

Joint Shuttle-ISS Operational Flight Rules Annex

STS-117/13A ISS Expedition 15

Mission Operations Directorate

Final

February 22, 2007

Final, PCN-3

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National Aeronautics and
Space Administration

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JOINT SHUTTLE-ISS OPERATIONAL FLIGHT RULES ANNEX

STS-117/13A, ISS EXPEDITION 15

FINAL, PCN-3

PAGE CHANGE NOTICE (PCN) REVISION INSTRUCTION SHEET

THIS FINAL, PCN-3, DATED JUNE 4, 2007, REFLECTS CHANGES RELATIVE TO ALL FLIGHTS SINCE THE FINAL, PCN-2 DOCUMENT, DATED MAY 24, 2007. UPDATE THIS DOCUMENT IN ACCORDANCE WITH THE FOLLOWING INSTRUCTIONS.

ADD, REMOVE, OR REMOVE AND REPLACE THE FOLLOWING PAGES:

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STS-117/13A, ISS EXPEDITION 15

FINAL, PCN-3

JUNE 4, 2007

THIS DOCUMENT INCORPORATES CHANGES TO THE FOLLOWING RULES (SINCE THE FINAL, PCN-2 DATED, MAY 24, 2007) BY THE APPLICABLE DISCREPANCY NOTICES (DN'S) AND CHANGE REQUESTS (CR'S).

<u>RULE NO.</u>	<u>DN/CR NO.</u>	<u>RUSSIAN REFERENCE</u>	<u>RULE NO.</u>	<u>DN/CR NO.</u>	<u>RUSSIAN REFERENCE</u>
13A_A2-11	CR 8617A				
13A_B2-2	ED	[RC]			
13A_B2-16	CR 8622A				
13A_C2-71	ED	[RC]			
13A_C2-106	CR 8324A	[RC]			
13A_C10-11	CR 8619	[RC]			
13A_C12-3	CR 8621				
13A_A13-2	CR 8607				
13A_A13-4	CR 8608				
13A_C17-2	ED	[RC]		BOOK MGR	<u>BAL 06/04/07</u>
13A_C17-3	ED	[RC]		FINAL QA	<u>ned 06/04/07</u>

JOINT SHUTTLE-ISS OPERATIONAL FLIGHT RULES ANNEX

STS-117/13A, ISS EXPEDITION 15

FINAL, PCN-3

PREFACE

THIS DOCUMENT, DATED JUNE 4, 2007, CONTAINS THE FINAL, PCN-3 VERSION OF THE STS-117/13A, ISS EXPEDITION 15 FLIGHT-SPECIFIC FLIGHT RULES AND IS INTENDED TO BE USED IN CONJUNCTION WITH NSTS-12820, SPACE SHUTTLE OPERATIONAL FLIGHT RULES, VOLUME A; ISS GENERIC OPERATIONAL FLIGHT RULES, VOLUME B; JOINT SHUTTLE/ISS GENERIC OPERATIONAL FLIGHT RULES, VOLUME C; OR SOYUZ/PROGRESS/ISS JOINT FLIGHT RULES, VOLUME D, WHICH CONTAIN THE GENERIC FLIGHT RULES FOR ALL FLIGHTS.

IT IS REQUESTED THAT ANY ORGANIZATION HAVING COMMENTS, QUESTIONS, OR SUGGESTIONS CONCERNING THESE FLIGHT RULES CONTACT DA8/ B. A. LEVY, FLIGHT DIRECTOR OFFICE, BUILDING 4 NORTH, ROOM 3027A, PHONE 281-483-8586.

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THIS IS A CONTROLLED DOCUMENT AND ANY CHANGES ARE SUBJECT TO THE CHANGE CONTROL PROCEDURES DELINEATED IN APPENDIX B. THIS DOCUMENT IS NOT TO BE REPRODUCED WITHOUT THE WRITTEN APPROVAL OF THE CHIEF, FLIGHT DIRECTOR OFFICE, DA8, LYNDON B. JOHNSON SPACE CENTER, HOUSTON, TEXAS.

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FLIGHT RULES

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FLIGHT RULES

13A A2-11 LANDING SITE SELECTION [HC]

THE FOLLOWING EXCEPTIONS TO RULE {A2-207}, LANDING SITE SELECTION [HC], ARE APPLICABLE FOR STS-117/13A: @CR 8617A]

Due to 2007 Space Shuttle Program Probabilistic Risk Analysis (PRA) updates and an incorporation of the latest LANDSCAN 2005 population database, the overall space shuttle entry risk posture has improved by approximately 15 percent. This improved risk posture warranted a change to the crossranges in Rule {A2-207}, LANDING SITE SELECTION [HC], Paragraph C, EOM Priorities, and Paragraph E, Compromised Orbiter Priorities, for STS-117/13A. These updates documented in this annex rule were reviewed by Ascent/Entry Flight Techniques Panel (A/EFTP) #231 on May 18, 2007.

A. RTLS/TAL PRIORITIES: NO EXCEPTIONS

B. AOA PRIORITIES: NO EXCEPTIONS

C. EOM PRIORITIES:

1. KSC
2. EDWARDS 22/04
3. NORTHRUP

NOTE: WHEN FEASIBLE AND WHILE SATISFYING OTHER LANDING SITE SELECTION PRIORITIES FOR WEATHER, CONSUMABLES, RUNWAY CONDITIONS, AND ENTRY CONSTRAINTS, THE FOLLOWING CROSSRANGES WILL BE AVOIDED IN ORDER TO ABATE RISK TO THE GENERAL PUBLIC:

	<u>ASCENDING LEFT</u>	<u>ASCENDING RIGHT</u>
<u>KSC</u>	<u>NONE</u>	<u>NONE</u>
<u>EDW 22</u>	<u>335-637 NM</u>	<u>NONE</u>
<u>EDW 04</u>	<u>0-22 NM</u> <u>356-680 NM</u>	<u>0-158 NM</u>
<u>NOR 17</u>	<u>NONE</u>	<u>720-731 NM</u>
<u>NOR 35</u>	<u>NONE</u>	<u>722-730 NM</u>

@CR 8617A]

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FLIGHT RULES

13A A2-11 LANDING SITE SELECTION [HC] (CONTINUED)

Due to the advantages in vehicle turnaround, the Space Shuttle Program has directed that nominal end of mission (EOM) landings utilize KSC as the first priority landing site. @[CR 8617A]

After KSC, next in the EOM runway selection priority is Edwards AFB, because of the availability of the concrete runway and because of the significant vehicle post landing and turnaround operations capabilities. NOR is generally last priority because, although it provides an excellent orbiter landing site (laser-leveled runways, crossing runways, significant runway lateral and longitudinal margin, all required landing aids, and NAVAIDS for day and night, etc.), the ability to support the orbiter systems postlanding and for turnaround/ferry operations is much reduced as compared to KSC or Edwards, resulting in the potential for significant (several weeks') shuttle schedule/manifest impacts.

As a result of NASA Range Safety policy (ref. NASA Procedural Requirements, NPR 8715.5, Range Safety Program), entry public risk is a consideration in space shuttle landing site selection. The Space Shuttle Program and the Agency have determined that the entry public risk associated with the highest risk ascending landing opportunity to KSC is acceptable for the remaining space shuttle missions. This is because of the established space shuttle design and operational constraints and, further, because any significant changes to shuttle entry operations could have a negative effect on the crew and mission. Additionally, the combination of STS hardware improvements, launch and orbit imagery capability, and post launch vehicle inspections established for Return to Flight (RTF) provides significant abatement for entry public risk. Finally, since all ascending approaches to KSC from the ISS orbit are of the same order of magnitude relative to entry public risk, there are no entry public risk restrictions for any EOM KSC ascending approach.

When EDW and NOR must be utilized, the level of risk defined by the highest risk KSC opportunity serves as benchmark to define higher risk crossranges that should be given special consideration. For EDW-04, ascending left crossranges from 0-22 nm and 356-680 nm along with ascending right crossranges from 0 to 158 nm exceed the highest risk KSC opportunity. For EDW-22, only ascending left crossranges from 335-637 nm exceed this limit. For Northrup 17 landings, ascending right crossranges from 720-731 nm exceed that of the highest risk KSC opportunity. For Northrup 35 landings, ascending right crossranges from 722-730 nm exceed that of the highest risk KSC opportunity. When Edwards or Northrup is required, the deorbit/entry approach should be selected to avoid these crossranges to the extent feasible and when not precluded by other high priority requirements that provide for a safe entry and landing such as weather, consumables, runway conditions, entry constraints, crew health, etc.

For PLS planning, the special EDW and NOR crossrange placards will not be utilized to select the daily and/or no comm PLS to maximize operational flexibility and number of landing opportunities available. Once a PLS is declared, this rule will be utilized to determine the correct landing site and deorbit opportunity. @[CR 8617A]

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FLIGHT RULES

13A A2-11 LANDING SITE SELECTION [HC] (CONTINUED)

Additionally, EOM descending opportunities are not used operationally on ISS missions because of significant impacts to the crew timeline and sleep shifting, noctilucent clouds concerns during the summer months (June through August), and an additional 15 fps propellant cost for the deorbit burn, which is not budgeted for pre-mission. However, if a descending opportunity were planned for nominal EOM, there are no restrictions for Edwards approaches. KSC15 opportunities for descending right 749-758 nm will be avoided to the extent feasible. KSC33 opportunities from descending left 741-777 nm along with descending right 737-771 nm will also be avoided to the extent feasible. Finally, Northrup descending left opportunities from 767-784 nm will be avoided to the extent feasible. @[CR 8617A]

Finally, EDW-04 opportunities with ascending left crossranges from 8 nm to 35 nm need to be carefully evaluated using established Flight Dynamics Officer and Entry Support procedures to ensure that initial bank direction is in the expected direction (to the left). Based on this analysis, the EDW-04 crossrange placards for these opportunities may need to be expanded.

Reference Program Requirements Control Board, December 2, 2004; A/EFTP #209A, January 21, 2005; and A/EFTP #231, May 18, 2007.

Reference Rule [A4-109], DEORBIT PRIORITY FOR EOM WEATHER.

Reference Rule [A2-202], EXTENSION DAY GUIDELINES, for cases where the PLS is NO-GO.

D. SYSTEMS FAILURE PRIORITIES: NO EXCEPTIONS

E. COMPROMISED ORBITER PRIORITIES:

1. FOR THE PURPOSES OF ENTRY PUBLIC RISK, A COMPROMISED ORBITER IS A CONDITION THAT SUBSTANTIALLY REDUCES THE LIKELIHOOD OF A NOMINAL ENTRY INCLUDING:
 - a. LOSS OF ALL FAULT TOLERANCE IN AN ENTRY CRITICAL SYSTEM DUE TO A COMMON CAUSE FAILURE MODE
 - b. APU, OMS, RCS FUEL LEAK WITH RISK OF FUEL COMBUSTION DURING ENTRY
 - c. STUCK OR MECHANICAL DEGRADATION OF ANY AEROSURFACE ACTUATOR (ELEVON, BODYFLAP, SPEEDBRAKE, OR RUDDER)
 - d. ANY THERMAL PROTECTION SYSTEM DAMAGE THAT MEETS REPAIR CRITERIA @[CR 8617A]

THIS RULE CONTINUED ON NEXT PAGE

FLIGHT RULES

13A A2-11 LANDING SITE SELECTION [HC] (CONTINUED)

- e. ENTRY CRITICAL STRUCTURAL OR MECHANISM DAMAGE
@[CR 8617A]
- f. ANY CONDITION(S) THAT CAUSE THE ORBITER TO FLY
OUTSIDE CERTIFIED ENTRY CAPABILITY

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2. IN THE CASE OF A COMPROMISED ORBITER, THE EOM PRIORITIES
ARE MODIFIED TO FURTHER ABATE RISK TO THE GENERAL PUBLIC
BY SELECTING SPECIFIC LOWER PUBLIC RISK APPROACHES. FOR
NORTHROP AND EDWARDS, THE SPECIFIC CROSSRANGES IN THE
TABLE WILL BE TARGETED:

- a. NORTHROP
- b. EDW 22/04
- c. KSC

<u>CROSSRANGE</u>	<u>ASCENDING LEFT</u>	<u>ASCENDING RIGHT</u>
<u>NOR 17</u>	<u>0-430 NM</u>	<u>0-178 NM</u> <u>230-630 NM</u> <u>780-830 NM</u>
<u>NOR 35</u>	<u>0-462 NM</u>	<u>0-140 NM</u> <u>167-227 NM</u> <u>269-649 NM</u> <u>772-828 NM</u>
<u>EDW 22</u>	<u>NONE</u>	<u>459-617 NM</u> <u>670-702 NM</u>
<u>EDW 04</u>	<u>NONE</u>	<u>410-600 NM</u>
<u>KSC</u>	<u>NONE</u>	<u>NONE</u>

A compromised orbiter is defined as any condition or failure that substantially reduces the likelihood of a nominal entry and landing. A compromised orbiter results from a loss of all fault tolerance in an entry critical system due to a common cause failure mode or known damage in vehicle structures, mechanisms, or thermal protection system (TPS), or any scenario that is predicted to result in conditions that cause the orbiter to fly outside the certified entry capability. In order to meet the compromised orbiter definition, there must be a known pre-deorbit burn condition where there is a significant increased risk of loss of control during entry such as those listed in Paragraph E.1. Since it is impossible to list all possible compromised orbiter scenarios, other failures with a significantly increased risk of loss of control during entry may be evaluated in real time. @[CR 8617A]

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FLIGHT RULES

13A A2-11 LANDING SITE SELECTION [HC] (CONTINUED)

Loss of Entry Critical Fault Tolerance: Loss of all fault tolerance (i.e., zero fault tolerant configuration) in an entry critical system does not constitute a compromised orbiter scenario unless that loss of fault tolerance is due to a common cause failure mechanism (i.e., generic failure mode). For a loss of all fault tolerance in an entry critical system unrelated to common cause, the EOM priorities shall be followed and are as listed in paragraphs C and D of this rule. ©[CR 8617A]

APU, OMS, RCS Fuel Leaks: OMS, RCS, or APU fuel leaks pose a significant risk of combustion and collateral damage in the associated pod or aft part of the vehicle during the subsonic portion of entry.

Stuck or Mechanically Degraded Aerosurface: These are Crit 1/1 failure modes that the vehicle Flight Control System (FCS) was not designed to accommodate. Other FCS Channel problems are governed by paragraph D.

Thermal Protection System (TPS) Damage: Until certified TPS repair techniques are developed, any TPS damage that meets repair criteria will be categorized as a compromised orbiter.

Entry Critical Structural Damage: Any damage to structure or mechanisms that provide insufficient thermal or structural margin for entry and landing will be placed in the compromised orbiter category (i.e., multiple vent doors or star tracker doors failed open).

Conditions Outside Certified Entry Capability: When an entry is planned such that the vehicle is flying outside the certified analyzed entry capability, the compromised orbiter landing site considerations apply. One known exception to this category is a landing weight exceedance that is subsequently cleared through thermal and/or structural analysis.

A compromised orbiter entry will be performed to Northrup, Edwards, and KSC, in that order of priority and within the landing site crossrange restrictions listed, in order to abate the public risk to the extent feasible while maintaining a CONUS PLS landing capability. The crossranges identified in paragraph E reduce risk to the general public by approximately one order of magnitude when compared to the highest risk KSC opportunity.

Although descending opportunities are not planned to be used pre-mission, if they are utilized in a compromised orbiter scenario, the following crossranges should be utilized provided mission specific crossrange limits are met. ©[CR 8617A]

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FLIGHT RULES

13A A2-11 LANDING SITE SELECTION [HC] (CONTINUED)

<u>CROSSRANGE</u>	<u>DESCENDING LEFT</u>	<u>DESCENDING RIGHT</u>
<u>NOR 17</u>	<u>476-512 NM</u> <u>128-474 NM</u>	<u>29-189 NM</u> <u>204-410 NM</u> <u>497-600 NM</u>
<u>NOR 35</u>	<u>131-527 NM</u>	<u>34-198 NM</u> <u>201-416 NM</u> <u>497-604 NM</u>
<u>EDW 22</u>	<u>> 764 NM</u> <u>694-709 NM</u>	<u>> 831 NM</u> <u>769-784 NM</u>
<u>EDW 04</u>	<u>> 665 NM</u>	<u>773-786</u>
<u>KSC</u>	<u>NONE</u>	<u>NONE</u>

@[CR 8617A]

F. PREDEORBIT LANDING SITE EVALUATION: NO EXCEPTIONS @[CR 8617A]

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FLIGHT RULES

ISS ONLY RULES

13A_B2-1 CONTINGENCY EVA'S

A STAGE CONTINGENCY EVA WILL BE CONSIDERED FOR ANY OF THE FOLLOWING:

- A. 13A STAGE UNIQUE TASKS: @[CR 8255]
 - 1. DEPLOY S4 PVR
 - 2. DEPLOY S4 SAW

- B. COMPLETE USOS OR RS CRITICAL MAINTENANCE TASKS ("BIG 13"):
 - 1. REPLACE SEQUENTIAL SHUNT UNIT (SSU).
 - 2. REPLACE DC SWITCHING UNIT (DCSU).
 - 3. REPLACE DC-DC CONVERTER UNIT (DDCU-E).
 - 4. MANUAL POSITIONING OF SOLAR ARRAYS.
 - 5. REPLACE PUMP FLOW CONTROL SUBASSEMBLY (PFCS).
 - 6. NH₃ LEAK ISOLATION/RECOVERY (FLAP AND FLUID LEAK INDICATOR (FLI)) @[CR 8314]
 - 7. REPLACE PHOTOVOLTAIC CONTROLLER UNIT (PVCU) MDM.
 - 8. REPLACE PUMP MODULE (PM).
 - 9. REPLACE MAIN BUS SWITCHING UNIT (MBSU).
 - 10. REPLACE LAB INTERFACE HEAT EXCHANGER (IFHX).
 - 11. BACK OUT BATTERY CHARGE/DISCHARGE UNIT (BCDU).
 - 12. REPLACE EXTERNAL CONTROL ZONE (EXT) MDM.
 - 13. REPLACE FLEX HOSE ROTARY COUPLER (FHRC). @[CR 8255]
@[CR 8314]

FLIGHT RULES

13A_B2-2 PERMISSIBLE ISS STAGE ATTITUDES AND ATTITUDE DEVIATIONS [HC] [RC] @[DN 180]

~~PENDING RUSSIAN CONCURRENCE~~

A. THE FLIGHT ATTITUDES AND THEIR ASSOCIATED ATTITUDE ENVELOPES DEFINED IN TABLE 13A_B2-2-I PROVIDE THE LIMITING ATTITUDE ENVELOPE VALUES IN THE EVENT THAT THE EATCS ATTITUDE ENVELOPE CONSTRAINTS IN TABLE 13A_B2-2-II ARE EXCEEDED. @[CR 8360] @[ED]

TABLE 13A_B2-2-I - ATTITUDE ENVELOPE LIMITS IF EATCS ATTITUDE CONSTRAINTS ARE EXCEEDED

REFERENCE FRAME	BETA [2]	ATTITUDE NAME	APPROVED ATTITUDE RANGES		
			YAW	PITCH	ROLL
ISS LVLH	$\beta \leq -52^\circ$	+ZLV +XVV	-5° TO +15°	-20° TO +15°	0° TO +15°
	$-52^\circ < \beta < +52^\circ$		-15° TO +15°	-20° TO +15°	-15° TO +15°
	$\beta \geq +52^\circ$		-15° TO +5°	-20° TO +15°	-15° TO +5°

The nominal flight attitudes and their associated attitude envelopes and constraints are identified in Table 13A_B2-2-I above and do not take into account ETCS analysis. Table 13A_B2-2-II was developed to capture these attitude envelope modifications.

The TRRJ Autotrack algorithm requires attitude specific PPL's to operate per design, per Rule {13A_B18-25}, TRRJ AUTOTRACK BIAS MANAGEMENT. In the event that Autotrack is not used, the TRRJ will be parked per analyzed parking Tables in Rule {13A_B18-2}, MANUAL TRRJ POSITIONING.

These PPL's and parking tables were constructed around the predicted TEA's (± 5 deg per axis) at the time of the active thermal control system (ATCS) analysis. These same TEA's were used to construct the attitude envelopes in Table 13A_B2-2-II.

It is understood that based upon a number of variables, the TEA's analyzed by ATCS could differ from the ones that the GN&C attitude controllers (which are certified to meet the +ZLV +XVV attitude envelope requirements) will try to maintain when they are implemented on-orbit. In the event that the actual, on-orbit TEA's fall outside of the range of the attitude envelopes shown in Table 13A_B2-2-II, but remain within the bounds of Table 13A_B2-2-I, guidance is provided in the Table Notes on the positioning of the TRRJ's.

1. TRANSITORY EXCURSIONS OUTSIDE APPROVED RANGES MAY BE UP TO AND INCLUDING 5 DEGREES PER AXIS.

Although the instantaneous ISS attitude may deviate from the approved envelopes, the orbit average must still be within limits. Source: SSCN 3383B (January 2001) to D684-10198-06 DCN002, ISS Flight Attitudes (December 1, 1999). @[CR 8360]

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FLIGHT RULES

13A_B2-2 PERMISSIBLE ISS STAGE ATTITUDES AND ATTITUDE DEVIATIONS [HC] [RC] (CONTINUED)

- 2. MANEUVERS BETWEEN APPROVED ATTITUDE ENVELOPES SHALL BE PERFORMED WITH THE FOLLOWING CONSTRAINTS: @CR 8360]
 - a. THE MAXIMUM MANEUVER TIME SHALL BE ONE ORBITAL PERIOD.
 - b. THE SOLAR POINTING VECTOR IN THE ISS BODY AXIS SHALL NOT BE STATIC DURING THE MANEUVER.

Source: SSCN 3383B (January 2001) TO D684-10198-06 DCN002, ISS Flight Attitudes (December 1, 1999). @ED]

- B. THE PLANNED STAGE ATTITUDE ENVELOPES ARE DEFINED IN TABLE 13A_B2-2-II.

TABLE 13A_B2-2-II - PLANNED ATTITUDE ENVELOPES

REFERENCE FRAME	BETA [2]	ATTITUDE NAME	PLANNED ATTITUDE ENVELOPES [2] [3]		
			YAW	PITCH	ROLL
ISS LVLH	$\beta \leq -52^\circ$ [1]	+ZLV +XVV	-5° TO +3°	-13° TO -3°	0° TO +7° [4]
	$-52^\circ < \beta < +52^\circ$		-7° TO +3°	-13° TO -3°	-3° TO +7°
	$\beta \geq +52^\circ$ [1]		-7° TO +3°	-13° TO -3°	-3° TO +5°

NOTES:

- [1] THE YAW AND ROLL RANGES FOR THE +ZLV +XVV ATTITUDE WHEN |BETA| > 52 ARE CONSTRAINED BY NODE 1 MDM AND ESP1 PFCS THERMAL LIMITS.
- [2] POWER GENERATION MUST BE SUFFICIENT TO SUSTAIN THE NECESSARY ISS SYSTEMS. ANY DEFICIENCIES SHALL BE MANAGED PER RULE (B9-453), ENERGY MANAGEMENT [HC] [RC] [E]. THIS INCLUDES TRANSITIONS BETWEEN LVLH REFERENCE FRAME FLIGHT ATTITUDES.
- [3] IN THE EVENT THAT THE AVERAGE VEHICLE YAW, PITCH, OR ROLL VALUES OVER THE COURSE OF A FULL ORBIT FALL OUTSIDE OF THE RANGE DEFINED IN TABLE 13A_B2-2-II, THE TRRJ WILL BE MANAGED PER RULES (13A_B18-2), MANUAL TRRJ POSITIONING, AND (13A_B18-25), TRRJ AUTOTRACK BIAS MANAGEMENT.
- [4] GN&C ANALYSIS HAS SHOWN THAT THE ROLL ATTITUDE ENVELOPE LIMIT OF 0 DEG MAY BE VIOLATED BY UP TO 2 DEG UNDER STEADY STATE CONDITIONS. THE ROLL ATTITUDE MAY SETTLE OUT AT ROLL = -2 DEG. PTCS AND ATCS HAVE APPROVED THIS POTENTIAL CONSTRAINT VIOLATION AND HAVE NO ISSUES. PTCS ACCEPTANCE OF THIS CONSTRAINT EXCEEDANCE APPLIES TO 13A STAGE ONLY. @CR 8360]

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Verify that this is the correct version before use.

FLIGHT RULES

13A_B2-2 PERMISSIBLE ISS STAGE ATTITUDES AND ATTITUDE DEVIATIONS [HC] [RC] (CONTINUED)

Between Flight 5A and Assembly Complete, the MDM radiator's coating degrades the heat rejection capability, and IR heating from adjacent structure increases the base plate temperatures (to temperatures greater than component limits). This constraint restricts the ISS flight attitudes in an effort to prevent the MDM from overheating until the enhanced radiator is installed (ref. SSCM 1128). @[CR 8360]

C. RUSSIAN VEHICLE DOCKING ATTITUDES USING +ZLV ±XVV

RUSSIAN VEHICLE DOCKINGS WILL BE PERFORMED IN THE FLIGHT ATTITUDE ENVELOPES DEFINED BY TABLES 13A_B2-2-III (PREFERRED) AND 13A_B2-2-IV.

TABLE 13A_B2-2-III - PERMISSIBLE ATTITUDE ENVELOPES +ZLV +XVV

ATTITUDE	BETA RANGE	ATTITUDE ENVELOPE				TIME IN ATTITUDE	RECOVERY TIME
		YAW	PITCH	ROLL			
+ZLV +XVV	$+52^\circ \leq \beta \leq +75^\circ$	-15° TO +5°	-20° TO +15°	-15° TO +5°	[1]	N/A	
+ZLV +XVV	$-52^\circ < \beta < +52^\circ$	-15° TO +15°	-20° TO +15°	-15° TO +15°			
+ZLV +XVV	$-75^\circ \leq \beta \leq -52^\circ$	-5° TO +15°	-20° TO +15°	0° TO +15°			

NOTES

[1] POWER GENERATION MUST BE SUFFICIENT TO SUSTAIN THE NECESSARY ISS SYSTEMS. ANY DEFICIENCIES SHALL BE MANAGED PER RULE (B9-453), ENERGY MANAGEMENT [HC] [RC] [E]. THOUGH A CERTIFIED ATTITUDE, TIME IN THE DOCKING ATTITUDE CONFIGURATION IS NOT UNLIMITED. @[CR 8360]

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FLIGHT RULES

13A_B2-2

**PERMISSIBLE ISS STAGE ATTITUDES AND ATTITUDE
DEVIATIONS [HC] [RC] (CONTINUED)**

Nonetheless, the 90 deg pitch attitudes also provide a larger separation rate from ISS for both Soyuz and Progress, thus providing additional clearance relative to ISS during the Soyuz/Progress deorbit burn (nominally 1.5 - 2 revs after undocking). @[CR 8360]

References: Hazard Report RSCE-0021-9A.1, Collision of a Spacecraft with the Station After Separating - Cause 2. Hazard Report RSTV-0026-A, The Soyuz TMA Vehicle and the Station Collide During Separation - Causes 1 and 3. Hazard Report TCS-1204, Loss of ISS Element or Critical and Non-Critical Hardware Due to Thermal Extreme - Cause 2, Control 5.

F. SOYUZ RELOCATION ATTITUDES

1. FOR SOYUZ UNDOCKING AND FLYAROUND, IT IS PREFERRED THAT ISS WILL HOLD THE ATTITUDE LVLH (0, -20, 0) (YAW-PITCH-ROLL) . @[ED]
2. PRIOR TO THE START OF FINAL APPROACH, ISS WILL SWITCH TO THE CURRENT INERTIAL ATTITUDE ("ТИ" OR "ИСК-Т"). NOMINALLY THIS SWITCH WILL OCCUR TWO MINUTES PRIOR TO ORBITAL SUNSET. THIS ATTITUDE WILL BE HELD FOR THE LENGTH OF THE FINAL APPROACH, WHICH IS APPROXIMATELY 10 MINUTES.
3. NOMINALLY, FINAL APPROACH WILL BEGIN AT ORBITAL SUNSET AND COMPLETE DURING ECLIPSE.

MCC-M requires the switch to inertial in order to provide for better manual control. By starting in the 20 deg pitch down attitude, a good portion of the inertial "rotation" relative to the LVLH reference frame will occur within the permissible envelope in Paragraph A. This plan, in combination with the inertial hold occurring during orbital eclipse, should minimize the thermal implications of the inertial hold. The entire attitude timeline must first be approved via the CHIT process.

- G. THE ALLOWABLE ATTITUDE ENVELOPE FOR THE DEBRIS AVOIDANCE MANEUVER (DAM) USING A DC-1 NADIR PROGRESS IS DEFINED IN TABLE 13A_B2-7-I. @[CR 8360]

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FLIGHT RULES

13A_B2-2

**PERMISSIBLE ISS STAGE ATTITUDES AND ATTITUDE
DEVIATIONS [HC] [RC] (CONTINUED)**

H. FREE DRIFT OR LOAC PERIODS @[CR 8360]

1. FREE DRIFT OR LOAC DURING A THRUSTER INHIBIT PERIOD

IF THE ISS IS IN FREE DRIFT OR EXPERIENCES A LOSS OF ATTITUDE CONTROL (LOAC) EVENT WHEN PERFORMING A PLANNED ACTIVITY THAT REQUIRES ALL THRUSTER FIRINGS TO BE INHIBITED, THE ACTIVITY MAY BE CONTINUED WHILE IN FREE DRIFT UNTIL IT CAN BE PROPERLY SAFED. SAFING OF THE ACTIVITY MAY ENTAIL ITS COMPLETION IF OTHER OPERATIONAL CONSIDERATIONS, WHEN TAKEN INTO ACCOUNT, INDICATE THAT COMPLETION OF THE ACTIVITY IS NECESSITATED.

a. TEMPERATURES OF ALL INSTRUMENTED EXTERNAL COMPONENTS WILL BE MONITORED DURING THE ATTITUDE EXCURSION.

(1) IF TEMPERATURE TRENDS INDICATE THAT OPERATIONAL LIMITS WILL BE VIOLATED, THE ISS MUST RETURN TO THE NOMINAL +ZLV ±XVV ATTITUDE DEFINED IN PARAGRAPH A OR B PRIOR TO THE HARDWARE LIMIT VIOLATION.

(2) FOLLOWING AN ATTITUDE ENVELOPE DEVIATION, THE ISS ATTITUDE MUST REMAIN INSIDE THE ENVELOPE FOR 10 HOURS BEFORE ADDITIONAL DEVIATIONS OCCUR.

b. POWER GENERATION MUST BE SUFFICIENT TO SUSTAIN THE NECESSARY ISS SYSTEMS. ANY DEFICIENCIES WILL BE MANAGED PER RULE {B9-453}, ENERGY MANAGEMENT [HC] [RC] [E].

c. FOR GUIDANCE ON EATCS OPERATIONS REFER TO RULE {13A_B18-2}, MANUAL TRRJ POSITIONING. @[CR 8360]

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FLIGHT RULES

13A B2-15 EQUIPMENT POWERDOWNS FOR LOW PRESSURE [RC] (CONTINUED)

B. FOR A LOSS OF PRESSURE IN THE LAB OR JOINT AIRLOCK, THE ITCS WILL BE CONFIGURED TO EITHER SINGLE LT OR SINGLE MT MODE WITH A TWMV TEMPERATURE SETPOINT OF 21 DEG C (70 DEG F). @[CR 8505]

Upon loss of cabin pressure, unpowered ORU's lose heat readily. ITCS is reconfigured to Single MT mode or Single LT mode, and the temperature setpoint is set to the highest commandable value of 21 deg C/ 70 deg F to maximize the survival heat to those ORU's.

DOCUMENTATION: CHIT 001559, ISS Equipment Minimum Operating Pressures (U.S. Equipment), CHIT 001615, ISS Equipment Minimum Operating Pressures (RS Equipment), CHIT 2095; Real Time Flight Rule Change Request: PHALCON Flight Note 2441A.

SVHS13442L, Critical Item Development Specification for the IMV Fan; SVHS14568, Critical Item Development Specification for the Inlet ORU; JSC 28626A, Certification Report for the ISS SIGI ORU, October, 1999; JSC 28039, Safety Analysis Report (SAR) and FMEA for the ISS Global Positioning System (GPS) Subsystem, October 1997; CHIT ISS-312 ISS0036, Potential Low ISS Atmospheric Total Pressure Violation After Russian EVA on 10/8, October 2, 2001;RWS.47179, Space Station Robotic Work Station: Effect of Cabin Pressure Drop on RWS Operation, prepared by MD Robotics, September 9, 2002; JSC 38829, Standard Interface Control Document: Oxygen Recharge Compressor Assembly (ORCA), August 1998; D684-10508, Volume 2, Book 02, Revision C, ECLS Architecture Description Document, 2000; SSP 50066 Airlock to Russian Hardware Interface Control Document Part 1, September 22, 1995; S683-70731, INT SYS Software Requirements Specification (SRS), Revision K, December 8, 2000; S683-70870, INT SYS R2 Software Requirements Specification (SRS), Revision C, February 14, 2002; Boeing Short Sheet (SSODB) N1-ECLS-32 Node 1 FDS Subsystem, September 6, 2002; Boeing Short Sheet (SSODB) USL-ECLS-33 U. S. Lab THC Subsystem, January 3, 2002; SSP 50506-2, Basic Guidelines for Crew Activities During ISS Depressurization, Flight 5A.1 up to 10A, October 2001; 683-10009, Carbon Dioxide Removal Assembly (CDRA) Envelope Drawing, Revision K, March 18, 1988. @[CR 8505]

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FLIGHT RULES

13A B2-16 MITIGATION OF N2/O2 CONCENTRATION BUILDUP BEHIND CLOSEOUTS PRIOR TO MAINTENANCE [HC]

THIS FLIGHT SPECIFIC RULE SUPERSEDES RULE {B17-159}, CLOSEOUT VENTILATION REQUIREMENTS PRIOR TO MAINTENANCE. @CR 8622A]

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A. THE FOLLOWING CLOSEOUT LOCATIONS (AND VOLUMES TOUCHING THESE CLOSEOUTS) ARE SUSCEPTIBLE TO NITROGEN AND/OR OXYGEN CONCENTRATION BUILDUP IN THE VOLUMES BEHIND THE PANELS AND/OR INTERNAL TO THE RACK VOLUMES:

1. BEHIND LAB END CONES CLOSEOUT PANELS

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<u>LAB1D0-02 (N2/O2)</u>	<u>LAB1D0-03 (N2/O2)</u>	<u>LAB1D1-01 (N2)</u>
<u>LAB1D1-02 (N2/O2)</u>	<u>LAB1O1-01 (N2)</u>	<u>LAB1P0-01 (N2/O2)</u>
<u>LAB1P0-02 (N2/O2)</u>	<u>LAB1P0-03 (N2/O2)</u>	<u>LAB1P0-04 (N2/O2)</u>
<u>LAB1P1-01 (N2/O2)</u>	<u>LAB1P6-01 (N2/O2)</u>	<u>LAB1P7-01 (N2/O2)</u>
<u>LAB1P7-02 (N2/O2)</u>	<u>LAB1P7-03 (N2/O2)</u>	<u>LAB1P7-04 (N2/O2)</u>
<u>LAB1O6-03 (N2/O2)</u>		

2. BEHIND LAB STANDOFF CLOSEOUT PANELS

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<u>LAB1PD1 (N2/O2)</u>	<u>LAB1PD2 (N2/O2)</u>	<u>LAB1PD3 (N2/O2)</u>
<u>LAB1PD4 (N2/O2)</u>	<u>LAB1OP1 (N2)</u>	<u>LAB1OP2 (N2)</u>
<u>LAB1OP3 (N2)</u>	<u>LAB1OP4 (N2)</u>	<u>LAB1OP5 (N2)</u>
<u>LAB1OP6 (N2)</u>	<u>LAB1SD1 (N2)</u>	<u>LAB1SD2 (N2)</u>
<u>LAB1SD3 (N2)</u>	<u>LAB1SD4 (N2)</u>	

3. WITHIN THE VOLUME OF LAB RACKS

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<u>LAP6 (LT CCAA RACK) (N2)</u>	<u>LAS6 (MT CCAA RACK) (N2)</u>	<u>LAD4 (CHECS RACK) (N2/O2)</u>
<u>LAB1P1 (OGS) (O2/N2)</u>	<u>LAB1P2 (EXPR#4) (N2)</u>	<u>LAB1P4 (HRF2) (N2)</u>
<u>LAB1S2 (HRF1) (N2)</u>	<u>LAB1S3 (MSG) (N2)</u>	<u>LAB1S4 (EXP5) (N2)</u>
<u>LAB1O1 (EXP2) (N2)</u>	<u>LAB1O2 (EXP3) (N2)</u>	<u>LAB1O3 (EXP3) (N2)</u>
<u>LABEO4 (MELFI) (N2)</u>		

@CR 8622A]

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FLIGHT RULES

13A B2-16 MITIGATION OF N2/O2 CONCENTRATION BUILDUP BEHIND CLOSEOUTS PRIOR TO MAINTENANCE [HC] (CONTINUED)

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4. BEHIND AIRLOCK CLOSEOUT PANELS @[CR 8622A]

<u>A/L1OA0 (N2/O2)</u>	<u>A/L1OA1 (N2/O2)</u>	<u>A/L1OA2 (N2/O2)</u>
<u>A/L1A0 (N2/O2)</u>		

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5. BEHIND NODE 1 CLOSEOUT PANELS (ALL NODE CLOSEOUTS. NODE 1 HAS NO BAFFLES BETWEEN VOLUMES.)

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<u>NOD1P0-01 (N2/O2)</u>	<u>NOD1P0-02 (N2/O2)</u>	<u>NOD1S0-01 (N2/O2)</u>
<u>NOD1S0-02 (O2/N2)</u>	<u>NOD1O2-11 (O2/N2)</u>	<u>NOD1O2-12 (O2/N2)</u>
<u>NOD1O2-13 (O2/N2)</u>	<u>NOD1O2-14 (O2/N2)</u>	<u>NOD1O2-15 (O2/N2)</u>
<u>NOD1O2-16 (O2/N2)</u>	<u>NOD1O1-01 (O2/N2)</u>	<u>NOD1O1-02 (O2/N2)</u>
<u>NOD1D1-01 (O2/N2)</u>	<u>NOD1D1-02 (O2/N2)</u>	<u>NOD1D2-11 (O2/N2)</u>
<u>NOD1D2-12 (O2/N2)</u>	<u>NOD1D2-13 (O2/N2)</u>	<u>NOD1D2-14 (O2/N2)</u>
<u>NOD1D2-15 (O2/N2)</u>	<u>NOD1D2-16 (O2/N2)</u>	<u>NOD1P2-11 (O2/N2)</u>
<u>NOD1P2-12 (O2/N2)</u>	<u>NOD1P2-13 (O2/N2)</u>	<u>NOD1P2-14 (O2/N2)</u>
<u>NOD1P2-15 (O2/N2)</u>	<u>NOD1P2-16 (O2/N2)</u>	<u>NOD1P1-01 (O2/N2)</u>
<u>NOD1P1-02 (O2/N2)</u>	<u>NOD1S1-01 (O2/N2)</u>	<u>NOD1S1-02 (O2/N2)</u>
<u>NOD1S2-11 (O2/N2)</u>	<u>NOD1S2-12 (O2/N2)</u>	<u>NOD1S2-13 (O2/N2)</u>
<u>NOD1S2-14 (O2/N2)</u>	<u>NOD1S2-15 (O2/N2)</u>	<u>NOD1S2-16 (O2/N2)</u>
<u>NOD1OP2-21 (O2/N2)</u>	<u>NOD1OP2-22 (O2/N2)</u>	<u>NOD1OP2-23 (O2/N2)</u>
<u>NOD1OP2-24 (O2/N2)</u>	<u>NOD1OP2-25 (O2/N2)</u>	<u>NOD1OP2-26 (O2/N2)</u>
<u>NOD1OP2-27 (O2/N2)</u>	<u>NOD1OP2-28 (O2/N2)</u>	<u>NOD1OS2-21 (O2/N2)</u>
<u>NOD1OS2-22 (O2/N2)</u>	<u>NOD1OS2-23 (O2/N2)</u>	<u>NOD1OS2-24 (O2/N2)</u>
<u>NOD1OS2-25 (O2/N2)</u>	<u>NOD1OS2-26 (O2/N2)</u>	<u>NOD1OS2-27 (O2/N2)</u>
<u>NOD1OS2-28 (O2/N2)</u>	<u>NOD1PD2-21 (O2/N2)</u>	<u>NOD1PD2-22 (O2/N2)</u>
<u>NOD1PD2-23 (O2/N2)</u>	<u>NOD1PD2-24 (O2/N2)</u>	<u>NOD1PD2-25 (O2/N2)</u>
<u>NOD1PD2-26 (O2/N2)</u>	<u>NOD1PD2-27 (O2/N2)</u>	<u>NOD1PD2-28 (O2/N2)</u>
<u>NOD1SD2-21 (O2/N2)</u>	<u>NOD1SD2-22 (O2/N2)</u>	<u>NOD1SD2-23 (O2/N2)</u>
<u>NOD1SD2-24 (O2/N2)</u>	<u>NOD1SD2-25 (O2/N2)</u>	<u>NOD1SD2-26 (O2/N2)</u>

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FLIGHT RULES

13A B2-16 MITIGATION OF N2/O2 CONCENTRATION BUILDUP BEHIND
CLOSEOUTS PRIOR TO MAINTENANCE [HC] (CONTINUED)

NOD1SD2-27 (O2/N2)	NOD1SD2-28 (O2/N2)	NOD1O2-31 (O2/N2)
NOD1O2-32 (O2/N2)	NOD1O2-33 (O2/N2)	NOD1O2-34 (O2/N2)
NOD1O2-35 (O2/N2)	NOD1O2-36 (O2/N2)	NOD1O3-01 (O2/N2)
NOD1D3-01 (O2/N2)	NOD1D3-02 (O2/N2)	NOD1D3-03 (O2/N2)
NOD1D2-31 (O2/N2)	NOD1D2-32 (O2/N2)	NOD1D2-33 (O2/N2)
NOD1D2-34 (O2/N2)	NOD1D2-35 (O2/N2)	NOD1D2-36 (O2/N2)
NOD1S2-31 (O2/N2)	NOD1S2-32 (O2/N2)	NOD1S2-33 (O2/N2)
NOD1S2-34 (O2/N2)	NOD1S2-35 (O2/N2)	NOD1S2-36 (O2/N2)
NOD1S3-01 (O2/N2)	NOD1P2-31 (O2/N2)	NOD1P2-32 (O2/N2)
NOD1P2-33 (O2/N2)	NOD1P2-34 (O2/N2)	NOD1P2-35 (O2/N2)
NOD1P2-36 (O2/N2)	NOD1P3-01 (O2/N2)	NOD1OS3 (O2/N2)
NOD1OP3 (O2/N2)	NOD1SD3 (O2/N2)	NOD1PD3 (O2/N2)
NOD1O4-01 (O2/N2)	NOD1O4-02 (O2/N2)	NOD1O4-03 (O2/N2)
NOD1S5-01 (O2/N2)	NOD1S5-02 (O2/N2)	NOD1P5-01 (O2/N2)
NOD1P5-02 (O2/N2)	NOD1D4-01 (O2/N2)	NOD1D4-02 (O2/N2)
NOD1S4-01 (O2/N2)	NOD1S4-02 (O2/N2)	NOD1S4-03 (O2/N2)
NOD1SD4-01 (O2/N2)	NOD1OS4-01 (O2/N2)	NOD1P4-01 (O2/N2)
NOD1P4-02 (O2/N2)	NOD1P4-03 (O2/N2)	NOD1PD4-01 (O2/N2)
NOD1OP4-01 (O2/N2)	NOD1OS4 (O2/N2)	NOD1OP4 (O2/N2)
NOD1SD4 (O2/N2)	NOD1PD4 (O2/N2)	

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Volumes behind racks are not susceptible to buildup since the act of rotating the rack displaces the stagnant air behind the rack.

Ground analysis has shown that the secondary seal in the OD's that interconnect the nitrogen and oxygen systems do not seal properly, thus resulting in increased nitrogen and oxygen concentrations behind panels and racks (e.g., any area behind a closeout panel (endcone, standoff, etc.) or within a rack volume) that have nitrogen and oxygen lines.

B. NO ACTION IS REQUIRED FOR ACCESSING THE LAB PRESSURE CONTROL ASSEMBLY (PCA) VENT AND RELIEF ASSEMBLY (VRA) VACUUM ACCESS PORT (VAP) BEHIND PANEL LAB1DO-02. @[CR 8622A]

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FLIGHT RULES

**13A B2-16 MITIGATION OF N2/O2 CONCENTRATION BUILDUP BEHIND
CLOSEOUTS PRIOR TO MAINTENANCE [HC] (CONTINUED)**

C. NO ACTION IS REQUIRED FOR RACKS WHICH ACTIVELY EXCHANGE AIR WITH THE CABIN VOLUME. @[CR 8622A]

D. PRIOR TO PERFORMING MAINTENANCE IN ANY CLOSED OUT VOLUME IN PARAGRAPH A, ONE OF THE FOLLOWING ACTIONS WILL BE TAKEN:

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1. VERIFY THE OXYGEN CONCENTRATION IN THE CLOSEOUT VOLUME IS BETWEEN 15.7 PERCENT (REFERENCE RULE {B13-54}, MINIMUM PPO2 CONSTRAINTS [HC] [RC] [E]) AND 24.1 PERCENT (REFERENCE RULE {B17-3}, OXYGEN PARTIAL PRESSURE MANAGEMENT [HC] [RC] [E] [A]), PROTECTING FOR SENSOR ERROR DOCUMENTED IN RULE {B17-15}, USE OF OXYGEN PARTIAL PRESSURE SENSORS [RC] [E].

EITHER CSA-O2 OR CSA-CP MAY BE USED TO MAKE THESE MEASUREMENTS. THE DEVICE MUST BE VERIFIED AGAINST AN INDEPENDENT O2 MEASUREMENT DEVICE (AS DEFINED IN FLIGHT RULE {B17-15}, USE OF OXYGEN PARTIAL PRESSURE SENSORS [RC] [E]) PRIOR TO USE BEHIND THE PANEL. SAMPLES SHALL NOT BE TAKEN USING THE SAMPLE PROBE AND/OR SAMPLE PUMP.

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CREW SHOULD SAMPLE BEHIND THE CLOSEOUT FOR AT LEAST 1 MINUTE BEFORE INGRESSING THE VOLUME.

FOR LARGE VOLUMES, CREW SHOULD SAMPLE FOR AT LEAST 1 MINUTE NEAR EACH COMPLEX O2/N2 COMPONENT PRIOR TO WORKING IN THE VICINITY OF THE COMPONENT.

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2. ACTIVELY VENTILATE THE CLOSE-OUT VOLUME WITH A UOP POWERED PORTABLE FAN ASSEMBLY (PFA) FOR AT LEAST 2 MINUTES.
3. ACTIVELY VENTILATE THE CLOSE-OUT VOLUME WITH A BATTERY POWERED PORTABLE FAN (MRK FAN) FOR AT LEAST 9 MINUTES.
4. ACTIVELY VENTILATE THE CLOSE-OUT VOLUME WITH THE AIRLOCK FLEXIBLE VENTILATION DUCT (ELEPHANT TRUNK) CONNECTED TO THE CONDITIONED AIR SUPPLY FOR AT LEAST 4 MINUTES. @[CR 8622A]

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FLIGHT RULES

13A B2-16 MITIGATION OF N2/O2 CONCENTRATION BUILDUP BEHIND CLOSEOUTS PRIOR TO MAINTENANCE [HC] (CONTINUED)

5. PASSIVELY VENTILATE (NO FORCED VENTILATION) THE CLOSE OUT VOLUME FOR AT LEAST 1.3 HOURS. @[CR 8622A]

Low oxygen concentration is indicative of nitrogen leaks into the closeout volume. High oxygen concentration is indicative of oxygen leaks into the volume. Rule [B17-15], USE OF OXYGEN PARTIAL PRESSURE SENSORS [RC] [E], defines oxygen sensors and sensor accuracies. For example, if the ISS minimum total pressure is 14.0 psia, and the CSA-O2 is used for measuring O₂ concentration, the resulting instrumentation error is 0.8 percent. CSA-O2 readings would have to be between 16.5 percent and 23.3 percent to meet requirements. If using the CSA-CP or CSA-O2 to verify oxygen concentration, an ambient reading needs to be taken first to verify the device is working properly. CSA failure modes (Off Scale High or Zero Indication, Erroneous High or Low Reading, Fails Off) are described in JSC 62789, FMEA/CIL for the CSAS. Crew should not break the plane of the panel prior to taking one of the actions listed in Paragraph D.

To prevent any explosive hazard from oxygen or loss of consciousness/death from nitrogen to the crew when performing maintenance behind these panels, adequate ventilation time needs to be performed to mix air behind panels with the cabin air.

Volumes behind racks are not susceptible to buildup since the act of rotating the rack displaces the stagnant air behind the rack.

DOCUMENTATION: This is documented in Chit 2349, ECLSS: Ventilation Behind Closeout Prior to Maintenance; and Hazard Reports ISS-ECL-0206, Cause 3, Inadvertent/Excessive Nitrogen Introduction or Release Through the Nitrogen Introduction Valve (NIV); and ISS-ECL-404, Cause 6, Inadvertent/Excessive Oxygen Introduction Through the Oxygen Distribution/Transfer System. @[CR 8622A]

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FLIGHT RULES

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FLIGHT RULES

JOINT SHUTTLE/ISS RULES

PRELAUNCH

13A_C2-1 SHUTTLE LAUNCH WINDOW

- A. FOR PRE-LAUNCH PLANNING PURPOSES, THE JUNE 8, 2007 LAUNCH WINDOW OPENS AT APPROXIMATELY 23:32:56 GMT AND CLOSES AT 23:42:56 GMT BASED ON THE PREDICTED ISS REFERENCE TRAJECTORY DELIVERED IN JANUARY 2007, AND STANDARD PLANAR CONSTRAINTS. @[CR 8212A] @[CR 8547]

THE LAUNCH PERIOD WILL BE DEFINED AS 10 MINUTES PRIOR TO THE WINDOW OPEN UNTIL 10 MINUTES AFTER WINDOW CLOSE, BASED ON THE MAXIMUM PRE-LAUNCH PREDICTED PLANAR WINDOW. IN GENERAL, THE LAUNCH WINDOW SHIFTS EARLIER BY APPROXIMATELY 25 MINUTES EACH DAY, REPEATING APPROXIMATELY EVERY 60 DAYS.

- B. THE PHASE ANGLE AT OMS-2 WILL DETERMINE THE RENDEZVOUS PLAN FOR SUCCESSFUL DOCKING TO ISS. THE FOLLOWING RENDEZVOUS CONSTRAINTS WILL BE IN PLACE FOR STS-117:

1. LAUNCH WINDOW PRIORITIES ARE AS FOLLOWS:

FLIGHT DAY 3 RENDEZVOUS LAUNCH WINDOW WILL UTILIZED WHENEVER PRACTICAL.

It is essential that the STS-117/13A mission dock on FD3 in order to accomplish all mission objectives and protect 2 contingency days for a fourth EVA if P6 solar array retraction requires EVA support. Consideration will be given to using a FD4 RNDZ launch window if the mission objectives can be met within existing consumable resources. The FD4 launch window may result in SCSC violations.

2. THE MAXIMUM PHASE ANGLE AT OMS-2 FOR A FD3 RENDEZVOUS IS APPROXIMATELY 276 DEGREES WHILE THE MINIMUM PHASE ANGLE IS APPROXIMATELY 40 DEGREES. @[CR 8212A] @[CR 8547]

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FLIGHT RULES

13A_C2-53

**ATTITUDE AND SOLAR ARRAY FEATHERING CONSTRAINTS
FOR MATED SHUTTLE WASTE/WATER DUMPS [RC]
(CONTINUED)**

In order to assure that water/ice particles from the waste/supply water dump do not impinge on the orbiter, the centerline of the nozzle must point in a retrograde direction. All ISS hardware has been cleared of any mechanical damage from waste/supply water dumps with the centerline pointed in the pure out-of-plane direction per the ISS Environments Protocol, dated November 1, 2004. However, the protocol does not include orbiter hardware. There is very little empirical data of damage potential to orbiter surfaces by these particles at these impact velocities other than windows. Therefore, to avoid recontact with the particles, the dump nozzle centerline must be oriented such that the centerline is greater than or equal to the expected water plume half cone angle in the retrograde direction. In this case, the plume half cone angle is expected to be 10 degrees. (Note per Rule {A2-109C}.b, PREFERRED ATTITUDE FOR WATER DUMPS: The distribution of particle ejection angles is such that 95 percent of the particles are ejected within a 10-degree half-cone angle of the orbiter -Y axis.) @[CR 8211]

In real time, if VRCS fails, then USTO could be used with an 11-degree retrograde component. If ALT DAP is required, the Station Program will then assess an attitude which provides the 10-deg retro component +5 deg ALT deadband; however, this will likely mean that the orbital average attitude will be outside the attitude envelope and violate the rule in Paragraph 1. If the PRCS control option is chosen to be utilized, then the attitude excursions will need to be assessed in addition to performing ISS Environments analysis for erosion and contamination per the agreements as demonstrated on STS-121/ULF1.1. Allowable attitude control modes and their priorities are documented in Rule {13A_C8-4}, ORBITER/STATION ATTITUDE CONTROL AND MANEUVER CONSTRAINTS AND PRIORITIES [HC] [RC]. @[ED]

References: Joint U.S./Russian Agreement on Recontact from Water Dump and Propellant Purge Particles, November 1, 2004; On-Orbit Flight Techniques Panel (OFTP) Meeting #95 Minutes, April 21, 1989; OFTP Meeting #120 Minutes July 12, 1991; and NCR-ISS-063, Zero Fault Tolerant Reaction Jet Driver (RJD) Causing Inadvertent Primary Jet Firing.

Reference Rules {13A_C8-4}, ORBITER/STATION ATTITUDE CONTROL AND MANEUVER CONSTRAINTS AND PRIORITIES [HC] [RC], and {C17-1}, SHUTTLE VENT MANAGEMENT [RC] [E]. @[ED]

B. STATION SOLAR ARRAY CONSTRAINTS

THE OPTIMAL FEATHERING CONSTRAINTS (LOADS AND EROSION) FOR MATED ATTITUDE WASTE/WATER DUMPS ARE LOCATED IN THE RULE {13A_B2-10}, USOS NOMINAL SOLAR ARRAY CONSTRAINTS PLANNING [HC] [RC]. @[CR 8211]

FLIGHT RULES

ISS DOCKED OPERATIONS

13A_C2-71 MATED ATTITUDES AND ATTITUDE CONSTRAINTS [HC]
[RC] @[DN 181]

~~PENDING RUSSIAN CONCURRENCE~~

A. THE FLIGHT ATTITUDES AND THEIR ASSOCIATED ATTITUDE ENVELOPES DEFINED IN TABLES 13A_C2-71-I AND 13A_C2-71-II PROVIDE THE LIMITING ATTITUDE ENVELOPE VALUES IN THE EVENT THAT THE EATCS ATTITUDE ENVELOPE CONSTRAINTS IN TABLES 13A_C2-71-III THROUGH 13A_C2-71-VI (NOT INCLUDING SAW DEPLOY) ARE EXCEEDED. @[CR 8359]
 @[ED]

TABLE 13A_C2-71-I - ATTITUDE ENVELOPE LIMITS PRIOR TO MOVING S3/S4 TO THE PRE-INSTALL POSITION IF EATCS ATTITUDE CONSTRAINTS ARE EXCEEDED

BETA ANGLES	ATTITUDE REFERENCE FRAME	ISS ATTITUDE NAME	APPROVED ATTITUDE ENVELOPES		
			YAW	PITCH	ROLL
$-60^\circ \leq \beta \leq +15^\circ$	ISS LVLH	+XVV W/ROLL BIAS	-15° TO +15°	+0° TO +25°	+30° TO +50°
$-10^\circ \leq \beta \leq +60^\circ$		+XVV W/ROLL BIAS	-15° TO +15°	+0° TO +25°	-30° TO -50°
$-60^\circ \leq \beta \leq +10^\circ$		-XVV W/ROLL BIAS	+165° TO +195°	+0° TO +25°	-50° TO -30°
$-15^\circ \leq \beta < +60^\circ$		-XVV W/ROLL BIAS	+165° TO +195°	+0° TO +25°	+30° TO +50°

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FLIGHT RULES

13A_C2-105

**ORBITER SYSTEM FAILURES AND CONTINGENCY SHUTTLE
CREW SUPPORT (CSCS)/LAUNCH ON NEED (LON)
(CONTINUED)**

The requirement to protect an unmanned undocking capability is not considered as mandatory and is not included as part of the rule. The CSCS/LON scenario is invoked because the orbiter has sustained a failure that does not permit a safe reentry and landing of the orbiter. If the orbiter can get safely docked, the opportunity exists to get the stranded crew safely home. @[DN 182]

The optimal unmanned undocking procedure would include the disposal burn. If the orbiter failure is such that you have achieved docking (or are already docked) but does not provide a CSCS undocking/separation capability, there are other undocking options available that were reviewed at the ISS Safe Haven JOP's. For instance, a +Rbar docking could be performed that does not require any active attitude control and Orbital Mechanics takes care of separating the vehicles. The drawback is that a disposal burn cannot be performed. For the scenario where the orbiter cannot be undocked, once the cryo consumables are depleted, the Orbiter Docking System (ODS), Pressurized Mating Adapter (PMA), and Lab hatches will be closed.

Time permitting, the MMT will have the final decision in invoking CSCS/LON option. If the orbiter system failure requires immediate response, the Flight Control Team will use the available data to determine the proper course of action to safely return the crew (Emergency D/O or CSCS).

The bottom line is, all that can be done will be done to improve the probabilities and risks to provide the opportunity to get the stranded shuttle crew safely home.

Reference Rules {A2-101}, VEHICLE SYSTEMS REDUNDANCY DEFINITIONS; {13A_C2-102}, CONTINGENCY SHUTTLE CREW SUPPORT (CSCS) [RI]; {13A_C2-103}, CONTINGENCY SHUTTLE CREW SUPPORT (CSCS) DECLARATION ACTIONS [RI]; and {13A_A2-3}, NEXT PRIMARY LANDING SITE (PLS) REQUIREMENTS. @[DN 182]

FLIGHT RULES

**13A C2-106 STS-117/13A USOS SOLAR ARRAY CONSTRAINT
CONTINGENCY ATTITUDE CONTROL RESPONSE [HC] [RC]
[C]**

A. IF A CONTINGENCY ARISES WHICH REQUIRES SHUTTLE VRCS CONTROL (E.G., LOAC), THE ISS FCT MAY REQUIRE TIME TO VERIFY/RE-POSITION THE P4 SARJ/BGA OUTSIDE OF A VRCS DYNAMIC LOADS KEEP-OUT ZONE. @[CR 8324A]

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TO ENSURE A GOOD COMMUNICATIONS LINK WITHOUT CREATING A P4 SAW CATASTROPHIC HAZARD:

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1. VRCS JET L5L MAY BE DESELECTED, AFTER WHICH LVLH WILL BE SELECTED ON THE DAP TO HOLD THE CURRENT MATED ATTITUDE. L5L WILL BE RESELECTED AS SOON AS THE ISS FCT VERIFIES/COMMANDS P4 SAW TO A SAFE DYNAMIC LOADS ZONE. AFTER L5L IS RESELECTED, THE ORBITER MAY MANEUVER THE MATED STACK TO THE DESIRED ATTITUDE USING AUTO ON THE DAP.

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2. THE SELECTION OF LVLH WITH VRCS JET L5L DESELECTED WILL OCCUR NO LATER THAN 20 MINUTES AFTER LOAC OF THE MATED STACK.

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3. TOTAL SHUTTLE VRCS CONTROL TIME WITH L5L DESELECTED SHALL NOT EXCEED 1 HOUR.

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B. THIS CONTINGENCY RESPONSE CAN BE INITIATED ONLY IF THE FOLLOWING CONDITIONS ARE MET:

1. THE MATED STACK CONTINGENCY (LOAC) BEGAN IN THE TORQUE EQUILIBRIUM ATTITUDE (TEA) FOR THE STACK'S CURRENT CONFIGURATION. ONE EXCEPTION IS THAT THIS CONTINGENCY RESPONSE CAN ALSO BE INITIATED DURING THE ISS MANEUVER FROM THE DOCKED TEA TO THE OVERNIGHT PARK TEA ON FLIGHT DAY 3.

2. THE S3/S4 TRUSS IS IN ONE OF THE FOLLOWING POSITIONS:

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a. BERTHED IN THE ORBITER PAYLOAD BAY

b. ON THE SRMS IN THE TILT, HIGH HOVER, OR HANDOFF POSITION

c. ON THE SSRMS IN THE HANDOFF OR PRE-INSTALL POSITION @[CR 8324A]

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FLIGHT RULES

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FLIGHT RULES

**13A C2-106 STS-117/13A USOS SOLAR ARRAY CONSTRAINT
CONTINGENCY ATTITUDE CONTROL RESPONSE [HC] [RC]
[C] (CONTINUED)**

d. INSTALLED ON THE ISS WITH AT LEAST 3 SSAS BOLTS
FULLY TIGHT @[CR 8324A]

3. THE S4 SAW HAS NOT BEEN DEPLOYED.

4. REFERENCE RULE {13A C2-74}, DOCKED LOADS CONSTRAINTS
[HC] [RC] [C], FOR ANY ADDITIONAL CONSTRAINTS.

VRCS jet L5L may induce unacceptable structural loading on P4 SAW mast or DLA gear if SARJ/BGA's are located in a dynamic loads RED or YELLOW zone at the time of the L5L firing(s). For this reason, L5L should be deselected if attitude control is mandatory to ensure good communications link during the contingency.

Analysis has shown that shuttle cannot hold 5-jet VRCS during mated operations for an extended period due to SODB limit of 1000 pulses/hr. In addition, the use of manual LVLH attitude hold was shown to be far more benign with L5L deselected than the use of Auto to attempt a maneuver to a desired attitude. Therefore, 5-jet VRCS control time will be limited to < 1 hour using the LVLH function of the DAP. One hour is sufficient time for Phalcon to assess the P4 SAW critical hazard risk and take the appropriate action to ensure that P4 SAW is outside a dynamic loads zone. Once L5L is reselected, the orbiter may resume all nominal VRCS attitude control functions.

Draper Labs performed 13A flight specific shuttle control analysis with L5L deselected, starting from the TEA with the S3/S4 truss at the positions listed above. The flight control analysis showed acceptable performance in these configurations. Reference Rule {13A C2-74}, DOCKED LOADS CONSTRAINTS ~~[RH][C]~~[HC][RC][C], for specific DAP configurations. The ISS maneuver on FD3 from the docked TEA to the overnight park TEA is a small maneuver (less than 10 degrees) accomplished at a very slow rate (.001 deg/sec). Draper performed analysis for this particular maneuver and the performance was acceptable.

Both Shuttle RMS and Space Station RMS loads were examined for the S3/S4 truss positions listed above and- were found to be acceptable. Using the 12A.1 loads assessment, the Integrated Shuttle/ISS Loads and Dynamics Team was comfortable with the mated stack loads during 5-jet VRCS operations with the exception of S3/S4 install, prior to three bolts fully tight. Reference Rule {13A C10-2}, SSAS BOLT FULLY TIGHT DEFINITION.

Dynamic loads keep-out zones for S4 SAW have not been defined for VRCS control with L5L deselected. Therefore, 5-jet VRCS operations is not allowed post-S4 SAW deploy.

Reference Draper Labs/Mike Martin analysis, L5L Deselection for ISS LOAC, November 17, 2006, and STS-117/13A Mated Shuttle/ISS & OBSS Operations DAP Modes and Constraints. @[CR 8324A]

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FLIGHT RULES

SECTION 10 - MECHANICAL

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JOINT SHUTTLE/ISS RULES

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FLIGHT RULES

13A_C10-11 APU OPERATION WHILE DOCKED [RC], ~~[C]~~@[CR 8535] @[CR 8619]

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DURING THE DOCKED MISSION PHASE, THE FOLLOWING CONDITIONS AND CONSTRAINTS APPLY TO ORBITER AUXILIARY POWER UNIT (APU) OPERATION: @[CR 8205]

- A. IF NEEDED FOR THE PURPOSE OF MAINTAINING APU FUEL COMPONENT TEMPERATURES WITHIN ACCEPTABLE LIMITS, THEN:
 - 1. OPERATION WILL BE FOR APPROXIMATELY 5 MINUTES,
 - 2. THE ASSOCIATED SYSTEM'S HYDRAULIC MAIN PUMP WILL REMAIN IN LOW PRESS, AND
 - 3. AT LEAST ONE COMPLETE APDS HOOK GANG MUST BE CLOSED.
- B. IF NEEDED TO DEplete AN APU FUEL TANK THAT HAS A SUSPECTED OR CONFIRMED NONISOLATABLE LEAK, THEN:
 - 1. THE ASSOCIATED SYSTEM'S HYDRAULIC MAIN PUMP WILL BE TAKEN TO NORM PRESS AND AEROSURFACE DRIVE WILL BE ENABLED ASAP,
 - 2. THE ASSOCIATED SYSTEM'S HYDRAULIC MPS/TVC ISOLATION VALVE WILL REMAIN CLOSED WHILE AEROSURFACE DRIVE IS ENABLED, AND
 - 3. TWO COMPLETE APDS HOOK GANGS MUST BE CLOSED.
- C. ONLY A SINGLE APU MAY BE OPERATED AT A TIME.
- D. U.S. LAB WINDOWS MUST BE CLOSED.
- E. SHUTTLE VRCS ATTITUDE CONTROL IS REQUIRED; SHUTTLE PRCS OR ISS ATTITUDE CONTROL ARE NOT PERMITTED.
 - 1. APU OPERATION AND ASSOCIATED VRCS ATTITUDE CONTROL WILL BEGIN ONLY AFTER THE ISS FCT VERIFIES/COMMANDS ALL SAW ASSEMBLIES TO A SAFE DYNAMIC LOADS ZONE.
 - 2. APU OPERATION WILL NOT COMMENCE WITH ANY VERNIER JET DESELECTED. @[CR 8535]

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FLIGHT RULES

13A_C10-11 APU OPERATION WHILE DOCKED [RC] ~~{C}~~ (CONTINUED)

- F. CREW EXERCISE IS PROHIBITED. PUSH LOADS FROM IVA ACTIVITIES MUST BE MINIMIZED. @[CR 8535]
- G. THE SSRMS MUST BE UNLOADED AND PARKED IF IT IS NOT GRAPPLED TO THE S3/S4 TRUSS.
- H. THE SRMS MUST BE UNLOADED AND IN THE PRE-CRADLE POSITION IF IT IS NOT GRAPPLED TO THE S3/S4 TRUSS. @[CR 8619]
- I. THE S3/S4 TRUSS MUST BE IN ONE OF THE FOLLOWING POSITIONS:
 - 1. BERTHED IN THE ORBITER PAYLOAD BAY~~-~~
 - 2. ON THE SRMS IN THE TILT, HIGH HOVER, OR HANDOFF POSITION ←
 - 3. ON THE SSRMS IN THE HANDOFF OR PRE-INSTALL POSITION~~-~~
 - 4. INSTALLED ON THE ISS WITH AT LEAST THREE SSAS BOLTS FULLY TIGHT~~-~~. @[CR 8619]

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APU service and bypass lines, fuel pump, and valve module can freeze, leading to line rupture and fuel leakage, for failure of the APU GAS GEN/FUEL PUMP heaters. Periodic APU operation will prevent freezing of the APU: heat soakback from 5 minutes of operation will maintain the APU above the fuel freezing point for approximately 12 hours. Keeping the hydraulic main pump in low press minimizes the quantity of fuel consumed and the thrust created by the APU exhaust, and thereby limits the effects of plumbing on the ISS and the amount of shuttle PROP consumables that must be used to maintain the mated stack attitude. The short period of operation will preclude the need for lube oil cooling; therefore, no WSB water/PGME exhaust will be generated. One fully closed APDS hook gang is sufficient to provide mated structural margins during the low thrust venting associated with running the APU for thermal management. Reference "STS-117/13A Shuttle/ISS Mated Vehicle Structural Loading Due to Auxiliary Power Unit Thermal Management Operation" memo dated February 2007 (S4460-07-ODL-0035). Reference Rules {A10-1A}.7, APU LOSS DEFINITIONS [HC], {C10-103B}, HOOK REQUIREMENTS FOR DOCKED OPERATIONS [RI], and {A10-30A}, LOSS OF APU HEATERS/INSTRUMENTATION [CIL]. @[CR 8535]

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FLIGHT RULES

13A_C10-11 APU OPERATION WHILE DOCKED [RC] ~~{C}~~ (CONTINUED)

If the APU fuel system has a nonisolatable leak, then a significant amount of free hydrazine will be introduced into the aft compartment creating a severe safety hazard. The only way to mitigate this hazard is to operate the APU thereby consuming hydrazine that would otherwise leak into the orbiter aft compartment. In order to minimize the total amount of fuel leaked, the APU should be operated at as high a load as possible. The highest load is achieved by operating the APU with the associated hydraulic main pump in Norm Press, the associated MPS/TVC Isolation Valve open, and Aerosurface Drive enabled. Analysis of previous station assembly sequences indicated that this APU configuration overwhelmed the control authority provided by the VRCS. The STS-117 analysis was done for the hydraulic main pump in Norm Press and Aerosurface Drive enabled, but with the associated MPS/TVC Isolation Valve closed. This APU configuration is controllable, and is the most effective means of depleting the APU fuel tank while docked. Two fully closed APDS hook gangs are required to provide mated structural margins during the high-thrust venting associated with running the APU to fuel tank depletion. Reference "STS-117/13A Mated Loads Due to Vernier Reaction Control System Jet Firings During Auxiliary Power Unit Fuel Leak Operations" memo dated February 22, 2007 (S4460-07-ODL-0034). Reference Rules {A10-1A}.1, APU LOSS DEFINITIONS [HC], {C10-103A}, HOOK REQUIREMENTS FOR DOCKED OPERATIONS [RI], and {A10-27B}, APU FUEL LEAKS [CIL].

Ⓜ[CR 8535]

Analysis has only been performed for mated configurations with a single APU running; therefore, only a single APU may be operated at a time while docked. Loading analysis did not include additional loads induced by crew exercise or IVA activities; and therefore, these activities are constrained.

Ⓜ[CR 8205]
Ⓜ[CR 8344]

Shuttle VRCS attitude control is the only analyzed and therefore the only permitted method of docked phase attitude control during APU operation. Previous analyses of earlier flight configurations indicated that shuttle PRCS attitude control is not possible due to PRCS jet on/off time constraints for relatively high APU vent thrusting cases (running the APU to deplete the fuel tank), however, for the low thrust venting associated with running the APU for thermal management, ALT DAP may be acceptable but was not analyzed. ISS attitude control may be possible for some short duration, low thrust APU venting scenarios, but is not recommended due to the possibility of CMG saturation and in order to minimize the use of ISS propellant. Assuming that no other failures necessitate the use of extra shuttle propellant, then the nominal margins for STS-117 are sufficient for controlling the mated assembly during APU operation.

The L5L (R5R) jet poses a plumbing concern for the P4 (S4) SAW, and therefore the P4 (S4) SAW must be positioned in a safe zone prior to firing of the L5L (R5R) jet. Loading analysis did not cover the deactivation of any jet during APU operation and therefore APU operation will be delayed until the P4 SAW and the S4 SAW can be safely positioned, thereby allowing the use of all jets. Reference Rule {13A C2-106}, STS-117/13A USOS SOLAR ARRAY CONSTRAINT CONTINGENCY ATTITUDE CONTROL RESPONSE [HC] [RC], for deselection of L5L (R5R) prior to use of verniers while docked.

Reference Rule {13A_B2-8}, SOLAR ARRAY POSITIONING PRIORITIES [HC] [RC], for guidelines on array positioning for contamination/erosion.

Ⓜ[CR 8535]

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FLIGHT RULES

13A_C10-11 APU OPERATION WHILE DOCKED [RC] ~~{C}~~ (CONTINUED)
(CONTINUED)

U.S. concurrence has been generically given for exposure for up to 285 lbs (typical APU fuel tank quantity while docked) of cumulative hydrazine emissions per year for U.S. segments, provided the U.S. lab windows are closed during APU operation. For the GAS GEN/FUEL PUMP heater failure scenario requiring periodic APU operation while docked during STS-117, approximately 70 lbs of fuel will be exhausted worst-case (approximately 5 lbs of fuel used each run x 2 runs per day x 7 docked days). Russian engineering written concurrence for contamination of Russian segments from APU exhaust is pending. Russian engineering estimates find the expected exhaust quantities to be acceptable for the more severe tank depletion case. Russian approval of this rule signifies concurrence for operating an APU while docked. @[CR 8344] @[CR 8535]

Space Station RMS loads were examined for the S3/S4 truss positions listed above and were found to be acceptable. Reference memo "Effect of Shuttle and Space Station Jet Firings on SSRMS Performance Flight 13A, S3/S4 Truss Installation", MDA-SS-MOA-F13A-014 Revision B dated May 2007. The shuttle RMS loads are acceptable when in the pre-cradle position. ~~It may be possible for~~ Analysis has confirmed that APU operations can be safely performed with the shuttle RMS to safely grappled to the S3/S4 truss in the Tilt, High Hover, or Handoff positions during APU operations, however, analysis verifying these positions is pending. Reference Memo ESCG07-014. Analysis did not evaluate having the OBSS grappled to either the shuttle RMS or the station RMS during APU operation; therefore, unless grappled to the S3/S4 truss, the shuttle RMS and station RMS should be unloaded. This implies that the OBSS is latched during APU operation. @[CR 8619]

The S3/S4 truss is securely attached for the positions mentioned above. Reference Rule {13A_C10-2}, SSAS BOLT FULLY TIGHT DEFINITION. @[CR 8535]

Rule {13A_C10-10}, APU GAS GEN/FUEL PUMP HEATER MANAGEMENT [RI], references this rule. @[CR 8205]

FLIGHT RULES

SECTION 12 - ROBOTICS

SHUTTLE ONLY RULES

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STARBOARD MPM/MRL SYSTEMS MANAGEMENT

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SRMS DRIVE SYSTEM MANAGEMENT

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GO/NO-GO CRITERIA

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ISS ONLY RULES

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FLIGHT RULES

JOINT SHUTTLE/ISS RULES

GENERAL

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FLIGHT RULES

13A_C12-3 MSS THERMAL CONSTRAINTS [C] @CR 8621]

A. ~~DURING MT TRANSLATIONS BETWEEN WORKSITES, ALL COMPONENTS ON THE MBS CAN SURVIVE WITHOUT HEATER POWER FOR AT LEAST TBD HOURS WITH THE FOLLOWING EXCEPTIONS: THE 13A MT LATCHING ANALYSIS SUPPORTS ALL TRANSLATIONS PER TABLE 13A C12-3 I FOR ALL BETAS BETWEEN -60 AND +60 WITH PROVIDED EXCEPTIONS FOR THREE CONTINGENCY TRANSLATIONS AT BETAS NEAR +40 DEGREES AND -60 DEGREES.~~

TABLE 13A_C12-3-I - ~~MBS COMPONENTS~~LATCHING ANALYSIS CONSTRAINTS

WS1	WS2	WS3	WS4	WS5	LATCHING ANALYSIS	ARTICULATING STRUCTURE ASSUMPTIONS
	CURRENT	DESTINATION			OK	CONFIGURATION 1: P6 2B, P4 SAW AUTO TRACKING, S4 DEPLOYED, P64B RETRACTED, PORT TRRJ IN AUTO TRACK, STARBOARD TRRJ AT ZERO.
		CURRENT	DESTINATION		OK EXCEPT AT BETA -60	CONFIGURATION 1
		CURRENT		DESTINATION	OK	CONFIGURATION 2: BOTH P6 SAW STOWED, AND ALL OTHER HARDWARE IN AUTO TRACK.
			DESTINATION	CURRENT	OK	CONFIGURATION 2
		DESTINATION		CURRENT	OK EXCEPT AT BETA +40	CONFIGURATION 2
	DESTINATION			CURRENT	OK EXCEPT AT BETA -60	CONFIGURATION 2
DESTINATION				CURRENT	OK	CONFIGURATION 2
DESTINATION		CURRENT			OK	CONFIGURATION 2
	DESTINATION	CURRENT			OK	CONFIGURATION 2
CURRENT	DESTINATION				OK	CONFIGURATION 2
CURRENT		DESTINATION			OK	CONFIGURATION 2
CURRENT			DESTINATION		OK	CONFIGURATION 2

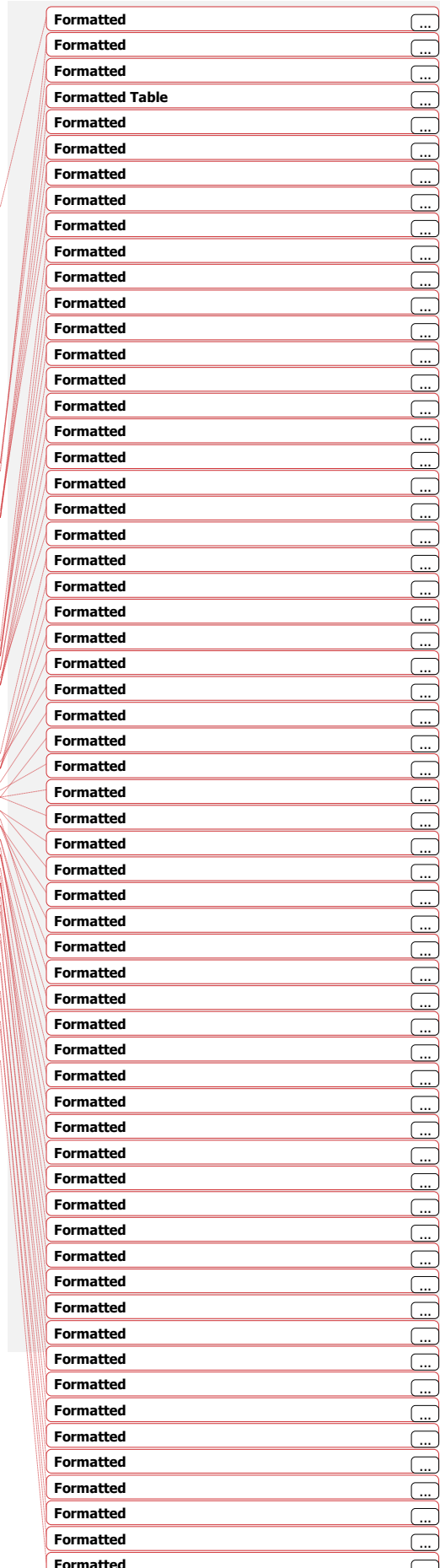
@DN 7]

Analysis Assumed -XVV TEA per Rev F of the MT analysis Memo.

Source: Flight 13A Mobile Transporter Latching Analysis; Rev A, ISS-HOU-MSER-JM-070039A, May 2007. Note, the report summary covers betas 0 to 60 but Rev B due to be published prior to 13A covers -60 to 0. @CR 8621]

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Verify that this is the correct version before use.



FLIGHT RULES

13A_C12-3 MSS THERMAL CONSTRAINTS [C] (CONTINUED)

**TABLE 13A_C12-3-IV - WS5 TIME TO LIMIT IN HRS WITHOUT
SSRMS @[CR 8621]**

BETA ANGLE	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35
MBS														
CRPCM														
MCU1														
MCU2														
VDU1														
VDU2														
POA1														
CLA									28.1	22.0	22.0	9.9	8.3	4.9
CLPA						12.9	8.2	5.3	6.7	8.3	6.7	3.3	3.4	4.9
MCAS												0.4	0.2	0.4

@[DN 7]

Source 13A Flight MT Translation Analysis, HTR-1377 Rev C, May 22, 2007 by MDA. @[DN 7]
@[CR 8621]

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13A_C12-4 RESERVED @[DN 178] @[CR 8109]

FLIGHT RULES

SECTION 13 - AEROMEDICAL

SHUTTLE ONLY RULES

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13A_A13-4	CABIN ATMOSPHERE CONTAMINATION - HALON 1301 [HC]RESERVED	13-2

ISS ONLY RULES

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JOINT SHUTTLE/ISS RULES

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FLIGHT RULES

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FLIGHT RULES

SECTION 13 - AEROMEDICAL

SHUTTLE ONLY RULES

13A_A13-1 RESERVED @[CR 8070]

13A_A13-2 ~~PPCO2 CONSTRAINT (TWO GAS) [HC]RESERVED~~ @[CR 8240]
 @[CR 8607]

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13A_A13-3 SHUTTLE COMPOUND SPECIFIC ANALYZER - COMBUSTION
 PRODUCTS (CSA-CP) MANAGEMENT

WHENEVER THE CSA-CP IS BEING USED, COMPARE THE INDICATED CSA-CP VALUES DIRECTLY WITH THE VALUES IN THE FOLLOWING TABLE INSTEAD OF THE 24-HOUR SMAC LIMITS SHOWN IN RULE {A13-157}, CABIN ATMOSPHERE CONTAMINATION FIRE/SMOKE, PARAGRAPH G. THE VALUES LISTED IN THE TABLE BELOW ARE THE FIRE/SMOKE QDM MASKING LEVELS WHICH HAVE BEEN CORRECTED FOR VARIOUS CABIN PRESSURES. NO CORRECTION FACTOR NEEDS TO BE APPLIED TO THE INDICATED CSA-CP VALUES WHEN USING THE VALUES IN THIS TABLE. @[CR 8183]

TABLE 13A_A13-3-I - CSA-CP READINGS EQUIVALENT TO 24-HOUR SMAC LIMITS (MASKING LEVELS)

CABIN PRESSURE (PSIA)	HCN (PPM)	CO (PPM)	HCL (PPM)
16.00 - 14.00	4.0	20	2.0
13.99 - 12.00	3.0	19	1.5*
11.99 - 10.0	2.4	19	1.2*
9.99 - 8.00	2.1	18	1.0*

* PRESSURE-CORRECTED VALUES FOR HCL ARE ONLY ESTIMATES. THEY WERE DEVELOPED USING AN INDIRECT METHOD OF ANALYSIS DUE TO THE REACTIVITY OF THE COMPOUND DURING CHAMBER TESTS.

The shuttle CSA-CP is used as one of the indicators to determine when the crew can doff QDM's as outlined in Rule {A13-157}, CABIN ATMOSPHERE CONTAMINATION FIRE/SMOKE, Paragraph G, following a fire or smoke event. CSA-CP unit testing indicated the hydrogen cyanide (HCN), carbon monoxide (CO), and hydrogen chloride (HCL) sensors of the CSA-CP are biased low at lower pressures. Therefore, the actual constituent levels in the cabin could be higher than the CSA-CP unit readings.

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FLIGHT RULES

13A_A13-3

SHUTTLE COMPOUND SPECIFIC ANALYZER - COMBUSTION PRODUCTS (CSA-CP) MANAGEMENT (CONTINUED)

The values in table 13A_A13-3-I represent indicated CSA-CP values at various cabin pressures. If appropriate pressure corrections are applied, the values listed in the table would equal the 24-hour SMAC for those compounds as given in Rule {A13-157}, CABIN ATMOSPHERE CONTAMINATION FIRE/SMOKE, Paragraph G. Using the equivalent 24-hour SMAC limits provides a conservative approach to the biased readings that the CSA-CP provides. ©[CR 8183]

The true atmospheric contaminant concentrations at reduced pressure must be obtained by the flight control team by correcting the CSA-CP display value using the following equations: ©[CR 8183]

$$C_t = D * CF$$

Where

C_t = True atmospheric contaminant Concentration (ppm)

D = CSA-CP Displayed value called down by the crew (ppm)

CF = CSA-CP Correction Factor for that contaminant at that atmospheric pressure (unitless)

and the correction factors for carbon monoxide and hydrogen cyanide are given by:

Carbon Monoxide: $CF = -0.2366LN(P) + 1.6448$

Hydrogen Cyanide: $CF = 0.001222P^4 - 0.05565P^3 + 0.92815P^2 - 6.8577P + 20.9885$

Where

P = Absolute pressure at the time of the CSA-CP display call-down (psia)

LN = Natural log

A correction formula for HCl is not provided because HCl is too reactive a gas to be able to perform reduced pressure testing in the laboratory. However, based on data using an indirect method, HCl responses can be estimated (greater degree of uncertainty) at reduced pressures. A correction multiplier of 2.2 provides a good approximation of the actual exposure concentration at 8 psia with linear extrapolation between 15 (multiplier of 1) and 8 psia. Moreover, the probability of a combustion event that does not produce CO is remote; hence, the progress of post-fire cabin cleanup can be monitored by measurement of CO and HCN, both of which are more difficult to remove than HCl.

The shuttle CSA-CP design is certified with an operational pressure range of 7.8 psia to 16.0 psia for the CO and HCN sensors.

Documentation: SF23-07-071, February 2007; and judgment of the NASA Chief Toxicologist. ©[CR 8183]

FLIGHT RULES

13A_A13-4

~~CABIN ATMOSPHERE CONTAMINATION — HALON 1301~~
~~[HC]RESERVED~~ @[CR 8202] @[CR 8608]

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FLIGHT RULES

ISS ONLY RULES

13A_B13-1

RESERVED @[CR 8283]

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FLIGHT RULES

JOINT SHUTTLE/ISS RULES

13A_C13-1 RESERVED @[CR 8056]

13A_C13-2 RESERVED @[CR 8453]

FLIGHT RULES

13A_C17-1 SHUTTLE VENT MANAGEMENT [RC] (CONTINUED)

- d. SRMS VIDEO OF A WASTE DUMP PRIOR TO DOCKING, OR THE FIRST DOCKED DUMP, IS HIGHLY DESIRED IF MODIFICATION OR MAINTENANCE THAT COULD PERTURB THE WASTE DUMP PLUME PATTERN HAS OCCURRED SINCE THE LAST IN-FLIGHT VERIFICATION OF A NOMINAL (PERPENDICULAR TO THE ORBITER FUSELAGE) WASTE DUMP PLUME PATTERN.

To ensure that the waste dump plume will not impinge on the USOS solar arrays, it is highly desired to get SRMS wrist camera video of the plume. This can be accomplished during shuttle free flight (more desirable) or during the first waste dump while docked. In addition to video verification of a perpendicular plume pattern, waste dump nozzle temperature, and flowrate data will also be used to verify that there is no ice forming on the nozzle that could deflect the plume. Inability to confirm nominal waste dump characteristics could result in the prohibition of docked waste dumps and in the use of CWC's for all condensate and urine collection during docked operations.

- D. IF A CWC DUMP IS NECESSARY PRIOR TO UNDOCKING, IT WILL BE PERFORMED AFTER A SCHEDULED SUPPLY OR WASTE WATER DUMP WHEN PRACTICAL. IF REQUIRED, A CWC-ONLY DUMP MAY BE PERFORMED.

To minimize the number of nozzle dump occurrences and the associated attitude changes, CWC dumps should be performed in conjunction with supply and/or wastewater dumps when possible. CWC-only dumps may be performed, when required, if attitude constraints or timeline activities do not allow for dumping adjacent to supply and/or wastewater dumps.

- E. URINE WILL BE STORED IN THE ORBITER WASTE TANK ONLY, UNLESS A WASTE SYSTEM FAILURE REQUIRES URINE TO BE STORED IN CWC'S.

Due to cabin contamination concerns, the stowage of wastewater in CWC's will not be considered as a method of minimizing the amount of wastewater dumped while docked. Engineering judgment.

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FLIGHT RULES

13A_C17-2 MANAGEMENT OF LIOH STOWED ON ISS [RC]

~~PENDING RUSSIAN CONCURRENCE~~

THIS RULE SUPERSEDES RULE {C17-18}, MANAGEMENT OF LIOH STOWED ON ISS [RC]. @[CR 8549] @ED _____]

A. 117(13A) SHUTTLE LIOH STOCKPILE REQUIREMENTS:

U.S. LIOH CANS IN THE ISS LIOH STOCKPILE ARE REQUIRED TO SUPPORT THE 117 SHUTTLE CREW IN THE EVENT OF A CARBON DIOXIDE REMOVAL ASSEMBLY (CDRA) FAILURE AND THE CDRA IS UNRECOVERABLE DURING THE DOCKED TIMEFRAME.

The LiOH stockpile is intended to provide a redundant CO₂ removal capability to the CDRA while shuttle is docked.

Stockpile LiOH cans plus orbiter LiOH cans will provide CO₂ control for the shuttle crew in the event the ISS Carbon Dioxide Removal Assembly (CDRA) were to fail after liftoff and was unrecoverable for the entire docked duration.

This is documented in section 6.8 of the Standard Integration Agreement for all Space Shuttle Program and International Space Program Missions (SIA) NSTS 21458.

B. 117(13A) ISS CONSUMABLES RESERVE REQUIREMENTS:

THE ISS WILL MAINTAIN A LIOH CONSUMABLES RESERVE DURING 117(13A) PER RULE {B17-16}, ISS CONSUMABLES RESERVE REQUIREMENTS [RC].

The ISS Program requires that 15 days of LiOH be available for the main ISS crew consisting of 3 crewmembers ~~to provide a redundant method of CO₂ removal~~ in the event of failures of the ISS CO₂ removal systems. This reserve will provide time to perform repairs to restore the primary systems.

Russian LiOH canisters provide approximately 72 man-hours per can. The ISS inventory of Russian LiOH cans for 117(13A) is assumed to be 16 cans at Shuttle docking which will provide 16 day reserve of LiOH cans for 3 crewmembers ~~worth of CO₂ control~~. @ED _____]

Assuming there are no Russian LiOH cans available for the contingency reserve at docking of 117(13A), 23 U.S. LiOH cans would be required to provide the entire 15 days of CO₂ control. @[CR 8549]

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FLIGHT RULES

13A_C17-2 MANAGEMENT OF LIOH STOWED ON ISS [RC]
(CONTINUED)

2. IT IS ALLOWED TO USE EXPIRED RUSSIAN LIOH CANS ON ISS;
HOWEVER, EXPIRED RUSSIAN LIOH CANS WILL NOT BE COUNTED
TOWARD ISS RESERVE OR STOCKPILE REQUIREMENTS. @ED]

The Russian cans storage constraints are imposed based on the conditions for provision of the declared CO₂ absorption efficiency. The increased storage period currently in place merely leads to reduction of absorbing properties of LiOH substance and does not violate the safe use requirements and, therefore, makes it possible to use absorption cans on ISS under that condition.

C. ISS LIOH STOCKPILE MAY NOT BE "DOUBLE BOOK KEPT" FOR BOTH SHUTTLE USE AND ISS USE DURING 117 (13A). @CR 8549]

IF CDRA FAILS PRIOR TO DOCKING AND IS UNRECOVERABLE DURING THE DOCKED MISSION, THE SHUTTLE MISSION DURATION WILL BE DECREASED IF REQUIRED TO PROTECT THE ISS CONTINGENCY RESERVE.

Due to Ascent Performance Margin constraints, STS-117/13A cannot carry sufficient LiOH to protect for a CDRA failure during the entire docked mission. The ISS and shuttle programs have accepted the risk such that if a CDRA failure occurs and there is insufficient LiOH, it may be necessary to shorten the mission based on when CDRA fails and the actual CO₂ production rates. @CR 8549] @ED]

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FLIGHT RULES

13A_C17-3

STATION AND SHUTTLE ATMOSPHERE CONDITIONS PRIOR
TO HATCH OPENING AND DURING MATED FLIGHT [RC]

PENDING RUSSIAN CONCURRENCE

- A. THE SHUTTLE AND ISS ARE RESPONSIBLE FOR MEETING THE FOLLOWING COMBINED CONDITIONS AT HATCH OPENING AND FOR THE DURATION OF THE MATED FLIGHT: @CR 8407] @ED]
1. THE PPCO₂ LEVEL PER RULE {B13-53}, PPCO₂ CONSTRAINT [RC] [E]
 2. THE PPO₂ LEVEL BETWEEN 146 AND 178 MMHG/2.82 AND 3.44 PSIA PER RULE {B13-54}, MINIMUM PPO₂ CONSTRAINTS [HC] [RC] [E], AND AN O₂ CONCENTRATION PER RULE ~~← 24.1 PERCENT PER RULE~~ {B17-3}, OXYGEN PARTIAL PRESSURE MANAGEMENT [HC] [RC] [E] [A]. @ED]
 3. THE PPN₂ LEVEL < 600 MMHG/11.6 PSIA PER RULE {B17-4}, NITROGEN PARTIAL PRESSURE MANAGEMENT [RI]
 4. TOTAL PRESSURE BETWEEN 724 AND 770 MMHG/14.0 AND 14.9 PSIA PER RULE {B17-2}, TOTAL PRESSURE MANAGEMENT [RC]
 5. IN SUPPORT OF AN ISS JOINT AIRLOCK EVA, THE TOTAL PRESSURE AND O₂ CONCENTRATION SHALL BE MANAGED PER RULE {C17-19}, ISS JOINT AIRLOCK PRE-EVA ATMOSPHERE REQUIREMENTS [RC] [E]. @CR 8407]

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FLIGHT RULES

13A_C17-3

**STATION AND SHUTTLE ATMOSPHERE CONDITIONS PRIOR
TO HATCH OPENING AND DURING MATED FLIGHT [RC]
(CONTINUED)**

- B. BOTH THE SHUTTLE AND STATION WILL PROVIDE ATMOSPHERE CONDITIONING WHICH MEETS THE REQUIREMENTS LISTED IN PARAGRAPH A BY USING THE FOLLOWING NOMINAL SYSTEM CONFIGURATIONS: @[CR 8407]
1. PPO₂ (IN PRIORITY ORDER):
 - A. THE SHUTTLE ~~SHALL~~ AND ISS SHALL PROVIDE O₂ CONSUMABLES FOR METABOLIC USE AND LEAK MAKEUP. THE ELEKTRON WILL NOMINALLY ~~NOT~~ BE ACTIVATED ~~AND WHILE~~ THE SHUTTLE BLEED ORIFICE OPENED AS REQUIRED TO ~~IS PROVIDING~~ PROVIDE PPO₂ CONTROL. @[ED]
 - b. PROGRESS O₂
 - c. SM TPK CARTRIDGES
 - d. JOINT AIRLOCK O₂ TANKS
 2. PPN₂: THE SHUTTLE SHALL PROVIDE N₂ CONSUMABLES FOR LEAK MAKEUP. U.S. SHALL PROVIDE N₂ CONSUMABLES FOR LEAK MAKEUP DURING EVA'S FROM JOINT AIRLOCK. @[ED]
 3. PPCO₂: CDRA AND VOZDUKH WILL BE OPERATED CONCURRENTLY TO REMOVE CO₂. VOZDUKH WILL BE OPERATED IN A THREE-CREWMEMBER CO₂ REMOVAL MODE. U.S. LIOH WILL BE USED IF NECESSARY TO SUPPLEMENT THESE CAPABILITIES AND MAINTAIN CO₂ WITHIN LIMITS.
 4. PPH₂O: THE SHUTTLE HUMIDITY REMOVAL SYSTEM, THE LAB CCAA, AND THE SERVICE MODULE <SKV> [CKB] HUMIDITY REMOVAL SYSTEM WILL BE OPERATED SIMULTANEOUSLY.
 5. ATMOSPHERE CONTAMINANTS: THE LAB TCCS, THE SM <BMP> [BMP], AND THE SHUTTLE AMBIENT TEMPERATURE CATALYTIC OXIDIZER OPERATE CONTINUOUSLY. THE USOS TCCS MAY BE POWERED DOWN PER RULE {B17-11}, TRACE CONTAMINANT REMOVAL SYSTEMS MANAGEMENT [RC], TO MEET THE USOS POWER REQUIREMENTS. @[CR 8407]

THIS RULE CONTINUED ON NEXT PAGE

FLIGHT RULES

13A_C17-3

STATION AND SHUTTLE ATMOSPHERE CONDITIONS PRIOR
TO HATCH OPENING AND DURING MATED FLIGHT [RC]
(CONTINUED)

The conditions listed are referenced from other flight rules and represent the atmospheric conditions for normal operations. Both the shuttle and station should condition their respective ECLSS atmospheres to ensure that the limits are not violated during mated flight. Flight specific rules will dictate exact systems configurations. @ED]

DOCUMENTATION: Rules {B17-2}, TOTAL PRESSURE MANAGEMENT [RC]; {B17-3}, OXYGEN PARTIAL PRESSURE MANAGEMENT [HC] [RC] [E] [A]; {B17-4}, NITROGEN PARTIAL PRESSURE MANAGEMENT [RI]; {B17-5}, CO2 PARTIAL PRESSURE LIMITS AND ACTIONS [HC] [RC] [H]; and {B13-54}, MINIMUM PPO₂ CONSTRAINTS [HC] [RC] [E]. @[CR 8407]

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