hardware.

Objectives:
- Become familiar with articulating portable foot restraint, tool stanchion, and Orbital Replacement Unit (ORU) stanchion operations.
- Become familiar with EVA crane operations.
- Become familiar with crew equipment translation aid cart operations.

27 EVA OPS 1G 21001

Title: Extravehicular Activity Operations 1G
Duration: 2.0 hours
Medium: Classroom-NBL/Mockup South (NBL/MU-S)
Student: EV1, EV2, IV
Source: DX32
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): ISS SUIT QUAL 21027
Preparation: None

Synopsis: Students will become familiar with Shuttle and Station Airlock (A/L) egress scenarios. Suit fit for buoyancy control will be discussed at length. Specific EVA task will also be discussed with the students.

Objectives: Students will become familiar with:
- Buoyancy control in all orientations (vertical, horizontal, heads down, translation up/down the water column, etc.)
- Shuttle A/L egress (install safety tethers)
- Shuttle payload bay translation techniques
- Shuttle worksite familiarization including translating by KU band, radiator, winch, door drive linkages
- Station A/L egress (install safety tethers)
- Station worksite familiarization including translating of primary translation paths, Crew Equipment Translation Aid (CETA), Spur, Face1, P6, and aft of S1 and P1
- Station Toolbox orientation
- Articulating Portable Foot Restraint (APFR) operations
- Body Restraint Tether (BRT) operations
EVA Generic Operations Lesson Descriptions

28  EVA OPS 21027

Title: Extravehicular Activity Operations
Duration: 7.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2
Source: DX32
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): EVA OPS 1G 21001
Preparation: None

Synopsis: Students will perform both a Shuttle and a Station Airlock (A/L) egress. The emphasis of this lesson will be to optimize suit fit for buoyancy control. The main difference will be the introduction of the A/L tasks along with a brief introduction of tools usage. Throughout the run the student will be asked for areas of suit concerns, suit discomfort, buoyancy issues, proper elevation in suit, etc. Tether protocol should be a secondary emphasis and should be maintained throughout all translations. (After this run, another suit fit should be performed if required.)

Objectives: Students will become familiar with:
- Buoyancy control in all orientations (vertical, horizontal, heads down, translation up/down the water column, etc.)
- Shuttle A/L egress (install safety tethers)
- Shuttle payload bay translation techniques
- Shuttle worksite familiarization including translating by KU band, radiator, winch, door drive linkages
- Station A/L egress (install safety tethers)
- Station worksite familiarization including translating of primary translation paths, Crew Equipment Translation Aid (CETA), Spur, Face1, P6, and aft of S1 and P1
- Station Toolbox orientation
- Articulating Portable Foot Restraint (APFR) operations
- Body Restraint Tether (BRT) operations
EVA Generic Operations Lesson Descriptions

29  ISS EVA P/P 21105
Title: ISS EVA Prep and Post (Shared – ISS)  
Duration: 5.0 hours  
Medium: Space Station Mock-Up And Training Facility  
Student: EV1, EV2  
Source: DX35  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): SAFER INTRO 21016  
Preparation: None  

Synopsis: This lesson provides a suited exercise of flight EVA preparation and post EVA procedures in the ISS joint airlock. Students perform all timelined steps required for Airlock (A/L) Prep, EMU Resize, EMU Checkout, EVA Prep, Suit donning, A/L Depress, Repress, Post-EVA, EMU maintenance, A/L maintenance, and stowage configuration. During this class, the instructor may aid the crew to complete the objectives. This class will be repeated in the flight-specific flow with the goal that the crewmembers will perform all procedures with no instructor assistance during the final lesson. (The student is required to have an EMU suit fit check with all hardware fitting properly prior to this exercise).

Note: Core objectives listed; may vary in repeated sessions.

Objectives:  
• Perform aided EMU Checkout, EVA Prep, Prebreathe protocol and suit donning.  
• Perform aided depress/repress (simulated).  
• Perform unaided reach evaluations (all Display and Control Module (DCM) controls, visors, tethers, cuff checklist) at simulated EVA conditions.  
• Perform aided battery recharge (helmet light, power tool, Rechargeable EVA Battery Assembly (REBA), EMU) procedures.  
• Perform aided don/doff procedures.

30  EVA OPS 1G 22001
Title: Extravehicular Activity Operations 1G  
Duration: 2.0 hours  
Medium: Classroom-NBL/Mockup South (NBL/MU-S)  
Student: EV1, EV2  
Source: DX32  
Date: 10/05  
Lesson(s) Replaced: None
EVA Generic Operations Lesson Descriptions

30 EVA OPS 1G 22001 (Concluded)

Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): EVA OPS 21027
Preparation: None

Synopsis: Students will become familiar with specific EVA tasks, including Shuttle contingency tasks, and basic Station tasks.

Objectives: Students will become familiar with:
- Tool Stowage Assembly (TSA) operations
- Shuttle Radiator disconnect
- Shuttle KU Band Stow
- Shuttle Winch operations
- Station Articulating Portable Foot Restraint (APFR) translation and installation
- Station Crew Equipment Translation Air (CETA) Cart translation
- Station Worksite setup with APFR
- Station Tool Retrieval from toolbox
- Removal of Orbital Replacement Unit (ORU) on Face1 while on CETA Cart

31 EVA OPS 22027

Title: Extravehicular Activity Operations
Duration: 7.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2
Source: DX32
Date: 10/05
Lesson(s) Replaced: None
Note: With Veteran EVA crewmember

Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): EVA OPS 1G 22001
Preparation: None

Synopsis: This lesson is a continuation of working in the EMU. Students will extend their knowledge of the skill of translating and working at worksites while in the EMU. The emphasis during this run will begin to shift from only concern with suit fit to the ability to perform specific EVA tasks. The lesson will be divided between Shuttle and Station tasks. Airlock egress may or may not be performed depending on NBL configuration.
EVA Generic Operations Lesson Descriptions

31  EVA OPS 22027 (Concluded)

Objectives: Student will become familiar with:
- Tool Stowage Assembly (TSA) operations
- Shuttle Radiator disconnect
- Shuttle KU Band Stow
- Shuttle Winch operations
- Station Articulating Portable Foot Restraint (APFR) translation and installation
- Station Crew Equipment Translation Aid (CETA) Cart translation
- Station Worksite setup with APFR
- Station Tool Retrieval from toolbox
- Removal of Orbital Replacement Unit (ORU) on Face1 while on CETA Cart

32  ISS EVA MAINT 1G 21001

Title:  ISS Extravehicular Activity Maintenance 1G (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom (NBL/MU-S (NBL, Mockup South))
Student: EV1, EV2
Source: DX32
Date: 03/02
Lesson(s) Replaced: P/L EVA 1G 31001
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): ISS EVA SMALL TOOLS 21001, ISS JNT AL INTRO 21105, EVA OPS 22027
Preparation: None

Synopsis: This lesson is a walk-through/briefing on the objectives and techniques involved with EVA operations for ISS maintenance. An overview of potential failures is presented as well as EVA techniques to perform ISS maintenance.

Objectives:
- Review operations of hardware pertaining to particular NBL configuration.
- Discuss and perform possible EVA techniques needed for ISS maintenance.
33  ISS EVA SCUBA 21027

Title:  ISS Extravehicular Activity SCUBA  
Duration:  4.0 hours  
Medium:  Neutral Buoyancy Lab  
Student:  EV1, EV2  
Source:  DX32  
Date:  10/05  
Lesson(s) Replaced:  None  
Equipment Required:  Swimming suit, EVA tools and equipment  
Prerequisite Lesson(s):  ISS EVA MAINT 1G 21001  
Preparation:  None

Synopsis:  This lesson will provide the students with exposure to Station EVA tasks prior to their upcoming suited runs. This class includes a pre-brief, 2 hours on SCUBA, and debrief while waiting for the 1-hour medical observation period to pass. The student will gain general Station EVA knowledge and EVA skills. It is highly recommended that the instructor use the Surface Supplied Diving System (SSDS) to communicate with the students and the utility divers.

Objectives:  
• Perform Station Airlock operations
• Perform safety tether swaps
• Perform foot restraint and body restraint tether operations
• Perform EVA maintenance tasks (utilizing various EVA tools and CETA Cart)

34  ISS EVA MAINT 21027

Title:  ISS Extravehicular Activity Maintenance Operations (Shared – ISS)  
Duration:  9.5 hours  
Medium:  Neutral Buoyancy Lab  
Student:  EV1, EV2  
Source:  DX32  
Date:  03/05  
Lesson(s) Replaced:  P/L EVA 21027  
Equipment Required:  EMUs, EVA tools and equipment  
Prerequisite Lesson(s):  ISS EVA SMALL TOOLS 21001, ISS JNT AL INTRO 21105, EVA OPS 22027  
Preparation:  None

Synopsis:  This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)
EVA Generic Operations Lesson Descriptions

34  ISS EVA MAINT 21027 (Concluded)
This lesson provides the student with objectives and techniques involved with EVA operations for ISS maintenance.

Objectives:
• Airlock Egress/Ingress (Station).
• Translation path familiarization.
• Safety tether swaps.
• Articulating Portable Foot Restraint (APFR)/tool stanchion familiarization.
• ISS EVA toolbox familiarization.
• Small/large Orbital Replacement Unit (ORU) changeout.
• EVA crane familiarization.
• Electrical/fluid connector operations.
• Node bag access.

35  EMU/AL 21020
Title: Extravehicular Activity Mobility Unit/Airlock
Duration: 2.0 hours
Medium: FFT
Student: EV1, EV2, IV
Source: DX35
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: EMU, EVA tools and equipment
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This EMU familiarization lesson provides a description of, and hands-on experience with the major EMU components, configuration/procedures, and ancillary EVA equipment.

Objectives:
• Know and identify EMU physical features.
• Be familiar with and identify physical features with which the crewmember interfaces during EVA operations (switches, airlock panels, valves, umbilicals, display locations, and hatch configurations).
• Perform component mating/demating procedures.
• Perform airlock hatch operations and launch/on-orbit/re-entry stowage of EVA equipment.
• Know stowage locations of ancillary EVA hardware.
EVA Generic Operations Lesson Descriptions

ECWS INTRO 21014
Title: Extravehicular Mobility Unit Caution and Warning System Introduction
Duration: 2.0 hours
Medium: EMU Mal Sim
Student: EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: EMU CWS 21014
Equipment Required: None
Prerequisite Lesson(s): EMU/AL 21020 (Generic flow)
Preparation: None
Synopsis: This lesson provides an overview of the EMU Caution and Warning System (CWS) operational procedures and introduces the student to the operation of the EMU malfunction simulator.

Objectives:
• Know the EMU and shuttle airlock fluid/electrical systems (schematic review).
• Be familiar with the EMU CWS and the EMU airlock flight procedures.
• Exercise EMU and shuttle airlock controls and interfaces.
• If required for V1103 support, know V1103 procedures and hardware.

ECWS MALS 21014
Title: Extravehicular Mobility Unit Caution and Warning System Malfunctions
Duration: 2.0 hours
Medium: EMU Mal Sim
Student: EV1, EV2, IV (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: EMU CWS 22014
Equipment Required: None
Prerequisite Lesson(s): ECWS INTRO 21014
Preparation: None
Synopsis: This lesson provides an exercise of nominal and malfunction procedures on the EMU Caution and Warning System (CWS) simulator. The student, aided by the instructor, will walk through the standard procedures. The instructor will insert malfunctions into the standard procedures for the student to resolve.

Objectives:
• Review EMU and airlock fluid and electrical systems.
• Exercise the EMU CWS and the EMU airlock flight procedures.
• Perform limited EMU malfunction procedures.
EVA Generic Operations Lesson Descriptions

38  **EVA P/P 21020**

Title: Extravehicular Activity Prep and Post  
Duration: 4.0 hours  
Medium: CCT, FFT, or CCT II  
Student: EV1, EV2  
Source: DX35  
Date: 03/02  
Lesson(s) Replaced: EVA P/P 1 21020  
Equipment Required: EMU and ancillary equipment  
Prerequisite Lesson(s): ECWS INTRO 21014  
Preparation: None  

Synopsis: This lesson provides an EMU suited end to end exercise of flight EVA preparation and post procedures. This lesson starts with equipment preparation and continues through post-EVA entry preparation. (The student is required to have an informal EMU suit fit check, all hardware fitting properly, prior to this exercise.)  

Objectives:  
- Be familiar with EMU and STS airlock procedures for flight EVA preparation and post activities.  
- Perform pre-EVA equipment preparation for single crewmember.  
- Perform EVA procedures through post-EVA servicing and entry preparation.  
- Practice EMU don/doff in shuttle airlock.  

39  **ECWS V1103 21014**

Title: Extravehicular Mobility Unit Caution and Warning System V1103 Operations  
Duration: 2.0 hours  
Medium: EMU Mal Sim  
Student: ASP  
Source: DX35  
Date: 03/02  
Lesson(s) Replaced: None  
Equipment Required: Current V1103 procedures  
Prerequisite Lesson(s): ECWS MALS 21014  
Preparation: None  

Synopsis: This lesson is used for the Astronaut Support Personnel (ASP) who travels to KSC for preflight orbiter EMU functional hardware checkout. It must be completed so that flight-critical testing may be performed safely and successfully. This minimizes the risk of impacting KSC processing schedules, damaging EVA hardware, or injuring test personnel. CB
EVA Generic Operations Lesson Descriptions

39 **ECWS V1103 21014 (Concluded)**

Participants should have completed the 20000-level EMU systems lesson portion of the generic training flow. A minimum 1-year proficiency is required for this lesson before supporting V1103.

Objectives:
- Review V1103 procedures and hardware handling protocol.
- Discuss procedure rationale and impacts to EMU systems.
- Discuss test-unique hardware, operations, constraints, and lessons learned.
- Prepare new personnel for handling and operation of critical flight hardware.

40 **HDW V1103 21001**

Title: Class I Hardware V1103 Operations  
Duration: 1.0 hour  
Medium: Classroom (at USA/FCE)  
Student: ASP  
Source: DX35  
Date: 03/02  
Lesson(s) Replaced: None  
Equipment Required: Class I EMU, V1103 Ground Support Equipment  
Prerequisite Lesson(s): ECWS V1103 21014  
Preparation: None

**Note:** ECWS V1103 21014 should be scheduled prior to this lesson.

Synopsis: This lesson is used for the Astronaut Support Personnel (ASP) who travels to KSC for preflight EMU functional hardware checkout. It must be completed so that flight-critical testing is performed safely and successfully. This minimizes the risk of impacting KSC processing schedules, damaging EVA hardware or injuring test personnel. CB participants should have completed the 20000-level EMU systems lesson portion of the generic training flow. A minimum 1 year proficiency is required for this lesson before supporting V1103.

Objectives:
- Become familiar with flight interfaces and operation.
- Discuss ground support equipment and its operation.
- Handle V1103 unique test support equipment.
- Identify critical flight hardware interfaces and operating constraints.
- Train new personnel for performing procedures with critical flight hardware.
EVA Generic Operations Lesson Descriptions

**CLS III MEAS PRF 61001**

Title: Class III Measurements Proficiency (Shared – ISS)  
Duration: 1.5 hours  
Medium: Classroom  
Student: EV1, EV2, IV  
Source: DX35  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CLS III MEAS 61001  
Preparation: None  
**Note:** Needs to be scheduled at least five days prior CLS III GLOVE FIT PRF.

Synopsis: This lesson provides the student and Flight Crew Equipment (FCE) opportunity for proficiency of EMU measurements.

Objectives: None

**CLS III GLV FIT PRF 61001**

Title: Class III Glove Fit Check Proficiency (Shared – ISS)  
Duration: 2.0 hours  
Medium: Classroom  
Student: EV1, EV2, IV  
Source: DX35  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CLS III GLOVE FITCK 61001  
Preparation: None  
**Note:** Needs to be scheduled at least five days prior CLS III FIT PRF.

Synopsis: This lesson provides the student and Flight Crew Equipment (FCE) a proficiency fit check verification of the student’s CLS III gloves.

Objectives: None
EVA Generic Operations Lesson Descriptions

**CLS III FIT PRF 61001**

Title: Class III Fit Check Proficiency (Shared – ISS)  
Duration: 2.0 hours  
Medium: Classroom  
Student: EV1, EV2, IV  
Source: DX35  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CLS III FITCK 61001  
Preparation: None  
**Note:** Needs to be scheduled at least two days prior NBL or Prep/Post (P/P) suited event.

Synopsis: This lesson provides the student and Flight Crew Equipment (FCE) a proficiency fit check of the student’s CLS III EMU suit.

Objectives: None
Figure 8-2. EVA Systems Operations Training Flow  
(Assembly from Station Airlock)
Figure 8-2. EVA Systems Operations Training Flow
(Assembly from Station Airlock) (Concluded)
Figure 8-3. EVA Systems Operations Training Flow (Shuttle EVA)
## Table 8-2. EVA Systems Operations Training Requirements

| Stage | Ref Num | Lesson Code | Media | Sched Code | (Suit IV) | (Task IV) | PS | C | IV | EV MS1 | EV MS2 | Alt Fac | Comments |
|-------|---------|-------------|-------|------------|-----------|-----------|    |   |    |        |        |         |          |
| 1     | 1       | SAFER RES OPS 91016 | VR LAB | 2          | 1         | 2         | 2  | 2 | 2  | 2      | 2      | S-IV/V-T-IV |          |
| 2     | 2       | ISS JNT AL RDW 31105 | SSMF  | 4          | 4         | 4         | 4  | 4 | 4  | 4      | 4      | S-IV/V-T-IV |          |
| 3     | 3       | ISS JNT EVA SSAS 31170 | SSSST | 2          | 4         | 2         | 2  | 2 | 2  | 2      | 2      | S-IV/V-T-IV |          |
| 4     | 4       | ISS ECWS PRF 41014 | EMU   | 2          | 1         | 2         | 2  | 2 | 2  | 2      | 2      | S-IV/V-T-IV |          |
| 5     | 5       | ISS EVA P/P 31105 | SSMF  | 9          | 4         | 9         | 2  | 2 | 2  | 2      | 2      | S-IV/V-T-IV |          |

| Stage | Ref Num | Lesson Code | Media | Sched Code | (Suit IV) | (Task IV) | PS | C | IV | EV MS1 | EV MS2 | Alt Fac | Comments |
|-------|---------|-------------|-------|------------|-----------|-----------|    |   |    |        |        |         |          |
| 4     |         |             |       |            |           |           |    |   |    |        |        |         | Note: In the event that a flight decides not to use both a Suit and Task IV, the IV crewmember will complete the combined columns so that all classes are covered. |

**Date Last Modified:** 06/08
## Table 8-2. EVA Systems Operations Training Requirements (Concluded)

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EVA Systems Operations Lesson Descriptions

1  SAFER RES OPS 91016

Title: Simplified Aid for Extravehicular Activity Rescue (Shared – Shuttle)
Duration: 2.0 hours
Medium: Virtual Reality Trainer
Student: EV1, EV2, Suit IV (Schedule individually.)
Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SAFER INTRO 21016
Preparation: None

Synopsis: This lesson provides hands-on experience in a virtual reality environment using SAFER to perform self-rescue operations.

Objectives:
- Perform unaided self-rescue operations:
  - Demonstrate the ability to control SAFER.
  - Demonstrate the ability to recover from a series of tumbles and return to Orbiter/ISS safely.

2  ISS JNT AL HDW 31105

Title: ISS Joint Airlock Hardware (Shared – ISS)
Duration: 4.0 hours
Medium: Space Station Mock-Up And Training Facility
Student: EV1, EV2, Suit IV, Task IV
Source: DX35
Date: 06/08
Lesson(s) Replaced: ISS JNT AL HDW C 31105
Equipment Required: None
Prerequisite Lesson(s): ISS JNT AL INTRO 21105
Preparation: None

Synopsis: This lesson re-familiarizes the crewmember with the Joint Airlock hardware interfaces/controls and allows the crewmember to work through various Airlock hardware malfunctions and off-nominal EVA-related and Joint Airlock maintenance procedures.
EVA Systems Operations Lesson Descriptions

2  ISS JNT AL HDW 31105 (Concluded)

Objectives:  
- Explain Airlock hardware interfaces and the status of various indicators under nominal operational conditions.  
- Identify and respond to In-flight Refill Unit (IRU) malfunctions.  
- Identify and respond to Power Supply Assembly (PSA) malfunctions.  
- Identify and respond to Metox Regenerator malfunctions.  
- Identify and respond to Battery Charger Assembly (BCA) and Battery Stowage Assembly (BSA) malfunctions.  
- Perform Umbilical Interface Assembly (UIA) water flushing connections and Service and Cooling Umbilical (SCU) swap.  
- Perform UIA biocode filter changeout.  
- Identify requirements for UIA replacement and remote Equipment Lock location installation.  
- Perform Emergency Repress procedures with instructor assistance.  
- Perform Contingency Water Container (CWC) dump.

3  JNT EVA SSCS 31170

Title:  ISS Space-to-Space Communication System (Shared – ISS)  
Duration:  2.0 hours  
Medium:  EVA Space To Space Communication System Trainer  
Student:  EV1, EV2, Suit IV, Task IV  
Source:  DX35  
Date:  06/08  
Lesson(s) Replaced:  ISS SSCS C 31170  
Equipment Required:  None  
Prerequisite Lesson(s):  EVA SSCS 21002  
Preparation:  None

Synopsis:  This lesson consists of a 60-minute briefing to discuss the operation of nominal and back-up EVA communication configurations for Shuttle, ISS, and docked operations. The second half of the class is spent reviewing nominal and off-nominal procedures and troubleshooting communication malfunctions.

Objectives:  
- Identify the Space-to-Space EMU Radio (SSER) controls and the Communications Carrier Assembly (CCA).  
- Identify and operate the Display and Control Module (DCM) controls associated with the SSER.  
- Explain the nominal communications configuration rationale.  
- Know the flight rules associated with the SSER.  
- Perform nominal and off-nominal ISS communication procedures and understand the rationale behind these procedures.  
- Identify symptoms of various communication failures.
### EVA Systems Operations Lesson Descriptions

#### 4 ISS ECWS PRF 41014

**Title:** ISS EVA Caution and Warning System Proficiency (Shared – ISS)

**Duration:** 2.0 hours

**Medium:** EMU Mal Sim

**Student:** EV1, EV2, *Suit IV, Task IV* (Schedule individually.)

**Source:** DX35

**Date:** 06/08

**Lesson(s) Replaced:** ISS ECWS PRF C 41014

**Equipment Required:** None

**Prerequisite Lesson(s):** ISS ECWS MALS 21014

**Preparation:** None

**Synopsis:** This is the first lesson in a series of three reviews of the EMU Caution and Warning System (CWS) operational procedures and the ISS airlock procedures. The student will be asked to respond to various EMU malfunctions put in by the instructor.

**Objectives:**
- Describe the architecture and operations of the EMU Life Support System (LSS).
- Explain the rationale for malfunction procedures for the EMU.
- Perform, unaided, the nominal procedures.
- Respond to EMU CWS alarms with instructor assistance.

#### 5 ISS EVA P/P 31105

**Title:** ISS EVA Prep and Post (Shared – ISS)

**Duration:** 9.0 hours

**Medium:** Space Station Mock-Up And Training Facility

**Student:** EV1, EV2, *Suit IV, Task IV*

**Note:** See Table 8-2 for specific IV hours.

**Source:** DX35

**Date:** 06/08

**Lesson(s) Replaced:** ISS EVA P/P C 31105

**Equipment Required:** Exercise bike (not Cycle Ergometer with Vibration Isolation System (CEVIS))

**Prerequisite Lesson(s):** ISS ECWS PRF 41014

**Preparation:** None
EVA Systems Operations Lesson Descriptions

5  **ISS EVA P/P 31105 (Concluded)**

Synopsis: This lesson provides a suited exercise of flight EVA preparation and post EVA procedures in the ISS Joint Airlock (A/L). Students perform all timeline steps required for Airlock Prep, EMU resize, EMU Checkout, EVA Prep, suit donning, A/L Depress/Repress, Post-EVA, EMU maintenance, A/L maintenance, and EMU stowage procedures. IV/EV interaction is emphasized. In subsequent classes, tool stowage and configuration is covered. During this class, the instructor may aid the crew to complete the objectives. During the final prep and post lesson, the crewmembers will perform all procedures with no instructor assistance. (The student is required to have an EMU suit fit check with all hardware fitting properly prior to this exercise.)

**Note:** Core objectives listed; may vary in repeated sessions.

Objectives:
- Perform aided EMU checkout, A/L prep, EVA prep, and suit donning.
- Perform aided Depress/Repress (simulated).
- Perform unaided reach evaluations (all Display and Control Module (DCM) controls, visors, tethers, Cuff Checklist) at simulated EVA conditions.
- Perform aided battery recharge (helmet light, power tool, EMU).
- Perform aided EMU doffing procedures.

6  **SAFER RES OPS 92016**

(Shared – Shuttle)

Refer to SAFER RES OPS 91016 for description. *Task IV attends SAFER RES OPS 92016 in lieu of Suit IV.*

7  **ECWS PRF 41014**

Title: Extravehicular Mobility Unit Caution and Warning System Proficiency (Shared – ISS)

Duration: 2.0 hours

Medium: EMU Mal Sim

Student: EV1, EV2, *Suit IV* (Schedule individually.)

Source: DX35

Date: 06/08

Lesson(s) Replaced: ECWS PRF ADV 41014

Equipment Required: None

Prerequisite Lesson(s): ECWS MALS 21014

Preparation: None
EVA Systems Operations Lesson Descriptions

7  **ECWS PRF 41014 (Concluded)**

Synopsis: This lesson provides an exercise of nominal and malfunction procedures on the EMU malfunction simulator.

Objectives:
- Know nominal and malfunction procedures for the EMU and airlock.
- Perform nominal EVA prep/post procedures and malfunctions.

8  **EVA P/P 31020**

Title: Extravehicular Activity Prep and Post
Duration: 6.0 hours
Medium: CCT, FFT, or CCT II
Student: EV1, EV2, *Suit IV*
Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EMUs (sized), various EVA tools and equipment
Prerequisite Lesson(s): ECWS PRF 41014
Preparation: None

Synopsis: This lesson provides a suited exercise of flight EVA preparation and post procedures in the shuttle airlock.

Objectives:
- Know end-to-end flight EVA preparation and post procedures for EVA.
- Coordinate EVA preparation/post tasks with the EV crewmember and IV support.
- Practice EMU don/doff in the airlock.
- Execute EVA Checklist (C/L) (generic and flight-specific).

9  **ISS EVA P/P 32105**

Title: ISS EVA Prep and Post (Shared – ISS)
Duration: 9.0 hours
Medium: Space Station Mock-Up And Training Facility
Student: EV1, EV2, *Suit IV, Task IV*

*Note:* See Table 8-2 for specific IV hours.
Source: DX35
Date: 06/08
Lesson(s) Replaced: ISS EVA P/P C 32105
Equipment Required: Cycle Ergometer with Vibration Isolation System (CEVIS)
Prerequisite Lesson(s): ISS EVA P/P 31105
Preparation: None

*Note:* PREBREATHE 31001 is a mandatory requirement for ISS EVA P/P 32105 if not completed for ISS EVA P/P 31105.
EVA Systems Operations Lesson Descriptions

9 ISS EVA P/P 32105 (Concluded)

Synopsis: This lesson is a repeat of ISS EVA P/P 31105. The student will perform a suited exercise of flight EVA preparation and post-EVA procedures in the ISS joint airlock. Students perform all timeline steps required for Airlock (A/L) Prep, EMU resize, EMU Checkout, EVA Prep, suit donning, A/L Depress/Repress, post-EVA, EMU maintenance, A/L maintenance, and EMU stowage procedures. IV/EV interaction is emphasized. During this class, the instructor may aid the crew to complete the objectives. During the final prep and post lesson, the crewmembers will perform all procedures with no instructor assistance.

Note: Core objectives listed; may vary in repeated sessions.

Objectives:
- Perform aided EMU Checkout, A/L Prep, EVA Prep, and suit donning.
- Perform aided depress/repress (simulated).
- Perform unaided reach evaluations (all Display and Control Module (DCM) controls, visors, tethers, Cuff Checklist) at simulated EVA conditions.
- Perform aided battery recharge (helmet light, power tool, EMU).
- Perform aided EMU doffing procedures.
- Perform aided EMU maintenance/recharge procedures.
- Conduct joint airlock power down.
- Perform aided EMU resize.
- Conduct tool configuration.

10 EVA TPS SAFER 91016

Title: EVA Thermal Protection System Simplified Aid for EVA Rescue
Duration: 2.0 hours
Medium: Virtual Reality Trainer
Student: EV1, EV2, Task IV
Source: DX35
Date: 06/08

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SAFER RES OPS 91016

Note: Each EV member assigned for Thermal Protection System (TPS) contingency will perform this lesson twice; once as one performs fly practice and the other performs Ground Control Assist (GCA), and then reverse roles in the second class. Task IV should attend the first lesson only for tabletop discussion portion of the lesson.
EVA Systems Operations Lesson Descriptions

10 EVA TPS SAFER 91016 (Concluded)

Synopsis: This lesson includes a tabletop discussion of SAFER TPS inspection scenarios, configuration, and hardware modifications. Inspection simulations are then performed using the virtual reality simulator.

Objectives: • Discuss scenarios that would necessitate a SAFER inspection. • SAFER inspection hardware overview. • Review SAFER inspection procedure. • Fly SAFER inspection cases in Virtual Reality environment.

11 BTA OPS 31001

Title: Bends Treatment Adapter Operations (Shared – ISS) Duration: 1.25 hours Medium: Classroom Student: EV1, EV2, Suit IV Source: DX35 Date: 06/08

Lesson(s) Replaced: BTA OPS/EMU RESIZE 31001 Equipment Required: None Prerequisite Lesson(s): ISS EVA P/P 31105, EVA P/P 31020 Preparation: None

Synopsis: This lesson provides the crewmember with a basic understanding of Bends Treatment Adapter (BTA) operations and the associated procedures. These procedures would be used to treat an EV crewmember suffering from decompression sickness. The crewmember will have the opportunity to see the Secondary Oxygen Package (SOP) and Primary Life Support System (PLSS) with the Thermal Model Generator (TMG) removed and performs BTA procedures.

Objectives: • Learn the procedures for use of the BTA. • Perform BTA operations. • Recognize the SOP, PLSS, and other EMU hardware. • Perform Contaminant Control Cartridge (CCC) and battery component changeouts.
EVA Systems Operations Lesson Descriptions

12  EMU RESIZE 31209

Title: Extravehicular Mobility Unit Resize (Shared – ISS)  
Duration: 1.0 hour  
Medium: Bldg 9 Floor  
Note: This lesson is held at building 9N floor.  
Student: EV1, EV2, Suit IV  
Source: DX35  
Date: 06/08  
Lesson(s) Replaced: BTA OPS/EMU RESIZE 31001  
Equipment Required: None  
Prerequisite Lesson(s): ISS EVA P/P 31105, EVA P/P 31020  
Preparation: None  
Synopsis: This lesson provides crewmembers with the opportunity to perform EMU resizing procedures.  
Objectives:  
• Perform Space Suit Assembly (SSA) components changeouts.  
• Perform suit hardware interchange.  
• Discuss suit assembly and possible sizing workarounds.  
• Identify the procedures necessary for arm and leg resizing and component changeout.  
• Perform unaided arm and leg resizing using sizing rings and cams.  
• Perform unaided any necessary component changeouts.

13  CLS I GLOVE FITCK 61001

Title: Class I Glove Fit Check (Shared – ISS)  
Duration: 2.0 hours  
Medium: Classroom  
Student: EV1, EV2 (Schedule individually.)  
Source: DX35 (USA/FCE)  
Date: 03/02  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None  
Synopsis: This event will provide Flight Crew Equipment (FCE) a fit check verification of the student’s Class I (flight) EMU gloves. The class I gloves (no other suits, or hardware required) are provided at the FCE facility with student and engineer using the FCE Glove Box for verification of proper fit. This fit check is designed to ensure good fit of the Class I gloves prior to the student’s vacuum chamber run. Mission Operations Directorate (MOD) personnel should attend this activity if possible.

Objectives: None
EVA Systems Operations Lesson Descriptions

14 **CLS I BOOT EVAL 61001**

Title: Class I Boot Evaluation (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: EV1, EV2 (Schedule individually.)
Source: DX35 (USA/FCE)
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: The Class I boot evaluation is conducted at the Flight Crew Equipment (FCE) facility. The boot fit evaluation, conducted by the suit engineer, has been designed to ensure comfortable boot fit using the sock and boot configuration preferred by the crewmember. Adjustments to the configuration will be made as required to be assured that the fit is usable. In addition, the suit technicians will demonstrate methods to adjust the boot bladder to improve fit. Mission Operations Directorate (MOD) personnel may or may not attend either activity.

Objectives: None

15 **CLS I BT/GLV FITCK 61001**

Title: Class I Boot/Glove Fitcheck (Shared – ISS)
Duration: 4.0 hours
Medium: Classroom
Student: EV1, EV2 (Schedule individually.)
Source: DX35 (USA/FCE)
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: The Class I (flight) boot and glove fit check is conducted at the Flight Crew Equipment (FCE) facility. The boot fit evaluation, conducted by the suit engineer, has been designed to ensure comfortable boot fit using the sock and boot configuration preferred by the crewmember. Adjustments to the configuration will be made as required to be assured that the fit is usable. In addition, the suit technicians will demonstrate methods to adjust the boot bladder to improve fit. The Class I glove fit check will provide FCE a fit check verification of the student’s Class I (flight) EMU gloves. The Class I gloves are provided with student and engineer using the FCE
EVA Systems Operations Lesson Descriptions

15 **CLS I BT/GLV FITCK 61001 (Concluded)**

Glove Box for verification of proper fit. This fit check is designed to ensure good fit of the Class I gloves prior to the student’s vacuum chamber run. Mission Operations Directorate (MOD) personnel should attend this activity if possible.

Objectives: None

16 **SSATA PREP 31014**

Title: Space Station Airlock Test Article Preparation (Shared – ISS)
Duration: 2.0 hours
Medium: EMU Mal Sim
Student: EV1, EV2, *Suit IV* (Schedule individually.)
Source: DX35
Date: **06/08**
Lesson(s) Replaced: SSATA PREP C 31014
Equipment Required: None
Prerequisite Lesson(s): ISS EVA P/P 31105
Preparation: None

Synopsis: This lesson provides an exercise of both nominal and malfunction procedures in the EMU malfunction simulator to prepare an EV crewmember to do a chamber run. The crewmember will step through chamber procedures prior to performing the Space Station Airlock Test Article (SSATA) walk-through and chamber run (ISS EMU/AL WT 31154, ISS EMU/AL 31154). In this class, the crewmember will have the opportunity to ask any generic or flight-specific EMU questions prior to launch.

Objectives:
- Know EVA Vacuum Chamber-specific objectives.
- Review and perform EMU Checkout, EVA Prep, Depress/Repress, and Post EVA procedures for the ISS Joint Airlock.
- Review and perform malfunction procedures at vacuum using the Cuff Checklist.
- Review flight-specific EMU configuration/operation.
EVA Systems Operations Lesson Descriptions

17 FFV 61001
Title: Flight Fit Verification (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: EV1, EV2 (Schedule individually.)
Source: DX35 (USA/FCE)
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Synopsis: This verification uses a Class III Hard Upper Torso (HUT) with Class I gloves, and associated hardware to ensure proper fit. This activity is necessary if a Class I glove reach evaluation (for either prime or backup Class I gloves) cannot be performed or are not available during the crewperson’s vacuum chamber run. Mission Operations Directorate (MOD) personnel may or may not attend this activity.

Objectives: None

18 ISS SSATA WT 31154
Title: ISS Space Station Airlock Test Article Chamber Walk-Through (Shared – ISS)
Duration: 6.0 hours
Medium: Space Station Airlock Test Article
Student: EV1, EV2, Suit IV (Schedule individually or in pairs with IV.)
Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SSATA PREP 31014
Preparation: None
Synopsis: This lesson is comprised of a briefing on ISS SSATA 31154, a walk-through of the facility systems, and a pressurized suit donning exercise in the Space Station Airlock Test Article (SSATA) vacuum chamber. IV attends the second hour through the end of the lesson to exercise flight-specific EVA procedures with the EV crewmembers. This is the first part of a two-day event for crewmembers that have never performed an SSATA chamber run.
EVA Systems Operations Lesson Descriptions

18  ISS SSATA WT 31154 (Concluded)

Objectives:
• Be familiar with facility procedures used in the SSATA.
• Perform suit fit and proper EMU function.
• Perform ISS Joint Airlock and EMU operations using flight hardware.
• Perform suit donning and pressurization in the chamber.
• Be familiar with prebreathe mask objectives.

19  ISS SSATA 1DAY 31154

Title: ISS Space Station Airlock Test Article One-Day Chamber Run (Shared – ISS)
Duration: 10.5 hours
Medium: Space Station Airlock Test Article
Student: EV1, EV2, Suit IV (Schedule individually.)
Note: See Table 8-2 for specific IV hours.
Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SSATA PREP 31014
Preparation: None

Synopsis: As in the two-day event, this lesson provides the objectives of both ISS SSATA WT 31154 and ISS SSATA 31154 in a one-day event. This lesson provides an exercise of the ISS joint airlock and EMU flight integrated procedures at simulated flight environment pressures in a flight-configured airlock. Students perform EMU Checkout, EVA Prep, and Airlock Depress. Students then respond to simulated malfunction procedures at vacuum using the Cuff Checklist. The student then represses and finishes with post-EVA procedures, including battery recharge and Metox regeneration. This class is an option for experienced EVA crewmembers that have completed other chamber runs prior.

Objectives:
• Configure Airlock.
• Conduct EMU checkout, airlock prep, and prebreathe demonstration.
• Perform aided donning and pressurization of Class I EMU in the chamber.
• Perform unaided depress/repress.
• Perform reach tests to ensure adequate suit mobility to reach all EMU and airlock controls.
• Perform aided procedures as called for using the Cuff Checklist.
• Respond to the fit, feel and sound of the EMU at vacuum.
• Evaluate flight-specific hardware.
EVA Systems Operations Lesson Descriptions

20  ISS SSATA 31154

Title: ISS Space Station Airlock Test Article Chamber Run (Shared – ISS)
Duration: 8.25 hours
Medium: Space Station Airlock Test Article
Student: EV1, EV2, Suit IV (Schedule individually.)

Note: See Table 8-2 for specific IV hours.

Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS EMU/AL WT C 31154
Preparation: None

Synopsis: This lesson provides an exercise of the ISS joint airlock and EMU flight integrated procedures at simulated flight environment pressures in a flight-configured airlock. Students perform EMU Checkout, EVA Prep, and Airlock (A/L) Depress. Students then respond to simulated malfunction procedures at vacuum using the Cuff Checklist. The student then represses and finishes with post-EVA procedures, including battery recharge and Metox regeneration.

Objectives:
• Configure airlock.
• Conduct EMU checkout, A/L prep, and prebreathe demonstration.
• Perform aided donning and doffing of Class I EMU.
• Perform unaided depress/repress.
• Perform reach tests to ensure adequate suit mobility to reach all EMU and airlock controls.
• Perform aided procedures as called for using the Cuff Checklist.
• Respond to the fit, feel and sound of the EMU at vacuum.
• Evaluate flight-specific hardware.

21  ISS EVA P/P 33105

Title: ISS EVA Prep and Post (Shared – ISS)
Duration: 9.0 hours
Medium: Space Station Mock-Up and Training Facility
Student: EV1, EV2, Suit IV, Task IV

Note: See Table 8-2 for specific IV hours.

Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Cycle Ergometer with Vibration Isolation System (CEVIS)
Prerequisite Lesson(s): ISS EVA P/P 32105; ISS ECWS PRF 41014
Preparation: None
EVA Systems Operations Lesson Descriptions

21  ISS EVA P/P 33105 (Concluded)

Synopsis: This lesson provides a suited exercise of flight EVA preparation and post EVA procedures in the ISS Joint Airlock (A/L). Students perform all timeline steps required for Airlock Prep, EMU resize, EMU Checkout, EVA Prep, suit donning, A/L Depress/Repress, Post-EVA, EMU maintenance, A/L maintenance, and EMU stowage procedures. IV/EV interaction is emphasized. In subsequent classes, tool stowage and configuration is covered. During this class, the instructor may aid the crew to complete the objectives. During the final prep and post lesson, the crewmembers will perform all procedures with no instructor assistance. (The student is required to have an EMU suit fit check with all hardware fitting properly prior to this exercise.)

Note: Core objectives listed; may vary in repeated sessions.

Objectives:
- Perform unaided EMU checkout, A/L prep, EVA Prep, and suit donning.
- Perform unaided Depress/Repress (simulated).
- Perform unaided reach evaluations (all Display and Control Module (DCM) controls, visors, tethers, Cuff Checklist) at simulated EVA conditions.
- Perform unaided donning and doffing of Simplified Aid for EVA Rescue (SAFER).
- Perform aided battery recharge (helmet light, power tool, EMU).
- Perform unaided EMU doffing procedures.
- Perform unaided EMU maintenance/recharge procedures.
- Conduct joint airlock power down.
- Perform unaided EMU resize (when applicable).
- Conduct tool configuration.

22  EVA TPS SAFER RES 91705

Title: EVA Thermal Protection System Simplified Aid for EVA Rescue
Duration: 2.0 hours
Medium: Virtual Reality Trainer and Precision Air Bearing Floor
Student: EV1, EV2
Source: DX35
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EVA TPS SAFER 91016
Preparation: None
EVA Systems Operations Lesson Descriptions

22  EVA TPS SAFER RES 91705 (Concluded)

Synopsis: This class is the final review of the SAFER flying techniques involved in performing both a self rescue and a tile inspection. It also serves as the final review of the contingency safety tether used during a SAFER tile inspection.

Objectives:
- Perform unaided SAFER rescue cert run at 1.0 ft/s.
- Perform SAFER inspection case.
- Perform contingency safety tether rescue on the Precision Air Bearing Floor (PABF).
- As time allows, additional SAFER rescue and/or tile inspection runs may be performed.

23  STS SSCS 31170

Title: STS Space-to-Space Communications System
Duration: 2.0 hours
Medium: EVA Space To Space Communication System Trainer
Student: EV1, EV2, Suit IV
Source: DX35
Date: 06/08
Lesson(s) Replaced: EVA COMM 31001
Equipment Required: EVA Comm Caps
Prerequisite Lesson(s): EVA SSCS 21002
Preparation: None

Synopsis: This lesson consists of a 30-minute briefing to discuss the operation of the nominal and back-up EVA communication configurations for Shuttle. The second half of the class is spent reviewing nominal and off-nominal procedures and troubleshooting communication malfunctions.

Objectives:
- Identify the Space-to-Space EMU Radio (SSER) controls and the Communications Carrier Assembly (CCA).
- Identify and operate the Display and Control Module (DCM) controls associated with the SSER.
- Explain the nominal communications configuration rationale.
- Know the flight rules associated with the SSER.
- Perform nominal and off-nominal Shuttle procedures and understand the rationale behind these procedures.
- Identify symptoms of various communication failures.
- Respond to malfunctions of the STS Space-to-Space Communication System (SSCS).
EVA Systems Operations Lesson Descriptions

24 **EVA P/P 32020**

Title: Extravehicular Activity Prep and Post  
Duration: 6.0 hours  
Medium: CCT, FFT, or CCT II  
Student: EV1, EV2, Suit IV  
Source: DX35  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EMUs (sized), various EVA tools and equipment  
Prerequisite Lesson(s): EVA P/P 31020  
Preparation: None

Synopsis: This lesson provides a suited exercise of flight EVA preparation and post procedures.

Objectives:
- Know the EMU water recharge procedure, the battery changeout procedure, and the LiOH canister changeout procedure.
- Perform equipment preparation for EVA utilizing flight-similar stowage.
- Perform post-EVA entry preparation using EV and IV crewmembers.
- Perform EMU maintenance and recharge procedures.
- Know end-to-end flight EVA preparation and post procedures for EVA.
- Coordinate EVA preparation/post tasks with the EV crewmember and IV support.
- Practice EMU donn/doff in the airlock.
- Execute EVA Checklist (generic and flight-specific).
- Perform prebreathe mask procedures.

25 **ECWS ETA/REV 31014**

Title: Extravehicular Mobility Unit Caution and Warning System for Environmental Test Article and Preflight Review  
Duration: 2.0 hours  
Medium: EMU Mal Sim  
Student: EV1, EV2, Suit IV (Schedule individually.)  
Source: DX35  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): EVA P/P 32020  
Preparation: None

Note: This lesson should be scheduled one day to one week prior to EMU/AL WT 31054.
EVA Systems Operations Lesson Descriptions

25  **ECWS ETA/REV 31014 (Concluded)**

Synopsis: This lesson provides an exercise of nominal and malfunction procedures in the EMU Caution and Warning System (CWS) simulator. The crewmember will step through the chamber procedures prior to the Environmental Test Article (ETA) walk-through and chamber run (EMU/AL WT 31054, EMU/AL 31054), and have the opportunity to ask any generic or flight-specific EMU questions prior to launch.

Objectives:
- Know EVA Vacuum Chamber-specific objectives and procedures.
- Review flight-specific EMU configuration/operation.
- Review crew/flight controller coordination protocol for EVA operations.
- Review MCC EMU telemetry capability.

26  **EMU/AL WT 31054**

Title: Extravehicular Mobility Unit Airlock/Altitude Chamber Walk-Through
Duration: 4.5 hours
Medium: ETA
Student: EV1, EV2, *Suit IV* (Schedule individually or in pairs with IV.)
Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Flight EMU (Class I) and ancillary equipment
Prerequisite Lesson(s): ECWS ETA/REV 31014
Preparation: None

**Note:** Extensive advance planning is necessary for this lesson. ECWS ETA/REV 31014 is to be taken one day to one week prior to the chamber walk-through.

Synopsis: This lesson consists of a briefing of EMU/AL 31054, a walk-through of the facility systems, and suit donning and pressurization in the Environmental Test Article (ETA) Vacuum Chamber.

Objectives:
- Be familiar with the procedures to be used in the ETA chamber.
- Perform suit fit and EMU system verification.
- Perform airlock/EMU operations using flight hardware.
- Perform suit donning and pressurization of Class I EMU in the airlock.
- Cover prebreathe mask objectives if an overnight prebreathe is not scheduled.
EVA Systems Operations Lesson Descriptions

27  **EMU/AL 31054**

Title: Extravehicular Mobility Unit Airlock Altitude Chamber Run  
Duration: 8.0 hours  
Medium: ETA  
Student: EV1, EV2 (Schedule individually.)  
Source: DX35  
Date: 03/02  
Lesson(s) Replaced: None  
Equipment Required: Flight EMU (Class I) and ancillary equipment  
Prerequisite Lesson(s): EMU/AL WT 31054  
Preparation: None  
**Note:** Extensive advance planning is necessary for this lesson.

Synopsis: This lesson provides an exercise of orbiter/airlock and EMU flight-integrated procedures at simulated flight environment pressures in a flight configured airlock.

Objectives:  
- Perform 4 hour in-suit prebreathe protocol.  
- Be familiar with flight crew specific EMU.  
- Perform nominal malfunctions of EMU.  
- Perform EMU hardware verification prior to flight.  
- Perform airlock-to-EMU life support transfers, airlock depress/repress, and EMU servicing.

28  **EMU/AL 1DAY 31054**

Title: Extravehicular Mobility Unit/Airlock One Day Chamber Run  
Duration: 10.0 hours  
Medium: ETA  
Student: EV1, EV2 (Schedule individually.)  
Source: DX35  
Date: 03/02  
Lesson(s) Replaced: None  
Equipment Required: Flight EMU (Class I) and ancillary equipment  
Prerequisite Lesson(s): ECWS ETA/REV 31014; previous vacuum chamber run (ETA, SSATA)  
Preparation: None  
Synopsis: This lesson provides a one-day exercise of orbiter/airlock and EMU flight integrated procedures at simulated flight environment pressures in a flight configured airlock. This class is optional for experienced EVA crewmembers that have completed other chamber runs prior.
EVA Systems Operations Lesson Descriptions

28  **EMU/AL 1DAY 31054 (Concluded)**

Objectives:
- Perform 4 hr in-suit prebreathe protocol.
- Be familiar with flight crew specific EMU.
- Perform nominal malfunctions of EMU.
- Perform EMU hardware verification prior to flight.
- Perform airlock-to-EMU life support transfers, airlock depress/repress, and EMU servicing.

29  **EVA P/P 33020**

Title: Extravehicular Activity Prep and Post
Duration: 6.0 hours
Medium: CCT, FFT, or CCT II
Student: EV1, EV2, *Suit IV*
Source: DX35
Date: *06/08*
Lesson(s) Replaced: None
Equipment Required: EMUs (sized), various EVA tools and equipment
Prerequisite Lesson(s): EVA P/P 32020
Preparation: None

Synopsis: This lesson provides a suited exercise of flight EVA preparation and post procedures. Crewmembers have opportunity for questions and review prior to launch.

Objectives:
- Know the EMU water recharge procedure, the battery changeout procedure, and the LiOH canister changeout procedure.
- Perform equipment preparation for EVA utilizing flight-similar stowage.
- Perform post-EVA entry preparation using EV and IV crewmembers.
- Know end-to-end flight EVA preparation and post procedures for EVA.
- Coordinate EVA preparation/post tasks with the EV crewmember and IV support.
- Practice EMU donn/doff in the airlock.
- Execute EVA Checklist (generic and flight-specific).
EVA Systems Operations Lesson Descriptions

40000-Level Lessons (Proficiency, Refresher)

**EVA DECON 31001**

Title: Extravehicular Activity Decontamination (Shared – ISS)
Duration: 1.5 hours
Medium: Classroom
Student: EV1, EV2, *Suit IV*
Source: DX35
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EVA Tools, VCR, TV, PC, projector
Prerequisite Lesson(s): ISS ECWS MALS 21014
Preparation: None

Synopsis: This lesson includes a classroom presentation covering sources of EVA contamination, hazards, and contingency responses. EVA hardware used for chemical detection will be introduced, and the long form malfunction will be summarized.

Objectives:
- Understand types and sources of contamination on ISS and Space Transportation System (STS).
- Understand hazards and risks of introducing contamination to the IV environment.
- Introduce EVA hardware used to remove and test for contamination.
- Perform overview of long form malfunction procedure.

**SAFER PRF 41016**

Title: Simplified Aid for Extravehicular Activity Rescue Proficiency (Shared – ISS)
Duration: 2.0 hours
Medium: Virtual Reality Trainer
Student: EV1, EV2 (Schedule individually.)
Source: DX35
Date: 03/02
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SAFER INTRO 21016
Preparation: None

Synopsis: This lesson provides a review of the SAFER components and procedures. The crewmember will have the opportunity to practice basic SAFER piloting techniques.
EVA Systems Operations Lesson Descriptions

SAFER PRF 41016 (Concluded)

Objectives:
- Know SAFER systems and controls.
- Perform unaided basic piloting procedures.
- Perform unaided simple rescue scenarios.

ISS ECWS PRF 41014

Title: ISS EVA Caution and Warning System Proficiency (Shared – ISS)
Duration: 2.0 hours
Medium: EMU Mal Sim
Student: EV1, EV2, Suit IV, Task IV (Schedule individually.)
Source: DX35
Date: 06/08
Lesson(s) Replaced: ISS ECWS PRF C 41014
Equipment Required: None
Prerequisite Lesson(s): ISS ECWS MALS 21014
Preparation: None

Synopsis: This is three reviews of the EMU Caution and Warning System (CWS) operational procedures and the ISS airlock procedures. The student will be asked to respond to various EMU malfunctions put in by the instructor.

Objectives:
- Describe the architecture and operations of the EMU Life Support System (LSS).
- Explain the rationale for malfunction procedures for the EMU.
- Perform, unaided, the nominal procedures.
- Respond to EMU CWS alarms with instructor assistance.

ISS EVA P/P 41105

(Shared – ISS)
Refer to ISS EVA P/P 32105 for description.
EVA Systems Operations Lesson Descriptions

ECWS PRF 41014
Title: Extravehicular Mobility Unit Caution and Warning System Proficiency (Shared – ISS)
Duration: 2.0 hours
Medium: EMU Mal Sim
Student: EV1, EV2, Suit IV (Schedule individually.)
Source: DX35
Date: 06/08
Lesson(s) Replaced: ECWS PRF ADV 41014
Equipment Required: None
Prerequisite Lesson(s): ECWS MALS 21014
Preparation: None
Synopsis: This lesson provides an exercise of nominal and malfunction procedures on the EMU malfunction simulator.
Objectives:
• Know nominal and malfunction procedures for the EMU and airlock.
• Perform nominal EVA prep/post procedures and malfunctions.

EVA P/P 41020
Refer to EVA P/P 33020 for description.

CLS I GLV FIT PRF 61001
Title: Class I Glove Fit Check Proficiency (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: EV1, EV2 (Schedule individually.)
Source: DX35 (USA/FCE)
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CLS I GLOVE FITCK 61001
Preparation: None
Synopsis: This lesson provides the student and Flight Crew Equipment (FCE) a proficiency fit check verification of the student’s CLS I gloves.
Preparation: None
CLS I BOOT FIT PRF 61001

Title: Class I Boot Fit Check Proficiency (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: EV1, EV2 (Schedule individually.)
Source: DX35 (USA/FCE)
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CLS I BOOT EVAL 61001
Preparation: None

Synopsis: This lesson provides the student and Flight Crew Equipment (FCE) a proficiency fit check verification of the student’s CLS I boots.

Objectives: None
Figure 8-4. EVA Task Operations Training Flow
Figure 8-4. EVA Task Operations
Training Flow (Concluded)
### Table 8-3. EVA Task Operations
#### Training Requirements

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Note 1: For 7:1 ratio, M1 attends third (EVAX 93027), fourth (EVAX 94027) and final NBL run (EVAX 97027). M2 (if assigned) attends fifth NBL run (EVAX 95027).

Note 2: In the event that a flight decides not to use both a Suit and Task IV, the IV crewmember will complete the combined columns so that all classes are covered.
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Note 1: For 7:1 ratio, M1 attends third (EVAX 93027), fourth (EVAX 94027) and final NBL run (EVAX 97027). M2 (if assigned) attends fifth NBL run (EVAX 95027).

Note 2: In the event that a flight decides not to use both a Suit and Task IV, the IV crewmember will complete the combined columns so that all classes are covered.
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Sub Total for Stage: 68.0
Stage Totals Per Crewmember: 68.0

Note 1: For 7:1 ratio, M1 attends third (EVAX 93027), fourth (EVAX 94027) and final NBL run (EVAX 97027). M2 (if assigned) attends fifth NBL run (EVAX 95027).
For 5:1 ratio, M1 attends third (EVAX 93027) and final NBL run (EVAX 95027). M2 (if assigned) attends fourth NBL run (EVAX 94027).

Note 2: In the event that a flight decides not to use both a Suit and Task IV, the IV crewmember will complete the combined columns so that all classes are covered.
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Note 1: For 7:1 ratio, M1 attends third (EVAX 93027), fourth (EVAX 94027) and final NBL run (EVAX 97027). M2 (if assigned) attends fifth NBL run (EVAX 95027).
For 5:1 ratio, M1 attends third (EVAX 93027) and final NBL run (EVAX 95027). M2 (if assigned) attends fourth NBL run (EVAX 94027).

Note 2: In the event that a flight decides not to use both a Suit and Task IV, the IV crewmember will complete the combined columns so that all classes are covered.
1  **EVA FLOW 61001**

**Title:** Extravehicular Activity Flow/Requirements Overview (Shared – ISS)

**Duration:** 1.0 hour

**Medium:** Classroom

**Student:** COMMANDER, MS 1, MS 2, MS 3, PILOT

**Source:** DX32/DX35

**Date:** 03/02

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** None

**Preparation:** None

**Synopsis:** This lesson is the initial meeting with crew, DT/Training Manager (and Increment Training Integrator, as required), EVA Training Schedulers, EVA Systems and EVA Task leads, to discuss the EVA training requirements and flow.

**Objectives:** Discuss EVA training requirements with crew.

2  **EVA PGT/TM 31001**

**Title:** Extravehicular Activity Piston Grip Tool/Torque Multiplier Operations (Shared – ISS)

**Duration:** 1.5 hours

**Medium:** Classroom

**Student:** EV1, EV2, *Task IV* (Schedule in groups of up to 3.)

**Source:** DX32

**Date:** 06/08

**Lesson(s) Replaced:** EVA PGT/TM C 31001

**Equipment Required:** EVA tools and equipment

**Prerequisite Lesson(s):** ISS EVA SMALL TOOLS 21001

**Preparation:** None

**Synopsis:** This lesson provides the student with a detailed description of the Pistol Grip Tool (PGT) and Torque Multiplier (TM) operations. The student gets hands-on application of the EVA hardware.

**Objectives:**
- Become familiar with PGT operations.
- Become familiar with TM operations.
- Become familiar with re-programming capability of the PGT software using a computer.
EVA Task Operations Lesson Descriptions

3  **EVA CETA OPS 31028**

Title: EVA Crew Equipment Translation Aid Operations  
Duration: 1.0 hour  
Medium: Air Bearing Table  
Student: EV1, EV2,  *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): EVA SOP 21007  
Preparation: None  

Synopsis: This lesson familiarizes student with Crew Equipment Translation Aid (CETA) cart objectives.

Objectives: Become familiar with CETA cart hardware and operations.

4  **ISS EVA SMALL TOOLS 31001**

Title: ISS Extravehicular Activity Small Tools  
Duration: 2.0 hours  
Medium: Classroom (at NBL)  
Student: EV1, EV2,  *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): EVA PGT/TM 31001  
Preparation: None  

Synopsis: This lesson includes a description of the EVA tools used during ISS EVA operations. This lesson consists of a classroom briefing and hands-on applications of the EVA hardware.

Objectives:  
- Be familiar with and operate EVA tools.  
- Be familiar with EVA tool operational constraints.
EVA Task Operations Lesson Descriptions

5  **EVA OPS 1G 31001**

Title: Extravehicular Activity Operations 1G  
Duration: 2.0 hours  
Medium: Classroom (NBL/MU-S (NBL, Mockup South))  
Student: EV1, EV2,  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: This lesson provides the crew with a detailed knowledge of mission specific tasks. The crew performs mission specific procedures using mockups and EVA hardware.  

Objectives:  
- Become familiar with EVA mission-specific tasks.  
- Become familiar with EVA hardware-specific to those tasks.

6  **EVA SCUBA 91027**

Title: Extravehicular Activity SCUBA  
Duration: 4.0 hours  
Medium: Neutral Buoyancy Lab  
Student: EV1, EV2,  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: Swimming suit, EVA tools, and equipment  
Prerequisite Lesson(s): EVA OPS 1G 31001  
Preparation: None

Synopsis: This lesson will provide the students with proficiency and exposure to Shuttle/Station EVAs prior to their upcoming suited runs. This class includes a pre-brief, 2 hours on SCUBA, and debrief while waiting for the 1-hour medical observation period to pass. The student will review general Shuttle EVA knowledge and EVA skills, such as translation and foot restraint operations while being exposed to Shuttle and Station. It is highly recommended that the instructor use the Surface Supplied Diving System (SSDS) to communicate with the students and the utility divers.  

Objectives:  
- Review Shuttle coordinate system.  
- Review Shuttle Airlock (A/L) operations.  
- Translate to a few contingency worksites and on Station.
EVA Task Operations Lesson Descriptions

6 EVA SCUBA 91027 (Concluded)

- Review the Station coordinate system.
- Review the Station trusses and elements.
- Review the Station A/L.
- Introduce hardware locations and tasks associated with assigned EVA(s).

7 EVAX 91027

Title: Extravehicular Activity Mission-Specific Tasks and Timeline Operations
Duration: 9.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, Suit IV, Task IV, R1 or M1 (RMS operator should attend 50% of total number of timeline runs when RMS is used for EVA operations)

Note: See Table 8-3 for specific IV hours.
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): EVA OPS 1G 31001
Preparation: None

Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.) This lesson instructs the students of the mission-specific EVA tasks for an EVA timeline.

Objectives:
- Perform EVA mission-specific tasks.
- Perform steps to egress/ingress the airlock.
- Translate to tool stowage areas.
- Perform worksite setup/cleanup.
- Perform team plan and/or technique for accomplishment of EVA tasks.
- Coordinate tasks with SRMS or SSRMS operator.
- Practice EVA timeline choreography.
EVA Task Operations Lesson Descriptions

8

**ISS EVA MASS OPS 91016**

Title: ISS Extravehicular Activity Mass Handling (Shared – ISS)  
Duration: 1.0 hour  
Medium: Virtual Reality Trainer  
Student: EV1, EV2, *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: Virtual Reality Simulator  
Prerequisite Lesson(s): EVAX 91027  
Preparation: None

Synopsis: This lesson provides an environment that allows the crew to determine body positions, along with the level of work required to perform various EVA operations. This class is taught in the Virtual Reality (VR) simulator which provides a six degrees-of-freedom virtual environment. Crewmembers will be provided with the opportunity to perform and evaluate mass handling related tasks.

Objectives:  
- Perform and evaluate mass handling activities.  
- Evaluate various body positions and work loads to determine the most effective method of task completion.

9

**EVA FLUID QD OPS 31197**

Title: Extravehicular Activity Fluid Quick Disconnect Operations  
(Shared – Shuttle)  
Duration: 2.0 hours  
Medium: EVA Fluid QD Trainer (in Building 9)  
Student: EV1, EV2, *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): EVAX 91027  
Preparation: None

Synopsis: The lesson provides the student with a detailed knowledge of EVA fluid connector operations. The student will operate the connectors under pressurized conditions.

Objectives:  
- Become familiar with proper operations of an EVA fluid connector.  
- Become familiar with EVA tools used to operate EVA fluid connector functions.
EVA Task Operations Lesson Descriptions

10 EVA MASS OPS 31028
Title: Precision Air Bearing Floor Mass Handling
Duration: 1.0 hour
Medium: AB Table (9N/PABF)
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: EVA OPS 31028
Equipment Required: EVA tools and equipment; EMU as required
Prerequisite Lesson(s): EVAX 91027
Preparation: None

Synopsis: This lesson provides an environment that allows the crew to determine body positions, along with the level of work required to perform various EVA operations. With the class taught at the PABF, the crew will be allowed three degrees-of-freedom to perform their tasks, while the Virtual Reality (VR) simulator will provide a six degrees-of-freedom virtual environment. Crewmembers will be provided with the opportunity to perform and evaluate mass handling related tasks.

Objectives:
• Perform and evaluate mass handling activities.
• Evaluate various body positions and work loads to determine the most effective method of task completion.
• Perform and evaluate loaded and unloaded Crew and Equipment Translation Aid (CETA) cart translations.

11 EVA T/U 61001
Title: Extravehicular Activity Tag-up
Duration: 1.0 hour
Medium: Classroom
Student: EV1, EV2, Task IV (as required)
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This event provides EVA crew and instructors the opportunity to discuss any EVA related topics. Topics can include EVA timelines, new EVA tasks, EVA training plan, etc. (Requirement is optional per crew.)

Objectives: Discuss EVA-related topics.
EVA Task Operations Lesson Descriptions

12 EVAX 92027
   Refer to EVAX 91027 in Crew Training Catalog.

13 ISS EVA TOOL CONFIG 31105
   Title: ISS Extravehicular Activity Tool Configuration (Shared – ISS)
   Duration: 2.0 hours
   Medium: Space Station Mock-Up And Training Facility
   Student: EV1, EV2, Task IV
   Source: DX32
   Date: 06/08
   Lesson(s) Replaced: EVA TOOL CONFIG 1 C 91105
   Equipment Required: EVA tools and equipment
   Prerequisite Lesson(s): EVAX 92027
   Preparation: None

   Synopsis: This lesson is the first of three that are provided for the crew to go through the tool configuration of the prep and post procedures of their EVA timeline. The crew will practice retrieving the necessary tools from the stowed locations, and place them where required prior to their EVA.

   Objectives:
   • Perform EVA prep and post tool configuration timeline.
   • Identify optimal stowage locations for EVA hardware in the airlock.

14 EVAX 93027
   Refer to EVAX 91027 in Crew Training Catalog. This is also an EVA Assessment Team (EVAAT) NBL run whereby a veteran EVA member participates:
   • as a third suited member
   • or SCUBAs on the Single-Surface Diving System (SSDS)
   • or from the Test Conductor console area.

   (During EVAAT events, the crewmembers will perform a SAFER Reach Evaluation to ensure that the SAFER Hand Control Module is accessible.)

15 ISS EVA MASS OPS 92016
   Refer to ISS EVA MASS OPS 91016 in Crew Training Catalog.

16 EVA FLUID QD OPS 32197
   (Shared – Shuttle)
   Refer to EVA FLUID QD OPS 31197 in Crew Training Catalog.
EVA Task Operations Lesson Descriptions

17 EVA PGT/TM 32001
Refer to EVA PGT/TM 31001 in Crew Training Catalog.

18 EVA MASS OPS 32028
Refer to EVA MASS OPS 31028 in Crew Training Catalog. Only schedule if required by the crew.

19 EVAX 94027
Refer to EVAX 91027 in Crew Training Catalog. This is also an EVA Assessment Team (EVAAT) NBL run whereby a veteran EVA member participates:
- as a third suited member
- or SCUBAs on the Single-Surface Diving System (SSDS)
- or from the Test Conductor console area.

(During EVAAT events, the crewmembers will perform a SAFER Reach Evaluation to ensure that the SAFER Hand Control Module is accessible.)

20 ISS EVA TOOL CONFIG 32105
(Shared – ISS)
Refer to ISS EVA TOOL CONFIG 31105 in Crew Training Catalog.

21 EVA CONT 1G 31001
Title: Extravehicular Activity Contingency 1G
Duration: 2.0 hours
Medium: Classroom (NBL/MU-S (NBL, Mockup – South))
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): EVAX 91027
Preparation: None

Synopsis: This lesson provides the crewmember with a walk-through briefing of the mission-specific contingency tasks. The crew performs mission-specific contingency procedures using mockups and EVA hardware.

Objectives: Perform EVA-specific timeline contingency procedures.
EVA Task Operations Lesson Descriptions

22  EVA CONT 91027

Title: Extravehicular Activity Contingency Operations
Duration: 9.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, Task IV, Suit IV (optional), R1 (as required)
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): EVAX 91027
Preparation: None

Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)

This lesson provides the crewmember an opportunity to perform mission specific contingency tasks in the NBL. The crew performs mission-specific contingency procedures using mockups and EVA hardware.

Objectives:
• Perform EVA-specific timeline contingency procedures.
• Formulate a plan to resolve contingency situations via EVA.

23  EVAX 95027

Refer to EVAX 91027 in Crew Training Catalog.

24  KU BAND 31001

Title: Ku-Band Antenna Extravehicular Activity Operations
Duration: 1.0 hour
Medium: Classroom (at Bldg. 44)
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CONT OPS 21002
Preparation: None
EVA Task Operations Lesson Descriptions

24  **KU BAND 31001 (Concluded)**

Synopsis: This lesson provides crewmembers with the opportunity for a walk-through briefing on the objectives and techniques involved with EVA operations of the Ku-Band antenna. An overview of the hardware, potential failures, and EVA procedures are presented.

Objectives:
- Familiarize crew with Ku-Band antenna.
- Review potential Ku-Band hardware failures.
- Know EVA procedures for Ku-Band antenna gimbal align.

Title: Orbiter, Docking and Remote Manipulator System Contingency 1G
Duration: 2.0 hours
Medium: Classroom (NBL/MU-S (NBL, Mockup-South))
Student: EV1, EV2, *Task IV*
Source: DX32
Date: 06/08
Lesson(s) Replaced: RMS CONT 31001
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): KU BAND 31001
Preparation: None

Synopsis: This lesson is a walk-through briefing for orbiter, docking, and SRMS contingency operations. A briefing on the failure conditions is presented, followed by a discussion of EVA procedures to be used for contingency operations.

Objectives:
- Discuss orbiter contingency procedures (reference generic flow orbiter contingency class objectives).
- Discuss orbiter docking system contingency procedures.
- Discuss SRMS contingency procedures (shoulder brace release, tie down, manipulator positioning mechanism deploy/stow, joint alignment).
- Discuss flight-specific orbiter/SRMS contingency procedures (i.e., Payload Retention Latch Actuator (PRLA), Remotely Operated Electrical Umbilical (ROEU), grapple fixture release, etc.).
EVA Task Operations Lesson Descriptions

26   O/D/R CONT 31027

Title: Orbiter, Docking, and Remote Manipulator System Contingency Operations
Duration: 9.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, Task IV, Suit IV (optional)
Source: DX32
Date: 06/08
Lesson(s) Replaced: DOOR CONT 2 31027, LATCH CONT 2 31027, ORB CONT 31027, and RMS CONT 31027
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): O/D/R CONT 1G 31001
Preparation: None

Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)

This lesson provides the crewmember an exercise to perform orbiter, docking, and SRMS contingency operations. The exercise will include manually closing the payload bay doors and radiators and performing payload bay centerline latch and bulkhead latch tool installation. This lesson provides the crewmember an exercise to perform end-to-end EVA SRMS contingency operations. This lesson also provides the crewmember an exercise to perform orbiter docking system contingency operations.

Objectives: • Discuss orbiter contingency procedures (reference generic flow orbiter contingency class objectives).
• Discuss orbiter docking system contingency procedures.
• Discuss SRMS contingency procedures (shoulder brace release, tie down, manipulator positioning mechanism deploy/stow, joint alignment).
• Discuss flight-specific orbiter/SRMS contingency procedures (i.e., Payload Retention Latch Actuator (PRLA), Remotely Operated Electrical Umbilical (ROEU), grapple fixture release, etc.).

27   EVA MASS OPS 33028

Refer to EVA MASS OPS 31028 in Crew Training Catalog. Only schedule if required by the crew.

28   EVA CONT 1G 32001

Refer to EVA CONT 1G 31001 in Crew Training Catalog.
EVA Task Operations Lesson Descriptions

29 **EVA CONT 92027**

Refer to EVA CONT 91027 in Crew Training Catalog.

30 **EVAX 96027**

Refer to EVAX 91027 in Crew Training Catalog.

31 **EVA PGT POGO 31028**

- **Title:** Extravehicular Activity Pistol Grip Tool Pogo Operations
- **Duration:** 2.0 hours
- **Medium:** AB Table (in Building 9)
- **Student:** EV1, EV2 *(Task IV optional)*
- **Source:** DX32
- **Date:** 06/08
- **Lesson(s) Replaced:** None
- **Equipment Required:** EVA tools, equipment and EMU gloves
- **Prerequisite Lesson(s):** EVA PGT/TM 31001
- **Preparation:** None

**Synopsis:** This lesson provides the student an opportunity to become familiar with Pistol Grip Tool (PGT) operations under torque-loaded conditions.

**Objectives:** Become familiar with PGT operations under torque-loaded conditions.

32 **EVA FLUID QD OPS 33197**

*(Shared – Shuttle)*

Refer to EVA FLUID QD OPS 31197 in Crew Training Catalog.

33 **EVA PGT/TM 33001**

- **Title:** Extravehicular Activity Piston Grip Tool/Torque Multiplier Operations *(Shared – ISS)*
- **Duration:** 0.5 hours
- **Medium:** Classroom
- **Student:** EV1, EV2, *Task IV* *(Schedule in groups of up to 3.)*
- **Source:** DX32
- **Date:** 06/08
- **Lesson(s) Replaced:** EVA/PGT/TM C 31001
- **Equipment Required:** EVA tools and equipment
- **Prerequisite Lesson(s):** ISS EVA SMALL TOOLS 21001
- **Preparation:** None
EVA Task Operations Lesson Descriptions

33 EVA PGT/TM 33001 (Concluded)

Synopsis: This lesson provides the student with a detailed description of the Pistol Grip Tool (PGT) and Torque Multiplier (TM) operations. The student gets hands-on application of the EVA hardware.

Objectives:
- Review PGT operations.
- Review TM operations.
- Review re-programming capability of the PGT software using a computer.

34 EVA CONT 93027

Refer to EVA CONT 91027 in Crew Training Catalog.

35 EVA MASS OPS 34028

Refer to EVA MASS OPS 31028 in Crew Training Catalog. Only schedule if required by the crew.

36 EVA CONT 94027

Refer to EVA CONT 91027 in Crew Training Catalog.

37 EVAX 97027

Refer to EVAX 91027 in Crew Training Catalog. This is the final set of EVA timeline runs.

38 P/L EVA 1G 31001

Title: Payload Extravehicular Activity 1G
Duration: 2.0 hours
Medium: Classroom (NBL/MU-S (NBL, Mockup South))
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: P/L EVA 31001
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): ISS EVA MAINT 21027
Preparation: None

Synopsis: This lesson is a walk-through briefing of the mockup and tools in support of objectives and techniques involved with EVA operations of the payload, an overview of mechanisms, procedures, and potential failures is presented, as well as EVA techniques to deal with scheduled, unscheduled, and contingency scenarios.
EVA Task Operations Lesson Descriptions

38  **P/L EVA 1G 31001 (Concluded)**

Objectives:
- Walk-through briefing of mockup and tools review.
- Review mechanisms and operations of hardware pertaining to particular flight.
- Discuss and perform possible EVA techniques needed for scheduled, unscheduled, and contingency payload scenarios.

39  **ORB CONT 31027**

Title: Orbiter Contingency Operations  
Duration: 6.5 hours  
Medium: Neutral Buoyancy Lab  
Student: EV1, EV2, *Task IV, Suit IV (optional)*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: DOOR CONT 2 31027, LATCH CONT 2 31027  
Equipment Required: EMUs, EVA tools and equipment  
Prerequisite Lesson(s): ISS EVA MAINT 21027  
Preparation: None

Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)

This lesson familiarizes the student with EVA orbiter contingency operations. The student continues to develop EMU familiarity (mobility, positioning, etc.). The primary focus of this class is door contingency operations.

Objectives:
- Know Shuttle airlock egress.
- Know Portable Foot Restraint (PFR) ingress.
- Know door drive linkage cut.
- Know door drive linkage disconnect.
- Know electrical crossover disconnect.
- Know proper body positioning at the worksite.
- Know EV1 installation on bulkhead and centerline latches.
- Know EV2 installation of bulkhead and centerline latches.
- Know Shuttle airlock ingress.
Title: Payload Extravehicular Activity Operations
Duration: 9.5 hours
Note: Length of lesson may be shorter depending upon mission specific requirements.
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, Task IV, Suit IV (optional)
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): P/L EVA 1G 31001
Preparation: None
Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)

This lesson provides the crewmember an exercise to perform EVA procedures for contingency scheduled and unscheduled payload-related operations. Crewmembers may perform part-task or end-to-end payload flight-related EVA operations. Objectives of other lessons may be covered to ensure that crewmembers maintain proficiency in payload EVA tasks.

Objectives: Perform mission-specific EVA procedures for any payload-related operations.

ORB CONT 32027
Refer to ORB CONT 31027 in Crew Training Catalog.

P/L EVA 92027
Refer to P/L EVA 91027 in Crew Training Catalog.

ORB CONT 33027
Refer to ORB CONT 31027 in Crew Training Catalog.

P/L EVA 93027
Refer to P/L EVA 91027 in Crew Training Catalog.
**EVA Task Operations Lesson Descriptions**

45  **EVA TOOL CONFIG 31020**

Title: Extravehicular Activity Tool Configuration  
Duration: 2.0 hours  
Medium: CCT, FFT, or CCT II  
Student: EV1, EV2, Task IV  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): EVAX 97027  
Preparation: None  
**Note:** This lesson is scheduled in conjunction EVA P/P 31020.

Synopsis: This lesson is the first of three that are provided for the crew to go through the tool configuration of the prep and post procedures of their EVA timeline. The crew will practice retrieving the necessary tools from the stowed locations, and place them where required prior to their EVA.

Objectives:  
- Perform EVA prep and post tool configuration timeline.  
- Identify optimal stowage locations for EVA hardware in the airlock.

46  **EVA TOOL CONFIG 32020**

Refer to EVA TOOL CONFIG 31020 in Crew Training Catalog.

47  **EVA TOOL CONFIG 33020**

Refer to EVA TOOL CONFIG 31020 in Crew Training Catalog.

48  **EVA RCC REPAIR DGB 61001**

Title: Extravehicular Activity Reinforced Carbon-Carbon Dual Glove Box  
Duration: 10.0 hours  
Medium: Bldg 7 Glovebox  
Student: EV1  
Source: DX32  
Date: 07/07  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): None  
Preparation: None  
Synopsis: This lesson reviews the skills required to enact Reinforced Carbon-Carbon (RCC) repairs in the glovebox environment.
EVA Task Operations Lesson Descriptions

48  EVA RCC REPAIR DGB 61001 (Concluded)

Objectives:
• Review detailed EVA procedures, tools, and techniques for RCC repair.
• Perform repairs on RCC samples with repair material at vacuum to gain experience with the material properties.

49  EVA TPS REPAIR 21002

Title: EVA Thermal Protection System Repair
Duration: 4.0 hours
Medium: Workbook
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DX32
Date: 09/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides an overview of the Thermal Protection System (TPS) components on the Space Shuttle, historical TPS damage, and EVA inspection and repair methods.

Objectives:
• Become familiar with the TPS components on Orbiter (blankets, tile, Reinforced Carbon-Carbon (RCC)).
• Identify different tile types and tile damage (historical and testing).
• Identify RCC components and RCC damage (historical and testing).
• Describe tile and RCC repair materials, tools, and methods.
• Become familiar with boom hardware and operations.
• Describe nominal and EVA inspection operations.
• Become familiar with EVA access to Orbiter TPS areas.

50  EVA TPS OV 31706

Title: EVA Thermal Protection System Overview
Duration: 3.0 hours
Medium: Thermal Protection System Trainer
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DX32
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: TPS components, Thermal Protection System Trainer, and Precision Air Bearing Floor
Prerequisite Lesson(s): None
Preparation: EVA TPS REPAIR 21002
EVA Task Operations Lesson Descriptions

50  **EVA TPS OV 31706 (Concluded)**

Synopsis: This lesson is intended to familiarize Shuttle crewmembers with the Orbiter Thermal Protection System (TPS) as it relates to EVA inspection and EVA repair. This lesson explains the principle design function of the TPS during entry and points out the location of tiles, blankets, and Reinforced Carbon-Carbon (RCC) components. This includes TPS nomenclature and familiarization with the sub-components of tile and RCC layups. The students will handle samples of the various TPS sub-components. Examples of tile and RCC damage and repairs are also discussed at a high level. This lesson includes a discussion of EVA inspection locations, requirements, and methods. It concludes with development of techniques on the Precision Air Bearing Floor (PABF) for contingency safety tether use during SAFER TPS inspection.

Objectives:
- Understand the various TPS components on the Orbiter.
- Understand TPS sub-component nomenclature.
- Understand what typical TPS damage may look like.
- Gain a high level understanding of TPS repair materials and their functionality.
- Gain a basic understanding of EVA access to TPS.
- Understand inspection resolution requirements.
- Introduce inspection activities in a typical flight plan.
- Understand failures that lead to EVA inspection.
- Understand EVA inspection tools and timelines.
- Develop skills required for contingency safety tether retrieval during SAFER inspection.

51  **EVA TILE REPAIR 31703**

Title: EVA Tile Repair  
Duration: 3.5 hours  
Medium: Thermal Protection System Trainer  
Student: EV1, EV2, *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA Tools and Equipment  
Prerequisite Lesson(s): EVA TPS OV 31706  
Preparation: None
EVA Task Operations Lesson Descriptions

51 EVA TILE REPAIR 31703 (Concluded)

Synopsis: This lesson provides the information and skills required to enact Space Shuttle Thermal Protection System (TPS) tile repairs. The lesson discusses the required tools for the repairs and the material properties of the systems. Hands-on procedures and techniques practice is the focus of the lesson.

Objectives: • Discuss detailed EVA procedures, tools, and techniques for TPS tile repairs, including tile overlay and Emittance Wash (EW) repair.
• Practice TPS tile repair methods.
• Introduce Tile Repair Ablator Dispenser (TRAD).

52 EVA TPS LOADS 31016

Title: EVA Thermal Protection System Loads
Duration: 1.0 hour
Medium: Virtual Reality Trainer
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08

Lesson(s) Replaced: None
Equipment Required: EVA Tools and equipment
Prerequisite Lesson(s): EVA TILE REPAIR 31703
Preparation: None

Synopsis: This lesson familiarizes EV/IV crewmembers with the movements of the robotic systems, boom, and Orbiter during Thermal Protection System (TPS) inspection and repair operations. The Virtual Reality (VR) simulator and equipment provide a high fidelity platform to simulate the movements from the robotic arms and boom when EV crewmembers impact forces and moments (loads) into a dynamic system. Crewmembers will perform TCS repair operations using EVA repair tools and discuss cautions and warnings associated with the dynamic system.

Note: This class will be scheduled immediately prior to PDRS EVA Wing Leading Edge Mapping class in the Virtual Reality Lab.

Objectives: • Discuss historical dynamic system movement experience.
• Impart forces into simulator to understand the resultant reaction of the systems.
• Discuss and practice recommended techniques for enacting inspection or repair with a dynamic system.
• Become familiar with the constraints, cautions, and warnings for TPS procedures with a dynamic system.
EVA Task Operations Lesson Descriptions

53  **EVA TPS OPS 1G 31001**

**Title:** EVA Thermal Protection System Repair 1G  
**Duration:** 3.5 hours  
**Medium:** Classroom (NBL/MU-S (NBL, Mockup-South))  
**Student:** EV1, EV2, *Task IV*  
**Source:** DX32  
**Date:** 06/08  
**Lesson(s) Replaced:** None  
**Equipment Required:** EVA tools and equipment  
**Prerequisite Lesson(s):** EVA TPS LOADS 31016  
**Preparation:** None

**Synopsis:** This lesson is a 1G session to prebrief the details of the Neutral Buoyancy Lab (NBL) class, EVA TPS OPS 91027. This lesson familiarizes Shuttle crewmembers with the EVA procedures associated with Thermal Protection System (TPS) inspection and repair methods. Students will configure EVA tools for various repair methods. Translation paths, worksite familiarity, and body positioning with respect to a TPS damage area will be discussed.

**Objectives:**
- Configure Tools for SSRMS and Boom-based TPS repairs and inspection:
  - Tile Repair methods
  - Reinforced Carbon-Carbon (RCC) Repair methods
  - Inspection
- Discuss translation paths and body positioning.

54  **EVA TPS OPS 91027**

**Title:** EVA Thermal Protection System Repair  
**Duration:** 9.5 hours  
**Medium:** Neutral Buoyancy Lab  
**Student:** EV1, EV2, *Task IV, Suit IV (optional)*  
**Source:** DX32  
**Date:** 06/08  
**Lesson(s) Replaced:** None  
**Equipment Required:** EMUs, EVA tools and equipment  
**Prerequisite Lesson(s):** EVA TPS OPS 1G 31001, EVA TPS OPS 1G 31001  
**Preparation:** None

**Synopsis:** This lesson familiarizes Shuttle crewmembers with the EVA procedures associated with Thermal Protection System (TPS) inspection repair methods. Students will configure EVA tools, set up worksites, and perform operations for various TPS inspection repair methods.
EVA Task Operations Lesson Descriptions

54 EVA TPS OPS 91027 (Concluded)

Objectives:
• Perform handling and translation of required tools for the various repair methods.
• Perform worksite setup/cleanup techniques for SSRMS and Boom-based EVA.
• Perform repair operations at TPS worksite:
  – Tile Repair methods
  – Reinforced Carbon-Carbon (RCC) Repair methods
• Perform boom contingencies as time allows.

55 EVA TILE REPAIR 32703

Title: EVA Tile Repair II
Duration: 2.0 hours
Medium: Thermal Protection System Trainer
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): EVA TILE REPAIR 31703
Preparation: None

Synopsis: This lesson provides the information and skills required to enact Space Shuttle Tile Protection (TPS) tile repairs. The lesson discusses the required tools for the repairs and material properties. Hands-on procedures and techniques practice is the focus of this lesson. This lesson also discusses the External Tank (ET) umbilical doors mechanisms, procedures, translation, ET centerline latch operations, and ET door jam/debris removal.

Objectives:
• Discuss detailed EVA procedures, tools, and techniques for TPS tile repairs.
• Practice TPS tile repair methods, including Tile Repair Ablator Dispenser (TRAD).
• Explain ET door mechanisms and operation.
• Explain the ET centerline latch tool function/operation.
• Discuss jam and debris removal tools.
EVA Task Operations Lesson Descriptions

56  EVA RCC REPAIR 31703

Title: EVA Reinforced Carbon-Carbon Repair
Duration: 4.0 hours
Medium: Thermal Protection System Trainer
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): EVA TPS OV 31706
Preparation: None

Synopsis: This class provides a walkthrough of EVA repair procedures and hands-on experience with Reinforced Carbon-Carbon (RCC) repair tools, materials, and repair techniques.

Objectives:
• Review RCC composition and damage types.
• Understand RCC repair materials properties.
• Understand RCC repair tools operations and constraints.
• Perform RCC repairs (hands-on demonstrations).
• Perform procedures for IV tool assembly.
• Perform detailed EVA repair procedures with repair tools and materials.
• Perform post-EVA cleanup and tool stowage procedure.

57  EVA TPS REPAIR SKLS 31703

Title: EVA Thermal Protection System Repair Skills
Duration: 2.0 hours
Medium: Thermal Protection System Trainer
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): EVA TILE REPAIR 32703, EVA RCC REPAIR 31703
Preparation: None

Synopsis: This lesson reviews the skills required to enact Thermal Protection System (TPS) repairs. Hands-on procedures and techniques practice is the focus of the lesson.

Objectives:
• Review detailed EVA procedures, tools, and techniques for Reinforced Carbon-Carbon (RCC) repair.
• Review detailed EVA procedures, tools, and techniques for tile repair.
EVA Task Operations Lesson Descriptions

40000-Level Lessons (Proficiency, Refresher)

**CONT OPS 41001**

Title: Contingency Operations  
Duration: 2.0 hours  
Medium: Classroom (at NBL)  
Student: EV1, EV2, *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): CONT OPS 21002  
Preparation: None

Synopsis: This lesson provides an overview to the baseline EVA shuttle support equipment. The class will familiarize the students with the EVA equipment and the procedures to operate them. EVA NBL training tools and slides of the interfaces are used during this classroom session. Students will receive some hands-on application of the tools to orbiter interfaces at 42B mockup in the high bay.

Objectives:  
- Identify/describe the nominal and contingency Shuttle EVA support equipment.  
- Describe the purpose and stowage locations of Shuttle EVA tools.  
- Operate all of the Shuttle EVA tools.  
- Review hardware locations and tasks associated with Shuttle EVA(s).

**ISS EVA SMALL TOOLS 41001**

Title: ISS Extravehicular Activity Small Tools Refresher (Shared – ISS)  
Duration: 2.0 hours  
Medium: Classroom (at NBL)  
Student: EV1, EV2, *Task IV*  
Source: DX32  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: EVA tools and equipment  
Prerequisite Lesson(s): None  
Preparation: None
EVA Task Operations Lesson Descriptions

ISS EVA SMALL TOOLS 41001 (Concluded)

Synopsis: This lesson provides the student a refresher of the EVA tools used during ISS EVA operations. The student will get hands-on application of the EVA hardware.

Objectives: Become familiar with the operations of EVA tools, including any operational constraints.

EVA REVIEW 1G 41001

Title: Extravehicular Activity Review 1G (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom (NBL, Mockup South)
Student: EV1, EV2
Source: DX32
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): ISS EVA MAINT 21027 (completed ASCAN flow)
Preparation: None

Synopsis: This lesson provides the student with a detailed knowledge of EVA skills/tasks. The student performs EVA skills procedures using mockups and EVA hardware.

Objectives:
• Become familiar with EVA skills/tasks.
• Become familiar with EVA hardware specific to these tasks.

EVA REVIEW 41027

Title: Extravehicular Activity Review (Shared – STS)
Duration: 9.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2
Source: DX32
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EMUs, EVA tools and equipment
Preparation: None

Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)
EVA Task Operations Lesson Descriptions

EVA REVIEW 41027 (Concluded)

This lesson provides proficiency/skills-based training for EVA crewmembers who have completed the generic EVA training flow. The students will revisit general EVA operations required to perform contingency tasks in the payload bay. (This lesson is intended to have minimum impact on other NBL operations.)

Objectives: Perform tasks that will develop the student’s EVA skills.

EVA SCUBA 41027

Title: Extravehicular Activity SCUBA
Duration: 4.0 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Swimming suit, EVA tools and equipment
Prerequisite Lesson(s): ISS EVA SMALL TOOLS 21001
Preparation: None

Synopsis: This lesson will provide the students with proficiency and exposure to Shuttle/Station EVAs prior to their upcoming suited runs. This class includes a pre-brief, 2 hours on SCUBA, and debrief while waiting for the 1-hour medical observation period to pass. The student will regain general Shuttle EVA knowledge and EVA skills, such as translation and foot restraint operations while being exposed to Shuttle and Station. It is highly recommended that the instructor use Surface Supplied Diving System (SSDS) to communicate with the students and the utility divers.

Objectives:
- Review Shuttle coordinate system.
- Practice various translation techniques.
- Review Shuttle A/L operations.
- Translate to a few contingency worksites and on Station.
- Review Station coordinate system.
- While swimming, point out all the Station trusses and elements.
- Review Station A/L.
EVA Task Operations Lesson Descriptions

EVA OPS 1G 41001
Title: Extravehicular Activity Operations 1G (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom (NBL/MU-S (NBL poolside, Mockup South))
Student: EV1, EV2, Task IV
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EVA tools and equipment
Prerequisite Lesson(s): EVAX 91027
Preparation: None
Synopsis: This lesson provides the student a refresher of mission-specific tasks. The crew performs mission-specific procedures using mockups and EVA hardware.
Objectives:
• Refresh knowledge of mission-specific tasks.
• Refresh knowledge of mission-specific EVA hardware.

EVA HDW/PRF 41027
Title: Extravehicular Activity Hardware/Proficiency Evaluations
Duration: 9.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, Task IV, Suit IV (optional)
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): EVA OPS 1G 41001
Preparation: None
Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)

This lesson is used for hardware development/evaluations and procedures validation (both mission-specific and other programs). EVA proficiency may also be satisfied within this lesson.
Objectives:
• Evaluate/develop payload EVA hardware designs/concepts.
• Validate EVA procedures.
• Remain proficient in EVA tasks.
EVA Task Operations Lesson Descriptions

P/L PRF ADV 41027
Title: Payload Extravehicular Activity Proficiency
Duration: 9.5 hours
Medium: Neutral Buoyancy Lab
Student: EV1, EV2, *Task IV, Suit IV (optional)*
Source: DX32
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: EMUs, EVA tools and equipment
Prerequisite Lesson(s): P/L EVA 1G 31001
Preparation: None

Synopsis: This lesson begins with the 1G portion which includes physical, prebrief, Extravehicular Mobility Unit (EMU) donning, EMU doffing, and ends with the lesson debrief, after the NBL session. (The student must remain at the NBL one hour post-run for NBL safety/medical requirements.)

In this lesson, EVA crewmembers perform unscheduled contingency or scheduled end-to-end payload flight-related EVA tasks. This lesson is used specifically for launch slip proficiency and/or crew/instructor requested runs. Objectives of other lessons may be covered to ensure that crewmembers maintain proficiency in payload EVA tasks. If time permits, any of the orbiter contingency EVA tasks may be covered.

Objectives: Perform mission-specific EVA procedures.

EVA MASS OPS 41016
Refer to ISS EVA MASS OPS 91016 in Crew Training Catalog.

EVA FLUID QD OPS 41197
(Shared – ISS)
Refer to EVA FLUID QD OPS 31197 in Crew Training Catalog.
EVA Task Operations Lesson Descriptions

EVA PGT/TM 41001

(Shared – ISS)

Refer to EVA PGT/TM 31001 in Crew Training Catalog.

ISS EVA TOOL CONFIG 41105

(Shared – Shuttle)

Refer to ISS EVA TOOL CONFIG 31105 in Crew Training Catalog.
SECTION 9.0 PAYLOAD DEPLOYMENT AND RETRIEVAL SYSTEM TRAINING COURSE

The PDRS Training Course presents the training required to prepare future RMS operators for a flight. The basic philosophy of the PDRS curriculum uses a spiral learning curve, which allows knowledge application to begin at the earliest levels of learning and to continue through increasingly complex topics and skills.

The PDRS training course teaches not only system functions and processes, but also techniques and the skill to use them. “Flying the arm” is not a procedure, but a skill analogous to flying the orbiter. As such, it requires development and practice. It is furthermore payload- and task-specific; techniques learned in early training will be applied differently to different payloads and payload bay configurations.

Since PDRS operators need to develop and refine the skill of flying the arm, the generic (20000-level) lessons have been developed to provide formal qualification status for each operator. This process guarantees that all operators who achieve qualification are competent RMS operators, and should be able to handle any flight-specific RMS tasks. If lesson objectives are not completed then the lesson will be repeated. The qualification lessons are intended to pull the various skills together at one time and identify those areas in which the student excels or may need improvement.

The generic (20000) PDRS Orbiter Boom Sensor System (OBSS) lessons provide an introduction to OBSS survey skills and concepts. The generic OBSS classes may be taken as part of the generic PDRS flow or separately if the student has already completed the generic PDRS flow.

Following qualification and crew assignment, each RMS operator will go through assigned crew (30000-level) and load specific (90000-level) lessons. The concepts taught at each level of learning are listed below:

Generic Training (20000-level)
- PDRS Basics
- PDRS Unloaded Nominal Operations
- PDRS Loaded Nominal Operations
- PDRS Single Joint Operations
- PDRS Advanced Operations
- Formal Qualification
- Generic Operational Proficiency
- Generic OBSS

Assigned Crew Training (30000-level)
- Orbiter/RMS Interfaces
- PDRS Neutral Buoyancy Lab (NBL) Familiarization
Load-specific Assigned Crew Training (90000-level)

- PDRS Nominal Operations
- PDRS Nominal Operations, Single Joint Arm
- PDRS Contingency Operations
- PDRS Contingency Operations, Single Joint Arm (if applicable)
- PDRS Malfunction Response and Workaround
- Load-specific Operational Proficiency

Once a 20000-level qualified student is scheduled for generic simulation (sim) support, a familiarization is required unless qualification was achieved in the last six months and the student is familiar with the generic timeline. Requalification for flight assignment must be achieved prior to the start of 30000-level training. However, students may schedule refresher lessons at any time and are encouraged to do so.

Although RMS operations are unique to each particular flight, the skills necessary to perform a task are universal. Skills are applied to mission-unique operations. There are nine basic descriptions under which RMS operations may fall: Contingency-only unloaded RMS operations, Unloaded RMS operations, Loaded RMS operations, Deployment RMS operations, Retrieval RMS operations, Deployment and Retrieval RMS operations, Station Build RMS operations, RMS/EVA operations, and RMS/OBSS operations. The load-specific flow is therefore divided into nine branches. Each class will be designated with a branch-specific lesson code. The planned RMS operations for each flight will determine which branch of the flow will be required. Each RMS flight could also have more than one RMS payload or more than one set of operations. This would then require use of multiple branches or portions of multiple branches of the flow for flight training. For a Station Build mission, the Station Build RMS operations branch will be required for each station element. Additionally, several lessons, as noted in this branch, will be required for each task performed. Lastly, if the mission requires RMS/EVA operations, the RMS/EVA operations branch will be required for each EVA day. The PDRS training flow supervisor will be responsible for determining which flows are applicable for each flight, as well as defining the element and task definitions for Station Build flights. In addition, an Instructor Astronaut (IA) will be invited to observe at least one lesson during each flow.

RMS is unique in that a 2-person team will usually conduct all RMS operations. For flight planning, these operators will be designated as R1 and R2. The operator actually designated to manipulate the arm for each task will be selected after the flight assignment is made. The same arm operator does not have to be the arm manipulator for all tasks.

Some of the ORB SKL lessons have the provision to run in a combined Fixed Base (FB)/NBL environment. The flight-assigned RMS and EVA instructors will determine whether this configuration is required.
There are 4 main facilities used for hands-on RMS training: Shuttle Engineering Simulator (SES), DST, Virtual Reality Trainer (VR LAB), and SMS. The SES has a high-fidelity visual simulation plus a dynamic model of the arm, and is therefore the facility used to actually train techniques, procedures, and arm/payload responses. It can also simulate a limited number of malfunctions. There is also a part-task trainer, the DST, that is utilized during training. The DST is a high-fidelity visual simulator with a dynamic model of the arm. The VR LAB is similar to the DST but has the additional capability to use virtual reality to help train for EVA. The SMS has only a rigid dynamic arm (booms are not flexible, but rigid members; servo loop dynamics are correctly modeled). However, it does allow the full range of RMS operations, malfunctions, orbiter interfaces, and most importantly, operator coordination. Each facility is used to its maximum potential in the flow.

During training, the PDRS flow will address all PDRS criticality 1/1 and criticality 2/1R Failure Mode and Effects Analysis (FMEA) categories for which training is listed as acceptance rationale. Training cannot be used as real-time safety rationale for contingency situations not covered during training. Also, PDRS flight rules will be addressed during training.

A one-hour robotics aptitude assessment, including a pre-brief and video explaining the tasks to be performed, have been added to the beginning of the PDRS 20000-level flow. The assessment is designed to provide insight into robotic aptitude for astronaut interviewees and is currently in the verification stage. Scores from the assessment will be compared to qualification scores at the outcome of the PDRS flow to determine if a direct correlation can be drawn. The aptitude assessment, pre-brief, and video are only required once per student and if they were completed in the student’s interview process, they are not required prior to entering into the 20000-level PDRS flow.
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 1 of 13)
Figure 9-1. PDRS Operations Lesson Flow Chart
(Sheet 2 of 13)
Figure 9-1. PDRS Operations Lesson Flow Chart
(Sheet 3 of 13)
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 4 of 13)
Contingency-only Unloaded
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 5 of 13)
Unloaded
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 6 of 13)
Loaded
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 7 of 13)
Deploy
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 8 of 13)
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 9 of 13)
Deploy and Retrieve
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 10 of 13)
Station Build

* One lesson per task
** One lesson per element
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 11 of 13) RMS/EVA
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 12 of 13)
RMS/OBSS
Figure 9-1. PDRS Operations Lesson Flow Chart (Sheet 13 of 13)
RMS/ORM
Table 9-1. Payload Deployment and Retrieval System
Crew Training Requirements

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Includes EV1, EV2. Schedule this lesson with EVA BOOM OPS TBD lesson

Sub Total for Stage: 14
Stage Totals Per Crewmember: 7

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Sub Total for Stage: 14
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Date Last Modified: 06/08
## Table 9-1. Payload Deployment and Retrieval System
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Table 9-1. Payload Deployment and Retrieval System
Crew Training Requirements (Continued)

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|-------|---------|-------------|-------|-----|------------|---|---|-----|-----|-----|-----|-----|----|----|-----|-----|---------|-----------|
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| 0     | 20      | PDRS SJ LD3 21069 | SEDS 2 | 2   | 1          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 21      | PDRS SJ RVW 21069 | SEDS 2 | 2   | 1          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 22      | PDRS SJ TSK 21069 | SEDS 2.5 | 1   | 2.5       | 2.5 | 2.5 |     |     |     | 2   |     |     |     | 2   |     | Schedule Robotics IA for session |
| 0     | 23      | PDRS ADV SRG 21002 | W BK 1 | 1   | 1          | 1 | 1 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 24      | PDRS H/W SYS 21001 | CLR 2 | 2   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 25      | PDRS S/W SYS 21001 | CLR 1 | 2   | 1          | 1 | 1 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 26      | PDRS MAL OPS 21001 | CLR 2 | 2   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 27      | PDRS MAL 2 21012 | FB 4 | 2   | 4          | 4 | 4 |     |     |     | 4   |     |     |     | 4   |     | GNS Schedule Robotics IA for session |
| 0     | 28      | PDRS MAL2 21012 | FB 4 | 2   | 4          | 4 | 4 |     |     |     | 4   |     |     |     | 4   |     | GNS Schedule Robotics IA for session |
| 0     | 29      | PDRS EVA OPS 22016 | VR LAB 2 | 1   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 30      | PDRS RVW 21069 | SEDS 2 | 1   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 31      | PDRS QUAL 21069 | SEDS 3.5 | 1   | 3.5       | 3.5 | 3.5 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 32      | PDRS QUAL2 21069 | SEDS 4 | 1   | 4          | 4 | 4 |     |     |     | 4   |     |     |     | 4   |     | Schedule Robotics IA for session |
| 0     | 33      | PDRS EVAL 21069 | SEDS 3 | 1   | 3          | 3 | 3 |     |     |     | 3   |     |     |     | 3   |     | Schedule Robotics IA for session |
| 0     | 34      | PDRS FLT QL 1 31069 | SEDS 3 | 1   | 3          | 3 | 3 |     |     |     | 3   |     |     |     | 3   |     | As required | Schedule Robotics IA for session |
| 0     | 35      | PDRS FLT QL 2 31069 | SEDS 3 | 1   | 3          | 3 | 3 |     |     |     | 3   |     |     |     | 3   |     | As required | Schedule Robotics IA for session |
| 0     | 36      | PDRS OBSS INTRO 21025 | DST 3 | 3   | 3          | 3 | 3 |     |     |     | 3   |     |     |     | 3   |     | DST 2,3,4,5 |
| 0     | 37      | PDRS OBSS SURVEY 21069 | SEDS 3 | 2   | 3          | 3 | 3 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 38      | PDRS OBSS SURVEY 22069 | SEDS 3 | 2   | 3          | 3 | 3 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 39      | PDRS OBSS SURVEY 23069 | SEDS 3 | 2   | 3          | 3 | 3 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 40      | PDRS UNDK SJ OBSS 21069 | SEDS 2 | 2   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
| 0     | 41      | PDRS LD OPS 91069 | SEDS 2 | 1   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
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| 0     | 43      | PDRS LD INT 91012 | FB 3 | 3   | 3          | 3 | 3 |     |     |     | 3   |     |     |     | 3   |     | GNS         |            |
| 0     | 44      | PDRS LD SJ 91069 | SEDS 2 | 2   | 2          | 2 | 2 |     |     |     | 2   |     |     |     | 2   |     |         |            |
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Table 9-1. Payload Deployment and Retrieval System
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**Sub Total for Stage:** 237  
**Stage Totals Per Crewmember:** 237 237 0 0 7 237 0 237 0 0 0
PDRS Lesson Descriptions

1  ROBOTICS APT 21025

Title: Robotics Aptitude Assessment
Duration: 1.0 hour
Medium: Dynamic Skills Trainer 1
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 03/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: Read 14 page Robotic Aptitude Assessment pre-brief and view 22 minute video obtained from Astronaut Scheduling Office.

Synopsis: This session will assess the aptitude a student has for robotics. The lesson is in the validation stage and the scores will be compared to the qualification scores attained at the end of the robotics training flows to determine if a direct correlation can be made.

Objectives: Demonstrate the robotic skill basics.

1A  PDRS NOM SRG 21002

Title: Payload Deployment and Retrieval System Nominal Student Reference Guide
Duration: 1.0 hour
Medium: Workbook (PDRS Student Reference Guide)
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS OV 21002
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This document contains information on PDRS systems and operations. The Nominal section introduces the student to the PDRS displays and controls, operating modes, and operating constraints.

Objectives:
• Comprehend the displays and controls associated with PDRS operations.
• Comprehend the PDRS operating modes.
• Comprehend the PDRS operating constraints.
PDRS Lesson Descriptions

2 PDRS INTRO 21001
Title: Payload Deployment and Retrieval System Introduction
Duration: 2.0 hours
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS NOM SRG 21002
Preparation: None

Synopsis: This lesson contains an overview of the PDRS training flow, training facilities, and FDF. The lesson also introduces the PDRS displays and controls including PDRS-related SPECs and Panel A8.

Objectives:
• Know the scope and purpose of the PDRS 20000 level flow.
• Identify RMS training facilities capabilities and constraints.
• Know the FDF, reference documentation, and resources associated with RMS operations.
• Know the role of displays and controls associated with PDRS operations.
• Identify the generic PDRS procedures.
• Comprehend the Task Standards and Evaluation Criteria for the PDRS flow.

3A PDRS BASICS 21001
Title: Payload Deployment and Retrieval System Basics
Duration: 0.5 hours
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS UNL OPS 21001
Equipment Required: None
Prerequisite Lesson(s): PDRS INTRO 21001
Preparation: None

Synopsis: The student will learn the coordinate frames and the use of Euler Sequences. Correct hand controller techniques will be introduced. The grapple target will also be explained.
PDRS Lesson Descriptions

3A  **PDRS BASICS 21001 (Concluded)**

Objectives:  
- Comprehend the coordinate systems used in RMS Operations.  
- Comprehend the RMS unloaded operating modes.  
- Comprehend the available cameras to support tasks.  
- Comprehend correct Hand Controller (HC) techniques.  
- Comprehend the skills associated with grapple fixture target alignment.

3B  **PDRS BASICS 21172**

Title:  Payload Deployment and Retrieval System Basics  
Duration:  2.0 hours  
Medium:  Dynamic Skills Trainer 3 or DST 1, 2, 4 or 5  
Student:  R1, R2 (Schedule individually.)  
Source:  DX25/Robotics Shuttle Training  
Date:  09/03  
Lesson(s) Replaced:  PDRS BASICS 21025, PDRS UNL OPS 21024  
Equipment Required:  None  
Prerequisite Lesson(s):  PDRS BASICS 21001  
Preparation:  None  

Synopsis:  The student will be shown the operation of the DST by an instructor. The student will also demonstrate knowledge and utilization of RMS coordinate systems and modes. The student will practice good hand controller techniques and understand how to read a grapple target.

Objectives:  
- Demonstrate DST facility operations.  
- Comprehend the coordinate systems used in RMS Operations.  
- Demonstrate the skills associated with maneuvering an unloaded RMS.  
- Demonstrate the proper use of camera views to support tasks.  
- Demonstrate correct hand controller techniques.  
- Demonstrate the skills associated with grapple fixture target alignment.

4A  **PDRS GRP SKL 21001**

Title:  Payload Deployment and Retrieval System Grapple Skills  
Duration:  0.5 hours  
Medium:  Classroom  
Student:  R1, R2  
Source:  DX25/Robotics Shuttle Training  
Date:  09/03  
Lesson(s) Replaced:  PDRS UNL OPS 21001  
Equipment Required:  None  
Prerequisite Lesson(s):  PDRS BASICS 21172  
Preparation:  None
PDRS Lesson Descriptions

4A   PDRS GRP SKL 21001 (Concluded)

Synopsis: The student will learn the correct use of the grapple target overlay. The student will learn End Effector (EE) operations and hardware limitations.

Objectives: • Comprehend correct use of the Grapple Target Overlay.
             • Comprehend EE Operations.
             • Comprehend the correct response to a missed grapple (constrained).
             • Comprehend the cues corresponding with the grapple envelope.

4B   PDRS GRP SKL 21172

Title: Payload Deployment and Retrieval System Grapple Skills
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 3 or DST 1, 2, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS UNL OPS 21024, PDRS D&C MAL 21024
Equipment Required: None
Prerequisite Lesson(s): PDRS GRP SKL 21001
Preparation: None

Synopsis: The student will practice grapple approaches with varying alignment and demonstrate understanding of grapple target errors and End Effector (EE) operations.

Objectives: • Demonstrate the skills associated with maneuvering an unloaded RMS.
             • Demonstrate the proper use of camera views to support tasks.
             • Demonstrate the skills associated with grapple target alignment.
             • Perform payload grapple and ungrapple.
             • Demonstrate proper use of grapple target overlay.
             • Demonstrate skills associated with alternate mode grapple approaches.
             • Demonstrate skills associated with No EE camera grapple approaches.
PDRS Lesson Descriptions

5A  PDRS UL OPS 21001

Title: Payload Deployment and Retrieval System Unloaded Operations
Duration: 1.0 hour
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS UNL OPS 21001, PDRS LD OPS 21001
Equipment Required: None
Prerequisite Lesson(s): PDRS GRP SKL 21172
Preparation: None

Synopsis: This prebrief will provide a discussion of the material to be covered in the associated lesson. The material includes arm capabilities and constraints and Auto modes. Space Flight Resource Management (SFRM) as it pertains to arm operations will also be discussed.

Objectives:
• Comprehend singularities and reach limits of RMS.
• Comprehend the function of Position Orientation Hold Submode (POHS) in RMS Ops.
• Comprehend the use of Relative (REL) Display Mode in RMS Ops.
• Comprehend SFRM techniques associated with RMS tasks.
• Comprehend the correct response to a missed grapple (free flyer).

5B  PDRS UL OPS 21172

Title: Payload Deployment and Retrieval System Unloaded Operations 1
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 3 or DST 1, 2, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS NOM TSK 21024, PDRS UNL OPS 21024
Equipment Required: None
Prerequisite Lesson(s): PDRS UL OPS 21001
Preparation: None

Synopsis: The student will practice avoiding Reach Limits and singularities while maneuvering the RMS and learn how to get out of singularities. Auto modes, rate hold, and relative coordinates will also be covered.
PDRS Lesson Descriptions

5B  PDRS UL OPS1 21172 (Concluded)

Objectives:
• Demonstrate skills associated with unloaded RMS operations.
• Demonstrate the skills associated with performing an Operator
  Commanded Auto Sequence (OCAS) and Automatically Commanded
  Auto Sequence (ACAS).
• Comprehend RMS Singularity Regions.
• Demonstrate avoidance of Reach Limits and Singularities.
• Demonstrate skills associated with using Relative (REL) Display Mode.
• Demonstrate skills associated with using Rate Hold.

6  PDRS TOOLS 21025

Title: Payload Deployment and Retrieval System Tools
Duration: 1.0 hour
Medium: Dynamic Skills Trainer 1
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: Payload General Support Computer (PGSC)
Prerequisite Lesson(s): PDRS UL OPS1 21172
Preparation: None

Synopsis: The student will learn the software tools used with the RMS.

Objectives:
• Comprehend the use of RMS Software Tools.
• Demonstrate proper use of RMS Software Tools.

7  PDRS UL OPS2 21069

Title: Payload Deployment and Retrieval System Unloaded Operations 2
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS UNL OPS 21024, PDRS LD OPS 21024,
  PDRS LD SKL 21069
Equipment Required: Payload General Support Computer (PGSC)
Prerequisite Lesson(s): PDRS TOOLS 21025
Preparation: None
PDRS Lesson Descriptions

7  PDRS UL OPS2 21069 (Concluded)

Synopsis: The student will demonstrate skills associated with maneuvering the RMS using RMS tools. Grapple approaches and capture/release skills associated with Free Flyer are also practiced.

Objectives: • Demonstrate skills associated with unloaded RMS operations.
• Perform translations and rotations simultaneously while using correct hand controller techniques.
• Demonstrate the skills associated with grapple target alignment.
• Perform payload grapple and ungrapple.
• Perform Space Flight Resource Management (SFRM) techniques associated with unloaded RMS tasks.
• Demonstrate the skills associated with payload release.
• Demonstrate the skills associated with payload track and capture.

8A  PDRS LD OPS 21001

Title: Payload Deployment and Retrieval System Loaded Operations
Duration: 1.0 hour
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS UL OPS2 21069
Preparation: None

Synopsis: The student will learn about various loaded modes and associated information, including Payload (PL) Identification (ID) and mass effects. Unberthing/berthing targets will also be discussed. The End Effector (EE) Cue Card is covered as it applies to loaded operations.

Objectives: • Comprehend the RMS loaded operating modes.
• Comprehend how alignment aids are utilized for RMS operations.
• Comprehend Keel and Mirror target cues.
• Comprehend the use of digital readouts with respect to mode and PL ID.
PDRS Lesson Descriptions

8B PDRS LD OPS1 21172

Title: Payload Deployment and Retrieval System Loaded Operations 1
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 3 or DST 1, 2, 4, or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS LD OPS 21024, PDRS LD SKL 21069
Equipment Required: None
Prerequisite Lesson(s): PDRS LD OPS 21001
Preparation: None

Synopsis: The student will perform payload unberthing and berthing using the Mirror and Keel targets.

Objectives:
- Demonstrate skills associated with maneuvering in Loaded RMS modes.
- Demonstrate the skills associated with payload berthing and unberthing.
- Demonstrate the skills associated with Keel and Mirror target alignment.

9 PDRS LD OPS2 21069

Title: Payload Deployment and Retrieval System Loaded Operations 2
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS LD OPS 21024, PDRS LD SKL 21069
Equipment Required: Payload General Support Computer (PGSC)
Prerequisite Lesson(s): PDRS LD OPS 21172
Preparation: None

Synopsis: The student will perform unberth and berth operations. Loaded RMS maneuvering skills are demonstrated.

Objectives:
- Demonstrate Space Flight Resource Management (SFRM) techniques associated with loaded RMS tasks.
- Demonstrate the skills associated with payload grapple, unberth, and berth.
- Demonstrate the skills associated with payload maneuvering.
PDRS Lesson Descriptions

10A  PDRS MODES 21001
Title: Payload Deployment and Retrieval System Modes
Duration: 0.5 hours
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS LD OPS2 21069
Preparation: None

Synopsis: The lesson reviews the relationship between Mode, Payload (PL) Identification (ID), and digital displays. The concepts of Fly-Camera and Fly-Payload modes are introduced as well as the strategies and techniques involved in Keel and Mirror target alignment.

Objectives:
• Comprehend the relationship between Mode, PL ID, and digitals.
• Comprehend the concepts of Fly-Camera and Fly-Payload modes.
• Comprehend strategies and techniques involved in Keel/Mirror target alignment.
• Comprehend Space Flight Resource Management (SFRM) techniques associated with Fly-Camera and Fly-Payload.
• Comprehend the use of Relative (REL) Display Mode with Fly Camera and Fly-Payload modes.

10B  PDRS MODES 21069
Title: Payload Deployment and Retrieval System Modes
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS MODES 21001
Preparation: None

Synopsis: The student will unberth and berth payloads in Fly-Camera and Fly Payload modes using the Mirror and Keel targets and Relative (REL) Display Mode.
PDRS Lesson Descriptions

10B  **PDRS MODES 21069 (Concluded)**

Objectives:
- Demonstrate strategies and techniques involved in Keel and Mirror target alignment.
- Demonstrate Space Flight Resource Management (SFRM) techniques associated with Fly-Camera and Fly-Payload.
- Demonstrate the use of REL.
- Demonstrate skills associated with payload unberth/berth using Fly-Camera and Fly-Payload modes.

11A  **PDRS EVA OPS 21001**

**Title:** Payload Deployment and Retrieval System Extravehicular Activity Operations

**Duration:** 0.5 hours

**Medium:** Classroom

**Student:** R1, R2

**Source:** DX25/Robotics Shuttle Training

**Date:** 09/03

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** PDRS LD OPS2 21069

**Preparation:** None

**Synopsis:** The lesson introduces the hardware associated with RMS/EVA operations. RMS-to-EVA interaction will be discussed, including voice protocol between the RMS operator and the EVA crewmember on the arm.

**Objectives:**
- Comprehend RMS EVA Voice Protocol.
- Identify the hardware associated with RMS EVA operations.
- Comprehend the use of digital readouts, Payload (PL) Identification (ID), and operating modes for EVA operations.
- Comprehend Space Flight Resource Management (SFRM) techniques associated with RMS EVA operations.
PDRS Lesson Descriptions

11B  PDRS EVA OPS 21016
Title: Payload Deployment and Retrieval System Extravehicular Activity Operations
Duration: 2.0 hours
Medium: Virtual Reality Trainer
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: Payload General Support Computer (PGSC)
Prerequisite Lesson(s): PDRS EVA OPS 21001
Preparation: None

Synopsis: This lesson will introduce the student to the Virtual Reality (VR) Lab. The student will perform RMS EVA operations and tasks. There is an emphasis on communication between the RMS operator and EVA crewmembers.

Objectives:
• Demonstrate correct RMS/EVA Voice Protocol.
• Demonstrate mode optimization during RMS/EVA maneuvers.
• Demonstrate use of cameras to constantly view EVA crewmember.
• Demonstrate awareness of joint reach limits during RMS EVA operations.

12  PDRS NOM RVW 21069
Title: Payload Deployment and Retrieval System Nominal Review
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS EVA OPS 21016, PDRS MODES 21069
Preparation: None

Synopsis: The student will practice tasks to prepare for the PDRS NOM TSK class.

Objectives:
• Demonstrate skills associated with nominal unloaded and loaded RMS operations.
• Demonstrate skills associated with Free Flyer Release and Capture.
• Demonstrate skills associated with Space Flight Resource Management (SFRM).
PDRS Lesson Descriptions

13 PDRS NOM TSK 21069

Title: Payload Deployment and Retrieval System Nominal Task
Duration: 2.5 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS NOM TSK 21024
Equipment Required: Instructor Astronaut (IA), Payload General Support Computer (PGSC)
Prerequisite Lesson(s): PDRS NOM RVW 21069
Preparation: None

Synopsis: The student will perform nominal RMS tasks. A PDRS Checklist (C/L) and RMS software tools will be available. This includes loaded/unloaded operations, End Effector (EE) operations, Free Flyer Track and Capture/Release, and Fly-Camera/Fly-Payload operations. An Instructor Astronaut (IA) will observe this class and provide oral and written feedback of the student’s progress.

Objectives:
• Demonstrate skills associated with Payload grapple, unberth, and maneuvering.
• Demonstrate skills associated with Free Flyer Release and Capture.
• Demonstrate skills associated with Space Flight Resource Management (SFRM).

14 PDRS SJ SRG 21002

Title: Payload Deployment and Retrieval System Single Joint Student Reference Guide
Duration: 1.0 hour
Medium: Workbook (PDRS Student Reference Guide)
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS OV 21002
Equipment Required: None
Prerequisite Lesson(s): PDRS NOM TSK 21069
Preparation: None
PDRS Lesson Descriptions

14  **PDRS SJ SRG 21002 (Concluded)**

Synopsis: This document will compare and contrast the three Single Joint operating modes of the PDRS. The Single Joint section of this document will introduce the student to Single Joint operating techniques and strategies.

Objectives:  
- Comprehend the three Single Joint PDRS modes.  
- Comprehend the strategies for Single Joint PDRS operations.

15A  **PDRS SJ UL 21001**

Title: Payload Deployment and Retrieval System Single Joint Unloaded  
Duration: 0.5 hours  
Medium: Classroom  
Student: R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: PDRS SJ UNL 21001  
Equipment Required: None  
Prerequisite Lesson(s): PDRS NOM TSK 21069, PDRS SJ SRG 21002  
Preparation: None

Synopsis: This lesson is a discussion of single joint strategies and techniques. This includes unloaded maneuvering and capture/release of a free flyer.

Objectives:  
- Comprehend visualization techniques associated with unloaded Single Joint (SJ) operations.  
- Comprehend strategies and operational techniques involved in unloaded SJ operations.  
- Comprehend strategies and operational techniques as applied to unloaded SJ dynamics.

15B  **PDRS SJ UL1 21173**

Title: Payload Deployment and Retrieval System Single Joint Unloaded 1  
Duration: 2.0 hours  
Medium: Dynamic Skills Trainer 4  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: PDRS SJ UNL 21024, PDRS SJ SKL 21069  
Equipment Required: None  
Prerequisite Lesson(s): PDRS SJ UL 21001  
Preparation: None
PDRS Lesson Descriptions

15B  PDRS SJ UL1 21173 (Concluded)

Synopsis: The student will perform single joint unloaded maneuvering, including grapple approaches with and without digitals.

Objectives: • Demonstrate visualization techniques associated with unloaded single joint operations.
• Demonstrate strategies and operational techniques involved in unloaded single joint operations.
• Demonstrate strategies and operational techniques as applied to unloaded single joint dynamics.

16  PDRS SJ UL2 21173

Title: Payload Deployment and Retrieval System Single Joint Unloaded 2
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 4
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS SJ UNL 21024, PDRS SJ SKL 21069
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ UL1 21173
Preparation: None

Synopsis: The student will perform grapple approaches in both single and direct mode.

Objectives: • Demonstrate visualization techniques associated with unloaded single joint operations.
• Demonstrate strategies and operational techniques involved in unloaded single joint operations.
• Demonstrate strategies and operational techniques as applied to unloaded single joint dynamics.
PDRS Lesson Descriptions

17 PDRS SJ UL3 21069

Title: Payload Deployment and Retrieval System Single Joint Unloaded 3
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS SJ UNL 21024, PDRS SJ SKL 21069
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ UL2 21173
Preparation: None

Synopsis: The student will practice cradling/uncradling the RMS in primary and backup modes. Track and captures will also be performed.

Objectives:
• Demonstrate skills associated with single joint unloaded operations in Single and Direct modes.
• Demonstrate skills associated with unloaded single joint dynamics.

18A PDRS SJ LD 21001

Title: Payload Deployment and Retrieval System Single Joint Loaded
Duration: 0.5 hours
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 11/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ UL3 21069
Preparation: None

Synopsis: This discussion will introduce arm dynamics associated with loaded single joint RMS operations. The student will be introduced to methods of minimizing and counteracting arm oscillations.

Objectives:
• Comprehend visualization techniques associated with loaded single joint operations.
• Comprehend strategies and operational techniques involved in loaded single joint operations.
• Comprehend strategies and techniques as applied to loaded single joint dynamics.
PDRS Lesson Descriptions

18B PDRS SJ LD1 21173
Title: Payload Deployment and Retrieval System Single Joint Loaded 1
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 4
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS SJ LD 21024, PDRS SJ SKL 22069
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ LD 21001
Preparation: None
Synopsis: The student will perform single joint unberth and berth of a payload with
digitals.
Objectives:
• Demonstrate skills associated with loaded single joint operations in
  single and direct modes.
• Demonstrate skills associated with loaded single joint dynamics.

19 PDRS SJ LD2 21173
Title: Payload Deployment and Retrieval System Single Joint Loaded 2
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 4
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS SJ LD 21024, PDRS SJ SKL 22069
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ LD1 21173
Preparation: None
Synopsis: The student will perform single joint unberth and berth of a payload with
and without digitals.
Objectives:
• Demonstrate visualization techniques associated with loaded single
  joint operations.
• Demonstrate strategies and operational techniques involved in loaded
  single joint operations.
• Demonstrate strategies and operational techniques as applied to
  loaded single joint dynamics.
PDRS Lesson Descriptions

20 PDRS SJ LD3 21069

Title: Payload Deployment and Retrieval System Single Joint Loaded 3
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS SJ LD 21024, PDRS SJ SKL 22069
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ LD2 21173
Preparation: None

Synopsis: The student will perform single joint unberth and berth of a payload with and without digital.

Objectives:
• Demonstrate visualization techniques associated with loaded single joint operations.
• Demonstrate strategies and operational techniques involved in loaded single joint operations.
• Demonstrate strategies and operational techniques as applied to loaded single joint dynamics.

21 PDRS SJ RVW 21069

Title: Payload Deployment and Retrieval System Single Joint Review
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS SJ LD3 21069
Preparation: None

Synopsis: The student will practice tasks to prepare for PDRS SJ TSK.

Objectives:
• Demonstrate the skills associated with Single Joint (SJ) payload grapple and unberth/berth.
• Demonstrate Space Flight Resource Management (SFRM).
22  **PDRS SJ TSK 21069**

Title: Payload Deployment and Retrieval System Single Joint Task  
Duration: 2.5 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 11/04  
Lesson(s) Replaced: PDRS SJ TSK 21024  
Equipment Required: Instructor Astronaut (IA)  
Prerequisite Lesson(s): PDRS SJ RVW 21069  
Preparation: None

Synopsis: The student will perform tasks learned throughout Single Joint (SJ) Operations. This includes loaded/unloaded single joint operations and End Effector (EE) operations. An Instructor Astronaut (IA) will observe this class and provide oral and written feedback of the student’s progress.

Objectives:  
- Demonstrate the skills associated with SJ grapple.
- Demonstrate the skills associated with SJ payload unberth/berth.

23  **PDRS ADV SRG 21002**

Title: Payload Deployment and Retrieval System Advanced Student Reference Guide  
Duration: 1.0 hour  
Medium: Workbook (PDRS Student Reference Guide)  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: PDRS OV 21002, PDRS MAL 21002  
Equipment Required: None  
Prerequisite Lesson(s): PDRS SJ TSK 21069  
Preparation: None

Synopsis: This document contains details of the PDRS hardware and software. The Advanced section of this document will also introduce the student to PDRS failures, malfunctions, and workarounds.

Objectives:  
- Comprehend the PDRS components.  
- Comprehend the PDRS power and data flows.  
- Comprehend PDRS failure indications, malfunctions, and workarounds.
PDRS Lesson Descriptions

24   PDRS H/W SYS 21001

Title:   Payload Deployment and Retrieval System Hardware Systems  
Duration: 2.0 hours  
Medium:   Classroom  
Student:   R1, R2  
Source:   DX25/Robotics Shuttle Training  
Date:   09/03  
Lesson(s) Replaced:   None  
Equipment Required:   None  
Prerequisite Lesson(s):   PDRS SJ TSK 21069, PDRS ADV SRG 21002  
Preparation:   None  

Synopsis: This lesson discusses PDRS hardware systems and components at an advanced level. The student is introduced to the hardware and malfunction signatures of possible component failures.

Objectives:

• Describe the PDRS components and command/data flow.
• Explain the command paths for manual augmented, single, direct, and backup modes.
• Know the redundancy level of Manipulator Positioning Mechanism (MPM) and Manipulator Retention Latch (MRL) components.
• Comprehend the operational impact due to the loss of RMS-related components.

25   PDRS S/W SYS 21001

Title:   Payload Deployment and Retrieval System Software Systems  
Duration: 1.0 hour  
Medium:   Classroom  
Student:   R1, R2  
Source:   DX25/Robotics Shuttle Training  
Date:   09/03  
Lesson(s) Replaced:   None  
Equipment Required:   None  
Prerequisite Lesson(s):   PDRS H/W SYS 21001  
Preparation:   None  

Synopsis: This lesson introduces the student to the RMS software. The software modes will be discussed along with system health checks and Fault Detection performed by the software.
PDRS Lesson Descriptions

25 PDRS S/W SYS 21001 (Concluded)

Objectives:
- Explain the functions of the RMS software.
- Describe the software checks utilized in the RMS software.
- Describe the Fault Detection in the RMS software.
- Explain the functions of the Manipulator Controller Interface Unit (MCIU) firmware.

26 PDRS MAL OPS 21001

Title: Payload Deployment and Retrieval System Malfunction Operations
Duration: 2.0 hours
Medium: Classroom
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS S/W SYS 21001
Preparation: None

Synopsis: This briefing will cover the End Effector (EE) Cue Card in detail. Malfunction response and workarounds are discussed including SPEC 95, EVA, In-Flight Maintenance (IFM), and jettison options.

Objectives:
- Comprehend how the EE cue card is utilized in RMS operations.
- Comprehend the skills and techniques associated with display and control failure workarounds.
- Explain how IFMs are used to regain RMS capabilities.
- Explain how EVA activities support RMS failure resolution.
- Comprehend RMS jettison operations.
- Comprehend RMS failure monitoring at a functional level.
PDRS Lesson Descriptions

27  PDRS MAL1 21012

Title:  Payload Deployment and Retrieval System Malfunction 1
Duration:  4.0 hours
Medium:  SMS-FB (GNS)
Student:  R1, R2
Source:  DX25/Robotics Shuttle Training
Date:  09/03
Lesson(s) Replaced:  PDRS MAL 21012, PDRS D&C MAL 21024
Equipment Required:  RMS D&C Kit from IFM locker
Prerequisite Lesson(s):  PDRS MAL OPS 21001
Preparation:  None

Synopsis:  This lesson will present various PDRS malfunction scenarios related to the Manipulator Positioning Mechanism (MPM), Hand Controller (HC), Display and Control (D&C) panel including the installation and use of the D&C Kit. Most malfunctions will be removed after the proper procedure is complete. SPEC 95 overrides will be used.

Objectives:
- Comprehend RMS failure impacts to the D&C, HC and RMS Joints, and MPMs.
- Demonstrate proficiency in correctly responding to system failures associated with the PDRS.
- Demonstrate skills and techniques associated with D&C, HC, RMS Joints, and MPM failure workarounds.
- Demonstrate the use of PDRS D&C In-Flight Maintenance (IFM) kit and associated FDF.
- Comprehend the rationale for the D&C kit checkout.
- Demonstrate skills associated with alternate grapple approaches (HC axis swap).
- Demonstrate skills associated with Space Flight Resource Management (SFRM).
- Perform RMS On-Orbit Init, RMS Powerup, and RMS Checkout.
PDRS Lesson Descriptions

28  PDRS MAL2 21012
Title:  Payload Deployment and Retrieval System Malfunction 2
Duration:  4.0 hours
Medium:  SMS-FB (GNS)
Student:  R1, R2
Source:  DX25/Robotics Shuttle Training
Date:  09/03
Lesson(s) Replaced:  PDRS MAL 21012
Equipment Required:  Instructor Astronaut (IA), PGSC
Prerequisite Lesson(s):  PDRS MAL1 21012
Preparation:  None

Synopsis:  This lesson will present various PDRS malfunction scenarios related to the Manipulator Controller Interface Unit (MCIU), Arm-Based Electronics (ABE), and other systems. Most malfunctions will be removed after the proper procedure is complete. An Instructor Astronaut (IA) will observe this class and provide oral and written feedback of the student’s progress.

Objectives:  
•  Comprehend RMS failure impacts to the Display and Control (D&C), MCIU, ABE, End Effector (EE), and Manipulator Retention Latches (MRLs).
•  Demonstrate proficiency in correctly responding to system failures associated with the PDRS.
•  Demonstrate skills and techniques associated with D&C failure workarounds.
•  Demonstrate skills associated with Space Flight Resource Management (SFRM).
•  Perform a Station Build task.

29  PDRS EVA OPS 22016
Title:  Payload Deployment and Retrieval System Extravehicular Activity Operations
Duration:  2.0 hours
Medium:  Virtual Reality Trainer
Student:  R1, R2 (Scheduled individually.)
Source:  DX25/Robotics Shuttle Training
Date:  09/03
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  PDRS MAL2 21012
Preparation:  None
PDRS Lesson Descriptions

29  PDRS EVA OPS 22016 (Concluded)

Synopsis: This lesson will continue to demonstrate the need for clear concise communication between the RMS operator and EVA crewmember.

Objectives: • Demonstrate correct RMS/EVA Voice Protocol.
• Demonstrate mode optimization during RMS/EVA maneuvers.
• Demonstrate use of cameras to constantly view EVA crewmember.
• Demonstrate awareness of joint reach limits during RMS EVA operations.

30  PDRS RVW 21069

Title: Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: PDRS RVW 21016
Equipment Required: None
Prerequisite Lesson(s): PDRS EVA OPS 22016
Preparation: None

Synopsis: The student will perform tasks learned throughout the PDRS flow. This class is an opportunity for the student to review all RMS operations with an instructor prior to the PDRS QUALs.

Objectives: • Demonstrate proficiency in the skills associated with maneuvering an unloaded and loaded RMS.
• Demonstrate proficiency in the skills associated with unloaded and loaded Single Joint RMS operations.
PDRS Lesson Descriptions

31  **PDRS QUAL 1 21069**

Title: Payload Deployment and Retrieval System Qualification 1  
Duration: 3.5 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: PDRS QUAL 21024, PDRS QUAL 21069  
Equipment Required: None  
Prerequisite Lesson(s): PDRS RVW 21069  
Preparation: None  

Synopsis: This will be one of two operator qualification sequence lessons. Manual augmented maneuvering skills and single joint operations will be stressed. Along with skill evaluation, the operator will be evaluated on Space Flight Resource Management (SFRM), operating within applicable flight rules, and utilizing defined safe operational techniques.

Objectives: Demonstrate proficiency in all skills associated with RMS tasks.

32  **PDRS QUAL 2 21069**

Title: Payload Deployment and Retrieval System Qualification 2  
Duration: 4.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: PDRS QUAL 21024, PDRS QUAL 21069  
Equipment Required: Instructor Astronaut (IA)  
Prerequisite Lesson(s): PDRS QUAL 1 21069  
Preparation: None  

Synopsis: This will be one of two operator qualification sequence lessons. Manual augmented maneuvering skills and single joint operations will be stressed. Along with skill evaluation, the operator will be evaluated on Space Flight Resource Management (SFRM), operating within applicable flight rules, and utilizing defined safe operational techniques. An Instructor Astronaut (IA) will observe this class and evaluate the student along with the instructor.

Objectives: Demonstrate proficiency in all skills associated with RMS tasks in configurations previously unseen.
PDRS Lesson Descriptions

33  PDRS EVAL 21069

Title:  Payload Deployment and Retrieval System Evaluation
Duration:  3.0 hours
Medium:  Shuttle Engineering Simulator Dome
Student:  R1, R2 (Schedule individually.)
Source:  DX25/Robotics Shuttle Training
Date:  09/03
Lesson(s) Replaced:  None
Equipment Required:  Instructor Astronaut (IA)
Prerequisite Lesson(s):  PDRS QUAL2 21069
Preparation:  Self Study and PDRS proficiency lessons

Synopsis:  The student should take this class annually to assess the retention of RMS skills. Manual augmented maneuvering skills and single joint operations will be evaluated. Along with skill evaluation, the operator will be evaluated on Space Flight Resource Management (SFRM), operating within applicable flight rules, and utilizing defined safe operational techniques. An Instructor Astronaut (IA) will observe this class and evaluate the student along with the instructor.

Objectives:  Demonstrate proficiency in skills associated with nominal and Single Joint RMS operations.

34  PDRS FLT QL 1 31069

Title:  Payload Deployment and Retrieval System Flight Qualification 1
Duration:  3 hours
Medium:  Shuttle Engineering Simulator Dome
Student:  R1, R2 (Schedule individually.)
Source:  DX25/Robotics Shuttle Training
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  PDRS QUAL 2 21069
Preparation:  Self Study and PDRS proficiency lessons

Synopsis:  This will be the first of two operator qualification sequence lessons. Manual augmented maneuvering skills and single joint operations will be stressed. Along with skill evaluation, the operator will be evaluated on Space Flight Resource Management (SFRM), operating within applicable flight rules, and utilizing defined safe operational techniques.

Objectives:  Demonstrate proficiency in all skills associated with RMS tasks.
PDRS Lesson Descriptions

35  **PDRS FLT QL 2 31069**

<table>
<thead>
<tr>
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<td>R1, R2 (Schedule individually.)</td>
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<td>Source</td>
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Synopsis: This will be the second of two operator qualification sequence lessons. Manual augmented maneuvering skills and single joint operations will be stressed. Along with skill evaluation, the operator will be evaluated on Space Flight Resource Management (SFRM), operating within applicable flight rules, and utilizing defined safe operational techniques. An Instructor Astronaut (IA) will observe this class and evaluate the student along with the instructor.

Objectives: Demonstrate proficiency in all skills associated with RMS tasks in configurations previously unseen.

36  **PDRS OBSS INTRO 21025**

<table>
<thead>
<tr>
<th>Title</th>
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</tr>
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<td>Duration</td>
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</tr>
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<td>Source</td>
<td>DX25/Robotics Shuttle Training</td>
</tr>
<tr>
<td>Date</td>
<td>06/08</td>
</tr>
<tr>
<td>Lesson(s) Replaced</td>
<td>PDRS UL SURVEY 91025, PDRS UL SURVEY 21025</td>
</tr>
<tr>
<td>Equipment Required</td>
<td>Payload General Support Computers (PGSCs) w/RSAD &amp; DOUG</td>
</tr>
<tr>
<td>Prerequisite Lesson(s)</td>
<td>PDRS EVAL 21069 or PDRS QUAL2 21069</td>
</tr>
<tr>
<td>Preparation</td>
<td>None</td>
</tr>
</tbody>
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Synopsis: This lesson permits the arm operator to practice the exterior crew cabin survey and PDRS procedures pertaining to the OBSS grapple, unberth, and berth procedures.
PDRS Lesson Descriptions

36  PDRS *OBSS INTRO* 21025 (Concluded)

Objectives:
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
- Perform berthed Orbiter Boom Sensor System (OBSS) grapple, unberth, berth, and release.
- Perform the PDRS Exterior Crew Cabin Survey per the PDRS Operations (OPS) Checklist (C/L) procedures.
- Perform OBSS berth thermal cases as time permits.
- Demonstrate appropriate use of Dynamic Skills Trainer (DST) for future self study.

37  PDRS OBSS SURVEY 21069

Title: Payload Deployment and Retrieval System OBSS Survey
Duration: 3.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule together.)
Source: DX25/Robotics Shuttle Training
Date: 02/06
Lesson(s) Replaced: PDRS OBSS SURVEY 91069
Equipment Required: Payload General Support Computers (PGSCs) w/RSAD & DOUG
Prerequisite Lesson(s): PDRS *OBSS INTRO* 21025, LDRI EQ 21001
Preparation: None

Synopsis: This lesson focuses on the undocked PDRS procedures pertaining to the Orbiter Boom Sensor System (OBSS) scan operations for the starboard wing.

Objectives:
- Integrate Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) PGSCs into survey operations scan pattern.
- Perform OBSS grapple, unberth, and starboard wing scan.
- Perform undocked loaded PDRS/OBSS survey of the starboard wing per the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures.
PDRS Lesson Descriptions

38  **PDRS OBSS SURVEY 22069**

Title: Payload Deployment and Retrieval System OBSS Survey  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2 (Schedule together.)  
Source: DX25/Robotics Shuttle Training  
Date: 02/06  
Lesson(s) Replaced: PDRS OBSS SURVEY 92069  
Equipment Required: Payload General Support Computers (PGSCs) w/RSAD and DOUG  
Prerequisite Lesson(s): PDRS OBSS INTRO 21025, LDRI EQ 21001  
Preparation: None

Synopsis: This lesson focuses on the undocked PDRS procedures pertaining to the Orbiter Boom Sensor System (OBSS) scan operations for the nose and surrounding area.

Objectives:  
- Integrate Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) PGSCs into survey operations scan pattern.  
- Perform maneuver from the end of the starboard scan to the start position for the nose scan, and then scan the nose.  
- Perform undocked loaded PDRS/OBSS survey of the nose and surrounding area per the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures.

39  **PDRS OBSS SURVEY 23069**

Title: Payload Deployment and Retrieval System OBSS Survey  
Duration: 3.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2 (Schedule together.)  
Source: DX25/Robotics Shuttle Training  
Date: 02/06  
Lesson(s) Replaced: PDRS OBSS SURVEY 93069  
Equipment Required: Payload General Support Computers (PGSCs) w/RSAD & DOUG  
Prerequisite Lesson(s): PDRS OBSS INTRO 21025, LDRI EQ 21001  
Preparation: None

Synopsis: This lesson focuses on the undocked PDRS procedures pertaining to the Orbiter Boom Sensor System (OBSS) scan operations for the port wing.
PDRS Lesson Descriptions

39  **PDRS OBSS SURVEY 23069 (Concluded)**

Objectives:
- Integrate Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) PGSCs into survey operations scan pattern.
- Perform maneuver from the end of the nose scan to the start position for the port wing scan, and then scan the port wing. After the scan is complete, berth OBSS, SRMS release, and backaway.
- Perform undocked loaded PDRS/OBSS survey of the port wing per the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures.

40  **PDRS UNDK SJ OBSS 21069**

Title: Payload Deployment and Retrieval System Undocked Single Joint OBSS
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule together.)
Source: DX25/Robotics Shuttle Training
Date: 06/08
Lesson(s) Replaced: PDRS UNDK SJ OBSS 91069
Equipment Required: Payload General Support Computers (PGSCs) w/RSAD & DOUG
Prerequisite Lesson(s): PDRS OBSS SURVEY 21069, PDRS OBSS SURVEY 22069, PDRS OBSS SURVEY 23069
Preparation: None
Synopsis: This lesson focuses on undocked PDRS single joint Orbiter Boom Sensor System (OBSS) operations.

Objectives:
- Integrate Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) PGSCs into survey operations scan pattern.
- Perform undocked single joint grapple of OBSS.
- Perform single joint unberth of OBSS *with and without digitals* ending at a hover position.
- Perform single joint berth of OBSS *with and without digitals* starting from a hover position.
PDRS Lesson Descriptions

41  **PDRS NBL FAM 31027**

Title: Payload Deployment and Retrieval System Neutral Buoyancy Lab Familiarization
Duration: 1.0 hour
Medium: Neutral Buoyancy Lab
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training, DX/NBL RMS operator
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS QUAL2 21069 or **PDRS FLT QL 2 31069**
Preparation: None

Synopsis: This lesson should be scheduled after the student completes the PDRS QUAL2 21069, **PDRS FLT QL 2 31069**, or upon request. The student will be briefed by NBL operators on the safety and operation of the NBL RMS. The student will learn how to operate the controls and practice safety involved with working in the NBL.

Objectives: Know how to operate the controls in the NBL RMS workstation.

42  **ORB/RMS I/F 31012**

Title: Orbiter and Remote Manipulator System Interfaces
Duration: 4.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 11/04
Lesson(s) Replaced: ORB/RMS I/F 21001, ORB/RMS I/F 21012
Equipment Required: None
Prerequisite Lesson(s): PDRS QUAL2 21069 or **PDRS FLT QL 2 31069**
Preparation: None

Synopsis: This lesson introduces the crew to orbiter malfunctions and procedures that affect the RMS, and to PDRS malfunctions and procedures that affect the orbiter. This lesson also introduces the concept of the arm operators working together with the orbiter operators to complete a particular task. The lesson includes some nominal and some malfunction aspects of the EPS, DPS, Reaction Control System (RCS), CCTV system, payload deployment, proximity operations, and payload retrieval. The lesson will start with the arm in the launch configuration. The PDRS OPS C/L ON-ORBIT INIT and RMS POWERUP will be done, after which the crew,
**PDRS Lesson Descriptions**

### 42 ORB/RMS I/F 31012 (Concluded)

Using the appropriate PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS), will grapple, unlatch, unberth, and release the payload, back off approximately 100 feet, and approach and regrapple the payload. All applicable generic flight rules will be discussed during the course of the lesson.

**Objectives:**
- Perform the generic and flight-specific portions of the PDRS OPS C/L, as required to get the arm configured for payload grapple, unberth, release, recapture, and powerdown.
- Recognize various systems malfunctions and troubleshoot per the appropriate procedures while continuing with scheduled arm operations.
- Coordinate malfunctions and symptoms between the arm operators and orbiter operators to correctly diagnose malfunction effects and determine workarounds.
- State the generic PDRS flight rules applicable to the operations contained in this lesson.

### 43 PDRS OPS 91001

**Title:** Payload Deployment and Retrieval System Flight-Specific Operations Briefing

**Duration:** 3.0 hours

**Medium:** Classroom

**Student:** COMMANDER, MS 2, PILOT, R1, R2

**Note:** Invite flight-specific CAPCOM(s)

**Source:** DX25/Robotics Shuttle Training, DX22/Robotics Systems

**Date:** 02/07

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** ORB/RMS I/F 31012

**Preparation:** None

**Synopsis:** This briefing, presented by the Flight Controllers and Instructors, is designed to introduce the student to all flight-specific PDRS operations that will be conducted for the mission. It will also describe the Orbiter Boom Sensor System (OBSS) and surveys, payload(s) and retention systems, payload bay and camera configuration, and any preliminary flight rules that may be known at the time. In addition, the instructors will discuss the PDRS Training Flow and lessons learned.
PDRS Lesson Descriptions

43  PDRS OPS 91001 (Concluded)

Objectives:
• Describe the mission operations at an overview level.
• Discuss the survey operations, autosequences, and Payload Identification (PL ID) information.
• Discuss the payload configuration(s), if applicable, and the payload bay and camera layout.
• Discuss any applicable flight rules known at this time.
• Discuss layout of PDRS Checklist (C/L).
• Discuss controlling documents.
• Discuss PDRS training flows.
• Discuss PDRS lessons learned using the checklist in the presentation.

44  PDRS UL OPS 91025

Title: Payload Deployment and Retrieval System Unloaded Nominal Operations
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, or 5
Student: R1, R2 (Schedule individually.)
Note: Schedule NET L-20 weeks.
Source: DX25/Robotics Shuttle Training
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS OPS 91001
Preparation: None

Synopsis: This lesson provides the student with an introduction to flight-specific payload bay configurations. The student will perform a free form payload bay survey, noting locations of payload bay features and any visual obstructions of those features. The arm will start in the cradled position, and the operator will perform the ON-ORBIT INIT and RMS POWERUP from the generic PDRS Operations (Ops) Checklist (C/L), followed by the nominal RMS procedures listed in the PDRS OPS C/L Flight Supplement (FS). Time permitting, the student will perform the RMS Checkout (C/O), RMS powerdown, and RMS Deactivate procedures from the generic PDRS OPS C/L. The student will become familiar with visual cues for each major stopping point in the procedures along the way. Visual cue determination will encompass CCTV and window views. Applicable RMS flight rules will be described during the lesson.
PDRS Lesson Descriptions

44 PDRS UL OPS 91025 (Concluded)

Objectives:
• Describe the locations of payload bay features and any visual obstructions of those features.
• Be familiar with window and camera views for each phase of the nominal procedures.
• Perform arm uncradle per the generic PDRS OPS C/L.
• Discuss flight rules that apply to various RMS operations.
• Demonstrate appropriate use of Dynamic Skills Trainer (DST) for future self study.

45 PDRS UL OPS 91069

Title: Payload Deployment and Retrieval System Unloaded Nominal and Contingency Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Note: Schedule NET L-20 weeks.
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS UL OPS 91025
Preparation: None

Synopsis: This lesson permits the arm operator to determine the payload bay survey and revisit PDRS procedures. The class will start with a payload bay survey, during which the location of various payload bay features will be noted. Window and CCTV views will be determined, and any visual obstructions will also be noted. The arm will then be cradled in BACKUP. Emphasis will be placed on the use of out-the-window and CCTV views rather than the use of digitals. Full-up arm nominal procedures will be performed per the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures.

Objectives:
• Note the location of payload bay features and visual obstructions during payload bay survey and window/CCTV view familiarization.
• Perform arm uncradle per the generic PDRS OPS C/L.
• Perform the full-up arm nominal and contingency procedures per the PDRS OPS C/L FS, as applicable, and as the facility permits.
• Cradle the arm in BACKUP per the generic PDRS OPS C/L.
PDRS Lesson Descriptions

46  **PDRS UL SJ 91025**

Title: Payload Deployment and Retrieval System Unloaded Single Joint Operations

Duration: 2.0 hours

Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, or 5

Student: R1, R2 (Schedule individually.)

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS UL OPS 91069

Preparation: None

Synopsis: This lesson allows the arm operator to perform nominal and contingency procedures (if applicable) with a Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. The arm will start out in the cradled position. The arm will be uncradled, and then the applicable SJ procedures will be performed. After the nominal and contingency operations have been performed, the operator will cradle the arm.

Objectives:

- Uncradle and cradle the arm visually.
- Perform the nominal and any applicable contingency flight-specific procedures with a SJ arm.

47  **PDRS UL SJ 91069**

Title: Payload Deployment and Retrieval System Unloaded Single Joint Operations

Duration: 2.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: R1, R2

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS UL SJ 91025

Preparation: None
PDRS Lesson Descriptions

47  PDRS UL SJ 91069 (Concluded)

Synopsis: This lesson will allow the arm operator to perform single joint operations with the flight-specific payload bay configuration. All operations will be visual only -- No digitals will be used. The arm will be uncradled, maneuvered to the flight-specific configurations, and then cradled in BACKUP. Proper elbow camera alignment will be demonstrated. All applicable visual cues will be noted, and relevant flight rules will be discussed.

Objectives:

• Uncradle the arm visually.
• Perform the flight-specific arm maneuvers, confirming all relevant visual cues.
• Cradle arm in BACKUP and correctly stow the elbow camera.

48  PDRS LD OPS 91069

Title: Payload Deployment and Retrieval System Loaded Nominal Operations

Duration: 2.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: R1, R2 (Schedule individually.)

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS OPS 91001

Preparation: None

Synopsis: This lesson provides the student with an introduction to flight-specific payload and payload bay configurations. The student will perform a free-form payload bay survey, noting locations of trunnions, V-guides, grapple fixtures, and any visual obstructions of those features. The arm will start in the cradled position, and the operator will perform the RMS POWERUP from the generic PDRS Operations (OPS) Checklist (C/L). The student will then proceed to perform the nominal RMS procedures listed in the PDRS OPS C/L Flight Supplement (FS). Cross-coupling effects will be carefully examined. The student will become familiar with visual cues for each major stopping point in the procedures (e.g., low hover, high hover, etc.) along the way. Visual cue determination will encompass CCTV and window views.
The operator will also cycle through all Payload (PL) Identifications (IDs) while grappled to the berthed payload to become familiar with the PL IDs. Applicable RMS flight rules will be described during the lesson.

Objectives:
- Describe the locations of the trunnions, V-guides (or other payload retention devices and alignment guides), grapple fixtures, and any visual obstructions of those features.
- Be familiar with window and camera views for each phase of the nominal procedures.
- Determine cross-coupling effects and correctly compensate for them during RMS operations.
- Describe each PL ID while grappled to the berthed payload.
- Discuss flight rules that apply to various RMS operations.

Title: Payload Deployment and Retrieval System Loaded Nominal Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS LD OPS 91069
Preparation: None

Synopsis: The lesson will start with a payload bay survey, during which the location of grapple fixtures and payload retention system/alignment guides will be noted. Window and CCTV views will be determined, and any visual obstructions will also be noted. The arm will be uncradled via the generic PDRS Operations (OPS) Checklist (C/L) procedures, followed by payload grapple and unlatch per the Flight Supplement (FS) procedures. The payload will be unberthed to low hover. As time permits, loaded ops will also be performed. The payload will then be berthed and latched, and the arm will be ungrappled. The arm will then be cradled in BACKUP and the elbow camera will be stowed. Emphasis will be placed on the use of out-the-window and CCTV views rather than the use of digitals.
PDRS Lesson Descriptions

49  PDRS LD OPS 92069 (Concluded)

Objectives:
- Describe the location of grapple fixtures, payload retention latches/alignment guides, keel targets, or other unberthing/berthing aids, and any visual obstructions during payload survey and window/CCTV view familiarization.
- Perform arm uncradle per the generic PDRS OPS C/L.
- Perform payload grapple, unlatch, unberth to low hover, loaded maneuvers as time permits, reberth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable.
- Cradle the arm in BACKUP per the generic PDRS OPS C/L and correctly stow the elbow camera.

50  PDRS LD INT 91012

Title: Payload Deployment and Retrieval System Loaded Introduction
Duration: 3.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS LD OPS 92069
Preparation: None

Synopsis: This lesson will allow the arm operators to perform the nominal full-up RMS procedures in the controlling Checklist (C/L) (FLIGHT PLAN, EVA C/L, etc.). It will also introduce coordination of duties between the 2 arm operators and the orbiter operator. The class will not be run on a strict timeline. The procedures will be run slowly and methodically, during which the arm operators will try various camera views, C/L and task management techniques, verbal communication coordination, orbiter operator coordination, etc. For heavy payloads, if time permits, manual minimum impulse flying may be briefly introduced.

Objectives:
- Perform nominal timeline procedures with a full-up arm.
- Coordinate duties between the 2 arm operators, and with the orbiter operator, during nominal timeline operations.
- Demonstrate basic mechanics of manual minimum impulse flying if required for this payload.
PDRS Lesson Descriptions

51  PDRS LD SJ 91069

Title: Payload Deployment and Retrieval System Loaded Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): LOAD MAL T/L 91012 (ORB FO),
                      PDRS LD INT 91012
Preparation: None

Synopsis: This lesson allows the arm operator to perform nominal procedures with a
Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. The arm
will start out in the cradled position. The arm will be uncradled, and then
the following SJ procedures will be performed: grapple, unberth to
low hover, loaded operations, berth from low hover, ungrapple, and cradle.
For loaded operations above the low hover position, the operator will use
the Checklist (C/L) procedures and establish the visual cues for each joint
movement.

Objectives: • Uncradle, grapple, ungrapple, and cradle the arm visually.
            • Perform the nominal flight-specific procedures with a SJ arm.
            • Describe the visual cues for each joint movement above the low
              hover position.

52  PDRS LD SJ 92069

Title: Payload Deployment and Retrieval System Loaded Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS LD SJ 91069
Preparation: None
PDRS Lesson Descriptions

52  PDRS LD SJ 92069 (Concluded)

Synopsis: This lesson will allow the arm operator to perform single joint operations. All operations will be visual only -- no digitals will be used. The arm will be uncradled, the payload will be grappled and unberthed to low hover. As time permits, loaded maneuvers will be performed. The Payload (PL) will then be reberthed. After ungrapple, the arm will be cradled in BACKUP.

Objectives: • Uncradle the arm visually.
• Grapple the payload in single joint without using digitals.
• Unberth to low hover, maneuver, and reberth the payload visually.
• Ungrapple payload, cradle arm in BACKUP.

53  PDRS LD CON 91069

Title: Payload Deployment and Retrieval System Loaded Contingency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): LOAD SJ T/L 91012 (ORB FO), PDRS LD SJ 92069
Preparation: None

Synopsis: This lesson will introduce the student to contingency operations for a full-up arm, contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Some of these procedures may include, but are not limited to, EVA/appendage deploy procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled as needed to meet mission-specific requirements.

Objectives: • Perform all contingency or secondary full-up arm RMS procedures contained in the PDRS OPS C/L FS. State under what conditions each would be used.
• Determine the correct visual cues during each procedure.
• Describe RMS flight rules applicable to these procedures.
PDRS Lesson Descriptions

54 PDRS LD CON 92069

Title: Payload Deployment and Retrieval System Loaded Contingency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS LD CON 91069
Preparation: None

Synopsis: This lesson will allow the student to perform contingency operations, contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS), for a full-up arm, as the facility permits. Some of these procedures may include, but are not limited to, EVA/appendage deploy procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled as needed to meet mission-specific requirements.

Objectives:
• Perform all contingency or secondary full-up arm RMS procedures contained in the PDRS OPS C/L FS, as the facility permits. State under which conditions each would be used.
• Determine correct visual cues during each procedure.
• Describe RMS flight rules applicable to these procedures.

55 PDRS DPLY OPS 91069

Title: Payload Deployment and Retrieval System Deploy Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS OPS 91001
Preparation: None
PDRS Lesson Descriptions

55  **PDRS DPLY OPS 91069 (Concluded)**

Synopsis: This lesson provides an introduction to flight-specific payload and payload bay configurations. The student will perform a free-form payload bay survey, noting locations of trunnions, V-guides, grapple fixtures, and any visual obstructions of these features. The arm will start in the cradled position, and the operator will perform the RMS POWERUP from the generic PDRS Operations (OPS) Checklist (C/L). Nominal RMS procedures listed in the PDRS OPS C/L Flight Supplement (FS) will then be performed. Cross-coupling effects will be carefully examined. The student will become familiar with visual cues for each major stopping point in the procedures (e.g., low hover, high hover, etc.) along the way. Visual cue determination will encompass CCTV and window views. The operator will also cycle through all Payload (PL) Identifications (IDs) while grappled to the berthed payload to become familiar with the PL IDs. Applicable RMS flight rules will be described during the lesson.

Objectives:
- Describe the locations of the trunnions, V-guides (or other payload retention devices and alignment guides), grapple fixtures, and any visual obstructions of those features.
- Be familiar with window and camera views for each phase of the nominal procedures.
- Determine cross-coupling effects and correctly compensate for them during RMS operations.
- Describe each PL ID while grappled to the berthed payload.
- Discuss flight rules that apply to various RMS operations.

56  **PDRS DPLY OPS 92069**

Title: Payload Deployment and Retrieval System Deploy Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS DPLY OPS 91069
Preparation: None
PDRS Lesson Descriptions

56  PDRS DPLY OPS 92069 (Concluded)

Synopsis: The class will start with a payload bay survey, during which the location of grapple fixtures and payload retention system/alignment guides will be noted. Window and CCTV views will be determined, and any visual obstructions will also be noted. The arm will be uncradled via the generic PDRS Operations (OPS) Checklist (C/L) procedures. Payload grapple and unlatch will then be performed per the Flight Supplement (FS) procedures, and the payload will be unberthed to low hover. As time permits, deploy operations will also be performed. The payload will then be berthed and latched, and the arm will be ungrappled. The arm will then be cradled in BACKUP and the elbow camera will be stowed. Emphasis will be placed on the use of out-the-window and CCTV views rather than the use of digitals.

Objectives:
• Discuss the location of grapple fixtures, payload retention latches/alignment guides, keel targets, or other unberthing/berthing aids, and visual obstructions during payload survey and window/CCTV view familiarization.
• Perform arm uncradle per the generic PDRS OPS C/L.
• Perform payload grapple, unlatch, unberth to low hover, reberth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable.
• Cradle the arm in BACKUP per the generic PDRS OPS C/L and correctly stow the elbow camera.

57  PDRS DPLY INT 91012

Title: Payload Deployment and Retrieval System Deploy Introduction
Duration: 3.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS DPLY OPS 92069
Preparation: None
PDRS Lesson Descriptions

57  **PDRS DPLY INT 91012 (Concluded)**

**Synopsis:** This lesson allows the performance of nominal full-up arm procedures in the controlling Checklist (C/L) (DEPLOY, FLIGHT PLAN, etc.). It will also introduce coordination of duties between the 2 arm operators and the orbiter operator. This lesson will not be run on a strict timeline. The procedures will be run slowly and methodically, during which the arm operators will try various camera views, C/L and task management techniques, verbal communication coordination, orbiter operator coordination, etc. For heavy payloads, if time permits, manual minimum impulse flying may be briefly introduced.

**Objectives:**
- Perform nominal timeline procedures with a full-up arm.
- Coordinate duties between the 2 arm operators and with the orbit operator during nominal timeline operations.
- Demonstrate the basic mechanics of manual minimum impulse flying if required for this payload.

58  **PDRS DPLY SJ 91069**

Title: Payload Deployment and Retrieval System Deploy Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): DPLY MAL T/L 91012 (ORB FO), PDRS DPLY INT 91012
Preparation: None

**Synopsis:** This lesson allows the arm operator to perform nominal procedures with a Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. The arm will start out in the cradled position. The arm will be uncradled, and then the following SJ procedures will be performed: grapple, unberth to low hover, deploy, and cradle. For deploy operations above the low hover position, the operator will use the Checklist (C/L) procedures and establish the visual cues for each joint movement.

**Objectives:**
- Uncradle, grapple, ungrapple, and cradle the arm visually.
- Perform the nominal flight-specific procedures with a single joint arm.
- Describe visual cues for each joint movement above the low hover position.
PDRS Lesson Descriptions

59  **PDRS DPLY SJ 92069**
Title: Payload Deployment and Retrieval System Deploy Single Joint  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS DPLY SJ 91069  
Preparation: None

Synopsis: This lesson will allow the arm operator to perform single joint operations. All operations will be visual only -- no digitals will be used. The arm will be uncradled, the payload will be grappled and unberthed to low hover. As time permits, deploy operations above low hover will be attempted. The payload will then be returned to low hover and reberthed. After ungrapple, the arm will be cradled in BACKUP.

Objectives:  
• Uncradle the arm visually.  
• Grapple the payload in single joint without using digitals.  
• Unberth to low hover and reberth the payload visually.  
• Perform deploy maneuvers.  
• Ungrapple payload, cradle arm in BACKUP.

60  **PDRS DPLY CON 91069**
Title: Payload Deployment and Retrieval System Deploy Contingency  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): DPLY SJ T/L 91012 (ORB FO), PDRS DPLY SJ 92069  
Preparation: None
PDRS Lesson Descriptions

60  PDRS DPLY CON 91069 (Concluded)

Synopsis: This lesson will introduce the student to contingency operations for a full-up arm, which are contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Some of these procedures may include, but are not limited to, EVA/appendage deploy procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled, as needed, to meet mission-specific requirements.

Objectives:
- Perform all contingency or secondary full-up arm RMS procedures contained in the PDRS OPS C/L FS. State under what conditions each would be used.
- Determine correct visual cues during each procedure.
- Describe RMS flight rules applicable to these procedures.

61  PDRS DPLY CON 92069

Title: Payload Deployment and Retrieval System Deploy Contingency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS DPLY CON 91069
Preparation: None

Synopsis: This lesson will allow the student to perform, as time permits, contingency operations for a full-up arm, which are contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Some of these procedures may include, but are not limited to, EVA/appendage deploy procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled, as needed, to meet mission-specific requirements.
PDRS Lesson Descriptions

61 PDRS DPLY CON 92069 (Concluded)

Objectives:
- Perform all contingency or secondary full-up arm RMS procedures contained in the PDRS OPS C/L FS. State under what conditions each would be used.
- Determine correct visual cues during each procedure.
- Describe RMS flight rules applicable to these procedures.
- State in which controlling document the procedures are also located.

62 PDRS RETR OPS 91069

Title: Payload Deployment and Retrieval System Retrieve Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS OPS 91001
Preparation: None

Synopsis: This lesson is an introduction to flight-specific payload and payload bay configurations. The student will perform a free-form payload and payload bay survey, noting locations of trunnions, V-guides, grapple fixtures, and any visual obstructions of those features. The arm will start in the cradled position, and the operator will perform the RMS POWERUP from the generic PDRS Operations (OPS) Checklist (C/L). Nominal RMS procedures, listed in the PDRS OPS C/L Flight Supplement (FS), will then be performed. Cross-coupling effects will be carefully examined. The student will become familiar with visual cues for each major stopping point in the procedures (e.g., low hover, high hover, etc.) along the way. Visual cue determination will encompass CCTV and window views. The operator will also cycle through all Payload (PL) Identifications (IDs) while grappled to the berthed payload to become familiar with the PL IDs. Applicable RMS flight rules will be described during the lesson.

Objectives:
- Describe the locations of the trunnions, V-guides (or other payload retention devices and alignment guides), grapple fixtures, and any visual obstructions of those features.
- Be familiar with window and camera views for each phase of the nominal procedures.
PDRS Lesson Descriptions

62  PDRS RETR OPS 91069 (Concluded)

- Determine cross-coupling effects and correctly compensate for them during RMS operations.
- Describe each PL ID while grappled to the berthed payload.
- Discuss flight rules that apply to various RMS operations.
- Comprehend the correct response to a missed grapple.

63  PDRS RETR OPS 92069

Title: Payload Deployment and Retrieval System Retrieve Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR OPS 91069
Preparation: None

Synopsis: The lesson will start with a payload bay survey, during which the location of grapple fixtures and payload retention system/alignment guides will be noted. Window and CCTV views will be determined, and any visual obstructions will also be noted. The arm will be uncradled via the generic PDRS Operations (OPS) Checklist (C/L) procedures. Payload grapple and unlatch will then be performed per the Flight Supplement (FS) procedures, and the payload will be unberthed to low hover. As time permits, retrieve operations will also be performed. The payload will then be berthed and latched, and the arm will be ungrappled. The arm will then be cradled in BACKUP and the elbow camera will be stowed. Emphasis will be placed on the use of out-the-window and CCTV views, as well as the use of digitals.

Objectives:
- Describe the location of grapple fixtures, payload retention latches/alignment guides, keel targets, or other unberthing/berthing aids and any visual obstructions during payload survey and window CCTV view familiarization.
- Perform arm uncradle per the generic PDRS OPS C/L.
- Perform payload grapple, unlatch, unberth to low hover, reberth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable.
- Cradle the arm in BACKUP per the generic PDRS OPS C/L, and correctly stow the elbow camera.
PDRS Lesson Descriptions

64  PDRS RETR INT 91012

Title: Payload Deployment and Retrieval System Retrieve Introduction
Duration: 3.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR OPS 92069
Preparation: None

Synopsis: This lesson will allow the arm operators to perform the nominal full-up RMS procedures in the controlling Checklist (C/L) (FLIGHT PLAN, EVA C/L, etc.). It will also introduce coordination of duties between the 2 arm operators and the orbiter operator. The lesson will not be run on a strict timeline. The procedures will be run slowly and methodically, during which the arm operators will try various camera views, C/L and task management techniques, verbal communication coordination, orbiter operator coordination, etc. For heavy payloads, if time permits, manual minimum impulse flying may be briefly introduced.

Objectives:
• Perform nominal timeline procedures with a full-up arm.
• Coordinate duties between the 2 arm operators and with the orbiter operator during nominal timeline operations.
• Demonstrate basic mechanics of manual minimum impulse flying if required for this payload.

65  PDRS RETR SJ 91069

Title: Payload Deployment and Retrieval System Retrieve Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RETR MAL T/L 91012 (ORB FO), PDRS RETR INT 91012
Preparation: None
PDRS Lesson Descriptions

65  PDRS RETR SJ 91069 (Concluded)

Synopsis: This lesson allows the arm operator to perform nominal procedures with a Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. The arm will start out in the cradled position. The arm will be uncradled, and then the following SJ procedures will be performed: Maneuver to poised-for-capture orientation, payload capture, maneuver to low hover, berth from low hover, ungrapple, and cradle. For maneuvers above the low hover position, the operator will use the Checklist (C/L) procedures and establish the visual cues for each joint movement.

Objectives:
• Uncradle, ungrapple, and cradle the arm visually.
• Perform the nominal flight-specific procedures with a SJ arm.
• Describe visual cues for each joint movement above the low hover position.

66  PDRS RETR SJ 92069

Title: Payload Deployment and Retrieval System Retrieve Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR SJ 91069
Preparation: None

Synopsis: This lesson will allow the arm operator to perform single joint operations with the flight-specific payload mockup. All operations will be visual only -- no digitals will be used. The arm will be uncradled, the payload will be grappled and unberthed to low hover. Retrieve maneuvers will be performed as time permits. The Payload (PL) will then be reberthed. After ungrapple, the arm will be cradled in BACKUP.

Objectives:
• Uncradle the arm visually.
• Grapple the payload in single joint without using digitals.
• Unberth to low hover, maneuver, and reberth the payload visually.
• Perform retrieve maneuvers.
• Ungrapple payload, cradle arm in BACKUP.
PDRS Lesson Descriptions

67  PDRS RETR CON 91069
Title: Payload Deployment and Retrieval System Retrieve Contingency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR SJ 92069, RETR SJ T/L 91012 (ORB FO)
Preparation: None

Synopsis: This lesson will introduce the student to contingency operations for a full-up arm contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Some of these procedures may include, but are not limited to, EVA/appendage stow procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled as needed to meet mission-specific requirements.

Objectives:
• Perform all contingency or secondary full-up arm RMS procedures contained in the PDRS OPS C/L FS. State under which conditions each would be used.
• Determine correct visual cues during each procedure.
• Describe RMS flight rules applicable to these procedures.

68  PDRS RETR CON 92069
Title: Payload Deployment and Retrieval System Retrieve Contingency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR CON 91069
Preparation: None
PDRS Lesson Descriptions

68  **PDRS RETR CON 92069 (Concluded)**

Synopsis: This lesson will allow the student to perform contingency operations, contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS), for a full-up arm as the facility permits. Some of these procedures may include, but are not limited to, EVA/appendage stow procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled as needed to meet mission-specific requirements.

Objectives:

- Perform all contingency or secondary full-up arm RMS procedures contained in the PDRS OPS C/L FS. State under what conditions each would be used.
- Determine correct visual cues during each procedure.
- Describe RMS flight rules applicable to these procedures.

69  **PDRS D&R OPS 91069**

Title: Payload Deployment and Retrieval System Deploy and Retrieve Operations

Duration: 2.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: R1, R2 (Schedule individually.)

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS OPS 91001

Preparation: None
PDRS Lesson Descriptions

69  PDRS D&R OPS 91069 (Concluded)

Synopsis: This lesson provides an introduction to flight-specific payload and payload bay configurations. The student will perform a free-form payload bay survey, noting locations of trunnions, V-guides, and grapple fixtures, and any visual obstructions of those features. The arm will start in the cradled position, and the operator will perform the RMS POWERUP from the generic PDRS Operations (OPS) Checklist (C/L). Nominal RMS procedures, listed in the PDRS OPS C/L Flight Supplement (FS), will then be performed. Cross-coupling effects will be carefully examined. The student will become familiar with visual cues for each major stopping point in the procedures (e.g., low hover, high hover, etc.) along the way. Visual cue determination will encompass CCTV and window views. The operator will also cycle through all Payload (PL) Identifications (IDs) while grappled to the berthed payload to become familiar with the PL IDs. Applicable RMS flight rules will be described during the lesson.

Objectives:
- Describe the locations of the trunnions, V-guides (or other payload retention devices and alignment guides), grapple fixtures, and any visual obstructions of these features.
- Be familiar with window and camera views for each phase of the nominal procedures.
- Determine cross-coupling effects and correctly compensate for them during RMS operations.
- Describe each PL ID while grappled to the berthed payload.
- Discuss flight rules that apply to various RMS operations.

70  PDRS D&R OPS 92069

Title: Payload Deployment and Retrieval System Deploy and Retrieve Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS D&R OPS 91069
Preparation: None
PDRS Lesson Descriptions

70  **PDRS D&R OPS 92069 (Concluded)**

Synopsis: This lesson provides an introduction to flight-specific payload and payload bay configurations. The student will perform a free-form payload and payload bay survey, noting locations of trunnions, V-guides, grapple fixtures, and any visual obstructions of those features. The arm will start in the cradled position, and the operator will perform the RMS POWERUP from the generic PDRS Operations (OPS) Checklist (C/L). Nominal RMS procedures, listed in the PDRS OPS C/L Flight Supplement (FS), will then be performed. Cross-coupling effects will be carefully examined. The student will become familiar with visual cues for each major stopping point in the procedures (e.g., low hover, high hover, etc.) along the way. Visual cue determination will encompass CCTV and window views. The operator will also cycle through all Payload (PL) Identifications (IDs) while grappled to the berthed payload to become familiar with the PL IDs. Applicable RMS flight rules will be described during the lesson.

Objectives:  
- Describe the locations of the trunnions, V-guides (or other payload retention devices and alignment guides), grapple fixtures, and any visual obstructions of those features.  
- Be familiar with window and camera views for each phase of the nominal procedures.  
- Determine cross-coupling effects and correctly compensate for them during RMS operations.  
- Note each PL ID while grappled to the berthed payload.  
- Discuss flight rules that apply to various RMS operations.  
- Comprehend the correct response to a missed grapple.

71  **PDRS D&R OPS 93069**

Title: Payload Deployment and Retrieval System Deploy and Retrieve Operations  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS D&R OPS 92069  
Preparation: None
PDRS Lesson Descriptions

71  PDRS D&R OPS 93069 (Concluded)

Synopsis: The lesson will start with a payload bay survey, during which the location of grapple fixtures and payload retention system/alignment guides will be noted. Window and CCTV views will be determined, and any visual obstructions will also be noted. The arm will be uncradled via the generic PDRS Operations (OPS) Checklist (C/L) procedures. Payload grapple and unlatch will then be performed per the Flight Supplement (FS) procedures, and the payload will be unberthed to low hover. As time permits, deploy operations will also be performed. The payload will then be berthed and latched, and the arm will be ungrappled. Emphasis will be placed on the use of out-the-window and CCTV views rather than the use of digitals.

Objectives:  
• Discuss the location of grapple fixtures, payload retention latches/alignment guides, keel targets or other unberthing/berthing aids, and visual obstructions during payload survey and window/CCTV view familiarization.
• Perform arm uncradle per the generic PDRS OPS C/L.
• Perform payload grapple, unlatch, unberth to low hover, reberth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable.

72  PDRS D&R OPS 94069

Title: Payload Deployment and Retrieval System Deploy and Retrieve Operations
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS D&R OPS 93069
Preparation: None

Synopsis: The lesson will start with a payload bay survey, during which the location of grapple fixtures and payload retention system/alignment guides will be noted. Window and CCTV views will be determined, and any visual obstructions will also be noted. The arm will be uncradled via the generic PDRS Operations (OPS) Checklist (C/L) procedures. Payload grapple and unlatch will then be performed per the Flight Supplement (FS) procedures, and the payload will be unberthed to low hover. As time permits, retrieve operations will also be performed.
PDRS Lesson Descriptions

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<th>Lesson Number</th>
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| 72 | PDRS D&R OPS 94069 (Concluded) | The payload will then be berthed and latched, and the arm will be ungrappled. Emphasis will be placed on the use of out-the-window and CCTV views as well as the use of digitals. Objectives:  
- Note the location of grapple fixtures, payload retention latches/alignment guides, keel targets or other unberthing/berthing aids, and visual obstructions during payload survey and window/CCTV view familiarization.  
- Perform arm uncradle per the generic PDRS OPS C/L.  
- Perform payload grapple, unlatch, unberth to low hover, reberth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable. |

73 | PDRS D&R INT 91012 | Title: Payload Deployment and Retrieval System Deploy and Retrieve Introduction  
Duration: 4.0 hours  
Medium: SMS-FB (GNS)  
Student: COMMANDER, R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS D&R OPS 94069  
Preparation: None  
Synopsis: This lesson will allow the arm operator to perform the nominal full-up arm procedures in the controlling Checklist (C/L) (DEPLOY, FLIGHT PLAN, etc.). It will also introduce coordination of duties between the 2 arm operators and the prime orbiter operator. The lesson will not be run on a strict timeline. The procedures will be run slowly and methodically, during which the arm operators will try various camera views, C/L and task management techniques, verbal communication coordination, orbiter operator coordination, etc. For heavy payloads, if time permits, manual minimum impulse flying may be briefly introduced.  
Objectives:  
- Perform nominal timeline procedures with a full-up arm.  
- Coordinate duties between the 2 arm operators and with the orbit operator during nominal timeline operations.  
- Demonstrate basic mechanics of manual minimum impulse flying if required for this payload. |
Title: Payload Deployment and Retrieval System Deploy and Retrieve Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): DPLY MAL T/L 91012 (ORB FO), PDRS D&R INT 91012, RETR MAL T/L 91012 (ORB FO)

Preparation: None

Synopsis: This lesson allows the arm operator to perform nominal procedures with a Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. The arm will start out in the cradled position. The arm will be uncradled, and then the following SJ procedures will be performed: Grapple, unberth to low hover, deploy, and cradle. For deploy operations above the low hover position, the operator will use the Checklist (C/L) procedures and establish the visual cues for each joint movement.

Any deploy contingency operations that have SJ procedures will also be performed in this lesson.

Objectives:
- Uncradle, grapple, ungrapple, and cradle the arm visually.
- Perform the nominal flight-specific procedures with a SJ arm.
- Describe visual cues for each joint movement above the low hover position.
- Perform any deploy contingency SJ operations.
PDRS Lesson Descriptions

75  PDRS D&R SJ 92069

Title: Payload Deployment and Retrieval System Deploy and Retrieve Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS D&R SJ 91069
Preparation: None

Synopsis: This lesson allows the arm operator to perform nominal procedures with a Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. The arm will start out in the cradled position. The arm will be uncradled, and then the following SJ procedures will be performed: Maneuver to poised-for-capture orientation, payload capture, maneuver to low hover, berth from low hover, ungrapple, and cradle. For maneuvers above the low hover position, the operator will use the Checklist (C/L) procedures and establish the visual cues for each joint movement.

Any retrieve contingency operations that have SJ procedures will also be performed in this lesson.

Objectives:
• Uncradle, ungrapple, and cradle the arm visually.
• Perform the nominal flight-specific procedures with a SJ arm.
• Describe visual cues for each joint movement above the low hover position.
• Perform any retrieve contingency SJ operations.

76  PDRS D&R SJ 93069

Title: Payload Deployment and Retrieval System Deploy and Retrieve Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS D&R SJ 92069
Preparation: None
PDRS Lesson Descriptions

76  PDRS D&R SJ 93069 (Concluded)

Synopsis: This lesson will allow the arm operator to perform Single Joint (SJ) operations. All operations will be visual only; no digitals will be used. The arm will be uncradled, the payload will be grappled and unberthed to low hover. Deploy operations above low hover will be attempted as time permits. The payload will then be returned to low hover and reberthed. After ungrapple, the arm will be cradled in BACKUP. Any deploy contingency operations that have single joint procedures will also be performed in this lesson.

Objectives:
• Uncradle the arm visually.
• Grapple the payload in single joint without using digitals.
• Unberth to low hover and reberth the payload visually.
• Perform deploy maneuvers.
• Ungrapple payload, cradle arm in BACKUP.
• Perform deploy contingency single joint procedures.

77  PDRS D&R SJ 94069

Title: Payload Deployment and Retrieval System Deploy and Retrieve Single Joint
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS D&R SJ 93069
Preparation: None

Synopsis: This lesson will allow the arm operator to perform Single Joint (SJ) operations. All operations will be visual only; no digitals will be used. The arm will be uncradled, the payload will be grappled and unberthed to low hover. Retrieve maneuvers will be performed as time permits. The Payload (PL) will then be reberthed. Any retrieve contingency operations that have SJ procedures will also be performed in this lesson.

Objectives:
• Uncradle the arm visually.
• Grapple the payload in SJ without using digitals.
• Unberth to low hover, maneuver, and reberth the payload visually.
• Perform retrieve maneuvers as time permits.
• Perform retrieve contingency SJ procedures.
PDRS Lesson Descriptions

78  PDRS D&R CON 91069

Title:  Payload Deployment and Retrieval System Deploy and Retrieve Contingency
Duration:  2.0 hours
Medium:  Shuttle Engineering Simulator Dome
Student:  R1, R2
Source:  DX25/Robotics Shuttle Training
Date:  09/03
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  DPLY SJ T/L 91012 (ORB FO), PDRS D&R SJ 94069, RETR SJ T/L 91012 (ORB FO)
Preparation:  None

Synopsis:  This lesson is an introduction to deploy and retrieve contingency operations, contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS), for a full-up arm. Some of these procedures may include, but are not limited to, EVA/appendage deploy procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson. This lesson will be scheduled as needed to meet mission-specific requirements.

Objectives:  

- Perform all deploy and retrieve contingency or other off-nominal RMS procedures contained in the PDRS OPS C/L FS. State under what conditions each would be used.
- Determine correct visual cues during each procedure.
- Describe RMS flight rules applicable to these procedures.

79  PDRS D&R CON 92069

Title:  Payload Deployment and Retrieval System Deploy and Retrieve Contingency
Duration:  2.0 hours
Medium:  Shuttle Engineering Simulator Dome
Student:  R1, R2
Source:  DX25/Robotics Shuttle Training
Date:  03/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  PDRS D&R CON 91069
Preparation:  None
PDRS Lesson Descriptions

79  PDRS D&R CON 92069 (Concluded)

Synopsis: This lesson will allow the student to perform deploy and retrieve contingency operations, contained in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Some of these procedures may include, but are not limited to, EVA/appendage deploy procedures, secondary grapple fixture procedures, and contingency (possibly designated secondary) loaded operations. The operator will note all visual cues during the procedures, and determine the best CCTV coverage of each operation. Any applicable RMS flight rules will be discussed during the lesson.

This lesson will be scheduled as needed to meet mission-specific requirements.

Objectives:  
- Perform, as time permits, all deploy and retrieve contingency or other off-nominal RMS procedures contained in the PDRS OPS C/L FS. State under which conditions each would be used.
- Determine correct visual cues during each procedure.
- Describe RMS flight rules applicable to these procedures.

80  PDRS N-TSK X 91025

Title: Payload Deployment and Retrieval System Nominal (Station Element Build) Task X
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS OPS 91001
Preparation: None

Synopsis: This lesson introduces the arm operator to the flight-specific Station element and will be executed for each Station element task. The student will be shown a Bird’s Eye View during which the location of the grapple fixtures and payload retention system/alignment guides will be noted. The arm will be configured for the start of the task as noted by the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures. The Station element will be maneuvered to its appropriate position for the specific task. As time permits, the Station element may be berthed and latched if applicable, and the arm may be ungrappled.
PDRS Lesson Descriptions

80  PDRS N-TSK X 91025 (Concluded)

Emphasis will be placed on the use of out-the-window and CCTV views rather than the use of digitals.

Objectives:

- Emphasis will be placed on the instructor demonstrating Station element clearance issues, limitations of the SRMS, and complications associated with each element task.
- Describe the location of grapple fixtures, payload retention latches/alignment guides, keel targets, or other unberthing/berthing aids, Ready-To-Latch (RTL), and any visual obstructions during payload bay familiarization and window/CCTV view familiarization.
- Perform Station element task as defined in the PDRS OPS C/L FS.
- Perform berth, latch, and ungrapple, as applicable.
- Describe the Station element Payload (PL) Identification (ID).
- Be familiar with window and camera views for each phase of the nominal procedures.
- Demonstrate appropriate use of Dynamic Skills Trainer (DST) for future self study.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

81  PDRS N-TSK X 92025

Title: Payload Deployment and Retrieval System Nominal (Station Element Build) Task X
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS N-TSK X 91025
Preparation: None

Synopsis: This lesson will be scheduled for each task to provide the student further exercise in optimizing the Station element task avoiding reach limits and singularities. As time permits, the Station element may be berthed, latched, and ungrappled, if applicable.

Emphasis will be placed on the use of out-the-window and CCTV views rather than the use of digitals.
PDRS Lesson Descriptions

81 PDRS N-TSK X 92025 (Concluded)

Objectives:  
- Perform the Station element task, avoiding reach limits and singularities, as defined in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS).
- Perform berth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

82 PDRS N-TSK X 91069

Title: Payload Deployment and Retrieval System Nominal (Station Element Build) Task X

Duration: 2.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: R1, R2

Source: DX25/Robotics Shuttle Training

Date: 02/07

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS N-TSK X 92025

Preparation: None

Synopsis: The arm will be configured for the start of the task as defined in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) and the student will perform the nominal RMS task. Cross-coupling effects will be carefully examined. The student will become familiar with visual cues for each major stopping point in the procedures (e.g., low hover, pre install, etc.) along the way. Visual cue determination will encompass CCTV and window views. The operator will also cycle through all Payload (PL) Identifications (IDs) while grappled to the element to become familiar with the PL IDs. Applicable RMS flight rules will be described during the lesson.
PDRS Lesson Descriptions

82  PDRS N-TSK X 91069 (Concluded)

Objectives:  
- Determine cross-coupling effects and correctly compensate for them during RMS operations.
- Discuss flight rules that apply to various RMS operations.
- Perform the Station element task, avoiding reach limits and singularities, as defined in the PDRS OPS C/L FS.
- Develop Space Flight Resource Management (SFRM) between the 2 arm operators.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

83  PDRS N-TSK X 92069

Title:  Payload Deployment and Retrieval System Nominal (Station Element Build) Task X
Duration:  2.0 hours
Medium:  Shuttle Engineering Simulator Dome
Student:  R1, R2
Source:  DX25/Robotics Shuttle Training
Date:  02/07
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  PDRS N-TSK X 91069
Preparation:  None

Synopsis:  This lesson will be scheduled for each task to provide the student further exercise in optimizing the Station element task avoiding reach limits and singularities. Cross-coupling effects will be carefully examined. Applicable RMS flight rules will be described during the lesson. If desired, combine this class with the Cupola station for SSRMS activities.

Objectives:  
- Perform the Station element task, avoiding reach limits and singularities, as defined in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS).
- Perform berth, latch, and ungrapple per the PDRS OPS C/L FS, as applicable.
- Discuss flight rules that apply to various RMS operations.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
PDRS Lesson Descriptions

84  **PDRS SJ TSK X 91173**

Title: Payload Deployment and Retrieval System Single Joint  
(Station Element Build) Task X  
Duration: 2.0 hours  
Medium: Dynamic Skills Trainer 4  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS N-TSK X 92069  
Preparation: None

Synopsis: This lesson will be scheduled for each Station element task. The lessons will allow the arm operator to perform a Single Joint (SJ) Station element task with the flight-specific Station element. All operations will be visual only -- no digitals will be used. The arm will begin in the position as determined by the task, and the operator will perform the PDRS operations in SJ.

Objectives:  
- Perform the SJ Station element task as specified in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS).  
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

85  **PDRS NOM TSK X 91012**

Title: Payload Deployment and Retrieval System Nominal (Station Build)  
Task X  
Duration: 4.5 hours  
Medium: SMS-FB (GNS), SSTF (Check with instructor if required.)  
Student: COMMANDER, MS 2, PILOT, R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: Equipment to support mission timeline exercised; request the SSTF crew station, visuals, and TRICK model anytime a combined session using the SSRMS is planned.  
Prerequisite Lesson(s): PDRS NOM TSK X 91001  
Preparation: None
PDRS Lesson Descriptions

85  PDRS NOM TSK X 91012 (Concluded)

Synopsis: During this lesson, the crewmembers will perform the flight-specific PDRS Station build task on the Station element, with an emphasis on the use of FDF and Flight Rules. This lesson will be scheduled for each Station element task. Some malfunctions may be introduced on a review basis. The emphasis should be on Space Flight Resource Management (SFRM). A script meeting may be required to determine the specific objectives and insert malfunctions into the timeline, if necessary.

Objectives:
- Perform all PDRS operations of the Station build task as called out in the timeline while performing other timelined activities.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

86  PDRS SJ TSK X 91069

Title: Payload Deployment and Retrieval System Single Joint (Station Element Build) Task X
Duration: 3.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS NOM TSK X 91012
Preparation: None

Synopsis: This lesson will be scheduled for each Station element task. The lessons will allow the arm operator to perform a Single Joint (SJ) arm. Emphasis will be placed on RMS dynamics. At the start of the lesson, the arm will be positioned at the beginning of the Station element task. The arm will be maneuvered via the SJ procedures in the flight-specific PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS).

Objectives:
- Perform the flight-specific Station element task with a SJ arm.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
PDRS Lesson Descriptions

87  **PDRS ELE MAL X 91012**

Title: Payload Deployment and Retrieval System (Station) Element Malfunction X  
Duration: 4.5 hours  
Medium: SMS-FB (GNS), SSTF (Check with instructor if required.)  
Student: COMMANDER, MS 2, PILOT, R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 02/07  
Lesson(s) Replaced: None  
Equipment Required: Equipment to support mission timeline exercised; request SSTF crew station, visuals, and TRICK model anytime a combined session using the SSRMS is planned.  
Prerequisite Lesson(s): PDRS ELE MAL X 91001  
Preparation: None  
Synopsis: This lesson will be scheduled for each Station element. During the lesson, the crewmembers will perform the flight-specific Station element PDRS operations as impacted by the malfunctions and/or instructor-provided scenario, with an emphasis on the use of FDF and Flight Rules. The emphasis should be on Space Flight Resource Management (SFRM). A script meeting will be required to determine the specific objectives and insert malfunctions into the timeline.  
Objectives: • Perform the Station element tasks impacted by PDRS malfunctions. This may include execution of contingency operations for the Station element as determined by Flight Rules and CAPCOM calls. • Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

88  **PDRS/EVA FAM X 91001**  
Title: Payload Deployment and Retrieval System/Extravehicular Activity Familiarization X  
Duration: 1.0 hour  
Medium: Classroom  
Student: EV1, EV2, IV, R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS OPS 91001  
Preparation: None
**PDRS Lesson Descriptions**

**88 PDRS/EVA FAM X 91001 (Concluded)**

**Synopsis:** During this lesson, the RMS and EVA operators will sit down with the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) and EVA C/L FS and instructors to discuss the flow of the EVA from the RMS position perspective. During this discussion, the crew will gain a more in-depth awareness of the operations from both sides.

**Objectives:** Describe the RMS/EVA task positions.

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**89 PDRS/EVA OPS X 91016**

**Title:** Payload Deployment and Retrieval System/Extravehicular Activity Operations X

**Duration:** 4.0 hours

**Medium:** Virtual Reality Trainer

**Student:** EV1, EV2, IV, R1, R2

**Source:** DX25/Robotics Shuttle Training

**Date:** 09/03

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** PDRS/EVA FAM X 91001

**Preparation:** None

**Synopsis:** During this session, the whole crew will exercise an entire day of RMS/EVA operations per the flight-specific PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). During execution, the RMS/EVA positions and attitudes will be assessed from an RMS operator and EVA point of view for efficiency and accessibility. Voice protocol for Ground Controlled Approach (GCA) and high situational awareness will be emphasized. Off-nominal EVA positions close to the final position values and close to structure will be used to emphasize the need for high situational awareness.

**Objectives:**

- Perform the flight-specific PDRS OPS C/L FS procedures for the EVA day.
- Demonstrate proper voice protocol.

**Note:** Class credit can be given for NBL simulation time.
PDRS Lesson Descriptions

90  PDRS/EVA TSK X 91025

Title:  Payload Deployment and Retrieval System/Extravehicular Activity
        Task X
Duration:  2.0 hours
Medium:  Dynamics Skills Trainer 1 or DST 2, 3, 4 or 5
Student:  R1, R2 (Schedule individually.)
Source:  DX25/Robotics Shuttle Training
Date:  02/07
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  PDRS/EVA OPS X 91016
Preparation:  None

Synopsis: This lesson will be scheduled for each EVA day utilizing the RMS. This lesson will allow the operator to perform simulated RMS/EVA operations for the flight-specific payload tasks utilizing flight-like EVA hardware. During this lesson, the operator will perform RMS/EVA maneuvers as noted in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Close attention shall be given to peculiar maneuvers that may come close to reach limits and singularities. Window and CCTV views will be determined, and any visual obstructions will also be noted. Voice protocol for Ground Controlled Approach (GCA) and high situation awareness will be emphasized. Off-nominal EVA positions close to the final position values and close to structure will be used to emphasize the need for high situational awareness.

Objectives:
• Describe the RMS/EVA task positions.
• Describe visual obstructions and window/CCTV view familiarization.
• Perform RMS/EVA flight-specific payload tasks per the PDRS OPS C/L FS.
• Recognize reach limit and singularity constraints, as applicable.
• Demonstrate appropriate use of Dynamic Skills Trainer (DST) for future self study.
PDRS Lesson Descriptions

91 PDRS/EVA OPS X 91069

Title: Payload Deployment and Retrieval System/Extravehicular Activity Operations X

Duration: 3.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: R1, R2 (Schedule individually or together.)

Source: DX25/Robotics Shuttle Training

Date: 02/07

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS/EVA TSK X 91025

Preparation: None

Synopsis: This lesson will allow the operator to perform simulated RMS/EVA operations for the flight-specific payload tasks with simulated RMS dynamics. During this lesson, the operator will perform the RMS/EVA maneuvers as noted in the PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Off-nominal modes may be utilized to prepare the student for possible failure scenarios (e.g., Single Joint (SJ) operations). Close attention shall be given to peculiar maneuvers that may come close to reach limits and singularities. Window and CCTV views will be determined, and any visual obstructions will also be noted. Voice protocol for Ground Controlled Approach (GCA) and high situational awareness will be emphasized. Off nominal EVA positions close to the final position values and close to structure will be used to emphasize the need for high situational awareness.

Objectives:
- Describe visual obstructions and window/CCTV view familiarization.
- Perform RMS/EVA flight-specific payload tasks per the PDRS OPS C/L FS.
- Recognize reach limit and singularity constraints, as applicable.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
**PDRS Lesson Descriptions**

### 92 PDRS/EVA DAY X 91016

**Title:** Payload Deployment and Retrieval System/Extravehicular Activity Day X  
**Duration:** 2.0 hours  
**Medium:** Virtual Reality Trainer  
**Student:** EV1, EV2, IV, R1, R2  
**Source:** DX25/Robotics Shuttle Training  
**Date:** 02/07  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** PDRS/EVA OPS X 91069  
**Preparation:** None

**Synopsis:** During this session, the whole crew will exercise the RMS/EVA positions and attitudes for the flight-specific EVA day. The crew will perform the RMS/EVA operations per the flight-specific PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS). Voice protocol for Ground Controlled Approach (GCA) and high situational awareness will be emphasized. Off-nominal EVA positions close to the final position values and close to structure will be used to emphasize the need for high situational awareness. Last minute changes to procedures are suggested to be practical during this session if applicable.

**Objectives:**
- Perform the flight-specific PDRS OPS C/L FS procedures for the EVA day.
- Demonstrate proper voice protocol.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

**Note:** Class credit may be given for NBL simulation time.

### 93 PDRS LSN LRN 91001

**Title:** Payload Deployment and Retrieval System Lessons Learned  
**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** COMMANDER, MS 2, PILOT, R1, R2  
**Note:** Schedule NET L-10 weeks  
**Source:** DX25/Robotics Shuttle Training  
**Date:** 02/07  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** None  
**Preparation:** None
PDRS Lesson Descriptions

93  PDRS LSN LRN 91001 (Concluded)
Synopsis: This briefing is designed to discuss lessons learned from previous missions involving PDRS operations. It will be used as a forum to brief the student(s) on items of interest and last minute “what-if” scenarios.

Objectives: • Discuss PDRS/EVA lessons learned from previous mission operations including malfunctions.
• Describe PDRS techniques used on previous missions.
• Review PDRS Lessons Learned Checklist from PDRS OPS 91001 briefing and any other recent flight lessons learned.

94  PDRS TPS OBSS H/O 91069
Title: Payload Deployment and Retrieval System TPS OBSS Handoff
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule together.)
Source: DX25/Robotics Shuttle Training
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS UNDK SJ OBSS 21069, LCS EQ 31001, LDRI EQ 31001
Preparation: None

Synopsis: This lesson focuses on the docked PDRS procedures pertaining to the Orbiter Boom Sensor System (OBSS) nominal and single joint handoff operations.

Objectives: • Perform docked SSRMS handoff of the OBSS to the SRMS. This is to be performed using SRMS nominal and single joint procedures.
• Perform docked SRMS handoff of the OBSS to the SSRMS. This is to be performed using SRMS nominal and single joint procedures.
• Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
PDRS Lesson Descriptions

95  PDRS TPS OBSS H/O 91121

Title: Payload Deployment and Retrieval System TPS OBSS Handoff
Duration: 3.0 hours
Medium: SMS-FB/SSTF (SESD/Cupola)
Student: COMMANDER, MS 2, PILOT, R1, R2, M1, M2
Source: DX25/Robotics Shuttle Training, DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: PDRS DOCK SURVEY 91121
Equipment Required: Request the SSTF crew station, visuals, and TRICK model anytime a combined session using the SSRMS is planned.
Prerequisite Lesson(s): PDRS TPS OBSS H/O 91069
Preparation: None
Note: This lesson should be scheduled in conjunction with the Mobile Servicing System (MSS) Thermal Protection System (TPS) Orbiter Boom Sensor System (OBSS) Handoff (H/O) 91069 listed in the ISS Crew Training Catalog (CTC).

Synopsis: This lesson focuses on the docked PDRS procedures pertaining to the Orbiter Boom Sensor System (OBSS).

Objectives:
• Perform docked SSRMS grapple of OBSS, and handoff the OBSS to the SRMS.
• SRMS perform a docked focused inspection with the OBSS.
• SRMS handoff the OBSS to SSRMS and SSRMS berth OBSS.
• Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

96  PDRS OBSS FOC INSPI 91069

Title: Payload Deployment and Retrieval System OBSS Focused Inspection
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule together.)
Source: DX25/Robotics Shuttle Training
Date: 06/08
Lesson(s) Replaced: PDRS UNDOCK SURVEY 91069
Equipment Required: None
Prerequisite Lesson(s): PDRS TPS OBSS H/O 91121
Preparation: None

Synopsis: This lesson focuses on PDRS focused inspection procedures with the Orbiter Boom Sensor System (OBSS).
PDRS Lesson Descriptions

96  **PDRS OBSS FOC INSP 91069 (Concluded)**

Objectives:
- Perform Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) review using setup checklist with DOUG target file.
- Perform a focused inspection using focused inspection procedures from a previous flight.
- Demonstrate appropriate use of RSAD and DOUG for each task.

97  **PDRS TPS REPAIR 91069**

**Title:** Payload Deployment and Retrieval System Thermal Protection System (TPS) Repair  
**Duration:** 2.0 hours  
**Medium:** Shuttle Engineering Simulator Dome  
**Note:** This lesson can be done in the SES-D (or VR Lab).  
**Student:** R1, R2, EV1, EV2 (Schedule together.)  
**Source:** DX25/Robotics Shuttle Training  
**Date:** 06/08  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** PDRS OBSS FOC INSP 91069  
**Preparation:** None  
**Note:** Scheduling this lesson with the EVA BOOM OPS TBD lesson should be considered.

**Synopsis:** This lesson focuses on PDRS contingency TPS repair with EV1 based on the Orbiter Boom Sensor System (OBSS).

**Objectives:**
- Perform a contingency TPS repair with EV1 based on the OBSS including EV ingress, maneuver to repair position, and maneuver back to egress.  
- Demonstrate appropriate Ground Control Assist (GCA) in support of TPS repair.  
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
PDRS Lesson Descriptions

98  **PDRS OBSS BERTH 91069**

Title:  Payload Deployment and Retrieval System Orbiter Boom Sensor System (OBSS) Berth  
Duration:  2.0 hours  
Medium:  Shuttle Engineering Simulator Dome  
Student:  R1, R2 (Schedule together.)  
Source:  DX25/Robotics Shuttle Training  
Date:  06/08  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  PDRS TPS REPAIR 91069  
Preparation:  None  

Synopsis:  This lesson focuses on PDRS Orbiter Boom Sensor System (OBSS) berthing operations.

Objectives:  
- Perform several OBSS berths using the thermal model distortion models developed during STS-114.  
- Demonstrate appropriate use of T markings taking into account parallax between the OBSS and starboard manipulator positioning mechanisms.  
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

99  **PDRS SURVEY DAY 91012**

Title:  Payload Deployment and Retrieval System Survey Day  
Duration:  8.0 hours  
Medium:  SMS-FB  
Student:  COMMANDER, MS 2, PILOT, R1, R2  
Source:  DX25/Robotics Shuttle Training  
Date:  02/07  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  PDRS OBSS BERTH 91069, LDRI OPS 31012  
Preparation:  None

Synopsis:  This lesson focuses on PDRS flight day two operations. Flight Day One operations may also be used if desired.
PDRS Lesson Descriptions

99  PDRS SURVEY DAY 91012 (Concluded)

Objectives:
- Perform PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures pertaining to flight day two.
- Perform Orbiter Boom Sensor System (OBSS) grapple and unberth.
- Perform OBSS survey.
- Perform OBSS berth and release.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.

100  PDRS SRVY DAY RVW 91121

Title: Payload Deployment and Retrieval System Survey Day Review
Duration: 4.0 hours
Medium: SMS-FB/SSTF (SESD/Cupola)
Student: COMMANDER, MS 2, PILOT, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS SURVEY DAY 91012
Preparation: None

Synopsis: This lesson provides a review and focuses on PDRS flight day two operations. Flight Day One operations may also be used if desired.

Objectives:
- Perform PDRS Operations (OPS) Checklist (C/L) Flight Supplement (FS) procedures pertaining to flight day two.
- Perform Orbiter Boom Sensor System (OBSS) grapple and unberth.
- Perform OBSS starboard survey.
- Perform/Discuss pan/tilt crosshair operation communication with Thermal Protection System (TPS) Imagery Coordinator/Instrumentation and Communications Officer/Payload Deployment and Retrieval System/Capsule Communication (TIC/INCO/PDRS/CAPCOM).
- Perform OBSS berth and release as time permits.
- Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
PDRS Lesson Descriptions

101  PDRS ORM TSK 91069
Title: Payload Deployment and Retrieval System ORM Task
Duration: 7.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule together.)
Source: DX25/Robotics Shuttle Training
Date: 11/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS OPS 91001
Preparation: None

Synopsis: This lesson focuses on the docked PDRS procedures pertaining to the Orbiter Repair Maneuver (ORM) task and/or the Shuttle Development Test Objective (DTO) pertaining to the ORM.

Objectives:
- Perform docked grapple of the Pressurized Mating Adapter (PMA), undock, and perform auto sequence maneuver from the undocked position to the repair position.
- Discuss the situational awareness cues needed from ISS.
- Discuss the repair procedure.
- Perform auto sequence from the repair position to the pre-docked position.

102  PDRS ORM OPS 91121
Title: Payload Deployment and Retrieval System ORM Operations
Duration: 8.0 hours
Medium: SMS-FB/SSTF (SESD/Cupola)
Student: COMMANDER, MS 2, PILOT, R1, R2, M1, M2
Source: DX25/Robotics Shuttle Training, DX23/Station Mechanical & Robotic Systems Training
Date: 11/04
Lesson(s) Replaced: None
Equipment Required: Request the SSTF crew station, visuals, and TRICK model anytime a combined session using the SSRMS is planned.
Prerequisite Lesson(s): PDRS ORM TSK 91069
Preparation: None

Note: This lesson should be scheduled in conjunction with the Mobile Servicing System (MSS) Thermal Protection System (TPS) Orbiter Repair Maneuver (ORM) VIEW 91025 lesson listed in the ISS Crew Training Catalog (CTC).
PDRS Lesson Descriptions

102  PDRS ORM OPS 91121 (Concluded)

Synopsis: This lesson is a full dress rehearsal for the docked PDRS procedures pertaining to the Orbiter Repair Maneuver (ORM) operation and/or the Shuttle DTO pertaining to the ORM.

Objectives: • Perform docked grapple of the Pressurized Mating Adapter (PMA), undock, and perform auto sequence maneuver from the undocked position to the repair position.
• Demonstrate the coordination of the situational awareness cues needed from ISS.
• Discuss the repair procedure.
• Perform auto sequence from the repair position to the pre-docked position, dock the orbiter to the ISS, and ungrapple the PMA.

PDRS PRF ADV 41025

Title: Payload Deployment and Retrieval System Proficiency Advanced
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 02/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides a review of those RMS operations supported by the DST. The student will determine which operations to review and may repeat this lesson as desired without instructor involvement.

Objectives: • The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.
• Demonstrate appropriate use of Remote Manipulator System (RMS) Situational Awareness Display (RSAD) and Dynamic Onboard Ubiquitous Graphics (DOUG) for each task.
• Demonstrate appropriate use of Dynamic Skills Trainer (DST) for future self study.
PDRS Lesson Descriptions

PDRS PRF ADV 41001

Title: Payload Deployment and Retrieval System Proficiency Advanced
Duration: 0.5 hours
Medium: Classroom
Student: R1, R2 (Schedule individually or in pairs.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides a review of systems and operations best covered in a classroom environment. The specific content of the lesson will be determined by the student and instructor. The lesson may be repeated as desired.

Objectives: The objectives for this lesson will be determined by the student and the instructor on a case-by-case basis.

PDRS PRF ADV 41069

Title: Payload Deployment and Retrieval System Proficiency Advanced
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson provides a review of those RMS operations that are best supported by the SES. It is recommended that this lesson be taken on a periodic basis to maintain the proficiency of RMS operators. The instructor will select items for review prior to the session. This lesson may be repeated as desired, on an availability basis, but is recommended at least once every 3 months after qualification, on an alternating basis with PDRS PRF ADV 41025 and PDRS PRF ADV 41012.

Objectives: The objectives for this lesson will be assessed on a case-by-case basis by the RMS flight instructor, or by the PDRS training flow supervisor or lesson instructor should there be no assigned flight instructor.
PDRS Lesson Descriptions

**PDRS PRF ADV 41012**

Title: Payload Deployment and Retrieval System Proficiency Advanced  
Duration: 2.0 hours  
Medium: SMS-FB (GNS), SSTF (Check with instructor if required.)  
Student: COMMANDER, R1, R2 (Schedule individually or in pairs.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: Request SSTF crew station, visuals, TRICK model anytime a combined session using SSRMS is planned.  
Prerequisite Lesson(s): None  
Preparation: None  
Synopsis: This lesson provides for a review of those RMS operations requiring crew coordination and orbiter interfaces. It is recommended that this lesson be taken on a periodic basis to maintain the proficiency of RMS operators. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis, but is recommended at least once every 3 months, on an alternating basis with PDRS PRF ADV 41025 and PDRS PRF ADV 41069.  
Objectives: The objectives for this lesson will be assessed on a case-by-case basis by the RMS flight instructor, or by the PDRS training flow supervisor or lesson instructor should there be no assigned flight instructor.

**CONUL RVW 41025**

Title: Contingency-Only Unloaded Payload Deployment and Retrieval System Review  
Duration: 2.0 hours  
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None
PDRS Lesson Descriptions

CONUL RVW 41025 (Concluded)

Synopsis: This lesson provides a review of those contingency-only unloaded RMS operations supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

CONUL PRF 41069

Title: Contingency-Only Unloaded Payload Deployment and Retrieval System Proficiency

Duration: 2.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: COMMANDER, R1, R2 (Schedule individually.)

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): None

Preparation: None

Synopsis: This lesson provides for a review of those contingency-only unloaded RMS operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every month.

Objectives: The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.

CONUL RVW 41012

Title: Contingency-Only Unloaded Payload Deployment and Retrieval System Review

Duration: 2.0 hours

Medium: SMS-FB (GNS)

Student: COMMANDER, R1, R2

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): None

Preparation: None
PDRS Lesson Descriptions

CONUL RVW 41012 (Concluded)

Synopsis: This lesson provides a review of those contingency-only unloaded RMS operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

UL RVW 41025

Title: Unloaded Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS UL SJ 91069, UNLD MAL T/L 91012 (ORB FO)
Preparation: None

Synopsis: This lesson provides a review of those unloaded RMS operations supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

UL PRF 41069

Title: Unloaded Payload Deployment and Retrieval System Proficiency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS UL SJ 91016, UNLD MAL T/L 91012 (ORB FO)
Preparation: None
# PDRS Lesson Descriptions

## UL PRF 41069 (Concluded)

**Synopsis:** This lesson provides a review of those unloaded RMS operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after completion of scheduled flight-specific SES training.

**Objectives:** The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.

## UL RVW 41012

**Title:** Unloaded Payload Deployment and Retrieval System Review  
**Duration:** 2.0 hours  
**Medium:** SMS-FB (GNS)  
**Student:** COMMANDER, R1, R2  
**Source:** DX25/Robotics Shuttle Training  
**Date:** 09/03  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** PDRS UL SJ 91016, UNLD MAL T/L 91012 (ORB FO)  
**Preparation:** None  

**Synopsis:** This lesson provides a review of those unloaded RMS operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired, on an availability basis.

**Objectives:** The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

## LOAD RVW 41025

**Title:** Loaded Payload Deployment and Retrieval System Review  
**Duration:** 2.0 hours  
**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5  
**Student:** R1, R2 (Schedule individually.)  
**Source:** DX25/Robotics Shuttle Training  
**Date:** 09/03  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** PDRS LD CON 92069, RMS/PL CONT 91012 (ORB FO)  
**Preparation:** None
PDRS Lesson Descriptions

**LOAD RVW 41025 (Concluded)**

Synopsis: This lesson provides a review of those loaded RMS operations that are best supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

**LOAD PRF 41069**

Title: Loaded Payload Deployment and Retrieval System Proficiency  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome  
Student: R1, R2 (Schedule individually.)  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS LD CON 92069, RMS/PL CONT 91012 (ORB FO)  
Preparation: None  

Synopsis: This lesson provides for a review of those loaded RMS operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after completion of the last scheduled SES lesson.

Objectives: The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.

**LOAD RVW 41012**

Title: Loaded Payload Deployment and Retrieval System Review  
Duration: 2.0 hours  
Medium: SMS-FB (GNS)  
Student: COMMANDER, R1, R2  
Source: DX25/Robotics Shuttle Training  
Date: 09/03  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): PDRS LD CON 92069, RMS/PL CONT 91012 (ORB FO)  
Preparation: None
LOAD RVW 41012 (Concluded)

Synopsis: This lesson provides a review of those loaded RMS operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

DPLY RVW 41025

Title: Deploy Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS DPLY CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None

Synopsis: This lesson provides a review of those deploy RMS operations supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

DPLY PRF 41069

Title: Deploy Payload Deployment and Retrieval System Proficiency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS DPLY CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None
PDRS Lesson Descriptions

**DPLY PRF 41069 (Concluded)**

Synopsis: This lesson provides a review of those deploy RMS operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after the completion of the last scheduled SES lesson.

Objectives: The objectives for the lesson will be determined by the instructor and student on a case-by-case basis.

**DPLY RVW 41012**

Title: Deploy Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS DPLY CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None

Synopsis: This lesson provides a review of those deploy RMS operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

**RETR RVW 41025**

Title: Retrieve Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None
PDRS Lesson Descriptions

RETR RVW 41025 (Concluded)

Synopsis: This lesson provides a review of those retrieve RMS operations that are best supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

RETR PRF 41069

Title: Retrieve Payload Deployment and Retrieval System Proficiency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None

Synopsis: This lesson provides a review of those retrieve RMS operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after the last scheduled SES lesson.

Objectives: The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.

RETR RVW 41012

Title: Retrieve Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS RETR CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None
PDRS Lesson Descriptions

RETR RVW 41012 (Concluded)

Synopsis: This lesson provides a review of those retrieve RMS operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

D&R RVW 41025

Title: Deploy and Retrieve Payload Deployment and Retrieval System Review

Duration: 2.0 hours

Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5

Student: R1, R2 (Schedule individually.)

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS D&R CON 92069, RMS/PL CONT 91012 (ORB FO)

Preparation: None

Synopsis: This lesson provides a review of those deploy and retrieve RMS operations that are best supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

D&R PRF 41069

Title: Deploy and Retrieve Payload Deployment and Retrieval System Proficiency

Duration: 2.0 hours

Medium: Shuttle Engineering Simulator Dome

Student: R1, R2 (Schedule individually.)

Source: DX25/Robotics Shuttle Training

Date: 09/03

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): PDRS D&R CON 92069, RMS/PL CONT 91012 (ORB FO)

Preparation: None
PDRS Lesson Descriptions

D&R PRF 41069 (Concluded)

Synopsis: This lesson provides a review of those deploy and retrieve RMS operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after completion of the last scheduled SES lesson.

Objectives: The objectives for this lesson will be determined by instructor and student on a case-by-case basis.

D&R RVW 41012

Title: Deploy and Retrieve Payload Deployment and Retrieval System Review
Duration: 2.0 hours
Medium: SMS-FB (GNS)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS D&R CON 92069, RMS/PL CONT 91012 (ORB FO)
Preparation: None

Synopsis: This lesson provides a review of those deploy and retrieve RMS operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

PDRS TSK RVW 41025

Title: Payload Deployment and Retrieval System (Station Element) Task Review
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS ELE MAL X 91012
Preparation: None
PDRS Lesson Descriptions

PDRS TSK RVW 41025 (Concluded)

Synopsis: This lesson provides a review of those Station element RMS tasks that are best supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.

PDRS TSK PRF 41069

Title: Payload Deployment and Retrieval System (Station Element) Task Proficiency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS ELE MAL X 91012
Preparation: None

Synopsis: This lesson provides for a review of those Station element RMS tasks that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after completion of the last scheduled SES lesson.

Objectives: The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.

ELE/TSK RVW 41012

Title: (Station) Element/Task Review
Duration: 2.0 hours
Medium: SMS-FB (GNS), SSTF (Check with instructor if required.)
Student: COMMANDER, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: Request the SSTF crew station, visuals, and TRICK model anytime a combined session using the SSRMS is planned.
Prerequisite Lesson(s): PDRS ELE MAL X 91012
Preparation: None
PDRS Lesson Descriptions

**ELE/TSK RVW 41012 (Concluded)**

**Synopsis:** This lesson provides a review of those Station element RMS tasks requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

**Objectives:** The objectives for this lesson will be determined by the instructor and student(s) on a case-by-case basis.

**PDRS/EVA RVW 41025**

**Title:** Payload Deployment and Retrieval System/Extravehicular Activity Review

**Duration:** 2.0 hours

**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5

**Student:** R1, R2 (Schedule individually.)

**Source:** DX25/Robotics Shuttle Training

**Date:** 09/03

**Lesson(s) Replaced:** None

**Equipment Required:** None

**Prerequisite Lesson(s):** PDRS/EVA DAY X 91016

**Preparation:** None

**Synopsis:** This lesson provides a review of those RMS/EVA operations that are best supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

**Objectives:** The objectives for this lesson will be determined by the student and instructor on a case-by-case basis.
PDRS Lesson Descriptions

PDRS/EVA PRF 41069

Title: Payload Deployment and Retrieval System/Extravehicular Activity
Proficiency
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS/EVA DAY X 91016
Preparation: None

Synopsis: This lesson provides a review of those RMS/EVA operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after completion of the last scheduled SES lesson.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.

PDRS/EVA RVW 41016

Title: Payload Deployment and Retrieval System/Extravehicular Activity
Review
Duration: 2.0 hours
Medium: Virtual Reality Trainer
Student: EV1, EV2, IV, R1, R2
Source: DX25/Robotics Shuttle Training
Date: 09/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS/EVA DAY X 91016
Preparation: None

Synopsis: This lesson provides a review of those RMS/EVA operations requiring full crew coordination. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.
PDRS Lesson Descriptions

PDRS/OBSS RVW 41025

Title: Payload Deployment and Retrieval System/Orbiter Boom Sensor System Review
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4 or 5
Student: R1, R2 (Schedule individually.)
Source: DX25/Robotics Shuttle Training
Date: 03/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS SURVEY DAY 91012
Preparation: None

Synopsis: This lesson provides a review of those RMS/Orbiter Boom Sensor System (OBSS) operations that are best supported by the DST. The student will determine which operations to review, and may repeat this lesson as desired without instructor involvement.

Objectives: The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.

PDRS/OBSS RVW 41069

Title: Payload Deployment and Retrieval System/Orbiter Boom Sensor System Review
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome
Student: R1, R2 (Schedule together.)
Source: DX25/Robotics Shuttle Training
Date: 03/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PDRS SURVEY DAY 91012
Preparation: None

Synopsis: This lesson provides a review of those RMS/Orbiter Boom Sensor System (OBSS) operations that are best supported by the SES. The instructor and student will select items for review prior to the session. This lesson may be repeated as desired on an availability basis, but is recommended at least once every 2 weeks after completion of the last scheduled SES lesson.

Objectives: The objectives for this lesson will be determined by the instructor and student on a case-by-case basis.
PDRS Lesson Descriptions

PDRS/OBSS RVW 41121

Title: Payload Deployment and Retrieval System/Orbiter Boom Sensor System Review

Duration: 2.0 hours (or more if desired)

Medium: SMS-FB/SSTF (SESD/Cupola)

Student: R1, R2 (Schedule together.)

Source: DX25/Robotics Shuttle Training

Date: 03/04

Lesson(s) Replaced: None

Equipment Required: Request the SSTF crew station, visuals, and TRICK model anytime a combined session using the SSRMS is planned.

Prerequisite Lesson(s): PDRS SURVEY DAY 91012

Preparation: None

Synopsis: This lesson provides a review of those RMS/Orbiter Boom Sensor System (OBSS) operations requiring crew coordination and orbiter interfaces. The instructor and students will select items for review prior to the session. This lesson may be scheduled as desired on an availability basis.

Objectives: The objectives for this lesson will be determined by the instructor and students on a case-by-case basis.
SECTION 10.0 RENDEZVOUS/PROXIMITY OPERATIONS
TRAINING COURSE

The Rendezvous/Proximity Operations Training Course documents the training required for the CDR, PLT, and MS for Planned Rendezvous (Rndz), Deploy only, Deploy plus Proximity Operations (Prox Ops), and EVA Rescue. A core Rendezvous flow is included for CAPCOMs and Pilot Pool crews. The CDR will select the MS responsible for Rendezvous and Prox Ops support. An EVA crewmember should be avoided for this selection. A transfer crewmember for Station shall not be assigned to any rendezvous task.

Prior to starting rendezvous training, a student should consider taking MAN MNVR 21025 and the ORBIT DAP CBT lesson.

The training required consists of the following:

PLANNED or Planned Contingency Rendezvous (i.e., Station, HST):
Take the entire flow (20000 + 30000 + 90000)

CORE Rendezvous Flow (“CAPCOM” or “Pilot Pool” Flow):
Take 20000-level DEPLOY and RNDZ CORE Flow only

DEPLOY; planned or contingency PROX OPS return (i.e., EURECA):
Take: “DEPLOY CORE”
APP & F/A 31069
PO APPR 31069

DEPLOY ONLY (no planned return) (i.e., IUS):
Take: “DEPLOY CORE”
Orbit FO: PROX OPS T/L 91012 (may be deleted if objectives are met in another session)

EVA Rescue:
Take: PROX INTRO 21001
PROX INTRO 21069
EVA RESCUE 21001/21069

A crewmember is qualified to support a generic rendezvous integrated simulation upon completion of core training (20000-level) in the Rendezvous training flow, as long as proficiency is maintained at the advanced level. RNDZ PRF ADV 41006, R/PO PRF ADV 41069, and a sim-pack briefing need to have been taken within one month of the integrated simulation. This requirement can be waived if a crewmember supported an integrated simulation within the past 3 months.

After completion of the Planned Rendezvous Training or Contingency Rendezvous training, proficiency is maintained at the advanced level by taking R/PO PRF ADV 41069 and RNDZ PRF ADV 41006 every 6 months.
If a crewmember is qualified at the advanced level, the flight requirements for the core Rendezvous training can be met by taking RNDZ PRF ADV 41006 and EVA RESCUE 21069, and R/PO PRF ADV 41069, and then taking RNDZ QUAL 41006 and R/PO QUAL 41069. These lessons should be taken within one month of each other and need to be completed no sooner than L-12 weeks.

Lapsed proficiency may be regained by taking the following lessons:

- RNDZ PRF ADV 41006
- R/PO PRF ADV 41069
- RNDZ QUAL 41006
- R/PO QUAL 41069

PLANNED or Planned Contingency Rendezvous (i.e., HST):
Take the entire flow (20000 + 30000 + 90000)

The 30000-Level training is set up to start at L-6 months and should proceed at one session/week.

The 90000-Level training is set up to include integrated simulations to support the 1 session/week guideline. Standalone training has been reduced since the crew will practice the techniques required by the Flight Requirements Document during integrated simulations. Therefore, these simulations are required to cover tasks such as flyarounds, separations, and breakouts. The proficiency requirement is a minimum of 1 session every 2 weeks, which can include DST, Shuttle Engineering Simulator (SES), or SMS sessions.
The DPLY and RETR lessons from the Orbit flow may be taken during the same week as a Rendezvous/Prox ops lesson. If this plan is followed, proficiency lessons should not be required unless the launch date slips. The Rendezvous Training Philosophy is documented in the Rendezvous Instructor Handbook and should be followed for this training course.
DEPLOY CORE Training
Ready for Generic Deploy

Figure 10-1. Planned Rendezvous/Prox Ops Training Flow Chart
(Sheet 1 of 3)
Ready for RNDZ
Integrated Sims

CORE TRAINING

R/PO QUAL
41069 4

R/PO PRF ADV
41069 4/26

R/PO PRF ADV
41025 2/26

RNDZ QUAL
41006 2

RNDZ QUAL
21069 4

RNDZ QUAL
21069 33

RNDZ REVIEW
41001 2

RNDZ OPS
21012 5

RNDZ CRM BR
21001 1.5

APP & GRAP
21069 2 26

APP & DOCK
22069 2 28B

APP & DOCK
2201 2 28B

RNDZ MAN PH
22069 2 27B

RNDZ MAN PH
22001 0.5 27A

DST MAN PH
61025 2 25

AP & F/A
21069 2 16B

AP & F/A
21001 0.5 16A

RNDZ MAN PH
21069 4 23

AP & F/A
21069 2 21

AP & F/A BR
21001 2 20

AP & F/A
21001 2 21

DOCK ATT
21069 2 24B

DOCK ATT
21001 0.5 24A

RNDZ MAN PH BR
21001 0.5 22

APDS OPS
21029 1.5 19

APDS FAM
21205 1.5 18

APDS
21057 2 17

Figure 10-1. Planned Rendezvous/Prox Ops Training Flow Chart
(Sheet 2 of 3)
Figure 10-1. Planned Rendezvous/Prox Ops Training Flow Chart (Sheet 3 of 3)
Table 10-1. Rendezvous/Proximity Operations
Crew Training Requirements

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Stage Totals Per Crewmember: 7

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Sub Total for Stage: 36.5
Stage Totals Per Crewmember: 36.5

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Stage Totals Per Crewmember: 31

NOTE: 1. MS assigned to RNDZ should not be an EVA MS.
2. Gen RNDZ 31042 can substitute for RNDZ MAL 31012 or 32012.
3. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC or photo/TV setups or Flight Day 1 deploy.
Table 10-1. Rendezvous/Proximity Operations
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NOTE: 1. MS assigned to RNDZ should not be an EVA MS.
2. Gen RNDZ 31042 can substitute for RNDZ MAL 31012 or 32012.
3. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC or photo/TV setups or Flight Day 1 deploy.
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**NOTE:**
1. MS assigned to RNDZ should not be an EVA MS.
2. Gen RNDZ 31042 can substitute for RNDZ MAL 31012 or 32012.
3. As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson. This should be scheduled for all flights with complicated PGSC or photo/TV setups or Flight Day 1 deploy.
Rendezvous/Proximity Operations Lesson Descriptions

1  RNDZ TRNG OV BR 21001
Title: Rendezvous/Proximity Operations Training Overview Briefing
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): OGNC QUAL 21006 (N ASTRO), ORB MAN ATT 21012 (N ASTRO)
Preparation: None
Synopsis: This briefing identifies the facilities used, organization and the philosophy of the Rendezvous/Proximity Operations (Prox Ops) training flow.
Objectives: • Prepare student to start the rendezvous training flow.
• Identify training and reference sources.

2  RNDZ CT HB 21007
Title: Rendezvous Crew Training Handbook
Duration: 5.0 hours
Medium: Text
Student: COMMANDER, MS, PILOT (Other crewmembers may read.) (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 09/01
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Synopsis: The Rendezvous Crew Training Handbook is a collection of student handouts, briefings, and lessons in the Rendezvous/Prox Ops training flow. The material should be reviewed prior to attending each lesson, and should be brought to the lesson itself.
Objectives: • Review the outline of the Rendezvous/Prox Ops crew training flow.
• Bring this book to all sessions.
• Review all briefings and simulator (SST/SES/SMS) lesson objectives supplied by instructor prior to each session.
• Prior to each session, the student will be expected to review the section in this book that summarizes the lesson objectives.
PROX INTRO BR 21001

Title: Proximity Operations Introduction Brief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS, PILOT (Other crewmembers may attend.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: Orbiter Model for each student
Prerequisite Lesson(s): RNDZ CT HB 21007
Preparation: None

Synopsis: This briefing will introduce the terms, techniques, and hardware used to perform proximity operations.

Objectives:
- Define proximity operations (prox ops) and describe its characteristics and concerns.
- Define the following prox ops tasks: approach, separation, stationkeeping, transition, and flyaround.
- Describe the use of the DAP and Universal Pointing (UNIV PTG) in prox ops.
- Define the following terms: body vector, omicron, and Low Z.
- Relate aft Translation Hand Controller and Rotational Hand Controller (THC/RHC) inputs to the corresponding orbiter motion.
- Describe Attitude Direction Indicator (ADI) attitudes in +X and -Z sense.
- Describe the use of the following tools in prox ops:
  - Rendezvous Radar (RR)
  - Crew Optical Alignment Sight (COAS)
  - CCTV
- Describe the RR coordinate system.

Completion Standards:
- The student should be able to describe orbiter attitude and motion using a model, based on instructor-specified THC, RHC, ADI, or UNIV PTG inputs.
Rendezvous/Proximity Operations Lesson Descriptions

PROX INTRO 21069

Title: Proximity Operations Introduction
Duration: 2.0 hours
Note: Schedule 3 hours if in SMS-FB.
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: PROX INTRO 21015
Equipment Required: None
Prerequisite Lesson(s): PROX INTRO BR 21001
Preparation: None

Synopsis: In this lesson, the student is introduced to the aft station hardware and Guidance, Navigation, and Control (GNC) software used in prox ops. The student performs maneuvers using the Rotational Hand Controller (RHC), Translation Hand Controller (THC), radar, aft Attitude Direction Indicator (ADI), DAP, and prox ops displays, and will become familiar with the corresponding target movement in the Crew Optical Alignment Sight (COAS). This lesson will also review basic prox ops techniques. The MS should fly one segment of each run.

Objectives:
- Demonstrate an understanding of the use of the following in proximity operations applications:
  - ADI
  - Sense Switch
  - DAP
  - COAS
  - Universal Pointing (UNIV PTG)
  - Ku Radar
  - CCTV
- Use flight controls (THC, RHC, DAP) for proximity operations, and identify the proper target movement and position in the COAS.
- Demonstrate a basic understanding of the following proximity operations techniques:
  - Vbar approach
  - In-plane flyaround (transition)
- Use the CCTV and COAS ranging charts to determine range and range rate when radar is not available (< 100 ft).
- Choose the correct DAP (Low Z vs. Norm Z) based on the range to the target.
- Develop cockpit scan in the aft station.
Rendezvous/Proximity Operations Lesson Descriptions

4  PROX INTRO 21069 (Concluded)

Completion Standards:
- The student should be able to locate and correctly use the displays and controls in the aft station.

5  PROX TECH BR 21001

Title: Proximity Operations Techniques Brief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS, PILOT (Other MSs as assigned.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PROX INTRO 21069
Preparation: None

Synopsis: This briefing introduces the student to proximity operations - the piloting techniques, the crew insight into the orbiter/payload relative motion, and the expected relative motion based on relative position and Translation Hand Controller (THC) inputs. The briefing prepares the student for which cues to monitor during PROX TECH 21069. Rendezvous Tools are also introduced in this lesson. The students will be given the Rendezvous/Prox Ops Program Simulation (RPOPSIM) disk to install on their Personal Computer (PC).

Objectives:
- Define and explain the use of three types of stationkeeping: Vbar, Rbar, and inertial.
- Explain the use of the flight controls and navigation sensors in stationkeeping.
- Define separation and list some concerns regarding: Low Z and crew visibility.
- Define transitions and their use in proximity operations.
- Discuss Vbar, Rbar, and inertial approaches.
- Describe the short-term relative motion resulting from given initial conditions.
- Describe the short-term relative motion resulting from Orbiter Reaction Control System (RCS) cross-coupling.
Rendezvous/Proximity Operations Lesson Descriptions

6 TRAD OV 21195

Title: Tools for Rendezvous and Docking Overview
Duration: 1.5 hours
Medium: Payload General Support Computer (SMS conference room)
Student: COMMANDER, MS, PILOT (Other MSs as assigned.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: 2 PGSCs, HHL, Cables, RPOPSIM Disk, HHL & TCS users guides
Note: Stowage should be called to deliver the required equipment.
Prerequisite Lesson(s): PROX TECH BR 21001
Preparation: None

Synopsis: This briefing introduces the student to the basic Tools for Rendezvous and Docking (TRAD) system. The students should set up this system using the FDF in the Rendezvous Book. The TRAD system for docking flights will be introduced in this lesson.

Objectives:
• Introduce the generic TRAD system.
• Introduce the Trajectory Control Sensor (TCS) system and the use of the Command and Display (CAD) software.
• Identify other tools used in rendezvous and docking.
• Identify and connect the major cables, PGSC and Hand-Held Lidar (HHL) in the flight configuration using FDF and handouts.
• Demonstrate the proper use of the HHL.
• Demonstrate the RPOP:
  – Cable connections.
  – Trajectory and function keys.
  – Views, Tgt/Orb, Point of Reference (POR).
  – Basic operations and display information.
  – HHL modes.
• The HHL User Guide should be given to the students as a guide for self-practice.
• The TCS User Guide should be given to the students.

Completion Standards:
• By the end of rendezvous training, the student should be able to:
  – Define the basic TRAD set-up.
  – Describe the basic use of RPOP and TCS CAD.
  – Define the Modes and use the HHL to get range and range rate.
  – Describe proper aiming and shooting techniques for the HHL.
Rendezvous/Proximity Operations Lesson Descriptions

7 PROX TECH 21069

Title: Proximity Operations Techniques
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: PROX TECH 21015
Equipment Required: PGSC
Prerequisite Lesson(s): PROX TECH BR 21001, TRAD OV 21195
Preparation: None

Synopsis: This lesson introduces the student to several Prox Ops techniques: Vbar and Rbar approaches, separations, transitions, and stationkeeping. The necessary cues and piloting skills required to execute the Prox Ops successfully are practiced for each. The PGSC will be used during the second part of this lesson. The MS should fly one segment of each run.

Objectives: PART 1:
• Use flight controls (Translation Hand Controller (THC), Rotational Hand Controller (RHC), DAP) for proximity operations and identify the proper target movement in the Crew Optical Alignment Sight (COAS).
• Demonstrate a basic understanding of the following proximity operations techniques:
  – Approaches
  – Separations
  – Transitions
  – Stationkeeping
• Demonstrate an understanding of the short term relative motion resulting from given initial conditions.

PART 2:
• Perform the Part 1 objectives using the Tools for Rendezvous and Docking (TRAD) system.
• Demonstrate and use the TRAD system to aid in situational awareness during Prox Ops using the following automatic and manual modes:
  – Pulse Code Modulator (PCM) Modes (Auto SV and Auto Rendezvous Radar (RR), Views, Tgt/Orb, Point of Reference (POR))
  – Hand-Held Lidar (HHL) modes
  – Trajectory Control Sensor (TCS) operation
  – Add the TRAD system to the cockpit scan developed earlier
Rendezvous/Proximity Operations Lesson Descriptions

7  PROX TECH 21069 (Concluded)

HOMEWORK:
- Review the RPOP Playback Trainer on the Personal Computer (PC).
- Review the HHL and TCS User Guides.

8A  EVA RESCUE 21001

Title: Extravehicular Activity Rescue Prebrief
Duration: 0.5 hours
Medium: Classroom
Note: Schedule at SES Dome Prebrief Table.
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 09/01
Lesson(s) Replaced: EV RES/P-SEP 21001
Equipment Required: None
Prerequisite Lesson(s): PROX TECH 21069
Preparation: None

Synopsis: This lesson introduces prox ops concepts that can be applied to EVA rescue and the EVA rescue FDF (EVA Checklist (C/L)).

Objectives:
- Discuss the EVA Rescue FDF to be able to perform an EVA rescue in the SES.

Completion Standards:
- The student(s) should be able to explain the basic procedures and concerns associated with rescue of an incapacitated EVA crewmember.

8B  EVA RESCUE 21069

Title: Extravehicular Activity Rescue
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: EV RES/P-SEP 21069
Equipment Required: None
Prerequisite Lesson(s): EVA RESCUE 21001
Preparation: None
Rendezvous/Proximity Operations Lesson Descriptions

8B  EVA RESCUE 21069 (Concluded)

Synopsis: In this lesson, the student(s) will perform multiple rescues of an incapacitated EVA crewmember. The DAP is reconfigured as required to ensure his/her safety.

Objectives:

• Reconfigure the DAP, as required, based on the EVA crewmember’s position.
• Translate the orbiter towards the EVA crewmember.
• Rotate the orbiter, if necessary, to maintain visibility of the EVA crewmember.
• Perform three EVA rescues.
• Review the use of MUXed (multiplexed) CCTVs during prox ops.

Completion Standards:

The student(s) shall meet the following conditions:

• Exercise appropriate actions to perform a safe rescue of an incapacitated EVA crewmember.
• Utilize the DAP, Translation Hand Controller (THC), Rotational Hand Controller (RHC), Universal Pointing (UNIV PTG) and Attitude Direction Indicator (ADI) as appropriate for orbiter control and situational awareness.

9A  SEP/TRANS 21001

Title: Separation and Transition Prebrief
Duration: 0.5 hours
Medium: Classroom
Note: Schedule in SES briefing area.
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 09/01
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): PROX TECH 21069
Preparation: None

Synopsis: In this lesson, the student(s) will practice techniques to separate from an RMS-deployed payload and transition to a specified stationkeeping distance/altitude.
Rendezvous/Proximity Operations Lesson Descriptions

9A  SEP/TRANS 21001 (Concluded)

Objectives:
- Position the target in the end effector camera for separation.
- Perform +Vbar and +Rbar separations.
- Perform an AUTO transition from the +Vbar to the -Rbar.
- Perform manual and inertial transitions from the +Rbar to the +Vbar.
- Observe and describe the orbital mechanics effects during transitions.
- Observe and quantify the change in size of the target in the Crew Optical Alignment Sight (COAS) with range.

Completion Standards:
The student(s) shall meet the following conditions during each run:
- Correctly anticipate and describe target motion resulting from Translation Hand Controller (THC)/Rotational Hand Controller (RHC)/DAP inputs and orbital mechanics effects.
- Maintain the desired Rdot profile ±0.1 fps during separations.
- Maintain the desired range ±10% during stationkeeping and transitions.

9B  SEP/TRANS 21069

Title: Separation and Transition
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: SEP/TRANS 21015
Equipment Required: None
Prerequisite Lesson(s): SEP/TRANS 21001
Preparation: None

Synopsis: See SEP/TRANS 21001

Objectives: See SEP/TRANS 21001
Rendezvous/Proximity Operations Lesson Descriptions

10  **SEP/TRANS 22069**

**Title:** Separation and Transition 2  
**Duration:** 2.0 hours  
**Medium:** Shuttle Engineering Simulator Dome (SES AFT)  
**Student:** COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)  
**Source:** *DM34/Rendezvous Guidance, Procedures and Training*  
**Date:** 07/04  
**Lesson(s) Replaced:** SEP/TRANS 22015  
**Equipment Required:** None  
**Prerequisite Lesson(s):** SEP/TRANS 21069  
**Preparation:** None  

**Synopsis:** In this lesson, the student(s) will apply previously learned proximity operations techniques to perform +Rbar separations and transitions to the +Vbar.

**Objectives:**  
- Perform the separations and transitions from SEP/TRANS 21069 using alternate ranging techniques.  
- Use the PGSC with Hand-Held Lidar (HHL) as appropriate to aid in situational awareness.  
- Use CCTV and Crew Optical Alignment Sight (COAS) charts to determine range and range rate for Radar-failed cases.

**Completion Standards:**  
- Correctly anticipate and describe target motion resulting from Translation Hand Controller (THC)/Rotational Hand Controller (RHC)/DAP inputs and orbital mechanics effects.

11  **RNDZ CONCEPTS 21057**

**Title:** Rendezvous Concepts  
**Duration:** 2.0 hours  
**Medium:** CBT  
**Student:** COMMANDER, MS, PILOT (Schedule individually.)  
**Source:** *DM34/Rendezvous Guidance, Procedures and Training*  
**Date:** 05/97  
**Lesson(s) Replaced:** RNDZ CONCEPT 21057  
**Equipment Required:** None  
**Prerequisite Lesson(s):** RNDZ CT HB 21007  
**Preparation:** Introduction to Rendezvous GN&C (JSC-49686) or *DM34/Rendezvous Guidance and Procedures*
Rendezvous/Proximity Operations Lesson Descriptions

11 RNDZ CONCEPTS 21057 (Concluded)

Synopsis: This CBT is designed to be an overview of orbital mechanics, orbit navigation, and orbit targeting as applied to the rendezvous profile. The lesson also reviews the onboard SPECs used during a rendezvous.

Objectives: Please refer to RNDZ BRIEF 21001 for objectives.

12 RNDZ BRIEF 21001

Title: Rendezvous Briefing
Duration: 3.0 hours
Medium: Classroom
Student: COMMANDER, MS, PILOT (Other MSs as assigned.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 05/97
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ CT HB 21007
Preparation: RNDZ CONCEPTS 21057

Synopsis: This briefing is designed to be a complete and thorough overview of the rendezvous profile. Orbit navigation, orbital mechanics, the flight profile, orbit targeting, rendezvous procedures, and the dedicated software SPECs are all reviewed in detail.

Objectives:
• Define the 3 state vectors used in rendezvous and what is used in their propagation.
• Explain the effects of the 4 types of burns in both the inertial and LVLH frames.
• Describe the rendezvous profile with respect to burns, sensor passes, and orbiter attitude.
• Describe the use of orbiter displays for the following operations:
  – Star Tracker Navigation
  – Radar Navigation
  – Crew Optical Alignment Sight (COAS) Navigation
  – Targeting
• Explain the use of the burn display(s) and identify the different guidance modes.
• Define the rendezvous software operational constraints.
• Identify the major procedural steps in a rendezvous.
Rendezvous/Proximity Operations Lesson Descriptions

13A  RNDZ FAM 21001
Title: Rendezvous Familiarization Prebrief
Duration: 0.5 hours
Medium: Classroom
Note: Schedule in prebrief room.
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 04/93
Lesson(s) Replaced: None
Equipment Required: Rendezvous Checklist
Prerequisite Lesson(s): DPS FAM 23006 (N ASTRO), RNDZ CONCEPTS 21057
Preparation: Review the RNDZ BRIEF 21001, and any flight’s Rendezvous checklist

Synopsis: Refer to RNDZ FAM 21006 for synopsis.
Objectives: Refer to RNDZ FAM 21006 for objectives.

13B  RNDZ FAM 21006
Title: Rendezvous Familiarization 1
Duration: 2.0 hours
Medium: SST 1, SST 2, or SST 3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 09/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ FAM 21001
Preparation: None

Synopsis: In this lesson, the student will perform the nominal timeline from the start of the Rendezvous book to the MC2 burn. The use of rendezvous displays and sensor data will be stressed. The student will also use the annotated procedures found in the Rendezvous Crew Training Handbook.
Objectives: • Perform the nominal rendezvous timeline.
• Configure orbiter software and crew station switches for rendezvous operations.
• Evaluate and incorporate navigation sensor data.
• Target, evaluate and execute various rendezvous burns.
Rendezvous/Proximity Operations Lesson Descriptions

14 DST FAM 21025

Title: Dynamic Skills Trainer Familiarization
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 (DST 2, DST 6)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training

Date: 07/04
Lesson(s) Replaced: None
Equipment Required: PGSC
Prerequisite Lesson(s): EVA RESCUE 21069, SEP/TRANS 22069
Preparation: None

Synopsis: In this lesson, the students will learn how to log on to the DST desktop simulator. This will include PGSC set-up specific to the DST.

Objectives:
• Log on to the DST and call up the desired initial condition to run.
• Perform at least one proximity operations run.

Completion Standards:
• The students should be able to start up the trainer and select and run an initial condition unassisted by the instructor.

15 PO APPR 21069

Title: Proximity Operations Approaches
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately with MS attending one session. CB Instructor Astronaut (IA) required.)
Source: DM34/Rendezvous Guidance, Procedures and Training

Date: 07/04
Lesson(s) Replaced: PO APPR 21015
Equipment Required: PGSC
Prerequisite Lesson(s): DST FAM 21025
Preparation: None

Synopsis: In this lesson, the student(s) will perform +Vbar, -Rbar and inertial approaches using Radar, the Crew Optical Alignment Sight (COAS) subtended angle chart, CCTVs and camera angle ranging chart, and visual cues. Orbital mechanics effects and observation of braking gates are stressed. Fuel usage will be recorded for comparison later. This class can be considered as a progress check.
Rendezvous/Proximity Operations Lesson Descriptions

15 **PO APPR 21069 (Concluded)**

Objectives:
- Perform Vbar, Rbar and inertial approaches unaided.
- Use the PGSC and Hand-Held Lidar (HHL) to aid in situational awareness.
- Perform one Vern fail run.

Completion Standards:
The student(s) shall meet the following conditions:
- Perform a Vbar approach (400 ft to stable in end effector camera, Low Z at 200 ft) within 35 minutes and a total fuel usage of less than 100 lbs.
- Perform an Rbar approach (400 ft to stable in end effector camera, Low Z at 200 ft) within 35 minutes and a total fuel usage of less than 150 lbs.
- Perform an inertial approach (400 ft to stable in end effector camera, Low Z at 200 ft) within 35 minutes and a total fuel usage of less than 150 lbs.

16A **APPR & F/A 21001**

Title: Approach, and Flyaround Prebrief
Duration: 0.5 hours
Medium: Classroom
Note: Schedule in SES Prebrief area.
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with the MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 10/01
Lesson(s) Replaced: APP/GRAP 21001
Equipment Required: None
Prerequisite Lesson(s): PO APPR 21069
Preparation: None

Synopsis: This briefing reviews the tasks involved in an approach, such as determining range, range rate, orientation of the payload, and the division of tasks between the PLT and MS. The briefing also reviews the coordination of tasks and teamwork required for a successful grapple.

Objectives:
- Discuss tasks and teamwork to accomplish an approach and grapple.
- Define pilot tasks.
- Define RMS operator tasks.
- Define approach and flyaround tasks.
- Define grapple tasks.
- Discuss contingency operations.
Rendezvous/Proximity Operations Lesson Descriptions

16A  **APPR & F/A 21001 (Concluded)**

Completion Standards:
The student(s) should be able to:
- Explain the basic tasks and teamwork required to accomplish a payload approach, flyaround, and grapple.
- Explain the crew actions required for a failed grapple attempt.

16B  **APPR & F/A 21069**

Title: Approach and Flyaround  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome (SES AFT)  
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with the MS attending one session.)  
Source: *DM34/Rendezvous Guidance, Procedures and Training*  
Date: 07/04  
Lesson(s) Replaced: APPR & F/A 21015  
Equipment Required: None  
Prerequisite Lesson(s): APPR & F/A 21001  
Preparation: None

Synopsis: In this lesson, the student(s) will perform +Vbar or +Rbar approaches and evaluate the position of the payload's grapple fixture relative to the RMS end effector. The student(s) will perform the flyaround maneuver by two different methods -- AUTO and manual. Piloting skills and pilot/MS coordination are stressed. The PGSC will not be used in this lesson. The MS should fly one run.

Objectives:  
- Perform Vbar and Rbar approaches from 200 feet to stable in the end effector.
- Evaluate orientation of grapple fixture and estimate flyaround axis.
- Perform appropriate Translation Hand Controller (THC) inputs to maintain target position relative to RMS end effector.
- Perform AUTO flyarounds using Universal Pointing (UNIV PTG).
- Perform manual flyarounds using Rotational Hand Controller (RHC) inputs.

Completion Standards:  
- Complete the flyaround(s) with the target not leaving the field of view of both the end effector and A (or B) cameras.
Rendezvous/Proximity Operations Lesson Descriptions

17 APDS 21057

Title: Androgynous Peripheral Docking System
Duration: 2.0 hours
Medium: Computer-Based Trainer (CBT)
Student: COMMANDER, MS, PILOT
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: Personal Computer (PC)
Prerequisite Lesson(s): None
Preparation: Read:

- Shuttle Crew Operations Manual (SCOM); Section 2.20, Orbiter Docking System

Synopsis: Shuttle/ISS docking missions are accomplished using the Orbital Docking System (ODS). This lesson covers the Androgynous Peripheral Docking System (APDS), a component of the ODS. The major components of the APDS, their functions, and associated controls and displays are discussed. Additionally, the major operational sequences associated with docking and undocking are explained. Only nominal operations (OPS) will be presented. Off-nominal procedures will be covered in subsequent APDS classes. For illustration purposes, the animations in this lesson depict component movement at an accelerated rate. In reality, the components move at a much slower rate.

Objectives:
- Locate the APDS in the orbiter.
- Name the major components of the APDS and identify their functions.
- Recognize the various APDS avionics boxes and identify their functions.
- Recognize the controls and displays associated with the APDS and identify the purpose of each.
- Describe the operational positions of the active docking ring.
- Associate display status lights and SPEC 167 indicators with hardware operations.
- Identify the events associated with the following APDS operational sequences: Initialization, Power-up, Ring Extension, Docking, and Undocking.
Rendezvous/Proximity Operations Lesson Descriptions

18 APDS FAM 21205

Title: APDS Familiarization
Duration: 1.5 hours
Medium: Androgynous Peripheral Docking System (APDS) Trainer
Student: COMMANDER, MS, PILOT
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: APDS Trainer in Space Vehicle Mockup Facility, Building 9, Video Cassette Recorder player with monitor, flip charts, video tape, enlargements, wireless microphone, laser pointer, two easels, table and chairs
Prerequisite Lesson(s): APDS 21057
Synopsis: Students will receive a briefing on the docking sequence, the APDS components, and a hands-on familiarization with the APDS mechanisms and components.
Objectives: After completion of this lesson, the students will be able to:
• Identify and locate major APDS components
• Describe how components work together
• Demonstrate six Degrees of Freedom (DOFs)
• Explain the docking sequence
• Manually open latches
• Locate sensors

19 APDS OPS 21029

Title: APDS Operations
Duration: 1.5 hours
Medium: Payload Trainer (PYLD)
Student: COMMANDER, MS, PILOT
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): APDS FAM 21205
Preparation: None
Rendezvous/Proximity Operations Lesson Descriptions

19  APDS OPS 21029 (Concluded)

Synopsis: This lesson includes a prebrief on interpreting SPEC 167 telemetry data and use of Docking System Power (A6) panel and APDS Control Panel (A7) push-buttons and sensor lights. The student(s) will exercise all nominal operations for the APDS, including initialization, power up, prepare for docking, dock and undocking, and powerdown.

Objectives: Upon completion of this lesson, the student will be able to:
- Understand and perform nominal docking and undocking sequences.
- Interpret telemetry on SPEC 167 and indicator light on A7.
- Correctly configure A6 and A7 panels to support pre-docking, initialization, power up, docking, and undocking activities.
- Explain which sensors drive which illuminator lights on A7 and drive telemetry on SPEC 167.

20  APPR & DOCK BR 21001

Title: Approach and Docking Brief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: Orbiter and Station models
Prerequisite Lesson(s): APDS OPS 21029
Preparation: None

Synopsis: During this briefing, the students will discuss prox ops techniques, concepts, constraints and tools used in docking with another spacecraft.

Objectives: • Introduce the following approach and docking techniques and concepts:
  - Approach Corridor.
  - Docking Targets and CCTVs used.
  - Low Z/NORM Z transition point.
  - Post Contact Thrusting (PCT) execution and constraints.
  - Contact and capture indications.
  - Unsuccessful capture (bounce-off).
• Review Undocking and separations.

Completion Standards:
- List the four major goals of approach and docking in order of priority.
- List the contact condition limits for orbiter/ISS approach and docking.
Rendezvous/Proximity Operations Lesson Descriptions

21  APPR & DOCK 21069

Title: Approach and Docking 1
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: APPR & DOCK 21015
Equipment Required: PGSC
Prerequisite Lesson(s): APPR & DOCK BR 21001
Preparation: None

Synopsis: During this lesson, the student will demonstrate an understanding of the prox ops techniques and tools, as applied to docking with another spacecraft. The PGSC will be used in this session.

Objectives:
- Perform (aided) at least three approaches to docking.
- Perform (aided) the initial steps of the FAILED CAPTURE procedure.
- Demonstrate effective Cockpit Resource Management (CRM) habits and Tools for Rendezvous and Docking (TRAD) usage.

Completion Standards:
The student(s) must meet these conditions for all approaches:
- Docking contact conditions:
  - RDOT = -0.10±0.03 fps
  - Lateral misalignment < 3 inches
  - Angular misalignment < 2 degrees
- NORM Z braking = 0.1 fps.
- Maintain prescribed approach corridor and Rdot profile ±0.05 fps.
- The following propellant consumption standards are for reference only:
  - < 100 lb for Vbar approach from 300 ft, or Rbar approach from 170 ft.
  - < 200 lb for Twice Orbit Rate to a Vbar Approach (TORVA) from 600 ft through docking.
Rendezvous/Proximity Operations Lesson Descriptions

22 RNDZ MAN PH BR 21001

Title: Rendezvous Manual Phase Brief
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: RNDZ Checklist, PGSC
Prerequisite Lesson(s): RNDZ FAM 21006, SEP/TRANS 21069
Preparation: None

Synopsis: This briefing introduces procedures and skills required during the transition from the midcourse correction burns (SST training) to the final approach (SES training).

Objectives:
• Review the post Ti trajectory.
• Identify the major events in the rendezvous manual phase:
  – MC3 and MC4
  – MC2 ET timeline
  – Rdot gates
  – Config for Rbar
  – Establish Rbar
• Discuss the use of the Tools for Rendezvous and Docking (TRAD) system during this timeline (Hand-Held Lidar (HHL), Trajectory Control Sensor (TCS)).
• Discuss the concept of long and short trajectories.
• Discuss piloting cues:
  – Expected motion in the Crew Optical Alignment Sight (COAS).
  – Techniques for controlling out of plane motion.
  – Standard CCTV angles for range approximation.
  – Standard COAS subtended angle.
• Introduce the Radar Fail procedure using the FDF.
• Discuss some of the Rendezvous Rules of Thumb.
Rendezvous/Proximity Operations Lesson Descriptions

23  RNDZ MAN PH 21069

Title: Rendezvous Manual Phase 1
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately with the MS attending one.)

Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: RNDZ MAN PH 21015
Equipment Required: RNDZ Checklists, PGSC
Prerequisite Lesson(s): RNDZ MAN PH BR 21001
Preparation: None

Synopsis: In this lesson, the students will practice the transition between the rendezvous phase and the prox ops phase of the profile.

The nominal and radar fail rendezvous manual phase timelines from MC3 -5 min will be practiced. The Tools for Rendezvous and Docking (TRAD) system will be used. Five runs are planned.

Objectives:
- Perform the MC3 & MC4 burn and establish the Rbar using the nominal timeline and nominal vectors.
- Perform a twice orbit rate transition to the Vbar and arrive outside the corridor on the Vbar.
- Perform the Radar Fail manual phase from MC3 -5 min to the Rbar with and without radar to panel A2.
- Fly the trajectory within the required Rdot gates and identify how braking controls the trajectory.
- Identify and control out of plane motion.
- Use the TRAD system during the Rndz manual phase.
- Identify the standard TRAD/RPOP configuration for manual phase.
- Discuss the concept and differences of long and short trajectories.
- Discuss and use as required the following piloting cues:
  - CCTV angles
  - Crew Optical Alignment Sight (COAS) angles
  - DAP changes and deadbands
- Identify the callout in the nominal timeline to go to the RR FAIL Block in the checklist for no Rendezvous Radar (RR) to navigation case.
- Discuss parts of the Rules of Thumb document as required.
Rendezvous/Proximity Operations Lesson Descriptions

24A  DOCK ATT 21001

Title: Docking Attitude Alignment Introduction Prebrief
Duration: 0.5 hours
Medium: Classroom

Note: Schedule in SES Prebrief area.
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately with the MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 09/96
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): APPR & DOCK 21069
Preparation: None

Synopsis: This prebrief reviews the tasks involved in performing an attitude alignment, including target reading and pointing vector determination.

Objectives:
• Define the limits for angular misalignment for docking.
• Place the angular alignment maneuver within the approach and docking timeline.
• Define the markings on the centerline docking target.
• Describe methods for measuring angular misalignment.
• Describe the AUTO ANGULAR FLYOUT cue card.

Completion Standards:
The student(s) should be able to:
• Describe the markings on the docking target and how to read them.
• Describe how to use the AUTO ANGULAR FLYOUT cue card to perform an angular alignment maneuver.

24B  DOCK ATT 21069

Title: Docking Attitude Alignment
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: DOCK ATT 21015
Equipment Required: None
Prerequisite Lesson(s): DOCK ATT 21001
Preparation: None
Rendezvous/Proximity Operations Lesson Descriptions

24B  DOCK ATT 21069 (Concluded)

Synopsis: In this lesson, the students will perform multiple approaches to docking, including an attitude alignment maneuver at 30 ft.

Objectives:
- Perform (aided) multiple angular alignment maneuvers while stationkeeping at 30 ft.
- Perform (aided) an approach from 30 ft to docking, including an angular alignment maneuver.
- Perform (unaided) a +Vbar approach from 300 ft to docking, or an Rbar approach from 170 ft to docking, including an angular alignment maneuver.

Completion Standards:
The student(s) must meet these conditions on all approaches:
- Docking contact conditions:
  - Rdot = -0.10±0.03 fps
  - Lateral misalignment < 3 inches
  - Angular misalignment < 2 degrees
- NORM Z braking £ 0.1 fps
- Maintain prescribed approach corridor and Rdot profile ±0.05 fps.
- Maintain range > 10 ft until angular alignment verified.
- Propellant consumption limit is for reference only:
  - < 100 lb for Vbar approach from 300 ft, or Rbar approach from 170 ft.

25  DST MAN PH 61025

Title: Dynamic Skills Trainer Manual Phase
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 (DST 2, DST 6)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04

Lesson(s) Replaced: None
Equipment Required: PGSC
Prerequisite Lesson(s): RNDZ MAN PH 21069
Preparation: None

Synopsis: In this lesson, the students will learn how to configure the DST desktop simulator for docking and manual phase. The instructor will assist at the start of the session.

Objectives:
- Log on to the DST and call up the desired initial condition to run.
- Run at least one docking and one manual phase run.
Rendezvous/Proximity Operations Lesson Descriptions

25 DST MAN PH 61025 (Concluded)

Completion Standards:
- The students should be able to start up the trainer and select and run an initial condition unassisted by the instructor.

26 APPR & GRAP 21069

Title: Approach and Grapple 1
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: APP/GRAP 21069
Equipment Required: None
Prerequisite Lesson(s): APPR & F/A 21069
Preparation: None

Synopsis: In this lesson, the students perform two approaches to grapple. During these runs the students should evaluate the position of the payload grapple fixture, perform a flyaround if required, and perform a payload grapple. The third run should be from 100 feet to evaluate a rotating payload, match rates and grapple. The development of crew coordination and communication between the PLT and RMS operator are stressed.

Objectives:
- Practice coordinating approach and grapple techniques.
- Determine range and range rate using FDF charts.
- Evaluate and perform flyarounds to grapple a payload.

Completion Standards:
- The flyaround(s) should be completed with the target not leaving the field of view of the End Effector and A (or B) Cameras. The total approach from 400 feet through the flyaround and grapple should be done within 200 lbs.
Rendezvous/Proximity Operations Lesson Descriptions

27A  **RNDZ MAN PH 22001**

Title: Rendezvous Manual Phase 2 Prebrief  
Duration: 0.5 hours  
Medium: Classroom  
**Note:** Schedule in SES Aft cockpit briefing area.  
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately with the MS attending one session. CB Instructor Astronaut (IA) required.)  
Source:  
**DM34/Rendezvous Guidance, Procedures and Training**  
Date: 07/04  
Lesson(s) Replaced: None  
Equipment Required: RNDZ Checklist  
Prerequisite Lesson(s): RNDZ MAN PH 21069  
Preparation: Review the RR Fail procedure in the Rendezvous checklist.

**Synopsis:** During this class the students will do 4 runs from MC2+12 (MC3 -5 min) to stable on the Rbar (600 ft) or Vbar (350 ft). At least one run should go all the way to docking (a grapple run is not required). All runs will be Radar fail without any Trajectory Control Sensor (TCS) data. Hand-Held Lidar (HHL) will not be used any earlier than the first braking gate. This range should be determined by Crew Optical Alignment Sight (COAS) subtended angle. Your goal should be to do these runs by visual references only, therefore minimal HHL data will be used.

To help students evaluate and improve their skills, the instructor will allow the subtended angle data to be compared with the environment (or TCS) data. The instructor will note the fuel usage at the end of each run.

**Objectives:**  
- Review the nominal rendezvous manual phase using the FDF:  
  - MC3 and MC4 burns.  
  - Braking gates.  
  - Twice Orbit Rate to a Vbar Approach (TORVA) or Rbar approach.  
- Review the Rendezvous Radar (RR) Fail block in the Rendezvous checklist.  
- Review the HHL options in the RPOP.  
- Review the Tools for Rendezvous and Docking (TRAD) configuration for Radar Fail.  
- Review the subtended angle charts.
Rendezvous/Proximity Operations Lesson Descriptions

27B RNDZ MAN PH 22069

Title: Rendezvous Manual Phase 2
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session. CB Instructor Astronaut (IA) required.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: RNDZ MAN PH 22015
Equipment Required: PGSC
Prerequisite Lesson(s): RNDZ MAN PH 22001
Preparation: None

Synopsis: This lesson, like RNDZ MAN PH 21069, will exercise the Radar fail manual phase procedure in the FDF, except the radar will not be used at all this time. All the runs will begin at MC2 ET + 12 minutes (MC3 - 5 min) and conclude when on the Vbar or Rbar. One run will be taken to docking.

This lesson is a stress case. A major emphasis in this session will be the coordination and communication required to get range and range rate information to the pilot. The amount of failures required to get to this case should not be discussed.

Objectives: 
• Use the backup Range and Rdot cues (subtended angles) to perform the rendezvous manual phase without radar.
• Verify the subtended angle data with the radar (or Trajectory Control Sensor (TCS)) while performing the rendezvous manual phase.
• Input Range data (Subtended angle) as Hand-Held Lidar (HHL) Data in RPOP.
• Demonstrate that good Crew Optical Alignment Sight (COAS) logic, range and range rate are all that is required to fly any trajectory.

28A RNDZ MAL 21001

Title: Rendezvous Malfunction Prebrief
Duration: 0.5 hours
Medium: Classroom
Note: Schedule in an SST prebrief room.
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 05/97
Lesson(s) Replaced: None
Equipment Required: Rendezvous Checklist
Rendezvous/Proximity Operations Lesson Descriptions

28A RNDZ MAL 21001 (Concluded)

Prerequisite Lesson(s): RNDZ FAM 21006
Preparation: None

Synopsis: Refer to RNDZ MAL 21006 for synopsis.
Objectives: Refer to RNDZ MAL 21006 for objectives.

28B RNDZ MAL 21006

Title: Rendezvous Malfunction
Duration: 2.0 hours
Medium: SST 1, SST 2, or SST 3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 09/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ MAL 21001
Preparation: Review the “System Concerns” section of the RNDZ MAL 21001 handout.

Synopsis: This lesson covers the same trajectory as RNDZ FAM 21006. The lesson will start in MM202 post-NC Time ofIgnition (TIG) and end after the MC2 burn. In order to bring out a few key points, several malfunctions will be introduced. The lesson objectives are listed below. A detailed explanation of each is to be found in the Rendezvous Crew Training Handbook. During this lesson, the student may use either the Rendezvous FDF or the annotated procedures used in RNDZ FAM 21006.

Objectives:
- Describe the rendezvous profile with respect to burns, sensor passes, and orbiter attitude.
- Identify the major procedural steps in a rendezvous.
- Identify Data Processing System (DPS), Reaction Control System (RCS), hand controller, Inertial Measurement Unit (IMU), etc. failures and their impacts on the rendezvous.
- Exercise the timeline from preliminary NCC targeting through the MC2 burn.
- Discuss and recognize a star lock during a star tracker pass.
- Recognize questionable star tracker residuals.
- Perform a – Y star tracker pass.
- Recognize and recover a FF3 failure.
Rendezvous/Proximity Operations Lesson Descriptions

28B  **RNDZ MAL 21006 (Concluded)**

- Perform a restring and note effect on the rendezvous software.
- Perform the MC2 burn on a time constraint (vs. elevation angle constraint).

29A  **APPR & DOCK 22001**

**Title:** Approach and Docking 2 Prebrief  
**Duration:** 0.5 hours  
**Medium:** Classroom  
**Note:** Schedule in SES AFT Prebrief area.  
**Student:** COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)  
**Source:** *DM34/Rendezvous Guidance, Procedures and Training*  
**Date:** 09/96  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** DOCK ATT 21069  
**Preparation:** None

**Synopsis:** This lesson introduces malfunctions that affect approach and docking techniques, including loss of Trajectory Control Sensor (TCS), VERNs, Post Contact Thrusting (PCT), and centerline camera. Off-nominal separation techniques, such as failed capture, backouts, breakouts, and expedited separations, are also introduced.

**Objectives:**
- Describe range/rdot determination techniques using Hand-Held Lidar (HHL).
- Describe flight techniques for loss of vernier Reaction Control System (RCS).
- Describe centerline camera failure recovery techniques.
- Describe off-nominal separations:
  - Failed capture
  - Corridor backout
  - Breakouts
  - Expedited separation

**Completion Standards:**
The students(s) should be able to:
- Describe appropriate crew responses and flight techniques for failures of TCS, VERNs, centerline camera, and PCT.
- Distinguish between failed capture, backout, breakout, and expedited separation.
Rendezvous/Proximity Operations Lesson Descriptions

29B  **APPR & DOCK 22069**

Title: Approach and Docking 2  
Duration: 2.0 hours  
Medium: Shuttle Engineering Simulator Dome (SES AFT)  
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)  
Source: *DM34/Rendezvous Guidance, Procedures and Training*  
Date: 07/04  
Lesson(s) Replaced: APPR & DOCK 22015  
Equipment Required: None  
Prerequisite Lesson(s): APPR & DOCK 22001  
Preparation: None  

Synopsis: In this lesson, the student(s) will perform at least three approaches to docking with attitude alignment maneuvers and malfunctions, while demonstrating effective Cockpit Resource Management (CRM) habits and use of the Tools for Rendezvous and Docking (TRAD) system.

Objectives:  
- Perform (unaided) at least three approaches to docking with attitude alignment maneuvers and the following malfunctions/procedures:
  - Trajectory Control Sensor (TCS) fail  
  - VERN fail  
  - Corridor backout  
- Demonstrate effective CRM habits and use of the TRAD system, especially range/rdot determination without TCS.

Completion Standards:  
The student(s) must meet these conditions on all approaches:  
- Docking contact conditions:  
  - Rdot = -0.10±0.03 fps  
  - Lateral misalignment < 3 inches  
  - Angular misalignment < 2 degrees  
  - Norm Z braking = 0.1 fps  
- Maintain prescribed approach corridor and rdot profile ±0.05 fps.
- Propellant consumption standards are for reference only:  
  - VERN: < 100 lb for Vbar approach from 300 ft, or Rbar approach from 170 ft.  
  - VERN fail: < 200 lb for Vbar approach from 300 ft, or Rbar approach from 170 ft.
Rendezvous/Proximity Operations Lesson Descriptions

30  RNDZ CRM BR 21001

Title: Rendezvous Cockpit Resource Management Briefing
Duration: 1.5 hours
Medium: Classroom
Note: Schedule in SMS Prebrief Room.
Student: COMMANDER, MS, PILOT (CB Instructor Astronaut (IA) required.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: Rendezvous checklist
Prerequisite Lesson(s): DST FAM 21025, RNDZ MAL 21006
Preparation: None

Synopsis: This briefing is designed to encourage the students to consider and assess the roles of each crewmember in the cockpit during the Rendezvous and Prox Ops timelines. The list of tasks included is not intended to be a complete list; rather, it is intended to be a representative list for discussion in this briefing.

- The instructor will discuss Cockpit Resource Management (CRM) topics with the crew.
- The instructor will review the Tools for Rendezvous and Docking (TRAD) Configuration for the sim.
- Who will be responsible for PGSC inputs during manual phase?
- Who will be responsible for the Hand-Held Lidar (HHL) marks during manual phase?
- Who will do targeting and burns?
- Who will watch REL Navigation (NAV) during sensor passes?
- Who will work (manage) the checklist?
- Who will be the second set of eyes?
- How will malfunctions be managed?
- Who will supply CCTV data?
- Who will supply MCC with regular updates?
- Who will be responsible for photo DTOs, or how will this be worked into the timeline?

Objectives:
- The instructor will discuss some of the terms and concepts of CRM as they apply to rendezvous and prox ops.
- The instructor will review the DT recommended Standard Operating Procedures (crew task assignments) for Rendezvous and Prox Ops.
- The students will discuss, aided by the instructor, the CRM Plan for the upcoming SMS/SES sessions.
Rendezvous/Proximity Operations Lesson Descriptions

30 RNDZ CRM BR 21001 (Concluded)

- The instructor should review the starting point (and any initial conditions) for the SMS session (NCC - 45 min. or Phase Elapsed Time (PET) - 1:50).
- The instructor should review the payload for the load being used (picture) (e.g., grapple fixture location).

31 RNDZ OPS 21012

Title: Rendezvous Operations
Duration: 5.0 hours
Note: Thirty minutes of facility time (prior to this session) will be required for PGSC setup by the crew.
Medium: SMS-FB
Student: COMMANDER, MS, PILOT (CB Instructor Astronaut (IA) required.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: COAS, Aft Visual, PGSCs
Prerequisite Lesson(s): APPR & DOCK 22069, RNDZ CRM BR 21001, RNDZ MAN PH 21069
Preparation: None

Synopsis: This lesson brings together the skills learned in SST and SES training. The material will be similar to that of the two previous SST lessons, but the lesson will start 1 hour prior to the NCC burn (or NC - 30 min for 1 rev to Ti flights) and proceed through grapple (or docking). Some new information will be covered, and there will be malfunctions from which to recover. This is the first coordinated lesson with the dedicated rendezvous crewmembers, performing their assigned tasks, and exercising good crew coordination and communication. The Tools for Rendezvous and Docking (TRAD) system will be used in this session.

Objectives:
- Execute the rendezvous timeline from NCC-1hr to grapple or docking while exercising the CRM plan developed in the CRM briefing.
- Apply previously learned techniques to a crew environment.
- Demonstrate the following rendezvous procedures/signatures:
  - Crew Optical Alignment Sight (COAS) navigation.
  - Incorporation of sensor data in MM 202.
  - Rendezvous Radar autotrack acquisition.
  - Compute a burn with the Time of Ignition (TIG) in the past.
  - Divergence of Lambert guidance at 180° transfer angles.
  - Rendezvous radar mode indications.
Rendezvous/Proximity Operations Lesson Descriptions

31 RNDZ OPS 21012 (Concluded)
- Demonstrate effective use of the TRAD system during rendezvous and manual phase.
- Recognize the impacts to Rendezvous for some single system failures.

32 RNDZ QUAL 21006
Title: Rendezvous Qualification
Duration: 2.0 hours
Medium: SST 1, SST 2, or SST3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 02/90
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ OPS 21012
Preparation: None
Synopsis: This lesson will verify completion standards of the training course by executing the rendezvous timeline without the use of procedures. No malfunctions will be introduced.
Objectives:
- Execute the rendezvous timeline from the beginning of the Rendezvous book through the MC2 burn without procedures.
- Explain the purpose of the remaining two midcourse burns (MC3 and MC4).

33 R/PO QUAL 21069
Title: Rendezvous/Prox Ops Qualification
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session. CB Instructor Astronaut (IA) required.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: R/PO QUAL 21015
Equipment Required: None
Prerequisite Lesson(s): RNDZ OPS 21012
Preparation: None
Synopsis: During this lesson, the student will verify that manual flying completion standards for the 20000-Level Rendezvous training flow have been met.
Rendezvous/Proximity Operations Lesson Descriptions

33 R/PO QUAL 21069 (Concluded)

Objectives:
- Perform a “Radar Fail” approach from MC3 through a Twice Orbit Rate to a Vbar Approach (TORVA) and dock using less than 450 lbs. of fuel following current techniques and rdot profile. (Low Z at 1000 feet).
- Perform a Nominal approach from MC3 to an Rbar approach and grapple using less than 300 lbs. of fuel (Low Z at 200 feet).
- Use the PGSC.
- Do not use FDF Procedures.

34 RNDZ CRM BR 31001

Title: Rendezvous Cockpit Resource Management Meeting
Duration: 1.0 hour
Medium: Classroom
Note: Schedule in SMS Prebrief room.
Student: COMMANDER
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: Rendezvous checklist
Prerequisite Lesson(s): Flight assignment
Preparation: None

Synopsis: This is a meeting with the Commander assigned to a rendezvous flight. It should be conducted before the CDR makes his final Crew Task list (shortly after assigned to the flight).

The Rendezvous instructor will discuss some options for a Rendezvous Cockpit Resource Management (CRM) plan with the CDR before any training has started.

Objectives:
- Discuss interface with the payload (i.e., commanding) and the Tools for Rendezvous and Docking (TRAD) system during the PROX OPS timeline.
- The CDR and Rendezvous Instructor will discuss the CDR’s “Crew Assignment List” and try to optimize the assignments for Rndz/Prox Ops and other training required (PDRS/EVA).
Rendezvous/Proximity Operations Lesson Descriptions

35 RNDZ FS-TRAD BR 31001

Title: Flight-Similar Rendezvous Briefing
Duration: 3.0 hours
Medium: Classroom
Student: COMMANDER, MS, PILOT (Other crewmembers may support.)
Source: DM34/Rendezvous Guidance, Procedures and Training

Date: 09/05
Lesson(s) Replaced: None
Equipment Required: 1 PGSC, HHL, Cables, RPOP Playback trainer
Prerequisite Lesson(s): R/PO QUAL 21069, R/PO QUAL 41069,
                      RNDZ CRM BR 31001, RNDZ QUAL 21006,
                      RNDZ QUAL 41006

Preparation: None

Synopsis: This briefing is intended to provide a flight-similar introduction to the
planned rendezvous. It is normally given before any mission-specific or
load-specific data has been released. This briefing introduces the crew to
the type of rendezvous that they will support, and provides for a general
review/refresher of the rendezvous profile. Key DM personnel (Guidance
Procedures Officer (GPO), Flight Dynamics Officer (FDO)) should support
this briefing. Flight Director and CAPCOM can be invited to this briefing.
The Tools for Rendezvous and Docking (TRAD) configuration will be
reviewed. The Portable Onboard Computer Control Board (POCCB)
representative for the flight should attend this briefing.

Objectives:
• Review the latest Flight Operations Panel Profiles (if available) for
  Rendezvous and Prox Ops.
• Review the components of the TRAD system.
• Review the Trajectory Control Sensor (TCS) Hardware.
• Review the data that WinDecom supplies to RPOP.
• Demonstrate RPOP and RPOP guidance using the RPOP Playback
  Trainer.
• Connect the Hand-Held Lidar (HHL) to RPOP and demo its use.
• Review the connection of the TRAD System as described in the RNDZ
  TOOLS section of the Rendezvous checklist and the Flight-specific
  PGSC configuration (if available).
• Ensure the crew has a copy of the RPOP Playback Trainer and assist
  the crew in installing it on their Office Personal Computers (PCs) (if
  required).
• Give the crew a copy of the HHL Training Guide.
Rendezvous/Proximity Operations Lesson Descriptions

35  **RNDZ FS-TRAD BR 31001 (Concluded)**

- **Homework:**
  - Review the RPOP Playback Trainer.
  - Review the TRAD Malfunction Procedures (Section 7 in Rendezvous Checklist).
  - Review the HHL Training Guide.

36  **PO APPR 31069**

**Title:** Proximity Operations Approaches  
**Duration:** 4.0 hours  
**Medium:** Shuttle Engineering Simulator Dome (SES AFT)  
**Student:** COMMANDER, MS, PILOT  
**Source:** *DM34/Rendezvous Guidance, Procedures and Training*  
**Date:** 07/04  
**Lesson(s) Replaced:** None  
**Equipment Required:** PGSC  
**Prerequisite Lesson(s):** RNDZ FS-TRAD BR 31001  
**Preparation:** None

**Synopsis:** In this lesson, the student performs flight-similar approaches using techniques designed for the flight and/or payload(s) in question. The flight similar approach is practiced using CCTVs, radar, and the angle ranging chart while also observing orbital mechanics effects. The CDR and PLT should alternate runs flying and using the PGSC.

**Objectives:**
- Practice flight-similar approach techniques.
- Work on Cockpit Resource Management (CRM) topics.
- Use the Tools for Rendezvous and Docking (TRAD) system in this lesson.

37  **APPR & F/A 31069**

**Title:** Approach and Flyaround  
**Duration:** 4.0 hours  
**Medium:** Shuttle Engineering Simulator Dome (SES AFT)  
**Student:** COMMANDER, MS, PILOT  
**Source:** *DM34/Rendezvous Guidance, Procedures and Training*  
**Date:** 07/04  
**Lesson(s) Replaced:** APPR & F/A 31015  
**Equipment Required:** None  
**Prerequisite Lesson(s):** PO APPR 31069  
**Preparation:** None
Rendezvous/Proximity Operations Lesson Descriptions

37 **APPR & F/A 31069 (Concluded)**

Synopsis: In this lesson, the student will perform a flight-similar approach. The instructor will ensure that the payload/ISS is oriented in an off nominal orientation (with or without rates), such that a flyaround or attitude flyout is required for final grapple or docking. The CDR and PLT may alternate runs flying.

Objectives:
- Practice flight-similar approach with attitude flyout (and/or flyaround) techniques.
- Demonstrate the upper limits for a matched rate flyaround for “small payload” (e.g., SPARTAN, SPAS) grapple flights.
- Work on Cockpit Resource Management (CRM) topics.
- For grapple flights, do not use the PGSC in this lesson. All approaches shall be flown with Hand-Held Lidar (HHL) and visual cues only.
- For Docking flights:
  - Attitude flyouts should be practiced.
  - Approaches from long-range stationkeeping or from 30 ft. stationkeeping should be considered.
  - Tools for Rendezvous and Docking (TRAD) use is optional.

38 **SEP/TRANS 31069**

Title: Separation and Transition
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: SEP/TRANS 31015
Equipment Required: PGSC
Prerequisite Lesson(s): RNDZ FS-TRAD BR 31001
Preparation: None

Synopsis: In this lesson, the student will perform flight-similar techniques to separate from an RMS-deployed payload or to undock from a space station. Flight-similar transitions and approach techniques will be executed, as well as a contingency/emergency separation (i.e., No RMS deploy, Expedited Undocking).

Objectives:
- Practice flight-similar techniques to separate from an RMS deployed payload or a space station.
- Practice flight-similar transition and/or approach techniques (as required).
Rendezvous/Proximity Operations Lesson Descriptions

38 SEP/TRANS 31069 (Concluded)

- Perform a contingency/emergency payload separation.
- Work on Cockpit Resource Management (CRM) topics.
- Use the PGSC.
- For Docking Flights:
  - Perform the Undocking and Separation timeline.
  - Three runs planned.
  - Loss of Verns should be considered.

39A RNDZ MAL 31001

Title: Rendezvous Malfunctions 1 Prebrief
Duration: 1.0 hour
Note: This time should not conflict with PGSC set-up time in the simulator.
Medium: Classroom (SMS-Prebrief Room)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SEP/TRANS 31069 and APPR & F/A 31069
Preparation: Review a rendezvous checklist from a previous similar flight.

Synopsis: During this lesson, the crew will determine the Cockpit Resource Management (CRM) plan for the SMS lesson giving consideration to the planned malfunction. The instructor will identify the initial conditions of the simulation and assist with the CRM discussions. (Consider including the DM34/Docking Rationale (“Y-Y-Y”) presentation.)

Objectives:
- Define simulation initial conditions and FDF starting point.
- Distribute Preliminary Advisory Data (PAD) and Time of Ignition (TIG) list.
- Review CRM topics from the RNDZ CRM BR 31001 lesson.
- Review CRM topics observed during the SES training.
- Determine an initial CRM plan for this sim using the “Crew Management Plan” table.
Rendezvous/Proximity Operations Lesson Descriptions

39B  RNDZ MAL 31012

Title: Rendezvous Malfunctions 1  
Duration: 5.0 hours

Note: Thirty minutes of facility time (prior to this session) will be required for PGSC setup. The selected crewmembers should support this setup.

Medium: SMS-FB  
Student: COMMANDER, MS, PILOT  
Source: *DM34/Rendezvous Guidance, Procedures and Training*

Date: 03/05

Lesson(s) Replaced: None

Equipment Required: COAS, wireless headsets, aft visual, PGSC

Prerequisite Lesson(s): RNDZ MAL 31001

Preparation: None

Note: This class may be credited based on crew participation in a Generic or Flight-Specific integrated rendezvous simulation.

Synopsis: This lesson will begin with the orbiter several hours away from the target (Station). The main goal of this lesson is to slightly complicate the rendezvous timeline with navigation sensor failures and other orbiter malfunctions. During this period, several off-nominal procedures will be exercised to demonstrate how Rndz Nav and orbit targeting work.

Objectives:

- Perform the rendezvous timeline from NC -30 min (NCC - 1 hr) to docking (grapple) or breakout while exercising good Cockpit Resource Management (CRM).
  - Complete manual phase through docking/grapple within the budgeted fuel for the flight.
  - Maintain profile and attitude awareness.
- Demonstrate effective use of the Tools for Rendezvous and Docking (TRAD) system.
- Discuss various breakouts and when/where each is applicable.
- Recognize the impacts to Rendezvous for some single system failures.
  - Recognize the loss of the -Z Star Tracker (STRK) (panel bus) and the need to use the -Y STRK.
  - Recognize unacceptable radar angle data.
  - Perform a General Purpose Computer (GPC) redundant set reconfiguration during the rendezvous.
  - Coordinate the partial loss of translational capability.
- Examine and manage other orbiter system failures (including APDS) during the rendezvous timeline.
Rendezvous/Proximity Operations Lesson Descriptions

APPR & DOCK 31069

Title: Approach and Docking 1
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: APP DOCK MAL 31069
Equipment Required: PGSC
Prerequisite Lesson(s): PO APPR 31069
Preparation: None

Synopsis: This lesson is for docking flights only. During this lesson, the student will demonstrate an understanding of the Prox Ops techniques and tools as applied to docking with another spacecraft. Trajectory Control Sensor (TCS) and radar failures will be introduced to stress the visual cues. The PGSC will be used in this session.

Objectives:
• Perform TCS Fail approach and docking techniques.
• Work on Cockpit Resource Management (CRM) topics.
• Use the Tools for Rendezvous and Docking (TRAD) System with Hand-Held Lidar (HHL) data during this session.
• Attempt to minimize Translation Hand Controller (THC) inputs (use the whole corridor).
• Two runs planned:
  – MC3 through docking (TCS fail and failed capture).
  – MC3 through docking (Radar fail, TCS fail, and attitude flyout).

Completion Standards:
• Contact Conditions:
  – Position: < 2 inches
  – Angle: < 2 degrees
  – Rdot: 0.1±0.03 fps
• Complete within the defined (flight-specific) window.
Rendezvous/Proximity Operations Lesson Descriptions

41  RNDZ MAL 32012

Title: Rendezvous Malfunctions 2
Duration: 5.0 hours
Note: Thirty minutes of facility time (prior to this session) will be required for PGSC setup. The selected crewmembers should support this setup.
Medium: SMS-FB
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: COAS, wireless headsets, aft visual, PGSC
Prerequisite Lesson(s): RNDZ MAL 31012, SEP/TRANS 31069, and APPR & F/A 31069
Preparation: None
Note: This class may be credited based on crew participation in a Generic or Flight-Specific integrated rendezvous simulation.

Synopsis: This lesson, like RNDZ MAL 31012, will begin several hours away from the target (Station) (NCC -45 minutes or NC -30 minutes). The main goal of this lesson is to complete the rendezvous with no Rendezvous Radar to Navigation (NAV) (FF3). A trajectory dispersion may be introduced; as before, off-nominal procedures will be exercised to demonstrate how Rndz Nav and orbit targeting work. The crew should exercise their Cockpit Resource Management (CRM) plan as modified after the last SMS lesson.

Objectives: 
• Perform a Radar Fail rendezvous timeline from NC -30 min (NCC - 1 hr) to docking (grapple) or breakout while exercising good CRM.
  – Complete manual phase through docking/grapple within the budgeted fuel.
  – Maintain profile and attitude awareness.
• Demonstrate effective use of the Tools for Rendezvous and Docking (TRAD) system.
• Discuss various breakouts and when/where each is applicable.
• Recognize the impacts to Rendezvous for some single system failures, such as:
  – Recognizing a bad Inertial Measurement Unit (IMU) and how it may affect NAV.
  – Recognizing loss of General Purpose Computer (GPC) rendezvous radar pointing.
  – Recognizing loss of rendezvous radar data.
  – Discuss Translation Hand Controller (THC) contacts and jet requirements.
Rendezvous/Proximity Operations Lesson Descriptions

41  **RNDZ MAL 32012 (Concluded)**

- Examine and manage other orbiter system failures during the rendezvous timeline.
- Malfunction shopping list:
  - Demonstrate “FLTR - PROP > 40K” procedure (IMU).
  - Exercise RR AUTO TRACK ACQ cue card.
  - Use -Y Star Tracker (STRK) post Ti.
  - Practice Radar Fail manual phase techniques.
  - Examine and manage other orbiter system failures during the rendezvous timeline.
  - Use PGSC during rendezvous manual phase.
  - Performing FAILED CAPTURE due to an APDS problem is optional.
  - Exercise procedures from APDS OFF-NOMINAL on approach or after contact.

42  **RNDZ MAN PH 31069**

Title: Rendezvous Manual Phase 3  
Duration: 4.0 hours  
Medium: Shuttle Engineering Simulator Dome (SES AFT)  
Student: COMMANDER, MS, PILOT  
Source: *DM34* Rendezvous *Guidance, Procedures and Training*  
Date: 07/04  
Lesson(s) Replaced: None  
Equipment Required: PGSC (optional)  
Prerequisite Lesson(s): APP DOCK MAL 31069 (docking flights), APPR & F/A 31069, RNDZ MAL 31012  
Preparation: None  

Synopsis: In this lesson, the student will perform the initiation of the manual phase of rendezvous, using the Radar Fail procedure to complete the manual phase and to manage range and range rate. A flight-similar approach is used. Flight-similar information relative to piloting technique (plume impingement, etc.) is discussed. (Trajectory Control Sensor (TCS)/Hand-Held Lidar (HHL) data will not be used.)

One run post Ti through grapple or Docking may be included to exercise Crew Optical Alignment Sight (COAS) Navigation (NAV) procedures and techniques (as desired).
Rendezvous/Proximity Operations Lesson Descriptions

42  **RNDZ MAN PH 31069 (Concluded)**

Objectives:
- Perform manual phase rendezvous techniques.
- Use the Radar Fail procedure to complete the manual phase.
- Use COAS subtended angle and the PGSC to get range and range rate information.
- Transition to Vbar (Rbar), establish Vbar (Rbar) and perform a Vbar (Rbar) approach to grapple or docking (as required).
- Use PGSC during the manual phase (optional).
- Exercise the COAS NAV Radar Fail procedure (if desired).

Completion Standards:
- RMS Flights:
  - The flight similar approach from Post MC3 through grapple should be flown within 500 lbs. total Reaction Control System (RCS) fuel (this may include a flyaround).
- Docking Flights:
  - The flight-similar approach from MC2 + 10 minutes through docking should be flown within 500 lbs. total RCS fuel. This includes 5 minutes of stationkeeping at both a long range (170 ft.) and 30 ft. distance, and at least a one-axis attitude flyout.

43A  **TI DELAY 31001**

Title:  Ti Delay Prebrief
Duration:  0.5 hours
Medium:  Classroom
**Note:**  Schedule on prebrief room.
Student:  COMMANDER, MS, PILOT (Schedule individually.)
Source:  DM34/Rendezvous *Guidance, Procedures and Training*
Date:  05/97
Lesson(s) Replaced:  None
Equipment Required:  Rendezvous checklist
Prerequisite Lesson(s):  RNDZ MAL 32012
Preparation:  None

Synopsis:  Refer to TI DELAY 31006 for synopsis.
Objectives:  Refer to TI DELAY 31006 for objectives.
Rendezvous/Proximity Operations Lesson Descriptions

43B  **TI DELAY 31006**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Ti Delay</th>
</tr>
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<tbody>
<tr>
<td>Duration:</td>
<td>2.0 hours</td>
</tr>
<tr>
<td>Medium:</td>
<td>SST 1, SST 2, or SST 3</td>
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<tr>
<td>Student:</td>
<td>COMMANDER, MS, PILOT (Schedule individually.)</td>
</tr>
<tr>
<td>Source:</td>
<td><em>DM34/Rendezvous Guidance, Procedures and Training</em></td>
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<tr>
<td>Date:</td>
<td>09/05</td>
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<tr>
<td>Lesson(s) Replaced:</td>
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<tr>
<td>Equipment Required:</td>
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<tr>
<td>Prerequisite Lesson(s):</td>
<td>TI DELAY 31001</td>
</tr>
<tr>
<td>Preparation:</td>
<td>None</td>
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Synopsis: This lesson introduces the concepts, procedures, and issues associated with delaying the rendezvous with a Ti delay burn, and terminating a rendezvous with a backout or breakout. The lesson will begin with the orbiter about 30 minutes from the NCC burn. The main goal of this lesson is to execute the one-rev delay at the Ti point. Navigation (NAV) sensor anomalies will be demonstrated; the use of Star Tracker (STRK) data will be used post Ti, and the effect of OPS transitions on Rndz Nav will be demonstrated.

Objectives:

- Perform (aided) the Ti delay procedures.
- Perform (unaided) an External Delta-V (EXT DV) burn instead of a Lambert burn.
- Perform STRK and radar navigation post Ti or Ti delay.
- Demonstrate an understanding of the RNDZ BREAKOUT PROCEDURES OVERVIEW in the Rendezvous checklist.
- Perform RNDZ NAV SAFING and RECOVERY for an OPS transition.
- Manage other orbiter system failures during the rendezvous timeline.

44  **R/PO QUAL 31069**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Rendezvous and Proximity Operations Qualification</th>
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<tbody>
<tr>
<td>Duration:</td>
<td>4.0 hours</td>
</tr>
<tr>
<td>Medium:</td>
<td>Shuttle Engineering Simulator Dome (SES AFT)</td>
</tr>
<tr>
<td>Student:</td>
<td>COMMANDER, MS, PILOT</td>
</tr>
<tr>
<td>Source:</td>
<td><em>DM34/Rendezvous Guidance, Procedures and Training</em></td>
</tr>
<tr>
<td>Date:</td>
<td>07/04</td>
</tr>
<tr>
<td>Lesson(s) Replaced:</td>
<td>None</td>
</tr>
<tr>
<td>Equipment Required:</td>
<td>PGSC (Optional)</td>
</tr>
<tr>
<td>Prerequisite Lesson(s):</td>
<td>RNDZ MAN PH 31069</td>
</tr>
<tr>
<td>Preparation:</td>
<td>None</td>
</tr>
</tbody>
</table>
Rendezvous/Proximity Operations Lesson Descriptions

44 R/PO QUAL 31069 (Concluded)

Synopsis: During this lesson, the crew will demonstrate that manual flying completion standards for the planned rendezvous training flow have been met. (Use of FDF will be left up to the instructor.)

Objectives:
- Perform a “Radar Fail” approach from MC3 cutoff to grapple or docking using less than 450 lbs. of fuel. Perform Vbar (Rbar) stationkeeping as required. Perform a “Radar Fail” approach from MC3 cutoff to grapple or docking, using Hand-Held Lidar (HHL) only (no Tools for Rendezvous and Docking (TRAD)) and using less than 550 lbs. Perform Vbar (Rbar) stationkeeping as required and arrive at 250 feet prior to sunset.
- Contact conditions for docking flights:
  - Position: < 2 inches
  - Angle: < 1 degree
  - Rdot: 0.1±0.03 fps
  - Time: Within the docking window
  - Minimal Translation Hand Controller (THC) inputs (use the whole corridor)

45 RNDZ QUAL 31006

Title: Rendezvous Qualification
Duration: 2.0 hours
Medium: SST 1, SST 2, or SST 3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 04/88
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TI DELAY 31006
Preparation: None

Synopsis: This lesson is completed without the use of FDF in order to ascertain the student’s ability to complete a rendezvous without a so-called “cookbook” approach to the procedures. Awareness of the flight profile and the necessary actions are stressed.

Objectives:
- Demonstrate an understanding of the flight-specific rendezvous profile sequence.
- Perform necessary actions and malfunction procedures to complete the rendezvous without FDF from the NC burn through the MC2 burn.
Rendezvous/Proximity Operations Lesson Descriptions

46 PROX OPS TOPICS 31069

Title: Flight Specific Prox Ops Topics
Duration: 2.0 hours
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 03/06
Lesson(s) Replaced: EVA RESCUE 31069
Equipment Required: None
Prerequisite Lesson(s): EVA RESCUE 21069, R/PO QUAL 31069
Preparation: None
Note: Since the Joint Operations Panel has not addressed shuttle rescue of a stranded EVA crewmember while docked to a Station, this class will be used as a placeholder session for docking flights. Its' objectives will be left up to the instructor.

Synopsis: Review of various topics associated with the flight specific Prox Ops profile. These include but are not limited to:

- EVA Rescue
- Tools for Rendezvous and Docking (TRAD) skills
- Manual phase and approach skills and techniques
- Undocking and/or separation skills and techniques

Objectives: To be determined by the Instructor and the Flight Commander.

47 APPR & DOCK 91069

Title: Approach and Docking Timeline
Note: Schedule for docking flights only.
Note: Scheduled prior to first docking integrated simulation (sim).
Note: The CDR or Rndz instructor can move this lesson to the SMS as desired.
Duration: 4.0 hours
Medium: Shuttle Engineering Simulator Dome (SMS-FB)
Student: COMMANDER, MS, PILOT
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: APP DOCK 91069
Equipment Required: PGSC
Prerequisite Lesson(s): R/PO QUAL 31069 and RNDZ QUAL 31006
Preparation: None
Rendezvous/Proximity Operations Lesson Descriptions

47  APPR & DOCK 91069 (Concluded)

Synopsis: This lesson is for docking flights only and should be scheduled prior to the first integrated sim. During this lesson the student will demonstrate an understanding of the prox ops techniques and tools as applied to docking with another spacecraft. The PGSC will be used in this session.

Objectives:
- Perform nominal timeline from MC3 Time of Ignition (TIG) (MC2 Cutoff if in SMS) to docking.
- Work on Cockpit Resource Management (CRM) topics.
- Use PGSC (radar, Hand-Held Lidar (HHL), and Trajectory Control Sensor (TCS) data).
- Two runs planned from MC3 TIG through Docking (MC2 Cutoff if in SMS):
  - Failed capture is optional on one run.
  - Loss of verns is optional on one run.
- Undock and separate through the start of flyaround (if time permits).

48  RNDZ T/L 91012

Title: Rendezvous Timeline
Duration: 5.0 hours
Note: Schedule 1 hour prebrief as instructor/crew desire.
Medium: SMS-FB
Note: Thirty minutes of facility time (prior to this session) will be required for PGSC Setup. The selected crewmembers should support this setup.
Student: COMMANDER, MS, PILOT. Include the flight CAPCOM and RGPO.
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 03/05

Lesson(s) Replaced: None
Equipment Required: COAS, wireless headsets, aft visual, PGSC
Prerequisite Lesson(s): R/PO QUAL 31069, RNDZ QUAL 31006
Preparation: None

Synopsis: This lesson may be the crew’s first look at the rendezvous profile in the training load with the FDF. It may also be the crew’s first look at the rendezvous profile in the SMS. Most of this lesson will cover basic objectives. This method will allow the crew a chance to review the trajectory, the target sets, and the FDF. A training script with inputs from the crew, DT/Rendezvous training, and DM/Orbit Dynamics may be developed on a case-by-case basis. A prebrief covering the highlights of the flight-specific material may be conducted prior to the SMS session.
Rendezvous/Proximity Operations Lesson Descriptions

48  **RNDZ T/L 91012 (Concluded)**

Objectives:
- Examine rendezvous profile with load-specific software and FDF.
- Examine load-specific information:
  - Sun angle/lighting (beta)/DTOs
  - FDF changes
- Review several other training and malfunction objectives from the Rendezvous Training Flow (including APDS).

49  **RNDZ/PO T/L 91012**

Title: Rendezvous/Proximity Operations Timeline
Duration: 5.0 hours
Medium: SMS-FB
Note: Thirty minutes of facility time (prior to this session) will be required for PGSC Setup. The selected crewmembers should support this setup.
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (Include the flight CAPCOM, RGPO, PDRS, or MACCS (as desired).)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 11/01
Lesson(s) Replaced: RETR MAL T/L 91012
Equipment Required: COAS, wireless headsets, aft visual, PGSC
Prerequisite Lesson(s): APP DOCK 91069 (docking flights), R/PO QUAL 31069, RNDZ QUAL 31006
Preparation: None

Synopsis: This lesson will cover the nominal manual phase, rendezvous, and all of proximity operations through grapple or docking. Specific objectives will be flight-specific and arranged beforehand with the crew (e.g., undocking and/or separation profiles). Malfunctions may be introduced to promote crew interaction and coordination. Malfunctions for the sake of system training only should be discouraged.

Flight-Specific FDF should be used during this session.

Malfunction shopping list: Instructor should consider these malfunctions but should not try to use all of them in one session. Any malfunction used in this session must be apparent in the cockpit.

**Grapple Flight:**
- Payload Power interface problem
- Loss of safety inhibits
- Standard Switch Panel (SSP) Malfunctions
- Loss of Verns
- System Management (SM) General Purpose Computer (GPC) fail
Rendezvous/Proximity Operations Lesson Descriptions

RNDZ/PO T/L 91012 (Continued)

RMS hand controller problem
CCTV problem
End Effector (EE) malfunction

Docking Flight:
- Hooks single motor failure
- Fixers problem
- Damping problem
- Indicator light problem

Objectives:
- Exercise load-specific manual phase and proximity operations for both rendezvous and separation timelines.

- For PDRS Deploy (a PDRS instructor should support this session):
  - Exercise PDRS Deploy operations from payload unberth through the separation burns.
  - Exercise the retrieve timeline through payload berthing. This run should include a single axis flyaround for a payload that is not in the correct attitude.

- For docking Flights (an APDS instructor should support this session):
  - Perform one run from MC2 through docking (including attitude flyout).
  - Perform several runs from, and including, 30 feet stationkeeping through docking.
  - Failed capture/backouts for APDS problem and flyouts should be exercised.
  - One run to include undocking and separation profile from Orbit Docking System (ODS) power-up through the separation burns.

- Run 1: MC2 through docking (hard dock) or grapple (payload berth). (As time permits, some payload procedures may be considered after payload berth.)

- Run 2 (docking): Undocking - 30 minutes through a separation burn (May be a continuation of run 1, no reset required). (Early separation or breakout from the flyaround should be considered.)

- Run 2 (grapple): Payload activation/unberth through the Separation (SEP) 2 burn (May be done before Run 1).
Rendezvous/Proximity Operations Lesson Descriptions

49  **RNDZ/PO T/L 91012 (Concluded)**

- Run 3 (docking): Start at 30 ft. stationkeeping
  - Attitude flyout
  - Failed capture (APDS problem)
  - Perform the Corridor Backout to 30 ft.

- Run 4 (docking): Start at 30 ft. stationkeeping
  - Attitude flyout
  - Perform the Corridor Backout to 30 ft. for APDS problem

- Run 5 (docking): Start at 30 ft. stationkeeping
  - Attitude flyout
  - Station does not go to free drift (moding lights)
  - Un-latch and perform the Corridor Backout procedure to 30 ft.

50A  **UNDOCK MAL T/L 91001**

Title: Undock Malfunction Timeline Prebrief
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: *DM34/Rendezvous Guidance, Procedures and Training*
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SEP/TRANS 31069
Preparation: None

Synopsis: This lesson will provide the students with the timeline to be executed during the following lesson, UNDOCK MAL T/L 91012.

Guidelines for coordination between crewmembers should be discussed. Secondary tasks are prioritized as to not interfere with the primary task. Review the Rendezvous (RNDZ) Digital Autopilot (DAP) constraints for this timeline.

Objectives: Discuss the following:
- Nominal undocking timeline
- Flight Plan and possible contingency situations:
  - Initial Condition: Docked with Orbiter Docking System (ODS)
    - powered down, hatch opened
  - ODS Powerup
  - Vestibule depress
  - Leak Check
  - Undocking
Rendezvous/Proximity Operations Lesson Descriptions

50A UNDOCK MAL T/L 91001 (Concluded)

- Separation (SEP) 1 and backaway
- Fly around
- SEP 2 (Breakout can be substituted)

50B UNDOCK MAL T/L 91012

Title: Undock Malfunction Timeline
Duration: 4.0 hours
Note: As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson.
Medium: SMS-FB (FB, as requested.)
Student: Entire crew (CB Instructor Astronaut (IA) attendance optional.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: PGSC, COAS
Prerequisite Lesson(s): SEP/TRANS 31069,
 UNDOCK MAL T/L 91001
Preparation: None

Synopsis: Special attention should be paid to coordination between crewmembers and prioritization of tasks. This lesson exercises the Undocking timeline, integrating all Rendezvous (RNDZ), APDS and Payload tasks, as the crew will perform them in flight. The CDR should coordinate the flight deck activities to establish a proper balance between command and crewmember participation, and act decisively when the situation requires.

Objectives: • Perform undocking timeline with the following malfunctions:
  – Hatch Fail Leak Check
  – APDS manual hook release
  – Breakout from sep/flyaround due to orbiter problem or Any Attitude undock and separation

• Summary
  – Run 1 – Initial Condition: Hard Docked, orbiter controlling attitude, hatches open
• Close hatches
• Orbiter Docking System (ODS) Power-up
• Vestibule depress
• Leak Check
• Undocking
• Vbar Sep
• ODS power down
Rendezvous/Proximity Operations Lesson Descriptions

50B UNDOCK MAL T/L 91012 (Concluded)

- Flyaround (if timelined)
- Breakout burn
  - Run 2 (If time permits) – Initial Condition: Hard Docked, orbiter controlling attitude, hatches closed
- Any Attitude Separation

51 PROX OPS T/L 91012

Title: Proximity Operations Timeline
Duration: 4.0 hours
Note: As required, the SMS should be scheduled for one hour of PGSC and photo/TV setup training prior to the start of the lesson.
Medium: SMS-FB
Student: CDR, PLT, MS 1, MS 2, MS 3
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: PGSC, COAS
Prerequisite Lesson(s): RNDZ/PO QUAL 31069 (all flights), RMS/PL CONT 91012 (for grapple flights)
Preparation: None

Synopsis: During this lesson, the crewmembers will perform the flight-specific separations and/or approaches, with an emphasis on the recent changes to the FDF and Flight Rules. Some malfunctions may be introduced on a review basis. The emphasis should be on Cockpit Resource Management (CRM).

(Optional Class) The CDR and/or Rendezvous Instructor for the flight can credit this class if the objectives are met in another class.

For deploy flights, this lesson will be used to cover contingency procedures from the applicable deploy checklist.

Objectives: Deploy/Retrieve/Docking/Rendezvous flights:
- Perform deploy/undock timeline from the start of the release, deploy or docking system powerup timeline through the final Separation burn with malfunctions.
- Perform retrieve/dock timeline through berthing or docking system power down.
Rendezvous/Proximity Operations Lesson Descriptions

RNDZ MAN PH 91069

Title: Rendezvous Manual Phase 4

Note: Schedule at L-2 weeks or later.

Duration: 4.0 hours

Medium: Shuttle Engineering Simulator Dome (SES AFT)

Student: COMMANDER, MS, PILOT

Source: DM34/Rendezvous Guidance, Procedures and Training

Date: 07/04

Lesson(s) Replaced: RNDZ COMPL 91015

Equipment Required: PGSC

Prerequisite Lesson(s): RNDZ/PO T/L 91012

Preparation: None

Synopsis: In this lesson, the student will perform the initiation of the manual phase of rendezvous, using the Radar Fail and nominal procedures to complete the manual phase, and to manage range and range rate. A flight-similar approach is used. Flight-similar information relative to piloting technique (plume impingement, etc.) is discussed. Trajectory Control Sensor (TCS)/Hand-Held Lidar (HHL) data will not be used on one run.

Objectives:

• Perform the nominal manual phase rendezvous techniques.
• Use the Radar Fail procedure to complete the manual phase.
• Use Crew Optical Alignment Sight (COAS) subtended angle to get range and the PGSC to get range rate information.
• Use PGSC during manual phase.

Completion Standards: Have a good flight!

RNDZ FAM PRF 41001

Title: Rendezvous Familiarization 1 Briefing

Duration: 0.5 hours

Medium: Classroom

Student: COMMANDER, MS, PILOT (Schedule individually.)

Source: DM34/Rendezvous Guidance, Procedures and Training

Date: 07/93

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): EVA RESCUE 21069, RNDZ FAM 21006, SEP/TRANS 22069

Preparation: None

Synopsis: Refer to RNDZ FAM PRF 41006 for synopsis.

Objectives: Refer to RNDZ FAM PRF 41006 for objectives.
Rendezvous/Proximity Operations Lesson Descriptions

RNDZ FAM PRF 41006

Title: Rendezvous Familiarization 1
Duration: 2.0 hours
Medium: SST 1, SST 2, or SST 3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: *DM34*/Rendezvous *Guidance, Procedures and Training*
Date: 05/97
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ FAM PRF 21001
Preparation: None

Synopsis: This lesson is designed for students that have completed the “Deploy Only” part of this training flow. In this lesson, the student will perform the nominal timeline from the start of the Contingency Rendezvous book to the MC2 burn. The use of REL NAV (SPEC 33) ORBIT TGT (SPEC 34), and sensor data will be stressed. During the class, the student will use the annotated procedures found in the Rendezvous Crew Training Handbook.

Objectives:
- Perform the nominal rendezvous timeline.
- Evaluate Navigation (NAV) sensor data.
- Configure orbiter crew Station switches for rendezvous operations.
- Evaluate burn solutions, choose the correct engines, and execute rendezvous Reaction Control System (RCS) burns.
- Configure the software for rendezvous operations.
- Explain Inertial Measurement Unit (IMU) attitude selection.

PO PRF ADV 41069

Title: Proximity Operations Proficiency
Duration: 2.0 hours/as required
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: *DM34*/Rendezvous *Guidance, Procedures and Training*
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: PGSC
Prerequisite Lesson(s): PROX TECH 21069, SEP/TRANS 22069
Preparation: None
Rendezvous/Proximity Operations Lesson Descriptions

PO PRF ADV 41069 (Concluded)

Synopsis: This lesson is designed for students that have completed the “Deploy Only” part of this training flow. This lesson is designed to practice prox ops techniques.

Objectives: Exercise prox ops approaches and separations.

RNDZ PRF ADV 41001

Title: Advanced Rendezvous Proficiency Briefing
Duration: 0.5 hours
Medium: Classroom
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/93
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Completion of 20000-level Rendezvous training
Preparation: None

Synopsis: The prebrief will include content such as: the lesson overview, a systems review, a review of FDF use and procedures, switch configurations, and other crew training aids.

Objectives: Refer to RNDZ PRF ADV 41006 for objectives.

RNDZ PRF ADV 41006

Title: Advanced Rendezvous Proficiency
Duration: 2.0 hours/6 months
Medium: SST 1, SST 2, or SST 3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 05/97
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ PRF ADV 41001
Preparation: None

Synopsis: This lesson is designed to assure that the student has achieved a level of competence/awareness necessary to support an integrated rendezvous session. Sensor biases, their impact on rendezvous navigation, and subsequent Lambert targeting are stressed. In order to bring out a few key points, especially as far as the management of Rendezvous Navigation, several malfunctions will be introduced.
Rendezvous/Proximity Operations Lesson Descriptions

RNDZ PRF ADV 41006 (Concluded)

Objectives:
• Identify star lock-ons during a Star Tracker (STRK) pass.
• Perform DPS reconfigurations and recognize when RNDZ NAV SAFING and RECOVERY is required.
• Identify STRK power problems and sensor biases.
• Identify the radar/Nav data path.
• Evaluate burn solutions, choose the correct engines, and execute RNDZ OMS BURN procedure.
• Evaluate the MC2 solution and perform this burn on time rather than on elevation angle.

R/PO PRF ADV 41069

Title: Advanced Rendezvous and Proximity Operations Proficiency
Duration: 4.0 hours/6 months (Pilot Pool Proficiency)
          4.0 hours/2 weeks (Assigned crew proficiency)
Medium: Shuttle Engineering Simulator Dome (SES AFT)
Student: COMMANDER, MS, PILOT (Schedule CDR and PLT separately, with MS attending one session.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 07/04
Lesson(s) Replaced: RNDZ PROF 41012, PROX PRF ADV 41012
Equipment Required: PGSC
Prerequisite Lesson(s): Completion of 20000-level Rendezvous training
Preparation: None

Synopsis: This lesson is designed to maintain the proficiency level necessary to support integrated rendezvous simulations. Generic rendezvous approaches will be exercised to include nominal, short, and long trajectory cases. The rendezvous will span the timeframe between MC3 and stationkeeping, grapple, or docking. If this class is being used for proficiency after a launch slip, one class every two weeks is the requirement. This assures that the last class will be at L-2 weeks or less. A DST or SMS session can be substituted to meet this requirement.

Objectives: Exercise generic rendezvous approaches from MC3 to grapple or docking.
Rendezvous/Proximity Operations Lesson Descriptions

R/PO PRF ADV 41025

Title: Advanced Rendezvous and Proximity Operations Proficiency
Duration: 2.0 hours/as desired
Medium: Dynamic Skills Trainer 1
Student: COMMANDER, MS, PILOT (Schedule separately or as desired.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Note: Schedule as 71025 if instructor not required
Date: 05/97
Lesson(s) Replaced: None
Equipment Required: PGSC
Prerequisite Lesson(s): DST FAM 21025
Preparation: None

Synopsis: This lesson is designed to introduce the student to the capabilities of the DST. The instructor will demonstrate the logon procedure as well as the PGSC hook-ups. The rendezvous profile will span the timeframe between MC3 and stationkeeping, grapple or docking, as well as undocking and separations.

Objectives:

• Logon to the DST for use as a Rendezvous/Prox Ops and PGSC software trainer.
• Exercise generic rendezvous approaches from MC3 to grapple or docking.
• Practice using the PGSC and managing the data inputs.

RNDZ QUAL 41006

Title: Rendezvous Qualification
Duration: 2.0 hours
Medium: SST 1, SST 2, or SST 3
Student: COMMANDER, MS, PILOT (Schedule individually.)
Source: DM34/Rendezvous Guidance, Procedures and Training
Date: 02/90
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): RNDZ OPS 21012 or RNDZ PRF ADV 41006 if regaining proficiency
Preparation: None

Synopsis: In this lesson the student will verify completion standards of the training course by executing the rendezvous timeline without the use of procedures. No malfunctions will be introduced.

Objectives: Refer to RNDZ QUAL 21006 for objectives.
Rendezvous/Proximity Operations Lesson Descriptions

**R/PO QUAL 41069**

Title: Rendezvous Qualification  
Duration: 4.0 hours  
Medium: Shuttle Engineering Simulator Dome (SES AFT)  
Student: COMMANDER, MS, PILOT  
Source: DM34/Rendezvous *Guidance, Procedures and Training*  
Date: 07/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): RNDZ OPS 21012 or RNDZ PRF ADV 41006 if regaining proficiency  
Preparation: None  
Synopsis: Refer to R/PO QUAL 21069 for synopsis.  
Objectives: Refer to R/PO QUAL 21069 for objectives.

**GEN RNDZ 31042**

Title: Integrated Generic Rendezvous  
Duration: 8.0 hours  
Medium: MCC/FB  
Student: COMMANDER, MS, PILOT (Other crewmembers as required by CDR.)  
Source: DM34/Rendezvous *Guidance, Procedures and Training*  
Date: 04/93  
Lesson(s) Replaced: None  
Equipment Required: Rendezvous Checklist  
Prerequisite Lesson(s): RNDZ QUAL 21006  
Preparation: None  
Synopsis: It is highly desirable that the flight crew supports an integrated generic rendezvous simulation. RNDZ MAL 31012 or RNDZ MAL 32012 can be credited based on this support.  
Objectives: Exercise crew coordination options to complete the rendezvous during a generic rendezvous simulation.
SECTION 11.0 SPACEHAB/MPLM TRAINING COURSE

This section contains two separate training courses: for the Spacehab and for the Multipurpose Logistics Module (MPLM). The applicable training flow will be chosen based on the flight-specific mission configuration (i.e., which payload is manifested).

The Spacehab Training Course specifies the lessons required to prepare a student to understand and develop the skills necessary to operate the Spacehab. The subsystems for the Spacehab Logistics Module (LM) are dependent on the flight-specific configuration.

Upon completing the Spacehab Training Course, the student shall be able to perform all nominal procedures to operate the Spacehab module subsystems. Additionally, the student shall use the malfunction procedures to recognize and recover from module failures and failures of Orbiter interfaces.

The course utilizes various facilities for training including the classroom, the Payload Trainer (PYLD), the Spacehab Volumetric Trainer (SVT), the SMS, the FFT, and the CCT at JSC. The Payload Trainer is a UNIX-based trainer located in JSC’s building 4S providing standalone training on the Spacehab subsystems. The PYLD shall be used as the primary systems trainer for Spacehab. The FFT or CCT shall be used to provide Spacehab tunnel operations training. The facility used is dependent on the flight-specific Orbiter airlock configuration. The SMS-FB and SVT shall be used to exercise coordinated crew procedures required for Spacehab subsystem nominal and contingency operations. The SMS GNS and SVT may also be used for training (if required), although this combination is less desirable since the SMS-GNS is in building 35 and the SVT and SMS-FB are in building 5N.

The CDR shall select the MS responsible for Spacehab prime and backup support.

The MPLM Training Course specifies the lessons required to prepare a student to understand and develop the skills necessary to operate the MPLM Orbiter interfaces while in the payload bay. Upon completing the MPLM Training Course, the student shall be able to perform nominal demate/mate of the Remotely Operated Electrical Umbilical (ROEU) and release/latch of the MPLM Payload Retention Latch Assemblies (PRLA) and Active Keel Actuator (AKA).

The course utilizes various facilities for training, including the classroom and PYLD at JSC, as well as an actual MPLM during a supplemental facility visit at KSC.

The CDR shall select the MS responsible for MPLM prime and backup support.
Figure 11-1. Spacehab Lesson Flow Chart
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**Table 11-1. Spacehab Crew Training Requirements**

**Date Last Modified:** 06/08
Spacehab Lesson Descriptions

1  SHAB SUBSYSTEM 31001

Title: Spacehab Subsystems Familiarization Briefing  
Duration: 4.0 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1  
Source: Spacehab Inc.  
Date: 03/05  
Lesson(s) Replaced: SHAB FAM 31001  
Equipment Required: Overhead projector  
Prerequisite Lesson(s): New Astronaut Flow  
Preparation: None

Synopsis: This lesson is a briefing given by Spacehab Inc. about the Spacehab payload. The briefing provides an overview of the Spacehab module and each subsystem, including interfaces with the orbiter and crew. In addition, this lesson covers the purpose and use of the Spacehab Subsystem (SS) PGSC system as it relates to Spacehab, including a display overview and command capability.

Objectives: By the end of this lesson, the students will be able to:  
- Identify components and subsystems of the Spacehab module.  
- Name all Orbiter/crew interfaces.  
- Describe Spacehab operational concepts and procedures.

2  SHAB NOM OPS 31029

Title: Spacehab Operations Nominal  
Duration: 3.0 hours  
Medium: PYLD Trainer  
Student: As assigned by CDR (Schedule individually.)  
Source: DO5/Cargo Integration and Operations Branch  
Date: 03/05  
Lesson(s) Replaced: SHAB RDM NOM 31029  
Equipment Required: Spacehab Operations Checklist (SH OPS)  
Prerequisite Lesson(s): SHAB SUBSYSTEM 31001  
Preparation: None
Spacehab Lesson Descriptions

2 SHAB NOM OPS 31029 (Concluded)

Synopsis: This lesson provides an overview of the Spacehab Logistics Module (LM) EPS and Environmental Control Subsystem (ECS). The lesson builds student proficiency at monitoring and controlling the Spacehab Emergency direct current (EMER DC), DC, and AC power systems as well as the Atmosphere Revitalization Subsystem (ARS), water loop, and Fire Suppression Subsystem (FSS) systems. The lesson also discusses how the Orbiter provides power to Spacehab. It exercises the post insertion, activation, and entry prep procedures for unpowered ascent and powered entry configuration. Current FDF shall be used.

Objectives: By the end of this lesson, the student shall be able to:

- Identify the following cockpit interfaces:
  - Standard Switch Panel (SSP) switches and talkbacks
  - R1A1 and MA73C power switches
  - C3A5 switches
  - Multifunction Electronic Display Subsystem (MEDS) displays
  - MEDS commanding
- Describe the EPS in terms of:
  - EMER DC bus configuration
  - DC bus configuration
  - AC bus configuration
  - Experiment Connector Panel (EXCP) AC and DC power switching
- Describe the ECS in terms of:
  - ARS and Cabin Fan control and monitoring
  - ECS data displayed on the MEDS displays
  - Water loop control and monitoring
  - Module smoke detection
  - FSS commanding
  - FSS Self Test
  - Atmospheric Pressure Limiting Subsystem (APLS) valves
- Execute the Spacehab Activation procedure for unpowered ascent.
- Execute the Spacehab Entry Prep procedure for powered entry.
Spacehab Lesson Descriptions

3  SHAB EPS MAL 31029

Title: Spacehab Electrical Power Subsystem Malfunction
Duration: 2.0 hours
Medium: PYLD Trainer
Student: As assigned by CDR (Schedule individually or in pairs.)
Source: DO5/Cargo Integration and Operations Branch
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: Spacehab Operations Checklist (SH OPS), Spacehab Malfunction Procedures and System Data (SH MAL)
Prerequisite Lesson(s): SHAB NOM OPS 31029
Preparation: None

Synopsis: This lesson exposes the student to a variety of Spacehab EPS malfunction signatures. Malfunctions shall be exercised for the Spacehab Emergency direct current (EMER DC), DC, and AC power systems. Possible malfunction scenarios may include: relay failures, sensor failures, bus shorts, equipment shorts, fuse failures, switch failures, or Spacehab inverter failures. This lesson contains two objectives that must be completed before the lesson is considered complete.

Objectives: By the end of this lesson, the student shall be able to:
• Identify the Spacehab EPS anomalies presented and perform the appropriate malfunction procedure and/or recovery procedure from the SH OPS or SH MAL.
• Explain the impacts of each anomaly with respect to Spacehab systems and Orbiter operations.

4  SHAB ECS MAL 31029

Title: Spacehab Environmental Control Subsystem Malfunction
Duration: 2.0 hours
Medium: PYLD Trainer
Student: As assigned by CDR (Schedule individually or in pairs.)
Source: DO5/Cargo Integration and Operations Branch
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: Spacehab Operations Checklist (SH OPS), Spacehab Malfunction Procedures and System Data (SH MAL)
Prerequisite Lesson(s): SHAB EPS MAL 31029
Preparation: None
Spacehab Lesson Descriptions

4 SHAB ECS MAL 31029 (Concluded)

Synopsis: This lesson exposes the student to a variety of Environmental Control Subsystem (ECS) component failure signatures. This lesson contains two objectives that must be completed before the lesson is considered complete. Malfunctions shall be exercised in the Atmosphere Revitalization Subsystem (ARS), Atmosphere Thermal Control Subsystem (ATCS), Atmosphere Monitoring Subsystem (AMS), Atmosphere Pressure Limiting Subsystem (APLS), and the Fire Suppression Subsystem (FSS). Possible malfunction scenarios may include:

- Cabin leak
- Cabin/ARS fan delta pressure high/low
- Cabin pressure high/low
- Partial Pressure Carbon Dioxide (PPCO2) high/low
- Partial Pressure Oxygen (PPO2) high/low
- Cabin temperature high/low
- Water pump outlet pressure
- Water pump inlet pressure
- Water pump accumulator quantity
- Inadvertent FSS ARM
- Smoke sensor A/B alarm
- False fire
- Slow propagating fire
- Fast propagating fire
- Single bottle Halon discharge
- Multi-bottle Halon discharge

Objectives: By the end of this lesson, the student shall be able to:

- Identify the Spacehab ECS anomalies presented and perform the appropriate malfunction procedure and/or recovery procedure from the Spacehab Operations Checklist (SH OPS) or Spacehab Malfunction Procedures and System Data (SH MAL).
- Explain the impacts of each anomaly with respect to Spacehab systems and Orbiter operations.
Spacehab Lesson Descriptions

5 SVT FAM 31185

Title: Spacehab Volumetric Trainer Familiarization
Duration: 0.25 hours
Medium: SVT
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DO5/Cargo Integration and Operations Branch
Date: 10/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SHAB NOM OPS 31029
Preparation: None
Note: Schedule with SHAB LM COM 31187

Synopsis: This lesson shall cover a Spacehab Volumetric Trainer (SVT) familiarization briefing inside the SVT. Included in the briefing shall be safety features, operational constraints, and operational limitations.

Objectives: By the end of this lesson, the student shall be able to:
- Describe the SVT operational capabilities and limitations.
- Describe the SVT safety hazards.
- Follow the SVT safety precautions and escape routes in the event of fire.

6 SHAB LM COM 31187

Title: Spacehab Logistics Module Communication and Caution & Warning
Duration: 2.0 hours
Medium: SVTFB (SVTGNS)
Student: COMMANDER, MSs, PILOT (Schedule by shift, MSs as assigned.)
Source: DO5/Cargo Integration and Operations Branch
Date: 03/05
Lesson(s) Replaced: SHAB RDM COM 31187
Equipment Required: Spacehab Operations Checklist (SH OPS), Spacehab Experiment Handbook (if flown), Subsystem (SS) Payload General Support Computer (PGSC), Photo/Television (TV) Checklist (C/L) (as required), Battery Powered Speaker Microphone Unit (BPSMU)
Prerequisite Lesson(s): SHAB ECS MAL 31029, SVT FAM 31185, C/L CAMR OPS 91019
Preparation: None
Spacehab Lesson Descriptions

6 SHAB LM COM 31187 (Concluded)

Synopsis: The student shall receive an overview of the Spacehab Data subsystem, Caution and Warning (C&W), and Orbiter Fault Detection and Annunciation (FDA) provided for the Spacehab subsystems. This lesson contains four objectives that must be completed before the lesson is considered complete. The lesson provides an overview of the following classes of the C&W system:

- Class 1: Emergency C&W
- Class 2: Hardware C&W
- Class 2: Backup C&W
- Class 3: FDA

Objectives: By the end of this lesson, the student shall be able to:

- Describe the data flow between the Orbiter and Spacehab.
- Differentiate between the visual and aural cues for Class 1, 2, and 3 Spacehab C&W alarms.
- Perform the instructor-specified steps contained in the Spacehab Activation Section (SYSTEM CONFIG, MODULE CONFIG, SS PGSC ACTIVATION) of the Spacehab Operations Checklist (SH OPS), without instructor assistance.
- Perform the instructor-specified steps contained in the Spacehab Entry Prep section (MODULE CLOSEOUT, SYSTEM CONFIG) of the SH OPS, without instructor assistance.

7 SHAB FIRE CC 31001

Title: Spacehab Fire Alarm Cue Card Briefing
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DO5/Cargo Integration and Operations Branch
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: Overhead projector
Prerequisite Lesson(s): SHAB LM COM 31187
Preparation: None

Synopsis: The briefing covers the Ascent/Entry and Orbit Spacehab Fire Alarm Cue Cards (front and back). The format, expected crew responses to either smoke or fire indications, and flight rules will be reviewed.
Spacehab Lesson Descriptions

7  **SHAB FIRE CC 31001 (Concluded)**

Objectives: By the end of this lesson, the student shall be able to:
- Describe various paths of Spacehab Fire Alarm Cue Cards.
- Describe crew coordination required for Spacehab fire or smoke.
- Describe emergency deactivation, emergency egress, and 30-minute deactivation.
- Describe Spacehab operational procedures to be implemented during orbit and/or ascent/entry.

8  **SHAB LM MAL 91187**

Title: Spacehab Logistics Module Subsystem Malfunction Operations
Duration: 4.0 hours
Medium: SVTFB (SVTGNS)
Student: As assigned by CDR (Rest of crew optional.)
Source: DO5/Cargo Integration and Operations Branch
Date: 03/05
Lesson(s) Replaced: SHAB RDM MAL 91187
Equipment Required: Spacehab Volumetric Trainer (SVT) Middeck Locker Equivalent (MLE) mockups, hard lockers, experiment mockups or Class III training hardware, Spacehab Operations Checklist (SH OPS), Spacehab Malfunction Procedures and System Data (SH MAL), Spacehab Experiment Handbook (if flown), Flight-Specific FDF (as required), Subsystem (SS) Payload General Support Computer (PGSC), Photo/Television (TV) Checklist (C/L) (as required), Battery Powered Speaker Microphone Unit (BPSMU)
Prerequisite Lesson(s): SHAB FIRE CC 31001, ODS TNL OPS 91020
Preparation: None

Synopsis: This lesson shall cover the contingency and malfunction procedures contained in the SH OPS and SH MAL. Malfunctions will be individually presented by the instructor, and resolved by the student via the malfunction procedures. Other crew activities during the session may take place on a non-interference basis.

Objectives: By the end of this lesson, the student shall be able to:
- Utilize the SH OPS, SH MAL, and/or cue cards to identify and/or correct presented malfunctions.
- Update Spacehab subsystems measurements monitored on Systems Management (SM) SPEC 60.
- Change upper and lower alarm limits for Spacehab parameters.
Spacehab Lesson Descriptions

SUPPLEMENTARY LESSONS:

**SHAB MANUAL 31002**

Title: Spacehab Subsystem Training Manual  
Duration: 4.0 hours  
Medium: Workbook  
Student: As assigned by CDR (Rest of crew optional.) (Schedule individually.)  
Source: Spacehab Inc.  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): SHAB SUBSYSTEM 31001  
Preparation: None  

Synopsis: This manual provides the student with an operational knowledge of the Spacehab module and its subsystems.  

Objectives: Become familiar with the Spacehab subsystem design, operation, and interfaces with the orbiter.

**SHAB RVW 41029**

Title: Spacehab Subsystem Review  
Duration: 1.0 hour  
Medium: PYLD Trainer  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule individually or in pairs.)  
Source: DO5/Cargo Integration and Operations Branch  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: Spacehab Operations Checklist (SH OPS), Spacehab Malfunction Procedures and System Data (SH MAL), Spacehab Experiment Handbook (if flown)  
Prerequisite Lesson(s): SHAB ECS MAL 31029  
Preparation: None  

Synopsis: This lesson is available for a repeat of any of the previous lessons conducted in the Payload Trainer. This lesson shall concentrate on procedures or malfunctions specifically requested by the student or by agreement between student and instructor.  

Objectives: The objectives for this lesson shall be determined by the student and instructor on a case-by-case basis.
Spacehab Lesson Descriptions

**SHAB TNL RVW 41019**

Title: Spacehab Tunnel Review  
Duration: 1.0 hour  
Medium: FFT (CCT)  
Student: As assigned by CDR (Schedule in pairs.)  
Source: DX45/Crew Systems Group  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: Tunnel Adapter mockup with either Spacehab mockup or Spacelab tunnel, Spacehab Operations Checklist (SH OPS)  
Prerequisite Lesson(s): SHAB LM MAL 91187, ODS TNL OPS 91020  
Preparation: None  
Note: This lesson is conducted by request only.  
Synopsis: This lesson is available for a review of information that was covered in the ODS TNL OPS 91020 lesson.  
Objectives: The objectives for this lesson shall be determined by the student and instructor on a case-by-case basis.

**SHAB RVW 41187**

Title: Spacehab Subsystem Operations and Malfunctions Review  
Duration: 4.0 hours  
Medium: SVTFB (SVTGNS)  
Student: As assigned by CDR.  
Source: DO5/Cargo Integration and Operations Branch  
Date: 03/05  
Lesson(s) Replaced: None  
Equipment Required: Spacehab Volumetric Trainer (SVT) Middeck Locker Equivalent (MLE) mockups, hard lockers, experiment mockups or Class III training hardware, Spacehab Operations Checklist (SH OPS), Spacehab Malfunction Procedures and System Data (SH MAL), Spacehab Experiment Handbook, Flight-Specific FDF (as required), Subsystem (SS) Payload General Support Computer (PGSC), Photo/Television (TV) C/L (as required), Battery Powered Speaker Microphone Unit (BPSMU)  
Prerequisite Lesson(s): SHAB LM MAL 91187  
Preparation: None  
Note: This lesson is conducted by request only.
Spacehab Lesson Descriptions

SHAB RVW 41187 (Concluded)

Synopsis: This lesson is available for a repeat of any of the previous SHAB LM MAL 91187 lessons. This lesson shall concentrate on procedures or malfunctions specifically requested by the student or by agreement between student and instructor.

Objectives: The objectives for this lesson shall be determined by the student and instructor on a case-by-case basis.
Figure 11-2. MPLM Lesson Flow Chart
# Table 11-2. MPLM Crew Training Requirements

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MPLM Lesson Descriptions

1 SHUTTLE MPLM I/F 31001

Title: Shuttle Multipurpose Logistics Module Interfaces Overview
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: PC projector with PowerPoint or overhead projector (backup)
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This briefing is given by the Spaceflight Training Division subject matter expert on the Shuttle interfaces with the MPLM. The briefing reviews:

- The basic purpose of the MPLM
- An overview of the organizational structure, MPLM system, interfaces with the orbiter, crew, and MCC interfaces
- An overview of nominal and contingency operations, mission objectives, and flight rules with respect to MPLM in the Shuttle cargo bay

Objectives: Upon completion of this lesson, the student will be able to:

- State the primary mission objectives of the MPLM.
- Name and describe all MPLM-to-Orbiter interfaces including mechanical, electrical, command and data, and crew interfaces.
- Demonstrate a basic knowledge of operational concepts and procedures with respect to MPLM in the Shuttle cargo bay.
- Describe applicable MPLM subsystems and functions.
- Compare/contrast the passive and active configurations of MPLM with respect to MPLM in the Shuttle cargo bay.

2 MPLM ROEU/PRS OPS 31029

Title: Multipurpose Logistics Module Remotely Operated Electrical Umbilical/Payload Retention System Operations
Duration: 2.0 hours
Medium: PYLD Trainer
Student: As assigned by CDR.
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SHUTTLE MPLM I/F 31001
Preparation: None
MPLM Lesson Descriptions

2  MPLM ROEU/PRS OPS 31029 (Concluded)

Synopsis: This lesson provides an overview of how the Payload Retention System (PRS) and Remotely Operated Electrical Umbilical (ROEU) support MPLM and other applicable cargo elements. It also allows the student the opportunity to practice the PRS and ROEU operations incurred during unberthing/berthing of the MPLM. The student will also practice resolving anomalies affecting the PRS and ROEU systems.

Objectives: Upon completion of this lesson, the student should be able to:

- State the purpose of the PRS major components and ROEU.
- Describe the payload select rotary switch, payload retention latch switches and talkbacks, payload retention logic power, Motor Controller Assembly power logic circuit breakers, and payload bay mechanical power.
- Explain the latch, release, and ready-to-latch indications displayed on SPEC 97.
- Identify the types of PRS components that support MPLM.
- Given the appropriate FDF or Station Operations Data File (SODF), demate/mate ROEU and release/latch MPLM Payload Retention Latch Assemblies (PRLAs) and Active Keel Actuator (AKA).
- Recognize and resolve PRS and ROEU anomalies using the appropriate ROEU Malfunction and EVA contingency procedures or knowledge of the system to resolve a problem.

ASBLY OPS HB 31007

Title: Assembly Operations Handbook (Supplemental)
Duration: 4.0 hours
Medium: Text
Student: As assigned by CDR.
Source: DO5/Cargo Integration and Operations Branch
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SHUTTLE MPLM I/F 31001
Preparation: None
MPLM Lesson Descriptions

ASBLY OPS HB 31007 (Concluded)

Synopsis: An Assembly Operations Handbook (AOH) is developed for each ISS assembly mission by DO5/Cargo Integrations and Operations personnel. An AOH includes information covering the entire launch package, including MPLM-specific data for missions where an MPLM is manifested. The AOH provides systems descriptions of the MPLM command, telemetry, power, and data interfaces. This manual includes schematics and serves as an excellent data source. If the current mission AOH is not yet published, an AOH from the prior MPLM mission may be used as study material.

Objectives: Upon completion of this lesson, the student should be able to:
• Demonstrate knowledge of the systems drawings.
• Point out orbiter power, structural, and data interfaces applicable to MPLM.

MPLM FACIL 31031

Title: Multipurpose Logistics Module Hardware Facility Visit (Supplemental)
Duration: 4.0 hours (or as available)
Medium: KSC
Student: As assigned by CDR.
Source: DS45/Shuttle Systems Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SHUTTLE MPLM I/F 31001
Preparation: None

Synopsis: This lesson provides an opportunity for the student(s) to see actual MPLM flight hardware and get a hands-on look at the MPLM.

Note:
• Recommend scheduling this visit alongside other activities at KSC.
• Coordinate with Vehicle Integration and Test Team at KSC for this visit.
• Consider crew travel time between JSC and KSC.

Objectives: Upon completion of this lesson, the student should have developed familiarity with the locations of internal and external MPLM subsystem components that have potential for hands-on crew interface.
MPLM Lesson Descriptions

MPLM REVIEW 41029

Title: Multipurpose Logistics Module Review
Duration: 1.0 hour
Medium: PLYD Trainer
Student: As assigned by CDR.
Source: DS45/Shuttle Systems Training Group
Date: 03/05

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MPLM ROEU/PRS OPS 31029
Preparation: None

Synopsis: This lesson is a review of particular aspects of the MPLM operations. Emphasis is placed on in-depth discussion or review of payload systems, nominal/malfunction procedures, or other payload operations. The review may include portions of previous lessons. This lesson provides a review of the payload retention and umbilical system used for MPLM. It will review the payload retention and Remotely Operated Electrical Umbilical (ROEU) system equipment, the crew interfaces, the operating procedures, and the generic flight rules. The student should coordinate with the assigned instructor about the subject areas to be covered. This lesson is scheduled on request by the student or instructor, but frequency should be limited to once every four weeks.

Objectives: Lesson objectives vary with the subject matter covered and should be agreed to in advance by the student and instructor.
SECTION 12.0   CORE STATION SYSTEMS FOR STS CREW TRAINING

The Core Station Systems training flow for STS crewmembers is the subset of Station systems training relevant to the assigned Shuttle crews. It provides the flight crew with a reference to all Space Station-related training. Many classes in the flow are taken from the ISS training catalog, thus being a subset of those classes that Expedition crewmembers take. Certain core classes in this flow are actually Shuttle crewmember-unique versions of one or multiple related Station classes.

The core classes will cover an Operations Baseline review (flight-specific), ISS Operations Local Area Network (LAN) (Onboard Short Term Plan Viewer (OSTPV), International Procedure Viewer (IPV) and the Execute Package), Portable Computer System (PCS) operations, crew responsibility for Caution and Warning (C&W) events, EPS familiarization, Motion Control (including functions, attitude control operations concept, Guidance, Navigation, and Control (GNC) modes, docking timeline tasks), Structures and Mechanisms (S&M), Environmental Control and Life Support Systems (ECLSS), and use of audio and video equipment. The actual classes required will be very dependent upon mission activities.

Towards the end of the flow, an opportunity will be available to review past material and/or have the crew receive additional training due to updates to the mission profile. Integrated simulations between the Shuttle and ISS flight control teams will follow this review. In some cases, the actual Expedition crew, which will be on orbit with the Shuttle crew, will participate. These integrated simulations will occur in parallel with some planned system specific training. Lastly, an opportunity will be available to review Station Program Notes (SPNs) that were not able to be covered in training or are not already documented in procedures. Any changes in maintenance activities will also be covered close to launch.
Figure 12-1. Core Station Systems for STS Crew Training Flow Chart  
(Sheet 1 of 2)
Figure 12-1. Core Station Systems for STS Crew Training Flow Chart
(Sheet 2 of 2)
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## Table 12-1. Core Station Systems for STS Crew Training Requirements

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Date Last Modified: **06/08**
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### Core Station Systems for STS Crew Training Lesson Descriptions

1. **OPS BASELINE REVIEW 21001**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Operations Baseline Review</th>
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<tr>
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<tr>
<td>Medium:</td>
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<td>Student:</td>
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<tr>
<td>Source:</td>
<td>DA72/Station Training Leads and DO5/Cargo Integration &amp; Operations Branch</td>
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<tr>
<td>Date:</td>
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<td>Lesson(s) Replaced:</td>
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<tr>
<td>Equipment Required:</td>
<td>Computer/projector</td>
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<td>Prerequisite Lesson(s):</td>
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</tr>
<tr>
<td>Preparation:</td>
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</tr>
</tbody>
</table>

**Synopsis:** This class includes an assembly overview, assumptions, issues being worked, contingency scenarios, etc. Also presented is the training/simulation plan, showing how this fits in with the flight priorities. The Assembly and Checkout Officer (ACO) for the flight will lead this class.

**Objectives:** Describe the major Station-related activities for the mission.

2. **ISS OPS S/W INTRO 21257**

<table>
<thead>
<tr>
<th>Title:</th>
<th>ISS Operations Software Introduction</th>
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<td>Medium:</td>
<td>OPS LAN PTT</td>
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<tr>
<td><strong>Note:</strong></td>
<td>For crewmembers with previous ISS CAPCOM experience, this lesson may be more of a refresher and take less time.</td>
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<tr>
<td>Source:</td>
<td>DO55/Daily Operations Group</td>
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<tr>
<td>Date:</td>
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<td>Equipment Required:</td>
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<td>Prerequisite Lesson(s):</td>
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</table>

**Synopsis:** This lesson will introduce Shuttle crewmembers to the Operations Local Area Network (Ops LAN) onboard the ISS, its primary components, and the daily operations tools that reside on the Station Support Computers (SSCs). The students will perform practical exercises with the Onboard Short Term Plan Viewer (OSTPV), International Procedure Viewer (IPV), and the Execute Package that ISS crewmembers utilize onboard the ISS to execute daily tasks. Communication tools available on the SSCs are also demonstrated. Operational concepts are addressed regarding how the software tools are used individually and collectively.
Core Station Systems for STS Crew Training Lesson Descriptions

2  **ISS OPS S/W INTRO 21257 (Concluded)**

Objectives:  
- Access, configure, and use the OSTPV application for routine station operations.
- Access, annotate, and use the IPV application to find and read electronic-form procedures.
- Access and use Internet Explorer to read items from a typical Execute Package.
  - *Access, configure, and use the communication tools available on the Ops LAN.*
  - *Describe the current Ops LAN configuration and identify where the equipment you need to access is located onboard the ISS.*
- Describe how the OSTPV, IPV, and the Execute package interact with one another in the course of routine operations.

3  **PCS/C&W OPS 21110**

| Title: Portable Computer System/Caution and Warning Operations |
| Duration: 1.25 hours |
| Medium: *Space Station Training Facility (SSTF)* |
| Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule in pairs.) |
| Source: *DI25/Station Command & Data Handling Group* |
| Date: 06/08 |

Lesson(s) Replaced: **PCS/C&W OPS 21078**

Equipment Required: None

Prerequisite Lesson(s): ISS OPS S/W INTRO 21257

Preparation: None

Synopsis:  
- A Command and Data Handling (CDH) introduction to include the tiered structure and a general understanding of how the system recovers itself when there are malfunctions.
- Caution & Warning (C&W) information, including C&W classifications, ideology, C&W toolbar and summary pages, *and the* C&W panel.
- Overview of major telemetry indications and commanding from the Portable Computer System (PCS).

Objectives:  
- Describe the purpose of the ISS C&W system, and differentiate among the *four* classes of alarms.
- *For all C&W Hardware, describe the location, the signatures available and the functionality that each offers for the crew to respond to annunciations.*
- *Describe each of the three emergency events, identify the signatures associated with them, and manually initiate the annunciation of them.*
- *Demonstrate basic operation of the PCS including navigation, commanding and an understanding of how to utilize display standards.*
Core Station Systems for STS Crew Training Lesson Descriptions

4  **ISS EPS OV 21078**

**Title:**  ISS Electrical Power System Overview  
**Duration:**  1.0 hour  
**Medium:**  Generic Part Task Trainer  
**Student:**  COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule individually or in pairs.)  
**Source:**  *DI43/Station Electrical Power System and Thermal Control System Group*  
**Date:**  09/04  
**Lesson(s) Replaced:**  None  
**Equipment Required:**  None  
**Prerequisite Lesson(s):**  PCS/C&W OPS 21110  
**Preparation:**  None  

**Synopsis:**  There are two goals for this lesson.  
- The first is to give the students a very basic understanding of the EPS system architecture and redundancy. The student should have a basic understanding of how EPS failures can impact the station, and what would constitute a major failure.  
- The second goal is to provide the student with some basic commanding skills, so that they can use the EPS system in support of other systems' tasks. These skills will include EPS display navigation, Remote Power Control Module (RPCM) commanding, and the knowledge required to know when it is safe/allowable to command RPCMs.

**Objectives:**  
- Understand the basic architecture and redundancy of the EPS system.  
- Safely route power to other systems' Orbital Replacement Units (ORUs).

5  **ISS S/G VOICE OP/ML 21078**

**Title:**  ISS Space-to-Ground Voice Operations and Malfunctions  
**Duration:**  2.0 hours  
**Medium:**  Generic Part Task Trainer  
**Student:**  IV (ISS-based EVA) (Schedule in pairs.)  
**Source:**  *DI23/ISS Communications and Tracking Group*  
**Date:**  09/04  
**Lesson(s) Replaced:**  None  
**Equipment Required:**  None  
**Prerequisite Lesson(s):**  ISS EPS OV 21078  
**Preparation:**  None
Core Station Systems for STS Crew Training Lesson Descriptions

5  **ISS S/G VOICE OP/ML 21078 (Concluded)**

Synopsis: After a prebrief, which covers the Audio and S-band subsystems, the student will demonstrate how to execute some of the procedures associated with Audio and S-band (configure public calls, recover from loss of 1 Internal Audio Controller (IAC), Audio Terminal Unit (ATU) darkened front panel, S-Band String swap). The student steps through these procedures, elaborating on the steps and the rationale. The instructor will act as ground when directing the crew to perform S-band procedures. The lesson will end with a discussion about what the crewmember will be required to do to keep Audio operating and when to troubleshoot S-band. Emphasis is placed on awareness and understanding of how and when to run these procedures.

Objectives:
- State the function of Audio and S-Band display elements essential to crew tasking.
- Perform the following communications activities:
  - Using the Portable Computer System (PCS) and ATU, configure and execute Public Calls.
  - Troubleshoot ATU failures.
  - Recover from an IAC failure.
  - Discuss impacts of S-Band String handover.
- While executing these activities:
  - State the assumptions and rationale for the key operational and procedural steps.

6  **ISS AUDIO HW 21105**

Title: ISS Audio Hardware
Duration: 1.25 hours
Medium: Space Station Mock-up and Training Facility
Student: As assigned by CDR.
Source: DI23/ISS Communications and Tracking Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS S/G VOICE OP/ML 21078 (IV only)
Preparation: None
Core Station Systems for STS Crew Training Lesson Descriptions

6   **ISS AUDIO HW 21105 (Concluded)**

Synopsis: The lesson covers the layout and capabilities of the Audio Terminal Unit (ATU) and public call configurations. The students configure the ATU for public calls and communicate with each other using both the flight-like ATUs, portable microphones (P-mics), and the headsets. The class also covers Caution and Warning (C&W) interaction with the ATU. This lesson covers only nominal audio operations from the ATU. The lesson also covers audio connectivity to both the Russian Audio system and docked Orbiter.

Objectives:
- Demonstrate the public call configuration using the ATU.
- Demonstrate the use of the ATU front panel and headset controls.

7   **EPS HW TASKS 21105**

Title: ISS Electrical Power Systems Hardware Tasks
Duration: 1.0 hour
Medium: Space Station Mock-up and Training Facility
Student: As assigned by CDR.
Source: DI43/Station Electrical Power System and Thermal Control System Group
Date: 06/08
Lesson(s) Replaced: ISS EPS HW TASKS 21105
Equipment Required: See Building 9 FUR for lesson requirements.
Prerequisite Lesson(s): ISS EPS OV 21078
Preparation: None

Synopsis: This lesson is designed to cover EPS safety issues captured in the Operational Control Agreement Database (OCAD). All visitors to the ISS United States On-orbit Segment (USOS) are required to take this lesson to protect against shock hazard, cable entanglement, and to ensure successful egress on the USOS. The mockup is used to get hands-on interaction with EPS hardware. The mockup has very good fidelity and is used to give realistic Utility Outlet Panel (UOP) operations (button signatures), Emergency Egress Light (EEL) signatures, and the mechanical manipulation of a Rack Power Switch (RPS).

Objectives:
- Operate the ISS General Luminaire Assemblies (GLAs) in the USOS.
- Respond to illuminated ISS EELs.
- State the safety hazards associated with UOPs and portable equipment.
- Remove power from a rack using the RPS.
Core Station Systems for STS Crew Training Lesson Descriptions

8  MCS OV 21001

Title:  Motion Control System Overview  
Duration:  1.0 hour  
Medium:  Classroom  
Student:  As assigned by CDR.  
Source:  DI33/ISS Motion Control Group  
Date:  09/04  
Lesson(s) Replaced:  None  
Equipment Required:  Computer, projector  
Prerequisite Lesson(s):  ISS EPS OV 21078  
Preparation:  None

Synopsis:  This class is designed to introduce students to the Motion Control Group (MCG) at a high level. The students become familiar with the functions of MCG. The primary crew displays and schematics are utilized to place this information in an operational perspective. A high-level overview of each function is performed, including the minimum Orbital Replacement Units (ORUs) required during mated operations. Then, the attitude control operations concept (priorities, permissible attitude, attitude deviation constraints, how the ISS maintains attitude control, when/who will be in attitude control) during mated operation is reviewed, followed by the translation control operations concept. Next, ISS reference frames and Euler angles are defined. Time is then spent reviewing the Guidance, Navigation, and Control (GNC) modes, describing compatible US and Russian Segment (RS) GNC modes and operational scenarios when they are utilized. Finally, the docking timeline is described. This portion focuses on the actual docking, moding lights, docking sensors and hardware, and the requirements for docking.

Objectives:  
• Describe how each of the following ISS Motion Control System (MCS) functions are fulfilled by both the US and RS segments for your flight:
  – State Vector Determination
  – Attitude Determination
  – Attitude Control
  – Translational Control
  – Pointing & Support

• Describe the following reference frames and their uses:
  – ISS Body
  – LVLH
  – J2000
  – XPOP

• Recognize the RS СУДН and US GNC software modes used for attitude control.
Core Station Systems for STS Crew Training Lesson Descriptions

8  **MCS OV 21001 (Concluded)**

- Understand the ISS perspective of Orbiter docking and undocking.
- Be familiar with the MCS Malfunctions that can involve the Orbiter.
- Understand the attitude control handover process.

9  **RNDZ REVIEW 31001**

Title: Rendezvous Review  
Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT  
Note: Schedule with the Expedition Crew.  
Source: *DI33*/ISS Motion Control Group  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: Computer, projector  
Prerequisite Lesson(s): MCS OV 21001  
Preparation: None  

Synopsis: Rendezvous Review is a guided discussion between the Shuttle and Station crews to review the docking tasks and milestones. The crews step through a high-level docking timeline, emphasizing crew tasks with line-by-line reviews of procedures. The main purpose is to have the crews talk about what they are expecting of each other, particularly crew calls at docking (preferred wording, who’s making the calls, etc). Usually a Shuttle Rendezvous instructor, the Shuttle flight Motion Control Group (MCG) instructor, the Expedition crew MCG instructor, and an Attitude Determination and Control Officer (ADCO) are in attendance. This time also is a last chance for the Shuttle crew to ask any questions they have on the Motion Control System (MCS).

Objectives:  
- Summarize the Shuttle role during a docking to the ISS.  
- Discuss with Station crew the docking activities and crew calls.

10 **ISS UHF OPS/MAL 21078**

Title: ISS Ultra High Frequency Operations and Malfunctions  
Duration: 1.0 hour  
Medium: Generic Part Task Trainer  
Student: EV1, EV2, IV (ISS-based EVA.)  
Source: *DI23*/ISS Communications and Tracking Group  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None
Core Station Systems for STS Crew Training Lesson Descriptions

10  **ISS UHF OPS/MAL 21078 (Concluded)**

Prerequisite Lesson(s):  ISS AUDIO HW 21105  
Preparation:  None

Synopsis:  This lesson consists of the use of the UHF Subsystem through the Portable Computer System (PCS). Emphasis will be placed on UHF subsystem power up, configuration, and how to recognize and workaround system failures. The lesson begins with a subsystem familiarization that describes and demonstrates the controls of the system. Features and controls are pointed out. Activities are set to integrate student interaction, which will reinforce student abilities. Once student skill base has been established, there is a discussion of the related procedures.

Objectives:  The student will be able to accomplish the following:
- Use the PCS to activate and configure the UHF Subsystem for nominal EVA operations.
- Perform nominal UHF Subsystem activation, configuration, and subsystem monitoring.
- Identify and recover from a malfunction of a single UHF Subsystem radio.

11  **ISS VIDEO OPS 21078**

Title:  ISS Video Operations  
Duration:  2.0 hours  
Medium:  Generic Part Task Trainer  
Student:  As assigned by CDR. (Schedule in pairs.)  
Source:  *DI23*/ISS Communications and Tracking Group  
Date:  09/04  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  ISS AUDIO HW 21105  
Preparation:  None

Synopsis:  This lesson prepares students to use the Video Distribution Subsystem (VDS) in support of crew activities. Emphasis is placed on how the crew will use the VDS onboard ISS. The lesson provides a brief introduction to the VDS and its components. The students then role-play in crew activity scenarios (EVA, Robotics) in which they must route/deroute video from a Portable Computer System (PCS). The crew's actions in the scenarios are discussed and related to the grounds' actions. Also, the PCS video routes are compared and contrasted to video routes from the Robotics Workstation Display & Control Panel. The lesson also provides a high level explanation of the VDS hardware and software actions during an
Core Station Systems for STS Crew Training Lesson Descriptions

11 **ISS VIDEO OPS 21078 (Concluded)**

autoroute. The VDS interfaces to other subsystems, systems, and modules are discussed. The student also learns how to distribute video to/from these interfaces. Finally, a review is conducted to re-emphasize the lesson objectives.

Objectives:
- Describe the function of the VDS and each VDS Orbital Replacement Unit (ORU).
- Describe the capabilities and limitations of how crewmembers route video.
- Autoroute video signals from a given source to a given destination via PCS.
- Describe the differences between flight crew and flight controller responsibilities for the VDS.
- Describe the software and hardware process for routing video signals.
- Describe connectivity between VDS and other systems and subsystems.

12 **P EXPRESS RACK NOM 21165**

Title: ISS EXPRESS Rack Nominal Operations
Duration: 1.0 hour
Medium: SSTF Rack Build-Up Area
Student: As assigned by CDR. (Schedule individually.)
Source: EO20A/ISS Payload Training
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS OPS S/W INTRO 21257
Preparation: None

Synopsis: This lesson introduces the crewmembers to the EXpedite the PRocessing of Experiments to Space Station (EXPRESS) Rack nominal operations procedures. It begins with a review of the rack layout and panel nomenclature. Differences between the training and flight hardware are pointed out. The procedures to be performed are previewed by the instructor. Crewmembers then execute the procedures using the EXPRESS Rack Trainer and EXPRESS Rack Laptop Computer. As crewmembers step through the procedures, they will receive feedback on the fine points of the procedures and rationale for specific steps.
Core Station Systems for STS Crew Training Lesson Descriptions

12 P EXPRESS RACK NOM 21165 (Concluded)

Objectives:
• State the purpose of the EXPRESS Rack.
• List the major components of the EXPRESS Rack.
• Define the primary functions of the EXPRESS Rack major components.
• Perform specified EXPRESS Rack nominal operations procedures using the EXPRESS Rack Trainer.

13 P TRANSFER OV 21165

Title: Payload Transfer Overview (Shared – Shuttle)
Duration: 1.0 hour
Medium: SSTF Rack Build-Up Area
Student: As assigned by CDR.
Source: EO-10/Shuttle Operations Coordinator
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: The first part of this lesson is a classroom presentation consisting of the following: Flight-specific Shuttle and ISS mission topology, timeline, issues, and payload transport/transfer overview. The second part of the lesson will be hands-on instruction of the payload-unique aspects of transport and transfer operations. The hands-on instruction will conclude with instruction on the Daily Status Check Cue Card operations. Differences the crewmember will encounter between the training and the actual flight hardware they will be using on board the ISS are pointed out as the lesson progresses. The session shall end with a discussion of the lesson events, including a review of any action items that were assigned.

Objectives:
• Identify ISS payloads that have unique transport/transfer requirements.
• Describe the payload transfer activities.
• Describe the unique transfer activities associated with payloads.
• Perform Daily Status Check Cue Card steps.
### Core Station Systems for STS Crew Training Lesson Descriptions

**14 TOOL/REPAIR KITS 21208**

<table>
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<tr>
<th>Title:</th>
<th>ISS Repair Kits Familiarization (Shared – ISS)</th>
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<tr>
<td>Student:</td>
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<tr>
<td>Source:</td>
<td>DX42/Mechanisms &amp; Maintenance Systems Group</td>
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<tr>
<td>Date:</td>
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<td>Lesson(s) Replaced:</td>
<td>TOOL/REPAIR KITS 21105</td>
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<tr>
<td>Preparation:</td>
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</table>

**Synopsis:** During this lesson students learn the content and specific usage of all tools contained in the U.S. Intravehicular Activity (IVA) Toolbox, the power tools (including the cordless Driver Drill, Impact Driver, Scopemeter Power Adapter (SMPA)/Battery Charger Kit) and Repair kits onboard ISS. This lesson emphasizes hands-on practical applications and involves actual tool usage as might be encountered on-orbit. Tool stowage and organization is taught with the tools stowed in their correct on-orbit kits.

**Objectives:**
- Identify the contents and organization of the ISS IVA Toolbox.
- Demonstrate the use of select tools from the ISS IVA Toolbox (i.e., Torque Wrench).
- Describe/demonstrate use of the Power Tools (Driver Drill, Impact Driver & SMPA/Battery Charger Kits, etc.).
- Describe/demonstrate use of the Repair Kits (Clamp & Bracket, Sewing, Ethernet, Fiber Optic, etc.).
- State any crew safety issues related to the on-orbit equipment and procedures.

**15 ECG INTRO 11001**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Environmental Control Group Introduction (Shared – ISS)</th>
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<tbody>
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</table>
Core Station Systems for STS Crew Training Lesson Descriptions

15 ECG INTRO 11001 (Concluded)

Synopsis: The Environmental Control Group (ECG) Introduction lesson discusses the general atmospheric characteristics on the ISS, including total and partial pressures, and temperature and humidity. The bulk of the lesson focuses on key pieces of ECG equipment, including equipment for total and partial pressure control, temperature and humidity control, water resources, food and sanitary hygiene, and equipment used to detect and respond to ISS emergencies. Operator interfaces and responsibilities for equipment are discussed, as well as operational hierarchy.

Objectives:
- Discuss the general atmospheric characteristics on the ISS.
- Discuss the major functions of the ECG.
- List the major pieces of equipment that support the functions of ECG.

16 ISS O2 SAFETY 21001

Title: ISS Oxygen Systems Safety (Shared – ISS)
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DX42/Mechanisms & Maintenance Systems Group
Date: 08/03
Lesson(s) Replaced: ISS O2 SAFETY C 21001
Equipment Required: None
Prerequisite Lesson(s): ISS DIAG EQUIP 21001 (ISS), ECG INTRO 11001 (STS)
Preparation: None

Synopsis: This lesson covers the often over-looked topic of Oxygen System Safety, specifically concentrating on the correct and safe handling of oxygen equipment onboard the ISS. Safety protocols are needed to prevent possible ignition and subsequent explosion of oxygen systems onboard the ISS. These protocols include risk management through prevention and avoidance of contaminants, and the mechanics of oxygen ignition sources.

Objectives:
- Summarize the elements of the ISS Oxygen System.
- Explain ignition mechanisms to be aware of when handling oxygen equipment.
- Explain methods to minimize oxygen-related hazards.
Core Station Systems for STS Crew Training Lesson Descriptions

17 MPLM INTRO 31105

Title: Multi-Purpose Logistics Module Introduction (Shared – ISS)
Duration: 1.25 hours
Medium: Space Station Mock-up and Training Facility
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Note: Schedule with the Expedition Crew.
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson gives an overview of the purpose and capabilities of the Multi Purpose Logistics Module (MPLM), with special emphasis on the MPLM-unique crew interfaces. The instructor will define the purpose of the MPLM, show hardware and locations, demonstrate manipulation of manual interfaces and then observe student’s performance, and finally will briefly discuss crew activities as a lead into the MPLM Procedures lesson, taken by the crew later in the flow.

Objectives:
• State the purpose of the MPLM.
• Describe Environmental Control and Life Support System (ECLSS), Thermal Control System (TCS), EPS, and Communication and Tracking (C&T) components of the MPLM.
• Know which components are MPLM-unique.

18 RACK INSTAL SKL 21105

Title: ISS Rack Removal and Installation Skills (Shared – ISS)
Duration: 2.0 hours
Medium: Space Station Mock-up and Training Facility
Student: As assigned by CDR. (Schedule in groups of 3.)
Source: DX42/Mechanisms & Maintenance Systems Group
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TOOL/REPAIR KITS 21208, MPLM INTRO 31105
Preparation: None
Core Station Systems for STS Crew Training Lesson Descriptions

18 RACK INSTAL SKL 21105 (Concluded)

Synopsis: During this lesson students learn how to safely remove and install ISS System Racks, International Standard Payload Racks (ISPRs), Resupply Stowage Platforms (RSPs), ISS Lockers, and International Subrack Interface Standard (ISIS) Drawers. This class teaches the operation of all rack-to-module structural interfaces, including: launch restraints, pivot mechanisms, pivot pins, knee braces, grounding straps, and tethers. Mating of electrical, data, and fluid utility connectors is also covered. A generic MPLM-to-ISS rack transfer procedure is taught using medium and high fidelity mockups of each of the rack-to-module interfaces. The International Partners and Payload Principle Investigators will train the crew on any unique interfaces that are specific to their respective module or rack.

Objectives:
- Identify all rack-to-module structural interfaces.
- Explain the rationale for the sequence of steps used to install all rack-to-module structural interfaces.
- Perform a generic rack transfer procedure using all rack-to-module structural interfaces.
- State any crew safety issues related to the on-orbit equipment and procedures.

19 CAS SYS INTRO 21001

Title: Common Attach System Introduction (Shared – ISS)
Duration: 1.5 hours
Medium: Classroom
Student: As required by CDR.
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson describes the two types of Common Attach System (CAS): Payload Attach System (PAS) and the Unpressurized Cargo Carrier Attach System (UCCAS). Specifics of these mechanisms are discussed, including components, physical operation, system interfaces, and redundancy. Students are also shown photos of real flight hardware and videos of latch and Umbilical Mechanism Assembly (UMA) operations.
Core Station Systems for STS Crew Training Lesson Descriptions

19 **CAS SYS INTRO 21001 (Concluded)**

Objectives:
- Describe the components of the CAS.
- Explain the utilization of the CAS.
- Explain the operation of the CAS.
- Explain the redundancy of the CAS.
- Describe CAS Electrical Power System (EPS) and Command and Data Handling (CDH) connectivity.

20 **CAS OPS PREP-S 21001**

Title: Common Attach System Operations Preparation
Duration: 1.0 hour
Medium: Classroom
Student: As assigned by CDR. (Schedule in pairs.)
Source: DX23/Station Mechanical & Robotics
Date: 07/07
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CAS SYS INTRO 21001
Preparation: None

Synopsis: This lesson begins with a detailed discussion of Common Attach System (CAS) software configuration in the Multiplexer/Demultiplexers (MDMs). Next, a discussion of CAS operations, incorporating procedures and flight rules, introduces the student to CAS commands and constraints that are outlined in the flight rules. Overall focus on the lesson is on the system operational constraints, procedures execution, safety considerations, time constraints, and anticipated interfaces with Mission Control Center-Houston (MCC-H). CAS Portable Computer System (PCS) displays will be briefly introduced in this lesson.

Objectives:
- Explain key Integrated Motor Controller Assembly (IMCA) software concepts: Commands, Telemetry, and Modes.
- Compare Manual versus Normal CAS Application Software States.
- State the types of commands available to the operator.
- Describe CAS flight rule philosophy.
Core Station Systems for STS Crew Training Lesson Descriptions

21  **CAS OPS-S 21078**

Title: Common Attach System Operations  
Duration: 3.0 hours  
Medium: Generic Part Task Trainer  
Student: As assigned by CDR. (Schedule in pairs.)  
Source: DX23/Station Mechanical & Robotics  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CAS OPS PREP-S 21001  
Preparation: None  

Synopsis: After a review of topics from the mechanism System Intro lesson, and an overview of displays and the procedures, the student will execute a nominal mate and demate. Throughout the lesson, rationale for procedure steps, expected command responses, and applicable telemetry items are discussed. Emphasis in the lesson is placed on learning both the operational aspects of the Common Attach System (CAS) and the procedures associated with mating and demating.

Objectives:  
- Demonstrate proper display monitoring, navigation, and commanding skills.  
- Provide rationale for procedure steps.  
- Using CAS displays, verify proper command response and summarize the state of the system.  
- Characterize the crew versus ground roles in operations.

22  **CAS MAL PREP-S 21001**

Title: Common Attach System Malfunctions Preparation  
Duration: 1.0 hour  
Medium: Classroom  
Student: As assigned by CDR. (Schedule in pairs.)  
Source: DX23/Station Mechanical & Robotics  
Date: 07/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CAS OPS-S 21078  
Preparation: None
Core Station Systems for STS Crew Training Lesson Descriptions

22 CAS MAL PREP-S 21001 (Concluded)

Synopsis: This lesson revolves around introducing the student to the key malfunction scenarios of the Common Attach System (CAS), including typical causes and effects. The lesson covers CAS malfunction troubleshooting philosophy with emphasis placed on system knowledge. Overall focus of the lesson is on key aspects of malfunction recognition and resolution, impacts to other systems, operational constraints, safety considerations, time constraints, and anticipated interfaces with Mission Control Center-Houston (MCC-H) and on-orbit crewmembers.

Objectives:
- Given specific CAS failures, explain display indicators, possible causes, and impacts to operations.
- Describe CAS hardware and software responses, including Integrated Motor Controller Assembly (IMCA) responses to CAS malfunctions and interface failures.
- Anticipate the user response to CAS malfunctions and interface failures.

23 CAS MAL 21078

Title: Common Attach System Malfunctions (Shared – ISS)
Duration: 2.5 hours
Medium: Generic Part Task Trainer
Student: As assigned by CDR. (Schedule individually.)
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CAS MAL PREP-S 21001
Preparation: None

Synopsis: This lesson introduces the student to recognizing malfunctions in the Common Attach System (CAS) and the process for troubleshooting and recovering from those failures. The biggest part of the lesson is working with the malfunction procedures and their many intricacies.

Objectives:
- Identify failures and describe their impacts to CAS.
- Develop and execute a recovery plan.
- Summarize the state of the system throughout operations.
Core Station Systems for STS Crew Training Lesson Descriptions

24  **CAS SPEC MASTERY-S 21078**

Title: Common Attach System Specialist Mastery  
Duration: 2.0 hours  
Medium: Generic Part Task Trainer  
Student: As assigned by CDR. (Schedule individually.)  
Source: DX23/Station Mechanical & Robotics  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): CAS MAL 21078  
Preparation: None

Synopsis: This lesson is used to pull all material from the course together and maintain proficiency on system knowledge. Material from previous lessons will be reviewed and the student will get an opportunity to perform both nominal and malfunction procedures, including malfunction recognition and resolution. Feedback on performance and possible further study in preparation for increment-specific training will be provided at the end of the lesson.

Objectives: Given several Common Attach System (CAS)-related failure scenarios, using CAS procedures, without instructor assistance and within a timely manner, the student will perform the following:

- Using CAS displays, identify off-nominal signatures.
- Describe the immediate failure impacts, including impacts to the current hardware configuration.
- Determine appropriate malfunction procedure block(s) and execute them correctly.
- Confirm command actions through telemetry signatures.
- Summarize the degraded state of the CAS, including capabilities, limitations, and redundancies.
- Describe any impacts to the system, procedures, and/or operations.

25  **CBM SYS INTRO 21105**

Title: Common Berthing Mechanism System Introduction (Shared – ISS)  
Duration: 2.0 hours  
Medium: Space Station Mock-up and Training Facility  
Student: As assigned by CDR.  
Source: DX23/Station Mechanical & Robotics  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None
Core Station Systems for STS Crew Training Lesson Descriptions

25  **CBM SYS INTRO 21105 (Concluded)**

Prerequisite Lesson(s): None  
Preparation: None  

Synopsis: This lesson provides an introduction to the Common Berthing Mechanism (CBM) using a hands-on approach. Videos, schematics, and hardware mock-ups are used to explain the architecture, operation, redundancy, and interfaces of the mechanism.

Objectives:  
- Describe the components of the CBM.  
- Explain the utilization plan for the CBM.  
- Summarize flight rules for selected CBM operations.  
- Explain the operational sequence of the CBM.  
- Explain the redundancy of a CBM.  
- Describe the Electrical Power System (EPS) and Command and Data Handling (CDH) connectivity using CBM schematics and displays.

26  **CBM OPS PREP 21001**

Title: Common Berthing Mechanism Operations Preparation (Shared – ISS)  
Duration: 1.5 hours  
Medium: Classroom  
Student: As assigned by CDR.  
Source: DX23/Station Mechanical & Robotics  
Date: 07/07  
Lesson(s) Replaced: None  
Equipment Required: None  
Preprerequisite Lesson(s): CBM SYS INTRO 21105  
Preparation: None  

Synopsis: This lesson is geared towards giving the assigned crew member(s) the fundamental skills and knowledge items needed in order to nominally operate the Common Berthing Mechanism (CBM). The lesson covers Electrical Power System (EPS) and Command and Data Handling (CDH) interfaces (including command and telemetry paths), discusses the CBM display in detail, and also introduces students to the procedures they will be executing in their next lesson.

Objectives:  
- Review EPS and CDH connectivity and redundancy for CBM.  
- Trace CBM command and telemetry paths from Portable Computer System (PCS) to Controllers.  
- Identify display fields and information.  
- State the purpose of nominal CBM commands.
Core Station Systems for STS Crew Training Lesson Descriptions

26  **CBM OPS PREP 21001 (Concluded)**

- Using your nominal procedures, predict display changes.
- Understand the CBM hardware and software configuration at different milestones throughout the procedures.
- Explain the redundancy of CBM hardware.

27  **CBM OPS 21078**

Title: Common Berthing Mechanism Operations (Shared – ISS)
Duration: 2.5 hours
Medium: Generic Part Task Trainer
Student: As assigned by CDR. (Schedule in pairs.)
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CBM OPS PREP 21001
Preparation: None

Synopsis: After a review of topics from Common Berthing Mechanism (CBM) Operations Preparation, and an overview of displays and procedures, the student will execute a nominal Prep for Mate, Mate, Prep for Demate and Demate. Throughout the lesson, rationale for procedure steps, expected command and hardware responses, and applicable telemetry items are discussed. Emphasis in the lesson is placed on learning both the operational aspects of the CBM system and procedures associated with mating and demating.

Objectives: Given CBM procedures, with instructor assistance, the student will execute a nominal mate and demate while doing the following:
- Describe CBM display layout and content.
- Demonstrate proper display monitoring and navigation.
- Summarize CBM Nominal Procedures and Generic Flight Rules that govern those procedures.
- Provide rationale for procedures and significant steps.
- Execute nominal commands correctly.
- Using CBM displays and procedures, verify proper command response.
- Using CBM displays, summarize the state of the system (hardware and software).
Core Station Systems for STS Crew Training Lesson Descriptions

28  **CBM MAL PREP 21001**

Title: Common Berthing Mechanism Malfunctions Preparation  
(Shared – ISS)
Duration: 2.5 hours
Medium: Classroom
Student: As assigned by CDR.
Source: DX23/Station Mechanical & Robotics
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CBM OPS 21078
Preparation: None

Synopsis: The lesson starts with a short review of nominal Common Berthing Mechanism (CBM) software processes as this information is needed to understand off-nominal software responses. After the review, students learn about auto-safing responses, followed by a discussion of the various types of CBM malfunctions, including expected signatures and impacts. Once the students are familiar with CBM failure details, they learn about typical command responses to these different failures. Additionally, the malfunction recovery philosophy used in the malfunction procedures is covered. The CBM history can be discussed during the lesson (if time), or can be given as homework for students to review.

Objectives:

- Given a CBM-related failure, determine if any auto-safing responses would be performed by the Multiplexer/Demultiplexer (MDM), Master, and/or slave(s).
- Given a CBM-related failure, predict expected display signatures and potential failure causes.
- Given a CBM-related failure, summarize potential impacts to the system, procedures, operations, and the mission.
- Given a CBM-related failure, identify the appropriate malfunction procedures and flight rules needed to develop a recovery plan.
- Given a CBM malfunction procedure, describe the rationale for its particular organization and depth.
- Given any CBM configuration, determine how to safely attain structural integrity in the shortest possible time.
Core Station Systems for STS Crew Training Lesson Descriptions

CBM MAL 21078

Title: Common Berthing Mechanism Malfunctions (Shared – ISS)
Duration: 3.0 hours
Medium: Generic Part Task Trainer
Student: As assigned by CDR. (Schedule individually.)
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CBM MAL PREP 21001
Preparation: None

Synopsis: This lesson introduces students to a variety of failures that impact Common Berthing Mechanism (CBM) operations, while they execute procedures. After identifying any off-nominal signatures, the student will demonstrate how to read through malfunction procedures and execute a recovery plan. Each failure is presented separately to give the student an opportunity to fully resolve the problem. After recovery attempts are complete, the instructor should guide the students through assessing impacts to their system and the timeline. Students are also expected to provide rationale to any commands executed, as well as anticipate system response and display signatures. Overall focus of the lesson is on malfunction recognition and resolution, determining impacts to the timeline, and identifying existence of any safety issues or time constraints. The procedures executed in this lesson will be adjusted as appropriate based on the crew member’s task assignment. (Install-only tasks will cover the CBM Mating procedures and MPLM flights or Relocate tasks will cover both Mating and Demating procedures.)

Objectives: Given several CBM-related failure scenarios, using CBM procedures, with instructor assistance and within a timely manner, the student will perform the following for each failure case:

- Using CBM displays, identify off-nominal signatures.
- Describe the immediate failure impacts, including impacts to current hardware configuration.
- Determine appropriate malfunction procedure block(s) and execute them correctly.
- Confirm command actions through telemetry signatures.
- Summarize degraded state of the CBM, including capabilities, limitations and redundancies.
- Describe any impacts to the system, procedures, and/or operations.
Core Station Systems for STS Crew Training Lesson Descriptions

30   ISS AUD/VID RVW 21121

Title:   ISS Audio/Video Review  
Duration:   1.5 hours  
Medium:   Space Station Training Facility (SSTF)  
Student:   COMMANDER, PILOT, MS 1, MS 2, MS 3, MS 4, PS1 (Invite Mission CAPCOMs.)  
Source:   DI23/ISS Communications and Tracking Group  
Date:   06/08  
Lesson(s) Replaced:   None  
Equipment Required:   None  
Prerequisite Lesson(s):   ISS VIDEO OPS 21078  
Preparation:   None  

Synopsis:   The lesson starts with a review by the instructor of audio and video changes in system performance since their previous communication lessons. The crewmembers then will use the audio equipment, Audio Terminal Units (ATUs), Battery Powered Speaker Microphone Units (BPSMU(s)), etc., for crew calls using proper call protocol. The crew will be encouraged to work out their unique communications approach for the tasks they will perform. The video equipment (Robotics Workstation (RWS) and Portable Computer System (PCS)) will be available to practice video routing with audio coordination for their unique flight-specific tasks. Lastly, the crew will be given an opportunity to walk through airlock and EVA audio, procedures, and operations. The differences between SSTF airlock audio and the real audio will be explained and emphasized in order to facilitate successful simulations and real-time EVAs.

Objectives:   • Using ISS and STS communication procedures and Audio Hardware (HW), perform communication configurations.
• Explain voice paths relevant for flight configurations and crewmembers.
• Perform appropriate audio calls using proper call protocol and crew requirements.
• Perform Video Routing from ISS and STS locations per crew requirements.
Core Station Systems for STS Crew Training Lesson Descriptions

31 CBM SPEC MASTERY 21078

Title: Common Berthing Mechanism Specialist Mastery (Shared – ISS)
Duration: 2.5 hours
Medium: Generic Part Task Trainer
Student: As assigned by CDR. (Schedule individually.)
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CBM MAL 21078
Preparation: None

Synopsis: This lesson will confirm that the student can accurately work through nominal and malfunction procedures, responding appropriately to failures, without instructor assistance and under a time limit. The student will have one hour to work through scenario(s) given to them during this lesson. During nominal procedure execution, the student will encounter various failures that may not have a defined recovery plan specified in the malfunction procedures. The goal is for the student to either successfully recover from the failure and complete the task, or resolve the situation so that the system is left in a safe state. Successful completion of this lesson implies that the student has demonstrated an acceptable level of Common Berthing Mechanism (CBM) system knowledge needed to move forward to mission specific training. The scenarios presented in this lesson will be adjusted based on the crew member’s task assignment. (Crew members assigned to an Install-only task will only be required to demonstrate their skills for a Mate scenario. However, for crew members assigned to MPLM flights or Relocate tasks, they will be presented with Mate or Demate scenario, for which they will be required to demonstrate their skills).

Objectives: Given several CBM-related failure scenarios, using CBM procedures, without instructor assistance and within a timely manner, the student will perform the following:
- Using CBM displays, identify off-nominal signatures.
- Describe the immediate failure impacts, including impacts to the current hardware configuration.
- Determine appropriate malfunction procedure block(s) and execute them correctly.
- Confirm command actions through telemetry signatures.
- Summarize degraded state of the CBM, including capabilities, limitations and redundancies.
- Describe any impacts to the system, procedures and/or operations.
Core Station Systems for STS Crew Training Lesson Descriptions

32 MECH/ROBO INSTALL 21178

Title: Mechanisms/Robotics Installation (Shared – ISS)
Duration: 4.0 hours
Medium: Space Station Training Facility
Student: As assigned by CDR.
Source: DX23/Station Mechanical & Robotics and DX42/Mechanisms and Maintenance Training Group

Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CAS SPEC MASTERY-S 21078 or CBM SPEC MASTERY 21078
Preparation: None

Note: Every effort should be made to teach this lesson within 3 to 4 weeks prior to the associated integrated sim.

Synopsis: This lesson is to exercise the Space Flight Resource Management (SFRM) aspects of the Robotics and Mechanism mating tasks. These aspects are Communication, Decision Making, Situational Awareness, Leadership, Command, and Workload Management. The crewmembers are put in a flight-like environment and exercise flight-like procedures to install a payload on ISS. Throughout the task, they are managing systems and failures, maintaining situational awareness, communicating completion of steps, and communicating for good camera views. Malfunctions are added to emphasize the need for leadership and communication between students and vehicles (when Shuttle simulator also involved). This lesson is a bridge between the system-specific flows and the flight-specific simulations.

Objectives:
- Perform flight-like procedures to grapple and install an ISS payload utilizing a Common Attach System (CAS) or Common Berthing Mechanism (CBM).
- Demonstrate SFRM Command techniques by providing direction and information as needed by other crewmembers and ground.
- Demonstrate SFRM Leadership techniques by encouraging crewmember interaction.
- Demonstrate SFRM Workload Management techniques by planning and prioritizing activities and crewmember use.
- Demonstrate SFRM Communication techniques by communicating information between crewmembers and ground.
Core Station Systems for STS Crew Training Lesson Descriptions

32 MECH/ROBO INSTALL 21178 (Concluded)

- Demonstrate SFRM Situational Awareness techniques by scanning all camera views and displays, observing any warnings, and structural proximity concerns.
- Demonstrate SFRM decision-making techniques by recognizing and assessing problems and correctly responding to the failures.

Given the Mechanism procedures, perform them with minimal instructor assistance and demonstrate the following:
- Apply proper display navigation and scan pattern techniques during operation.
- Demonstrate proper command protocol.
- Anticipate and confirm telemetry changes due to command actions.
- Continually report system status to the ground.

Given the malfunction procedures, diagnose and maintain functionality of the system during a failure by demonstrating the following:
- Recognize and report failures to the ground.
- Describe failure impacts.
- Develop and exercise a failure resolution plan (with assistance, if requested).

33 MECH/ROBO UNINSTALL 21178

Title: Mechanism/Robotics Uninstallation (Shared – ISS)
Duration: 4.0 hours
Medium: Space Station Training Facility
Student: As assigned by CDR.
Source: DX23/Station Mechanical & Robotics and DX42/Mechanisms and Maintenance Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CAS SPEC MASTERY-S 21078 or CBM SPEC MASTERY 21078
Preparation: None

Note: Every effort should be made to teach this lesson within 3 to 4 weeks prior to the associated integrated sim.
Core Station Systems for STS Crew Training Lesson Descriptions

33 MECH/ROBO UNINSTALL 21178 (Continued)

Synopsis: This lesson is to exercise the Space Flight Resource Management (SFRM) aspects of the Robotics and Mechanism demating tasks. These aspects are Communication, Decision Making, Situational Awareness, Leadership, Command, and Workload Management. The crewmembers are put in a flight-like environment and exercise flight-like procedures to uninstall a payload on ISS. Throughout the task, they are managing systems and failures, maintaining situational awareness, communicating completion of steps, and communicating for good camera views. Malfunctions are added to emphasize the need for leadership and communication between students and vehicles (when Shuttle simulator also involved). This lesson is a bridge between the system-specific flows and the flight-specific simulations.

Objectives:
- Perform flight-like procedures to grapple and uninstall a payload utilizing a Common Attach System (CAS) or Common Berthing Mechanism (CBM).
- Demonstrate SFRM Command techniques by providing direction and information as needed by other crewmembers and ground.
- Demonstrate SFRM Leadership techniques by encouraging crewmember interaction.
- Demonstrate SFRM Workload Management techniques by planning and prioritizing activities and crewmember use.
- Demonstrate SFRM Communication techniques by communicating information between crewmembers and ground.
- Demonstrate SFRM Situational Awareness techniques by scanning all camera views and displays, observing any warnings, and structural proximity concerns.
- Demonstrate SFRM decision-making techniques by recognizing and assessing problems and correctly responding to the failures.

Given the Mechanism procedures, perform them with minimal instructor assistance and demonstrate the following:
- Apply proper display navigation and scan pattern techniques during operation.
- Demonstrate proper command protocol.
- Anticipate and confirm telemetry changes due to command actions.
- Continually report system status to the ground.
Core Station Systems for STS Crew Training Lesson Descriptions

33 MECH/ROBO UNINSTALL 21178 (Concluded)

Given the malfunction procedures, diagnose and maintain functionality of the system during a failure by demonstrating the following:
- Recognize and report failures to the ground.
- Describe failure impacts.
- Develop and exercise a failure resolution plan (with assistance, if requested).

34 CAS MIS SP TASKS 31078

Title: Common Attach System Mission Specific Tasks (Shared – ISS)
Duration: 2.0 hours
Medium: Generic Part Task Trainer
Student: As assigned by CDR. (Schedule in pairs.)
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CAS SPEC MASTERY-S 21078
Preparation: None

Note: Every effort should be made to teach this lesson after the last mechanism-related integrated sim.

Synopsis: This lesson will focus on Common Attach System (CAS) content specific to the crewmember’s flight or increment. The class may include flight rule discussions, addressing flight-specific issues or concerns, and working through flight- or increment-specific nominal and malfunction CAS procedures.

Objectives: The instructor will customize lesson objectives to fit the individual student and review them at the beginning of the lesson.

Possible objectives include:
- Perform CAS increment-/flight-specific activities and procedures.
- Diagnose and maintain functionality of the system during a failure external or internal to the CAS.
- Identify and resolve any CAS flight-specific issues.
Core Station Systems for STS Crew Training Lesson Descriptions

35  CBM MIS SP TASKS 31078
Title: Common Berthing Mechanism Mission Specific Tasks (Shared – ISS)
Duration: 2.0 hours
Medium: Generic Part Task Trainer
Student: As assigned by CDR. (Schedule in pairs.)
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): CBM SPEC MASTERY 21078
Preparation: None
Note: Every effort should be made to teach this lesson after the last mechanism-related integrated sim.

Synopsis: This lesson will be used to cover any mission specific information not discussed or which has changed since the student's previous Common Berthing Mechanism (CBM) training. Topics may include the following: software issues/updates, procedure issues/updates, display issues/updates, areas of concern during a specific CBM operation, etc.

Objectives: The instructor will customize lesson objectives to fit the individual student and review them at the beginning of the lesson. Possible objectives include:
- Discuss CBM increment-/flight-specific issues or updates to any of the following: displays, procedures, flight rules, software, hardware, etc.
- Perform CBM increment-/flight-specific activities and procedures.
- Given CBM displays, identify failure signatures affecting CBM operations for the student's particular mission.
- Perform safing or maintain functionality of the system.

36  O2N2 OPS 21001
Title: Oxygen and Nitrogen System Operations (Shared – ISS)
Duration: 2.0 hours
Medium: Classroom
Student: Crewmembers as assigned.
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS O2 SAFETY 21001 (STS & ISS)
Preparation: None
Core Station Systems for STS Crew Training Lesson Descriptions

36 O2N2 OPS 21001 (Concluded)

Synopsis: This lesson provides an overview of the U.S. oxygen and nitrogen supply and distribution system. The lesson introduces the three functional divisions of the system: High-pressure oxygen, low-pressure oxygen, and nitrogen. Each functional division is then discussed in detail, following the flow of gas from the storage tanks to the end users on-board ISS. Crew actions required for system reconfiguration due to flight software response are discussed. The second half of the lesson provides an overview of the recharge systems, following the flow of gas from the Shuttle storage tanks to the ISS O₂/N₂ systems. The lesson concludes with a discussion of the ISS/Shuttle oxygen system configuration to support prebreathe.

Objectives:
- Trace the flow path of the O₂/N₂ System and the key crew interfaces.
- Compare the high-pressure oxygen, low-pressure oxygen, and nitrogen supply and distribution systems, and the users of each system.
- Describe the nominal configuration of the oxygen and nitrogen supply and distribution systems during current ISS stage operations.
- Describe the oxygen and nitrogen recharge systems and their key crew interfaces.
- Compare and contrast the oxygen and nitrogen recharge systems.

37 ECLSS JNT AL OPS 21105

Title: Environmental Control and Life Support System Joint Airlock Operations (Shared – Shuttle)

Duration: 2.0 hours

Medium: Space Station Mock-Up and Training Facility

Student: EV1, EV2, IV

Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group

Date: 05/02

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): ECG INTRO 11001, ISS O2 SAFETY 21001, 02N2 OPS 21001

Preparation: None

Note: This lesson is a prerequisite to ISS EVA Prep and Post.

Synopsis: This lesson covers the nominal operation of Environmental Control and Life Support System (ECLSS) equipment required for an EVA from the Joint Airlock. The function, location, operational crew interfaces, and interfaces with other ISS systems are discussed for each piece of ECLSS hardware required for an EVA from the Joint Airlock. Emphasis is placed on the configuration of the Airlock for 10.2 psi operations.
Core Station Systems for STS Crew Training Lesson Descriptions

37 **ECLSS JNT AL OPS 21105 (Concluded)**

Objectives:
- Identify which ECLSS components are required for EVA from the Joint Airlock.
- Describe the function, location, operational crew interfaces, and nominal operational modes of each ECLSS component required for EVA from the Joint Airlock.
- Explain how each ECLSS component required for EVA from the Joint Airlock interfaces with other ECLSS subsystems or ISS systems.
- Describe the overall navigation scheme, general display contents (prominent Graphical User Interface (GUI) features and key telemetry fields) and crew controls available for ECLSS from the Joint Airlock Display.
- Describe the configuration of the Joint Airlock during the following activities: housekeeping mode, 10.2 psi operations, EMU purge, EMU prebreathe, and crew lock egress/ingress.

38 **O2N2 XFER OPS 21105**

Title: Oxygen and Nitrogen Transfer Operations (Shared – ISS)
Duration: 1.5 hours
Medium: Space Station Mock-Up and Training Facility
Student: Crewmembers as assigned. (Schedule in groups of 2.)
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): O2N2 OPS 21001 (STS & ISS)
Preparation: None

Synopsis: This lesson provides an opportunity for students to apply their knowledge of oxygen and nitrogen systems by performing oxygen and nitrogen transfer procedures. Students will perform the appropriate oxygen transfer initiation, and transfer procedures with a discussion of the termination process. Students will also practice any rapid safing responses. This lesson emphasizes both knowledge of system architecture, as well as proper safety techniques.

Objectives:
- Configure the Joint Airlock and Orbiter Docking System (ODS) Vestibule for oxygen and nitrogen tank transfer or EVA prebreathe correctly and in a safe manner.
- Describe what disconnections need to be made to safe the system and close the hatches between Shuttle and Station for emergency or nominal undocking.
Core Station Systems for STS Crew Training Lesson Descriptions

39  MPLM VEST PROC 31105

Title: ISS Multi Purpose Logistics Module Vestibule Procedures
       (Shared – ISS)
Duration: 2.0 hours
Medium: Space Station Mock-up and Training Facility
Student: As assigned by CDR.
Source: DX42/Mechanisms & Maintenance Systems Group
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: During this lesson students learn how to outfit the Inter-Module Vestibule before and after the mating or demating of the MPLM. This task includes removing the Center Disk Cover, Controller Panel Assemblies (CPAs), MPLM Thermal Blanket, and then installing the Element-to-Element Ground Straps, Vestibule Jumpers, and Vestibule Closeout Panel. Vestibule and MPLM ingress is also covered during this lesson. Vestibule ingress, which occurs prior to vestibule outfitting, includes vestibule pressurization and a gross leak check using the MPEV, Internal Sampling Adapter (ISA), Vacuum Access Jumper (VAJ), and ScopeMeter. MPLM ingress, which occurs after vestibule outfitting, includes air sampling of the MPLM using the External Sampling Adapter (ESA), L-shaped adapter, and Grab Sample Containers (GSCs). This class must be taught prior to all flights/increments where the MPLM is mated or demated.

Objectives:

- Identify vestibule cabling, plumbing, closeouts, thermal/debris blankets, and Common Berthing Mechanism (CBM) components.
- Explain the procedures for removing and replacing vestibule cabling, plumbing, closeouts, thermal/debris blankets, and CBM components.
- Remove and replace vestibule cabling, plumbing, closeouts, thermal/debris blankets, and CBM components.
- Perform MPLM ingress/egress procedure.
- State any crew safety issues related to the on-orbit equipment and procedures.
Core Station Systems for STS Crew Training Lesson Descriptions

40  MPLM VEST PROC/ACT 31105

Title: Multi-Purpose Logistics Module Vestibule Procedures and Activation (Shared – ISS)
Duration: 4.0 hours
Medium: Space Station Mock-up and Training Facility
Student: As assigned by CDR.
Note: Schedule with Expedition crew.
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group; DX42/Mechanisms & Maintenance Systems Group
Date: 03/05
Lesson(s) Replaced: MPLM VEST PROC/ACT 31179
Equipment Required: None
Prerequisite Lesson(s): MPLM VEST PROC 31105, SMALL VOL PRESS OPS 21105
Preparation: None
Synopsis: This lesson covers the nominal outfitting, activation, and ingress of the MPLM, and is conducted in a timeline format. The student(s) will perform all of the procedure activities associated with the same timelined activities that will be performed during flight. The function, location, operational crew interfaces, and interfaces with related ISS systems is also discussed. This lesson is conducted by instructors from both DX42/OSO and DI54/ECLSS sections.
Objectives: Perform the timelined activities that begin after MPLM berthing to ISS, continuing through the MPLM ingress.

41  SMALL VOL PRESS OPS 21105

Title: Small Volume Pressurization and Depressurization Operations (Shared – ISS)
Duration: 1.25 hours
Medium: Space Station Mock-up and Training Facility
Student: As assigned by CDR.
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 03/05
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Core Station Systems for STS Crew Training Lesson Descriptions

41 SMALL VOL PRESS OPS 21105 (Concluded)

Synopsis: After a short prebrief, which will present the tasks that need to be performed on orbit, the Internal Sampling Adapter (ISA)/Flukemeter, Vacuum Access Jumper (VAJ), Manual Pressure Equalization Valve (MPEV) will be passed around for student familiarization and inspection. The location, use, and function of each piece of equipment will be presented. After component familiarization, the students will be shown how to assemble the equipment for the Volume Repressurization and Depressurization tasks. The expected readings on the Flukemeter will be reviewed for each of the tasks. The instructor will discuss what specific Portable Computer System (PCS) steps need to be performed for the Volume Depress task. The student will perform Volume Repress, Depress, and Leak Check procedures using the PCS, Flukemeter, and support equipment.

Objectives: Conduct vestibule/volume depress, repress, and leak check, and contingency airlock depress operations per procedure.

42 O2N2 XFER PROF 41105

Title: Oxygen and Nitrogen Transfer Proficiency (Shared – Shuttle)
Duration: 1.5 hours
Medium: Space Station Mock-Up and Training Facility
Student: Crewmembers as assigned. (Schedule in groups of 2.)
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 01/03
Lesson(s) Replaced: None
Equipment Required: Appropriate clothing for SSMTF
Prerequisite Lesson(s): O2N2 XFER OPS 21105 (STS & ISS)
Preparation: None

Synopsis: This lesson provides a final pre-flight opportunity for students to apply their oxygen and nitrogen systems knowledge and skills. Students will receive a pre-flight update on the scheduled transfer activities and the students will then perform the appropriate oxygen and/or nitrogen transfer procedures. Students will also review the system safing responses. This lesson emphasizes both knowledge of system architecture, as well as proper safety techniques.

Objectives: Given Joint Airlock and Orbiter Docking System (ODS)/Pressurized Mating Adapter (PMA) mockups with all of the necessary Environmental Control and Life Support System (ECLSS) hardware and a procedure, configure the Joint Airlock and ODS Vestibule for oxygen and nitrogen tank recharge correctly and in a safe manner.
Core Station Systems for STS Crew Training Lesson Descriptions

43 STS RSP TO JNT EMER 31208

Title: Shuttle Response to Joint Emergency
Duration: 2.0 hours
Medium: SSMTF (Suit room)
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 04/06
Lesson(s) Replaced: ISS EMERGENCY H/W 11105
Equipment Required: Training Notes
Prerequisite Lesson(s): O2/N2 XFER OPS 21105
Preparation: None

Synopsis: This lesson is the first lesson the STS crew receives on handling an emergency (Fire, Rapid Depress, or Toxic Atmosphere) while docked to the ISS. It begins with a general introduction to the Joint Emergency philosophy, and then looks at each of the types of emergencies individually. The lesson moves from the philosophy discussion, to looking at the procedures and hardware (gas masks, fire extinguishers, etc.) the crew will interact with in the response. The initial response procedure will be covered in detail, and the crew will be able to interact with high fidelity mockups of the emergency equipment.

Objectives:
• Recall the responsibilities of an STS crew in an emergency situation while the Shuttle is docked to ISS.
• Identify the procedures to be run in responding to an emergency during the docked timeframe.
• Identify the actions the STS crew is required to perform in the emergency egress procedures.
• Identify the quantities of ISS emergency equipment in each module.
• Demonstrate the proper use of ISS emergency equipment.

44 ISS EMERGENCY OVW 31105

Title: ISS Emergency Overview
Duration: 2.5 hours
Medium: Space Station Mock-Up and Training Facility
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Core Station Systems for STS Crew Training Lesson Descriptions

44  ISS EMERGENCY OVW 31105 (Concluded)

Prerequisite Lesson(s): STS RSP TO JNT EMER 31208
Preparation: None

Synopsis: This is the second lesson in the STS crew’s ISS emergency training flow. It begins by showing the crew the location of emergency equipment on the ISS by using the mockups. Next, a review of the STS crew’s responsibilities during a joint emergency is covered. Finally, the crew will walk through multiple emergency scenarios in the mockups. Each scenario will be a different type of emergency and allows the crew to walk through their response in the mockups using necessary equipment. The lesson will also give the STS crew a chance to practice their actions in the Joint Emergency Egress procedure. This includes closing ISS hatches, including the Russian built Androgynous Peripheral Assembly System (APAS) hatch, as well as disconnecting the high pressure oxygen and nitrogen lines which run through the hatches. The lesson will focus on worst case situations where the emergency is between the STS crew and the Shuttle, and cases where some of the STS crew is isolated in the ISS Airlock (A/L).

Objectives:
- Identify the location of ISS emergency equipment in the ISS mockups.
- Demonstrate the proper response to emergencies during the docked timeframe.
- Demonstrate proper use of emergency equipment when responding to an emergency.
- Perform steps to safely isolate the ISS from the Shuttle as part of the Joint Emergency Egress procedure.

45  ISS/STS EMER SCEN 31105

Title: ISS Emergency Scenarios (Shared – ISS)
Duration: 2.0 hours
Medium: SSMTF
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DI54/Environmental Control and Life Support System (ECLSS) Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS EMERGENCY OVW 31105
Preparation: None
Core Station Systems for STS Crew Training Lesson Descriptions

45  **ISS/STS EMER SCEN 31105 (Concluded)**

Synopsis: ISS/STS Emergency Scenarios lesson is a “hands-on” lesson for Expedition and STS crewmembers. It will also be given to all STS crewmembers with instructors role playing ISS crewmembers, if necessary. This lesson will consist of a 0.5 hour prebrief to review the information provided in ISS EMERGENCY OVW 31105, a 1.0 hour scenarios lesson, and a 0.5 hour debrief. The lesson will utilize the Space Station Mockup Training Facility (SSMTF) and the Part Task Trainer (PTT). The lesson utilizes the spatial accuracy of the SSMTF module-layout combined with the Portable Computer System (PCS) Emergency telemetry and the Caution & Warning (C&W) tones provided by the PTT to train Expedition Crews and STS crews to Identify, Respond, and Recover from Emergency Scenarios in a safe and time efficient manner.

Objectives:
- Demonstrate the proper response to emergencies during the docked timeframe.
- Coordinate STS crew actions with ISS commander to properly respond to an emergency in the docked timeframe.
- Perform emergency egress of ISS and coordinate with ISS crew about completion of STS crew steps and information critical to crew response.
- Demonstrate the ability to isolate an emergency event and recover from it safely.

46  **ISS EMERGENCY REFR 41001**

Title: ISS Emergency Refresher
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: *DI54* /Environmental Control and Life Support System (ECLSS) Training Group
Date: 04/06
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS/STS EMER SCEN 31105
Preparation: None

Synopsis: This lesson is to provide proficiency on emergency response for the STS crew. The proficiency is needed if there is a greater than 12 week gap between the ISS/STS Emergency Scenarios lesson and the first emergency case in a flight-specific sim. This is to insure the STS crew will respond properly during an emergency in a sim. The lesson will be a
Core Station Systems for STS Crew Training Lesson Descriptions

46  **ISS EMERGENCY REFR 41001 (Concluded)**

tabletop review of the material previously covered, including crew responsibilities, procedure actions, and previous agreements with the ISS crew.

**Note:** This lesson is optional if the ISS/STS Scenarios lesson happens within 12 weeks of the crew's first emergency case in a joint integrated flight-specific sim.

**Objectives:**
- Review the STS crew responsibilities during a joint emergency scenario.
- Review the procedures the STS crew needs to run in a joint emergency, and the steps to be performed.
- Review agreements made with the ISS crew during the ISS/STS Emergency Scenarios class.

47  **ISS EMER REVIEW 91105**

**Title:** ISS Emergency Review
**Duration:** 1.5 hours
**Medium:** SSMTF (Suit room and Mockups)
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
**Source:** DI54/Environmental Control and Life Support System (ECLSS) Training Group
**Date:** 04/06
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** ISS/STS EMER SCEN 31105
**Preparation:** None

**Synopsis:** This lesson provides a review of joint emergency response closer to the STS crew launch date. The previous lesson on emergency response occurred sometime in the L-30 to L-14 week timeframe, so a review is needed before launch. It will start with a 30 minute prebrief, and then spend 60 minutes walking through some emergency cases in the mockups.

**Objectives:**
- Review the STS crew responsibilities during a joint emergency scenario.
- Review the procedures the STS crew needs to run in a joint emergency, and the steps to be performed.
- Review agreements made with the ISS crew during the ISS/STS Emergency Scenarios class.
Core Station Systems for STS Crew Training Lesson Descriptions

48 SYSTEM REVIEW 41078

Title: System Review  
Duration: 4.0 hours  
Medium: Generic Part Task Trainer  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule in pairs.)  
Source: DA72/Station Training Leads  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: The Systems Review class will be an opportunity to do refresher training for the crew upon their request, or add additional training due to changes in the mission profile.

Objectives: Provide refresher training and/or additional training prior to integrated simulations.

49 COR/ASSY PROC 31105

Title: ISS Corrective & Assembly Procedures (Shared – ISS)  
Duration: 2.0 hours  
Medium: Space Station Mock-up and Training Facility  
Student: As assigned by CDR.  
Source: DX42/Mechanisms & Maintenance Systems Group  
Date: 09/04  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: This lesson covers the particular Intravehicular Activity corrective maintenance and hardware installation activities planned for a specific increment or crew. This lesson is usually taught 1 to 2 months prior to crew launch to allow the addition of any last minute failures that may have occurred onboard the ISS. Some assembly tasks performed in this class may include the configuration of EPS connector patch panels, removal of Positive Pressure Relief Valves (PPRVs)/Negative Pressure Relief Valves (NPRVs), and the installation of Intermodule Ventilation valves. The majority of ISS assembly tasks are trained due to their inherent timeline and assembly risks. The International Partners will train students on how to perform corrective maintenance on their respective hardware components.
Core Station Systems for STS Crew Training Lesson Descriptions

49  **COR/ASSY PROC 31105 (Concluded)**

Objectives:
- Identify the tools and hardware associated with example corrective and assembly procedures.
- Explain the rationale for the sequence of steps in example corrective and assembly procedures.
- Perform example corrective and assembly tasks using on-orbit maintenance tools and procedures.
- State any crew safety issues related to the on-orbit equipment and procedures.

50  **SPN REVIEW 21001**

Title: Station Program Note Review
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Source: DA72/Station Training Leads
Date: 09/04

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This class will cover important Station Program Notes (SPNs) that should be reviewed with the crew just before flight. The SPNs will typically be limited to ones the crew may be likely to see, not already covered in training or documented in procedures.

Objectives: Review pertinent SPNs prior to flight.
SECTION 13.0  MOBILE SERVICING SYSTEM
FOR STS CREW TRAINING

The Mobile Servicing System (MSS) crew training flow has several major components. The first step is generic robotic skills. This is achieved by either completing the PDRS flow or Generic Robotics Training. This activity should occur before assignment as an MSS Specialist, as the flows assume that basic skills have been grasped.

Once a crewmember is assigned to operate the MSS, they enter the MSS Robotics Fundamentals Flow. This flow includes classes that help apply generic concepts to the ISS and MSS and includes two 1-week trips to the Canadian Space Agency (CSA) to complete the MSS Robotics Operator (MRO) course.

Upon completion of the MRO course, crewmembers continue to build their MSS operating skills in the MSS Qualification flow. The evaluation included in this flow should be completed before the L-6 month mark.

The remaining flows shown in this catalog depend on the specific task assignments of crewmembers. There are mission-specific task flows for EVA support, Main Element Installation, SPDM Qualification Flow, SPDM Maintenance, SSRMS Proficiency Flow, and Thermal Protection System (TPS) Inspection and Repair Support. Several lessons in these flows are shared with EVA and/or PDRS. The training manager and lead MSS instructor will develop a detailed training plan based on these flows, taking into consideration task assignments.
Figure 13-1. Mobile Servicing System for STS Crew Training
Lesson Flow Chart
(Sheet 1 of 9)
MSS Robotics Fundamentals
Figure 13-1. Mobile Servicing System for STS Crew Training Lesson Flow Chart
(Sheet 2 of 9)
SSRMS Qual Flow
Figure 13-1. Mobile Servicing System for STS Crew Training
Lesson Flow Chart
(Sheet 3 of 9)
MSS Complex EVA Flow (Page 1 of 2)
Figure 13-1. Mobile Servicing System for STS Crew Training
Lesson Flow Chart
(Sheet 4 of 9)
MSS Complex EVA Support (Page 2 of 2)
Figure 13-1. Mobile Servicing System for STS Crew Training
Lesson Flow Chart
(Sheet 5 of 9)
MSS Main Element
Figure 13-1. Mobile Servicing System for STS Crew Training
Lesson Flow Chart
(Sheet 6 of 9)
MSS TPS Inspection and Repair
Figure 13-1. Mobile Servicing System for STS Crew Training Lesson Flow Chart (Sheet 7 of 9)

SSRMS Proficiency
Figure 13-1. Mobile Servicing System for STS Crew Training Lesson Flow Chart 
(Sheet 8 of 9) 
*SPDM Maintenance*
Figure 13-1. Mobile Servicing System for STS Crew Training Lesson Flow Chart
(Sheet 9 of 9)
SPDM Qualification
Table 13-1. Mobile Servicing System for STS Crew Training Requirements

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Sub Total for Stage: 33.5
Stage Totals Per Crewmember: 2 33.5 2 6 2 0 0 33.5 2 2 2
### Table 13-1. Mobile Servicing System for STS Crew

#### Training Requirements (continued)

| Stage | Ref Num | Lesson Code | Media | Hrs | Sched Code | C | M1 | P | MS1 | MS2 | MS3 | MS4 | PS | M1 | C | P | MS1 | MS2 | Alt Fac | Comments |
|-------|---------|-------------|-------|-----|-----------|---|----|---|-----|-----|-----|-----|----|----|----|-----|-----|---------|----------|
| 3     | 29      | MSS/EVAA SUPT1 SOLO 91025 | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 30      | MSS/EVAA SUPT2 TEAM 91016 | VR LAB | 3   | 5         | 3 | 3  | 3 | 3   |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 31      | MSS/EVAB SUPT1 SOLO 91025 | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 32      | MSS/EVAB SUPT2 SOLO 91025 | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 33      | MSS/EVAA SUPT3 SOLO 91025 | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 34      | MSS/EVAB SUPT3 M1M2 91025 | DST 1 | 2   | 2         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 35      | MSS/EVAA SUPT4 SOLO 91025 | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 36      | MSS/EVAA SUPT4 TEAM 91016 | VR LAB | 3   | 5         | 3 | 3  | 3 | 3   |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 37      | MSS/EVAA SUPT5 M1M2 91016 | VR LAB | 2   | 2         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 38      | MSS/EVAB SUPT5 M1M2 91025 | DST 1 | 2   | 2         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 42      | TPS OBSS OPS1 91025      | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 43      | TPS OBSS OPS2 91025      | VR LAB | 2   | 2         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 44      | TPS OBSS H/O 91069       | SESD | 3   | 4         | 3 | 3  | 3 | 3   |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 VR Lab Crosslisted with PDRS |
| 3     | 47      | EL NOM INSTL 1 31025     | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 48      | EL NOM INSTL 2 32115     | MRMDF | 2   | 2         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 49      | EL NOM INSTL 3 93016     | VR LAB | 3   | 1         | 3 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |
| 3     | 55      | SSRMS PROF 2 22065      | DST 1 | 2   | 1         | 2 |    |   |     |     |     |     |     |    |    |    |     |     | DST 2,3,4,5,10 |

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Date Last Modified: 06/08
Table 13-1. Mobile Servicing System for STS Crew Training Requirements (continued)

| Stage | Ref Num | Lesson Code          | Media | Hrs | Sched Code | C | M1 | P | MS1 | MS2 | MS3 | MS4 | PS | M1 | C | P | MS1 | MS2 | Alt Fac | Comments |
|-------|---------|-----------------------|-------|-----|------------|---|----|---|-----|-----|-----|-----|----|----|----|-----|-----|---------|----------|
| 0     | 2       | MSS/EVAA SUPT6 M1M2 91025 | DST 1 | 2   | 2          | 2 | 2  | 2 | 2   | 2   | 2   | 2   | 2   | DST | 2,3,4,5,10 |
| 2     | 40      | MSS/EVAB SUPT6 TEAM 91016 | VR LAB | 3   | 5          | 3 | 3  | 3 | 3   | 3   | 3   | 3   | 3   | DST | 2,3,4,5,10 |
| 2     | 41      | MSS/EVAA SUPT7 TEAM 91016 | VR LAB | 3   | 5          | 3 | 3  | 3 | 3   | 3   | 3   | 3   | 3   | 45-Day Currency |
| 2     | 45      | TPS OBSS OPS3 91025     | DST 1 | 2   | 1          | 2 | 2  | 2 | 2   | 2   | 2   | 2   | 2   | DST | 2,3,4,5,10 |
| 2     | 46      | TPS OBSS MISSION 91016  | VR LAB | 2   | 2          | 2 | 2  | 2 | 2   | 2   | 2   | 2   | 2   | DST | 2,3,4,5,10 |
| 2     | 50      | EL NOM INSTL 4 91025    | DST 1 | 2   | 1          | 2 | 2  | 2 | 2   | 2   | 2   | 2   | 2   | DST | 2,3,4,5,10 |
| 2     | 57      | SSRMS PROF 3 23025      | DST 1 | 2   | 1          | 2 | 2  | 2 | 2   | 2   | 2   | 2   | 2   | DST | 2,3,4,5,10 |
| 2     | 57      | MSS SPN & REF DATA 91001 | CLR 1 | 1   | 1          | 1 | 1  | 1 | 1   | 1   | 1   | 1   | 1   | DST | 2,3,4,5,10 |

Sub Total for Stage: 17
Stage Totals Per Crewmember:

| Stage | Ref Num | Lesson Code          | Media | Hrs | Sched Code | C | M1 | P | MS1 | MS2 | MS3 | MS4 | PS | M1 | C | P | MS1 | MS2 | Alt Fac | Comments |
|-------|---------|-----------------------|-------|-----|------------|---|----|---|-----|-----|-----|-----|----|----|----|-----|-----|---------|----------|
| 1     | 51      | EL INSTL RVW 41025    | DST 1 | 3   | 1          | 3 | 3  | 3 | 3   | 3   | 3   | 3   | 3   | 2,3,4,5,10 | 45-Day Currency |

Sub Total for Stage: 3
Stage Totals Per Crewmember:
Table 13-1. Mobile Servicing System for STS Crew Training Requirements (concluded)

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Date Last Modified: 06/08

Sub Total for Stage: 192.0
Sub Total for Crewmember: 190.5

USA002960
Rev. J
Mobile Servicing System for STS Crew Training Lesson Descriptions

1  MSS CBT 21057

Title: Mobile Servicing System Computer Based Training (Shared – ISS)
Duration: 15.0 hours
Medium: Computer Based Trainer
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): Generic Robotics Training Flow or PDRS flow
Preparation: None

Synopsis: This Computer Based Training (CBT) introduces crewmembers to the Mobile Servicing System (MSS) and the Mobile Remote Servicer Base System (MBS). The CBT is arranged such that each module builds on the previous module. Module 1 describes the MSS system components, focusing on the structure, functionality, and characteristics of each component. It also introduces MSS operations and operational considerations. Module 2 describes the components, tools, and features used to command and control the MSS. Module 3 introduces the MSS System Architectures and focuses on how they are distributed throughout the MSS during the different operational states. An understanding of the system’s redundancy is also emphasized. Module 4 introduces the tools and processes used for MSS system health monitoring and failure detection, annunciation, and recovery.

Objectives:
• Identify MSS components and component parts.
• Define MSS capabilities.
• Identify MSS Graphical User Interface (GUI) functionality.
• Identify the coordinate frames used during MSS Operations.
• Distinguish between SSRMS Modes.
• Define MSS operational considerations.
• Describe MBS and SSRMS architectures.
• Explain the redundancy of the MSS.
• Describe health monitoring in terms of system detection versus operator detection.
• Recognize the different categories of failure annunciation.
• Describe the recovery process.
Mobile Servicing System for STS Crew Training Lesson Descriptions

2  **RWS SS 21102**

**Title:** ISS Robotic Workstation Overview (Shared – ISS)
**Duration:** 2.0 hours
**Medium:** Self Study
**Note:** This self study is optional.
**Student:** M1 (M2 *supports as needed*.)
**Source:** DX23/Station Mechanical & Robotics
**Date:** 06/08
**Lesson(s) Replaced:** None
**Equipment Required:** None
**Prerequisite Lesson(s):** MSS CBT 21057
**Preparation:** None

**Synopsis:** This study guide will provide feedback to ensure student understanding of the Robotic Workstation (RWS) section of the MSS SPECIFIC CBT lesson. The format is a series of questions and references to guide the student through the Computer Based Training (CBT). After working the study guide, the student will have a foundation on which the Robotic Workstation Software (RWS SW) lesson can be built.

**Objectives:**
- Identify the internal and external RWS components and their function(s).
- Define RWS power data, video, and thermal architectures.
- Define the general role(s) of Workstation Host Software (WHS), Operations and Control Software (OCS), and Video Graphic Software (VGS).
- Recognize the RWS power up/power down sequence.
- Identify the function of RWS in failure management.

3  **SSRMS D&C OV 21025**

**Title:** SSRMS Displays and Controls Overview (Shared – ISS)
**Duration:** 1.5 hours
**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
**Student:** M1 (M2 *supports as needed*.)
**Source:** DX23/Station Mechanical & Robotics
**Date:** 06/08
**Lesson(s) Replaced:** MSS D&C OV 21025
**Equipment Required:** None
**Prerequisite Lesson(s):** MSS CBT 21057
**Preparation:** None
Mobile Servicing System for STS Crew Training Lesson Descriptions

3  **SSRMS D&C OV 21025 (Concluded)**

Synopsis: The Mobile Servicing System (MSS) Displays and Controls class introduces the student to the crew interface for the MSS. The student will become familiar with all MSS displays and controls while practicing proper scan patterns and navigation in preparation for the Canadian Space Agency (CSA) MSS Robotics Operator (MRO) course. Some commands will be sent to the MSS, but the lesson emphasis will be on the display and telemetry changes due to student input. The Graphical User Interface (GUI) images incorporated into the lesson plan are from the 15A load and will need to be revised as the loads are updated.

Objectives:
- Describe the overall MSS navigation and commanding capabilities of the MSS Operator.
- Given a specific MSS telemetry item, navigate to the proper display.

4  **ISS ROBO ENVIRO 21025**

Title: ISS Robotics Environment (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamics Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SSRMS D&C OV 21025
Preparation: None

Synopsis: This lesson provides the student with an opportunity to learn the ISS environment from the perspective of the cameras available on station. Interpretation of camera cues is the most significant skill required for a robotic operator. The student will be shown the locations of the various ISS, Mobile Servicing System (MSS), and Orbiter camera ports and each of their respective views. Student handouts illustrate the location of each camera and their DCP numbers. While viewing each camera, identification of structure and orientation of both ISS Analysis Coordinate System (ISSACS) and Orbiter Body Axis System (OBAS) coordinate systems will occur. After viewing each camera, the student will be given several viewing task scenarios and will be asked to predict which cameras provide adequate or optimal views. The student will select the cameras and predict the proper pan and tilt commands needed to find the worksite or survey object. The final task is a robotic scenario for which the student must set-up the appropriate set of camera views on their workstation.
Mobile Servicing System for STS Crew Training Lesson Descriptions

4  **ISS ROBO ENVIRO 21025 (Concluded)**

A 3-dimensional ISS model is used to facilitate the teaching of all training points and the tasks.

Objectives:
- Given an ISS, MSS, or Orbiter camera view, identify ISS structure in site and pan/tilt the camera to view other specific ISS landmarks.
- Describe camera selection strategy for each camera.
- Given a viewing task, identify and pan/tilt the ISS, MSS, and Orbiter cameras in the correct direction to provide the appropriate view.
- Given a robotic task, configure the ISS, MSS, and Orbiter cameras to provide the appropriate views: big picture, task, and clearance.
- Given an ISS, MSS, or Orbiter camera view, identify the correct orientation of ISSACS and OBAS command frames.

5  **RWS S/W OPS 21110**

Title: Robotic Workstation Software Operations (Shared – ISS)
Duration: 1.5 hours
Medium: Space Station Training Facility
Student: M1 (M2 supports as needed)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SSRMS D&C OV 21025
Preparation: None

Synopsis: This lesson begins with a brief overview of the external and internal components of the Robotics Workstation (RWS). Data connectivity between those components is covered. This is followed by a discussion of data connectivity between the RWS and the rest of the Mobile Servicing System (MSS). Finally, the data connectivity between the MSS and the Command and Control (C&C) Multiplexer/Demultiplexer (MDM) is discussed. The functionality of the three major software packages contained in the RWS is covered during this discussion. Those packages are Workstation Host Software (WHS), Operations and Control Software (OCS), and Video Graphic Software (VGS). A nominal workstation activation and checkout procedures are used as a template to demonstrate the correlation of software packages to hardware activation. A brief discussion of the Artificial Vision Unit (AVU), Common Video Interface Units (CVIUs), and video architecture is included for completeness. The lesson concludes with several student activities.
Mobile Servicing System for STS Crew Training Lesson Descriptions

5  RWS S/W OPS 21110 (Concluded)

He/she is asked to trace the flow of data through the hardware/software for some nominal activities (applying brakes, etc.).

Objectives:
- Explain the functionality of the hardware components of the RWS.
- Describe the Control Electronics Unit (CEU) connectivity with other MSS components and the C&C MDM.
- Explain the high level functions of the WHS, OCS, and the VGS.
- Execute the RWS Power Up procedure.
- Execute the RWS Display and Control Panel checkout procedure.
- Execute the RWS Hand Controller checkout procedure.
- Describe the flow of data originating from the Display and Control Panel, SSRMS, and Portable Computer System (PCS) passing through various busses and software packages in the RWS.

6  MRO PREREQ SUM 21025

Title: MSS Robotics Operator Prerequisite Summary (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): ISS ROBO ENVIRO 21025
Preparation: None

Synopsis: This lesson helps the student transition from a Generic Robotics Training (GRT) environment into the SSRMS environment. This lesson complements the prerequisite MSS CBT for the Canadian Space Agency (CSA) Mobile Servicing System (MSS) Robotics Operator (MRO) course and provides an opportunity for the student to ask questions and review the important material from the MSS CBT. The lesson discusses GRT concepts and relates them to SSRMS. The lesson will review the manual mode control algorithms, single joint motions, and frames. The student will also look at the singularities and self-collisions associated with the SSRMS. Finally, the student will perform grapple and release operations using different Latching End Effector (LEE) operation modes. At the conclusion of the lesson, the student should have a good comprehension of all prerequisite material for the MRO course.
Mobile Servicing System for STS Crew Training Lesson Descriptions

6 MRO PREREQ SUM 21025 (Concluded)

Objectives:
- Describe in your own words the different coordinate frames, Frame of Resolution (FOR), Display Frame, Command Frame, and state specific SSRMS examples.
- Describe the 3 SSRMS control algorithms and their differences.
- Given an arm model, properly demonstrate SSRMS singularities and predict the Degree of Freedom (DOF) lost.
- Given an arm model and scenario, predict the correct single joint direction using the single joint mnemonics.
- Given the grapple mode, verbalize the operator actions and cues during grapple and release.

7 MRO PART 1 21113

Title: MSS Robotics Operator Course Part 1 (Shared – ISS)
Duration: 32.0 hours
Medium: Canadian Space Agency
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08

Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MRO PREREQ SUM 21025
Preparation: None

Synopsis: This course, conducted at the Canadian Space Agency (CSA) in Saint Hubert, Quebec, is designed to provide the skills, knowledge, and attitudes associated with Mobile Servicing System (MSS) unloaded operations under nominal conditions. Lessons include: MSS Overview, System Feedback, Coordinate Frames, Camera Selection & Control, Modes & Features Selection, Arm Configuration During Motion, MSS Unloaded Operations, Singularities & Self-Collisions, and a Nominal Unloaded Exercise. At the end of this one-week course, you will be asked to complete a performance check, which is a simulation exercise designed to assess your ability to safely and efficiently operate an unloaded SSRMS, situated on the Mobile Remote Servicer Base System (MBS), under nominal conditions.

Objectives:
- Demonstrate situational awareness of the MSS.
- Manage nominal MSS feedback data displayed at the Robotic Workstation (RWS) to ensure the safe operation of the MSS.
- Fly SSRMS to target destinations using different command and display frames.
- Select and control cameras while flying SSRMS to a target destination.
Mobile Servicing System for STS Crew Training Lesson Descriptions

7 MRO PART 1 21113 (Concluded)

- Select and implement proper modes and features for different operational tasks.
- Predict and control arm configuration during motion.
- Recognize and correctly respond to singularities, self-collision, and collision with structure.
- Maneuver SSRMS to perform nominal unloaded operations.

8 MRO1 PROF 1 41025

Title: MSS Robotics Operator Part 1 Proficiency 1 Mode Selection (Shared – ISS)

Duration: 2.0 hours

Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10

Student: M1 (M2 supports as needed)

Source: DX23/Station Mechanical & Robotics

Date: 06/08

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): MRO PART 1 21113

Preparation: None

Synopsis: This lesson is taught, as necessary, to maintain the student’s proficiency between the Canadian Space Agency’s (CSA) Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this exercise, the learner will perform a fly-to task, where s/he must determine/strategize which modes and features would be best to use. The most important part of this lesson, apart from getting the arm to its final destination, is the discussion of the various modes and features: their advantages and limitations, applicability to different situations, and efficiency.

Objectives:
- Select and control cameras to always monitor and maintain clearance between the SSRMS and ISS structure.
- Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
- Use appropriate scan patterns.
- Given a fly-to task, select an appropriate mode and discuss alternatives.
- Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
- Select proper operational features in accordance with operational tasks.
Mobile Servicing System for STS Crew Training Lesson Descriptions

9 MRO1 PROF 2 41025

Title: MSS Robotics Operator Part 1 Proficiency 2 Mode Selection (Shared – ISS)

Duration: 2.0 hours

Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10

Student: M1 (M2 supports as needed.)

Source: DX23/Station Mechanical & Robotics

Date: 06/08

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): MRO PART 1 21113

Preparation: None

Synopsis: This lesson is taught, as necessary, to maintain the student's proficiency between the Canadian Space Agency’s (CSA) Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this lesson, the learner will perform a fly-to task, where s/he must determine/strategize which modes and features would be best to use to complete the task. The most important part of this lesson, apart from getting the arm to its final destination, is the discussion of the various modes and features, their advantages and limitations, applicability to different situations, and efficiency. The learner will have an opportunity to compare efficiency by performing the fly-to task twice, using different combinations of modes.

Objectives:

- Select and control cameras to always monitor and maintain clearance between the SSRMS and ISS structure.
- Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
- Use appropriate scan patterns.
- Given a fly-to task, select an appropriate mode and discuss alternatives.
- Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
- Select proper operational features in accordance with operational tasks.
Mobile Servicing System for STS Crew Training Lesson Descriptions

10 MRO1 PROF 3 41025

Title: MSS Robotics Operator Part 1 Proficiency 3 Mode Selection
(Shared – ISS)

Duration: 2.0 hours

Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10

Student: M1 (M2 supports as needed.)

Source: DX23/Station Mechanical & Robotics

Date: 06/08

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): MRO PART 1 21113

Preparation: None

Synopsis: This lesson is taught, as necessary, to maintain the student's proficiency between the Canadian Space Agency's Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this exercise, the learner will perform an inspection task during which s/he must recognize and correctly respond to singularities, self-collision, and joint angle limits. It highlights Pitch Plane as an effective method to manage singularities and self-collisions, as well as locking the alternate joint when 6 Degree of Freedom (DOF) singularities are encountered. This exercise provides an opportunity for the learner to observe arm behavior and operator feedback. The learner should also make use of assessment tools, such as Self-Collision Charts and XYZ Position Grids.

Objectives:

- Select and control cameras to always monitor and maintain clearance between SSRMS and ISS structure.
- Select appropriate coordinate frames in accordance with dominant camera view.
- Predict arm destination based on Frame of Resolution (FOR) values and/or joint angles using model and/or XYZ Position Grids.
- Determine proper mode selection in accordance with operational tasks.
- Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
- Select appropriate operational features in accordance with operational task.
- Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
- Use smooth and multi-DOF HC motions.
- Demonstrate situational awareness by using available tools to avoid collision with structure.
Mobile Servicing System for STS Crew Training Lesson Descriptions

10 MRO1 PROF 3 41025 (Concluded)

- Using appropriate scan patterns, observe and correctly respond to Self Collision, Singularities, and Joint Angle Limits.
- Recognize the operational conditions and warnings for imminent singularities, self-collisions, and collisions with ISS structure.
- Correctly select the appropriate SSRMS modes to recover from singularities, self-collisions, and collisions with ISS structure.

11 MRO1 PROF 4 41025

Title: MSS Robotics Operator Part 1 Proficiency 4 Mode Selection (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MRO PART 1 21113
Preparation: None

Synopsis: This lesson is taught, as necessary, to maintain the student’s proficiency between the Canadian Space Agency’s (CSA) Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this exercise, the learner will perform an inspection task during which s/he must recognize and correctly respond to singularities, self-collision, and joint angle limits. It emphasizes the need to predispose a joint during Frame of Resolution (FOR) Operator Controlled Auto Sequence (OCAS); working around an Elbow Pitch (EP) singularity during inspection; the use of mixed command frames during inspection; and the difference between singularity management when a joint is held versus locked. The learner should also make use of assessment tools, such as Self-Collision Charts and XYZ Position Grids.

Objectives:
- Select and control cameras to always monitor and maintain clearance between SSRMS and ISS structure.
- Select appropriate coordinate frames in accordance with dominant camera view.
- Predict arm destination based on FOR values and/or joint angles using model and/or XYZ Position Grids.
- Determine proper mode selection in accordance with operational tasks.
Mobile Servicing System for STS Crew Training Lesson Descriptions

11 MRO1 PROF 4 41025 (Concluded)

- Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
- Select appropriate operational features in accordance with operational task.
- Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
- Use smooth and multi-Degree of Freedom (DOF) HC motions.
- Maintain situational awareness by using available tools to avoid collision with structure.
- Using appropriate scan patterns, observe and correctly respond to Self-Collision, Singularities, and Joint Angle Limits.
- Recognize the operational conditions and warnings for imminent singularities, self-collisions, and collisions with ISS structure.
- Correctly select the appropriate SSRMS modes to recover from singularities, self-collisions, and collisions with ISS structure.

12 MRO1 PROF 5 41025

Title: MSS Robotics Operator Part 1 Proficiency 5 Mode Selection (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MRO PART 1 21113
Preparation: None

Synopsis: This lesson is taught, as necessary, to maintain the student’s proficiency between the Canadian Space Agency’s (CSA) Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this exercise, the learner will perform an inspection task during which s/he must recognize and correctly respond to singularities, self-collision, and joint angle limits. It also reviews the use of mixed command frames during inspection and Pitch Plane as a method for avoiding self-collision. The learner should also make use of assessment tools, such as Self-Collision Charts and XYZ Position Grids.
Mobile Servicing System for STS Crew Training Lesson Descriptions

12 **MRO1 PROF 5 41025 (Concluded)**

Objectives:
- Select and control cameras to always monitor and maintain clearance between the SSRMS and ISS structure.
- Select appropriate coordinate frames in accordance with dominant camera view.
- Predict arm destination based on Frame of Resolution (FOR) values and/or joint angles using model and/or XYZ Position Grids.
- Determine proper mode selection in accordance with operational tasks.
- Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
- Select appropriate operational features in accordance with operational task.
- Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
- Use smooth and multi-Degree of Freedom (DOF) HC motions.
- Maintain situational awareness by using available tools to avoid collision with structure.
- Using appropriate scan patterns, observe and correctly respond to Self Collision, Singularities, and Joint Angle Limits.
- Recognize the operational conditions and warnings for imminent singularities, self-collisions, and collisions with ISS structure.
- Correctly select the appropriate SSRMS modes to recover from singularities, self-collisions, and collisions with ISS structure.

13 **MRO1 PROF 6 41025**

Title: MSS Robotics Operator Part 1 Proficiency 6 Mode Selection (Shared – ISS)

Duration: 2.0 hours

Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10

Student: M1 (M2 supports as needed.)

Source: DX23/Station Mechanical & Robotics

Date: 06/08

Lesson(s) Replaced: None

Equipment Required: None

Prerequisite Lesson(s): MRO PART 1 21113

Preparation: None

Synopsis: This lesson is taught, as necessary, to maintain the student’s proficiency between the Canadian Space Agency’s Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this exercise, the learner will perform a series of fly-to tasks, each of which requires the
Mobile Servicing System for STS Crew Training Lesson Descriptions

13  MRO1 PROF 6 41025 (Concluded)

learner to analyze the initial configuration of the SSRMS and strategize a trajectory, utilizing/rationalizing appropriate modes, coordinate frames and features to reach the given destination. The learner is constrained to flying all Frame of Resolution (FOR) Modes with a Locked Joint.

Objectives:
• Determine proper mode selection in accordance with operational tasks.
• Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
• Select appropriate coordinate frames in accordance with dominant camera view.
• Select appropriate operational features in accordance with operational tasks.
• Select and control cameras to always monitor and maintain clearance between the SSRMS and ISS structure.
• Predict arm destination based on FOR values and/or joint angles using model and/or XYZ Position Grids.
• Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
• Use smooth and multi-Degree of Freedom (DOF) HC motions.
• Maintain situational awareness by using available tools to avoid collision with structure.
• Using appropriate scan patterns, observe and correctly respond to Self-Collision, Singularities, and Joint Angle Limits.

14  MRO1 PROF 7 41025

Title: MSS Robotics Operator Part 1 Proficiency 7 Mode Selection
(Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MRO PART 1 21113
Preparation: None
Mobile Servicing System for STS Crew Training Lesson Descriptions

14 MRO1 PROF 7 41025 (Concluded)

Synopsis: This lesson is taught, as necessary, to maintain the student’s proficiency between the Canadian Space Agency’s (CSA) Mobile Servicing System (MSS) Robotics Operator (MRO) Part 1 and Part 2 courses. During this lesson, the learner will perform an inspection task, which requires the learner to analyze the initial configuration of the SSRMS and strategize a trajectory, utilizing/rationalizing appropriate modes, coordinate frames and features to reach the given destination. The learner is constrained to flying all Frames of Resolution Modes with a Locked Joint. In addition, the learner must recognize and correctly respond to Singularities, Self-Collision, and Joint Angle Limits.

Objectives:
- Determine proper mode selection in accordance with operational tasks.
- Determine proper mode termination procedure by applying Safing, Brakes, or selecting another mode in accordance with operational tasks.
- Select appropriate coordinate frames in accordance with dominant camera view.
- Select appropriate operational features in accordance with operational tasks.
- Select and control cameras to always monitor and maintain clearance between the SSRMS and ISS structure.
- Predict arm destination based on Frame of Resolution (FOR) values and/or joint angles using model and/or XYZ Position Grids.
- Correctly operate Hand Controller (HC) inputs to move the arm in the intended direction as verbalized by the operator.
- Use smooth and multi-Degree of Freedom (DOF) HC motions not to induce oscillations and control target positions.
- Maintain situational awareness by using available tools to avoid collision with structure or the MSS.
- Using appropriate scan patterns, observe and correctly respond to Self-Collision, Singularities, and Joint Angle Limits.

15 MRO PART 2 21113

Title: MSS Robotics Operator Course Part 2 (Shared – ISS)
Duration: 32.0 hours
Medium: Canadian Space Agency
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Mobile Servicing System for STS Crew Training Lesson Descriptions

15  **MRO PART 2 21113 (Concluded)**

Prerequisite Lesson(s): MRO PART 1 21113  
Preparation: None

Synopsis: This course is a follow-on to the Part 1 course and is designed to provide the knowledge, skills, and attitudes associated with MSS loaded operations under off-nominal conditions. Lessons include Part 1 Review, Effector Operations, Payload Operations, System Architecture, Failure and Recovery, and an Off-Nominal Loaded Exercise. The duration of this course is also one week, and will culminate in the performance of a final check designed to assess your ability to safely and efficiently operate the SSRMS, situated on the Mobile Remote Servicer Base System (MBS), with an attached payload, under off-nominal conditions.

Objectives:  
- Perform Latching End Effector (LEE)/Payload ORU Accommodation (POA) capture and release operations.  
- Maneuver the payload in free space.  
- Explain how the MSS System Architectures (power, thermal, data, and video) and their redundancies contribute to the operational capabilities of the MBS and SSRMS.  
- Recover from MSS failure conditions.  
- Perform MSS loaded operations.

16  **NBL SSRMS FAM 21027**

Title: Neutral Buoyancy Lab Space Station Remote Manipulator System Familiarization (Shared – ISS)  
Duration: 1.0 hour  
Medium: Neutral Buoyancy Lab  
Student: M1 (M2 supports as needed.)  
Source: DX23/Station Mechanical & Robotics  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MSS/EVAA SUPT2 TEAM 91016, MSS/EVAB SUPT2 SOLO 91025  
Preparation: None

Synopsis: The NBL SSRMS Familiarization lesson introduces robotic operators to the NBL simulator. The lesson stresses the facility safety and the differences between the hardware simulator arm and the flight equipment. An NBL technician will teach this class and cover all the pertinent safety issues associated with this facility.
Mobile Servicing System for STS Crew Training Lesson Descriptions

16  **NBL SSRMS FAM 21027 (Concluded)**

Objectives:  
- Identify the difference between the NBL SSRMS and the flight equipment.  
- Explain safety issues associated with the operation of the NBL SSRMS.

17  **SSRMS SUPT TOOLS 21025**

Title:  **SSRMS Support Tools (Shared – ISS)**
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  **MSS SUPT TOOLS 21025**
Equipment Required:  MSS  *Quick* Reference Guide and SSRMS scale model;  
* A31p SSC with DOUG v1.6
Prerequisite Lesson(s):  Robotics Fundamentals Flow
Preparation:  None

Synopsis:  This lesson will introduce the student to the basic features of three situational awareness tools used to support robotic operations.  This lesson is the student's first opportunity to have "hands on" use of Dynamic On-orbit Ubiquitous Graphics (DOUG) as a robotic tools, and the student will also practice using two targeting systems, the Centerline Berthing Camera System (CBCS) for mating operations to the ISS, and the Keel target for berthing operations in the Orbiter Payload Bay (PLB). Multiple exercises will be performed using each tool.  This class will prepare the student for the use of these tools in the remaining classes of generic MSS training and in support of flight and increment specific training.

Objectives:  
- Describe the DOUG functions that may be used for training or real time operations.  
- Configure the DOUG tool for use in support of robotic operations.  
- Interpret the misalignments seen with the CBCS as a primary targeting cue.  
- Interpret the misalignments seen with the Keel target as a secondary targeting cue.
Mobile Servicing System for STS Crew Training Lesson Descriptions

18  **SSRMS SPEC INTRO 21001**

**Title:**  SSRMS Specialist Skills Flow Introduction (Shared – ISS)  
**Duration:**  0.5 hours  
**Medium:**  Classroom  
**Student:**  M1 (M2 support as needed.) (CB Robotics Branch Chief should be scheduled to attend this lesson.)  
**Source:**  DX23/Station Mechanical & Robotics  
**Date:**  06/08  
**Lesson(s) Replaced:**  None  
**Equipment Required:**  None  
**Prerequisite Lesson(s):**  SSRMS SUPT TOOLS 21025  
**Preparation:**  None  

**Synopsis:**  This lesson is used to introduce the student to the Specialist Skills Flow. The content of each lesson and evaluation criteria is discussed. The student is provided with information of extra resources that can be utilized during the flow to achieve maximum benefit and score in the eval.

**Objectives:**  
- Know the expectation of the flow with respect to evaluation criteria and content of the course.  
- Know the resources available to students during the Spec Skills flow.

19  **SSRMS REFR 21025**

**Title:**  SSRMS Refresher  
**Duration:**  2.0 hours (As needed.)  
**Medium:**  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10  
**Student:**  M1 (M2 supports as needed.)  
**Source:**  DX23/Station Mechanical & Robotics  
**Date:**  06/08  
**Lesson(s) Replaced:**  None  
**Equipment Required:**  None  
**Prerequisite Lesson(s):**  SSRMS SPEC INTRO 21001  
**Preparation:**  None  

**Synopsis:**  This lesson is meant to serve as a refresher of Space Station Remote Manipulator System (SSRMS) knowledge and skills using the Dynamic Skills Trainer (DST) environment. Specific content of this lesson will be determined by the lead instructor for the flight.

**Objectives:**  Understand and perform the content of the lesson.
Mobile Servicing System for STS Crew Training Lesson Descriptions

20  MSS/EVA FAM 21025

Title:  MSS/EVA Familiarization (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s):  SSRMS SUPT TOOLS 21025
Preparation:  None

Synopsis:  The lesson covers the voice protocol that is used by the crew on orbit while supporting EVA. After a discussion of safety issues and voice protocols, the student will have practice moving the SSRMS using EVA protocol as the role played by the instructor. Typical EVA sites will be used for several exercises. The EVA rescue task is introduced and exercised at the end of the lesson.

Objectives:  • Understand and use correct EVA Communication protocol.
• Visualize Frame of Resolution (FOR), Command Frame (CDF), and Display Frame (DYF) axes.
• Determine best combination of FOR, CDF, and DYF to achieve desired motion as simply as possible.
• Execute correct maneuvers based on EVA voice commands.
• Maintain awareness of arm configuration to ensure crew and hardware safety.

21  MSS OPS COORD 21025

Title:  MSS Operations Coordination (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 10 or DST 2, 3, 4, 5
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s):  MSS/EVA FAM 21025
Preparation:  None
Mobile Servicing System for STS Crew Training Lesson Descriptions

21  MSS OPS COORD 21025 (Concluded)

Synopsis: The lesson presents SSRMS operations in a flight-like scenario by using procedures, robotics tools, and M1 and M2 coordination. The lesson will formally introduce the roles and responsibilities of the M1 and the M2, and emphasize the importance of communication and coordination required between the M1 and the M2 during robotics operations. Several mission typical procedures will be executed with the student in either the M1 or the M2 role. Situational awareness is an important aspect of all robotics and will be enhanced in this lesson with the use of the Dynamic Onboard Ubiquitous Graphics (DOUG).

Objectives:
- Execute roles and responsibilities of the M1 and M2.
- Communicate effectively with M1 or M2, EVA, MCC, and Shuttle using voice protocols.
- Make ALL STOP calls as appropriate.
- Predict arm motion, clearances, and any other general Situational Awareness (SA) concerns for each maneuver.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Execute robotics operations per procedure.
- Use DOUG as a secondary SA tool.
- Demonstrate proper hand controller technique.
- Verify system configuration using consistent technique Desat, Overlays, Cue Card, Controls, Cameras, Rates, and Mode (i.e., DOCCCRM).

22  SSRMS SPEC TSK1 21025

Title:  SSRMS Specialist Task 1 (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  MSS SPEC TASK 1 21025
Equipment Required:  MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s):  MSS OPS COORD 21025
Preparation:  None

Synopsis: This lesson exercises student skills associated with unloaded operations using the SSRMS. Tasks include three unloaded tasks that incorporate different clearance concerns, convoluting joint clusters, and the need to Pitch Plane. Single joint, manual, and automatic arm modes can be used.
Mobile Servicing System for STS Crew Training Lesson Descriptions

22 **SSRMS SPEC TSK1 21025 (Concluded)**

Objectives:
- Demonstrate strong situational awareness by executing a periodic scan, maintaining more than 2 good camera views, and avoiding joint limits, singularities, and collisions.
- Identify clearance concerns by verbalizing clearance ranges and monitoring the entire arm including elbow.
- Perform tasks accurately and efficiently by strategizing using 5S technique and completing tasks within tolerance and time constraints.
- Demonstrate proper hand controller techniques by good grip, smooth ramping, and multi-axis commands.
- Manage resources efficiently and effectively by utilizing Dynamic Onboard Ubiquitous Graphics (DOUG) and communicating and coordinating with M2.
- Correctly configure the system.
- Perform operations in accordance with procedures and flight rules.

23 **SSRMS SELF 81025**

**Title:** SSRMS Self Study  
**Duration:** 2.0 hours  
**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10  
**Student:** M1 (M2 supports as needed.)  
**Source:** DX23/Station Mechanical & Robotics  
**Date:** 06/08  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** SSRMS SPEC TSK1 21025  
**Preparation:** None

**Synopsis:** This self-paced lesson is used for self-study in the DSTs preparing for a lesson or maintaining proficiency without an instructor. A variety of self-paced exercises are available in the DSTs.

**Objectives:** None
Mobile Servicing System for STS Crew Training Lesson Descriptions

24  **SSRMS SPEC TSK2 21025**

Title:  **SSRMS** Specialist Task 2 (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  MSS SPEC TASK 2 21025
Equipment Required:  MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s):  SSRMS SPEC TSK1 21025
Preparation:  None

Synopsis:  This lesson exercises student skills associated with unloaded operations using the SSRMS. Tasks include three unloaded tasks that incorporate different clearance concerns, convoluting joint clusters, and the need to Pitch Plane. Single-joint, manual, and automatic arm modes can be used.

Objectives:  
- Demonstrate proper situational awareness by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self-collisions.
- Apply the 5S concept to develop a well planned strategy to arrive at the provided position and orientation within the allotted time.
- Demonstrate proper hand controller techniques through proper grip, smooth ramping of commands, and multi-axis flying.
- Demonstrate proper resource management techniques by utilizing the Dynamic Onboard Ubiquitous Graphics (DOUG) tool, communicating and coordinating with M2 and EVA for each task.
- Apply proper system management techniques to correctly configure the system for each task.
- Perform proper operations techniques by following procedures and adhering to flight rules.

25  **SSRMS SPEC TSK3 21025**

Title:  **SSRMS** Specialist Task 3 (Shared – ISS)
Duration:  2.5 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  MSS SPEC TASK 3 21025
Equipment Required:  MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s):  SSRMS SPEC TSK2 21025
Preparation:  None
Mobile Servicing System for STS Crew Training Lesson Descriptions

25  **SSRMS SPEC TSK3 21025 (Concluded)**

Synopsis: This lesson exercises student skills associated with loaded operations using the SSRMS. Tasks include a pre-grapple fly-to, grapple with no Latching End Effector (LEE) camera, unberth from the Orbiter Payload Bay (OPB), a loaded fly-to and ungrapple. Single-joint, manual, and automatic arm modes are used.

Objectives:
- Demonstrate proper situational awareness by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self-collisions.
- Identify and verbalize clearance issues for each task by consistently monitoring Elbow and the entire arm.
- Apply the 5S concept to develop a well planned strategy to arrive at the provided position and orientation within the allotted time.
- Demonstrate proper hand controller techniques through proper grip, smooth ramping of commands, and multi-axis flying.
- Demonstrate proper resource management techniques by utilizing the Dynamic Onboard Ubiquitous Graphics (DOUG) tool, communicating and coordinating with M2 for each task.
- Apply proper system management techniques to correctly configure the system for each task.
- Perform proper operational techniques by following procedures and adhering to flight rules.

26  **SSRMS SPEC PRAC 21025**

Title: **SSRMS Specialist Practice** (Shared – ISS)
Duration: 3.5 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08

Lesson(s) Replaced: MSS SPEC TASK 7 21025
Equipment Required: MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s): SSRMS SPEC TSK3 21025
Preparation: None

Synopsis: This lesson is designed to exercise all previously gained knowledge and skills for operating the SSRMS in preparation for the Mobile Servicing System (MSS) Specialist Evaluation (MSS SPEC EVAL). Tasks include unloaded and loaded maneuvering of the arm, EVA support, and a timed activity. The instructor provides an assessment of skills in several skill areas, including situational awareness, hand controller techniques, system and resource management, camera usage, and task completion.
Mobile Servicing System for STS Crew Training Lesson Descriptions

26 **SSRMS SPEC PRAC 21025 (Concluded)**

Objectives:
- Maneuver an unloaded SSRMS in various modes (manual, Single Joint (SJ), Operator Command Auto Sequence (OCAS), Pitch Plane) by determining proper direction of motion, using proper mnemonics and applying good hand controller skills so not to induce oscillations on the arm.
- Maneuver SSRMS with a large payload attached in different modes, including Manual, Joint OCAS, Frame of Resolution (FOR) OCAS safely, within flight rule constraints and without inducing oscillations.
- Apply the Latch End Effector (LEE) Cue Card appropriately during loaded operations.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Execute automatic and manual LEE Operations without instructor assistance.
- Maneuver the SSRMS with EVA crewmember attached using the Robotics/EVA voice protocol and EVA commands.
- Communicate sufficiently with EVA crew and M2.
- Configure the SSRMS system properly, including loading correct files and configuring the LEE for grapple without instructor assistance.

27 **SSRMS SPEC EVAL 21025**

Title: SSRMS Specialist Evaluation (Shared – ISS)
Duration: 4.0 hours
Medium: Dynamic Skills Trainer 1 or 2
Student: M1 (M2 supports as needed.) (IA Required)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: MSS SPEC EVAL 21025
Equipment Required: MSS Quick Reference Guide and SSRMS scale model
Prerequisite Lesson(s): SSRMS SPEC PRAC 21025
Preparation: None

Synopsis: The Mobile Servicing System (MSS) Evaluation is designed to exercise all previously gained knowledge and skills for operating the SSRMS. The evaluation includes unloaded and loaded maneuvering of the arm, EVA support and a timed activity. An instructor and an Instructor Astronaut (IA) perform the evaluation. Several skill areas are evaluated, including situational awareness, hand controller techniques, system and resource management, camera usage, and task completion.
Mobile Servicing System for STS Crew Training Lesson Descriptions

27  **SSRMS SPEC EVAL 21025 (Concluded)**

Objectives:

- Maneuver an unloaded SSRMS in various modes (manual, Single Joint (SJ), Operator Command Auto Sequence (OCAS), Pitch Plane) by determining proper direction of motion, using proper mnemonics and applying good hand controller skills so not to induce oscillations on the arm.
- Maneuver SSRMS with a large payload attached in different modes, including Manual, Joint OCAS, Frame of Resolution (FOR) Operator Command Auto Sequence (OCAS) safely, within flight rule constraints and without inducing oscillations.
- Apply Latch End Effector (LEE) Cue Card appropriately during loaded operations.
- Maintain situational awareness and clearance monitoring by selecting and adjusting appropriate camera views during tasks.
- Perform automatic and manual LEE Operations without instructor assistance.
- Maneuver the SSRMS with EVA crewmember attached using the Robotics/EVA voice protocol and EVA commands.
- Communicate sufficiently with the EVA crew and M2.
- Configure the SSRMS system properly, including loading correct files and configuring the LEE for grapple without instructor assistance.

28  **MSS/EVA SUPT OV 91001**

Title:  MSS EVA Support Overview (Shared – ISS)
Duration:  2.0 hours
Medium:  Classroom
Student:  EV1, EV2, IV, M1, M2
Source:  DX23/Station Mechanical & Robotics
Date:  09/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  EVA1 92027 (EVA OPS), EVA2 92027 (EVA OPS)
Preparation:  None

Synopsis:  The Mobile Servicing System (MSS) EVA Support Overview lesson provides an overview of all SSRMS-supported EVAs for the flight/increment. Photos, Dynamic Onboard Ubiquitous Graphics (DOUG) and other media are used to familiarize students with each of the EVAs. The focal point of the lesson hinges on a discussion of SSRMS support of the EVAs, highlighting the importance of team resource coordination. In addition, the lesson presents an overview of SSRMS configurations, a discussion of clearance and camera viewing issues and, finally, Ground
Mobile Servicing System for STS Crew Training Lesson Descriptions

28 MSS/EVA SUPT OV 91001 (Concluded)

Control Assist (GCA) protocol is addressed. This lesson is led by the Robotics Instructor and supported by Robotics and EVA Flight Control Leads. It is desired to have both Crews (ISS and Shuttle) present. At a minimum, the designated M1, M2, IV, EV1, and EV2 must be present.

Objectives:
- Identify the MSS configurations and maneuvers during all EVA timelines, including any associated clearance issues.
- Explain standard communication protocol with IV, EVA crew, and M2 specific to all EVA timelines.
- Describe EVA Ground Control Approach (GCA) command preferences based on EV1/EV2/IV’s experiences from the initial NBL runs for each timeline.

29 MSS/EVAA SUPT1 SOLO 91025

Title: MSS EVAA Support 1 with Solo M1 (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MSS/EVA SUPT OV 91001
Preparation: None

Synopsis: The Mobile Servicing System (MSS) EVAA Support 1 with Solo M1 lesson provides the Crew with an initial opportunity to gain situational awareness by exploring the trajectories, arm configurations, telemetry monitoring, clearances, and camera views associated with EVAA. The lesson emphasizes familiarity with the task and its nuances. The lesson concludes with a summary of the lesson activities and an informal skill review. M1 and M2 each take this lesson individually (solo) and operate from the M1 position. Flight procedures are used and the instructor role-plays M2, IV, EV1 and/or EV2.

Objectives:
- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Identify clearance issues for the MSS configurations and maneuvers during this EVA timeline.
- Identify limiting SSRMS configurations, such as reach limits, singularities, and self-collisions, encountered throughout this EVA timeline.
Mobile Servicing System for STS Crew Training Lesson Descriptions

29  MSS/EVAA SUPT1 SOLO 91025 (Concluded)

- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining situational awareness.
- List effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Explain SSRMS limitations and capabilities for joint locked and joint held algorithms.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).

30  MSS/EVAA SUPT2 TEAM 91016

Title:  MSS EVAA Support 2 for Team (Shared – ISS)
Duration:  3.0 hours
Medium:  Virtual Reality Trainer
Student:  EV1, EV2, IV, M1, M2
Source:  DX23/Station Mechanical & Robotics
Date:  09/04
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  MSS/EVAA SUPT1 SOLO 91025
Preparation:  None

Synopsis:  The Mobile Servicing System (MSS) EVAA Support 2 for Team is the first simulator lesson with M1, M2, IV, EV1, and EV2 working together in their designated positions for EVAA. The focus of this lesson is group coordination and communication (i.e., Space Flight Resource Management (SFRM)). By the end of this lesson, a Ground Control Assist (GCA) protocol is established. M1 and M2 operate from their designated positions, EV crew are in Virtual Reality (VR) helmets, and IV performs his/her designated tasks. All participants communicate via head-sets. The instructor role-plays any other crew as needed, to include controlling shuttle cameras. This lesson prepares M1/M2/IV/EV for the next NBL run. The lesson concludes with a review of the session’s events, and addresses participants’ strengths and weaknesses during the execution of those tasks.
Mobile Servicing System for STS Crew Training Lesson Descriptions

30  MSS/EVAA SUPT2 TEAM 91016 (Concluded)

Objectives:
- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Explain clearance issues for the MSS configurations and maneuvers during this EVA timeline.
- Explain limiting SSRMS configurations, such as reach limits, singularities, and self-collisions, encountered throughout this EVA timeline.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining situational awareness.
- Explain and use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Explain SSRMS limitations and capabilities for joint locked and joint held algorithms.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).

31  MSS/EVAB SUPT1 SOLO 91025

Title: MSS EVAB Support 1 with Solo M1 (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MSS/EVA SUPT OV 91001
Preparation: None
Mobile Servicing System for STS Crew Training Lesson Descriptions

31 MSS/EVAB SUPT1 SOLO 91025 (Concluded)

Synopsis: The Mobile Servicing System (MSS) EVAB Support 1 with Solo M1 lesson provides the Crew with an initial opportunity to gain situational awareness by exploring the trajectories, arm configurations, telemetry monitoring, clearances, and camera views associated with EVAB. The focus for the lesson is trajectory exploration and nuances. The lesson concludes with a summary of the lesson activities and an informal skill review. M1 and M2 each take this lesson individually (Solo) and operate from the M1 position. Flight procedures are used and the instructor role-plays M2, IV, EV1 and/or EV2.

Objectives:

- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Identify clearance issues for the MSS configurations and maneuvers during this EVA timeline.
- Identify limiting SSRMS configurations, such as reach limits, singularities, and self-collisions, encountered throughout this EVA timeline.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining situational awareness.
- List effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Explain SSRMS limitations and capabilities for joint locked and joint held algorithms.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

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<td><strong>Title:</strong></td>
<td>MSS EVAB Support 2 with Solo M1 (Shared – ISS)</td>
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<tr>
<td><strong>Duration:</strong></td>
<td>2.0 hours</td>
</tr>
<tr>
<td><strong>Medium:</strong></td>
<td>Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10</td>
</tr>
<tr>
<td><strong>Student:</strong></td>
<td>M1 (M2 supports as needed.)</td>
</tr>
<tr>
<td><strong>Source:</strong></td>
<td>DX23/Station Mechanical &amp; Robotics</td>
</tr>
<tr>
<td><strong>Date:</strong></td>
<td>06/08</td>
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<tr>
<td><strong>Lesson(s) Replaced:</strong></td>
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</tr>
<tr>
<td><strong>Equipment Required:</strong></td>
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<tr>
<td><strong>Prerequisite Lesson(s):</strong></td>
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</tr>
<tr>
<td><strong>Preparation:</strong></td>
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</tbody>
</table>

**Synopsis:** The Mobile Servicing System (MSS) EVAB Support 2 with Solo M1 lesson provides the crewmember with another opportunity to explore the trajectories, clearances, and camera views associated with EVAB. This lesson prepares MSS crewmembers for the next NBL run. The lesson concludes with a summary of the lesson activities and an informal skill review. M1 and M2 each take this lesson individually (Solo) and operate from the M1 position. Flight procedures are used and the instructor role-plays M2, IV, EV1 and/or EV2.

**Objectives:**
- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Explain clearance issues for the MSS configurations and maneuvers during this EVA timeline.
- Explain limiting SSRMS configurations, such as reach limits, singularities, and self-collisions, encountered throughout this EVA timeline.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining situational awareness.
- Explain and use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Explain SSRMS limitations and capabilities for joint locked and joint held algorithms.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

33 MSS/EVAA SUPT3 SOLO 91025

Title: MSS EVAA Support 3 with Solo M1 (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): NBL SSRMS FAM 21027, EVA1 93027 (EVA OPS)
Preparation: None

Synopsis: The Mobile Servicing System (MSS) EVAA Support 3 with Solo M1 lesson provides the crew with another opportunity to explore the trajectories, clearances, and camera views associated with EVAA. M1 and M2 each take this lesson individually (Solo) and operate from the M1 position. Flight procedures are used and the instructor role-plays M2, IV, EV1 and/or EV2. This lesson prepares the MSS crew for the next NBL run. The lesson concludes with a summary of the lesson activities and an informal skill review.

Objectives:

- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
- Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

34  MSS/EVAB SUPT3 M1M2 91025

Title:  MSS EVAB Support 3 for M1M2 (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  NBL SSRMS FAM 21027, EVA2 93027 (EVA OPS)
Preparation:  None

Synopsis:  The focus of the Mobile Servicing System (MSS) EVAB Support 3 for M1M2 lesson is M1/M2 coordination (i.e., Space Flight Resource Management (SFRM)). This is the first simulator lesson with the M1 and M2 working together in their designated positions for EVAB. Flight procedures are used and the tasks are flown as flight-like as possible, with the instructor role-playing EV and IV. This lesson prepares M1 and M2 for the next NBL run. The lesson concludes with a summary of the lesson activities and an informal skill review.

Objectives:

• Configure camera views to correctly monitor clearances and maintain situational awareness.
• Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
• Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
• Correctly configure the SSRMS system, including loading correct files without instructor assistance.
• Maneuver the SSRMS for each task in accordance with flight rules.
• Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

35  MSS/EVAA SUPT4 SOLO 91025

Title:  MSS EVAA Support 4 with Solo M1 (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  MSS/EVAA SUPT3 SOLO 91025
Preparation:  None

Synopsis:  The Mobile Servicing System (MSS) EVAA Support 4 with Solo M1 lesson provides the crew with yet another opportunity to explore the trajectories, clearances, and camera views associated with EVAA. Since this is the fourth time to see EVAA MSS activities, off-nominal scenarios are explored during this lesson. The off-nominal scenarios are at the discretion of the instructor and may include: camera failure(s), different joint lock/held algorithm, vastly different EV body positions, etc. M1 and M2 each take this lesson individually (Solo) and operate from the M1 position. The instructor role-plays M2, EV, and IV. Flight procedures are used.

Objectives:

- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
- Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
### Mobile Servicing System for STS Crew Training Lesson Descriptions

<table>
<thead>
<tr>
<th>Lesson ID</th>
<th>MSS/EVAB SUPT4 TEAM 91016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>MSS EVAB Support 4 for Team (Shared – ISS)</td>
</tr>
<tr>
<td>Duration</td>
<td>3.0 hours</td>
</tr>
<tr>
<td>Medium</td>
<td>Virtual Reality Trainer</td>
</tr>
<tr>
<td>Student</td>
<td>EV1, EV2, IV, M1, M2</td>
</tr>
<tr>
<td>Source</td>
<td>DX23/Station Mechanical &amp; Robotics</td>
</tr>
<tr>
<td>Date</td>
<td>09/04</td>
</tr>
<tr>
<td>Lesson(s) Replaced</td>
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</tr>
<tr>
<td>Equipment Required</td>
<td>None</td>
</tr>
<tr>
<td>Prerequisite Lesson(s)</td>
<td>MSS/EVAB SUPT3 M1M2 91025</td>
</tr>
<tr>
<td>Preparation</td>
<td>None</td>
</tr>
</tbody>
</table>

**Synopsis:**

The Mobile Servicing System (MSS) EVAB Support 4 for Team lesson is the first simulator lesson with M1, M2, IV, EV1, and EV2 working together in their designated positions for EVAB. The focus for this lesson is group coordination Space Flight Resource Management (SFRM). By the end of the lesson, a Ground Command Assist (GCA) protocol is established. M1 and M2 operate from their designated positions; EV crewmembers are in Virtual Reality (VR) helmets. The lesson concludes with a summary of the lesson activities and an informal skill review. All participants communicate via head-sets. The instructor adjusts Shuttle cameras if needed. This lesson prepares M1/M2/IV/EV1/EV2 for the next NBL run.

**Note:**

For Stage EVAs, M2 and IV are the responsibility of the ground MCC team and are role-played during this session.

**Objectives:**

- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
- Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

**37**  
**MSS/EVAA SUPT5 M1M2 91016**

Title: MSS EVAA Support 5 for M1M2 (Shared – ISS)  
Duration: 2.0 hours  
Medium: Virtual Reality Trainer  
Student: M1 (M2 supports as needed.)  
Source: DX23/Station Mechanical & Robotics  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MSS/EVAA SUPT4 SOLO 91025  
Preparation: None

Synopsis: The Mobile Servicing System (MSS) EVAA Support 5 for M1M2 lesson is the second simulator lesson with the M1 and M2 working together in their designated positions for EVAA. The focus for this lesson is M1/M2 coordination (Space Flight Resource Management (SFRM)). The lesson also provides crewmembers an opportunity to become proficient with camera commanding and camera configuration. The lesson uses current Flight procedures, and the tasks are flown as flight-like as possible, with the instructor role-playing EV and IV. This lesson prepares M1 and M2 for the next NBL run. At the end of this lesson, crew are comfortable and efficient with this timeline.

Objectives:  
- Configure camera views to correctly monitor clearances and maintain situational awareness.  
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.  
- Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.  
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.  
- Maneuver the SSRMS for each task in accordance with flight rules.  
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

38  MSS/EVAB SUPT5 M1M2 91025

Title:   MSS EVAB Support 5 for M1M2 (Shared – ISS)
Duration: 2.0 hours
Medium:   Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:   M1  (M2 supports as needed.)
Source:   DX23/Station Mechanical & Robotics
Date:  06/08
Lesson(s) Replaced:  None
Equipment Required:  None
Prerequisite Lesson(s):  MSS/EVAB SUPT4 TEAM 91016, EVA2 95027 (EVA OPS)
Preparation:  None

Synopsis:   The Mobile Servicing System (MSS) EVAB Support 5 for M1M2 lesson has M1 and M2 working together in their designated positions for part of the tasks, and then switching positions. This gives the “real” M1 his/her only opportunity to work as the M2 for EVAB. The lesson concludes with a summary of the lesson activities and an informal skill review. Flight procedures are used and the tasks are flown as flight-like as possible, with the instructor role-playing EV and IV.

Objectives:  • Configure camera views to correctly monitor clearances and maintain situational awareness.
• Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
• Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
• Correctly configure the SSRMS system, including loading correct files without instructor assistance.
• Maneuver the SSRMS for each task in accordance with flight rules.
• Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

39  **MSS/EVAA SUPT6 M1M2 91025**

**Title:** MSS EVAA Support 6 for M1M2 (Shared – ISS)  
**Duration:** 2.0 hours  
**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10  
**Student:** M1 (M2 supports as needed.)  
**Source:** DX23/Station Mechanical & Robotics  
**Date:** 06/08  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** MSS/EVAA SUPT5 M1M2 91016, EVA1 95027 (EVA OPS)  
**Preparation:** None  

**Synopsis:** The Mobile Servicing System (MSS) EVAA Support 6 for M1M2 lesson has M1 and M2 working together in their designated positions for part of the tasks, and will swap positions for the remainder of the session. This gives the “real” M1 his/her only opportunity to work as the M2 for EVAA. Flight procedures are used and the tasks are flown as flight-like as possible, with the instructor role-playing EV and IV. The lesson concludes with a summary of the lesson activities and an informal skill review.

**Objectives:**
- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
- Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

40 MSS/EVAB SUPT6 TEAM 91016

Title: MSS EVAB Support 6 for Team (Shared – ISS)
Duration: 3.0 hours
Medium: Virtual Reality Trainer
Student: EV1, EV2, IV, M1, M2
Source: DX23/Station Mechanical & Robotics
Date: 09/04
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MSS/EVAB SUPT5 M1M2 91025
Preparation: None

Synopsis: This is the final Mobile Servicing System (MSS) lesson for EVAB. It is desired to have the entire team (ISS and Shuttle) present. At a minimum, the designated M1, M2, IV, EV1, and EV2 must be present. M1 and M2 operate from their designated positions; EV crewmembers are in Virtual Reality (VR) helmets. All participants communicate via head-sets. It is desired to have the actual Shuttle camera operator present. Flight procedures are used and the tasks are flown as flight-like as possible. The lesson concludes with a summary of the lesson activities and an informal skill review.

Objectives:
• Configure camera views to correctly monitor clearances and maintain situational awareness.
• Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
• Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
• Correctly configure the SSRMS system, including loading correct files without instructor assistance.
• Maneuver the SSRMS for each task in accordance with flight rules.
• Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
### Mobile Servicing System for STS Crew Training Lesson Descriptions

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<tr>
<th>41</th>
<th>MSS/EVAA SUPT7 TEAM 91016</th>
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<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>MSS EVAA Support 7 for Team (Shared – ISS)</td>
</tr>
<tr>
<td><strong>Duration:</strong></td>
<td>3.0 hours</td>
</tr>
<tr>
<td><strong>Medium:</strong></td>
<td>Virtual Reality Trainer</td>
</tr>
<tr>
<td><strong>Student:</strong></td>
<td>EV1, EV2, IV, M1, M2</td>
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<tr>
<td><strong>Source:</strong></td>
<td>DX23/Station Mechanical &amp; Robotics</td>
</tr>
<tr>
<td><strong>Date:</strong></td>
<td>09/04</td>
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<td><strong>Lesson(s) Replaced:</strong></td>
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<td><strong>Equipment Required:</strong></td>
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<td><strong>Prerequisite Lesson(s):</strong></td>
<td>MSS/EVAA SUPT6 M1M2 91025</td>
</tr>
<tr>
<td><strong>Preparation:</strong></td>
<td>None</td>
</tr>
</tbody>
</table>

**Synopsis:** The Mobile Servicing System (MSS) EVAA Support 7 for Team session prepares the crew for the final NBL run of this EVAA timeline. It is desired to have entire the Crew (ISS and Shuttle) present. At a minimum, the designated M1, M2, IV, EV1, and EV2 must be present. M1 and M2 will operate from their designated positions; EV crew are in Virtual Reality (VR) helmets. All participants communicate via head-sets. It is desired to have the actual Shuttle camera operator present. Flight procedures are used and the tasks are flown as flight-like as possible. The lesson concludes with a summary of the lesson activities and an informal skill review.

**Note:** The next NBL run is assumed to be the final EVA1 NBL run in the ISS EVA flow.

**Objectives:**
- Configure camera views to correctly monitor clearances and maintain situational awareness.
- Accurately maneuver the SSRMS with an EVA crewmember attached, using the Robotics/EVA voice protocol and EVA commands while maintaining clearance and managing reach limits, singularities, and self-collisions.
- Use effective Ground Control Approach (GCA) communication among the crew, M1, M2, EV1, EV2, and IV, including but not limited to: direction, magnitude, verification, motion initiation, and all-stop for each task in the EVA timeline.
- Correctly configure the SSRMS system, including loading correct files without instructor assistance.
- Maneuver the SSRMS for each task in accordance with flight rules.
- Configure the Robotics Workstation (RWS) to ensure safe and efficient operations, including overlays, caution and warning summary page, MSS discrete log, and Dynamic Onboard Ubiquitous Graphics (DOUG).
Mobile Servicing System for STS Crew Training Lesson Descriptions

42  **TPS OBSS OPS1 91025**

Title:  Tile Protection System Orbiter Boom Sensor System Operations 1
        Solo (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:    06/08
Lesson(s) Replaced:  MSS TPS OBSS OPS1 91025
Equipment Required:  Flight-specific procedures
Prerequisite Lesson(s):  None
Preparation:  None

Synopsis:  The Mobile Servicing System (MSS) Tile Protection System (TPS) Orbiter
Boom Sensor System (OBSS) Operations 1 lesson focuses on the
SSRMS procedures used for OBSS grapple, unberth, and handoff to
SRMS, as well as the reberth into the Manipulator Positioning
Mechanisms (MPMs). The crewmember will execute the flight
procedures. The M1 and M2 for this task will complete this class
individually.

Objectives:  • Perform OBSS grapple, unberth, and maneuver to handoff position.
            • Perform the OBSS handoff to the SRMS.
            • Interpret the visual cues used to berth the OBSS into the MPMs.
            • Perform the OBSS berthing.

43  **TPS OBSS OPS2 91025**

Title:  TPS OBSS Operations 2 (Shared – ISS)
Duration:  2.0 hours
Medium:  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student:  M1 (M2 supports as needed.)
Source:  DX23/Station Mechanical & Robotics
Date:    06/08
Lesson(s) Replaced:  MSS TPS OBSS OPS2 91016
Equipment Required:  Flight-specific procedures, MSS Quick Reference Guide,
                    SSRMS Model (1/50th scale)
Prerequisite Lesson(s):  TPS OBSS OPS1 91025
Preparation:  None
Mobile Servicing System for STS Crew Training Lesson Descriptions

43  **TPS OBSS OPS2 91025 (Concluded)**

Synopsis: The Mobile Servicing System (MSS) Tile Protection System (TPS) Orbiter Boom Sensor System (OBSS) Operations 2 lesson allows the MSS specialists (M1 and M2) to work on coordination for SSRMS tasks related to the OBSS boom. The M1/M2 team will complete OBSS unberth, handoff, and berth operations using procedures.

Objectives:
- Perform OBSS grapple, unberth, handoff to the SRMS and reberth.
- Perform Space Flight Resource Management (SFRM) for OBSS operations.

44  **TPS OBSS H/O 91069**

Title: Tile Protection System Orbiter Boom Sensor System Handoff (Shared – ISS)

Duration: 3.0 hours
Medium: Virtual Reality Trainer or SESD
Note: Schedule in SESD only.
Student: M1, M2, R1, R2
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: **MSS TPS OBSS H/O 91069**
Equipment Required: SSRMS model (1/50th scale), MSS Quick Reference Guide, flight-specific procedures
Prerequisite Lesson(s): TPS OBSS OPS2 91025
Preparation: None
Note: This lesson is cross listed with PDRS.

Synopsis: The Mobile Servicing System (MSS) Tile Protection System (TPS) Orbiter Boom Sensor System (OBSS) Handoff lesson focuses on coordination between the Station and Shuttle crew for the OBSS handoff and survey operations. The crew will execute the joint procedures for this timeline, including OBSS handoff to the SRMS, survey operations with SSRMS viewing operations, and handoff to the SSRMS. The lesson will be conducted with M1, M2, R1, and R2 in the Systems Engineering Simulator (SES).

Objectives:
- Perform OBSS handoff from SSRMS to SRMS.
- Perform viewing operations and camera support during a portion of the OBSS surveys by SRMS.
- Perform OBSS handoff from SRMS to SSRMS.
- Perform dual arm operations Space Flight Resource Management (SFRM) skills for OBSS tasks.
Mobile Servicing System for STS Crew Training Lesson Descriptions

45  **TPS OBSS OPS3 91025**

**Title:**  TPS OBSS Operations 3 (Shared – ISS)  
**Duration:**  2.0 hours  
**Medium:**  Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10  
**Student:**  M1 (M2 supports as needed.)  
**Source:**  DX23/Station Mechanical & Robotics  
**Date:**  06/08  
**Lesson(s) Replaced:**  None  
**Equipment Required:**  SSRMS model (1/50th scale), MSS Quick Reference Guide, flight-specific procedures  
**Prerequisite Lesson(s):**  TPS OBSS H/O 91069  
**Preparation:**  None  

**Synopsis:**  The Mobile Servicing System (MSS) Tile Protection System (TPS) Orbiter Boom Sensor System (OBSS) Operations 3 lesson allows the MSS specialists (M1 and M2) to work on coordination for Space Station Robotics Manipulator System (SSRMS) tasks related to the OBSS boom. The M1/M2 team will complete the OBSS unberth, handoff, and berth operations using procedures.

**Objectives:**  • Perform OBSS grapple, unberth, handoff to the Shuttle Remote Manipulator System (SRMS), and reberth.  
• Perform Space Flight Resource Management (SFRM) for OBSS operations.

46  **TPS OBSS MISSION 91016**

**Title:**  Tile Protection System OBSS Mission (Shared – ISS)  
**Duration:**  2.0 hours  
**Medium:**  Virtual Reality Trainer  
**Student:**  M1 (M2 supports as needed.)  
**Source:**  DX23/Station Mechanical & Robotics  
**Date:**  06/08  
**Lesson(s) Replaced:**  MSS TPS MISSION 91016  
**Equipment Required:**  SSRMS model (1/50th scale), MSS Quick Reference Guide, flight-specific procedures  
**Prerequisite Lesson(s):**  TPS OBSS H/O 91069, EVA CONT 91027 (EVA OPS)  
**Preparation:**  None  

**Synopsis:**  This Mobile Servicing System (MSS) Tile Protection System (TPS) Mission lesson provides the final training session for the M1 and M2 crewmembers to review all the SSRMS procedures associated with tile inspection and repair while finalizing their Space Flight Resource Management (SFRM) teamwork skills. It will also be the final opportunity
Mobile Servicing System for STS Crew Training Lesson Descriptions

46  TPS MISSION 91016 (Concluded)

for the M1 and M2 operators to review any potential Thermal Protection System (TPS) scenarios, including Orbiter Boom Sensor System (OBSS) handoff operations, Orbiter Repair Maneuver (ORM) monitoring, or EVA repair scenarios.

Objectives:
• Execute procedures related to OBSS operations, ORM monitoring, and EVA tile repair.
• Demonstrate SFRM skills associated with tile inspection and repair tasks.

47  EL NOM INSTL 1 31025

Title: Element Nominal Installation #1 (Shared – ISS)
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): MSS SPEC EVAL 21025
Preparation: None

Synopsis: The Mobile Servicing System (MSS) Element Nominal Installation #1 lesson provides an initial exposure to the installation task and procedures for a specific element planned for an increment or flight. During this lesson, the student will unberth the element from the payload bay or accept a handoff from SRMS, translate the element to various points (low hover, premate, capture envelope, etc.), and then mate the element to the ISS. The unberth and mate will be nominal and allow the use of tools, such as Dynamic Onboard Ubiquitous Graphics (DOUG) and Robotics Situational Awareness Display (RSAD).

Objectives:
• Execute a nominal unberth/handoff, translate, and mate for the main element.
• Use the task-specific command frames, display frames, and Frames of Resolution (FOR) for the main element.
• Identify generic and element-specific flight rules associated with nominal operations.
• Describe unberthing/mating interfaces and associated system feedback for the main element.
• Describe the end-to-end process associated with unberthing and mating the main element.
Mobile Servicing System for STS Crew Training Lesson Descriptions

47  EL NOM INSTL 1 31025 (Concluded)

- Describe the operational constraints and limitations to the specific planned task, including the unberthing and mating corridors, visual cues, available robotics tools, etc.
- Communicate effectively with Shuttle and M2 using voice protocols.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Apply correct hand controller techniques as required for the specific task.

48  EL NOM INSTL 2 32115

Title: Element Nominal Installation #2 (Shared – ISS)
Duration: 2.0 hours
Medium: Multiuse Remote Manipulator Development Facility
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EL NOM INSTL 1 31025
Preparation: None

Synopsis: The Mobile Servicing System (MSS) Element Nominal Installation #2 lesson provides the M1 and M2 an opportunity to practice the installation of a specific element. During this lesson, the student will start grappled to an element and translate the element to various points (low hover, premate, capture envelope, etc.), and then mate the element to the ISS. The unberth and mate will be nominal and allow the use of tools, such as Dynamic Onboard Ubiquitous Graphics (DOUG) and Robotics Situational Awareness Display (RSAD). This lesson utilizes the hardware facility to emphasize the need to avoid structural contact and real camera use (focus iris zoom).

Objectives:
- Execute a nominal unberth/handoff, translate, and mate for the main element.
- Use the task-specific command frames, display frames, and Frames of Resolution (FOR) for the main element.
- Identify generic and element-specific flight rules associated with nominal operations.
- Describe unberthing/mating interfaces and associated system feedback for the main element.
Mobile Servicing System for STS Crew Training Lesson Descriptions

48  EL NOM INSTL 2 32115 (Concluded)

- Describe the end-to-end process associated with unberthing and mating the main element.
- Describe the operational constraints and limitations to the specific planned task, including the unberthing and mating corridors, visual cues, available robotics tools, etc.
- Communicate effectively with Shuttle and M2 using voice protocols.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Apply correct hand controller techniques as required for the specific task.
- Demonstrate proper facility-specific camera management during the operation.

49  EL NOM INSTL 3 93016

Title: Element Nominal Installation #3 (Shared – ISS)
Duration: 3.0 hours
Medium: Virtual Reality Trainer
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): EL NOM INSTL 2 32115
Preparation: None

Synopsis: The Mobile Servicing System (MSS) Element Nominal Installation #3 lesson provides another opportunity for the M1 and M2 to practice the procedures for a main element installation task planned for an increment or flight. During this lesson, the M1 will grapple an element and translate the element to various points (low hover, premate, capture envelope, etc.), and then mate the element to the ISS. The M2 will provide support during the task. The unberth and mate will be nominal and allow the use of tools, such as Dynamic Onboard Ubiquitous Graphics (DOUG) and Robotics Situational Awareness Display (RSAD). Using the Virtual Reality Lab allows the session to integrate Shuttle Robotics and EVA crew if appropriate.

Objectives:
- Execute a nominal unberth/handoff, translate, and mate for the main element.
- Use the task-specific command frames, display frames, and Frames of Resolution (FOR) for the main element.
Mobile Servicing System for STS Crew Training Lesson Descriptions

49  **EL NOM INSTL 3 93016 (Concluded)**

- Identify generic and element-specific flight rules associated with nominal operations.
- Describe unberthing/mating interfaces and associated system feedback for the main element.
- Describe the end-to-end process associated with unberthing and mating the main element.
- Describe the operational constraints and limitations to the specific planned task, including the unberthing and mating corridors, visual cues, available robotics tools, etc.
- Communicate effectively with Shuttle and M2 using voice protocols.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Apply correct hand controller techniques as required for the specific task.
- Demonstrate proper facility-specific camera management during the operation.

50  **EL NOM INSTL 4 91025**

**Title:**  Element Installation 4 (Shared – ISS)

**Duration:**  2.0 hours

**Medium:**  Dynamic Skills Trainer 1 or 2, 3, 4, 5, 10

**Student:**  M1 (M2 supports as needed.)

**Source:**  DX23/Station Mechanical & Robotics

**Date:**  06/08

**Lesson(s) Replaced:**  EL TRAJ MOD 1 91025

**Equipment Required:**  None

**Prerequisite Lesson(s):**  EL NOM INSTL 3 93016

**Preparation:**  None

**Synopsis:** The Mobile Servicing System (MSS) Element Installation #4 lesson provides a review of the specific task procedures and operations and includes changes/revisions/modifications that have been incorporated since the student last received the nominal lessons associated with the operation. The instructor will guide the student through the procedures, highlighting any changes with discussions regarding the reasoning behind the modifications. The lesson may be repeated as required.

**Objectives:**

- Execute a nominal unberth/handoff, translate, and mate for the main element.
- Use the task-specific command frames, display frames, and Frames of Resolution (FOR) for the main element.
Mobile Servicing System for STS Crew Training Lesson Descriptions

50  **EL NOM INSTL 4 91025 (Concluded)**

- Identify generic- and element-specific flight rules associated with nominal operations.
- Describe unberthing/mating interfaces and associated system feedback for the main element.
- Describe the end-to-end process associated with unberthing and mating the main element.
- Describe the operational constraints and limitations to the specific planned task, including the unberthing and mating corridors, visual cues, available robotics tools, etc.
- Communicate effectively with Shuttle and M2 using voice protocols.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Apply correct hand controller techniques as required for the specific task.
- Demonstrate proper facility-specific camera management during the operation.

51  **EL INSTL RVW 41025**

**Title:** Element Installation Review (Shared – ISS)
**Duration:** 3.0 hours
**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
**Student:** M1 (M2 supports as needed.)
**Source:** DX23/Station Mechanical & Robotics
**Date:** 06/08
**Lesson(s) Replaced:** EL INST RVW 41025
**Equipment Required:** None
**Prerequisite Lesson(s):** EL NOM INSTL 4 91025
**Preparation:** None

**Synopsis:** The Mobile Servicing System (MSS) Element Installation Review lesson provides additional practice for a specific element installation task planned for an increment or flight as necessary. During this lesson, the student will unberth the element from the payload bay or accept a handoff from SRMS, translate the element to various points (low hover, premate, capture envelope, etc.), and then mate the element to the ISS. The unberth and mate can be nominal or with malfunctions and allows the use of tools, such as Dynamic Onboard Ubiquitous Graphics (DOUG) and Robotics Situational Awareness Display (RSAD).
Mobile Servicing System for STS Crew Training Lesson Descriptions

**51 EL INSTL RVW 41025 (Concluded)**

Objectives:
- Execute a nominal unberth/handoff, translate, and mate for the main element.
- Use the task-specific command frames, display frames, and Frames of Resolution (FOR) for the main element.
- Identify generic and element-specific flight rules associated with nominal operations.
- Describe unberthing/mating interfaces and associated system feedback for the main element.
- Describe the end-to-end process associated with unberthing and mating the main element.
- Describe the operational constraints and limitations to the specific planned task, including the unberthing and mating corridors, visual cues, available robotics tools, etc.
- Communicate effectively with Shuttle and M2 using voice protocols.
- Configure camera views and robotics tools to correctly monitor clearances and maintain situational awareness, with instructor assistance.
- Apply correct hand controller techniques as required for the specific task.

**52 ROBOTICS LSN LRND 21001**

Title: Robotics Lessons Learned (Shared – ISS)
Duration: 1.0 hour
Medium: Classroom
Student: M1 (M2 *supports as needed.)*
Source: DX23/Station Mechanical & Robotics
Date: *06/08*
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This lesson covers the Robotics lessons learned. These include on-orbit close calls, software features, and significant robotics anomalies. The lesson also includes the All Stop Voice Protocol for unexpected arm motion.

Objectives:
- Describe the factors leading up to the robotics close calls on-orbit.
- Explain the All Stop Voice Protocol for unexpected arm motion.
- Describe the software feature updates that affect robotics operations.
- Summarize the significant robotics anomalies seen on-orbit.
Mobile Servicing System for STS Crew Training Lesson Descriptions

53  **MSS LTG OPS 31115**

Title:  MSS Lighting Operations  
Duration:  2.0 hours  
Medium:  Multiuse Remote Manipulator Development Facility  
Note:  This lesson requires night operations in Building 9 High Bay.  
Student:  M1 (M2 supports as needed.)  
Source:  DX23/Station Mechanical & Robotics  
Date:  06/08  
Lesson(s) Replaced:  None  
Equipment Required:  None  
Prerequisite Lesson(s):  None  
Preparation:  None  
Synopsis:  This lesson trains students to manage and control cameras that are affected from non-ideal lighting conditions while using the SSRMS. Tasks emphasize manipulating the camera viewing angles and control parameters to maintain an effective camera view when non-ideal lighting situations affect the view. Joint and manual modes are used.  

Objectives:  Recognize and properly react to camera effects due to adverse lighting conditions.

54  **SSRMS PROF 1 41025**

Title:  SSRMS Proficiency 1  
Duration:  2.0 hours  
Medium:  Dynamic Skills Trainer 1  
Student:  M1 (M2 supports as needed.)  
Source:  DX23/Station Mechanical & Robotics  
Date:  06/08  
Lesson(s) Replaced:  None  
Prerequisite Lesson(s):  ROBOTICS LSN LRND 21001  
Preparation:  None  
Synopsis:  This is a proficiency lesson in the skills for flying the SSRMS robotics system. This lesson fits the format of the Spec Skills classes. The student will be asked to plan trajectories and perform tasks that test the generic skills of robotics operations.
Mobile Servicing System for STS Crew Training Lesson Descriptions

54 **SSRMS PROF 1 41025 (Concluded)**

Objectives:
- Maneuver an unloaded SSRMS in various modes (Manual, Single Joint (SJ), Operator Command Auto Sequence (OCAS), Pitch Plane) by determining proper direction of motion, using proper mnemonics and applying good hand controller skills so not to induce oscillations on the arm.
- Maneuver SSRMS with a large payload attached in different modes, including Manual, Joint OCAS, Frame of Resolution (FOR), and OCAS safely, within flight rule constraints and without inducing oscillations.
- Apply Latch End Effector (LEE) Cue Card appropriately during loaded operations.
- Maintain situational awareness and clearance monitoring by selecting and adjusting appropriate camera views during tasks.
- Perform automatic and manual LEE Operations without instructor assistance.
- Maneuver the SSRMS with EVA crewmember attached using the Robotics/EVA voice protocol and EVA commands.
- Communicate sufficiently with EVA crew and M2.
- Configure the SSRMS system properly including loading correct files and configuring the LEE for grapple without instructor assistance.

55 **SSRMS PROF 2 22025**

Title: SSRMS Proficiency 2
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Prerequisite Lesson(s): SSRMS PROF 1 41025
Preparation: None

Synopsis: This is a proficiency lesson in the skills for flying the SSRMS robotics system. This lesson fits the format of the Spec Skills classes. The student will be asked to plan trajectories and perform tasks that test the generic skills of robotics operations.
Mobile Servicing System for STS Crew Training Lesson Descriptions

55  **SSRMS PROF 2 22025 (Concluded)**

Objectives:
- Maneuver an unloaded SSRMS in various modes (Manual, Single Joint (SJ), Operator Command Auto Sequence (OCAS), Pitch Plane) by determining proper direction of motion, using proper mnemonics and applying good hand controller skills so not to induce oscillations on the arm.
- Maneuver SSRMS with a large payload attached in different modes, including Manual, Joint OCAS, Frame of Resolution (FOR), and OCAS safely, within flight rule constraints and without inducing oscillations.
- Apply Latch End Effector (LEE) Cue Card appropriately during loaded operations.
- Maintain situational awareness and clearance monitoring by selecting and adjusting appropriate camera views during tasks.
- Perform automatic and manual LEE Operations without instructor assistance.
- Maneuver the SSRMS with EVA crewmember attached using the Robotics/EVA voice protocol and EVA commands.
- Communicate sufficiently with EVA crew and M2.
- Configure the SSRMS system properly including loading correct files and configuring the LEE for grapple without instructor assistance.

56  **SSRMS PROF 3 23025**

Title:  SSRMS Proficiency 3  
Duration:  2.0 hours  
Medium:  Dynamic Skills Training 1  
Student:  M1 (M2 supports as needed.)  
Source:  DX23/Station Mechanical & Robotics  
Date:  06/08  
Lesson(s) Replaced:  None  
Prerequisite Lesson(s):  SSRMS PROF 2 22025  
Preparation:  None  

Synopsis:  This is a proficiency lesson in the skills for flying the SSRMS robotics system. This lesson fits the format of the Spec Skills classes. The student will be asked to plan trajectories and perform tasks that test the generic skills of robotics operations.
Mobile Servicing System for STS Crew Training Lesson Descriptions

**SSRMS PROF 3 23025 (Concluded)**

Objectives:
- Maneuver an unloaded SSRMS in various modes (Manual, Single Joint (SJ), Operator Command Auto Sequence (OCAS), Pitch Plane) by determining proper direction of motion, using proper mnemonics and applying good hand controller skills so not to induce oscillations on the arm.
- Maneuver SSRMS with a large payload attached in different modes, including Manual, Joint OCAS, Frame of Resolution (FOR), and OCAS safely, within flight rule constraints and without inducing oscillations.
- Apply Latch End Effector (LEE) Cue Card appropriately during loaded operations.
- Maintain situational awareness and clearance monitoring by selecting and adjusting appropriate camera views during tasks.
- Perform automatic and manual LEE Operations without instructor assistance.
- Maneuver the SSRMS with EVA crewmember attached using the Robotics/EVA voice protocol and EVA commands.
- Communicate sufficiently with EVA crew and M2.
- Configure the SSRMS system properly including loading correct files and configuring the LEE for grapple without instructor assistance.

**MSS SPN & REF DATA 91001**

Title: MSS Station Program Note and Reference Data (Shared – ISS)
Duration: 1.0 hour
Medium: Classroom
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: The Mobile Servicing System (MSS) Station Program Note (SPN) and Reference Data lesson reviews pertinent SPNs that affect crew operations and provides the crew with any updates to operating software.

Objectives:
- Recognize relevant SPN cases.
- Explain major software updates relevant to the mission.
Mobile Servicing System for STS Crew Training Lesson Descriptions

58  **MSS CBT MOD 5/7 21057**

Title: MSS CBT Modules 5, 6, and 7  
Duration: 9.0 hours  
Medium: Computer Based Training  
Student: M1 (M2 supports as needed.)  
Source: DX23/Station Mechanical & Robotics  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None  

Synopsis: The Computer Based Training (CBT) is a Canadian Space Agency (CSA) product.

Objectives: None

59  **SPDM TOOLS/ORU 21217**

Title: SPDM Tools and ORU Lesson (Shared – ISS)  
Duration: 2.0 hours  
Medium: Dexterous Manipulator Trainer (Building 9 High Bay)  
Student: M1 (M2 supports as needed.)  
Source: DX23/Station Mechanical & Robotics  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): MSS CBT MOD 5/7 21057  
Preparation: None  

Synopsis: The purpose of this lesson is to prepare the student for the Canadian Space Agency (CSA) Special Purpose Dexterous Manipulator (SPDM) Mobile Servicing System (MSS) Robotics Operator (MRO) course by introducing them to the SPDM tools and Orbital Replacement Units (ORUs). Main point one covers the components of the ORU Tool Changeout Mechanism (OTCM) and how the grippers and socket drive interfaces with the SPDM tools. Main point two goes through the three SPDM tools: Set, Robotic Offset Tool (ROST), and Robot Micro Conical Tool (RMCT) and how these tools operate with the OTCM. Main point three addresses the different type of grasp fixtures that the OTCM and SPDM tools interface with and their differences. The order of this lesson follows the mechanical means necessary to interact with an ORU grasp fixture, i.e.: OTCM > Tool > Grasp Fixture. This part of the lesson plan is meant to provide a working knowledge of the SPDM tools and how they
Mobile Servicing System for STS Crew Training Lesson Descriptions

59  **SPDM TOOLS/ORU 21217 (Concluded)**

interface with the OTCM and associated grasp fixtures. This lesson also explores characteristics of SPDM compatible ORUs. More specifically; what makes an ORU SPDM compatible, where these ORUs and spares are physically located, how they are attached, what the attach status indicators are, what alignment guides and markings (if available) they have, what tool(s) are required for removal and insertion, what types of targets exist on the ORUs, SPDM compatible Flight Support Equipment (FSE)s (Flight Releasable Attachment Mechanism (FRAM) (External Stowage Platform (ESP)-2, Integrated Cargo Carrier (ICC), and Square grid) & Cargo Transport Container (CTC)).

Objectives:

- Identify components of OTCM.
- Describe how the OTCM interfaces with tools and fixtures.
- Describe the operation of each of the 3 SPDM tools while interfacing with an ORU.
- Describe how each tool interfaces with the tool holster.
- Identify the fixtures each tool interfaces with.
- Identify/locate ORU and Spare locations (handout).
- Identify ORU Targets & Grapple fixture types (handout and Dexterous Manipulator Trainer (DMT) ORU models).
- Describe the various ORU alignment markings (DMT ORU models).
- Describe the various ORU hold-down mechanisms (handout and DMT models).
- Describe ORU status indicators and how they operate (handout and DMT ORU models).
- Identify ORU Carriers (FRAM, CTC, Columbus External Payload Adapter (CEPA), etc.).

60  **SPDM MRO PART 1 21512**

Title: CSA SPDM MRO Part 1
Duration: 32.0 hours
Medium: Canadian Training Facility
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SPDM TOOLS/ORU 21217
Preparation: None

Synopsis: This training is conducted at the Canadian Space Agency (CSA).

Objectives: None
Mobile Servicing System for STS Crew Training Lesson Descriptions

61  SPDM PROF1 21025

Title: SPDM Proficiency 1
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): SPDM MRO PART 1 21512
Preparation: None

Synopsis: This is a proficiency lesson in the skills for flying the Special Purpose Dexterous Manipulator (SPDM) robotics system. This lesson is optional and intended to refresh SPDM operational concepts and techniques. It is intended for students with long breaks between SPDM MRO Part 1 and 2.

Objectives:

• Maneuver an unloaded SPDM in various modes (Manual, Single Joint (SJ), Operator Command Auto Sequence (OCAS), Pitch Plane) by determining proper direction of motion, using proper mnemonics and applying good hand controller skills so not to induce oscillations on the arm.

• Maneuver SPDM with a payload attached in different modes including Manual, Joint OCAS, Frame of Resolution (FOR), and OCAS safely, within flight rule constraints and without inducing oscillations.

• Maintain situational awareness and clearance monitoring by selecting and adjusting appropriate camera views during tasks.

• Perform ORU and Tool Changeout Mechanism (OTCM) Operations without instructor assistance.

• Maneuver the SPDM with EVA crewmember Ground Control Assistance (GCA) using the proper voice protocol.

• Communicate sufficiently with EVA crew and M2.

• Configure and manage the SPDM system properly without instructor assistance.
Mobile Servicing System for STS Crew Training Lesson Descriptions

62  **SPDM MRO PART 2 21512**

Title: CSA SPDM MRO Part 2  
Duration: 32.0 hours  
Medium: Canadian Training Facility  
Student: M1 (M2 supports as needed.)  
Source: DX23/Station Mechanical & Robotics  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: This course is taught at the Canadian Space Agency (CSA).

Objectives: None

63  **SPDM MAINT1 41025**

Title: Special Purpose Dexterous Manipulator Maintenance Lesson 1  
Duration: 3.0 hours  
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10  
Student: M1 (M2 supports as needed.)  
Source: DX23/Station Mechanical & Robotics  
Date: 06/08  
Lesson(s) Replaced: None  
Equipment Required: None  
Prerequisite Lesson(s): None  
Preparation: None

Synopsis: This is the first in a series of maintenance lessons designed to keep a Station crewmember proficient in complex operations using the Special Purpose Dexterous Manipulator (SPDM). The class will cover EVA or payload operations concentrating on the end-to-end process. Student will interact with EVA while maneuvering payloads, such as batteries and other Orbital Replacement Units (ORUs). Determination of task will be made by the Lead robotics instructor for the Increment.

Objectives:  
• Demonstrate proper situational awareness by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self collisions.  
• Identify and verbalize clearance issues for each task by consistently monitoring arm operations.  
• Demonstrate proper hand controller techniques through proper grip, smooth ramping of commands, and multi-axis flying.
Mobile Servicing System for STS Crew Training Lesson Descriptions

63  **SPDM MAINT1 41025 (Concluded)**

- Demonstrate proper resource management techniques by utilizing the Dynamic Onboard Ubiquitous graphics (DOUG) tool, communicating and coordinating with M2 and EVA for each task.
- Apply proper system management techniques to correctly configure the system for each task.
- Perform proper operations techniques by following procedures and adhering to flight rules.

64  **SPDM MAINT2 42025**

**Title:** Special Purpose Dexterous Manipulator Maintenance Lesson 2  
**Duration:** 3.0 hours  
**Medium:** Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10  
**Student:** M1 (M2 supports as needed.)  
**Source:** DX23/Station Mechanical & Robotics  
**Date:** 06/08  
**Lesson(s) Replaced:** None  
**Equipment Required:** None  
**Prerequisite Lesson(s):** None  
**Preparation:** None

**Synopsis:** This is the second in a series of maintenance lessons designed to keep a Station crewmember proficient in complex operations using the Special Purpose Dexterous Manipulator (SPDM). The class will cover EVA or payload operations and focus on the end-to-end process. Student will interact with EVA while maneuvering payloads, such as batteries and other On-Orbit Replaceable Units (ORUs). Determination of task will be made by the Lead robotics instructor for the Increment.

**Objectives:**
- Demonstrate proper situational awareness by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self collisions.
- Identify and verbalize clearance issues for each task by consistently monitoring arm operations.
- Demonstrate proper hand controller techniques through proper grip, smooth ramping of commands, and multi-axis flying.
- Demonstrate proper resource management techniques by utilizing the Dynamic Onboard Ubiquitous graphics (DOUG) tool, communicating and coordinating with M2 and EVA for each task.
- Apply proper system management techniques to correctly configure the system for each task.
- Perform proper operations techniques by following procedures and adhering to flight rules.
Mobile Servicing System for STS Crew Training Lesson Descriptions

65  **SPDM MAINT3 43025**

Title: Special Purpose Dexterous Manipulator Maintenance Lesson 3
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This is the third in a series of maintenance lessons designed to keep a Station crewmember proficient in complex operations using the Special Purpose Dexterous Manipulator (SPDM). The class will cover EVA or payload operations. Student will refamiliarize with tools while performing tasks with the SPDM. Determination of task will be made by the Lead robotics instructor for the Increment.

Objectives:

- **Demonstrate proper situational awareness** by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self collisions.
- **Identify and verbalize clearance issues** for each task by consistently monitoring arm operations.
- **Demonstrate proper hand controller techniques** through proper grip, smooth ramping of commands, and multi-axis flying.
- **Demonstrate proper resource management techniques** by utilizing the Dynamic Onboard Ubiquitous Graphics (DOUG) tool, communicating and coordinating with M2 and EVA for each task.
- **Apply proper system management techniques** to correctly configure the system for each task.
- **Perform proper operations techniques** by following procedures and adhering to flight rules.

66  **SPDM MAINT4 44025**

Title: Special Purpose Dexterous Manipulator Maintenance Lesson 4
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Mobile Servicing System for STS Crew Training Lesson Descriptions

66 SPDM MAINT4 44025 (Concluded)

Prerequisite Lesson(s): None
Preparation: None

Synopsis: This is the fourth in a series of maintenance lessons designed to keep a Station crewmember proficient in complex operations using the Special Purpose Dexterous Manipulator (SPDM). The class will cover EVA or payload operations. Student will interact with EVA while maneuvering payloads, such as batteries and other On-Orbit Replaceable Units (ORUs). Determination of task will be made by the Lead robotics instructor for the Increment.

Objectives:
- Demonstrate proper situational awareness by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self collisions.
- Identify and verbalize clearance issues for each task by consistently monitoring arm operations.
- Demonstrate proper hand controller techniques through proper grip, smooth ramping of commands, and multi-axis flying.
- Demonstrate proper resource management techniques by utilizing the Dynamic Onboard Ubiquitous Graphics (DOUG) tool, communicating and coordinating with M2 and EVA for each task.
- Apply proper system management techniques to correctly configure the system for each task.
- Perform proper operations techniques by following procedures and adhering to flight rules.

67 SPDM MAINT5 45025

Title: Special Purpose Dexterous Manipulator Maintenance Lesson 5
Duration: 2.0 hours
Medium: Dynamic Skills Trainer 1 or DST 2, 3, 4, 5, 10
Student: M1 (M2 supports as needed.)
Source: DX23/Station Mechanical & Robotics
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): None
Preparation: None
Mobile Servicing System for STS Crew Training Lesson Descriptions

67  **SPDM MAINT5 45025 (Concluded)**

**Synopsis:** This is the fifth in a series of maintenance lessons designed to keep a Station crewmember proficient in complex operations using the Special Purpose Dexterous Manipulator (SPDM). The class will cover EVA or payload operations. Student will interact with EVA while maneuvering payloads, such as batteries and other On-Orbit Replaceable Units (ORUs). Determination of task will be made by the Lead robotics instructor for the Increment.

**Objectives:**
- Demonstrate proper situational awareness by performing a constant scan pattern, maintaining 2 or more good camera views, and avoiding unexpected reach limits/singularities/self collisions.
- Identify and verbalize clearance issues for each task by consistently monitoring arm operations.
- Demonstrate proper hand controller techniques through proper grip, smooth ramping of commands, and multi-axis flying.
- Demonstrate proper resource management techniques by utilizing the Dynamic Onboard Ubiquitous Graphics (DOUG) tool, communicating and coordinating with M2 and EVA for each task.
- Apply proper system management techniques to correctly configure the system for each task.
- Perform proper operations techniques by following procedures and adhering to flight rules.
SECTION 14.0 TRANSFER OPERATIONS FOR SHUTTLE CREWS TRAINING COURSE

The Transfer Operations for Shuttle Crews Training Course provides the flight crew and selected flight operations support personnel with the knowledge and skills necessary to perform the transfer of logistics from Shuttle, SPACEHAB, MPLM, or Automatic Transfer Vehicle (ATV) to ISS and back using the Transfer List Procedures.

Upon completion of the Transfer Operations for Shuttle Crews Training Course, the student will be able to:

- Perform simple and complex logistics transfers using the Transfer List procedure and associated referenced procedures.
- Transfer powered payloads.
- Understand the priorities of logistics transfer and how transfer tasks fit into the objectives and timeline for the flight.

Training facilities used include classroom instruction and the Building 9A ISS mockups for hands-on performance of logistics transfer. The Loadmaster will attend the ISS Hardware Bench Review that is held in Houston to review the hardware involved in complex transfers or hardware used in docked Shuttle operations.
Figure 14-1. Transfer Operations for Shuttle Crews Lesson Flow Chart
## Table 14-1. Transfer Operations for Shuttle Crews Training Requirements

Date Last Modified: 06/08

| Stage | Ref Num | Lesson Code | Media | Hrs | Sched Code | C   | P   | MS1 | MS2 | MS3 | MS4 | PS | C   | P   | MS1 | MS2 | Alt Fac | Comments |
|-------|--------|-------------|-------|-----|------------|-----|-----|-----|-----|-----|-----|----|-----|-----|-----|-------|----------|
| 2     | 1      | TRANS FAM 31001 | CLR   | 1.25|            | 1.25| 1.25| 1.25| 1.25| 1.25| 1.25| 1.25| 1.25| 1.25|       |          |
| 2     | 2      | TRANS PLAN 1 31001 | CLR   | 2.5 |            | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |       | Loadmaster & Backup - As assigned by CDR |
| 2     | 3      | TRANS PLAN 2 31001 | CLR   | 0.75|            | 0.75| 0.75| 0.75| 0.75| 0.75| 0.75| 0.75| 0.75|       | Loadmaster & Backup - As assigned by CDR |
| 2     | 4      | PWR PYLD TRANS 31001 | CLR   | 1   |            | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |       | If manifested; As assigned by CDR |
| 2     | 5      | TRANS HANDS-ON RVW 31105 | SSMTF | 3   |            | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |       | Loadmaster & Backup - As assigned by CDR |

### Sub Total for Stage Stage Totals Per Crewmember:

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| Stage | Ref Num | Lesson Code | Media | Hrs | Sched Code | C   | P   | MS1 | MS2 | MS3 | MS4 | PS | C   | P   | MS1 | MS2 | Alt Fac | Comments |
|-------|--------|-------------|-------|-----|------------|-----|-----|-----|-----|-----|-----|----|-----|-----|-----|-------|----------|
| 1     | 6      | TRANS PLAN 3 31001 | CLR   | 2.5 |            | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |       | Loadmaster & Backup - As assigned by CDR |
| 1     | 7      | TRANS OV TLCN 31040 | MCC   | 0.5 |            | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |       | Commander & Loadmaster as assigned by CDR |
| 1     | 8      | TRANS PLAN 4 31001 | CLR   | 1.5 |            | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |       | Loadmaster & Backup - As assigned by CDR. Schedule during Quarantine |

### Sub Total for Stage Stage Totals Per Crewmember:

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<tr>
<th>Stage</th>
<th>Sub Total</th>
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</table>
Transfer Operations for Shuttle Crews Training Lesson Descriptions

1 TRANS FAM 31001

Title: Transfer Familiarization
Duration: 1.25 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT

Note: Schedule with Expedition crew if crew exchange mission.

Source: DO55/Daily Operations Group
Date: 07/04
Lesson(s) Replaced: None
Equipment Required: Viewgraph machine or computer and corresponding electronic view projector
Prerequisite Lesson(s): None
Preparation: None

Synopsis: This class will focus on reviewing the protocol for transferring supplies to and from the Station and Shuttle. First, students will be introduced to transfer lists, which detail everything that needs to be transferred both from the Station to the Shuttle, and from the Shuttle to the Station. Then, students will become familiar with the procedures that must be followed when making these transfers. Students will also be introduced to the Shuttle Loadmaster and the FDF that he or she maintains. Finally, students will become familiar with the tabs and tab content of the FDF. This lesson will show students examples of returning Cargo Transfer Bags (CTB) content and re-supplying CTB content, as well as photos of ISS stowage and past staging areas (used for temporary stowage), FDF examples from previous flights, and a preliminary Transfer List from their upcoming flight for them to practice reading. By the end of this class, students will have been introduced to all aspects of a transfer. They will be self-directed in performing these tasks, as the Shuttle Loadmasters are frequently too busy to supervise.

Objectives:
- Identify the Shuttle Loadmaster and state his/her job.
- Identify the Transfer List and state its purpose.
- Describe the transfer operations concept for their specific flight.
- Execute self-directed transfers from the Transfer List as timelined.
- Describe the layout of the flight-specific Transfer FDF and its tabs.
Transfer Operations for Shuttle Crews Training Lesson Descriptions

2 TRANS PLAN 1 31001

Title: Transfer List Format & Transfer Plan Review 1
Duration: 2.5 hours
Medium: Classroom
Student: Loadmaster and backup as assigned by CDR.
Source: DO55/Daily Operations Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: Viewgraph projector or computer and electronic projector
Prerequisite Lesson(s): TRANS FAM 31001
Preparation: None

Synopsis: This is the first in a series of four sessions dedicated to the review and understanding of the flight-specific Transfer List tasks – line-by-line review. A second objective will be to familiarize the crew with an example of their Flight Data File - the tabs and the contents. The crew will learn how to use the Flight Data File: where to find the stowage layouts, the Master Transfer List, where to find various alphabetic or numeric sorts of the Transfer List, and how to find other procedures associated with Transfer.

Objectives:
- Explain how to read a Transfer List.
- Execute the transfer item as instructed.
- Perform the additional tasks and procedures as noted on the Transfer List and check the transfer item off as complete.
- Explain how to use the Flight Data File.
- Describe how to read logistics stowage drawings and ISS location coding and relate that back to the Transfer List.
- Recall the content of the Transfer List and the ODF Transfer book.

3 TRANS PLAN 2 31001

Title: Transfer List Format & Transfer Plan Review 2
Duration: 0.75 hours
Note: This session may be lengthened if an MPLM flight.
Note: This lesson is to be scheduled No Later Than (NLT) L-5 weeks.
Medium: Classroom
Student: Loadmaster and backup as assigned by CDR.
Source: DO55/Daily Operations Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TRANS PLAN 1 31001
Preparation: Review the Transfer List
Transfer Operations for Shuttle Crews Training Lesson Descriptions

3 TRANS PLAN 2 31001 (Concluded)

Synopsis: This is the second in a series of four Transfer Plan sessions. The lesson will discuss the choreography of unloading and reloading the logistics vehicle in relationship to the Flight Timeline and number of crew assigned to the transfer task. *The transfer roles and responsibilities of the crew during a Launch On Need (LON) shuttle mission will also be discussed.*

Objectives:
- Relate items seen at the bench reviews to the Transfer List instructions.
- Identify how the Loadmaster will manage the crew within the constraints of the flight to accomplish the transfer tasks.
- *Describe the roles and responsibilities associated with transfer for a Launch On Need (LON) shuttle mission.*

4 PWR PLYD TRANS 31001

Title: Powered Payload Transfer
Duration: 1.0 hour
Medium: Classroom
Student: As assigned by CDR.
Source: DO55/Daily Operations Group
Date: 11/03
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TRANS PLAN 2 31001
Preparation: Review the Power Payloads Transfer Procedure

Synopsis: This lesson is required only when crew will be transferring powered payloads. Either Assembly and Checkout Officer (ACO) Systems or ACO Data will brief the crew on the powered transfer procedures. A review of the Power Payloads Transfer Procedure will take place, with a focus on execution and coordination of transfers in parallel. The lesson will focus much attention to procedure updates that have been made (often significant) since MSFC trained the crew.

Objectives:
- Explain how to transfer the powered payload.
- Describe the preparation for the transfer.
- List the constraints in handling the payload.
- Identify how to power up the payload.
Transfer Operations for Shuttle Crews Training Lesson Descriptions

5 TRANS HANDS-ON RVW 31105

Title: Transfer Hands-On Review (Shared – ISS)
Duration: 3.0 hours
Medium: Space Station Mock-Up And Training Facility
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Note: Schedule with the Expedition crew if crew exchange mission.
Source: DO55/Daily Operations Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: See Facility Utilization Request
Prerequisite Lesson(s): TRANS PLAN 2 31001
Preparation: Review the Transfer List

Synopsis: This class is a practical follow up to the Transfer Operations class. The first hour is a lecture that focuses on reviewing the flight-specific transfer list and other documents and concepts that were introduced in the Transfer Operations class. This first hour is also used to set up the following hands-on activities by showing the students actual documents that they will use in the mockups. The last two hours of the class are used for practical hands-on exercises of the material. The instructor will first walk the students through the mockups, pointing out and explaining various stowage locations and other areas the instructor deems important. After the walk through, the students will perform a mock transfer under the supervision of the instructor. By the end of the class, the students will be able to perform an unsupervised transfer of materials between the Station and Shuttle.

Objectives:
- Read and follow a transfer list and track transfers.
- Find specific item to transfer and locate it on the Transfer List.
- Find specific ISS stowage locations (as detailed on the Transfer List).
- Execute Transfer List as a team (Station and Shuttle crew).
- Describe what to do with a particular transfer item.
- Provide calldowns to the ground regarding transfer status.
Transfer Operations for Shuttle Crews Training Lesson Descriptions

6 | TRANS PLAN 3 31001
Title: Transfer List Format & Transfer Plan Review 3
Duration: 2.5 hours
Medium: Classroom
Student: Loadmaster and backup as assigned by CDR.
Source: DO55/Daily Operations Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TRANS HANDS-ON RVW 31105
Preparation: Review of Transfer List

Synopsis: This session is the third in the four-part series of Transfer Plan sessions. This lesson will build on the previous lessons and review the entire Transfer List in a line-by-line fashion. The crew will learn to determine the purpose of each item – if it is simply logistics resupply for Expedition Crew, an item needed to execute a Shuttle docked procedure, or part of a complex procedure for items being swapped. This session also briefly highlights changes in the stowage layouts and transfer lists from the previous sessions. The focus is on several major things: loading the logistics vehicle for return, real time operations, and how to use the electronic version of the Transfer List. The Real Time operations review gives both the ground controllers and loadmaster an opportunity to discuss each other’s roles and responsibilities during the flight regarding transfer call downs, execute package messages, and change coordination. The Electronic Transfer File training is also given at this session, or this can be done in the crew office around their personal computer. The crew will learn about electronic sorts and how to perform sorts in Microsoft Excel.

Objectives:
- Explain the purpose of each item in the Transfer List.
- Explain which items have transfer constraints and why.
- Explain the changes/updates in the Transfer List.
- Describe how to consolidate foam, return trash, and manage other packing materials in order to satisfy the returning logistics module loads and Center of Gravity (c.g.) requirements.
- Describe the role of the Shuttle Loadmaster in relation to the ground Assembly and Checkout Officer (ACO) Transfer Flight Controller position and how they will communicate during the mission with execute package messages, real time call downs, and Transfer List changes.
- Show how to perform various “sorts” using the Microsoft Excel version of the Transfer List.
- Identify the operations to accomplish the transfer mission.
Transfer Operations for Shuttle Crews Training Lesson Descriptions

7 TRANS OV TLCN 31040

Title: Transfer Teleconference
Duration: 0.5 hours
Medium: MCC
Student: Commander and Loadmaster as assigned by CDR.
Source: DO55/Daily Operations Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: This telecon will be arranged by DO5 in the Blue Flight Control Room (FCR) – usually held in the BME room
Prerequisite Lesson(s): TRANS PLAN 3 31001
Preparation: None

Synopsis: This is the teleconference between the onboard Expedition Crew and at least the Shuttle Loadmaster. If possible, have the Shuttle CDR there, too. This serves as the Final Transfer Station/Shuttle Tag up before flight to answer questions, review late changes, and coordinate between them. This will be facilitated by Assembly and Checkout Officer (ACO) Prepack and ACO Transfer. The discussion is expected to clarify any remaining logistics operational issues and allow the on-orbit crew to tell the Shuttle Loadmaster about the transfer “staging areas” for returning items.

Objectives: Describe the details of how resupply and returning logistics will be handled between both Shuttle and Expedition Crews.

8 TRANS PLAN 4 31001

Title: Transfer List Format & Transfer Plan Review 4
Duration: 1.5 hours
Note: This session may be lengthened if an MPLM flight.
Note: This lesson is to be scheduled during Quarantine.
Medium: Classroom
Student: Loadmaster and backup as assigned by CDR.
Source: DO55/Daily Operations Group
Date: 06/08
Lesson(s) Replaced: None
Equipment Required: None
Prerequisite Lesson(s): TRANS PLAN 3 31001
Preparation: Review the Transfer List
Transfer Operations for Shuttle Crews Training Lesson Descriptions

8 TRANS PLAN 4 31001 (Concluded)

Synopsis: This session is the fourth in the four-part series of Transfer Plan sessions. This session should briefly highlight changes in the stowage layouts and transfer lists from the previous session and review the return logistics transfer plan in detail. The crew will be given information on Transfer priorities for the case of a shortened undock mission. There will also be a final question and answer session, and a review of transfer operations.

Objectives:  
- Explain the changes/updates in the Transfer List.
- Describe the transfer priorities for a shortened undock mission.
SECTION 15.0 INTEGRATED SIMULATIONS TRAINING COURSE

Eventually, all training courses lead to integrated simulations (sims). These simulations build the team coordination that is necessary between the crew, the Flight Control Teams, MCC-M, and the customer Payload Operations Control Centers (POCCs) to ensure a successful mission.

Table 15-1 is a summary of standard integrated simulation requirements. This table is used in the initial development of each mission’s integrated simulation requirements, which are approved at the Mission Operations Directorate (MOD) Cargo Integration Review Dry Run (CIRD).

Typically, there are four 4-hour ascent simulations and one 4-hour Flight Dynamics Officer (FDO)/Booster System Engineer (BSE) ascent simulation required per flight. The prime crew is required for all five sims, for a total of 20 hours.

There are two 4-hour entry simulations and one 5-hour entry simulation. The prime crew is required for all three, for a total of 13 hours.

A 4-hour post-insertion simulation is required unless a day 1 simulation starting from lift-off is already scheduled.

A 7-hour deorbit preparation simulation is required unless a requirement exists for a simulation such as a SPACEHAB deactivation, which runs for 8 hours, ending with landing.

The prime crew is required for post-insertion, deorbit preparation, and all orbit simulations which are Joint Integrated Simulations (JIS) involving the customers/remote POCCs. PSs are required for the post-insertion simulation. PS participation in other orbit simulations will be determined on a sim-by-sim basis.

One planning team simulation concentrating on orbiter systems is required unless the planning team is involved in one or more long simulation shifts.

Many lessons in this section are used for both load specific and generic training. These will be indicated by the advanced 20000 level code in parenthesis next to the load specific 90000 level code. Integrated generic lessons are specifically designed to meet Flight Controller training objectives and do not impose additional training requirements on Flight Crews.
### Table 15-1. Integrated Simulations Crew Training Requirements

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Date Last Modified: 04/06
The medium and associated facility codes for integrated simulations may be any of the following:

MCC XX040
MCC/FB XX042
MCC/GNS XX022
MCC/FB/NBL XX080
MCC/GNS/NBL XX039
MCC/MB XX043
STRING1/FB XY121
STRING2/FB XY122
STRING1/GNS XY123
STRING2/GNS XY124
MCC/STRING1 XY125
MCC/STRING2 XY126
MCC/STRING 1/FB XY127
MCC/STRING 2/FB XY128
MCC/STRING 1/GNS XY129
MCC/STRING 2/GNS XY130
STRING 1/MB XY132
STRING 2/MB XY133
STRING 1/NBL XY134
STRING 2/NBL XY135
STRING 1/FB/NBL XY136
STRING 2/FB/NBL XY137
STRING 1/GNS/NBL XY138
STRING 2/GNS/NBL XY139
MCC/STRING 1/NBL XY140
MCC/STRING 2/NBL XY141
MCC/STRING 1/FB/NBL XY142
MCC/STRING 2/FB/NBL XY143
MCC/STRING 1/GNS/NBL XY144
MCC/STRING 2/GNS/NBL XY145

The “XX” or “XY” may be a “91” for flight-specific integrated simulations or a “21” for generic integrated simulations.
Table 15-2. Integrated Sim Requirements

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</table>

(1) FOR ISS FLIGHTS THE FLIGHT PLAN WILL BE REVIEWED AND THE CRITICAL ACTIVITIES WILL BE DETERMINED AND COVERED DURING SIMULATIONS.

* IF SCHEDULE CONSTRAINTS REQUIRE – ONE ASCENT AND ONE ENTRY CAN BE COMBINED INTO A SINGLE 6-HR SIM (3 hours ascents/3 hours entries)

FOIG Approved 2/88
INTEGRATED SIMULATIONS LESSON LIST

The following list includes all the lessons in the Integrated Simulations Training Course. The lessons in this course are unnumbered and are arranged in this catalog in the order shown below.

ABT AOA 910XX (210XX)  ROBOTICS DPLY 9XYYY (2XYYY)
ABT-ATO 910XX (210XX)  ROBOTICS L DPLY 99XYYY (2XYY)
ABT-CONT 910XX (210XX)  ROBOTICS OPS 9XYYY (2XYYY)
ABT-NOM 910XX (210XX)  PLD-PRELAUNCH 910XX (210XX)
ABT-PAD 910XX (210XX)  PROX/PDRS 910XX (210XX)
ABT-REV3 910XX (210XX)  INT SIM MEET 91001
ABT-RTLS 910XX (210XX)  DEPART 9XYYY (2YXXX)
ABT-TAL 910XX (210XX)  
FDO/BSE-AOA 910XX (210XX)  
FDO/BSE-ATO 910XX (210XX)  
FDO/BSE-CONT 910XX (210XX)  
FDO/BSE-NOM 910XX (210XX)  
FDO/BSE-PAD 910XX (210XX)  
FDO/BSE-RSO 910XX (210XX)  
FDO/BSE-RTLS 910XX (210XX)  
FDO/BSE-TAL 910XX (210XX)  
ENTRY 910XX (210XX)  
D/O PREP 910XX (210XX)  
PO INS 9XYYY (2XYYY)  
SYSTEMS 9XYYY (2XYYY)  
ACT/DEACT 9XYYY(2XYYY)  
DAY X 9XYYY (2XYYY)  
MOD 9XYYY (2XYYY)  
EVA 9XYYY (2XYYY)  
RNDZ/DOCK 9XYYY (2XYYY)  
RNDZ/PROX 9XYYY (2XYYY)  
MAJOR CASE 9XYYY(2XYYY)  
PLANNING 9XYYY (2XYYY)  
LONG SIM 9XYYY(2XYYY)  
ORB OPS/EVA 9XYYY (2XYYY)  
ORBIT OPS 9XYYY (2XYYY)  
Pwald DPLY 9XYYY (2XYYY)  
Pwald L DPLY 9XYYY(2XYYY)  
DEBRIEF 9XYYY (2XYYY)  

Integrated Simulations Lesson Descriptions

Objectives

I. Generic Integrated Simulation Training Goals and Objectives

Prior to flight-specific simulations, it is assumed that each operator is qualified to operate his/her systems and maintain the associated operational capability according to the roles and characteristics as defined by the Flight Controller Integrated Simulation Objectives (ISOs). See the Flight Controller ISO list below. These ISOs define the qualities that are desirable in a Flight Controller. The goal of generic integrated simulations is to develop these qualities in all flight control operators.

The objective of generic simulations is to present scenarios to the individual operators in order to develop the qualities listed in the ISOs. The ISOs are the criteria used to gauge the successful resolution by any Flight Control Operator of any scenario presented to them in an integrated simulation.

Flight Controller Integrated Simulation Objectives

1. The Flight Controllers must demonstrate an awareness of mission status under all situations, including payload operations. The Flight Controllers must present and discuss any deviations from normal systems operations and must realize how any failures that occur in any discipline affect the activity that is taking place, as well as the impact to their own disciplines’ systems.

2. The Flight Controllers must accurately and concisely convey system limitations in their disciplines, caused by failures within their disciplines, to all other affected Flight Controllers. They must also inform the other Flight Controllers of the impact of any subsequent failures to the systems.

3. The Flight Controllers must convey accurately and concisely to the Flight Director what has occurred and recommend the appropriate corrective action. They must also provide the rationale for the action that must be taken. They are to clearly communicate any mission duration/success impacts to the Flight Director.

4. The Flight Controllers must define plans for resolving and managing problems that develop in a mission by considering mission status and failure impacts. They must make trade-offs involving flight activities, wave-offs, extension days, or other management techniques required to prevent or minimize violations of flight rules/redlines.

5. The Flight Controllers must demonstrate the ability to work with all console tools and must coordinate and submit all the forms/paperwork associated with the operation of their consoles.
Integrated Simulations Lesson Descriptions

Objectives (Continued)

6. The Flight Controllers must guide the crew and the rest of the Flight Control Team through the successful completion of all actions and procedures that are required in order to maintain systems integrity and capabilities, mission success, vehicle integrity, and crew safety.

7. The Flight Controllers must demonstrate a knowledge of the interactions of other systems in all disciplines with their own systems. The Flight Controllers must be able to identify the effect of other disciplines’ system failures on their own systems.

8. The Flight Controllers must demonstrate confidence, ownership, competence, and a commanding knowledge of their own disciplines’ systems. The Flight Controllers must stand by all calls made to the Flight Director. The Flight Controllers should be open minded but they must also exhibit the confidence to not let the Flight Director change their minds if they feel they are correct. It is the Flight Director’s prerogative to simply override them, but this should not change the Flight Controllers’ minds or alter their confidence in their own decisions.

9. The Flight Controllers must exhibit and demonstrate a positive attitude towards console operations. They must exhibit a courteous and cooperative relationship with all other Flight Controllers. When developing solutions and workarounds, they must demonstrate that every effort has been made to obtain a solution. No possibility for a solution is to be left unexplored.

10. The Flight Controllers must demonstrate accurate, cordial, coordinated, and professional intra- and inter-discipline team communication/management. They must demonstrate assertive, but not aggressive, communication.

11. The Flight Control Room (FCR) Flight Controllers must demonstrate the ability to manage and adjust to the capabilities and deficiencies of their Multipurpose Support Room (MPSR) Flight Controllers. The FCR Flight Controllers are to ensure that two-way communication occurs. The FCR Flight Controllers must keep the MPSR team informed of the overall mission status. The FCR Flight Controllers are to routinely poll the MPSR on their workload and systems’ status. They must properly and evenly allocate the workload to the MPSR team.

12. The FCR Flight Controllers must demonstrate that they accept responsibility for all of the disciplines of the FCR position. They must demonstrate that they accept responsibility for all of the team’s decisions and recommendations.
Integrated Simulations Lesson Descriptions

Objectives (Continued)

13. The Flight Controllers must willingly admit when they have erred or are incorrect as well as when they do not have an immediate solution or matter of recourse in a given situation. They must not demonstrate a tendency to assign blame to others or to variables that may have contributed to their poor performance. If they do not have the answer to the situation or scenario, they are to demonstrate an attitude that they will do their best to obtain the solution to the situation/scenario.

II. Flight-Specific Integrated Simulation Training Goals and Objectives

1.0 Ultimate Goal

The ultimate goal of flight-specific integrated simulations is to mold a Flight Team that is capable of safely managing orbiter/payload operations in any possible situation. The Flight Team is defined as the Houston-MCC Flight Controllers, the mission’s POCC Flight Controllers, the Flight Crew, and any other entity that is involved in flight operations.

2.0 Flight-Specific Integrated Simulation Training Goal

The flight-specific integrated simulation training goal is to exercise and develop the Flight Team’s ability, system knowledge, and confidence to safely operate all orbiter/payload/ground capabilities and to successfully accomplish the mission in a manner consistent with the flight rules. The objective of scenarios used in the flight-specific simulations should be a stimulus to aid in the molding of the individuals composing the Flight Team into a team that operates as a whole. An assumption is that each individual is qualified (certified) to operate his/her system in order to fulfill his/her responsibility. Characteristics that each individual must possess prior to Flight Team training are developed during generic simulations. In summary, the tasks of the simulation team for flight-specific integrated simulations are:

- To present a “Flight” environment that is as realistic as possible. This should include minimum interaction between the Flight Team and the sim team during the run (zero is ideal).

- To present scenarios/cases that promote interaction and communication between the Flight Crew, the Flight Control Team, and the payload operations team.
Integrated Simulations Lesson Descriptions

Objectives (Continued)

– To mold the individual Flight Controllers, the Flight Crew, the Payload Team, and the Science Team into one team (Flight Team) that has confidence and trust in themselves and each other.
– To present simulations that test the Flight Team’s ability to recognize and solve problems in a timely and comprehensive manner while ensuring that safety and mission objectives are met.

3.0 Flight Team Objectives

There are two major types of training objectives that are to be accomplished for the Flight Team during flight-specific integrated simulations. The first type is training objectives that prepare the Flight Team for the specific mission, and the second is training objectives that stress the Flight Team’s ability to maintain the operational capability of the orbiter and all associated systems and operations.

3.1 Mission Training Objectives

The mission and the mission objectives are the primary purpose of any flight. Flight-specific integrated simulation mission training objectives are those objectives that develop the Flight Team’s overall ability to execute the mission. These mission training objectives stress the Flight Team’s capability to accomplish primary mission objectives and exercise the Flight Team’s prioritization and capability to replan the mission.

The exercising of different timelines and scenarios are used to accomplish flight-specific integrated simulation mission training objectives. The flight-specific integrated simulation mission training objectives are:

– For the Flight Team to exercise the prime mission objectives and timelines for the mission.
– For the Flight Team to work alternative timelines for the mission, including minimum duration flight, launch slips, off-nominal orbits, and next Primary Landing Site (PLS).
– For the Flight Team to work timelines and scenarios that test their ability to cope with the realtime reprioritization and replanning of mission objectives.
– For the Flight Team to work scenarios that stress mission constraints such as water dumps, thermal attitudes, DAP constraints, etc.
– For the Flight Team to work tradeoffs between various mission objectives or between various operational capabilities.
Objectives (Concluded)

3.2 Operational Capability Objectives

An operational capability is a primary orbiter, payload, or ground system characteristic or capability that must be maintained to satisfy mission requirements or vehicle and Flight Crew safety. Examples of operational capabilities include: Navigation and Energy Management, Vehicle Control, Power Generation, and Communication. It is the job of the Flight Team to preserve operational capabilities in order to safely accomplish the mission. The emphasis should always be on safety.

The flight-specific integrated simulation operational capability training objectives are objectives that cause the Flight Team to make tradeoffs between maintaining the operational capability of the orbiter and ground systems and satisfying the mission’s objectives. Each operational capability objective will impact an individual operator’s system that provides a certain capability. Each system’s operator (Flight Controller) is responsible for the health and maintenance of that system and the operational capability that it supports. The flight-specific integrated simulation operational capability training objectives are:

- For the Flight Team to work tradeoffs between regaining the loss of capability of any individual member of the Flight Team’s system, caused by a failed or degraded system, and the mission objectives.
- For the Flight Team to cope with a lost or degraded system capability of any individual member of the Flight Team in order to have the Flight Team engage in communication, cooperation, and team building between the individual with the lost or degraded system and another/other members of the Flight Team.
- For the Flight Team to cope with and work with the loss or degradation of a system that is extremely important to the mission’s objectives.
- To have all Flight Team members impacted by the loss or degradation of a system utilize all data, support tools, operators, and documentation in an effort to maintain the system and the operational capability it supports.
Integrated Simulations Lesson Descriptions

ABT-AOA 910XX (210XX)
ABT-ATO 910XX (210XX)
ABT-CONT 910XX (210XX)
ABT-NOM 910XX (210XX)
ABT-PAD 910XX (210XX)
ABT-REV3 910XX (210XX)
ABT-RTLS 910XX (210XX)
ABT-TAL 910XX (210XX)

Title: Integrated Ascent Simulation
Duration: 4.0 hours/4 sessions for flight-specific
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: MS seats installed, ascent FDF set up, ACESs required for prime crew during 2 ascent simulations

Preparation: Flight-specific ascent integrated simulations require that the crew(s) scheduled to support have completed the first 3 standalone ascent skills lessons (ASC SKL 31011, ASC SKL 32011, ASC SKL 33011), with at least 1 of those on a simulator training load similar to the one scheduled for the integrated simulation.

Synopsis: Flight-specific crew coordination/interaction with MCC will be exercised in at least one of each type of the basic abort profiles associated with that flight’s ascent trajectory. The crew should complete at least 4 hours of standalone load-specific ascent skills before their first load-specific integrated ascent simulation. The approximate timeframe for these simulations should be between the weeks of Launch-12 (L-12) and L-1. The final ascent is scheduled during the L-1 week.
Title: Integrated Flight Dynamics Officer/Booster Systems Engineer Ascent Simulation
Duration: 4.0 hours
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: MS seats installed, ascent FDF set up
Preparation: None

Synopsis: Flight-specific coordination/interaction between the crew and MCC is exercised concerning critical ascent calls made by the Flight Dynamics Officer (FDO) and Booster Systems Engineer (BSE) MCC operators. The script will emphasize any flight-specific changes in the calls related to trajectory and performance (such as abort boundaries and main engine limits management). Only those malfunctions required to exercise the required type of FDO/BSE cases will be included. Full MCC team manning is not required. The Flight Director, Booster Systems Engineer, Flight Dynamics Officer, Trajectory Console Operator, and Guidance/Procedures Officer are required to support. The flight-specific FDO/BSE must include a Range Safety case to demonstrate the Range Safety decision making process, communications flow, and to exercise limit line avoidance procedures.

Generic FDO/BSE simulations are used to more efficiently train the uncertified Flight Directors, Booster Systems Engineers, Flight Dynamics Officers, Trajectory Console Operators, and Guidance and Procedures Officers. The Guidance, Navigation and Control (GNC) and Propulsion (PROP) console operators also benefit from participation in these simulations. The sim is more efficient for these personnel because orbiter systems failures are kept to a minimum. Flight Crews and Flight Directors for upcoming flights may also benefit by scheduling themselves for these simulations since the flight loads for the next flight are usually scheduled for use. Thus, these sims become, in effect, an “extra” simulation for the Flight Crew and Flight Director.
Integrated Simulations Lesson Descriptions

ENTRY 910XX (210XX)

Title: Integrated Entry Simulation
Duration: 4.0 hours/2 sessions; 5.0 hours/1 session flight-specific
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: MS seats installed, standard entry FDF set up, deorbit FDF available

Preparation: Flight-specific entry integrated simulations require that the crew scheduled to support has completed the first 2 standalone entry skills lessons (ENT SKL 31011, ENT SKL 32011), with at least one of those on a simulator load similar to the one scheduled for the integrated entry simulation.

Synopsis: Flight-specific crew coordination/interaction with the MCC will be exercised on numerous 200K feet runs through landing. At least one run per flight will continue through postlanding procedures. Some runs may start prior to the Deorbit (D/O) burn or prior to Entry Interface (EI). The crew should complete at least 4 hours of load-specific standalone entry skills before their first load specific integrated entry simulation. The approximate timeframe for these simulations should be during Launch (L)-12 and L-1 weeks. The final entry is scheduled between the L-1 week.

Flight-specific ENTRY #2 is 5 hours with all runs going to the backup landing site. The first run will start at D/O - 30 minutes, with the rest starting at 200K.
Integrated Simulations Lesson Descriptions

D/O PREP 910XX (210XX)

Title: Integrated Deorbit Preparation Simulation
Duration: 7.0 hours
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Full stowage, MS seats stowed, PGSC, standard Deorbit (D/O) and entry FDF stowed, orbit FDF set up, ACES required for D/O PREP 91042 (all crewmembers), flight-specific locker stowage configuration (for sims occurring within L-8 weeks)
Preparation: Flight-specific deorbit preparation simulations require that the crew scheduled to support has completed the first 2 standalone Entry Skills lessons (ENT SKL 31011, ENT SKL 32011).

Synopsis: Flight-specific crew coordination/interaction with MCC will be exercised from just prior to entering in the D/O PREP Checklist (C/L) (D/O-5 hours through post-landing activities). The load-specific simulator software training load for that flight will be used.

PO INS 9XYYY (2XYYY)

Title: Integrated Post Insertion Simulation
Duration: 4.0 hours
Note: Duration varies with flight.
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (CB IA attendance mandatory.)
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Full stowage, Crew Optical Alignment Sight (COAS), PGSC, ascent FDF set up, ACES required for PO INS 91042 (all crewmembers), flight-specific locker stowage configuration (for sims occurring within L-8 weeks)
Preparation: None

Synopsis: Flight-specific crew coordination/interaction with MCC will be exercised from Lift-Off (L/O)-9 minutes through an approximate MET of 4 hours. This lesson may be credited if a flight’s orbit simulation requirements include the post insertion timeline as part of a longer simulation.
Integrated Simulations Lesson Descriptions

SYSTEMS 9XYYY (2XYYY)

Title: Flight-Specific Integrated Systems Simulation
Duration: 6.0 hours
Note: Duration varies with flight.
Student: COMMANDER, MS 1, MS 2, PILOT (Prime crew not required.)
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)
Preparation: None

Synopsis: The first systems simulation is typically the first integrated simulation done for each flight. Flight-specific crew coordination/interaction with the MCC will be exercised on numerous orbiter systems problems. The timeline used is typically that which the planning team would be involved in planning for during the mission.
Integrated Simulations Lesson Descriptions

**ACT/DEACT 9XYYY (2XYYY)**
**DAY X 9XYYY (XYYY)**
**MOD 9XYYY (2XYYY)**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Integrated Orbit Simulation</th>
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<tr>
<td>Duration:</td>
<td>8.0, 12.0, or 16.0 hours (Per session.)</td>
</tr>
<tr>
<td>Student:</td>
<td>COMMANDER, MS 1, MS 2, MS 3, PILOT</td>
</tr>
<tr>
<td>Source:</td>
<td>DA724/Simulation Supervisor Group</td>
</tr>
<tr>
<td>Date:</td>
<td>07/00</td>
</tr>
<tr>
<td>Lesson(s) Replaced:</td>
<td>None</td>
</tr>
<tr>
<td>Equipment Required:</td>
<td>Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)</td>
</tr>
<tr>
<td>Preparation:</td>
<td>None</td>
</tr>
</tbody>
</table>

**Synopsis:** Activation and deactivation simulations are used to exercise the Flight Controllers and Flight Crews in the Orbiter and Module/Element systems and interfaces. The simulations are also to be used for Flight Controller and Flight Crew team building as well as for development of proper coordination between MCC-H, the Crew, and other control centers.

The Spacehab Activation simulation may also be used to satisfy the requirement for the flight-specific post-insertion integrated simulation if it begins in the prelaunch count (usually Lift-Off minus 9 minutes MET). When this option is exercised, the entire Flight Crew must participate.

The Spacehab Deactivation simulation may preclude the need for the flight-specific Deorbit Prep integrated simulation if it is conducted through landing with the entire Flight Crew participating.
Integrated Simulations Lesson Descriptions

EVA 9XYYY (2XYYY)

Title: Integrated Extravehicular Activity Simulation
Duration: 8.0-10.0 hours (Per session. Duration varies with Flight)
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT (CB IA attendance optional.)
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)
Preparation: None

Synopsis: One integrated flight-specific EVA simulation is usually required per planned EVA. This simulation will begin prior to airlock egress and end post airlock ingress.

RNDZ/DOCK 9XYYY (2XYYY)

RNDZ/PROX 9XYYY (2XYYY)

Title: Integrated Rendezvous/Docking/Proximity Operations/Retrieval Simulation
Duration: 8.0-10.0 hours (Per session.)
Note: Duration varies with flight.
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Stowage, COAS, PGSC, flight specific locker stowage configuration (for sims occurring within L-8 weeks)
Preparation: Generic rendezvous simulations require that the crew scheduled to support meets the requirements for generic rendezvous integrated simulations, as defined in the Rendezvous/Proximity Operations Training Course. Rendezvous simulations including RMS operations require that the RMS crewmember complete the core training within the PDRS Training Course.

Synopsis: Two runs are required for missions with planned rendezvous/prox ops/retrieval operations. These runs begin prior to Terminal Phase Initiation (TI) and continue until retrieval operations completion or docking.
Integrated Simulations Lesson Descriptions

MAJOR CASE 9XYYY (2XYYY)

Title: Integrated Major Case Simulation  
Duration: 10.0 hours  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DA724/Simulation Supervisor Group  
Date: 04/99  
Lesson(s) Replaced: None  
Equipment Required: Stowage, COAS, PGSC, FDF  
Preparation: None

Synopsis: Crew coordination/interaction with MCC will be exercised in the handling of major malfunction scenarios. Crews scheduled for this type of simulation should contain a high level of experience. The following are examples of major case simulation scenarios:

- **Post-insertion:**
  - Rev 3 deorbit
  - Operational Sequence (OPS) 3 overlay uplink
  - Primary Avionics System Software (PASS) recovery after Backup Flight Software (BFS) engage

- **Orbit:**
  - Emergency deorbit
  - Contingency deorbit/major power downs
  - Loss of Flash Evaporator System (FES)
  - Loss of two fuel cells
  - Loss of two H₂O loops
  - Loss of two freon loops
  - Major ISS assembly problem
  - Major ISS system failure

- **Deorbit Preparation:**
  - Deorbit backout
Integrated Simulations Lesson Descriptions

**PLANNING 9XYYY (2XYYY)**

Title: Integrated Planning Team Simulation  
Duration: 8.0 hours  
Medium: MCC (MCC/SMTF or MCC/SSTF)  
Student: No Crew Required  
Source: DA724/Simulation Supervisor Group  
Date: 04/99  
Lesson(s) Replaced: None  
Equipment Required: None  
Preparation: None  
Synopsis: This simulation is an integrated simulation for the purpose of conducting a planning team shift for a Flight Control Team. If the SMS is not utilized, any vehicle response requirements are provided by the Training Team. This simulation may also be part of a multiple part simulation. The Execute Package generated during these sims can be used to start a full integrated simulation on the following day.

This simulation can be utilized for either flight-specific or generic simulations.

**LONG SIM 9XYYY (2XYYY)**

Title: Integrated Long Duration Simulation  
Duration: Up to 56.0 hours  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: DA724/Simulation Supervisor Group  
Date: 04/99  
Lesson(s) Replaced: None  
Equipment Required: Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)  
Preparation: None  
Synopsis: This simulation involves continuous support from the SMS/SSTF and MCC. Flight Crew support is required during crew awake periods only.

Generic long duration simulations require that the crew scheduled to support has completed the training course requirements associated with the timeline to be exercised during the simulation. This will be coordinated between the Simulation Supervisor, Station Training Lead, Payload/Communications Department, and the Crew Scheduling Office.
Integrated Simulations Lesson Descriptions

**ORB OPS/EVA 9XYYY (2XYYY)**

Title: Integrated Generic Orbit Operations/Extravehicular Activity Simulation  
Duration: 8.0 hours  
Student: COMMANDER, MS 1, MS 2, PILOT  
Source: **DA724**/Simulation Supervisor Group  
Date: 04/99  
Lesson(s) Replaced: None  
Equipment Required: Stowage, COAS, PGSC, FDF  
Preparation: None  
Synopsis: These simulations involve a known pre-run scenario requiring an unscheduled EVA. This may include orbiter or payload-related EVAs.

**ORB OPS 9XYYY (2XYYY)**

Title: Integrated Generic Orbit Operations Simulation  
Duration: 8.0 hours  
Student: COMMANDER, MS 1, MS 2, MS 3, PILOT  
Source: **DA724**/Simulation Supervisor Group  
Date: 07/00  
Lesson(s) Replaced: ORBIT OPS 21042  
Equipment Required: Stowage, COAS, PGSC, FDF  
Preparation: None  
Synopsis: These simulations are flight-specific or generic integrated simulations that involve timeline or payload operations so unique that they are not accurately described by the other flight-specific integrated simulation lesson descriptions. MCC only, voice only, or “paper” simulations that do not involve the use of a Front End Processor (FEP) may also use this lesson code. These simulations, however, still do “execute” and follow a timeline.
Integrated Simulations Lesson Descriptions

**PYLD DPLY 9XYYY (2XYYY)**

Title: Payload Deploy Simulations  
Duration: 8.0 hours (Duration varies with flight.)  
Student: COMMANDER, MS 1, MS 2, PILOT  
Source: DA724/Simulation Supervisor Group  
Date: 04/99  
Lesson(s) Replaced: None  
Equipment Required: Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)  
Preparation: All payload-specific Systems Training Courses through the MAL 3X0XX level must have been completed by the Flight Crew before they may be scheduled to support.

Synopsis: Integrated deploy simulations will consist of any simulation in which a payload is deployed by any means other than with the PDRS. This is to include all currently known carriers, as well as any future carriers.  

The PYLD L DPLY code will be used only when the simulation begins at a prelaunch point, usually Lift-Off (L/0)-9 minutes, and proceeds through deploy. This does not include long simulations, which have their own lesson description and code.

**DEBRIEF 9XYYY (2XYYY)**

Title: Integrated Simulation Debrief  
Duration: Variable  
Student: Flight Control Team and Flight-Crew  
Note: This debrief lesson code is to be used only when the debrief is conducted on another day than that of the simulation.  
Source: DA724/Simulation Supervisor Group  
Date: 04/99  
Lesson(s) Replaced: None  
Equipment Required: Headsets or conference room  
Preparation: None

Synopsis: Integrated simulation debriefs are for discussing and reviewing the simulation. All issues and concerns are to be brought up as well as scenarios that were not fully understood by either the Flight Control Team or the Flight Crew.
Integrated Simulations Lesson Descriptions

**ROBOTICS DPLY 9XYYY (2XYYY)**

**Title:** Payload Deploy and Retrieval System Payload Deploy Simulations

**Duration:** 8.0 hours

**Note:** Duration varies with flight.

**Student:** COMMANDER, MS 1, MS 2, PILOT

**Source:** DA724/Simulation Supervisor Group

**Date:** 04/99

**Lesson(s) Replaced:** None

**Equipment Required:** Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)

**Preparation:** Completion of the PDRS Training Course flow by the RMS crewmember is required for these simulations.

**Synopsis:** Integrated deploy simulations will consist of any simulation in which a payload is deployed with the use of the PDRS. This is to include all currently known payloads such as Hubble Space Telescope (HST), Shuttle-Pointed Autonomous Research Tool for Astronomy (SPARTAN), etc., as well as any future PDRS deployable payloads.

The PDRS L DPLY code will be used only when the simulation begins at a prelaunch point, usually Lift-Off (L/O)-9 minutes, and proceeds through a deploy. This does not include long simulations which have their own lesson description and code.

**ROBOTICS OPS 9XYYY (2XYYY)**

**Title:** Payload Deploy and Retrieval System Attached Operations Simulations

**Duration:** 8.0 hours (Duration varies with flight.)

**Student:** COMMANDER, MS 1, MS 2, PILOT

**Source:** DA724/Simulation Supervisor Group

**Date:** 03/94

**Lesson(s) Replaced:** None

**Equipment Required:** Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)

**Preparation:** Completion of the PDRS Training Course flow by the RMS crewmember is required for these simulations.

**Synopsis:** Integrated Robotics Operations (OPS) simulations will consist of any simulation in which a payload is already unberthed but is still grappled to the RMS and involves RMS operations (Attached OPS). This is to include all currently known payloads such as Hubble Space Telescope (HST), SPARTAN, as well as any future payloads.
Integrated Simulations Lesson Descriptions

PLD-PRELAUNCH 910XX (210XX)

Title: Payload Prelaunch Simulation
Duration: 3.5 hours
Student: Flight-specific payload Flight Controllers
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Headsets
Preparation: None

Synopsis: Payload Prelaunch Simulations are conducted for selected STS missions in parallel with the TCDT for the same STS mission. The simulation "piggy-backs" with the TCDT countdown and begins at L-3 hour 30 minutes. It is a voice only simulation and all the scenarios are "greencarded". The intent is to exercise the payload management personnel for that flight with respect to Launch GO/NO-GO criteria as well as the entire decision making process.

PROX/PDRS 910XX (210XX)

Title: Proximity/Payload Deploy and Retrieval System Operations Simulations
Duration: 8.0 hours (Duration varies with flight.)
Student: COMMANDER, MS 1, MS 2, PILOT
Source: DA724/Simulation Supervisor Group
Date: 04/99
Lesson(s) Replaced: None
Equipment Required: Stowage, COAS, PGSC, FDF, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)
Preparation: The crew scheduled to support must meet the requirements defined in the Rendezvous/Proximity Operations Training Course. Completion of the PDRS Training Course flow by the RMS crewmember is also required for these simulations.

Synopsis: Integrated Proximity/PDRS Operations (OPS) Simulations will consist of any simulation which begins with a Payload that is within approximately 400 feet of the orbiter and with the intent of proceeding through with an RMS capture and berthing of the payload. This is to include all currently known payloads such as SPARTAN, etc., as well as any future payload.
Integrated Simulations Lesson Descriptions

INT SIM MEET 91001
Title: Integrated Simulation Meeting
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS 1
Source: DA724/Simulation Supervisor Group
Date: 07/00
Lesson(s) Replaced: None
Equipment Required: None
Preparation: None
Synopsis: The primary purpose of this meeting is for the Flight Crew and Simulation Supervisors to establish a working relationship to use during the course of the flight-specific integrated simulation training. The Simulation Supervisors and Flight Crew will discuss the overall plan and objectives for the flight-specific integrated simulations at this time. The crew may also take this opportunity to inform the Simulation Supervisors of any concerns and issues they would like to see addressed during the course of the flight-specific integrated simulations.

DEPART 9XYYY(2XYYY)
Title: Integrated Undocking/Departure Simulation
Duration: 8.0-10.0 hours
Medium: SMTF/MCC/SSTF
Student: COMMANDER, MS 1, MS 2, MS 3, ISS-1, ISS-2, ISS-3, PILOT
Source: DA72/Training Execution Branch
Date: 06/98
Lesson(s) Replaced: None
Equipment Required: Stowage, COAS, PGSC, flight-specific locker stowage configuration (for sims occurring within L-8 weeks)
Prerequisite Lesson(s): None
Preparation: None
Synopsis: This simulation exercises Shuttle crew/Flight Control Team (FCT) to ISS crew/FCT communication and coordination during undocking operations. It is preferred that MCC-M participate to provide the most realistic practice for multi-segment interactions. The simulation spans the activities beginning with powerdown of ISS systems, continues through Shuttle undocking and finishes with ISS system power up or Shuttle Sep 2 burn, whichever occurs later.
# CREW TRAINING CATALOG ADDENDUM

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A.1 INTRODUCTION

Purpose

This addendum documents and describes assigned crew activities and training other than those listed in the main section of the Crew Training Catalog. Specifically, it is designed to give readers a general overview of those assigned crew activities routinely conducted prior to flight that are in addition to the formal lessons outlined in the Crew Training Catalog.

Scope

This addendum lists the most common preflight crew activities and training requirements for Space Shuttle flight operations, which are assigned in addition to those courses specified in the formal Crew Training Catalog lesson flows. Activities in this addendum have been identified as:

(a) Flight Support Requirements, such as Annual Physical and Flight Operations Review

(b) Aircraft Operations Requirements for Assigned Crews, such as T-38 flight time

(c) Informal Requirements for Assigned Crews, such as admin time

Other additional training requirements for payloads or technical activities associated with a particular flight may not be included in this addendum, but will be included in the crew training plan for that particular shuttle flight as they become identified. This addendum does not cover the astronaut candidate training program, unassigned astronaut training requirements, or post-flight activities.

Addendum Revisions

Addendum revisions are accomplished by Lesson Change Requests (LCRs). These revisions require the approval of the Crew Training Catalog Addendum supervisor and concurrence by the designated CB training representative. The addendum will be revised along with the Crew Training Catalog on an as-needed basis.

A.2 FLIGHT SUPPORT REQUIREMENTS

The following table outlines the content of this section. The activities contained in this section are scheduled items that must be accomplished by flight crewmembers during the time frame indicated. Refer to Flight Support Descriptions on the following pages for details about each activity.
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>Yearly</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>FS-34</td>
<td>Annual IT Security Briefing</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td></td>
<td>Yearly</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>FS-35</td>
<td>ELSA Training</td>
<td>0.25</td>
<td>1</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>L-6 weeks</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>FS-25</td>
<td>L-6 DA7/CB T/U</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>L-6 weeks</td>
<td>Other crewmembers as assigned by CDR</td>
</tr>
<tr>
<td>2</td>
<td>FS-36</td>
<td>TV STRATEGY</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>L-5 weeks</td>
<td>@ FCE; sometimes split over two days</td>
</tr>
<tr>
<td>2</td>
<td>FS-37</td>
<td>BENCH REVIEW</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>L-5 weeks</td>
<td>With PGSC Engineer; best to schedule around Bench Review</td>
</tr>
<tr>
<td>2</td>
<td>FS-38</td>
<td>POC REVIEW</td>
<td>1.5</td>
<td>1</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>L-5 weeks</td>
<td>L-5 weeks for approximate timeframe</td>
</tr>
<tr>
<td>2</td>
<td>FS-39</td>
<td>Crew Press Conf</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>L-5 weeks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>FS-40</td>
<td>FCOD FRR</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L-1 month</td>
<td>Should be scheduled directly before the first Integrated Ascent or Entry simulation after TCDT</td>
</tr>
<tr>
<td>1</td>
<td>FS-41</td>
<td>Range Safety Brief at JSC</td>
<td>0.25</td>
<td>2</td>
<td>0.25</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L-11 months</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>FS-42</td>
<td>TCDT</td>
<td>22</td>
<td>8</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>L-3 weeks</td>
<td>Additional travel time required</td>
</tr>
<tr>
<td>1</td>
<td>FS-43</td>
<td>L-10 PHYSICAL</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>L-10 days</td>
<td>Loadmaster only</td>
</tr>
<tr>
<td>1</td>
<td>FS-44</td>
<td>L-10 Bench Review</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L-10 days</td>
<td>@ KSC during TCDT</td>
</tr>
<tr>
<td>1</td>
<td>FS-45</td>
<td>FNL FDF RVW</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>L-4 weeks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>FS-46</td>
<td>FLY DIR MTG</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>L-1 week</td>
<td>Loadmaster +1; this bench review is only required for Shuttle Missions launching logistics modules (i.e., MPLM, Spacehab, JEM, Columbus)</td>
</tr>
<tr>
<td>0</td>
<td>FS-47</td>
<td>MPLM KSC Bench Review</td>
<td>8</td>
<td>2</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Optional</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>FS-48</td>
<td>Initial FDF T/U</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>L-11 months</td>
<td>@ KSC during TCDT</td>
</tr>
<tr>
<td>0</td>
<td>FS-49</td>
<td>MSN Study Time</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>L-11 months</td>
<td>Optional</td>
</tr>
<tr>
<td>0</td>
<td>FS-50</td>
<td>RANGE SAFETY</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L-3 weeks</td>
<td>As needed</td>
</tr>
<tr>
<td>0</td>
<td>FS-51</td>
<td>PREFLT MENU</td>
<td>0.5</td>
<td>2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>L-9 to L-1 month</td>
<td>2 weeks prior to TCDT</td>
</tr>
<tr>
<td>0</td>
<td>FS-52</td>
<td>Earth Observations Briefing</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>L-9 to L-1 month</td>
<td>As needed</td>
</tr>
<tr>
<td>0</td>
<td>FS-53</td>
<td>Payload MST</td>
<td>2 days</td>
<td>4</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>L-2 months</td>
<td>SHAB/PYLD flights only</td>
</tr>
<tr>
<td>0</td>
<td>FS-54</td>
<td>Payload IVT</td>
<td>2 days</td>
<td>4</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>L-4 weeks</td>
<td>SHAB/PYLD flights only</td>
</tr>
<tr>
<td>0</td>
<td>FS-55</td>
<td>Payload FDF Review</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>L-4 weeks</td>
<td>SHAB/PYLD flights only</td>
</tr>
<tr>
<td>0</td>
<td>FS-56</td>
<td>Brooks AFB Centrifuge</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L-1 week</td>
<td>First time crewmembers; additional travel time required</td>
</tr>
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</table>
FLIGHT SUPPORT ACTIVITY DESCRIPTION

FS-1  ACES Fitcheck

Duration: 2.0 hours
Medium: Flight Crew Equipment (FCE) Facility
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
(Schedule individually.)
Timeframe: L-6 months
Source: USA/FCE

Synopsis: This is a fit check of the ACES and parachute harness, which are worn during launch and entry in case of an emergency bailout by the crew during controlled flight.

FS-2  TRAINING KICKOFF MTG

Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: Start of Training
Source: DA72/Training Execution Branch

Synopsis: This is a meeting led by the Training Manager, in which all Training Leads and Subject Matter Experts (SMEs) are introduced to the crew and flight directors. A high level training plan for each discipline is discussed.

FS-3  OnOrbit Crew Email

Duration: 1.0 hour
Medium: Classroom
Student: CDR, PLT, MS 1, MS 2, MS 3, MS 4, MS 5
Timeframe: Stage 4
Source: CB/Astronaut Office

Synopsis: This is a briefing conducted by the technical assistant to the Chief of the Astronaut Office. The On-Orbit Email event informs the shuttle crewmembers of the current policies and procedures regarding the use of the on-orbit e-mail. The crewmembers are also briefed on the policies for the Internet Protocol (IP) phone and Orbiter Communications Adapter (OCA) video-teleconference, and Handheld Amateur Radio Operator (HAM) radio messages.
FS-4  **Annual Physical**

Duration: 3.5 hours*
Medium: Flight Medicine Clinic/Bldg. 8 – JSC
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule individually.)
Frequency: Annually on birth month
Source: SD2/Medical Operations Branch

Synopsis: Crewmembers are required to fast for 12 hours before their physical. The physical consists of blood draws, electrocardiogram, pulmonary functions, an ophthalmology exam, and a dental visit, if requested.

*Note: If a treadmill or proctology exam is required, add one hour per procedure to the baseline 3 1/2-hour exam.

FS-5  **Crew Equipment Review**

Duration: 1.0 hour
Medium: Crew Office
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: Stage 4
Source: USA/FCE

Synopsis: Astronaut Office crew equipment personnel provide a briefing to inform crewmembers of the known scheduled activities for their flight and discuss crew equipment needed. Crewmembers select two training shirts shortly following this meeting.

FS-6  **Crew Study Guide**

Duration: 2.0 hours
Medium: Self Study
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Schedule individually.)
Timeframe: Upon crew assignment through start of SMS training
Source: DA7/Space Flight Training Management Office

Synopsis: The crew will be responsible for reviewing the crew study guide prior to SMS training start time. This is done to prepare crew for their simulations beforehand in an effort to better utilize SMS facilities.
**FS-7  Crew Task Panel**

Duration: 2.0 hours  
Medium: Meeting Room  
Student: COMMANDER  
Timeframe: Start of Training  
Source: DA8/Flight Director’s Office

Synopsis: This is a meeting chaired by the Flight Director’s office to discuss crew tasks. It is supported by the Training Manager to discuss the tasking effects on crew loading. The goal of the meeting is to assign the crew tasks in a way that is most effective and efficient for training and on orbit tasks.

**FS-8  Dental**

Duration: 0.5 hours  
Medium: Clinic (B8/278)  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: Annually  
Source: Dental Services

Synopsis: This is the annual dentist appointment.

**FS-9  Flight IPT**

Duration: 2.0 hours  
Medium: Meeting Room  
Student: COMMANDER  
Timeframe: Every 2-8 wks  
Source: Flight Integration Manager (FIM)

Synopsis: This is the Integrated Product Team (IPT) meeting, in which all flight products are discussed and issues are resolved.

**FS-10  Flight JOP**

Duration: 2.0 hours  
Medium: Meeting Room  
Student: Representative from assigned crew  
Frequency: Every 4-8 wks  
Source: DA8

Synopsis: This is the Joint Operations Plan meeting chaired by the Flight Director’s office to work out operations issues specific to a particular flight.
FS-11  **Shuttle Food Sys Briefing**

- **Duration:** 1.0 hour
- **Medium:** Food System Engineering Facility
- **Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
- **Timeframe:** L-9 months
- **Source:** SA/Space and Life Sciences Directorate

**Synopsis:** Each of the categories of foods--fresh food, intermediate moisture, natural form, rehydratable, and thermostabilized--are discussed, and opening techniques for each type of packaging--beverage pouch, can, retort pouch, and square rehydratable container--are demonstrated. Crewmembers are given an opportunity to evaluate the different foods and beverages and are responsible for selecting their own personal flight menus. Food preferences for the Terminal Countdown Demonstration Test (TCDT), preflight food service, and launch day carry-on are also discussed. A second session may be arranged at a later date upon request by one or more of the crewmembers.

FS-12  **Physical Training (Gym)**

- **Duration:** 1.5 hours
- **Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
  (Schedule individually.)
- **Frequency:** 3 times per week
- **Synopsis:** This time allows for crewmembers to keep up their physical training while preparing for flight. It should not be scheduled in place of lunch. The time of 1.5 hours enables transit time and time to shower after working out.

Beginning at six months prior to launch. Shuttle EVA crewmembers should be scheduled for a minimum of 3 two-hour sessions per week.
FS-13  SFRM Training Strategy Meeting
Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER
Timeframe: Prior to any 30000 Level SMS lessons
Source: DA7/Space Flight Training Management Office

Synopsis: This meeting will be held with:
- CDR
- CB Instructor Astronaut (IA)
- SMS Team Lead
- Topics to be addressed will include:
  - SMS lessons the CB IA will attend (additional to those already marked as mandatory in the Crew Training Catalog)
  - CDR’s expectations
  - CB IA expectations
  - CDR’s, CB IA’s and SMS Team Lead’s roles for debriefing CRM topics during SMS debriefs

After this meeting, the SMS Team Lead will supply the name of the primary assigned CB IA and which SMS lessons he/she will attend to the Training Manager.

CB IA attendance is mandatory for the following classes:
- ASC SKL 33011
- E SKL 32011
- PO INS OPS 91012

CB IA attendance is possible for the following classes:
- DPLY MAL T/L 91012
- RETR MAL T/L 91012
- EVA 910XX

FS-14  Med DSO Brf
Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: L-9 months
Source: SA/Space and Life Sciences Directorate

Synopsis: Specific medical experiments are proposed for each flight. Crew participation in DSO’s is optional and voluntary. Training for a medical DSO is highly variable and may consist of one or more sessions to familiarize the crew with equipment needed to perform the experiment, as well as baseline data takes, sometimes through launch week.
FS-15  **Vision**

Duration: 1.0 hour  
Medium: Clinic (B8)  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: Annually (Near annual physical)  
Source: Flight Medicine

Synopsis: A complete visual system evaluation is performed, to include dilation of the pupils. A detailed stowage plan for eyeglasses and contact lenses is delineated within 6 months of launch.

FS-16  **FPSR**

Duration: 3.0 hours  
Medium: Meeting Room  
Student: Representative from assigned crew  
Timeframe: 7-8 months prior to launch  
Source: Flight Integration Manager (FIM)

Synopsis: This meeting is the last opportunity to manifest simple middeck payload items. 3-4 weeks prior to the Flight Planning Stowage Review (FPSR), a FPSR Assessment List is distributed to the IPT identifying a list of candidate DTOs/DSOs, and secondary payloads that should be assessed for compatibility with mission capabilities (crew time, stowage volume, weight, etc.). The FPSR occurs as a special IPT, chaired by the Flight Manager.

FS-17  **Flight Clothing Fitcheck**

Duration: 2.0 hours  
Medium: Flight Crew Equipment (FCE) Facility  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
(Schedule individually.)  
Timeframe: L-6 months  
Source: USA/FCE

Synopsis: Measurements are taken for flight clothing to be worn while in orbit. Selection of personal crew equipment to be flown for each individual is also made.
FS-18  Postflight Appearances Planning Meeting

Duration:       0.5 hours
Medium:        Crew Office
Student:       COMMANDER
Timeframe:      L-3 months
Source:        CB/Astronaut Appearances Office

Synopsis: This meeting will explain role differences between the Publicist and Appearance Administrator, define NASA’s expectations for the postflight program, inquire about preferences for postflight visits/publicity, determine tentative postflight period, inquire about pre-arranged appearance requests that need to be logged into the appearance database, and determine the Commander’s preference for communication flow with other crew members. The meeting also serves to determine if any short-fused, high profile appearances held immediately after landing are in accordance with the Commander’s planning schedule.

FS-19  Crew Photo

Duration:       4.0 hours
Medium:        Bldg. 8 Studio
Student:       COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe:      L-8 months
Source:        IS/Information and Imaging Sciences Division

Synopsis: Each assigned crew is required to take a crew photo. Timeframe for this picture is dependent on when the crew has finished designing their crew patch. This photo may require more than one visit to the photo studio, however, the standard should be to placeholder one 4-hour session.

FS-20  Flight Ops Review

Duration:       8.0 hours (over the course of 3-4 days)
Medium:        Meeting Room
Student:       Representative from assigned crew
Timeframe:      3-4 months prior to flight
Source:        Flight Director's Office

Synopsis: This is a meeting held with all Mission Operations Directorate disciplines, Shuttle Program Office, and any Shuttle Program customers to ensure all products are available to properly train the crew.
FS-21  FDF/ODF Pre Simulation Briefing

Duration: 1.5 hours
Medium: B4S, Crew Conference Room
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Including ODF and Expedition (EXP) crews, if available.)
Timeframe: At least 2 weeks before start of integrated training.
Source: DO3/Flight Procedures Management

Synopsis: Prior to the start of integrated crew training, the FDF (and ODF) Coordinator(s) conduct a Pre Simulation Briefing with the shuttle crew. At the meeting, the Coordinator(s) review the Content List(s) with the crew to determine the quantity of the flight books, cue cards, miscellaneous documents, removable software, hardware, and office supplies required for sims and for flight.

FS-22  PAO Big Picture Meeting

Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: L-5 months to L-4 months
Source: AP/Office of Communications and Public Affairs

Synopsis: The crew is required to meet with the Office of Public Affairs to discuss strategy of public relations-type activities to be performed during preparation for flight.

FS-23  VITT Brief

Duration: 2.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: L-3 months
Source: CA4/Vehicle Integration Test Office

Synopsis: This briefing, conducted by the lead Vehicle Integration Test Team (VITT) engineer for that particular flight, will outline the schedule of activities to be conducted at KSC during the launch processing flow. The crew will decide which of the activities will be supported and which crewmembers will support them.

The primary tests requiring crew support are the following:

- Crew Equipment Interface Test
- Payload Interface Verification Test
- Payload Mission Sequence Test
- Terminal Countdown Demonstration Test
FS-24  Guest List
Duration: 2.0 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: Stage 2  
Source: CB  
Synopsis: This is scheduled by the crew secretary for each crewmember to go through their guest list for launch.

FS-25  L-16 DA7/CB T/U and L-6 DA7/CB T/U
Duration: 0.5 hours  
Medium: Meeting room  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-4 months and L-2 months  
Source: DA7/Space Flight Training (SFT) Director  
Synopsis: This meeting is held with the CDR and Training organization to review flight training status and address any training concerns that the CDR may have.

FS-26  Menu Review
Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: Stage 2  
Source: USA Space Food Systems Laboratory  
Synopsis: This is a review with the food lab to go over menu item preferences with each crewmember.

FS-27  FCOD MRR
Duration: 1.5 hours  
Medium: Classroom  
Student: COMMANDER  
Timeframe: L-3 months  
Source: CB/Astronaut Office  
Synopsis: Mission status to FCOD and CB management. CDR (and other crewmembers designated by CDR) will status FCOD director, FCOD deputy director, Chief and Deputy Chief of the Astronaut Office on any outstanding issues relating to their mission.
FS-28  Individual PAO Interview

Duration: 1.5 hours  
Medium: Bldg. 2 Studio (Room 135)  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
(Schedule individually.)  
Timeframe: L-3 months  
Source: AP/Office of Communications and Public Affairs  

Synopsis: Each crewmember is required to hold an individual interview with the Office of Public Affairs.

FS-29  Contingency Landing Training

Duration: 1.5 hours  
Medium: Classroom  
Student: COMMANDER, PILOT  
Timeframe: L-6 weeks  
Source: DM3/Landing Support Office  
Note: Equipment required (PC with projector)  

Synopsis: Crew will be provided the capabilities and procedures for contingency landings at Transatlantic Abort Landing (TAL), East Coast Abort Landing (ECAL), Department of Defense Emergency Landing Site (DOD ELS), and Non-DOD ELS sites. Items covered will include: communications pre-landing, convoy support, post-landing communications, and post-landing procedures.

FS-30  CEIT

Duration: 1 and 1/2 days  
Note: Schedule additional time for travel.  
Medium: KSC  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-8 to L-6 weeks  
Source: CA4/Vehicle Integration Test Office  

Synopsis: This test consists of In-Flight Maintenance (IFM) checklist procedures walk-through, fit check of crew equipment in crew compartment, accessibility checks, payload fit checks and procedures, payload bay walkdown and sharp edge inspection. An additional Crew Equipment Interface Test (CEIT) is performed for Spacehab flights.
FS-31  **KSC Videotapes**

**Duration:** 1.0 hour  
**Medium:** Videotape  
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule individually.)  
**Frequency:** Annually  
**Source:** KSC  
**Synopsis:** Videotaped safety briefings required by Kennedy Space Center (KSC) prior to flight, which cover KSC facilities; not all videos require annual review.

FS-32  **Annual Ethics Briefing**

**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule individually.)  
**Frequency:** As required  
**Synopsis:** All NASA Civil Servants are required to attend the annual ethics briefing as prescribed by JSC Human Resources Office.

FS-33  **Annual Security Briefing**

**Duration:** 1.0 hour  
**Medium:** Classroom  
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT (Schedule individually.)  
**Frequency:** As required  
**Synopsis:** All NASA civil servants are required to attend the annual security briefing as prescribed by JSC Human Resources Office.

FS-34  **Annual IT Security Briefing**

**Duration:** 1.0 hour  
**Medium:** CBT  
**Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT  
**Timeframe:** Annually  
**Source:** Information Systems Directorate  
**Synopsis:** Annual requirement for all JSC employees to review IT security policies.
FS-35  **ELSA Training**

- **Duration:** 0.25 hours
- **Medium:** Classroom
- **Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
- **Timeframe:** Annually
- **Source:** NS226/Safety Learning Center

**Synopsis:** Required for unescorted badges at KSC and Edwards AFB. Training is provided on Emergency Life Support Apparatus (ELSA).

FS-36  **TV STRATEGY**

- **Duration:** 1.0 hour
- **Medium:** Classroom
- **Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
- **Timeframe:** L-5 weeks
- **Source:** AP/Office of Communications and Public Affairs

**Synopsis:** Review the TV programming plan for the mission and discusses any in-flight special events. CAPCOMs should also be scheduled for this meeting. This briefing will be supplemented with a written package of material to be delivered to the crew during quarantine. This package will include: approved client list, TV schedule, and hot topics.

FS-37  **BENCH REVIEW**

- **Duration:** 8.0 hours
- **Medium:** Flight Crew Equipment (FCE) Facility
- **Student:** COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
- **Timeframe:** L-5 weeks
- **Source:** USA/FCE

**Synopsis:** The crewmembers conduct a physical inventory of clothing, personal items, and equipment they will take onboard the orbiter. Any last-minute changes or modifications to the clothing or equipment inventory are made at this time. Upon completion of the bench review, the equipment, along with food to be flown on the flight, is shipped to the launch site for stowage on the orbiter. This requires that the bench review occur on or about the L-28 day timeframe.
**FS-38  POC Review**

Duration: 1.5 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-5 weeks  
Source: MS4/Flight Software Office  

Synopsis: This meeting is designed to review PGSC-related items (applications, procedures, ops notes, etc.) that the Crew, CAPCOM, and Flight Activities Officers (FAOs) should be aware of going into their upcoming flight. The meeting will also provide the Crew, CAPCOM, and FAOs an opportunity to understand schedules and strategies for PGSC-related activities once on orbit, such as OCA updates and family mail. Additionally, the PGSC Usage Chart, PGSC ops notes, and PGSC backup plan are discussed.

**FS-39  Crew Press Conf**

Duration: 4.0 hours  
Medium: Bldg. 2 Studio (Room 135)  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-5 weeks  
Source: AP/Office of *Communications and* Public Affairs

Synopsis: The conference is generally divided into a group press conference followed by round robin crew interviews.

**FS-40  FCOD FRR**

Duration: 2.0 hours  
Medium: Meeting Room  
Student: COMMANDER  
Timeframe: L-1 month  
Source: Flight Crew Operations Directorate

Synopsis: This is a meeting between the CDR and management in the Flight Crew Operations Directorate to review any concerns of the flight.
FS-41  Range Safety Brief at JSC

Duration: 0.25 hours  
Medium: Classroom  
Student: COMMANDER, PILOT  
Timeframe: Stage 1  
Source: DA8/Flight Director Office  
Note: Should be scheduled directly before the first Integrated Ascent or Entry simulation after Terminal Countdown Demonstration Test (TCDT).

Synopsis: Quick brief with Flight Director Office to obtain required signatures and assure that the crew knows their responsibility with regard to Range Safety at KSC.

FS-42  TCDT

Duration: 22.0 hours  
Note: Schedule additional time for travel.  
Medium: KSC  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-4 weeks to L-2 weeks  
Source: CA4/Vehicle Integration Test Office  
Synopsis: This is a dress rehearsal for the crew and their launch team in preparation for launch. It includes orbiter, payload, safety, crew escape briefings, and hands-on emergency training prior to the launch countdown test itself.

FS-43  L-10 PHYSICAL

Duration: 3.0 hours  
Medium: Flight Medicine Clinic/Bldg. 8  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-10 days  
Source: SD2/Medical Operations Branch  
Synopsis: Crewmembers are required to fast for 12 hours before the L-10 physical. The physical consists of:  
- Blood draws from each crewmember  
- Collection of baseline data for medical Detailed Secondary Objectives (DSOs)  
- Physical examinations  
- MED REFR 91001 is scheduled with the L-10 physicals.
FS-44  L-10 Bench Review
Duration: 3.0 hours
Medium: Flight Crew Equipment (FCE) Facility
Student: Loadmaster only
Timeframe: L-10 days
Source: USA/FCE
Synopsis: The crewmembers conduct a physical inventory of clothing, personal items, and equipment they will take onboard the orbiter. Any last minute changes or modifications to the clothing or equipment inventory are made at this time.

FS-45  FNL FDF RVW
Duration: 4.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: L-4 weeks
Source: DO3/Mission Operations Procedures Branch
Synopsis: This is a final review of the checklists, cue cards, and manuals that will be flown onboard the orbiter. This session allows the crew to highlight material and add non-technical reminders at the review. Upon completion of the review and any changes, the FDF is packed and shipped to the launch-site for stowage onboard the orbiter.

FS-46  FLT DIR MTG
Duration: 2.0 hours
Medium: JSC Crew Quarters
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Timeframe: L-1 week
Source: DA8/Flight Director Office
Synopsis: This meeting takes place the week before launch. At this time, the Flight Directors, CAPCOMs, FCOD Management, and other appropriate individuals meet with the flight crew to discuss flight operations and any safety issue before the flight. Crewmembers are given an opportunity to voice any concerns they may have prior to flight.
**FS-47  MPLM KSC Bench Review**

Duration: 8.0 hours  
**Note:** This bench review is **only required for Shuttle Missions launching logistics modules** (i.e., MPLM, Spacehab, JEM, Columbus).  
Medium: Flight Crew Equipment (FCE) Facility  
Student: Loadmaster (+1)  
Timeframe: Stage 0  
Source: USA/FCE  
Synopsis: The crew members conduct a physical inventory of clothing, personal items, and equipment they will take onboard the orbiter. Any last minute changes or modifications to the clothing or equipment inventory are made at this time.

**FS-48  Initial FDF T/U**

Duration: 1.0 hour  
Medium: Conference Room  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Including ODF and Expedition (EXP) crews, if available.)  
Timeframe: L-12 months  
Source: DO3/Flight Procedures Management  
Synopsis: This is an optional class that introduces key FDF and ODF personnel and processes to the crew early in the flow. At the meeting, the Coordinator(s) will review key FDF/ODF events, and discuss the FDF Workflow system as well as the Coordinator’s roles and responsibilities.

**FS-49  MSN Study Time**

Duration: 1.0 hour  
Medium: Self-Study  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
(Schedule individually.)  
Frequency: 3 times per week at SMS training start through L-1 week  
Synopsis: This time allows crew members to review lesson material and prepare for upcoming simulator sessions as needed.
FS-50  **RANGE SAFETY**

Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, PILOT  
Timeframe: Usually occurs during TCDT  
Source: Cape Canaveral Air Station  

Synopsis: Cape Canaveral Air Station provides a brief to the crew of actions that will be taken if there is a shuttle loss of control over a populated area.

FS-51  **PREFLT Menu**

Duration: 0.5 hours  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT  
Timeframe: 2 weeks prior to TCDT  
Source: Food Lab  

Synopsis: Review menu items for TCDT and quarantine.

FS-52  **Earth Observations Briefing**

Duration: 1.0 hour  
Medium: Classroom  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS  
Timeframe: L-9 months to L-1 month  
Source: SX/Human Exploration Science Office  

Synopsis: Once the trajectory and ground track for a flight are calculated, the Earth Science Branch will determine specific sites of interest for photography and viewing by the crew. Typical topics for discussion and observation are geological, meteorological, oceanographic, environmental, and geomorphological sites. Discussion also includes the types of film to be used and specific changes in the earth at given locations. Total time for training is dependent upon the crew, and the level of detail they request in these briefings. An initial briefing is held with the crew to establish specific briefing requirements.
### FS-53 Payload MST

**Duration:** 2 days  
**Note:** Duration is variable. Schedule additional time for travel.  
**Medium:** KSC  
**Student:** MS 1, MS 2, MS 3, MS 4, PS (Schedule Payload Crew, as required.)  
**Timeframe:** L-2 months  
**Source:** CA4/Vehicle Integration Test Office

**Synopsis:** A Mission Sequence Test (MST) is performed for certain Spacehab missions and other missions with complex payloads to verify that their payload and orbiter systems operate per mission planning. It is supported by the applicable payload crewmembers.

### FS-54 Payload IVT

**Duration:** 2 days  
**Note:** Duration is variable. Schedule additional time for travel.  
**Medium:** KSC  
**Student:** MS 1, MS 2, MS 3, MS 4, PS (Schedule Payload Crew, as required.)  
**Timeframe:** L-6 weeks  
**Source:** CA4/Vehicle Integration Test Office

**Synopsis:** This is scheduled for Spacehab or complex payload flights only. Verify electrical and functional interfaces between payload and orbiter. It is supported by the applicable payload crewmembers.

### FS-55 Payload FDF Review

**Duration:** 4.0 hours  
**Medium:** Classroom  
**Student:** MS 1, MS 2, MS 3, MS 4, PS (Schedule Payload Crew, as required.)  
**Timeframe:** L-4 weeks  
**Source:** DO3/Mission Operations Procedures Branch

**Synopsis:** This is scheduled for Spacehab or complex payload flights only. Crewmembers associated with payload activity may be required to participate in an additional FDF review for their payload procedures.
FS-56  Brooks AFB Centrifuge

Duration: 4.0 hours

Note: Travel time required.

Medium: Centrifuge

Student: MS 1, MS 2, MS 3, PILOT, PS (Schedule first-time crewmembers, as required.)

Timeframe: L-9 months to L-6 months

Source: Brooks AFB, San Antonio, TX and CB/Astronaut Office

Synopsis: This is an optional requirement to verify proper ACES suit fit under G loading.
A.3 AIRCRAFT OPERATIONS REQUIREMENTS FOR ASSIGNED CREWS

The following table summarizes the content in this section. The activities contained in this section are schedule items that should be accomplished by assigned crewmembers as indicated below. Refer to the Aircraft Operations Activity Descriptions on the following pages for details about each activity.

Table ADD-2. Aircraft Operations Requirements for Assigned Crews

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ref Num</th>
<th>Lesson Code</th>
<th>Hours</th>
<th>Sched Code</th>
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<th>P</th>
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<th>MS2</th>
<th>MS3</th>
<th>MS4</th>
<th>PS</th>
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<td>6</td>
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<td>1 sortie with L 6 months</td>
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<td>3.5</td>
<td>3.5</td>
<td>Every 3 years</td>
<td>Altitude Chamber</td>
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</tbody>
</table>

Note: This AMES exercise includes travel time of approximately 1.5 days to and from Ames.
AIRCRAFT OPERATIONS ACTIVITY DESCRIPTIONS

A/C-1 STA

Duration: 2.0 hours  
Note: Schedule an additional 4-6 hours travel time.  
Medium: STA  
Student: COMMANDER, PILOT (Schedule together.)  
Note: Although the requirement for this activity is for CDR and PLT, other crewmembers are invited to participate when feasible.  
Timeframe: (see below)  
Source: CC/Aircraft Operations Division  
Synopsis: The Shuttle Training Aircraft (STA) is flown by the CDR and PLT to familiarize themselves with an aircraft that approximates the handling characteristics of the orbiter during approach and landing. STAs are flown at the White Sands Missile Range (WSMR), Edwards Air Force Base (EDW), or the Kennedy Space Center (KSC).  
• From the time the crew assignment is announced to the L-9 month timeframe, the CDR and PLT will each fly the STA once per month.  
• From L-9 to L-6 months a crewmember flying in an assigned position for the first time will fly the STA on a bi-weekly basis. However, a crewmember flying in the same position in which they have flown previously will continue to fly at a once per month rate.  
• From L-6 to L-3 months, the CDR and PLT will fly on a bi-weekly basis regardless of past flight history.  
• From L-3 months to launch, the CDR and PLT will fly the STA on a weekly basis.  
Additional considerations:  
• Although not required, the CDR and PLT should fly four nighttime periods during the L-6 month to launch period.  
• From L-2 months to launch, the crew usually flies two EDW flights.  
• From L-1 month to launch, the crew usually flies two KSC flights.  
• Highly desired for the crew to fly at least two periods wearing the Launch and Entry Suit.  
• For flights having a nighttime launch and/or landing planned, the CDR and PLT will increase the number of nighttime periods.  
Note: Approximate travel times to/from the required sites is as follows:  
6 hours for EDW, 4-6 hours for KSC and 4 hours for WSMR.
A/C-2  T-38 Flight for STAs
Duration: 6.0 hours
Medium: T-38 Aircraft
Student: All T-38 flight crewmembers
Frequency: Bi-weekly until L-12 weeks; Weekly L-12 to launch
Source: CC/Aircraft Operations Division
Synopsis: Flight time to and from STA.

A/C-3  T-38 Q Check
Duration: 3.0 hours
Medium: T-38 Aircraft
Student: All T-38 flight crewmembers
Frequency: Annually
Source: CC/Aircraft Operations Division
Synopsis: Proficiency check flight includes a written examination and ejection seat/ground egress training. Mission Specialists (MSs) will complete a written exam and demonstrate proficiency in instrument procedures in conjunction with their annual proficiency check.

A/C-4  T-38 EP Sim
Duration: 3.0 hours
Note: Schedule additional time for travel.*
Medium: T-38 Aircraft
Student: Front seat T-38 pilots
Frequency: Annually
Source: CC/Aircraft Operations Division
Synopsis: Front seat T-38 crewmembers travel to one of the following Air Force Training Bases (Randolph, Vance, Reese, Laughlin, or Columbus) for a 1.3 hour simulation with an Air Force or Contract instructor. Training includes a review of the T-38 checklist emergency procedures as well as practicing aborts, loss of engine on takeoff, ejection, tire failure, and various systems malfunctions and emergencies.

*Note: Due to travel time required for this activity the entire process from takeoff to landing will range from 4-5 hours. Although the requirement for this activity is for front seat T-38 crewmembers, backseaters are welcome to go along on these trips, and usually are offered a chance to fly a T-38 sim with an Air Force instructor as well.
A/C-5  T-38 Groundschool

Duration:  4.0 hours

Note:  Ground School is offered the first Tuesday of the month.

Medium:  Ellington Field

Student:  All T-38 flight crewmembers

Frequency:  Annually

Source:  CC/Aircraft Operations Division

Synopsis:  This briefing is required prior to the front seat T-38 crewmember’s Instrument Check and the T-38 back seat crewmember’s Proficiency Check.

A/C-6  T-38 Flight For Pilots/For MS’s

Duration:  Variable*

Medium:  T-38 Aircraft

Student:  All T-38 flight crewmembers

Frequency:  15 hrs. per month (T-38 front seat)/5 hrs. per month (T-38 back seat)**

Source:  CC/Aircraft Operations Division

Synopsis:  Front seat T-38 Pilot time is logged when flying solo, when flying dual as the pilot at the controls, or when accompanied by a designated instructor pilot performing instructional duties.  Back seat T-38 Pilot time is logged when flying dual and not in any of the capacities previously listed.

*Note:  Out and back flight of roughly 3.0 logged hours requires 5 hours to include transit time to/from Ellington Field.  Local flight of roughly 1.5 hours requires 4 hours to include transit time to/from Ellington Field.

**Note:  All other T-38 activities such as Emergency Procedures (EP) sim technical travel are applicable to a crewmember’s flight time.
A/C-7    AMES

Duration:  4.0 hours  
**Note:** Schedule additional time for travel.*  
Medium:    VMS  
Student:   COMMANDER, PILOT  
Frequency: Every 6 months  
Source:    CB/Astronaut Office  

Synopsis:  Assigned CDRs and PLTs undergo high-stress landing and rollout training on a high-fidelity simulator.  

*Note:  This exercise, including travel time to and from Ames, requires approximately 1.5 days.  

A/C-8    T-38 Instrument CK

Duration:  3.0 hours  
Medium:    T-38 Aircraft  
Student:   Front seat T-38 pilots  
Frequency: Annually  
Source:    CC/Aircraft Operations Division  

Synopsis:  Instrument check ride includes written instrument exam. Instrument pre-check and instrument check flight shall be flown with different instructor pilots.  

A/C-9    HAT Flight

Duration:  4.0 hours  
Medium:    C9  
Student:   COMMANDER, PILOT  
Timeframe: 1 sortie within L-6 months  
Source:    CC/Aircraft Operations Division  

Synopsis:  The CDR and PLT will fly one Heavy Aircraft Training (HAT) flight within 6 months of launch in preparation for their shuttle flight. This flight will familiarize the crew with the handling characteristics of a large aircraft as opposed to the smaller T-38 and STA with which the crew is more familiar.
A/C-10  Physiological Refresher Training

Duration: 3.5 hours
Medium: Altitude Chamber
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Schedule individually.)
Frequency: Every 3 years
Source: SD/Medical Sciences Division

Synopsis: Lecture and brief exposure to hypobaric conditions in the altitude chamber for familiarization with one’s hypoxic symptoms.
### A.4 INFORMAL ACTIVITIES

The activities listed below are viewed by the Crew Office as having slightly lower priority than the Flight Support and Aircraft Operations activities for Assigned Crews. These activities may be amended or deleted by the assigned crewmembers.

Table ADD-3. Informal Requirements

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ref Num</th>
<th>Lesson Code</th>
<th>Hrs</th>
<th>Sched Code</th>
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<th>MS1</th>
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<td>Crew Briefs</td>
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<td>INF-7</td>
<td>Russian Language Training</td>
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<td>As requested by crewmember</td>
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**INF-1 ADMIN**

Duration: 1.0 hour  
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Schedule individually.)  
Frequency: 5 times per week  
Synopsis: This time allows crewmembers to perform administrative tasks.

**INF-2 CREW T/U**

Duration: 1.0 hour  
Medium: Crew Office  
Student: COMMANDER, MS 1, MS 2, MS 3, MS4, PILOT, PS  
Timeframe: Monthly  
Source: CB  
Synopsis: The crew meets in this forum to status each other on where they are in respect to mission readiness, discuss issues and concerns, and plan forward work.
INF-3 CB MTG

Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS
Frequency: Every Monday morning

Synopsis: Each crewmember is requested to attend Monday morning status meeting with the Crew Office.

INF-4 Aviation Safety Meeting

Duration: 1.0 hour
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Frequency: Bi-monthly (as required)

Synopsis: Each crewmember is requested to attend informational briefings presented by the Aircraft Operations Division as they are scheduled. Generally, these briefings will occur once every other month.

INF-5 Crew Debriefs

Duration: 3.0 hours
Medium: Classroom
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT
Frequency: Following each Space Shuttle mission

Synopsis: Debriefs from previous crews are scheduled for lessons learned.

INF-6 Public Relations Appearances

Duration: Variable
Medium: Public appearance
Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Schedule individually.)
Timeframe: Prior to L-6 months
Source: CB/Appearances Coordination/Scheduling

Synopsis: All public appearances are voluntary and subject to approval by crew commander. As a standard, there should be no scheduled public appearances after L-6 months. Appearances should be limited to one a month, not to exceed 48 hours away from the office during a work week (including travel time).
INF-7  Russian Language Training

Duration: 2.0 hours

Note: As requested by crewmember.

Medium: Classroom

Student: COMMANDER, MS 1, MS 2, MS 3, MS 4, PILOT, PS (Schedule individually.)

Timeframe: Schedule permitting

Source: JSC Language Education Center (JLEC)

Synopsis: Optional training for crewmembers assigned to ISS flights requiring some level of Russian language capability.
APPENDIX A
SHUTTLE BUDGET TEAM INFORMATION

A.1 PURPOSE
The Shuttle Budget will manage loading and stage distribution of the generic Shuttle crew training curriculum. This appendix documents the summary loading totals, the data used to model flight-specific applications of the generic curriculum, as well as charts depicting the current status of the generic curriculum.

A.2 SCOPE
The Shuttle Budget will assess those mission preparation activities that have loading impacts for Shuttle mission crewmembers. This includes both training and non-training activities. Guidelines for inclusion of activities in the budget are set forth in the Shuttle Budget Team (SBT) Model.

A.3 REVISIONS
Revisions to the Shuttle Budget, its tables, model, and appendix are accomplished by Lesson Change Requests (LCRs). These revisions require approval of the SBT Chair, the Astronaut Office Training Representative, the Training Integration Manager, and the Spaceflight Training Management Office Director. The appendix will be revised with the Crew Training Catalog on an as needed basis.

The model will continually be evaluated to ensure that it appropriately reflects training requirements for the majority of upcoming missions. Additionally, the model must be re-evaluated if major changes are proposed for any lessons that fall outside its range.

A.4 MODEL ASSESSMENT
The mission profile and crew task assignments defined in the SBT Model were established based on actual data from recently flown missions and on input from Subject Matter Experts (SMEs) projecting parameters for upcoming missions.

The budget contains all known mission prep activities, including generic flight requirements and anticipated meetings (IPTs, JOPs) as well as all training requirements associated with each mission task.

Each activity documented in the Crew Training Catalog will be assigned to a particular training stage. This will facilitate better distribution of the course load across the training template.
A.5  LOADING LIMITS

Shuttle Budget loading limits are different from but do not replace the limits defined for managing flight-specific crew loading. The budget loading limits are lower to account for total elapsed hours rather than event hours only. Elapsed hours represent a more comprehensive view of crew loading.

Event hours include only the length of the scheduled activities for each work week.

Elapsed hours include event hours and all overhead associated with the scheduled activities. The overhead includes travel time, meal breaks, and any other time between activities.

The stage loading limits were calculated by defining a practical duty week as an average of 48 elapsed hours. The daily overhead was estimated to be 1.5 hours. This daily estimate multiplied by 5 days equals 7.5 hours of overhead per week. Therefore, event hours are 40.5 hrs/wk. This was rounded to 41 hours.

\[ 48 \sim 41 + (1.5 \times 5) \]

Historical mission training records have shown a consistent need for an increased training load during the Stage 2 timeframe. This historical pattern is the basis for the increased acceptable load in Stage 2.

A.6  GROWTH

There is a need to account for flight-specific training plan growth within the generic curriculum. Training plans for previous flights were found to average a 15% growth rate in hours prior to integrated simulation start (Stages 4 & 3) and a 3% growth rate post integrated simulation start (Stages 2 & 1). These growth hours will be reflected in the CTC summary tables as a line item in each stage.

A.7  SHUTTLE BUDGET MODEL

A.7.1  Mission Profile Information

Three EVAs
- 1 with a 7:1 training ratio
- 2 with a 5:1 training ratio

Robotics (Mobile Servicing System – MSS)
- 1 Main Element Install Flow
- TPS OBSS Flow
- 1 Complex EVA Flow
- SSRMS Proficiency Flow
PDRS
Orbiter Boom Sensor System (OBSS)
Station Build Flow
Unloaded Flow

Payload/MPLM/SHAB/DTO&DSO
80 hrs total:
Stage 4 – 30 hrs
Stage 3 – 25 hrs
Stage 2 – 20 hrs
Stage 1 – 5 hrs

Table A-1. Crew Task Allocations
(Non-Crew Rotation and Crew Rotation)

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<th>Non-Crew Rotation</th>
<th>CDR</th>
<th>PLT</th>
<th>MS1</th>
<th>MS2</th>
<th>(MS3)</th>
<th>(MS4)</th>
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<td>EV1</td>
<td>EV2</td>
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<tr>
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<td>X</td>
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<td>Holidays and Leave</td>
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<td>Memorial Day</td>
<td>L-42</td>
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<tr>
<td>Summer Leave (1 wk)</td>
<td>L-38</td>
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<tr>
<td>Independence Day</td>
<td>L-37</td>
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<tr>
<td>Summer Leave (1 wk)</td>
<td>L-30</td>
</tr>
<tr>
<td>Labor Day</td>
<td>L-28</td>
</tr>
<tr>
<td>Columbus Day</td>
<td>L-23</td>
</tr>
<tr>
<td>Veterans’ Day</td>
<td>L-19</td>
</tr>
<tr>
<td>Thanksgiving (3 days)</td>
<td>L-16</td>
</tr>
<tr>
<td>Winter Break (2 days)</td>
<td>L-13</td>
</tr>
<tr>
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<td>L-12</td>
</tr>
<tr>
<td>Winter Break (2 days)</td>
<td>L-11</td>
</tr>
<tr>
<td>Martin Luther King Day</td>
<td>L-9</td>
</tr>
<tr>
<td>Presidents’ Day</td>
<td>L-4</td>
</tr>
<tr>
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<tr>
<td>CDR</td>
<td>L-24</td>
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<tr>
<td>PLT</td>
<td>L-28</td>
</tr>
<tr>
<td>MS1</td>
<td>L-15</td>
</tr>
<tr>
<td>MS2</td>
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<td>MS4</td>
<td>L-6</td>
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<tr>
<td>Launch</td>
<td>March</td>
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</table>
A.7.2 Assessment Information

Stage Breakdown:
Stage 4 – Training start through L-35
Stage 3 – L-34 through L-19
Stage 2 – L-18 through L-5
Stage 1 – L-4 through “T-38 to KSC” (not launch)

Stage Loading Limits:
These are average limits per week.
Stage 4 – 41 hrs
Stage 3 – 41 hrs
Stage 2 – 44 hrs
Stage 1 – 41 hrs

Growth:
Standard growth rates will be added to the total hours as follows:
12% of total hours added to Stages 3 & 4
3% of total hours added to Stage 2
1% of total hours added to Stage 1

A.7.3 Assumptions and Background Information

• Launch not “clustered” with others
• All milestones met, all flight products available on-time
• Start @ 52-weeks FULL TIME
• Task panel occurs 5 weeks prior to training start requirement
• Crewmembers all 20000-level qual’d in EVA, PDRS, RNDZ, and ROBO
• All standard Aircraft Operations Directorate (AOD) requirements, Physical Training, and Admin requirements are included in the assessment
• No AOD or other non-flight specific currency requirements will be satisfied within four weeks of launch
• JOP, IPT, Monthly crew tags through L-10
• No refresher, proficiency, or “as required” training in the budget
• Schedule constraints are not considered (e.g., Expedition crew availability, personal constraints, facility constraints)
• Only one Crew Medical Officer (CMO) for crew rotation flights
• PDRS crewmembers back each other up

• ROBO (MSS) operators back each other up

• CBM training is assumed for budget which should umbrella any necessary CAS or Segment-to-Segment Attachment System (SSAS) training

• *No travel PAO/Public Relations (PR) events inside of Stage 3. No local PAO/PR events inside of Stage 2*

• When CTC presents lesson options dependent upon experience or currency, budget will assume crew is inexperienced and/or out of currency. For example, budget will assess full chamber run and photo EQ lessons as opposed to overviews
## Table A-3. Budget Summary

<table>
<thead>
<tr>
<th>Flow Name</th>
<th>Non-Crew Rotation</th>
<th>Crew Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C     P   MS1  MS2  MS3  MS4</td>
<td>C     P   MS1  MS2</td>
</tr>
<tr>
<td><strong>Stage 4</strong></td>
<td>Stage Totals Per Crewmember:</td>
<td></td>
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<tr>
<td>CORE SYS Flow</td>
<td>15    19  2   19   2   0</td>
<td>15    19  2   19   2   0</td>
</tr>
<tr>
<td>CREW SYS Flow</td>
<td>5     5   11  11   5   5</td>
<td>5     5   11  11   5   5</td>
</tr>
<tr>
<td>MED OPS Flow</td>
<td>0.4   0.4  1.4  1.4   1.4  1.4</td>
<td>0.4   0.4  1.4  1.4   1.4  1.4</td>
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<tr>
<td>STS PHO/TV Flow</td>
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<td>22    22  22   22   22  22</td>
</tr>
<tr>
<td>ASC ENT Flow</td>
<td>83.5  83.5 22  83.5   5   3</td>
<td>83.5  83.5 22  83.5   5   3</td>
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<tr>
<td>ORB FO Flow</td>
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<td>40    40  38.5 38.5   32.5 0</td>
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<td>EVA TASK Ops Flow</td>
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<td>55.5  75  75   75  75  75</td>
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<td>PDRS Flow</td>
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<td>14    7   4    7    4   14</td>
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<td>RNDZ Flow</td>
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<td>SHAB Flow</td>
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<td>0     0   0    0    0   0</td>
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<tr>
<td>MPLM Flow</td>
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<td>0     0   0    0    0   0</td>
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<td>INT SIM Flow</td>
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<td>0     0   0    0    0   0</td>
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<td>113   92  92   92   95.5 92</td>
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<tr>
<td>Formal</td>
<td>107   107 107  107   107 107</td>
<td>107   107 107  107   107 107</td>
</tr>
<tr>
<td>A/C Ops</td>
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<td>110   110 16   16    23  16</td>
</tr>
<tr>
<td>Holiday/Leave</td>
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<td>56    56  56   56    56  56</td>
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<td>GROWTH</td>
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<td>24.75 24.75 24.75 24.75 24.75 24.75</td>
<td>24.75 24.75 24.75 24.75 24.75 24.75</td>
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<td>STS PHO/TV Flow</td>
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<td>17    17  7    17   7    0</td>
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<td>30.5  30.5 29   30.5  29   0</td>
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<td>0    25.25 25.25 25.25</td>
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<td>36.5  36.5 36.5 36.5  0   36.5</td>
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<td>INT SIM Flow</td>
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<td>94    94  94   94    94  94</td>
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# Table A-3. Budget Summary (Concluded)

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**Non-Crew Rotation**

**Crew Rotation**

**Sub Total for Stage**

**Stage Totals Per Crewmember:**

|        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 4      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 116.5  | 113    | 92     | 92     | 95.5   | 92     | 92     | 95.5   | 92     | 92     | 92     | 92     | 92     | 92     | 92     | 92     | 92     | 92     | 92     | 92     | 92     |

**Comments**

- @ FCE Schedule 2 at a time; try to schedule a flown crewmember with a non-flown crewmember.
- Prior to SMS
- Prior to 3000 SMS Lessons
- Prior to SMS Lessons CDR, CB IA, SMS Team Lead.
- As required
- Annually
- Schedule near Annual Physical
- 7 to 8 months prior to launch
- Food tasting
- Schedule
- 1.5 hours 3x/week
- Prior to 3000 SMS Lessons
- 1.5 hours 3x/week for EVA CMs within 6 mos of launch
- 3x/week
- 3x/week for EVA CMs within 6 mos of launch
- Train skeleton for EVA CMs within 6 mos of launch.
## Table A-4. Flight Support – Information (Continued)

| Stage | Seq Num | Lesson Code | Media | Hours | Sched Code | C | P | MS1 | MS2 | MS3 | MS4 | PS | C | P | MS1 | MS2 | MS3 | MS4 | PS | Comments |
|-------|---------|-------------|-------|-------|------------|----|----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|----|----------|
| 3     | 3F-8    | Annual Physical | JSC/Bldg 8 | 3.5  | 3.5 | 3.5 | 3.5 | | | | | | | | | | | Yearly on birth month |
| 3     | 3F-9    | Flight Crossing Firework | | | | | | | | | | | | | | | | 1-4 Months before T/LC |
| 3     | 3F-10   | Frequent Appearances Planning Meeting | | | | | | | | | | | | | | | | L-3 Months |
| 3     | 3F-11   | Flight Photo | Bldg 8 Studio | 8  | 8  | 8  | 8  | | | | | | | | | | | Every 2 to 8 weeks |
| 3     | 3F-12   | Flight IPT (2 hours x 4 months) | Mtg Rm | 8  | 8  | 8  | 8  | | | | | | | | | | | 3-4 months prior to flight |
| 3     | 3F-13   | Flight Ops Review | Mtg Rm | 8  | 8  | 8  | 8  | | | | | | | | | | | As needed |
| 3     | 3F-14   | Flight JOP (2 hours x 4) | Mtg Rm | 8  | 8  | 8  | 8  | | | | | | | | | | | As needed |
| 3     | 3F-15   | Physical Training (Gym)[4.5 hours x 15 weeks] | 3.5  | 3.5 | 3.5 | 3.5 | 3.5 | Yearly | | | | | | | | | | Yearly on birth month |
| 3     | 3F-16   | Flight Clothing Fitcheck | 2  | 2  | 2  | 2  | 2  | | | | | | | | | | | Every 2-6 months @ FCE |
| 3     | 3F-17   | Postflight Appeances Planning Meeting | Crew Office | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-18   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-19   | Physical Training (Gym)[4.5 hours x 15 weeks] | 3.5  | 3.5 | 3.5 | 3.5 | 3.5 | Yearly | | | | | | | | | | Yearly on birth month |
| 3     | 3F-20   | Flight Clothing Fitcheck | Mtg Rm | 8  | 8  | 8  | 8  | | | | | | | | | | | Every 2 to 8 weeks |
| 3     | 3F-21   | Flight Clothing Fitcheck | Mtg Rm | 8  | 8  | 8  | 8  | | | | | | | | | | | As needed |
| 3     | 3F-22   | Postflight Appearance Planning Meeting | Crew Office | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-23   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-24   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-25   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-26   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-27   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-28   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-29   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-30   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-31   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-32   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-33   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-34   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-35   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-36   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-37   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-38   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-39   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-40   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-41   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-42   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-43   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-44   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-45   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-46   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-47   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-48   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-49   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |
| 3     | 3F-50   | Postflight Appearance Planning Meeting | Bldg 8 Studio | 0.5 | 0.5 | | | | | | | | | | | | | | L-6 months |

**Date Last Modified:** 06/08
### Table A-4. Flight Support – Information (Concluded)

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Sub Total for Stage 4: Stage Totals Per Crewmember:

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Sub Total for Stage 1: Stage Totals Per Crewmember:

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Sub Total for Stage 1: Stage Totals Per Crewmember:
APPENDIX B  SPACEFLIGHT RESOURCE MANAGEMENT

CB IA will attend selected ORB FO lessons as determined in SFRM Training Strategy Meeting

CB IA will attend selected INT SIMs as determined in SFRM Training Strategy Meeting
APPENDIX C  PAYLOAD SPECIALIST TRAINING INFORMATION
# PAYLOAD SPECIALIST SELF STUDY MATERIAL LIST

<table>
<thead>
<tr>
<th>Title</th>
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<td>CREW CAB FAM 21020</td>
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**Recommended Reference Material**

- Shuttle Crew Operations Manual
- Shuttle Crew Training Catalog
PAYLOAD SPECIALIST TRAINING FLOW CHART

NEW ASTRONAUT FLOW

START

PS Training Flowchart – 1

USA002960
Rev. J
PS Training Flowchart – 3
## APPENDIX D  ACRONYMS AND ABBREVIATIONS

### D.1 COMMON WORDS AND ACRONYMS

The below listed acronyms do not have to be spelled out every time they appear.

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<td>Detailed Secondary Objectives</td>
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<td>JSC</td>
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<td>KSC</td>
<td>Kennedy Space Center</td>
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<td>L-</td>
<td>Launch minus</td>
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<td>VERN</td>
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D.2 DOCUMENT ACRONYMS

A/A  Air-to-Air
A/E  Ascent/Entry
A/L  Airlock
     Approach and Landing
A/G  Air-to-Ground
AA   Accelerometer Assembly
ABE  Arm-Based Electronics
ACAS Automatically Commanded Auto Sequence
ACCU Audio Central Control Unit
ACO  Assembly and Checkout Officer
ACS  Audio Control Subsystem
ADC  Analog to Digital Converter
ADCO Attitude Determination and Control Officer
ADI  Attitude Direction Indicator
ADS  Air Data System
     Audio Distribution System
ADTA Air Data Transducer Assembly
AESP Ascent/Entry Systems Procedure
AKA Active Keel Actuator
ALC  AFT Load Controller
AMI  Alpha Mach Indicator
AMS  Atmosphere Monitoring Subsystem
ANT  Antenna
AOA  Abort Once Around
AOD  Aircraft Operations Directorate
AOS  Acquisition of Signal
APCL Ascent Pocket Checklist
APFR Articulating Portable Foot Restraint
APLS Atmosphere Pressure Limiting Subsystem
APU  Auxiliary Power Unit
ARCS AFT Reaction Control System
ARS  Atmosphere Revitalization (Sub)system
ASA  Aerosurface Servo Amplifier
ASC  Ascent
ASM  Aviation Safety Meeting
ASP  Astronaut Support Personnel
ATCS Active Thermal Control System
     Atmosphere Thermal Control Subsystem
ATO  Abort To Orbit
ATT  Attitude
ATU  Audio Terminal Unit
ATV  Automatic Transfer Vehicle
ATVC Ascent Thrust Vector Control
AUT  Automatic
Av Avionics
AVVI Altitude Vertical Velocity Indicator
AVU Artificial Vision Unit
AZ Azimuth

BCA Battery Charger Assembly
BDA Bermuda
BFC Backup Flight Controller
BFS Backup Flight Software
Backup Flight System
BIT Built-In Test
BITE Built-In Test Equipment
BNC British Naval Connector
BOB Breakout Box
BPSMU Battery Powered Speaker Microphone Unit
BSA Battery Stowage Assembly
BSE Booster Systems Engineer
BTA Bends Treatment Adapter
BTU Bus Terminal Unit

C&C  Command and Control
C&DH Command and Data Handling
C&T Communication and Tracking
C&W Caution and Warning
C/L Checklist
C/O Checkout
c.g. Center of Gravity
CAD Command and Display
CAL Calibration
CAM Computer Annunciation Matrix
CAP Crew Activity Plan
CAS Common Attach System
cb circuit breaker
CBCS Centerline Berthing Camera System
CBT Computer Based Training
CCA Communications Carrier Assembly
CCC Contaminant Control Cartridge
CCCR Crew Compartment Configuration Review
CCK Contaminant Cleanup Kit
CCU Crew Communicator Umbilical
CDF Command Frame
CDH Command and Data Handling
CDM Carbon Dioxide Monitor
CEIT Crew Equipment Interface Test
CEPA Columbus External Payload Adaptor
CETA Crew and Equipment Translation Aid
Crew Equipment Translation Aid
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RCU  Remote Control Unit
RDM  Research Double Module
REBA Rechargeable EVA Battery Assembly
REF  Reference
REFSMMAT Reference Stable Member Matrix
REL  Relative Display Mode
RESID Residual
RF   Radio Frequency
RGA  Rate Gyro Assembly
RHC  Rotational Hand Control
RJD  Reaction Jet Driver
RM   Redundancy Management
RMCT Robot Micro Conical Tool
ROEU Remotely Operated Electrical Umbilical
ROS  Russian On-orbit Segment
ROST Robotic Offset Tool
RPCM Remote Power Control Module
RPOPSIM Rendezvous/Prox Ops Program Simulation
RPS  Rack Power Switch
RPTA Rudder Pedal Transducer Assembly
RR   Rendezvous Radar
RS   Redundant Set
     Russian Segment
RSAD Remote Manipulator System (RMS) Situational Awareness Display
RSO  Range Safety Officer
RSP  Resupply Stowage Platform
RTL  Ready-To-Latch
RTLS Return-To-Launch Site
RWS  Robotic Workstation
SA   Situational Awareness
SAIL Shuttle Avionics Integration Laboratory
SAR  Search and Rescue
SARSAT Search and Rescue Satellite Aided Tracking
SAW Soyuz, Acknowledge alarm, Warn others
SBT  Shuttle Budget Team
SBTC Speed Brake Thrust Controller
SCOM Shuttle Crew Operations Manual
SCU  Service and Cooling Umbilical
SEE  Shuttle Emergency Eyewash
SEP  Separation
SERC Single Engine Roll Control
SES  Shuttle Engineering Simulator
     Systems Engineering Simulator
SFRM Space Flight Resource Management
SGLS Space-Ground Link System
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<td>SSSR</td>
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Trajectory Control Sensor
TDRS  Tracking and Data Relay Satellite
TEC   techniques
TEPC  Tissue Equivalent Proportional Counter
TERM  Terminate
TFL   Telemetry Format Load
TGT   Target
THC   Translation(al) Hand Controller
TI    Terminal Phase Initiation
TIG   Time of Ignition
TM    Torque Multiplier
TMG   Thermal Model Generator
TNL   Tunnel
TORVA Twice Orbit Rate to a Vbar Approach
TPS   Thermal Protection System
TRAD  Tile Repair Ablator Dispenser
TRAJ  Trajectory
TRK   Track
TSA   Tool Stowage Assembly
TV    Television
      Time-Vector

UCCAS Unpressurized Cargo Carrier Attach System
UIA   Umbilical Interface Assembly
UMA   Umbilical Mechanism Assembly
UNIV  Universal
UOP   Utility Outlet Panel
USA   United Space Alliance
USOS  United States On-orbit Segment

V-BAR Velocity Vector Axis
VAJ   Vacuum Access Jumper
VCU   Video Control Unit
VDS   Video Distribution Subsystem
VGO   Velocity to Go
VGS   Video Graphic Software
VI    Inertial Velocity
VITT  Vehicle Integration Test Team
VLHS  Very Lightweight Headset
VMS   Vertical Motion Simulator
VR    Virtual Reality
Vrel  Relative Velocity
VSU   Video Switching Unit
VTR   Video Tape Recorder
VTS   Video Teleconference System
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The following list includes all the lessons in the Crew Training Catalog arranged in alphabetical order. Each lesson is identified by the training flow name and reference number for ease of reference.

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**Note On Stage Assignments:**

The N ASTRO Flow is completed before the crewmember is assigned to a mission; the stages only apply to time periods within training for a specific flight. The INT SIM section is not designed to be a flow. It is extremely flight-specific and is not consistent across missions. For more information on INT SIM stage assignments, refer to the INT SIM table.

*1 Lesson without a specific reference number. Refer to Table 1 or lesson description within course.
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