

# Flight Director Console Handbook

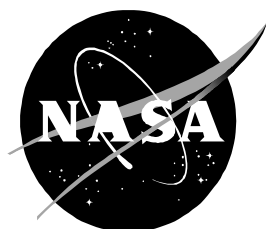
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All Flights

Mission Operations Directorate

Revision C  
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Revision C, PCN-4  
January 20, 2006



National Aeronautics and  
Space Administration

Lyndon B. Johnson Space Center  
Houston, Texas

## MISSION OPERATIONS DIRECTORATE

### FLIGHT DIRECTOR'S HANDBOOK

#### FINAL, REV C, PCN-4

#### PREFACE

This Revision C, PCN-4, dated January 20, 2006, is an update of Revision C, PCN-3 of the Flight Director's Handbook, dated July 8, 2005. It is requested that anyone having comments, questions, or suggestions concerning this handbook contact B. A. Levy, Flight Director Office, building 4N, room 3027A, phone (281) 483-8586.

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Prepared by: \_\_\_\_\_  
B. A. Levy

Approved by: \_\_\_\_\_  
P. L. Engelauf  
Acting Chief, Flight Director Office

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
LYNDON B. JOHNSON SPACE CENTER  
HOUSTON, TEXAS

## MISSION OPERATIONS DIRECTORATE

### FLIGHT DIRECTOR'S HANDBOOK

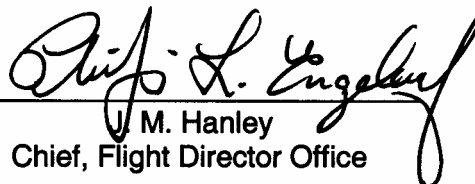
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Prepared by:   
B. A. Levy

Approved by:   
J. M. Hanley  
for Chief, Flight Director Office

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
LYNDON B. JOHNSON SPACE CENTER  
HOUSTON, TEXAS

FLIGHT DIRECTOR CONSOLE HANDBOOK

ALL FLIGHTS

FINAL, REV C, PCN-4, DATED JANUARY 20, 2006

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1.1 MISSION PLANNING TEMPLATE

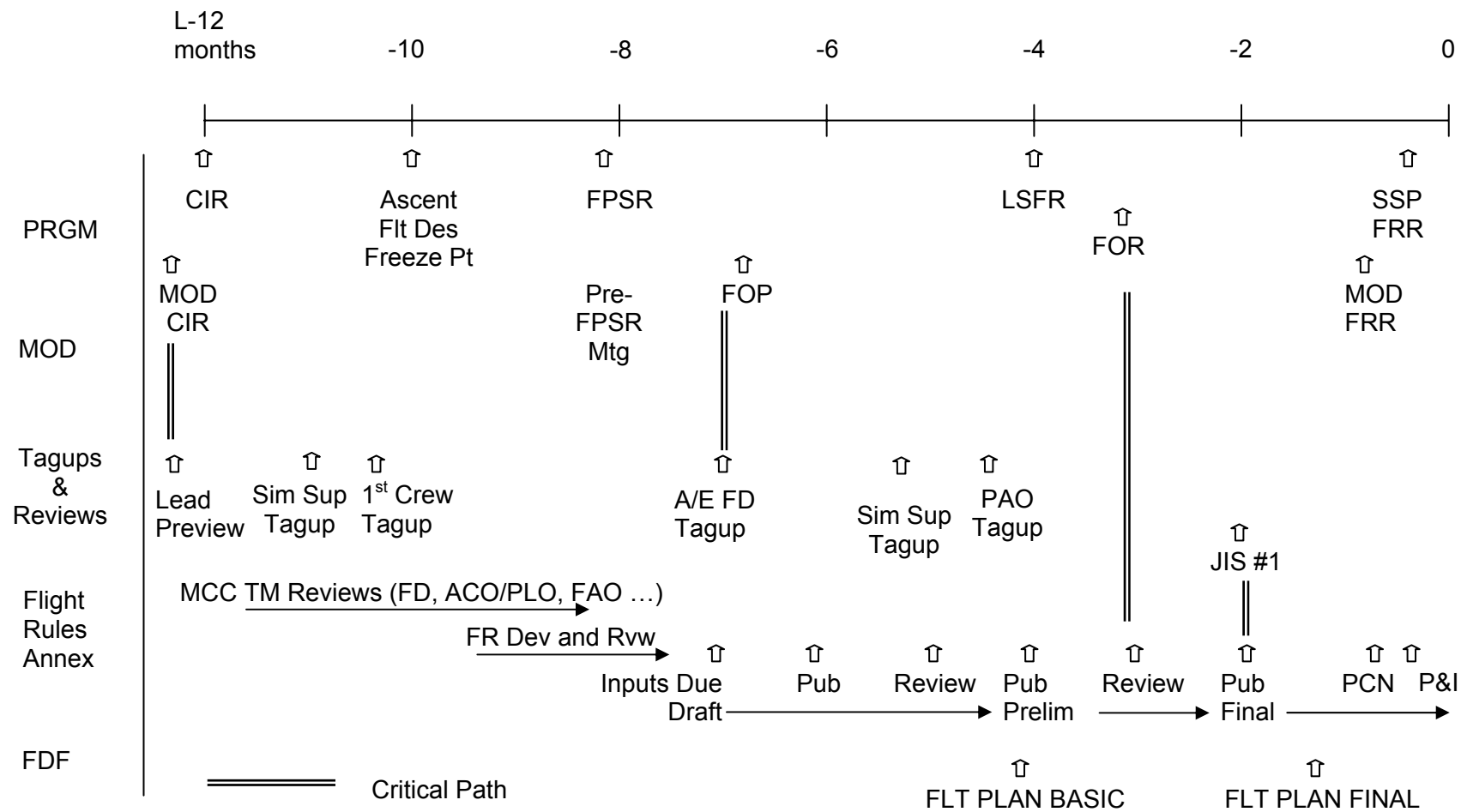


Figure 1.1-1. Lead Preflight Template

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**1.1.1 Orbit People/Contacts**

Org	Contact	Name	Mail Code	Phone	e-mail
FD	Shuttle Lead FD				
	Shuttle Orbit 2				
	Shuttle Planning				
	Shuttle Team 4				
	Ascent/Entry				
	ISS Lead FD				
	ISS Orbit 2				
	ISS Planning				
	ISS Team 4				
	MOD				
Crew	CDR				
	PLT				
	MS				
	Scheduler				
Program	Flight Manager				
	Launch Package Mgr				
	Flight Integration Mgr (FIM)				
	P/L Integration Mgr (PIM)				
	ISS Increment Manager				
FRs	Book Manager				
FDF/ODF	FDF Coordinator				
	ODF Coordinator				
Payload/ Customer	Mission Manager				
	Lead PODD				
	Customer Lead				
Onboard Laptops	PGSC Coordinator				
	SSC Laptop Coordinator				
Recon	Recon Manager				
Flt Design	Manager				
Training	Sim Sup				
	STL				
	Team Leads				
	P/L Training				
POC	POC Coordinator				

Shuttle FCT	ACO/Payloads				
	DPS				
	EECOM				
	EGIL				
	EVA				
	FAO				
	POINTER				
	FDO				
	GC				
	GNC				
	INCO				
	MMACS				
	PAO				
	PDRS				
	Photo/TV Lead				
	PROP				
	RNDZ				
	Surgeon				
ISS FCT	HSG				
	ADCO				
	CATO				
	ECLSS				
	ODIN				
	OPS PLN				
	OSO				
	PAO				
	PHALCON				
	RIO				
	Surgeon				
	THOR				
	TOPO				

## 1.1.2 Orbit Shuttle Lead Checklist

### Lead Flight Director Assignment

Lead flight director activities generally begin about one year before flight. When first assigned to a flight, flight specific documentation should be reviewed to become familiar with the Orbiter/cargo configuration, flight requirements, and objectives. There are several flight specific requirements documents and web sites available for flight specific information.

- Payload Integration Library System (PILS) at <http://sspweb.jsc.nasa.gov/pils/payload.cfm>
  - Flight Requirements Document (FRD)
  - ISS Mission Integration Plan (MIP)
  - Spacehab Carrier Integration Plan (Generic CIP and flight specific Addendums)
  - Payload Integration Plan (PIP)
  - Annexes
    - Annex 1 Payload Data package
    - Annex 2 Flight Planning
    - Annex 3 Flight Operations Support
    - Annex 4 Command and Data
    - Annex 5 Payload Operations Control Center (POCC)
    - Annex 6 Orbiter Crew Compartment
    - Annex 7 Training
    - Annex 9 Launch Site Standard Services
    - Annex 11 EVA
- Flight IPT home page at <http://sspweb.jsc.nasa.gov/ipt/>
- Flight Planning at <http://mod.jsc.nasa.gov/do4/flightplan/>
- MOD Flight Products at [http://mod.jsc.nasa.gov/mod/flight\\_products.cfm](http://mod.jsc.nasa.gov/mod/flight_products.cfm)

### Cargo Integration Review (CIR) ~L-10 to 12 months

The CIR is a three day series of meetings to review the basic flight requirements and to determine whether the manifested payloads and objectives are compatible. The CIR is chaired by the Flight Manager and includes participation from the FIMs, PIMs, payload customers, KSC processing, engineering support, operations, safety, and flight design. An introduction is provided at the beginning of the first day to review the high level objectives and Orbiter/cargo configuration. After the introduction is complete, the group breaks apart and supports the various splinter meetings as required. Lead Flight Director attendance at the splinter meetings depends on the flight specific issues. At the end of the week the CIR board is held, where a review of the issues is provided and any CRs or DNs are dispositioned.

In preparation for the CIR, a dry run is held approximately one month prior to the CIR. The purpose of the dry run is to review the CIR presentations to identify any issues or CIR splinter topics. The lead Flight Director is generally included on the agenda but normally does not provide charts. A MOD dry run is also held just before the CIRD to review the ACO/Payloads, FAO, and Flight Design charts. This review is generally held with the lead Flight Director and the DA8 Chief.

- MOD CIRD (~1week prior to CIRD)



- Review ACO/Payloads, FAO, Flight Design, and Training CIR presentations
- Ensure any potential issues with payload compatibility, timeline, consumables, safety, training, etc. are included
- CIRD (~2-4 weeks prior to CIR)
  - Provide any big picture issues or concerns
- CIR
  - Provide any big picture issues or concerns
  - Attend splinter meetings as required
  - Participate in CIR board

Flight Planning and Stowage Review (FPSR)

The FPSR is chaired by the Flight Manager and is held to identify whether the cargo/payloads are compatible and whether there is room for additional payloads or stowage. For some flights, FPSR is held at the end of CIR and for other flights, it may be held weeks after CIR depending on the flight specific template. At this point, the FAO should have enough Annex 2 Flight Planning inputs to support a draft timeline to ensure there is a high likelihood that the mission objectives can fit into the timeline. This is the forum to raise any flight planning or stowage issues.

Flight Operations Panel (FOP)

There are generally two FOPs, which are chaired by the Flight Design Manager, held per flight to review the MOD design before I-load design begins. The agenda includes a high level mission overview provided by the ACO/Payloads Officer, a timeline overview provided by the lead FAO, and a review of what will become the Level A Ground Rules and Constraints provided by the Flight Design Manager. The basic template for the FOPs varies depending on whether the flight is an ISS or non-ISS flight. For non-ISS flights, the first FOP is held at ~L-10 ½ months and is a basic review to make sure the flight design will work and that there are no major issues that cannot be resolved in preparation for building the Conceptual Flight Profile (CFP) I-loads. The 2<sup>nd</sup> FOP is more detailed and is held at ~L-8 ½ months in preparation for the One Cycle to Flight (OCF) I-load design. For ISS flights, since the design is much more standard, the first FOP is more detailed but is still held at ~L-10 ½ months. A second FOP is not held until ~L-6 months to capture the Ascent/Entry design deltas.

Non-ISS Flight		ISS Flight	
~L-10 ½ months	CFP FOP	~L-10 ½ months	CFP FOP
~L-8 ½ months	OCF FOP	~L-6 months	Delta FOP (Part 2)

Flight Rules (ref Section 1.4.2 for additional information)

L-7 months	Preliminary
L-4 months	Basic
L-3 months	FOR – DNs dispositioned
L-2 months	Basic Rev A (with approved DNs incorporated)
L-1 month	Final, PRCB presentation

- key mission events
- outline annex rules that are exceptions to All Flights, increased safety risks, unique

<L-1 month PCN's as required, PRCB presentation

Team Assignments/Shift Schedule Development ~L-3 ½ months (prior to FOR)

The shift schedule should be developed using the following guidelines and in accordance with the MOD work guidelines, documented in Memo DA-01-49:

- Determine critical and dynamic time periods and which teams should be assigned. Set simulation assignments accordingly.
- Keep a standard Ascent to O2 to Plng/O3 rotation unless there are flight unique drivers that make a nonstandard schedule preferable.
- Minimize changes to start/end of shifts as much as possible, shifting to a fairly constant rotation as soon as practical.
- Distribute preliminary shift schedules at FOR.

Flight Operations Review (FOR) ~L-3 months

The purpose of the FOR is to review and baseline the ops documentation in preparation for flight specific mission training. Proposed changes to the documentation are generated in the form of a Discrepancy Notice (DN) and are reviewed and given a final disposition at the FOR. The lead Flight Director is the sponsor of all MOD flight specific DNs submitted against the documentation under review. The lead flight director performs the following activities in preparation for FOR:

- Ensures flight operations documentation meets the defined flight requirements and that the associated ops risks have been adequately addressed.
- Ensures all Shuttle operations products for the flight are available to support the FOR.
- Arranges necessary MOD expertise and review support for FOR products (coordinated w/Station Flight Director if ISS flight).
- Ensures the MOD resources can adequately support the schedule for post-FOR action item closure related to the flight (Coordinated w/Station Flight Director if ISS flight).
- Distributes preliminary shift schedule.

PAO Mission Overview Press Conference

At approximately L – 1 month, a Mission Overview presentation is compiled with the Public Affairs Technical Director. This presentation should include a minimal number of word charts and should include animation and “show and tell” objects. It should last about 15 minutes with about 30 minutes of questions.

Shift Schedule Memo

~L-1 month Distribute draft of preliminary Shift Schedule Memo.

~L-2 weeks Distribute DA8 formal memo to include the MCC Flight Control Team manning schedule and the schedule for the key prelaunch activities. The memo is generally held up until the prelaunch times can be collected from the Ascent FD.

### Flight Readiness Review

- |            |  |
|------------|--|
| ~L-3 weeks | MOD FRR – Present Flight Rules Annex Overview (same as PRCB presentation)  |
| ~L-2 weeks | Level 1 FRR (at KSC) – Provide standard mission overview. Typically, the Chief of the FD Office travels to KSC and presents. |

### Post-flight Debriefs

The Lead Flight Director participates in the following post-flight debriefs and performs the functions as described:

- FD/Crew/CAPCOM Debrief – Lead Flight Director forwards the schedule for this debrief to all other flight directors supporting the flight and leads the discussion of key issues/items/questions during the debrief with the crew.
- SPAN/FCT Debrief – Lead Flight Director facilitates the review of the anomaly log by each of the flight controller disciplines. DA8 Integration support will coordinate the telecon, collect the list of questions from flight controllers, and also participate in the debrief.
- MOD Lessons Learned – Lead Flight Director presents summary overview of mission objectives accomplished, high level issues, and lessons learned. The DA8 SAC coordinates the schedule for this meeting in conjunction with the Lead Flight Director, distributes the agenda, and records actions.
- IPT Lessons Learned – Lead Flight Director presents similar information as MOD Lessons Learned but focuses on programmatic items or issues.

### Plaque Hanging

Shortly after landing, the Lead Flight Director will schedule the plaque hanging ceremony, which includes both the WFCR and the BFCR for Joint missions. This is an opportunity to recognize those disciplines who have made a significant contribution to the success of the mission. CB provides one plaque for each FCR without a specific request from DA8. The DA8 secretary will order two plaques for a Shuttle only mission, one for the Lead Flight Director and one for the group/discipline who gets to hang the plaque. For a joint Shuttle/ISS mission, the DA8 secretary will also order two additional plaques, one for the Lead ISS Flight Director and one for the ISS group/discipline who gets to hang the plaque in the BFCR. If the plaque hanging honor is “shared” or a “tie”, then the Lead Flight Director will need to make a specific request to the DA8 secretary to order the additional plaque(s). “Runners-up” will not receive plaques.

### 1.1.3 ISS Lead Checklist

#### **TBS**

#### *Mission Configuration Test Requirements*

~L-8 weeks                      DA6 will bring test requirement to the JOP for DA8 input to determine the best opportunities for conducting the test and defining mission specific requirements.

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#### 1.1.4 FOR Responsibilities

- NASA Space Shuttle Flight Manager co-chairs the FOR Board with the NASA Launch Package Manager and is responsible for assuring overall Shuttle mission requirements and Shuttle programmatic requirements for the assembly flight are met and that Shuttle mission risks have been adequately addressed.  
Responsible for arranging and managing necessary Shuttle Program technical expertise and review support for shuttle assembly flight FOR products.
  - Responsible for ensuring that all Shuttle Program requirements, constraints, data, analyses, hardware, software, and products for the shuttle assembly flight are available to support the FOR.
  - Responsible for assuring that the Shuttle Program can adequately support the schedule for post-FOR action item closure related to the assembly flight.
  - DO5 management chairs the FOR Pre-board as the agent of the Space Shuttle and ISS Programs.
  
- NASA Launch Package Manager (LPM) represents the ISS Program on the FOR Pre-board and co-chairs the Board with the NASA Space Shuttle Flight Manager and is responsible for assuring ISS programmatic requirements for the assembly flight and following stage are met and ISS mission risks have been adequately addressed.
  - Responsible for arranging and managing necessary ISS hardware provider technical expertise and review support for assembly flight and stage FOR products (Coordinated w/Boeing Launch Package Manager).
  - Sponsor and manage all ISS Program and Boeing submitted DN's against the assembly flight and following stage ops products under review (Coordinated w/Boeing Launch Package Manager).
  - Responsible for assuring that the ISS Program and Boeing resources can adequately support the schedule for post-FOR action item closure related to the assembly flight (Coordinated w/Boeing Launch Package Manager).
  
- NASA Increment Manager represents ISS Program on the FOR Pre-board and Board and is responsible for assuring ISS programmatic requirements for the portion of the overall increment under review are met and mission risks have been adequately addressed.
  - Responsible for ensuring that all ISS Program requirements, constraints, data, analyses, hardware, software, and products for the portion of the overall increment under review are available to support the FOR
  - Responsible for assuring that the ISS Program and Boeing resources can adequately support the schedule for post-FOR action item closure related to the increment-specific actions (Coordinated w/Boeing Launch Package Manager).
  - Sponsor of all ISS Program and Boeing submitted DN's against the increment-specific ops products under review.
  
- Shuttle Flight Director is the operations agent for the Space Shuttle Flight Manager, the NASA Launch Package Manager, and the Increment Manager.
  - Member of the FOR Pre-board and FOR Board, responsible for assuring that the Shuttle assembly flight operations documentation meets the defined flight requirements and that the associated ops risks have been adequately addressed
  - Responsible for ensuring that all Shuttle operations products for the shuttle assembly flight are available to support the FOR.

- Responsible for arranging necessary MOD expertise and review support for Shuttle assembly flight FOR products (Coordinated w/Station Flight Director).
  - Responsible for assuring that the MOD resources can adequately support the schedule for post-FOR action item closure related to the assembly flight (Coordinated w/Station Flight Director).
  - Sponsor of all MOD assembly flight specific DN's submitted against the ops products under review.
- Station Flight Director
    - Operations agent for the NASA Launch Package Manager and Increment Manager.
    - Member of the FOR Pre-board and Board, responsible for assuring that the increment-specific and ISS based assembly flight operations documentation meets the defined flight requirements and that the associated ops risks have been adequately addressed.
    - Responsible for ensuring that all ISS operations products for the increment-specific and ISS based assembly flight are available to support the FOR.
    - Responsible for arranging necessary MOD expertise and review support for increment-specific and ISS based assembly flight FOR products (Coordinated w/Shuttle Flight Director).
    - Responsible for assuring that the MOD resources can adequately support the schedule for post-FOR action item closure related to the increment-specific and ISS based assembly flight actions (Coordinated w/Shuttle Flight Director).
    - Sponsor of all MOD ISS-based assembly flight and increment-specific DN's submitted against the ops products under review.

### 1.1.5 Flight Specific JOP/FTP Topics

This checklist lists topics, which should typically be assessed at a flight specific JOP (ISS missions) or FTP (non-ISS Missions) prior to flight for on-orbit operations.

- Mission Timeline
- EVA Timelines
- Attitude Timeline
- Mission Priorities
- Minimum Duration Flight (what mission objectives will be accomplished for a minimum duration flight)
- Robotics Operations Review (operations, timelines, clearances, interdependencies with other operations)
- Constraints
  - DAP
  - Robotics
  - Mechanisms
  - Thermal
  - Attitude
  - Water dumps
  - Other flight specific constraints associated with payload/station operations
- Mission Specific Go/No-Go Table (go/no-go table for key mission events)
- Draper Labs DAP Assessment
- Loss of Orbiter Verniers Impacts
- Periods of Critical TDRSS Coverage
- Power Assessment (Orbiter cryo margins, ISS power margins for dock/undock, docked, stage operations)
- Limiting factors for Mission Extension Day for payload operations (cryo, prop, N2, etc.)
- Rendezvous, docking, and undocking operations (capture/berthing operations for non-station rendezvous)
- Contingency Procedures Review (review of techniques for working around single failure cases which have significant impact to mission objectives)
- Photo documentation requirements (unique requirements to document mission activities such as ISS post assembly closeout photos, or HST post repair photos)



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## **1.1.6 Flight Specific Rules**

TBS

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### 1.1.7 Crew Tagup Items

The final Flight Director/Orbiter Crew Tagup occurs while the crew is in quarantine just before they leave for KSC to launch usually about L-2 weeks. This is the last opportunity for the Flight Directors assigned to a flight to meet face to face with the entire crew. The CAPCOMs assigned to the flight will also be present. The purpose of this meeting is to provide an opportunity for the managers of the ground team and the crew to exchange any recent updates and to discuss operations protocol issues. The objective is to leave the meeting with the feeling that there are no unresolved issues between the ground team and flight crew and we are ready to fly. The meeting is normally conducted by the Lead Flight Director and follows the following agenda:

- A. Introduction of players – Lead FD
  - 1. All of the players may not have been involved in the simulations and this is an opportunity to make sure that the crew is aware of which Flight Directors and CAPCOMs will be working which shifts.
  - 2. A shift schedule should be provided to the CDR.
- B. Ascent/Entry – Asc/Ent FD's take the lead in this discussion
  - 1. Updates on Primary and Abort site status
  - 2. Review last minute procedure deltas approved or pending
  - 3. Review last minute Flight Rule changes approved or pending
  - 4. Review Launch window Flight Rules
  - 5. Review Deorbit Prep and Deorbit Backout Flight Rules
  - 6. Review changes to communications capability or protocols
  - 7. Review mass property updates
  - 8. Review post rollout activities
- C. Orbit – Lead FD
  - 1. Review last minute manifest changes
  - 2. Review last minute program requirements changes
  - 3. If ISS flight, review status of ISS
  - 4. Review last minute procedure deltas approved or pending
  - 5. Review last minute Flight Rule deltas approved or pending
  - 6. Review communications protocol, A/G, VHF, Private Meds, OCA
  - 7. Review Execute Package content, format, uplink timing, printing, # copies
  - 8. Review OCA use for private conferences
  - 9. Review crew sleep configuration, where each crew member will be and comm config
  - 10. Review mission priorities and contingency mission strategies

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### 1.1.8 Individual Flight Controller Tagup Items

At least once prior to the beginning of integrated simulations, the lead FD should meet with all their individual flight controllers to discuss the overall plan for the mission and any issues or concerns. Items of interest to potentially discuss include:

#### 1.1.8.1 Shuttle Flight Controllers

##### Generic (All operators)

- Vehicle specific hardware or software
- Flight specific hardware or software
- New/different capabilities in MOC, workstation, or Command Server
- Significant issues during previous flight (previous vehicle/flight) or turnaround flow
- Comments on simulations/training/prep
- Console support and times
- Tagups after MMT as reqd
- Keep FD informed of nominal timeline events
- Exchange home phone numbers

##### PROP

- Prop margins and where carried (OMS/RCS)
- PTI/DTO Prop Tracking
- Waveoff Day/rev protection
- Prop priority table

##### GNC

- DTO Cue Cards
- IMU Power up

##### GC

- Double check SHO times
- Review clock management
- FCR Front Display Management

##### DPS

- OI Summary – new capabilities, DR's

##### ACO/Payloads

- Mission priorities
- Coordination protocol with customer/BFCR

##### EPS

- Cryo Margins

##### EECOM

- Water management plan
- N2 budget/margins
- Coldsoak plans

#### INCO

- A/G loop management
- VHF plans
- Video management plan
- TFL/DFL Management

#### MMACS

- Full CWC stowage plan
- Hip Pocket IFM status

#### Booster

- NA

#### FAO

- FDF Status
- 482 Status
- Execute package timing
- OCA Management

#### PAO

- In-flight press conference requirements
- Post shift press conference plans
- In-flight TV requirements

#### Flight Surgeon

- In-flight Private medical conference protocol
- Unique medical requirements

#### PDRS

- Robotics operations

#### EVA

- EVA priorities
- EVA timelines, adequate margin to cover adjustment factor

#### CAPCOM

- Voice protocol with BFCR/ POCC/Crews
- A/G Loop protocol
- Handling of Private mail

### **1.1.8.2 ISS Flight Controllers**

#### CATO

- Predicted comm coverage for all the ISS comm systems
- Which comm systems are available and when
- Internal A/G and intercom configuration
- Tlm formats available for mission and what Russian tlm is available via US sources

#### ODIN

- Any planned or likely software or PPL uplinks
- C&DH config changes since last mission
- SPN significant effects to be concerned with

#### OSO

- Overview of any Russian or US planned or likely maintenance
- Review of CBM nominal and contingency procedures. Discuss any thermal conditioning required prior to mate. Discuss time limitations prior to final mate.

#### ADCO

- Review docking and undocking sequences and nominal and off nominal auto and manual responses.
- Review time critical Russian communications during docking/undocking.
- Discuss mass properties and attitude control management for this period.
- Review pointing responsibilities and plans.

#### THOR

- Shell warmup or dewpoint control plan
- Review nominal and contingency heater power requirements
- Review emergency powerdowns due to thermal failures

#### PHALCON

- Review power available and usage plans
- Review emergency powerdown plans
- Review agreements for providing power between partners and payloads/systems

#### ECLS

- Review air quality measurement and control techniques and capabilities
- Review ingress/egress procedure/rules
- Review current emergency procedures/rules

#### ROBO

- Robotics operations

#### EVA

- EVA priorities
- EVA timelines, adequate margin to cover adjustment factor

#### OPS PLAN

- Review plans
- Review FCOH and JOIP process and agreements for interactions between us and Partners and the ISS and Shuttle teams

#### ISS CAPCOM

- Review latest communication protocols with Partners and between ISS and Shuttle CAPCOMs
- Discuss strategy for FD/CAPCOM communications and division of responsibilities



TOPO

- Review latest debris avoidance strategies and plans
- Review altitude strategy

RIO

- Review latest information exchange agreements
- Discuss communication strategy and levels of information between RIO and FD

### **1.1.9 Sim Sup/STL Tagup Items**

The Lead Flight Director should meet with the Lead Simulation Supervisor/Station Team Lead around L-11 months to discuss and agree on the following:

- **Integrated training objectives**  
Discuss the high-level mission objectives. Identify the parts of the mission to be rehearsed and the relative order of the exercises. Identify any high-level contingency scenarios that should be rehearsed.
- **Integrated simulation plan**  
Develop a preliminary integrated training plan with launch minus (L-) scheduling. Consider key mission preparation milestones as well as customer travel constraints.
- **Simulation configuration**  
Discuss the configuration of the simulations. If EVA's will be included in the integrated training plan, identify which will be performed with the EVA crew in the NBL (wet EVA) or simulated in the SMS (dry).  
Discuss the overall simulation capabilities and limitations of the SMS/SSTF/MCC as well as the remote payload simulators.

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### 1.1.10 Console Log Book

#### A. Philosophy

1. Keep only the latest copy of anything received.
2. Electronic copies of status sheets are preferred.
3. Clipboards are reserved for past copies of items for easy access by MOD and FD.

#### B. Three-Ring Binder (responsibility of the Lead FD to get this prepared pre-flight)

Three-ring binder(s) are kept with the following tabbed sections:

1. Team Shift schedule
2. Log sheets (signed hard copies of logs typed on the PC or signed hard copies of handwritten log sheets)
3. Handover logs and relevant supporting data
4. Execute packages
5. Anomaly Logs for vehicle and MCC
6. Chit Log and Chits
7. Manning Rosters, FD Beeper List with special points of contact for Payload Community, and a copy of Joel Montalbano's Flight Director Phone List sheet.
8. Memo for Facility and Support and Memo for "Real Time Support and Launch Scrub Training Assessment Plan" from DT
9. Flight Rules in work
10. Entry inputs
  - (1) Latest SMG Weather Forecast Sheet package
  - (2) Landing Site Status memo
  - (3) Deorbit Opportunities Table (DOT)
  - (4) Inputs for Deorbit Prep and Entry Checklist Deltas

#### C. Optional Three-Ring Binder Material

The Lead FD may put together an information book of special topics that were worked preflight as reference material for the other FD's. Suggested contents:

1. Systems Division Flight Readiness Review
  - (1) Data Pack
  - (2) Updates (section G)

(3) Fly As-Is-Anomalies List

2. INCO COMM Planning memo
3. FAO Crew Scheduling and Constraints document
4. Payload information (as required)
5. Payload Operations Handbook or Assembly Operations Handbook

### 1.1.11 Integrated Sim Prep

- Review applicable flight rules
- Review FDF/ODF as appropriate
  - Use the sim status sheet for the appropriate versions
    - From office PC, Start ▶ MOD Server Menu ▶ MOD-Wide Applications ▶ FDF Books ▶ Status Sheets
    - From MCC PC, Start ▶ MCC Menu ▶ Flight Items ▶ FDF Books ▶ Status Sheets
  - Review Shuttle and Station flight plans and discuss with FAO/Ops Plan as required.
  - For Station, review the electronic OSTP version of the flight plans and use OSTP to click on and review the key procedures to be executed during the sim via MPV.
    - Turn on the OSTP bubble help.
    - Choose which OSTP viewing options to use.
  - For Shuttle, review FDF procedures included in flight plan.
- Review the system configuration for the sim type being run
  - Bring appropriate C&DH/Power/Thermal config drawings
  - Review the communications capabilities, which systems are available, basic comm coverage, capabilities between US and Russian segments
  - Power sharing agreements with the Russians for this config
- Determine if there are any final evals. If so, review this system in preparation for the increased level of activity in this area.
- Arrive at the console about 1 hour ahead of time.
  - Get large cup of coffee
  - Introduce yourself to any flight controllers you don't know
  - Refer to Sections 2.1.1 Console Initialization and 2.1.2 Integrated Simulation Checklist once on console.

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## 1.1.12 Shift Schedule Development

### Shuttle Flight

Guidelines for Shift Schedule Development (developed by the Lead FD):

- A. Plan in MET, then convert to Local times rounding to the nearest half hour for actual support. If you are doing it with pencil and paper, a “summary” level timeline (one line per 24 hours) is VERY useful. Get one from the lead FAO.
- B. Schedule the Pre-launch team (usually the planning team) to come on at L-13.5 hours.
- C. The Ascent team then comes on at L-5.5 hours.
- D. Next, plan the END of the mission. The Entry team comes on at Deorbit TIG - 7.5 hours.
- E. Adjust the Orbit 1 times throughout the mission to line up with the Entry team. Do any shifting at the BEGINNING of the mission in a few days as possible and keep the shifts “straight” for as many days as possible.
- F. Fill in the other shifts to match.
- G. Review the resulting schedule with an eye to special activities (rendezvous, docking, etc), which a specific team needs to support.
- H. Review the resulting schedule against the Shuttle Work Guidelines (DA-01-49):
  1. For preflight planned mission durations which require more than 12 consecutive shifts by the same team, either schedule a 4<sup>th</sup> team in the shift schedule or delegate 4<sup>th</sup> team assignments to the individual disciplines by using liberal substitution during mission phases appropriate to the discipline.
  2. If a 4<sup>th</sup> team is utilized, provide at least 2 days and preferably 4 days off between shift rotations, rotating to a later shift if possible.
  3. Shifts should generally be a maximum of 9 hours. When shorter shifts result from shifting on console times, the shift occurring between midnight and 6:00 am CST should be given priority for the shorter shift. Similarly, the shift with normal sleep patterns should be given priority for longer shifts.
- I. This process can be somewhat automated using a simple “spreadsheet” type program (written by Bob Castle). The program is available at \\jsc-mod-fs3\world\Divisions\Da8\Shared\Castle\Scheduler\setup.exe. Directions for use of this program:
  1. Install the program by running the setup program. Then run the program (called “Scheduler”).
  2. Fill in the entry boxes at the top of the screen.
    - a) Lift Off Date (LOCAL date of liftoff, not GMT if they should be different)
    - b) Lift Off Time (Again, LOCAL time)



- c) Flight (A name, can be anything for reference)
  - d) Landing MET (the box next to this will be automatically filled in with the Local date and time of landing based on the launch time and landing MET, check for reasonableness)
3. Enter the "RefTime". This is the time the program will use to convert from MET to local times. It is different than the launch time ONLY so you can "round" to the nearest half hour. You can round up or down as you please. You must enter a time however.
  4. Select "AutoFill" then "Names". This will fill in the team names (Orbit 1, 2, 3, Ascent and Entry) for the number of shifts required to complete the mission.
  5. Select Autofill and times. This will bring up a menu with several options, most of which will be self-explanatory. There is a check box labeled "shift at beginning of mission". If checked, the program will make on console on time adjustments at the mission beginning (usually the first 2-3 flight days) to make the Orbit 1 shift line up with the Entry team. If unchecked, the adjustments will be made at the END of the mission (usually the last 2-3 days). Usually we make adjustments at the BEGINNING.
  6. Now go through and edit the table as required. Note that the "selected" cell is shown in the box at the TOP of the window. You edit within this box, NOT in the actual cell. You will note you can edit only the first three columns. The others are automatically computed. Also note you can "copy" and "paste" using Control C and control V. The program will automatically adjust the times when you paste. Try it, you'll like it. You can also add or delete rows with the edit menu.
  7. Save the file using the File Save option. You can also print directly from the file menu (a very simple printout) or you can also "export" the file to the clipboard and then paste into Word where you can edit it for a more formal looking report.
  8. If the launch date/time should change, simply open the file, then enter the new launch date and time (also the Ref Time if it needs to change) and the program will compute the new local on console times. This is the real power of the program.
  9. You can save different versions to cover different dates if you like. For ISS missions you will often have a repeating pattern of 3 days, i.e., the MET of landing will change quite a bit for a launch one day later, but will repeat three days later. So three versions may be required. This is strictly your option however.

**ISS Increment Operations**

Guidelines for Shift Schedule Development (developed by the Increment Lead FD):

- A. Maintain standard shifts when possible:
  - 1. 9 hour shifts Monday through Friday (0700-1600, 1500-0000, 2300-0800)
  - 2. 13 hour shifts Saturday and Sunday (0700-2000, 1900-0800)
- B. If standard shifts must be rotated:
  - 1. Rotate shifts forward (i.e. later) if possible, allowing at least 24 hours off between beginning of shifts.
  - 2. Ensure no more than 3 consecutive shifts longer than 10 hours within a 5 day period.
  - 3. Ensure no shift longer than 13 hours
- C. Post shift schedule to Increment Web page.
- D. Each of the disciplines will populate these shifts based on their rotation plan and in accordance with the ISS 24/7 Work Guidelines (ref DA-01-49)
  - 1. For critical activities, the specific team-members assigned to those activities must support unless substitutions are approved by the Flight Director.
  - 2. If rotation shifts, rotate personnel later allowing at least 24 hours off between beginning of shifts.
  - 3. No more than 10 consecutive days on console and no more than a total of 90 hours of consecutive on console shifts.
  - 4. Ration of at least 1 day off for every 3 days worked over a two week period.
  - 5. No more than 3 consecutive shifts longer than 10 hours within a 5 day period.
  - 6. Schedule longer shifts near the beginning of the rotation
- E. Ensure weekly average  $\leq 45$  total hours (office + console)
- F. Coordinate with Lead Shuttle Flight Director for transition from Increment Ops scheduling to assembly/logistics flight scheduling (See **Shuttle Flight** section above)

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## 1.2 ASCENT/ENTRY PLANNING TEMPLATE

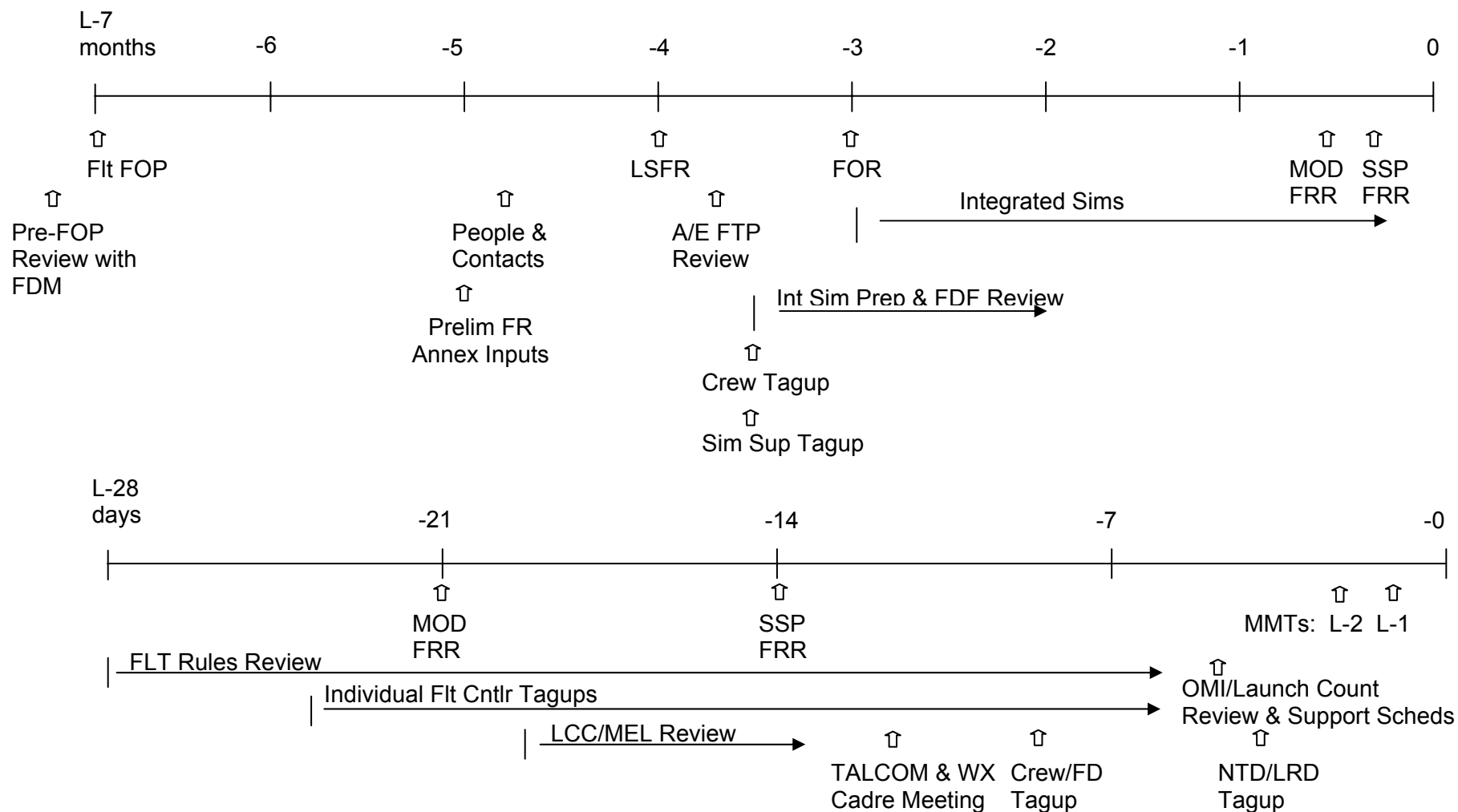


Figure 1.2-1. Ascent/Entry Template

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**1.2.1 People/Contacts**

Org	Contact	Name	Mail Code	Phone	e-mail
Crew	CDR				
	PLT				
	MS				
	Scheduler				
	VITT				
	ASP – Launch				
	ASP - Landing				
Program	FIM				
	Flight Manager				
	PIM				
Flt Design	Manager				
Training	Sim Sup				
	STL				
	Team Leads				
KSC	NTD				
	Convoy CDRs				
	Launch Director				
WX Cadre	TAL WX Aircraft				
	RTLS WX Aircraft				
	KSC EOM WX Aircraft				
	EDW EOM WX Aircraft				
	Ascent WX CAPCOM				
	Entry WX CAPCOM				
	Ascent CONUS WX				
	TAL WX				
	Entry WX				
DTO/ Eng Support					
Others					

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**1.2.2 Ascent/Entry Lead Checklist**

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### 1.2.3 Pre-FOP Review

1. Mission Objectives (Pri/Sec)
2. Type of Flight (Rndz, Deploy/Retrieve, etc)
3. Weights and CGs
  - a. RTLS, TAL, AOA, Rev 3, First Day PLS
  - b. Tire/Strut loads (abort & EOM)
  - c. Tire thermal conditioning for EOM, etc.
4. Prelaunch/Launch Window Constraints
  - a. Launch period and window size
  - b. Lighting
  - c. Crew Day
  - d. Payload requirements
  - e. Landing opportunities (trim burns, EOM, EOM + 1, EOM +2, EOM + 3)
  - f. Sunrise landings
  - g. Delayed launch impacts
  - h. Performance
    - i. Hold capability
      - (1) Drainback capability wrt TAL abort gaps (first 2 eng TAL, Last TAL/PTA)
      - (2) SSME Start Box
    - ii. P/L 2/3 sigma MPS performance
  - i. DOLILU
5. Abort Sites & Boundaries
  - a. TAL Sites – no gaps
  - b. Press Call (AOA/ATO min HP)
  - c. AOA Site Down (Press call, sys abort plan, incr TAL exposure, amount of time)
  - d. Variable IY & PTA/PTM
  - e. OMS Dumps – interconnect vs enabled
6. Inclination Impacts

- a. Ascent
  - b. Entry
  - c. Variable IY
  - d. Range Safety
  - e. Contingency Abort Sites (Bermuda, ECAL, downrange)
7. ET Foot Print
- a. 2/3 sigma
  - b. Location

#### 1.2.4 Crew Tagup Items

1. Landing site priorities
2. Runway selection criteria
  - a. Left overhead vs right overhead
  - b. Overhead vs straight-in (straight-in angle of comfort)
  - c. Nominal vs close-in
  - d. Short-field speedbrake (speedbrake setting comfort zone)
  - e. Tailwind vs headwind (preference between large SB/tailwind or Close-in/headwind)
  - f. Sun angle, glare
3. PLT flight controller power-on plan
4. Energy calls around the HAC (standard 90°, 180°)
5. Derotation speed
  - a. Aborts, EOM
  - b. Derotation assumptions to lessen load
6. Overview of comm plan during ascent
7. Landing aid settings for EOM/aborts (PAPIs, ball bar)
8. Pre-launch weather briefing (ECAL/ELS)
9. Stuck throttle calls
10. Runway remaining markers at EDW22 and ROTA
11. Pre-HAC wind breakdown, chute status, advisories
12. Preference for emergency calls (on HAC or post-wheels stop)
13. Reminder that Xwind DTO requires late chute deploy
14. Does the CDR want a reminder to land at 195 for SF SB?
15. Any concerns with “black hole effect for nighttime KSC 15 landing?
16. Ball bar and PAPI preferences
17. OMS Assist modification plan
18. ET photo DTO plan

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## **1.2.5 Flight Specific FTP Topics**

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## **1.2.6 Flight Specific Rules**

1. Ascent
  - a. Abort prop capabilities
  - b. FDO flight specific data table
  - c. Launch window review
  - d. Range Safety
  - e. OMS load and contingency CG box
  - f. Prop priority table
  - g. Payload LCC including facilities
  - h. Payload altitude/inclination requirements
  - i. DTO rules and priorities
2. Entry
  - a. Landing site summary and runway priorities
  - b. PTIs
  - c. Traj and guidance parameters
  - d. Tire pressure requirements
  - e. Derotation speed
  - f. DTO rules and priorities
3. Post-insertion
  - a. Payload items
  - b. DTOs
  - c. Handover time and coordination
  - d. Debris report (post OMS1/pre OMS2)



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### 1.2.7 Individual Flight Controller Tagup Items

1. Generic (All operators)
  - a. Vehicle specific hardware or software
  - b. Flight specific hardware or software (new OI drop or OMDP?)
  - c. New/different capabilities in MOC, workstation, or Command Server
  - d. Significant issues during previous flight (previous vehicle/flight) or turnaround flow
  - e. Comments on simulations/training/prep
  - f. Console support and times
  - g. Tagups after MMT as reqd
  - h. Keep FD informed of nominal timeline events
  - i. Exchange home/pager phone numbers
2. Ascent FDO
  - a. Stuck Throttle Calls
  - b. Intact abort boundaries and calls
  - c. Pre-launch WX Brief schedule (on-time) including ECAL/ELS WX obs
  - d. Review of CDR preferences for runway/traj options
3. Ascent GPO
  - a. Contingency abort boundaries and calls
  - b. DOLILU
4. Entry FDO
  - a. Landing opportunities and evaluation timeline (only 1 site on last rev)
  - b. WX Brief schedule (on-time)
  - c. Entry day on-shift time
  - d. Tagup after MMT each day as required
5. Entry GPO
  - a. Last state vector update
  - b. TACAN co-channel interference
6. Weather

- a. Pre-launch WX brief schedule (on-time) including ECAL/ELS WX obs
  - b. Pre-launch – critical times and final briefs (LD brief short and prepared to be go/no-go)
  - c. Deorbit decision point
  - d. Fog at KSC
  - e. Outside intrusion (WX Coord, CBers, etc.)
7. PROP
- a. Prop margins and where carried (OMS/RCS)
  - b. PTI/DTO Prop Tracking
  - c. Waveoff Day/rev protection
8. GNC
- a. IMU Power up
9. GC
- a. Double check SHO times
  - b. Review clock management
10. DPS
- a. DOLILU memory dump
11. ACO/Payloads
- a. A/E Power
  - b. Prelaunch config
  - c. Special items in post-insertion, D/O Prep (activation/deactivation)
  - d. Waveoff items
12. EPS
- a. Cryo Margins
  - b. Waveoff rev/day protection
13. ECLS
- a. Water to support waveoff attempts
  - b. Post-landing cooling
14. INCO

- a. DOLILU Uplink
- b. Prelaunch INCO commanding (you respond for FLT)
- c. Powered flight commands and SPCs loaded
- d. Entry comm plan/commanding (use of TDRS/GSTDN)
- e. Post-landing commanding and dumps

15. MMACS

- a. Tire pressure/temp requirements and tracking
- b. APU config
- c. FCS C/O APU
- d. Deorbit APU start plan
- e. Post-landing HYD load test
- f. SSME repositioning – insure TVC isol's open

16. Booster

- a. SSME/turbopump configuration
- b. SLWT/LWT
- c. Generic ullage pressure requirement

17. FAO

- a. FD1 flight plan and changes for launch slips

18. PAO

- a. TV of entry site

19. Flight Surgeon

- a. Crew health issues

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### **1.2.8 Ascent/Entry Sim Sup Tagup Items**

1. Schedule, number, and length of sims
  - a. Ascent/aborts
  - b. FDO/BSE
  - c. Entry
  - d. Post-insertion
  - e. D/O Prep
  - f. Placement of ECAL training in Flight Specific flow
2. Range Safety Calls
3. Contingency Abort/ECAL/Bermuda cases
4. Set Splits

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### 1.2.9 Integrated Sim Prep

1. Ascent FDO data review
  - a. Design/critical underspeed, OMS dump and loads
  - b. Boundary calls
  - c. Stuck throttle chart (uphill when stuck in bucket?)
  - d. Stuck throttle abort boundary calls
  - e. Arming mass
  - f. OMS dumps and delta V available
    - i. Pre- and post-MECO
    - ii. Interconnect INH/ENA
  - g. Sun angle violations at abort sites
2. Entry FDO data review
  - a. Sun angle violations
3. D/O Prep Attitude timeline (Vehicle thermal conditioning, cold soak)
4. Site Review
  - a. Lakebed status
  - b. Landing aid locations
  - c. MLS locations
  - d. Wind tower locations
  - e. XENONs
5. FDF Review
  - a. Ascent C/L
    - i. Payload items
    - ii. TACAN/MLS selection prelaunch
    - iii. No comm mode boundaries
    - iv. Systems flight rules
    - v. ET Photography
    - vi. OMS 1/2 Targeting performance chart and failure summary



- vii. OMS 1/2 Targets
- viii. Low energy TAL
- ix. Bermuda/ECAL
- x. Contingency abort cue cards
- xi. Landing site table
- xii. Ingress switch list config (P/L config)
- xiii. Ascent abort dump timers
- xiv. Contingency abort cards and stuck throttle
- xv. TAL Redesignation tables
- xvi. AOA PADs and Prebank table
- b. Post Insertion
  - i. P/L Activities
  - ii. DTO Activities
  - iii. Anything extra the crew is doing
- c. D/O Prep
  - i. P/L activities
- d. Entry Checklist
  - i. Elevon Schedule/body bending filter
  - ii. Landing site table
  - iii. P/L Deact activities
- e. Rev 3/6 Procedures
- 6. Post-landing
  - a. Hyd load test required
  - b. Payload cooling requirements
  - c. SSME Repositioning
- 7. Night landing items
- 8. Hardware/software/vehicle specific items
  - a. SSME's (Block II, IIA)

- b. APU start talkbacks
- c. TACANs (Collins vs Gould) – cooling
- d. Vehicle Upgrade configuration (MEDS, GPS, SSME AHMS, EAPU's, other)

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### **1.2.10 OMI/Launch Count Review and Support Schedules**

1. Support Schedules
  - a. Prelaunch Sim for Payloads
  - b. Flight/Countdown
    - i. L-1 Systems and WX Briefs
    - ii. Prelaunch
  - c. Flight Shifts
    - i. Ascent (L-5.5 hrs)
    - ii. D/O (TIG-6.5 to 5.5 hrs)
  - d. MCC Recorder Updates
2. OMI Review
  - a. Standard
  - b. DOLILU
3. LCC Review
  - a. Changes
  - b. MEL

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### 1.2.11 TALCOM Brief

(Set up by lead LSO about 1 week prior to launch)

#### Personnel

Ascent Flight Director  
Weather Flight Director  
LSO  
FDO  
CONUS Weather  
TAL Weather  
CAPCOM  
Weather CAPCOM  
Weather Coordinator  
TALCOMs  
STA Pilot

1. Pre-launch timeline, weather briefings, and decision points DA8/CB
2. TALCOM Schedules and data review LSO/CB
  - Flight Times
  - Adding/canceling flights
  - Abort Mode boundary charts
  - Prelaunch sequence of events and launch window
  - Sunrise/sunset times (if applicable)
  - Key personnel at each site
  - Travel schedules
3. Site specific weather patterns and issues SMG
4. RTLS Weather Recon schedules (T-38 and STA) CB/DA8
5. Weather rules and STA/WX Recon data CB/DA8
  - Flight specific items – night, etc.
6. Roles and interfaces wrt weather evaluation DA8/All
  - WX Recon Aircraft
  - Weather Coordinator
  - Weather CAPCOM
  - Weather
  - FDO
  - Ascent FD
  - Weather FD
  - Other personnel

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### 1.3 MOD CHECKLIST

Prior to L-12 mo. (Peer Review ~quarterly)

L-12 mo. Setup MOD CIRD

L-11 mo. CIR (check on Ops Issues for board, ensure MOD board support)

L-4 mo. FOR - insure proper support. Review significant issues.

L-3 mo. Setup MOD FRR - choose date, send out agenda at least 2 weeks prior  
ISS ARBs and COFRs - coord support

L-2 mo. Crew & Flight Controller Training Tagup:  
Lead and A/E Flight Dir, Sim Sup, Training Lead, EVA and PDRS Trg, etc.  
(Peer review to ~ 1 every 2 weeks - more informal if desired)

L-1 mo. Flight Rules to Program - Annex, All Flights  
Flight Director Flight Specific Certification  
MOD FRR  
Develop Level I FRR Presentations  
(Mission Ovrw, MOD pitch, Review USA and GSFC pitches)  
Check on Flight Director Media Briefing  
Check on Flight Crew Training Hot Topics  
FD Fourth Team Plan

L-3 to 2 weeks Level I FRR  
View from 40K ft (to the Ops Team)  
MOD Support Schedule during mission (significant ops periods, MMTs, etc.)  
Press Releases for 1st time Flight Directors

L-2 to 1 weeks Coordinate Press Briefings During Mission  
- New Flight Directors get experience - if possible  
MOD Binder and Console Documentation  
Cleanup MOD Console (throwing out previous flight stuff)

L-2 days Pre-Launch MMT (DOLILU, Lakebed Status, Significant Items since FRR)  
Coordinate MOD Support for Tanking MMT (typically the Planning Team FD)

#### **Mission Support**

Coordinate MOD Support to MMTs  
Coordinate Realtime MOD Support  
Coordinate Mission Status Briefings and other PAO Events

#### **Interfaces to check on regularly**

Lead/AE FD to Crew  
Lead FD to Flight Manager  
Flight Team  
MOD to CB, Program

#### **Post Flight**

MOD Post Flight Actions/Issues & review



Flight Controller Feedback  
Flight Director Feedback  
Flight Binder for Library  
Lead Flight Director – awards to teams/individuals  
Have Lead Flight Director send thank you notes  
(flowers - Mark, Terri & MacKenzie Shelton, 7105 Hazel Pl, North Richland Hills, Texas 76180)

## 1.4 GENERAL

### 1.4.1 JOP/Flight Techniques Panel Process

This procedure documents the actions and contacts in conducting JOP/Flight Techniques Panel meetings.

#### A. Setup

1. Prepare/update distribution list and provide to the DA8/JOP/FTP Coordinator and to the DA8 secretary.
2. Develop the Preliminary Agenda for distribution at least 2 weeks before the meeting. Send the Preliminary (and later, the Final) Agenda to the DA8 secretary (for FTP) or to the assigned FTP/JOP coordinator. For the Final Agenda a formal Memo will be prepared and mailed out to the standard distribution, as well to the assigned presenters.
3. Agenda should include: subject, short description of the topic, topic start time, presenter(s).
4. Provide the JOP/FTP Coordinator with the names/phone numbers of telecon participants.
5. The JOP/FTP Coordinator will provide the following setup functions:
  - a. Conference room scheduling
  - b. Collection of presentations
  - c. Preparation of handout packages
  - d. Preparation of viewgraphs and attendance sheets
  - e. Coordinate/set up the telecon with MSFC COMM
  - f. Fax or E-mail presentations to the telecon participants
  - g. Meeting room setup and preparation
  - h. Coordinator will provide the Chairperson with a copy of the presentation package on the day before the meeting.

#### B. Conduct of the meeting

1. Verify who is participating via telecon.
2. Be responsible for maintaining the agenda on the published time schedule.
3. Brief the participants on the goal and topics for the meeting. Announce any order changes, and any add/deletion of topics.
4. Review any assigned actions after each agenda topic.

5. Actions should include a description of the work needed, date due, and person(s) assigned.
6. Summarize conclusions and decisions after each agenda topic.
7. Coordinator will ensure that a copy of each presentation is collected for paper copy archives.

C. Meeting followup and Minutes

1. Whenever possible the Minutes should be completed within 2 weeks of the meeting.
2. The Chairperson is responsible for writing the meeting minutes and for assigning associated action items.
3. Once completed, the Minutes should be mailed to the DA8 secretary (FTP) or to the FTP/JOP coordinator for preparation of the formal memo and distribution. The Minutes will be distributed to the standard distribution list as well as to the presenters.
4. The DA8 secretary (or the FTP/JOP Coordinator) will add the Final Agenda and the Minutes to the DA8 Library.
5. For the Flight/Increment Specific JOP's, the Coordinator will incorporate the meeting action items into that flight's Action Item Database (if one has been created).

## **1.4.2 Flight Rule Generation and Control Process**

Flight Rule generation for orbiter and station operations fundamentally begin within the Systems Division where ownership of orbiter and station subsystem elements reside. Rules related to orbital mechanics are initiated from the Flight Design and Dynamics Division. Payload rules are initiated from Payloads Division and orbiter and station customers. Other rules are generated from Program Management, Aeromedical Surgeon, and from Space Environments. Review of the rules is managed by the Flight Director Office who may invite all elements of the Johnson Spaceflight Center, as well as other NASA Centers, Contractors, and International Partners to participate in the review.

Flight Rules are contained in two documents, NSTS-12820, Generic Flight Rules and NSTS-18308, Flight Specific Flight Rules. These documents are signed off by the Program Offices and are maintained under configuration management by change control procedures. A copy of these procedures resides in each Flight Rules document as Appendix B.

**ALL FLIGHTS  
FLIGHT RULE DEVELOPMENT  
FLOW DIAGRAM**

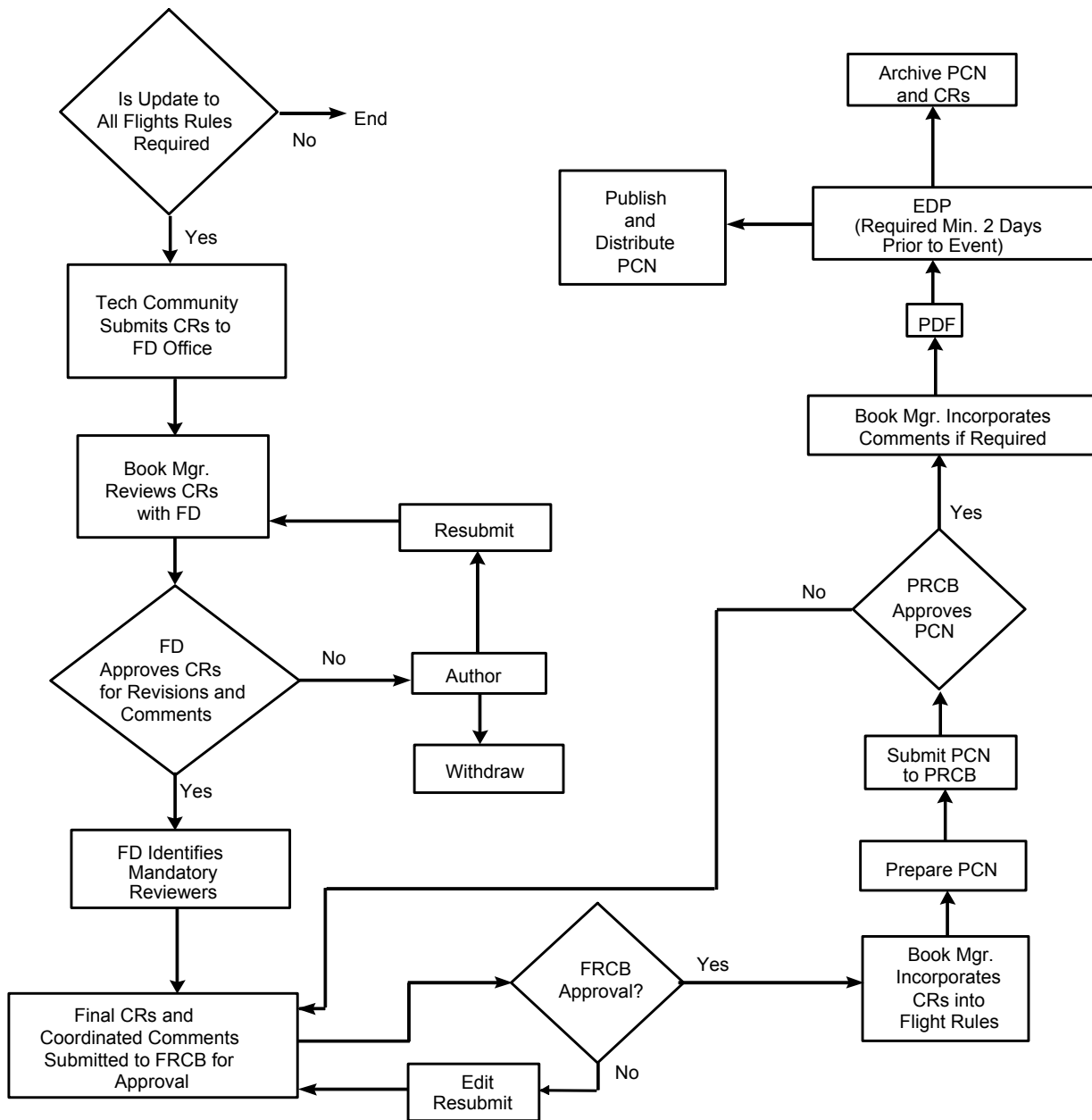


Figure 1.4.2-1. All Flights Flight Rule Development Process

### FLIGHT SPECIFIC ANNEX FLIGHT RULE DEVELOPMENT FLOW DIAGRAM

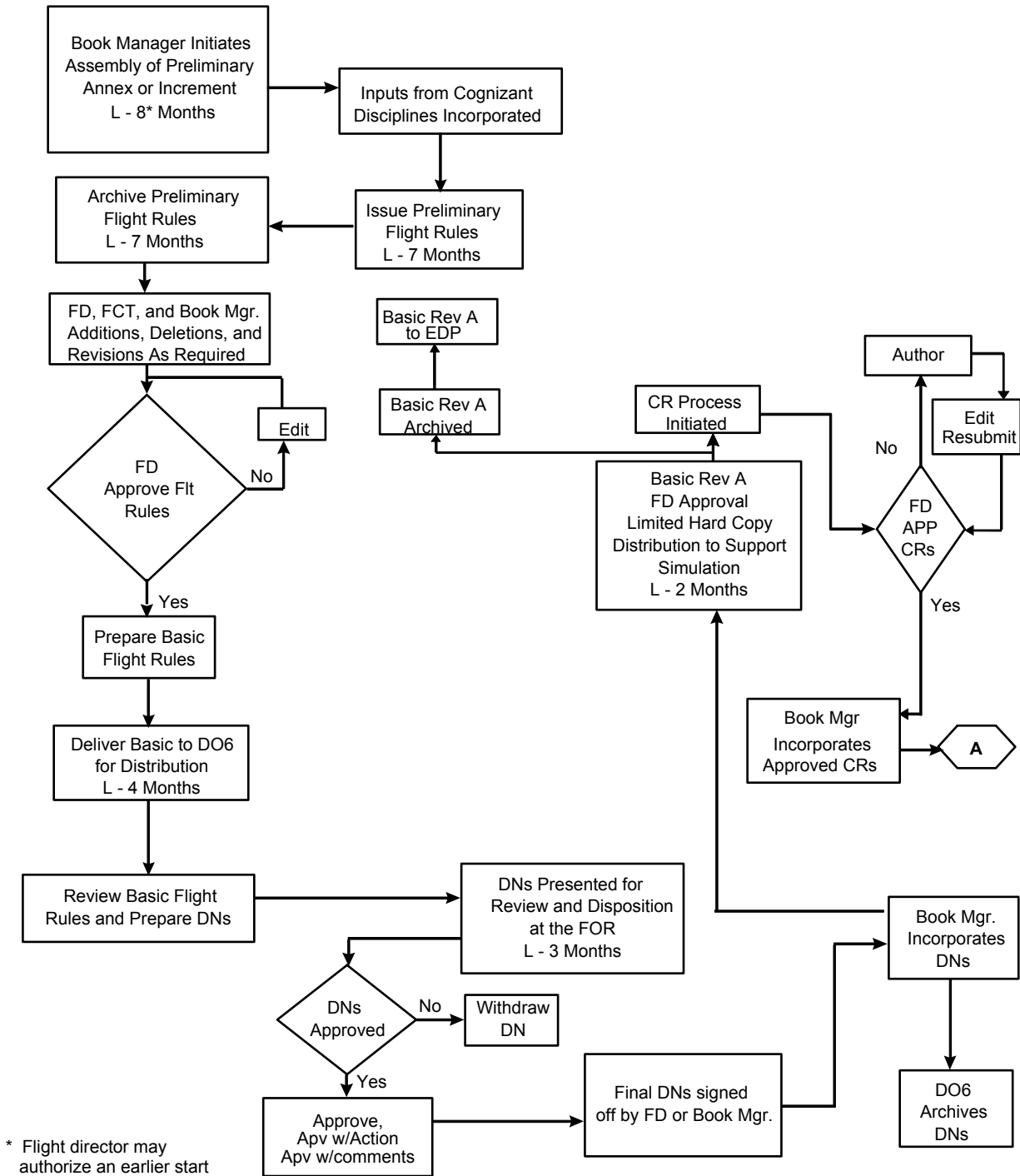


Figure 1.4.2-2. Flight Specific Annex Flight Rule Development Process

**FLIGHT SPECIFIC ANNEX  
FLIGHT RULE DEVELOPMENT  
FLOW DIAGRAM**

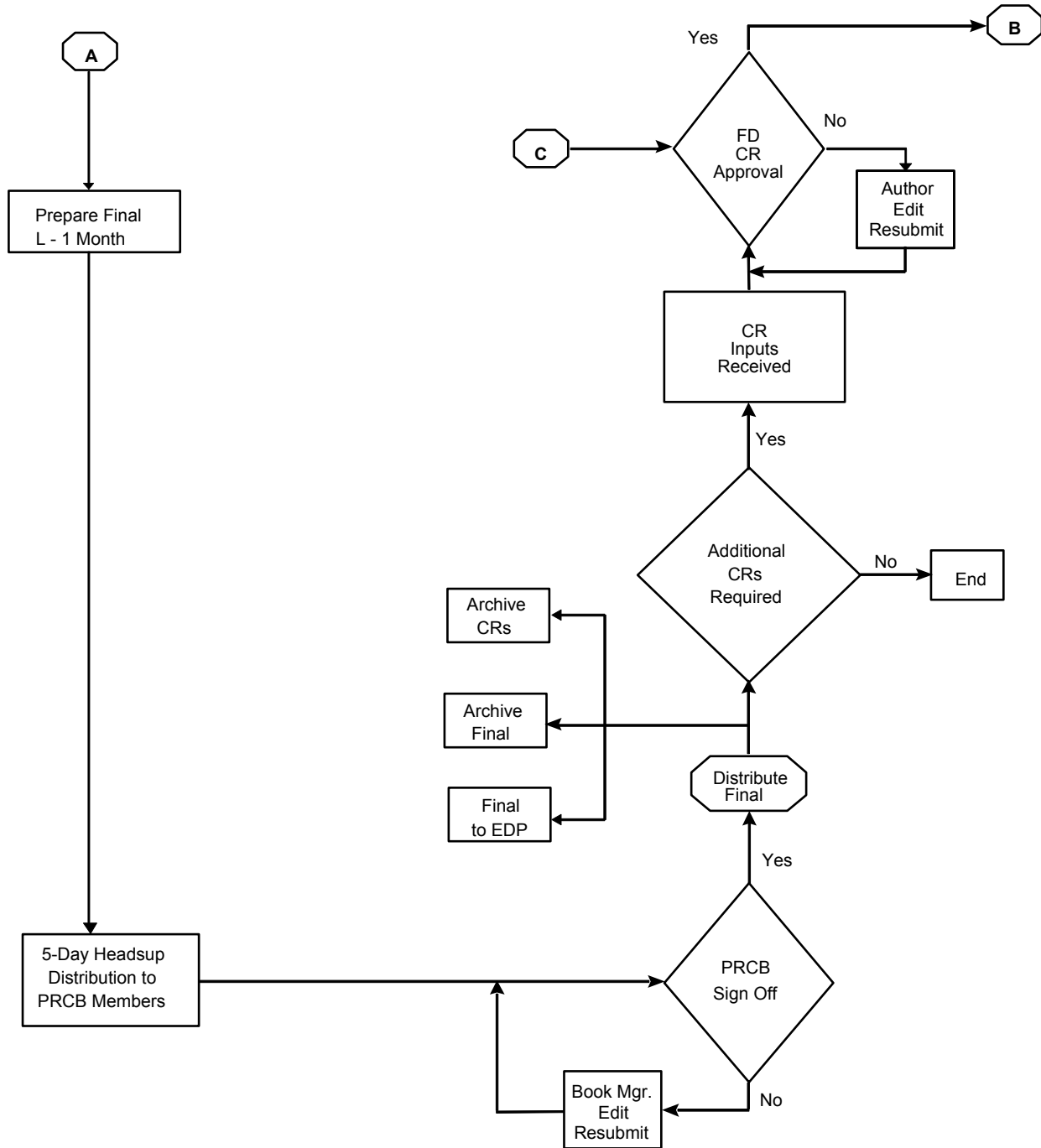


Figure 1.4.2-2. Flight Specific Annex Flight Rule Development Process (continued)

**FLIGHT SPECIFIC ANNEX  
FLIGHT RULE DEVELOPMENT  
FLOW DIAGRAM**

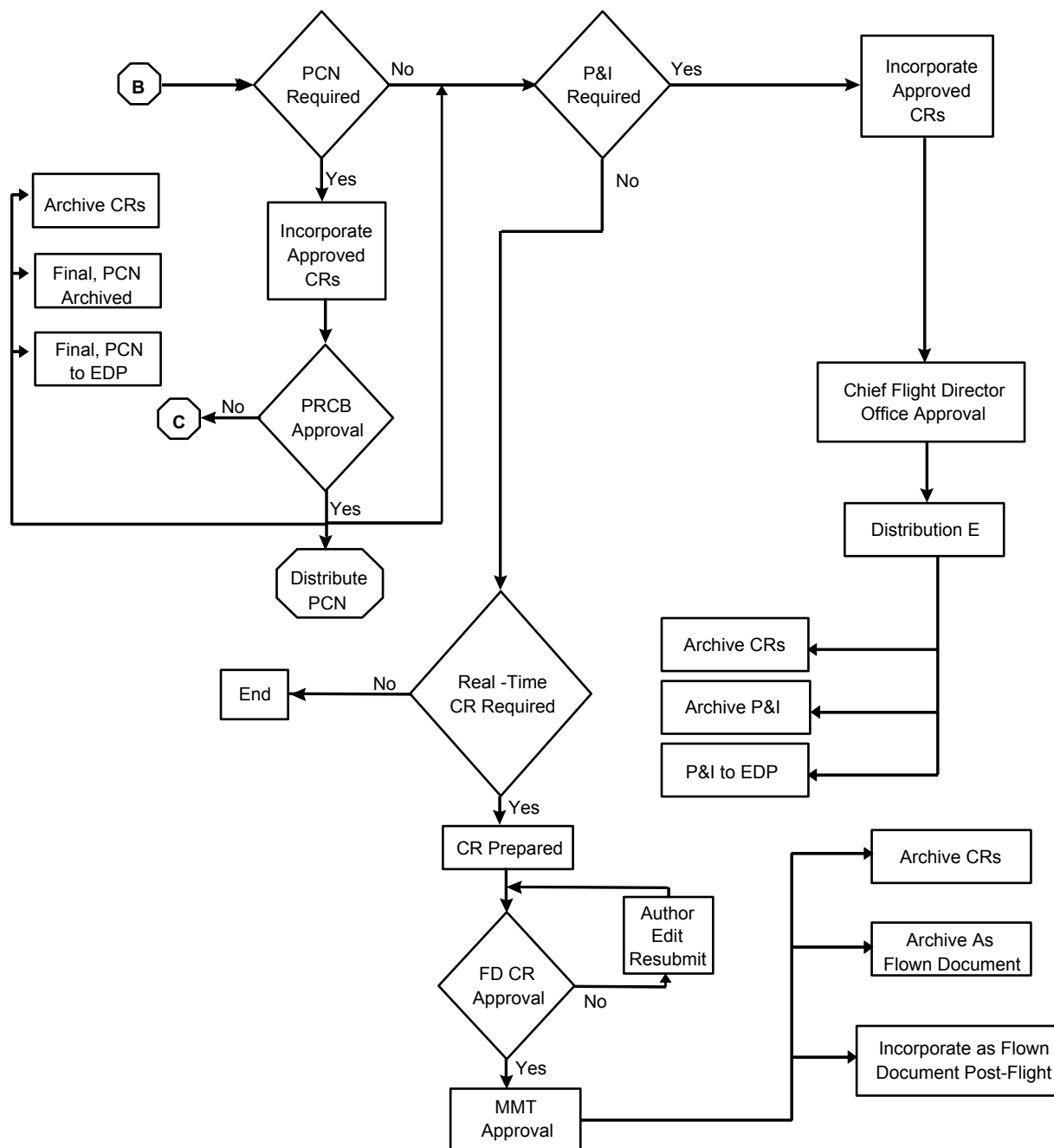


Figure 1.4.2-2. Flight Specific Annex Flight Rule Development Process (continued)



The generic Flight Rules document is in “Final” configuration and is updated as required according to the CR traffic or specific need via Page Change Notice (PCN) or Pen and Ink changes, and republished when appropriate. Figure 1.4.2-1 is a process flow diagram of the PCN development.

Flight Specific Annex documents are published to support each Space Shuttle launch and include flight specific payload rules. This document is initiated as a preliminary draft and reviewed through Basic and Final editions. These documents are under Configuration Management upon release of the Basic document. It is similarly under configuration management via Appendix B procedures. Figure 1.4.2-2 is a process flow diagram of Annex development.

An in depth discussion of Flight Rule generation and control is provided in document DA8-001, Processes and Procedures, Flight Director Support Office, Section 3.

### 1.4.3 Press Conferences

#### 1.4.3.1 Preflight Coordination

- A. There are two key individuals a lead FD should work with in terms of PAO-related matters associated with a particular shuttle flight. Each mission has a Lead PAO Commentator and Lead Technical Director assigned to the flight. Each individual has specific responsibilities.
1. Lead PAO Commentator
    - a. Represents PAO at specific mission-related flight control team meetings and training events.
    - b. Works with lead FD on sensitive mission issues that arise during the flight (i.e., animal experimentation) or on what themes the FD would like to stress during their briefings (i.e., international cooperation, scientific investigations, space station preparation).
    - c. Serves as the principal source of information to the commentary team regarding plans and issues associated with the assigned mission. This includes being familiar with the flight plan and daily mission events.
    - d. Working with the Media Services Mission Operations and NASA mission television program team members with coordination of NASA TV events (briefings, in-flight interviews, etc.).
  2. Lead Technical Director
    - a. Set up initial meeting with the Lead FD to discuss ideas on the Mission Overview briefing and determine what type of visuals are required. Determine approval deadlines for videos, visuals, and charts. Provide assistance with technical questions related to press briefing.
    - b. Coordinate with Lead FD and building 8 studio for FD team photo.
    - c. Notification of and participation in Crew TV Strategy meeting.
- B. The preflight mission briefings are usually held 7 to 14 days before launch. Most of the preflight briefings originate from JSC and are held in the building 2N briefing room. Standard briefings for every flight include a mission overview done by the lead FD and the crew doing the preflight press conference. Mission briefings should include themes and messages identified for the flight and avoid acronyms and technical jargon.
- C. All preflight briefings are carried on NASA TV and include two-way question and answer capability allowing the news media at other NASA centers and Headquarters to participate.
- D. The Lead Technical Director needs a hard copy of the FD's briefing charts no later than 10 days before the briefing in order to convert briefing charts into proper electronic format for television broadcast.

### 1.4.3.2 Press Conference Checklist

#### A. General.

1. Major accomplishments this shift new for this flight (especially related to whole program).
2. Problems – where discussion up front can benefit you in subsequent question/answer session.
3. Flight plan changes (work last if advertised options in effect).
4. Outlook for remainder of flight.
5. If PMC occurred, refer to crew health reporting policy.
  - a. Surgeon tag-up
  - b. PMC
  - c. Comments on open A/G

#### B. Be prepared but do not volunteer the following:

1. Weather
  - a. Near end-of-mission
  - b. Runway conditions
  - c. Solar flares
2. Comm Status
  - a. TDRS
  - b. WSGT

#### C. Issues/Questions from Previous questions/shift

- D. For DOD Payloads, state that “NASA and the DOD are cooperating in a variety of ways in an attempt to acquire information about the payload. By agreement with the DOD, NASA will not answer questions or make releases, which relate to DOD activities. The reasons for this policy should be clear. I will not respond to this or any other questions in this area.”

### 1.4.3.3 Crew Health Reporting Policy

#### A. BACKGROUND

NASA management requires in-flight knowledge of STS crew health status sufficient to assure proper actions are taken to provide for crew safety and mission success. NASA also recognizes an obligation to maintain a timely and accurate flow of public information about STS mission operations, including appropriate reports on the medical status of crewmembers. The private medical communication (PMC) is a confidential in-flight medical consultation between physician and patient (STS crewmember). The content of the PMC shall not be released to the public except as provided in this policy.

#### B. General Policy

1. It is the responsibility of the crew commander to report (via a PMC or on the open air-to-ground link), in at least a summary form, any crew health situation which will or may have mission impact.
2. PMCs normally will not be scheduled on a routine basis; however, a PMC will be arranged at the request of any crewmember or the Mission Control Center (MCC) physician. The exception to this is if there is an EVA scheduled during the first 3 days of the flight. In this case, a PMC will be scheduled. In the event a PMC does not disclose information, which will or may have a mission impact, the content of the PMC will not be released to the public.
3. In the event any PMC should disclose a condition that will or may have mission impact, the MCC physician will:
  - a. Communicate the assessment to the flight director in sufficient detail to permit a proper mission decision; information relayed to the flight director is releasable to the public in accordance with paragraph b. below.
  - b. Summarize for public release the diagnosis or impression, any therapy recommended, and the prognosis. This summary shall include only that information necessary for a clear understanding of the nature and gravity of the crew health situation as it relates to mission impact and the name of the crewmember.

#### C. Life Sciences Testing

1. Space adaptation syndrome (SAS) symptoms may occur naturally or be induced through provocative testing. It is the provocative life sciences testing and ensuing discussion on the air-to-ground that is addressed here. All other necessary SAS discussions will be reported per existing policy No. 8610.3.
2. Media questions pertaining to the life sciences investigations will be answered by the Mission Manager (or his designee) at the daily science briefing, or more frequently if circumstances dictate. The Mission Manager will address only the nature of the SAS inducing investigations, explanation of the reported indices of symptomatic severity and resulting impact on continuation of that experiment.
3. The FCR Flight Surgeon will maintain cognizance of crew health and will advise the Flight Director and POCC Director of any circumstances, which may adversely impact

the nominal mission. In the event that a crewman becomes ill or is being treated and is unable to be scheduled on either the payload or STS flight plan, then a prepared note from the FCR Surgeon will be read which will describe the illness, medication, and prognosis. Neither the Mission Manager nor the Flight Director will respond to questions speculating on the time that the crewman will be rescheduled for full duty. The Flight Director will discuss any STS flight plan changes made to accommodate the condition and the Mission Manager will do the same for the payload flight plan.

D. Crew Health Press Procedures for “Is the Crew Sick”

1. When asked “is the crew sick” and no PMC or air-to-ground on the subject has occurred, respond as follows:
  - a. There have been no PMC’s.
  - b. The crew has not commented on the A/G on their health or how they are feeling.
  - c. Therefore, I really do not know how the crew is feeling and I do not care to speculate on the subject.
  - d. But, I can say the crew’s performance has been outstanding, etc.
2. At the next press conference after a PMC if it has been determined that there is no mission impact, make the following statements during the briefing prior to questions.
  - a. A PMC occurred at XX:XX MET.
  - b. There is no impact on the mission.
  - c. I cannot comment further per the NASA policy on PMC’s.
  - d. If questions continue and PAO does not step in:
    - (1) State that Mr. \_\_\_\_ (the PAO rep) will discuss the NASA policy with all interested parties after this press conference.
    - (2) Ignore any more questions on the subject. An out is “next question” and smile.
3. At the next press conference after a PMC if it has been determined that there is a mission impact, make the following statements during the briefing prior to questions:
  - a. A PMC occurred at XX:XX MET.
  - b. Read a statement prepared by the Surgeon that summarizes diagnosis or impression, any therapy recommended, and the prognosis.
  - c. Summarize the mission impact in adequate detail to answer obvious questions.
  - d. Refer all further references concerning the PMC and crew’s health to the statement made in b.

**1.4.3.4 Animal Research Policy**

A. Background

NASA in the coming years will fly a number of research animals, in addition to plants and humans, to answer some fundamental questions related to the adaptation of living things to the space environment. In the beginning of space exploration, the question was whether life that evolved on Earth could survive outside Earth's atmosphere. Now that space travel has established that Earth-based life can continue with proper life support in weightlessness, the question remains how life will be sustained over time outside Earth's environment. Scientists have found from prior studies of humans and animals in space that a number of important physiological changes occur in weightlessness. Future studies will focus on the following biomedical aspects of spaceflight:

- Space adaptation syndrome (SAS)
- Cardiovascular deconditioning (CD)
- Muscle deterioration (muscle mass) (MD)
- Bone deterioration (calcium loss) (BD)
- Red blood cell changes (reduction in count) (RBCC)
- Electrolyte and hormone changes (secretion rates) (EHC)

Over the past several years, the agency has used monetary and professional resources to ensure that its animal research programs meet top professional and governmental standards. The NASA programs adhere to the appropriate federal and state regulations as well as to a number of additional safeguards for the humane treatment of animals. Three tenets of humane experimentation known among scientists as the three R's of research - replacement, reduction, and refinement - have been implemented by NASA and are the basis of a series of review procedures designed to assure that those scientists who must use animals in their research are held strictly accountable for their proper care.

- Replacement - Substitute non-animal procedures whenever possible
- Reduction - Use fewer animals
- Refinement - Modify existing techniques to reduce stress or pain to the animal

NASA has established animal care and use committees to review research proposals involving animals. In addition, science peer reviews are conducted for NASA by independent scientists to assure that animal experimentation is relevant to NASA's goals and objectives for space exploration.

## B. Policy

### 1. General

As with any NASA activity, the agency's policy regarding the release of information concerning animal research is based on the Space Act of 1958, which requires that NASA "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof..." as a function of the Administration. To assure that a cadre of fully informed and trained spokesmen exists within the agency to deal with questions relating to the use of animals in NASA-related research, certain specific Public Information Officers have been designated key spokesmen for the centers involved in this research. They are:

- NASA Headquarters, Charles Redmond

- For Johnson Space Center, Barbara Schwartz
- For Marshall Space Flight Center, Dave Drachlis

## 2. Preflight Release of Information

During the long training periods for the Payload and Mission Specialists (1 to 2 years), the release of information about planned animal experiments will be coordinated by the Public Affairs Office at Ames Research Center under the direction of the Public Affairs Officer for OSSA. This coordination includes requests for press conferences, interviews, and public appearances by the universities where some of the training takes place.

Any potential problem situations will be reported as soon as they are known to the Ames Life Sciences Public Affairs representative by the Ames crew training coordinator, the Ames project scientist or project manager, or the Ames Life Sciences Flight Experiments Project Office Chief or his deputy. The Ames Public Information Officer will report the situation immediately to the Public Affairs Officer for OSSA. He will immediately inform the Director of Public Affairs or his Deputy for Media Services. Should the OSSA Public Affairs Officer be unavailable, the Ames Life Sciences Public Information Officer will be responsible for contacting the Director of Public Affairs.

During preflight integration at Kennedy Space Center, once the animals arrive at Kennedy, the release of information regarding their condition will be coordinated between the Public Information Office at Kennedy, the Public Affairs Office at Ames, and the Public Affairs Officer for the OSSA.

## 3. In-flight Release of Information

Release of information from the spacecraft to the ground will be the responsibility of the Payload Specialist or Mission Specialist tasked with care of the animals.

As a general rule, payload commentators will summarize and repeat any reports on the animals' well-being given over air-to-ground by the Payload or Mission Specialist. Such commentary is necessary to avoid any misunderstanding about the condition of the animals arising from air-to-ground discussions which are based on operational requirements rather than by the need to release information to the public.

If an animal's behavior indicates a potential problem, the Payload or Mission Specialist in charge will consult as required with a veterinarian on the ground for the care of the animal subject. The veterinarian will be responsible for assuring that the flight director is fully informed of the situation. In addition, the veterinarian will summarize the situation, including diagnosis, therapy recommended, and prognosis, for Public Affairs release. Once the situation is understood and the Payload or Mission Specialist has a course of action, the payload commentator will prepare a report which will be ready for release at the next payload commentary opportunity.

In the event of an animal's death, the Payload or Mission Specialist will report the facts to the ground support team. The ground-based veterinarian will summarize the facts for Public Affairs release. The payload commentator will repeat the information about the death of an animal at the next opportunity within one orbit after the air-to-ground report. The veterinarian's assessment should be reported by the commentator at the next payload commentary opportunity within two orbits of the reporting of the animal's death. That report may simply be that the cause of the animal's death is unknown.

#### 4. Post-flight Release of Information

Once the spacecraft has landed, the animals will be removed within 3 hours after touchdown. Assuming a nominal landing at Kennedy Space Center, the animals will be taken directly to the Hangar L facility where postflight measurements will be made. Release of information about their condition will be the joint responsibility of the Kennedy Space Center Public Information Chief and the Ames Research Center Public Information Officer. The Ames Public Information Officer will interact with the scientists and veterinarians, providing a brief account to the Kennedy news center as soon as possible after the animals' arrival at Hangar L. The Ames Public Information Officer will obtain a summary report from the team examining the animals and provide a "Response to Query" (RTQ) on their condition within 2 hours of their arrival at Hangar L.

If the landing should occur at Dryden Flight Research Facility, the Ames (Dryden) Public Affairs Office will be responsible for obtaining the facts about the condition of the animals and reporting them in a timely manner. A brief report will be provided as soon as possible after the animals' arrival at the Dryden receiving facility. A summary report will be provided within 2 hours of their arrival at the Dryden facility.

If the mission ends at a contingency site other than Dryden, the possibility exists of an extreme crew emergency. NASA's first priority is the safety of the astronaut crew. Furthermore, NASA will put human safety above that of the animals if the condition of the Orbiter is considered dangerous. Contingency landing site plans are described in a separate document. The responsibility for reporting on the animals at a contingency site would rest with the Public Affairs Officer responsible for activities at that site.

#### C. Procedure

1. When asked about animal health and no air-to-ground talk on the subject has occurred, respond as follows:
  - a. There have been no crew air-to-ground reports on animal health/status.
  - b. Therefore, I really do not know of any change in animal health status, and I do not care to speculate on the subject.
  - c. Any further questions should be directed to the Spacelab Mission Manager who is tasked with maintaining cognizance of the latest status of animal health.
2. At the next press conference after a crew air-to-ground update of animal health status has occurred, respond as follows if there is no mission/crew activity impact:
  - a. A crew animal health status occurred at xx:xx mission elapsed time (MET).
  - b. The crew/animal interaction is operating normally.
  - c. Same as 1c above.
3. At the next press conference after a crew air-to-ground update of animal health status has occurred and if it has been determined that crew activities are impacted, respond as follows:



- a. A crew animal health status occurred at xx:xx MET.
- b. Read the statement prepared by the ground-based veterinarian that summarizes the animal health state/death, therapy or action recommended, and crew action taken.
- c. Summarize the crew timeline impacts in adequate detail to answer obvious questions.
- d. Refer all further questions/references concerning the Crew Air-To-Ground Animal Health Status Report to the Spacelab Mission Manager.
- e. If questions continue and the Public Affairs Officer does not step in:
  - (1) State that the Flight Control Team is not responsible for Spacelab experiments and refer again to the Mission Manager.
  - (2) Ignore any more questions on the subject. An out is "next question" and smile.

#### **1.4.4 STS Mementos Aboard Shuttle Flights (Code Federal Regulation 1214.6)**

##### **A. Definitions**

1. Mementos - Flags, patches, insignia, medallions, minor graphics, and similar items of little commercial value especially suited for display by the individuals or groups to whom they have been presented.
2. Official flight kit (OFK) - A container reserved for carrying official mementos of NASA and other organizations aboard Space Shuttle flights. No personal items will be carried in the OFK.
3. Personal preference kit (PPK) - A container separately assigned to each person accompanying a Space Shuttle flight for carrying personal mementos during the flight.

##### **B. Policy**

1. Premise - Mementos are welcome aboard Space Shuttle flights. However, they are flown as a courtesy - not as an entitlement. The Administrator is free to make exceptions to this accommodation without explanation. Moreover, mementos are ballast not payload. They can be reduced or eliminated by the Manager, National Space Transportation System Program, Johnson Space Center, for weight, volume, or other technical reasons without reference to higher authority.
2. Constraints - Mementos to be carried on Space Shuttle flights must be approved by the Administrator and stowed only in an OFK or a PPK. Mementos will not be carried within payload containers, including get-away specials.
3. Economic gain - Items carried in an OFK or a PPK will not be sold, transferred for sale, used or transferred for personal gain, or used or transferred for any commercial or fund-raising purpose. Items will not be approved for flight that have a known or suspected commercial value, such as philatelic covers or coins, or that by their nature lend themselves to exploitation by the recipients, or create problems with respect to good taste.

##### **C. Official Flight Kit**

1. Limitations - US national flags will not be flown as mementos except for US Government sponsors.
2. Approval of contents - At least 60 days before the launch of a Space Shuttle flight, a representative of each organization desiring mementos to be carried on the flight must submit an Official Flight Kit and Personal Preference Kit Request, NASA Form 1614, through the cognizant NASA Headquarters Program or Staff Office (e.g., foreign requests through the International Affairs Division, military requests through the DOD Affairs Division, payload requests through the NASA sponsor, and commercial launch service customer requests through the Associate Administrator for Space Flight) to the Associate Director, Johnson Space Center. The Director, Johnson Space Center, will compile the requests and forward them to the Associate Administrator for Space Flight with advice as to whether they can be accommodated within the weight and volume limitations of the specific mission. The Associate Administrator for Space Flight will

recommend to the Administrator a final list of items to be included in the OFK.

D. Personal Preference Kit

1. Limitations - The contents of a PPK must be limited to 20 separate items weighing a combined total of 1.5 pounds (680 grams). No more than one article may be given to any one individual. Increases in these limitations will be authorized only by the Administrator.
2. Approval of contents - At least 60 days before the scheduled launch of a Space Shuttle flight, each person assigned to the flight who desires to carry items in a PPK must submit an Official Flight Kit and Personal Preference Kit Request, NASA Form 1614, to the Associate Director, Johnson Space Center. The Associate Director, Johnson Space Center, will review the requests for compliance with this subpart and submit them with weight data through supervisory channels to the Associate Administrator for Space Flight who will similarly review the requests and forward them with recommendations to the Administrator for final approval. In conducting this review, the Associate Administrator for Space Flight will provide the requests of passengers (everyone who is not a commander, pilot, mission specialist, or payload specialist) to the Associate Administrator for External Relations for evaluation. Upon receipt of the Administrator's action, the Associate Administrator for Space Flight will provide a copy of each approved request to the requester, the General Counsel, and the Director, Johnson Space Center.

E. Media and Public Inquiries

1. Official flight kit - Information on the contents of OFK's will be routinely released to the media and public upon their request, but only after the contents have been approved by the Administrator.
2. Personal preference kit - Information on the contents of PPK's will be routinely released to the media and to the public upon their request immediately following postflight inventory.
3. Responsibility for release of information - The Director of Public Affairs, Johnson Space Center, is responsible for the prompt release of information on OFK and PPK contents.

#### **1.4.5 Preflight Briefing Templates**

TBS

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## **1.4.6 Postflight Briefings**

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## 2.1 GENERAL

### 2.1.1 Console Initialization

1. Sign onto DVIS key set using position ID followed by 4 digit personal ID (\_\_\_\_)

For ISS Sims: Use ISS #2 loops, Sim Houston Support, and Sim ISS OPS MH34  
For Shuttle or Dual Sims: Use Shuttle #2 loops during Shuttle flight otherwise use Shuttle #1 loops

#### NOTES

- Virtual key set IDs (4 digit personal ID used alone) are not recorded. Both keysets at the WFCR and BFCR consoles are recorded if signed on using the position ID or the position ID followed by your 4 digit personal ID.
- Do not modify pages 1 through 5 on the FD key sets unless you are using your 4 digit personal ID.

2. Log onto or shift handover DEC Alpha (contact Access control at x30266 or pager (713) 764-2563 for password reset)
3. Verify with GC Cmd Server ready to support, then sign on, select displays as desired

For flight access code: √Lead FD, Flight Specific Binder, or page GA (713) 902-5946  
For sim access code: √INCO or page GA (713) 902-5946

#### WARNING

If first login attempt is unsuccessful (Ref OPS Note CMDGEN0038), contact GC and WSS. Do NOT attempt another login.

4. Configure FD Status Application (ref section 2.9.6 for more info)
5. Configure MPV if desired (ref section 2.9.5 for more info)
6. Configure other displays/apps as desired (ref section 2.9.10 for commonly used displays)
7. Log onto MCC PC (contact JSCMODM support for password reset, phone # taped to PC Monitor)
8. Start Electronic Flight Notes (ref section 2.9.2 for more info)
  - a. If sim or prelaunch planning shift for non-ISS Shuttle flight: Reset Flt ID, Database, and Clock.
  - b. If prelaunch planning shift for ISS Shuttle flight: Reset Flt ID and Clock only. **DO NOT RESET DATABASE!**

#### CAUTION

DO NOT RESET DATABASE when using MCC PC Activity 1 (flight operations). This will delete all flight notes submitted during ISS increment operations.

NOTE

When the clock is reset, all operators' flight note applications will automatically terminate and must be manually restarted.

9. Setup Log and Hand-over Summary

√:\flight\template\FD\_Log\_Handover or from MS Word: File ▶ New ▶ DA8 tab ▶ FD\_Log\_Handover

NOTE

Changing the path and other fields will affect everyone using this template.

10. For ISS, Bring up OSTPV (ref section 2.9.13), MPV (ref section 2.9.5), and web planning product page.

Web planning product page at <http://mod.jsc.nasa.gov/mcc/>

### 2.1.2 Integrated Simulation Checklist

Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ Sim: \_\_\_\_\_ MCC Platform: \_\_\_\_\_

SMS Base: \_\_\_\_\_ SMS Load: \_\_\_\_\_ SSTF Load: \_\_\_\_\_

	<u>Shuttle</u>	<u>ISS</u>
FD	_____	_____
Sim Sup/STL	_____	_____
Crew	_____	_____
	_____	_____
	_____	_____
	_____	_____

<u>Shuttle Start Config</u>	<u>ISS Start Config</u>	<u>ICs</u>	<u>Evals</u>
Att:	Att:		Interim:
DAP:	MCS:		
Grp B:	Power Allocation:		
Ku:	Early Comm:		
TFL:	Module Pressures:		
RMS:			Final:
OMS/RCS:			
Cabin P:			

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Sim Start	Activities	Comments
-45 min	<p>ON CONSOLE</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Perform Console Initialization Checklist</li> <li><input type="checkbox"/> MCC facility status with GC (FD Loop)</li> <li><input type="checkbox"/> Simulator(s) status with Sim Sup/STL (<i>Sim Conf</i>)</li> <li><input type="checkbox"/> Review Prebrief plan, ICs, Evals with ISS/Shuttle FD and Sim Sup/STL (<i>FD Coord then Sim Conf</i>)</li> </ul>	<p>Reference section 2.1.1. Initial pre-sim facility status. If facility problems, identify potential delays and start time. Keep flight controllers informed.</p>
-40 min	<p>FDF AND CUE CARDS</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> √versions/sim packs vs FDF status sheet</li> <li><input type="checkbox"/> √FAO/Ops Plan to for applicable flight/daily plan</li> <li><input type="checkbox"/> Review execute package inputs as appropriate</li> </ul>	<p>From PC MOD Wide applications menu: FDF Books\Status Sheets</p>
-30 min	<p>FD STATUS FOR SIM START (<i>FD Loop</i>)</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Request AMBER when logged in.</li> <li><input type="checkbox"/> Request GREEN when ready for MOC/CMD Server ckpt</li> </ul>	<p>Separate checkpoints are made to the Shuttle and ISS command servers so each FD gives their GC a separate Go.</p>
-25 min	<p>ROSTER</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Distribute Manning Roster to FCR positions</li> </ul>	<p>From PC: u:\work\flight\template\FD Console\FD_Training Roster</p>
-15 min	<ul style="list-style-type: none"> <li><input type="checkbox"/> REVIEW FCT EXPECTATIONS (<i>FD Loop</i>) <ul style="list-style-type: none"> <li>• Review prebrief plan (Loop, FAO/Ops Planner, ICs)</li> <li>• A/G Protocol <ul style="list-style-type: none"> <li>- don't talk over crew/CAPCOM, Break-break if reqd</li> <li>- confirm good read-up/read-back</li> <li>- acknowledge crew call/action for your system</li> </ul> </li> <li>• Look ahead, what-if</li> <li>• System Problems <ul style="list-style-type: none"> <li>- failure, impact, options, recommendations, FR ref</li> <li>- heads up if "package" incomplete</li> <li>- Procedure title, FDF book, page #, starting step</li> <li>- Switch/panel nomenclature, SPEC/Item Entries</li> </ul> </li> <li>• Flight Notes when time permits</li> <li>• Dual Sim <ul style="list-style-type: none"> <li>- work with ISS/Shuttle counterparts</li> <li>- be cognizant of other FD loop</li> <li>- CAPCOM protocol</li> </ul> </li> </ul> </li> </ul>	
	<p>GO FOR CHECKPOINT (<i>FD Loop</i>)</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Give GC Go for CMD Server checkpoint</li> </ul>	
	<p>SIM PREBRIEF PREP (<i>FD Loop</i>)</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> If Remote POCC participating, patch PRIME OPS to AFD CONF</li> </ul>	<p>Prebrief conducted on AFD CONF loop. Includes Shuttle/ISS FCT, crew, Sim Sup/STL, and sometimes payload customers.</p>
-10 min	<ul style="list-style-type: none"> <li><input type="checkbox"/> SIM PREBRIEF (<i>AFD Conf</i>) <ul style="list-style-type: none"> <li>• Request RED on AFD CONF</li> <li>• Provide Sim Overview/Short Synopsis</li> <li>• Sim Sup/STL: <ul style="list-style-type: none"> <li>- Simulator status (including workarounds)</li> <li>- Projected sim start time</li> </ul> </li> <li>• FAO/Ops Planner: <ul style="list-style-type: none"> <li>- Timeline Overview, OSTPV file</li> <li>- FDF/ODF Configuration</li> </ul> </li> <li>• Flight Controllers: <ul style="list-style-type: none"> <li>- Initial conditions</li> </ul> </li> <li>• Flight Crew/Flight Controllers/Sim Sup/STL <ul style="list-style-type: none"> <li>- Final comments, questions</li> </ul> </li> <li>• FD Go/No-Go to pick start time</li> </ul> </li> </ul>	<p>If dual sim, ensure both teams ready before giving Sim Sup/STL a go to pick a start time.</p>

-5 min	SIM SUP/STL ANNOUNCES START TIME ( <i>FD Loop</i> ) <input type="checkbox"/> Each FD and GC should "copy"	Referenced in GMT
Sim Start	SIMULATOR STATUS ( <i>FD Loop</i> ) <input type="checkbox"/> Sim sup/STL Report <input type="checkbox"/> CAPCOM A/G Comm Check <input type="checkbox"/> Request GREEN for Go for Nominal Ops	Go for nominal ops means their systems are properly configured and they are ready for sim objectives.
+10 min	<input type="checkbox"/> GO FOR NOMINAL OPS ( <i>FD Loop</i> ) • Inform Sim Sup/STL FCT is ready to begin sim	Any anomalies before this point should not be considered Part of the sim and will be handled by Sim Sup/STL.
~Sim End	<input type="checkbox"/> SIM TERMINATION PREP ( <i>Sim Conf</i> ) • Review overall progress of sim with Sim Sup/STL • Determine appropriate sim termination time/event	Sim Sup/STL will announce sim termination and coordinate the debrief.
Sim Stop	<input type="checkbox"/> SIM TERMINATION ( <i>FD Loop</i> ) • √FCT finished with equipment • Release equipment to GC • Identify debrief start time	FDO is generally the only controller who requires the equipment after sim stop.
Debrief	<input type="checkbox"/> DEBRIEF ( <i>AFD Loop</i> ) • FD Review big picture objectives/team performance • Around the room(s) • Crew Questions/Comments • Sim Sup/STL Questions Comments	Flight Director leads the debrief by reviewing the big picture objectives of the sim and how the team performed. Discussion time should be given to malfunctions or scenarios that were not handled properly or provoked issues that should be resolved or procedures that should be updated.
Post Debrief	<input type="checkbox"/> REVIEW ACTIONS ( <i>FD loop or AFD CONF as desired</i> ) • Summarize actions, due date, method of closure • Release team	
	<input type="checkbox"/> FACILITY METRICS/EVAL • Complete Sim Sup/STL Feedback form	Sim Sup/STL will e-mail the feedback form to the Flight Director. Include MCC & SMS-SSTF facility metrics.

### 2.1.3 Handover Checklist

#### A. Outgoing Flight Director Checklist

- Ensure shift log is up to date and print a copy for the oncoming Flight Director at the beginning of the handover period.
- Complete handover summary (including Orbiter Summary, ISS Summary, PL Summary, MCC Summary, Other, and Open Work).
- Print a copy of the handover summary for the oncoming Flight Director at the beginning of the handover period and post it to the web by selecting the "WebSave" button in MSWord.
- Print copies of any flight related e-mail received or sent and attach to the handover summary.
- Brief oncoming Flight Director on significant activities, anomalies, and open work.
- At approximately 30 minutes into the handover period, when the oncoming Flight Director is ready for the team handover briefing, have the oncoming team go to the AFD Conference loop. (Note: Try to minimize handover time for ISS increment ops.)
- At approximately 1 hour into the handover period, when the oncoming Flight Director is ready for the oncoming team to begin operations;
  1. Announce that the outgoing team members can leave as soon as they have completed their own handovers.
  2. Log off the MODM server.
  3. Perform a shift handover on the console workstations.

#### B. Oncoming Flight Director Checklist

- Read console log and handover summary.
- Review MMT minutes, anomaly logs, new or updated chits, Execute Package.
- Discuss with the outgoing Flight Director significant activities, anomalies, and open work.
- At approximately 30 minutes into the handover period, lead a team handover briefing on AFD Conference loop, discussing with each FCR discipline current vehicle configuration, problem summaries, and open work. The purpose is to ensure that the team has a common understanding of the current vehicle status, upcoming operations, and open work. It is generally best not to work the open work items during the handover briefing, but to wait until handover is complete. Note that during joint missions, Shuttle and ISS handover periods are normally separated by one hour. Try to minimize handover time for ISS increment ops.
- At conclusion of the handover briefing, the oncoming team monitors activities on the FD and A/G loops, and waits for outgoing team to handover operations.



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## Shuttle Team

### FAO

- Items missed
- New items, upcoming activities
- Timeline changes/issues
- Messages for uplink

### ACO/PAYLOADS

- Items missed, new items
- Payload/experiment status
- ISS Status if joint mission

### GC

- MCC and network status
- Upcoming TDRSS conflicts

### RGPO

- Rndz nav/sensor status

### FDO

- Current orbit (Ha x Hp)
- State vector and maneuver status
- WX status and next PLS opps
- If rndz, distance/closing rate to target

### PROP

- OMS and RCS remaining
- Interconnect plan (next 24 hours)
- Jet status

### GNC

- IMU Align/comps
- Sensor status

### MMACS

- Circ pump status

### EGIL

- Systems status
- Cryo tank mgmt and margin status

### EECOM

- Water status (H2O dumps/FES)
- N2, O2, H2 status
- Critical thermal

### DPS

- Current GPC/String status

### INCO

- OPS Recorder dump status
- TDRS Link performance status
- Ku-band status

### PDRS

- RMS HTRS - AUTO/OFF
- RMS/MPM Status

### Surgeon

- Status

### EVA

- Status

### PAO

- Upcoming PAO events

### CAPCOM

- Additional comments

## ISS Team

### OPS Planner

- Items missed
- New items, upcoming activities
- Timeline changes/issues
- Messages for uplink

### ACO

- Items missed, new items
- Payload/experiment status
- Orbiter Status

### GC

- MCC and network status
- Upcoming TDRSS conflicts

### TOPO

- Conjunction status

### ADCO

- System Configuration
- Consumables status

### THOR

- Status

### Phalcon

- Systems status
- Power allocation

### OSO

- Status

### ROSO

- Status

### ECLS

- Water status
- N2, O2, status
- Critical thermal

### ODIN

- Status

### CATO

- TDRS Link performance status

### EVA

- Status

### Surgeon

- Status

### PAO

- Upcoming PAO events

#### **2.1.4 Off-Nominal Support Callup/Phone List**

The ISS and Shuttle Flight Director Phone Lists are updated frequently to a limited distribution. All Flight Directors will receive the latest version as updates are made and may use this page as a placeholder.

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## 2.1.5 Contingency Actions and Notifications

### 2.1.5.1 Spacecraft Emergency Checklist

This procedure should be executed following an event that has occurred with the on-orbit vehicle that could potentially result in the loss of the on-orbit crew and/or vehicle. The event may or may not result in an emergency de-orbit or evacuation of the Space Station by the ISS crew.

1. Address the onboard problem
2. Declare the Spacecraft Emergency on the Flight Director loop
3. Have the GC notify the Network Director of the declared emergency and implement the efforts to maximize communications coverage with the spacecraft. This includes calling up any additional TDRS satellite and/or Ground Stations to provide additional communications coverage.
4. Have the FDO contact LSO and call-up/notify landing sites as required (get a copy of ELS DOPS)
5. Ensure that the appropriate personnel are notified per FCOH SOP 2.8

Note – notify the MOD representative and have them execute FCOH SOP 2.8 for notification of the appropriate personnel.

6. Notify the MER and SPAN Managers and have them notify the required Engineering support personnel.
7. Execute **(ISS)** FCOH SOP 2.4.3 “Team 4 Contingency Operations Procedures”, as required, to aid in the resolution of the spacecraft emergency.
8. Have each Flight Controller notify the required technical support personnel (e.g. entry team).
9. Following the event, if required, execute the “Contingency Action Plan” (Console HB proc. 2.1.5.2) to support any investigation activity.

### 2.1.5.2 Contingency Action Plan

All attempts should be made to maximize the safety of the flight crew, the public, NASA and contractor personnel, and to minimize damage to program assets and payloads. Nothing in any contingency action procedure takes precedence over this. This procedure is principally applicable to post-contingency actions, Flight Rules, and crew procedures that are in effect during the resolution of a contingency operation.

#### A. Contingency Definitions

Contingency definition 1 from OSF Contingency Action Plan: “An SFO contingency is defined as any mishap, mission failure, incident, or close call that causes a major impact to space flight operations or prevents accomplishment of a primary mission objective involving OSF-controlled personnel, hardware, support equipment, or facilities or any personnel, hardware, software, equipment, or facilities that have been integrated with OSF controlled flight related systems.”

Contingency definition 2 from the Space Shuttle Program Contingency Action Plan: “. . . a program contingency is defined as any Space Shuttle Program-related failure, accident, or incident (involving Space Shuttle Program controlled flight or test hardware, support equipment, or facilities) that significantly delays or jeopardizes the Space Shuttle Program or a flight, prevents accomplishment of a major objective, or terminates a flight prematurely.”

Terminating a space shuttle mission at a planned daily PLS Go/No-Go point is not a contingency. Invoking Flight Rules that require Minimum Duration Flight is not a contingency. An intact ascent abort due to one SSME failure with no additional complications is not a contingency.

#### Definitions condensed from NMI 8621.1F:

1. Type A Mishap is one that causes death and/or property damage greater than \$1M, or if a test failure is likely to have significant program impact.
2. Type B Mishap is one that results in permanent disability or hospitalization or property damage between \$250K and \$1M.
3. Type C Mishap is one that results in lost workday injury or property damage between \$25K and \$250K.
4. Mission failure is any event that prevents accomplishment of a majority of the primary mission objectives.
5. Incident is defined as injury requiring more than first aid or damage between \$1K and \$25K
6. Close call is defined as no injury or interruption of productive work or damage less than \$1K but has a potential for a mishap.

Medical Codes

0 - Deceased or not expected to live

1 - Critical, immediate care required

2 - Fair to poor, care required

3 - Good to fair, hospitalization not required

B. Contingency Checklist

For a suspected contingency, refer to FCOH SOP 2.8 Procedures Part A:

1. Ensure the appropriate personnel are notified per SOP 2.8
2. Instruct all personnel to terminate unofficial telephone calls and make no public or private statement unless authorized

For a declared contingency, refer to FCOH SOP 2.8 Procedures Parts A. and B.:

1. Ensure the appropriate personnel are notified per SOP 2.8
2. Announce on the FD loop that a contingency has occurred and the contingency plan is in place.
3. Have all flight controllers perform FCOH Procedure 2.8

Notification (Reference Joel Montalbano's phone list for phone numbers):

Mission Operations Director

JSC Director

JSC Deputy Director

JSC Associate Director

Manager, Space Shuttle Program

Manager, International Space Station Program

Director, Safety, Reliability and Quality Assurance

Chairman, Mishap Investigation Team



C. Public Affairs Notes

The AA/OSF appoints a spokesperson to make a public announcement of known facts as soon as possible, with a goal of 1 hour. Information identifying any fatalities is not released until the next of kin are officially notified. The AA/OSF approves all press releases.

D. Other Applicable Documents and Reference Material

All of these documents are available in the Flight Director Library, building 4N, room 3006. The documents indicated with an "\*" are available at the Flight Director console. These documents are listed without a publication date because they are regularly updated at various intervals.

- \* Flight Control Operations Handbook, JSC-12805
  - SOP 2.8, JSC Contingency Plan
- \* Flight Rules, Space Shuttle Vol. A., All Flights, NSTS-12820
  - A1-2, Real-Time Operating Policy, paragraphs B and C
  - A1-3, Program Lifetime Operating Policy, paragraph B
  - A1-5, Flight Director Authority, paragraph B
  - A1-9, Postlanding Decision Authority, paragraph A.2
  - A1-10, Postlanding Emergency Declaration
- \* Space Shuttle Program Contingency Action Plan for Lyndon B. Johnson Space Center, JSC-14273
  - NSTS-07700, Vol. VIII, NSTS Operations
    - Appendix R, Contingency Landing Response Plan
    - Appendix S, TAL Orbiter Recovery Plan
- \* Space Flight Operations Contingency Action Plan, OSF SFO CAP
  - Office of Space Flight Space Shuttle Contingency Action Plan, OSF SSP CAP
- \* Space Shuttle Program Emergency Mission Control Center Activation and Operations Procedures, GSFC 532-CAP-EMCC
  - DFRC Shuttle Contingency Action Plan
  - DDMS Space Shuttle Support Operations Plan
  - DDMS Space Transportation System Contingency Support Procedures Document
  - Flight Crew Operations Directorate Space Shuttle Contingency Action Plan, JSC-23616

Additional documents not found in the FD library, include

NMI 8621.1, Mishap Reporting and Investigating

NMI 1382.4, Release to the News Media of Information Concerning Accidents and Casualties

NHB 1700.1, (Volume I), Basic Safety Manual

NHB 1700.1, (Volume II), Guidelines for Mishap Investigation

NHB 2710.1, Safety and Health Handbook, Occupational Safety and Health Programs

DoD-NASA Agreement for Joint Investigation of Aircraft or Space System Mishaps

JSC-05900 series documents for ground incident or accident

U. S. Department of Labor (OSHA), publication 2014

Executive Order 12196 and 29 CFR, parts 1960 and 1910, Occupational Safety and Health Act of 1970

JSC Announcement 87-64, New Mishap Reporting Procedure

JSCI 1382.1, Release of Information to News Media

### 2.1.5.3 ISS Operations Hurricane Plan

This section identifies the necessary actions to prepare for and to accomplish the transition of ISS operations to the Backup Control Center (BCC) and shut down the Mission Control Center in Houston. The plan is implemented based upon JSC center operations storm activity levels referenced below. Official Level change announcements are communicated to the MCC-H through the facility coordinator and ISS Ground Controller. The MCC weather console may be contacted for the latest updated or advisories regarding the storm path and strength.

#### References:

[http://mod.jsc.nasa.gov/da8/FCOH/EMCC\\_Hurricane\\_Plan/EMCC\\_Hurricane\\_Plan.pdf](http://mod.jsc.nasa.gov/da8/FCOH/EMCC_Hurricane_Plan/EMCC_Hurricane_Plan.pdf)

BCC Operations procedure A10.1; SAP-50643A

#### A. Definitions

- 1. Level 4 – Concern:** Level 4 activities are initiated when a storm poses a threat to JSC within 72 hours or a storm enters the Gulf of Mexico and poses a threat to JSC. Employees assigned responsibilities for hurricane/severe weather planning and implementation review and initiate preparedness plans to assure a state of readiness and be prepared to initiate Level 3 activities. On-site JSC EPR's will remind all supervisors and employees to verify that they have a "Hurricane Checklist Kit (yellow sheet)" for the protection of their PC workstations and that they know when to use them. Extra Hurricane Checklist Kits are available from the JB9/Supplies and Support Services Branch, ext. 36657. Supervisors and managers should review project priorities and assignments to assure operations can be reduced or terminated as necessary. Managers and supervisors may initiate a liberal leave policy for employees who demonstrate a particular vulnerability for themselves or their family from a severe weather condition or other emergency situation, including a preference to initiate their personal evacuation plan in advance of community warnings.
- 2. Level 3 - Preparation:** Level 3 activities prepare JSC to be in a position to be able to close down operations in a timely and orderly manner if necessary by notifying and assembling the appropriate personnel and groups. It is initiated upon authorization by the Director, Center Operations when there is a high probability that severe weather conditions pose a threat to the Center within 48 hours. The HRTC directs activation of the HCP upon authorization from the Director, Center Operations and provides the Director, Center Operations with continuing status reports on the protective measures being implemented. The HRTC will coordinate appropriate additional staffing to the HCP. The HRTC coordinates APT assignments, and the COD support services contractor's activities covered in Appendix A. Managers and supervisors should encourage a liberal leave policy for employees who demonstrate a particular vulnerability for themselves or their family from a severe weather condition or other emergency situation, including a preference to initiate their personal evacuation plan in advance of community warnings.
- 3. Level 2 - Response:** Level 2 activities consist of completing all protective measures that place the center in a final state of preparedness. It is initiated upon authorization by the Director, JSC and communicated to the HCP by the Director, Center Operations

when there is a high probability that severe weather conditions pose a threat to the Center within 36 hours. Completion of Level 2 activities may include release of all employees except those assigned to the HRT or those designated essential to the support of an ongoing space flight mission. Authority to release employees is reserved to the Director, JSC.

4. **Level 1 - Rideout and Recovery (post-storm):** The Director, JSC initiates level 1 activity upon authorization when a severe weather condition poses an imminent threat to the Center within 24 hours. Activities during the storm period limited to HRT activities. Essential emergency repairs may only be performed if they can be done without endangering the health and safety of assigned employees. Immediately after the storm, the HRTC assesses storm damage and arrange for necessary repairs on a priority basis.

B. Action Plan

1. **Level 4**

Inform HSG to be ready in case BCC activation becomes necessary.

2. **Level 3**

- a. All non-flight MCC-H operations are suspended, non-flight support personnel are released and non-flight equipment is powered down.
- b. ISS flight team begins activation of the Backup Control Center (BCC) in Moscow and prepares to handover operations to the BCC.
- c. Ensure that people who may have to travel to MCC-M keep their passport and MEV on hand.
- d. Build the phone list for MMT personnel.
- e. Build the phone list of personnel for HSG to call if they have questions and to call back in for re-activation of MCC-H.
- f. Build phone list for EOC personnel to call upon Hurricane plan activation (EMCC list).
- g. Consider giving building personnel an early go to do shutdown of some equipment in anticipation of Level 2.
- h. Controllers print and build notebooks of pertinent info to carry with them to answer questions as well as help with re-activation.

3. **Level 2**

- a. Build and load time tags for S-band (2/rev required for S-band only and total of 75 allowed in buffer). Consider loading Ku time tags if significant payload ops requires them. (Ku requires 3 commands/pass.)
- b. Consider calling up U.S. ground sites to beef up VHF coverage.
- c. Hand over ISS flight operations to the BCC.
- d. MCC-H flight operations are suspended, flight support personnel are released and all equipment is powered down.

C. Phone Lists

*Contact Numbers for Emergency Operations Center (EOC)(Reference Hale Phone List for home, cell, and pager numbers).*

MMT Phone List	Home	Cell	Pager	Console
ISS Program Manager				
IMMT Chair				
Increment Manager				X46152
MOD				X31401
Lead Flight Director				X31401
HSG				256.961.6221
POD – MSFC Rep				256.544.6036
Crew Rep				X45339

*MCC Phone List (Prime and backup for each)*

MCC – ISS Phone List	Home	Cell	Pager	Console
Flight Director				X31401
TTI Logistics				
ADCO				X45292
BME				X33214
SURGEON				X45348
CAPCOM				X45339
CATO				X45288
CIO				X46415
ECLSS				X45330
EVA				X45348
GC				X45279
ODIN				X37675
PHALCON				X45301
OSO				X45291

MCC – ISS Phone List	Home	Cell	Pager	Console
THOR				X45301

TOPO			281.434.5900 (group pager)	
POD				256.544.6036
MER Manager				

*EMCC Phone List*

Position	Home	Cell	Pager	Console
Flight Director				X31401
BCC Flight Director				256.961.6221
BCC Lead				256.961.6224
BCC Backup Lead				256.961.6224
POD				256.544.6036

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## 2.1.6 Crew Coordination of Uplink

A. Commanding - The crew must be notified of all commanding as listed below:

1. All GNC uploads except variable parameters and normal IMU compensations.
2. All SM loads except routine recorder management, routine comm system management, variable parameters, antenna management TMBUs, SPCs, TMBUs which do not affect crew display or FDA, and routine nonhazardous payload commands.
3. All BFS loads except routine recorder management, routine comm system management, antenna management TMBUs, and SPCs.
4. Any command normally requiring crew concurrence may be sent during sleep with Flight Director concurrence except GMEMs, DEU equivalents, and commands that set off alarms (the tone duration WILL NOT be set to 0 with DEU equivalents). This allows vectors, TFL/DFL loading, PLB TV, etc. to be done while the crew is asleep if the situation warrants. If a GMEM is important enough to do during sleep, it is important enough to wake the crew.
5. ISS commanding – Any command which affects the configuration of an ISS system unless pre-coordinated. Exceptions are routine communications configurations, routine MDM dumps to monitor performance, routine heater configuration.

Note: Any of these may be waived on a mission specific basis with prior crew coordination.

B. TV

1. Crew operated exterior TV - The MCC may freely select (NOT MOVE) cameras for downlink. The crew must be informed we are “looking over their shoulder.”
2. Interior TV - The crew MUST give a go for interior TV before it is downlinked. The GO must be given in real time immediately prior to the downlink (i.e., not pre-flight).
3. Ground operated exterior TV - The MCC may operate exterior cameras with prior crew concurrence. Again the crew must concur in real time just prior to the MCC taking control of one or more cameras. This may be one or all cameras and may be a part of crew-operated TV as required.

C. OCA

The crew does not need to be informed of OCA uplinks in advance but they should be informed soon afterward so they can retrieve the message. OCA uplinks without auto print are silent and can be performed throughout crew sleep.



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### 2.1.7 U.S. Strategic Command

The United States Strategic Command (USSTRATCOM) is the command and control center for U.S. strategic forces and controls military space operations, computer network operations, information operations, strategic warning and intelligence assessments as well as global strategic planning. The command is responsible for both early warning of and defense against missile attack and long-range conventional attacks. The Commander (CDR) of USSTRATCOM is also the DoD Manager for Manned Space Flight Support Operations.

The mission of USSTRATCOM is to establish and provide full-spectrum global strike, coordinated space and information operations capabilities to meet both deterrent and decisive national security objectives. This includes providing operational space support, integrated missile defense and specialized planning expertise as well as global command and control, communications, computers, intelligence, surveillance and reconnaissance to the joint warfighter.

U.S. Strategic Command controls military space operations, computer network operations, DOD information operations, strategic warning and intelligence assessments as well as global strategic planning. The command operates and maintains an underground command center as a primary command and control node. USSTRATCOM exercises command authority over the nation's strategic resources, to include intercontinental ballistic missiles, bomber aircraft and ballistic missile submarines.

USSTRATCOM support to NASA is provided primarily by the 21<sup>st</sup> Space Wing (SW) and the 45<sup>th</sup> SW. The 45<sup>th</sup> SW, headquartered at Patrick AFB, falls under the space forces support mission. The 45<sup>th</sup> SW conducts East Coast Range Operations at Cape Canaveral AFS and includes the Department of Defense Manned Space Flight Support Office (DDMS), responsible for the day-to-day operations and support to NASA. DDMS staff is also part of the Landing Support Office (LSO) located here at JSC. The 21<sup>st</sup> Space Wing (SW), headquartered at Peterson AFB, operates the Cheyenne Mountain Operations Center (CMOC) and falls under the space control mission, including threat and warning notification, collision avoidance screening, satellite break-up notification, space object identification (SOI) tasking, and radar restrictions coordination. USSTRATCOM personnel, located at USSTRATCOM HQ in Omaha, Nebraska, perform SOI analysis and disseminate wideband radar and optical images derived from the collection activities initiated by CMOC personnel.

CMOC includes seven centers, which conduct continuous operations. These seven centers include the Command Center, Air Warning Center, Missile Warning Center, Intelligence Watch Center, Systems Center, Weather Center, and the Space Control Center (SCC). JSC's primary interface with USSTRATCOM is the SCC, which performs orbit analysis and maintains current orbit elements on over 8000 objects. The SCC controls the Space Surveillance Network (SSN), which is a worldwide network of satellites, radar, and other sensors to detect, track, identify, and catalog all man-made objects approximately 10cm in diameter and larger. The SCC is also responsible for protecting manned space flight assets through conjunction analysis between other objects and the Space Shuttle and ISS, and through threat and warning notifications.

Naval Space Command operates a backup to CMOC, called the Alternate Space Command Control Center (ASCC), located in Dahlgren, Virginia. The ASCC provides similar support as the SCC, operating in parallel with CMOC to maintain readiness in case the SCC becomes unavailable.

### 2.1.7.0 Communications

The Flight Director generally does not interface directly with the SCC. However, if direct communication is required between the SCC and the Flight Director, the point of contact is the SCC Crew Commander or Space Battle Manager (SBM). As indicated in the table below, this position was formerly known as the Space Control Analyst or SCA. For Shuttle and/or ISS operations, the FDO/TOPO is the primary interface whose point of contact is the Orbital Safety Analyst (OSA). Note that most positions are staffed with Air Force personnel while the OSA is actually an Omtron contractor partially funded by NASA. Personnel at ASCC are military civil servants.

POC	Phone No.	Working Hours	When to Contact
USSTRATCOM Global Operations Center Space Desk	402-294-1752/1754	24/7	Emergencies or operations not covered by OSA, SBM, Crew Commander responsibilities
USSTRATCOM NASA Liaison	402-232-4421	Normal working hours (0730-1630 CT)	Administrative and / or policy matters
Orbital Safety Analyst (OSA)	Console: 719-474-4458 Fax: 719-474-3211 STU-III: 719-474-3380	24/7	Routine operations
Space Battle Manager (SBM) - (formerly the Space Control Analyst or SCA)	Console: 719-474-4407 Fax: 719-474-3211 STU-III: 719-474-3892	24/7	Threat and Warning matters
SCC Crew Commander	719-474-4401	24/7	Threat and Warning matters if can't reach SBM
ASCC SCAS	Console (STU-III): 540-653-6500 Fax (unclas): 540-653-6509 Fax (class): 540-653-6507	24/7	When ASCC is prime

Table 2.1.7-1 USSTRATCOM Points of Contact

Unclassified voice communication between the MCC and the SCC or ASCC is conducted on the NORAD COORD loop or by telephone. A special procedure, referred to as "ring-down", sounds a buzzer at the OSA and SBM consoles to alert them that the MCC is trying to contact them on NORAD COORD. This is performed by putting the NORAD COORD loop in talk mode and then pressing "RING" on the DVIS panel. At the OSA and SBM consoles, a light will illuminate and a click will be heard over the NORAD COORD loop. The OSA will then respond on the NORAD Coord loop. The SBM will respond if the OSA is not available. Since the TOPO's do not support 24/7, ISS FD's should keep NORAD COORD (as talk-listen) on their DVIS panels at all times. Talk-listen should be used with this loop because it is patched through a phone line and any configuration using "monitor" mode is equivalent to a phone off-the-hook.

Classified voice communication can be conducted via the Blue FCR Center Director's Suite's (BFCDS) Secure Terminal Equipment (STE) phone, via FDO's or TOPO's Secure Telephone Unit (STU-III) or via secure lines in the Comsec Equipment Facility (CEF) located on the first floor of 30M. Both phone types (STE and STU-III) can be used as either a BLACK or RED (secure) phone. The CEF phones can be used by first calling the CEF at x35063 or x27017, notifying them that you need to use their secure phone, and then heading to the CEF. The FDO/TOPO phone is locked in their safe and requires a FDO/TOPO for its use.

The BFCDS STE is available to the Flight Directors at any time. The phone number for the BFCDS STE is (281) 792-7012. Configuring the BFCDS STE for secure use requires activation with an electronic "key." This electronic key is locked in a drawer in the Blue FCR. For information regarding its access, contact the Flight Director Office Deputy Chief for ISS. Co-located with the electronic key are instructions for activating the phone and a copy of this document for reference. A cue card for activation and use is also located with the phone.

### 2.1.7.1 Collision Avoidance

One of US Strategic Command (USSTRATCOM's) primary services to the Space Shuttle and ISS Programs is collision avoidance screening. The Orbital Safety Analyst (OSA) predicts conjunctions between the Shuttle or ISS and objects contained in the Satellite Catalog in addition to others which have not been correlated to a parent object (referred to as analyst objects).

It is important to note that collision avoidance can only be performed for that portion of the orbital debris population that can be tracked (approximately softball size or larger). There are orders of magnitude more objects that cannot be tracked but are still large enough to cause damage to the Orbiter or ISS. ISS shielding varies depending on the module but generally offers protection against objects smaller than about 1 cm.

For Shuttle operations, the screening process begins prelaunch using FDO's predicted OMS-2 burnout vector and covers the period up to 4 hours MET. If an object is predicted to penetrate a  $\pm 5 \times \pm 15 \times \pm 5$  km box surrounding the Orbiter (referenced in the UVW frame and centered on the Orbiter) within the first 2 hours of the mission, launch will be held to the next even minute to eliminate the conjunction. Reference FR A4-3 for additional information. After OMS-2 is performed, an actual OMS2 burnout vector is provided to the OSA, who will repeat the screening process.

For Shuttle orbit operations, screening is performed for a time period of 36 hours using FDO supplied Orbiter state vectors. It generally takes about one hour per state vector for the OSA to complete the screening process. If no objects are detected inside the  $\pm 2 \times \pm 25 \times \pm 25$  km box surrounding the Orbiter (referenced in the UVW frame and centered on the Orbiter), the OSA will report "negative conjunctions" and no further assessment is required until the FDO provides a new Orbiter state vector. For coasting orbit operations, the FDO will provide a new Orbiter state vector every 8 hours or following a significant state vector update. Predicted burnout state vectors for all planned translation maneuvers are also provided to the OSA for screening to determine whether the burn plan should be adjusted to avoid a conjunction. The actual burnout vector is provided post-burn so that any differences between the planned and actual burn are taken into account when screening for conjunctions. For deploy operations, the OSA will also analyze FDO supplied vectors for the predicted post-deploy payload state vector, predicted post-Perigee Kick Motor (PKM) state vector, and predicted and actual post-separation Orbiter state vectors.

If an object does penetrate the notification box, the OSA will verbally notify FDO and provide written notification including the Orbiter state vector, object state vector, and miss distances at the time of closest approach (TCA). FDO uses the object state vector provided by OSA and the Orbiter ground ephemeris maintained by FDO and Ground Navigation personnel to confirm the conjunction. If the conjunction is confirmed, FDO will calculate a probability of collision ( $P_c$ ) using the Shuttle (or Shuttle/ISS) and debris state vectors along with the associated uncertainty information represented by their covariance matrix at TCA. If the object is consistently inside the maneuver thresholds defined in Flight Rule A4-106 or C4-51 for docked operations, a collision avoidance maneuver may be required. Refer to Flight Rules A4-106 and C4-51 for additional information on maneuver criteria.

The entire screening process is generally transparent to the Flight Director, unless an object penetrates the notification box. Then, the FDO will inform the Flight Director and provide the TCA and miss distances for each update via Flight Note. FDO procedures state that verbal notification will be provided to the Flight Director over the "airwaves" unless the Flight Director initiates discussion over the voice loops. This protocol has been used to minimize dissemination of sensitive events. However, if a collision avoidance maneuver is being considered, the Flight Director should initiate this discussion over the voice loops to ensure the team can provide input into the maneuver decision making process and adequately prepare for the maneuver. Depending on the likelihood of the maneuver and the maturity of the data, this discussion can take place on AFD Conference or the Flight loop. Unless the need for a maneuver is unlikely or the data is still premature, this discussion should take place on the Flight loop.

For ISS operations screening is based on USSTRATCOM tracking of the ISS. Once per shift (every 8-hours), the OSA screens the ISS against objects in the debris catalog that represent a possible threat (those with a perigee altitude of less than 600 km) using special perturbation (SP) processing on the Astrodynamics Support Workstation (ASW). The ASW identifies those objects predicted to penetrate a  $\pm 2 \times \pm 25 \times \pm 25$  km notification box centered about the ISS within the 72-hour ISS screening window. All box violations identified by the OSA are reported to the ISS Trajectory Operations Officer (TOPO) both verbally and via an Orbital Conjunction Message (OCM). If no objects are detected the OSA will report "negative conjunctions" and no further assessment is required. In addition to screening during "coasting" operations, the TOPO will provide the OSA with a predicted burnout state vector for any planned translation maneuver to determine whether the burn plan should be adjusted to avoid a conjunction. If any problems occurred during the burn, the TOPO notifies the OSA and provides an updated predicted burnout vector to make sure there is no increased risk due to unscreened conjunctions.

Conjunction screening for the ISS is based on a subset of the entire Satellite Catalog, which includes only those objects (~700) with a perigee less than 600 km. Each of these objects and the ISS are maintained at a higher fidelity than the remaining objects using the SP orbit determination process. Although SP orbit determination process is used even for initial notification, the accuracy of the state vectors is dependent on the frequency and type of tracking data. Tasking is increased on any object penetrating a  $\pm 10 \times \pm 40 \times \pm 40$  km box. If an object penetrates the  $\pm 2 \times \pm 25 \times \pm 25$  km notification box, the OSA will verbally notify TOPO and provide written notification including the ISS and object state vectors and covariance matrices at TCA, miss distances at TCA, and other orbit determination parameters. Covariance matrix data represents the state vector uncertainty and is calculated based on the quality of the tracking sensors, the number of tracking passes used, and the propagation time between the observations and TCA. However, at this time, the covariance data does not accurately account for drag modeling error and must be scaled by the TOPO based on the object's drag characteristics. The TOPO uses the data provided by the OSA and the scaled covariance matrices to compute a probability of collision ( $P_c$ ). TOPO does not typically compute  $P_c$  until 30 hours prior to TCA, to allow the miss distance and covariance data to stabilize per Flight Rule B4-101.

The OSA continues to provide updates to the TOPO, approximately every 4 hours, as new data are available until TCA is in the past or until the object no longer penetrates the notification box. Once sufficient data is available, if the object consistently satisfies the  $P_c$  maneuver criteria thresholds defined in Flight Rule B4-101, a collision avoidance maneuver may be required per the flight rules. Refer to Flight Rules B4-101 through B4-103 and C4-51 for additional information on collision avoidance maneuvers.

International Space Station (ISS) debris avoidance operations are dependent upon Russian segment and planning process constraints for the development and execution of collision avoidance maneuvers. Two unique timelines to support debris avoidance were developed based on ISS configuration, command capability, and ground operations.

The Russian planning process to support debris avoidance operations can be broken down into four parts: 1) Trajectory Planning, 2) Detailed Planning 3) Command Package Development, and 4) Integrated Ground Testing.

Trajectory planning involves the development of the primary and backup debris avoidance maneuver plans. The MCC-M ballistics team will determine parameters such as time of ignition, delta-v, thrust, and mass flow rate. Based on this data, the maneuvers will be modeled and the ballistic products provided to the various MCC-M customers.

Detailed planning consists of gathering initial conditions and input parameters, coordinating with MCC-M disciplines, and final development of the detailed plan. Plan inputs consist of parameters such as power balance, propellant tank and valve configurations, sensor configuration, thruster manifold configuration, time of maneuver, maneuver size, and attitude configuration. This is an abbreviated list of inputs, but indicates the large amount of information that is gathered and its complexity. A typical detailed plan consists of 66 parameters with 16 components for each parameter as input to the command package development process.

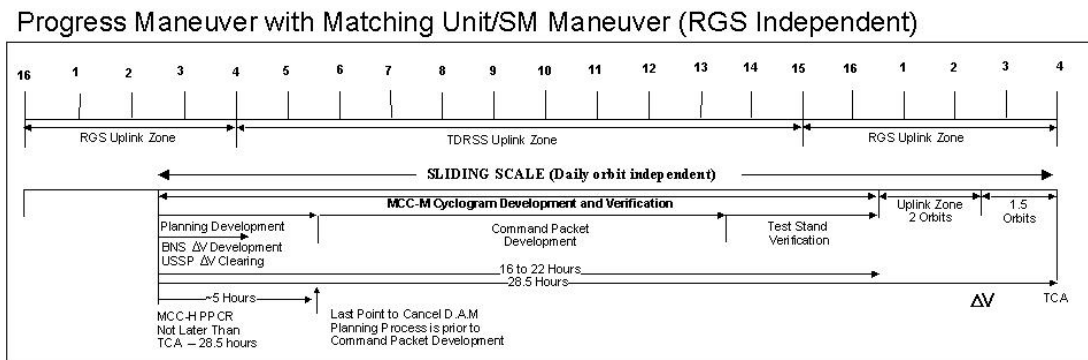
The MCC-M planning group delivers the detailed plan to the commanding specialists who build the command package (Cyclogram), containing a maneuver if required. Dual command packages exist only in rare cases when development of the nominal timeline command package has already begun. Dual command packages can be built in parallel but this overly stresses the nominal MCC-M process. Once a command package is developed, it is provided to the ground testing facility and ran through an integrated hardware and software test bed. The integrated testing insures the quality of the command package and verifies it for use onboard. Integrated testing can be performed at both the TsUP and the KhSC sub-contractor, Khartron. Khartron normally verifies the generic flight assignments and determines acceptable ranges for the variable parameters, while TsUP is used in real-time to verify the changes in the variable parameters.

The verified command package is then ready for uplink to the ISS. Nominal MCC-M procedures allow for two orbits to uplink the command package. The first orbit is considered prime and the second as a backup that is nominally used to verify a successful uplink. Commanding nominally occurs over the RGS zone of visibility, however, MCC-M has agreed to use US-TDRSS assets for debris avoidance operations for SM standalone maneuvers or Progress maneuvers when the YC-21 matching unit is installed and activated between the SM computer and the Progress vehicle on the SM aft docking port.

MCC-M requires between 22 and 16 hours to nominally complete the above development process. Thus, for debris avoidance operations, MCC-M has placed the constraint that MCC-H formally initiate debris avoidance planning not later than 28.5 hours prior to a conjunction event via the PPCR process so that nominal MCC-M support personnel and procedures can be used. MCC-M has imposed an additional constraint that MCC-H commit to performing a maneuver prior to development of the command package at 23.5 hours. This allows MCC-M to recover and still develop the nominal days timeline command package in the event a debris avoidance maneuver is canceled. For cases in which the matching unit is not installed, MCC-M has agreed to a more compressed timeline for ISS operations. A summary of both timelines is provided below:

**Progress Maneuver with Matching Unit/SM Maneuver (RGS Independent)**

- 1) Timeframe for first valid probability of collision
  - ✓ Approximately TCA -30 hours per Flight Rule.
- 2) Timeframe when formal MCC-M debris avoidance maneuver planning must be initiated.
  - ✓ MCC-H submits a PPCR to formally initiate debris avoidance maneuver planning not later than TCA-28.5 hours.
- 3) Last point to call off debris avoidance maneuver planning/execution.
  - ✓ The debris avoidance maneuver commitment is made at approximately TCA -23.5 hours (PPCR + 5 hours) when the MCC-M planners submit the required inputs to the command packet development personnel.
    - Note: The capability of zeroing the  $\Delta V$  component of maneuver exists and may be requested if required after TCA-23.5 hours. Reference FR {TBD}
- 4) Command Packet Uplink Opportunities
  - ✓ Nominally during the two orbits prior to the maneuver TIG
- 5) Debris Avoidance Maneuver Time of Ignition (TIG)
  - ✓ Nominally 1.5 orbits prior to TCA
  - ✓ Backup Maneuver Plan
    - Options may include increasing the burn magnitude or altering the ignition point.

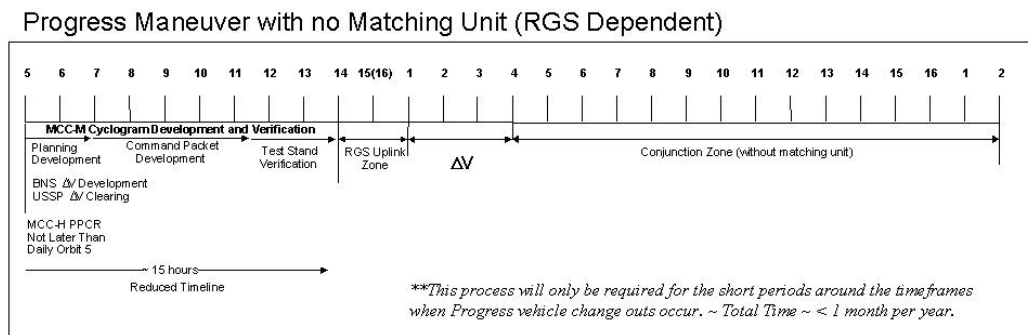


**Figure 2.1.7.1-1: Progress Maneuver with Matching Unit/SM Maneuver**



**Progress Maneuver with No Matching Unit (RGS Dependent)**

- 1) Timeframe for first valid probability of collision
  - ✓ Approximately TCA –30 hours per Flight Rule.
- 2) Timeframe when formal MCC-M debris avoidance maneuver planning must be initiated.
  - ✓ Not later than daily orbit 5 prior to the first maneuver opportunity.
- 3) Timeframe when final maneuver plan must be selected.
  - ✓ Not later than daily orbit 7 prior to the first maneuver opportunity when the MCC-M planners submit the required inputs to the command packet development personnel.
- 4) Last point to call off debris avoidance maneuver planning/execution.
  - ✓ Not later than daily orbit 14 prior to the first maneuver opportunity.
    - Note that this requires zeroing the  $\Delta V$  component of the maneuver.
- 5) Command Packet Uplink Opportunities
  - ✓ Nominally during the two orbits prior to the maneuver TIG
- 6) Debris Avoidance Maneuver Time of Ignition (TIG)
  - ✓ Nominally scheduled to occur on the first daily orbit 1 prior to TCA with backup opportunities on daily orbits 2 and 3.



**Figure 2.1.7.1-2: Progress Maneuver with No Matching Unit**

To cancel a debris avoidance maneuver, one of two options exists. The primary method of canceling a maneuver is for MCC-M controllers to send a single command to the ISS that zeros the  $\Delta V$  component of the maneuver. While no translation will occur, the maneuvers to and from burn attitude may still execute unless MCC-M is able to cancel the attitude maneuver {Ref FR B4-103}. This option can be used for either timeline given that MCC-M has enough time to generate and issue the required command. However, it should be used only when the benefits of not performing the maneuver outweigh the impacts of performing the burn. The secondary method of canceling a maneuver is uplink of a command package that does not contain the burn. This is not nominally an option unless development of an alternate or the planned timeline command package has occurred in MCC-M. In such cases, this would be the preferred method of canceling a maneuver since it does not represent the loss of the nominal timeline command package.

### 2.1.7.2 Satellite Breakups

Occasionally, USSTRATCOM sensors track multiple objects where only one was expected, indicating a possible satellite breakup. Historically, actual satellite breakup events occur about six to seven times a year. A satellite breakup is a concern to the Orbiter and ISS due to the number and dispersal of objects generated from the breakup. It can be days or weeks before orbits of major breakup fragments have been accurately determined to confirm a breakup. Once a breakup is identified, USSPACECOM will provide FDO/TOPO verbal and written notification, including a breakup message indicating approximately when the breakup occurred, the catalog number of the fragmented satellite, and upon request, Orbiter/ISS and parent object state vectors and miss distance at TCA. Additional information, such as the number of objects associated with the breakup, location of the breakup, and orbital elements for high and low objects will be provided as soon as they become available.

Evaluation of breakup events is currently a shared responsibility. When notification of a breakup event is received, FDO/TOPO will notify the designated SX representative (currently Nick Johnson). Upon notification, the SX rep will take the data FDO/TOPO has collected on the event, run Satellite Breakup Risk Assessment Model (SBRAM), and report results back to FDO/TOPO. SBRAM propagates the debris particle orbits with drag and other perturbations and determines close approaches to the Shuttle or ISS. For each close approach, a Pc is computed. To accomplish this, the debris and target objects are represented as 3-dimensional spatial distributions. Overlap between these areas is then examined for each conjunction's geometry. Next, multiple Monte Carlo runs are made to compute the total hazard. SBRAM presents several plots for evaluation:

- 1) Total Pc per day per m<sup>2</sup> vs. days after breakup
- 2) Pc per m<sup>2</sup> vs. yaw angle
- 3) Average number of cases vs. probability of individual encounter per m<sup>2</sup>
- 4) Yaw angle vs. days after breakup

Although there is no way to assess the distance required to ensure satellite breakup avoidance, in general, older breakups pose a smaller risk and the sooner a maneuver is executed, the greater the miss distance for a given  $\Delta V$ .

In the past, USSTRATCOM has failed to notify FDO of a confirmed breakup during pre-launch and launch countdown timeframes. Because it is a risk to fly anywhere near recent breakups, a pre-launch FDO/ USSTRATCOM tagup has been established at L -12 hrs. At this time, the Planning Team FDO will initiate a breakup conference with the OSA on the NORAD COORD loop. This conference comes at a convenient point for FDO to also provide USSTRATCOM with launch countdown status and inquire about foreign launches or "space events" which could interfere with Shuttle launch. During the conference, FDO will ask OSA if there have been any recent breakups or satellite separations.

### 2.1.7.3 Threat and Warning

**Note: See Classified Flight Rules stored in the FDO Safe and CEF for further information**

As part of its mission to protect US space assets, the USSTRATCOM Space Control Center (SCC) provides advisory, warning, and verification notifications of potential hostile events that may affect the Space Shuttle or ISS programs. Threat categories include antisatellite (ASAT) (co-orbital and direct ascent), electronic warfare (EW) (including radio frequency interference (RFI)), directed energy (DE) (including lasers), nuclear detonation (NuDet), and sabotage. The FD is responsible for all threat and warning responses, and all such message traffic coming into the CEF should be addressed to the Flight Director. However, the CEF occasionally routes this traffic to FDO or TOPO. If this happens, FDO or TOPO will immediately carry the message to the FD.

There are six different warning messages that may be sent from the SCC to the FD. Reference Table 2.1.7.3-1 for a description of these messages and the appropriate FD response. A copy of the classified rules is located in the FDO/TOPO safe and also in the CEF. The CEF procedures have been updated to include bringing a copy of the classified rules to the FD when a message is delivered. FDO, TRAJ, TOPO, or the CEF technician can retrieve a copy of the rules for the FD any time, if required. Since messages related to a verified space systems attack, probable space systems attack and space cancellation are classified, FD responses must be provided in hand-written form to the CEF technician for transmission to the SCC. The FDO, TRAJ, or TOPO can hand-carry this message to the CEF or the CEF technician can retrieve the message from the FD directly. Once the CEF technician has received the message from the FD, it is entered into a classified PC located in the CEF and transmitted over the secure message transmission system. A copy of the transmitted message will be brought back to the FD. Unclassified messages can be handled by the FDO, TRAJ, or TOPO via fax to/from the CEF.

If a Status Request message is received during a Threat and Warning scenario, the FD sends a SA05 Space Status message. For all other operations, any time Shuttle, ISS, or MCC status is other than Green, FD should call (or instruct FDO/TOPO to call) SBM with new status. There are separate status definitions for Shuttle/ISS, MCC, and overall space flight as shown below. Since the definitions are open to some interpretation, a short explanation should be included with the status color.

Shuttle/ISS:

Green – Nominal flight on nominal trajectory.

Yellow – Not capable of nominal flight or nominal trajectory.

Red – Crew safety or vehicle integrity requires an unscheduled Deorbit/crew return within the next 24 hours.

MCC:

Green – Nominal ops for all in-flight vehicles.

Yellow – MCC unable to simultaneously support all vehicles.

Red – MCC cannot support any vehicle and ETRO > 6 hours.

Overall Space Flight Assessment:

Green – Capable of satisfying all high priority objectives for flights in progress.

Yellow – Can satisfy some, but not all of the high priority flight objectives.

Red – Cannot satisfy any high priority flight objectives. Early mission termination is required.

USSTRATCOM may request a current state vector from FDO at any time without giving rationale for the request. Such requests may or may not be related to threat and warning issues. FDO will comply immediately to any USSTRATCOM state vector request.

As a requirement for certification, every FDO and FD must attend a briefing and read documents describing JSC response to threat and warning events. Briefings are arranged by the DM Threat and Warning point of contact. The current Point of Contact for this information is Jenny Gruber, x31914.

Table 2.1.7.3-1. Warning Messages

SCC <-----TTY (CEF)----->FLT

Message From SCC to FD			Response from FD to SCC			
Message Code	Description	Comments	Message Code	Description	Content	Action
SU02	Verified Space Systems Attack	An attack has occurred and has been verified				See Classified Flight Rules ASAP
			SA04	MCC Verified Space Systems Attack	Initiated by FD after MCC verifies attack	See Classified Flight Rules ASAP  Send SA04 message to SCC
SU03	Space Advisory	Initiates a "Space Event". Based on pre-event indicators, abnormal events, information/warning	SA05	Space Status	Real-time overall assessment of Shuttle, ISS, and MCC status (Green, Yellow, or Red with explanation)	See Classified Flight Rules ASAP  Send SA05 message to SCC
SU04	Probable Space Systems Attack	An attack may have occurred but has not yet been verified	No message reply required	N/A	N/A	See Classified Flight Rules ASAP
SU05	Space Cancellation	Cancels a space event and states why	SA06	Space Cancellation	Acknowledges receipt of Space Cancellation notice	Send SA06 message to SCC
SU06	Space Information	Free form data exchange	SA07	Space Information	Provides SCC with requested information or used to request information from SCC	Send SA07 message to SCC as required
SU39	Status Request	Request for an SA05 Status Message	SA05	Space Status	Real-time overall assessment of Shuttle, ISS, and MCC status. (Green, Yellow, or Red with explanation)	Send SA05 message to SCC

ZAA?ZYUW RUWRBCA0004 2151200-????--RUWRSPD.  
ZNY ??????  
Z 031200Z AUG 01  
FM NASA JOHNSON SPACE CEN HOUSTON TX//FLIGHT//  
TO RUWRSPD/CMOC SPADOC4 CHEYENNE MOUNTAIN AFS CO  
BT  
(Classification w/ Special Handling Designators if required)  
SUBJECT: SPADOC NOTIFICATION (U)  
(?) REAL/TEST/EXERCISE indicator  
1. (?) MESSAGE TYPE: VERIFIED SPACE SYSTEM ATTACK MESSAGE  
2. (U) PREPARATION DATE TIME: ddhhmmZmmmyy  
3. (?) DEFCON: naaaaaaaaaaaaaaaaaaaaa  
4. (?) EVENT NUMBER: SPADOC yyjjjnnnn  
5. (?) CINCSPACE VERIFIES TYPE OF ATTACK: aaaaaaaaaaaaaaaaaaaaaaaaaaaaa  
6. (?) NATIONAL ORIGIN OF ATTACK (COUNTRY): aaaaaaaaaaaaaaaaaaaaaaaaaaaaa  
7. (?) COMMON NAME OF SPACE SYSTEM ATTACKED:  
aaaaaaaaaaaaaaaaaaaaaaaaaaaa nn-aaaaaa  
8. (?) MISSION OF SPACE SYSTEM ATTACKED: aaaaaaaaaaaaaaaaaaaaaaaaaaaaa  
9. (?) SPACE SYSTEM ELEMENT ATTACKED: aaaaaaa  
10. (?) ORIGIN OF ATTACK BY LOCATION NAME, LATITUDE AND LONGITUDE:  
aaaaaaaaaaaaaaaaaaaaaaaaaaaa  
nn.nn DEG aaTH LATITUDE/nnn.nn DEG EAST LONGITUDE  
11. (?) DATE AND TIME OF ATTACK: yy-jjj-hhmmss.sssZ  
12. (?) LOCATION OF SPACE SYSTEM WHEN ATTACKED BY LATITUDE AND  
LONGITUDE:  
aa nn.nn DEG aaTH LATITUDE/nnn.nn DEG EAST LONGITUDE  
FOR ORBITAL INTERCEPTOR:  
DEGREES FROM ASCENDING NODE: nnn.nn  
13. (?) ATTACK VERIFICATION METHOD: aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa  
14. (?) ESTIMATED DAMAGE TO SPACE SYSTEM: aaaaaaaaaaaaaaaaaaaaaaaaaaaaa  
15. (?) CAPABILITY LOST: aaa  
16. (?) CAPABILITY REMAINING: aaa  
17. (?) REMARKS: aaa  
aa

DECLASSIFY ON OADR

BT  
#0004

NNNN

Figure 2.1.7.3-1. SA04 Example

(Classification w/ Special Handling Designators if required)  
SUBJECT: SPADOC NOTIFICATION (U)  
(?) REAL

1. (?) MESSAGE TYPE: SPACE STATUS MESSAGE
2. (U) PREPARATION DATE TIME: ddhhmmZMMMyy
3. (?) COMMON NAME OF SPACE SYSTEM: aaaaaaaaaaaaaaaaaaaaaa yy-aaaaaa
4. (?) SYSTEM ELEMENT/CONDITION/TIME OF OUTAGE/ESTIMATED TIME OF RETURN TO OPERATION/DEFERRABLE FLAG/CAUSE:  
aaaaaa c yy-jjj-hhmmss.tttZ yy-jjj-hhmmss.tttZ f aaaaaaaaaaaaa
5. (?) STATEMENT OF ABILITY/LIMITATIONS TO SUPPORT MISSION:  
aa
6. (?) ASSESSMENT OF OVERALL SYSTEM STATUS: cccccc
7. (?) SPECIAL EVENT INDICATOR: nn
8. (?) START/STOP TIME OF EVENT:  
yy-jjj-hhmmss.tttZ - yy-jjj-hhmmss.tttZ
9. (?) REMARKS: aaa  
aa

Notes:

1. ? = Classification markings.
2. d = Day of month
3. j = Day of year (001 - 366)
4. h = Hour of day
5. m = Minute of day
6. M = Month
7. y = Year
8. s = Second
9. t = Thousandths of second
10. a = Alphanumeric character
11. n = Numeric character
12. c = condition color (r or red, y or yellow, g or green)
13. f = deferrable flag (N, D)

Figure 2.1.7.3-2. SA05 Example

(Classification w/ Special Handling Designators if required)

SUBJECT: SPADOC NOTIFICATION (U)

(?) REAL

1. (?) MESSAGE TYPE: SPACE CANCELLATION MESSAGE
2. (U) PREPARATION DATE TIME: ddhmmZMMMyy
3. (?) EVENT NUMBER: SPADOC yyjjnnnn PREP DATE TIME: ddhmmZMMMyy
4. (?) CM CONTINGENCY PLAN NO: aaaaaa yyjjnnnn DTG: ddhmmZMMMyy
5. (?) CM PLAN NUMBER: aaaaaa yyjjnnnn DTG: ddhmmZMMMyy
6. (?) CM AUTHORIZATION NO: aaaaaa yyjjnnnn DTG: ddhmmZMMMyy
7. (?) CM ORDER NUMBER: aaaaaa yyjjnnnn DTG: ddhmmZMMMyy
8. (?) CLEARINGHOUSE EVENT NO: aaaaaa yyjjnnnn DTG: ddhmmZMMMyy
9. (?) ACCIDENTAL DE NO: aaaaaa yyjjnnnn DTG: ddhmmZMMMyy
10. (?) REMARKS: aa  
aaa

Notes:

2. ? = Classification markings.
3. d = Day of month
4. j = Day of year (001 - 366)
5. h = Hour of day
6. m = Minute of day
7. M = Month
8. y = Year
9. s = Second
10. a = Alphanumeric character
11. n = Numeric character

Figure 2.1.7.3-3. SA06 Example



#### **2.1.7.4 Radiation Event**

Occasionally during an STS mission, USSPACECOM will provide data on solar flares, geomagnetic storms, or other solar events in a Space Information Message. The CEF will route the message to FDO, although typically the message will be addressed to the FD. FDO will make two copies of this message. The original is passed to the FD, a copy is given to SURGEON, and another copy goes in the USSPACECOM section of the FDO's clipboard binder.

FDO is not responsible for analyzing or interpreting these data. The Space Radiation Analysis Group (SRAG), a SURGEON back room position located in the MCC room 325, performs this function. SRAG receives data on solar events from a multitude of sources, including the National Oceanic and Atmospheric Administration Space Environment Services Center. Radiation events should be discussed with Surgeon, who will consult with SRAG. If no surgeon is present, call SRAG at x33618 or on the STS Radiation loop.

For the most recent rules on radiation and space environment, consult the following sections of the ALL FLIGHTS Rules:

FR references:   Volume A Section 14  
                          Volume B Section 14

#### **2.1.7.5 Miscellaneous USSPACECOM Support**

##### Radar Restrictions

Many powerful radar sites in operation around the world have the potential to interfere with Orbiter avionics. Although most of these are located in foreign countries and not under USSPACECOM control, there are several very powerful USSPACECOM radar sites responsive to restrictions posed by the Orbiter's trajectory, including phased arrays at Eglin AFB in Florida, Cavalier AFB in North Dakota, Shemya AFS in the Alaskan Aleutian Islands and a C-band radar at Kwajalein. FDO computes periods during which the Orbiter will be susceptible to interference and provides these in a Radar Restrictions Message to USSPACECOM. USSPACECOM then coordinates a reduction in power level for phased arrays or for Kwajalein restrictions, ensures Kwajalein avoids tracking the Orbiter during the identified periods.

##### Clearing Spacecraft Translations

Under agreements with NASA or USSPACECOM, many spacecraft operations organizations are required to obtain advance clearance before performing a translation maneuver. When clearance is sought during a Shuttle mission, FDO is usually tasked with confirming safe motion of the translating spacecraft relative to the Orbiter.

### Postflight Reporting

USSTRATCOM provides classified postflight reports concerning launch and entry to the FDO and TOPO offices on a regular basis. These reports are transmitted to the CEF through a secure electronic media system called Secure Internet Router Network (SIPRNET). FDO and TOPO representatives retrieve these reports and store them in a safe located in the DM office area. These reports are maintained primarily for historical purposes; however, these classified services have been used in near real time under unique circumstances. To review these classified reports, or to obtain detailed information concerning the content of these reports, contact a DM USSTRATCOM representative.

### Space Object Identification (SOI)

USSPACECOM's SOI analysts determine the physical and dynamic characteristics of space vehicles by examining waveforms of signals collected by ground-based radar and electro-optical sensors. Items of interest to NASA include spin or tumble rates, rotation axis inertial orientation, stability mode (inertial or gravity gradient), changes from an earlier physical configuration (antenna or solar panel orientation), and reflectivity values, to name a few. Such information has been very valuable when collected on prospective rendezvous targets, such as WESTAR and PALAPA prior to STS-51A or Tethered Satellite during STS-75. Unfortunately, SOI data are generally classified, even when the objects tracked are not. If compromised, these data may reveal USSPACECOM's sensor and analysis capabilities. Therefore, requests for SOI data are only made when necessary, and USSPACECOM may or may not honor a request, depending on security issues or DoD priorities for use of SOI sensors. Since SOI data may be classified at a higher level than SECRET, there are only a few contacts with the appropriate security clearance to obtain this information. Any requests for SOI data are coordinated through the Flight Director who will contact MOD to obtain the support of these contacts.

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## 2.1.8 Tiger Team (Team 4) Operations Checklist

### PURPOSE:

To establish best practices for future Tiger Team operations and to make them more efficient based on past flight lessons learned.

### PROCEDURE:

- **Shuttle and ISS Team 4 FDs coordinate to create Team 4 contacts list and distribution lists:**
  - **Solicit names of team 4 members and contact information from Shuttle and ISS Flight Control Team positions (MOD, SD, CB).**
  - **Create contacts list and post to SPAN website.**
  - **Send the contact list and a request to the DA8 Office Support Staff to create at least two Team 4 distribution lists.**

*The first DL includes Team 4 members from the contacts list, MOD management, Flight Directors, and SPAN. A single DL is used for ISS and Shuttle to facilitate communication between the two teams. Given some of the postflight feedback from STS-114, it has been determined that it is best to just have one large distribution list with everyone included to make sure both sides were at least aware of the other's activities. If folks aren't interested, they can just delete the email!*

- JSC-DL-STS-XXX-YYY -Team4 where XXX (e.g. JSC-DL-STS-114-LF1-Team 4): Include at a minimum:
  - Team 4 members from contacts list (Shuttle and ISS)
  - JSC-DL-MOD-OFC/DIV-Chiefs
  - JSC-DL-MOD-CS-Branch-Chiefs
  - JSC-DL-MOD-CS-Group-Leads
  - JSC-DL-DA8-Flight-Directors
  - JSC-DL-SPAN

*The second DL is created in case a specific team 4 activity occurs during the mission. The intent is to have a DL at the Team 4 FDs' disposal to add/remove members specific to the particular activity. The standard Team 4 DL should be included when this activity specific DL is created and other members added as necessary. If more than one team4 activity occurs, the DA8 Office Support Staff can be contacted to create another activity specific DL if desired. Having at least one available before the mission, ensures that even if a Team 4 activity is initiated after normal business hours, that the Team 4 FD or SPAN can begin populating the DL with the applicable reps. Using a single DL for all activities is impractical due to the limitation on number of addresses in a global DL.*

- JSC-DL-STS-XXX-YYY-Team4-Activity: Include the JSC-DL-STS-XXX-YYY-Team4 as a starting point.
- **Coordinate with SPAN to determine if a standard conference room can be made available for team 4 activities during the mission.**

*Moving meeting locations often results in running into technological and logistical barriers associated with each meeting location resulting in lost time. Different conference rooms often have different teleconferencing systems, different electronic plug-in capabilities, some hardware may not be functional, etc. By staying in one location you go through this only once, rather than for each time you meet at a different location.*

- **Hold a preflight Team 4 Tag-up and include the SPAN team**
  - The Lead FAO and Ops Planner should provide a T/L overview briefing.
  - Outline your expectations, discuss logistics, and verify contact information. Expectations outlined should include whether or not your Team 4 personnel should be prepared to sit console and thus be up to speed regarding the mission to allow their counterpart to support Team 4 operations (i.e., if the person on console is the 'real expert' and the best person to support Team 4 work).
  - Emphasize that the purpose of Team 4 is to provide assistance to the on console team, not to circumvent them. For any team 4 activities, each member is expected to keep their on console counterparts and management informed.
  - Discuss the plan for tying a DVIS loop to Team 4 meeting telecons if held.
- **Prior to the mission, check out your work location in the White/Blue FCR Director's suite.**

*Some areas may have what you need to work, but the items may be broken or unused (i.e., the Director's Suite printer is broken, but you only find out by printing to it). By doing a preflight logistics check-out you ensure that you have everything you need when time is of the essence later on in the mission.*

- **Login to the PC(s) you expect to use and configure e-mail, printer, internet access, etc.**

- **Make note of the phone number(s) in the area and create an e-mail signature including these phone numbers**

*This provides a means to contact you other than e-mail since you may not have good blackberry reception.*
- **Configure the DVIS keyset if necessary or use your virtual ID**
- **Make sure the available resources are compatible with your needs (e.g. office supplies, printer paper, etc.)**
- **When scheduling Team 4 activities, request the following from the SPAN:**
  - **Schedule the conference room**
  - **Setup the telecon, including coordination with GC to patch the telecon into a DVIS loop**

*Telecon systems vary from conference room to conference room so it is important to ensure someone familiar with the telecon system available (to avoid delaying the start of the meeting).*
  - **Notify mandatory Team 4 members and communicate what is required of them in person or via phone call.**

*Do not assume that they will get an email message in time if it is sent via PC or Blackberry. In the past, email notifications alone were sent, sometimes after normal business hours for meetings early the next day. This did not provide sufficient notification for participants to create charts, review information, etc.*
  - **Send a meeting notification to the appropriate Team 4 DL with the list of mandatory participants, conference room, telecon number, and DVIS loop information.**

*When sending e-mail notifications, make it clear who are the mandatory participants. In addition to paging/calling mandatory participants, identify mandatory participants in the e-mail notice so those who aren't mandatory and didn't receive a phone call aren't left wondering whether they need to support.*
  - **Notify the on console flight director of the meeting time and DVIS loop**

*Depending on the on console team's activity, they may or may not be able to monitor the Team 4 meetings on a DVIS loop. But they should be made aware of the loop and meeting start time in case they are able to monitor.*
  - **Coordinate reproduction of handouts if required**
  - **Provide a sign-in roster and add attendees to the appropriate Team 4 DL after the meeting**

- **Provide a SPAN rep to take notes during the meeting**

*Utilize the SPAN as a technical and administrative resource. The SPAN can call people to notify them of a meeting, change in location of a meeting, or to let them know that charts are out for review and they have the charts in their inbox and should provide comments and/or concurrence within a specific time. Delegate items to the SPAN such as Team 4 agendas, meeting distribution, meeting minutes, presentation point of contact, Team 4 contact list, etc. To do this the Team 4 Flight Director must spend some time communicating expectations and support requirements to the SPAN, and keep the SPAN in the loop regarding Team 4 activities at the various facilities and decisions made.*

- **Communicate the results of Team 4 activities**

- **Provide verbal summary of team 4 activity and recommendations to the on console FDs (ISS and Shuttle). Remind Team 4 members to communicate with their on-console counterparts.**

*The best way identified to accomplish this from past experience is to talk directly to the on-console Flight Director (do not do this via email alone).*

- **Submit an Info Only Flight note summarizing the activity (can delegate to SPAN)**

*Summarizing the activity in an "information only" flight note will provide the Flight Control Team general awareness of the activity. This will let all parties know what options and recommendations are being evaluated by Team 4 and the MMT. Do this in such a way that avoids Team 4 giving direction to the on console FCT - that direction needs to come from the on console FD. Continue to remind your Team 4 folks to coordinate with their on console counterparts.*

- **Send an e-mail to the appropriate Team 4 DLs summarizing the activity (can delegate to SPAN)**

*E-mail is the means of communicating the results to the Team 4 members and MOD management.*

- **Post a summary of Team 4 activity and decisions to the Flight Director Handover page as soon as practical.**

*If posted electronically, let the on-console Flight Director know the summary is posted (via phone call). Do not assume that the on-console Flight Director will see or read an email.*

## 2.1.9 Flight Controller Expectations

### PURPOSE:

To document the expectations for individual flight controller performance during certification simulations to ensure consistent evaluation and flight controller certification policy implementation. The performance evaluation criteria documented below was developed by the JCAR-30 Flight Controller Certification and Attrition Tiger Team investigation in the 1999/2000 timeframe with support from all operations organizations including the Flight Director Office.

### PROCEDURE:

All operations organizations uniformly agree with the following flight controller certification and evaluation criteria. The location of this policy and criteria in this document is intended to serve as an easily accessible point of reference to ensure consistent implementation across the Flight Director Office.

#### Flight Controller - Evaluation Criteria -

	UNSATISFACTORY	SATISFACTORY	OUTSTANDING
<p><b>MISSION COGNIZANCE</b></p> <p><b>Integrated Simulation</b></p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>• Monitor Flight, Air to Ground, or other appropriate DVIS loops</li> <li>• Be aware of on-going, current, and future operations, vehicle/system configurations, and mission timelines</li> <li>• Modify planning system/vehicle timelines and management plans</li> <li>• Manage system/vehicle resources and resolve system conflicts involving safety margins or mission objectives</li> <li>• Modify plans to fit objectives and changes in vehicle conditions</li> <li>• Prioritize the team's work in respect to upcoming activity.</li> </ul>	<ul style="list-style-type: none"> <li>• Selects and <b>consistently</b> monitors Flight, Air to Ground, and other appropriate DVIS loops</li> <li>• Maintains an awareness of current, pending, and on-going operations</li> <li>• Maintains an awareness of vehicle/system configurations, and mission timelines</li> <li>• Modifies planned system/vehicle timelines and management plans to fit assembly objectives and observed changes in mission conditions</li> <li>• Manages system/vehicle resources and resolves system conflicts to maintain safety margins and/or meet mission objectives (uses good common sense)</li> <li>• Modifies manifest/re-supply/future assembly flight plans to fit assembly/safety objectives and observed changes in vehicle conditions</li> <li>• Prioritize the team's work in respect to upcoming activity.</li> </ul>	<p><b>CONSISTENTLY:</b></p> <ul style="list-style-type: none"> <li>• Monitors appropriate DVIS loops and maintains a consistent awareness of current, pending and future potential vehicle/system conditions, operations and timelines</li> <li>• Anticipates modifications to planning system/vehicle timelines and management plans to meet changing circumstances</li> <li>• Anticipates use and need for system resources, and manages their resources to recognize and resolve conflicts, safety margins and/or mission objectives</li> <li>• Evaluates and modifies manifest/re-supply and future assembly flight plans to fit assembly/safety objectives and changes in vehicle conditions</li> <li>• Anticipates upcoming problems and unplanned activity</li> </ul>



<p style="text-align: center;"><b>SYSTEMS KNOWLEDGE</b></p> <p>Standalone trainer</p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>• Demonstrate system knowledge appropriately to vehicle in given situation</li> <li>• Demonstrate knowledge of Flight Rules, procedures, and safety constraints</li> <li>• Apply appropriate protocols when working with deviations from Flight Rules or procedures</li> <li>• Use capabilities and limitations of vehicle systems to resolve operational needs</li> </ul>	<ul style="list-style-type: none"> <li>• Applies systems knowledge to maintain and operate vehicle</li> <li>• Demonstrates a good working knowledge of Flight Rules, procedures, and safety constraints in both planning and execution activities</li> <li>• Applies appropriate judgment w/respect to deviations from procedures: <ul style="list-style-type: none"> <li>• shows good judgment w/respect to developing or requesting deviations from procedures</li> <li>• provides technical rationale to obtain deviations from Flight Rules and safety constraints</li> <li>• seeks concurrence to deviations from Flight Rules and safety constraints</li> </ul> </li> <li>• Assesses capabilities and limitations of vehicle systems to resolve operational needs</li> </ul>	<p><b>CONSISTENTLY:</b></p> <ul style="list-style-type: none"> <li>• Applies appropriate system knowledge to maintain and operate the vehicle</li> <li>• Detailed knowledge of the Flight Rules, procedures and safety constraints in both planning and execution activities</li> <li>• Recognizes appropriate conditions and applies the correct protocols with respect to deviations from Flight Rules or procedures</li> <li>• Recognizes, assesses and uses capabilities of vehicle systems to resolve operational needs</li> </ul>
<p style="text-align: center;"><b>PROBLEM RECOGNITION AND RESOLUTION</b></p> <p>Standalone Trainer</p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>• Identify existence and confirm identity of a problem</li> <li>• Identify and execute time-critical responses for crew or vehicle safety</li> <li>• Assess impact of problems w/respect to: <ul style="list-style-type: none"> <li>• crew safety</li> <li>• current/future mission objectives</li> <li>• vehicle/system operations</li> </ul> </li> <li>• Develop options and recommendations</li> <li>• Make, present or execute recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies the existence of a problem</li> <li>• Gathers appropriate data to confirm identity of problem</li> <li>• Identifies/executes time-critical responses for crew/vehicle safety</li> <li>• Assesses direct impacts w/respect to: <ul style="list-style-type: none"> <li>• Crew safety</li> <li>• current/future mission objectives</li> <li>• vehicle/system operations</li> </ul> </li> <li>• Identifies associated system/vehicle vulnerabilities, and assesses their impacts w/respect to: <ul style="list-style-type: none"> <li>• Crew safety</li> <li>• current/future mission objectives</li> <li>• vehicle/system operations</li> </ul> </li> <li>• Develops options and recommendations</li> <li>• Presents and executes recommended recovery plan</li> </ul>	<p><b>CONSISTENTLY:</b></p> <ul style="list-style-type: none"> <li>• Anticipates and uses all available resources to identify the existence, confirm the identity and correctly define a problem</li> <li>• Anticipates, identifies, and executes time-critical responses affecting crew or vehicle safety</li> <li>• Anticipates both impacts and implications of the impacts to: <ul style="list-style-type: none"> <li>• Crew safety</li> <li>• current/future mission objectives</li> <li>• vehicle/system operations</li> </ul> </li> <li>• Initiates development of options and recommendations</li> <li>• Thoroughly presents and fully executes recovery plans</li> </ul>

	UNSATISFACTORY	SATISFACTORY	OUTSTANDING
<p><b>CONSOLE MANAGEMENT</b></p> <p>Standalone Trainer Integrated Simulation</p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>Use correct command protocols and procedures (if applicable).</li> <li>Use appropriate console tools</li> <li>Execute correct console responses</li> </ul>	<ul style="list-style-type: none"> <li>Uses appropriate commanding protocols (if applicable)</li> <li>Uses appropriate console tools</li> <li>Executes proper console response to given situation, including: logging of data, command execution, setting functional inhibits, use and reconfiguration of console tools</li> </ul>	<p><b>CONSISTENTLY:</b></p> <ul style="list-style-type: none"> <li>Recognizes and applies appropriate commanding protocols and procedures. Demonstrates detailed command of the command system.</li> <li>Recognizes and applies appropriate console tools for given circumstances</li> <li>Anticipates and executes correct console responses to given situations</li> </ul>
<p><b>COMMUNICATION</b></p> <p>Integrated Simulation</p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>Differentiate information required by pertinent FCT disciplines</li> <li>Use effective communication with others</li> <li>Use correct documents/references when communicating mission status or system status information</li> <li>Failure to compose Flight Notes that communicates problem includes corrective actions, and required time of action.</li> </ul>	<ul style="list-style-type: none"> <li>Differentiates information required by: FCR/MPSR, Flight Director, Crew, MER, Ops Planners, subsequent shift personnel, management, IP counterparts and other FCT disciplines</li> <li>With respect to communication with others, demonstrate: maintenance of appropriate loop protocols, timeliness, accuracy, clarity, conciseness, confidence, consistency, professionalism, and objectivity.</li> <li>Uses appropriate documents to communicate mission status or system status information. Includes: Flight Notes, subsequent shifts, deviations from Flight Rules or procedures, "chits", console logs, weekly/increment planning processes</li> </ul>	<p><b>CONSISTENTLY:</b></p> <ul style="list-style-type: none"> <li>Anticipates and provides appropriate information required by FCT disciplines</li> <li>Uses highly effective communication with others</li> <li>Always uses appropriate documentation to communicate mission status or system status information</li> </ul>
<p><b>TEAMWORK</b></p> <p>Integrated Simulation</p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>Plan and coordinate among: FCR, MPSR, Crew, IP and Shuttle counterparts</li> <li>(TBD) Discipline Leadership Objectives</li> <li>Resolve team conflicts</li> <li>Balance the team work loads</li> <li>Prioritizing team's tasks</li> </ul>	<ul style="list-style-type: none"> <li>Plans, prioritizes and coordinates among: FCR, MPSR, Crew, RSA and Shuttle counterparts</li> <li>(TBD) Discipline Leadership Objectives</li> <li>Resolves team interpersonal conflicts</li> <li>Balances team work load</li> <li>Prioritizes team tasks</li> </ul>	<p><b>CONSISTENTLY:</b></p> <ul style="list-style-type: none"> <li>Develops plans, correctly prioritizes, and integrates activities among FCT disciplines and Crewmembers</li> <li>(TBD) Discipline Leadership Objectives</li> <li>Mediates team interpersonal conflicts in a positive and timely manner</li> <li>Maintains a balanced team work load</li> </ul>
<p><b>ATTITUDE AND EFFORT</b></p> <p>Integrated Simulation</p>	<p><b>FAILURE TO:</b></p> <ul style="list-style-type: none"> <li>Accept responsibility for personal decisions and actions</li> <li>Provide inputs in a constructive and effective manner</li> <li>Represent system/vehicle requirements to others in a consistent manner</li> <li>Maintain persistence in problem recognition or resolution</li> <li>Encourage maximum effort from others</li> </ul>	<ul style="list-style-type: none"> <li>Accepts responsibility for personal decisions and actions</li> <li>Provides inputs in a positive, calm, and constructive manner</li> <li>Demonstrates consistency and initiative in representing system/vehicle requirements to others</li> <li>Demonstrates appropriate level of persistence in problem recognition or resolution</li> <li>Encourages maximum effort from others through personal words and actions</li> </ul>	

The following documents the **internal** Flight Director Office philosophy regarding flight controller expectations, and items that the Flight Director Office looks for during flight controller training when assessing an individual's performance against the minimum expectations. The items listed previously, although similar to what is listed below, are the overall agreements on flight controller standards across all of MOD. The following criteria have been developed over many years but reviewed in detail by the Flight Director Office as a whole as recently as the late 2005 timeframe.

### MISSION PREPARATION

**It is incumbent upon the flight controller to do what is required to gain the necessary knowledge and skills to do the job. Confidence in the preparation will be gained through training and rehearsal. Engineering preparation gets the hardware ready to fly, training gets the people ready to fly....**

### THE "WHAT IF....." PHILOSOPHY

The WHAT IF philosophy is the foundation of flight control. It forces you to "think out" situations before you get into them.

- Anyone can fly a nominal mission. In fact, if everything could be guaranteed to be nominal, we would only need a small flight control team.
- Flight Controllers are there to tackle the problems during flight, to work around them and do everything (all the tricks in the hat) to make the mission succeed.

### **A. TEAM MANAGEMENT**

It is in this area that we attempt to determine how well you work with other front room operators, the back room, the Flight Director and management.

- Delegate work items to the team/back room.
- Keep the team focused and in the right direction. Do not let them 'wander' off-course?
- Discuss with your team what work needs to be done, by when and the priority order and rationale of things you want done.
- Discuss with your team what is expected from them in their support of you.
- Make your expectations clear to your team.
  - Identify what kind of status calls do you want from them, what level of detail you want.
  - Identify who is responsible for running down applicable flight rules and writing Flight Notes.

**B. MISSION COGNIZANCE**

The flight controller must know their system or element and how it is to be managed relative to the mission timeline. This is a must!

- Know the guidelines and constraints that affect how the events are sequenced together!
  - You must do your “what if....?” for the flight plan before coming to the control center. It is essential that you do your homework in this area before you show up on the console.
  - Remember, simulations are not made to teach you your job...it is meant to test your knowledge and point out possible weaknesses that need improvement before flight.
- Look ahead in the mission timeline to identify and resolve any upcoming conflicts before they come up.
  - “Forward Looking” - this is the other critical area in assessing mission cognizance. Living ‘minute-by-minute’ and ‘trying to catch-up’ results in high risk to the team and the operation...and has no place in leadership within the team. The Flight Director (more than anyone on the team) must be looking out front....staying ahead of the timeline! Don’t let them do this by themselves.
  - Don’t get stuck on the here-and-now. Constantly be looking downstream in the timeline (one or two orbits ahead in the timeline from where you are).

**C. CONSOLE MANAGEMENT**

The flight controller must maintain an organized and well thought out approach to monitoring the mission data, reviewing mission documents, using their console tools and preparing for handover.

- Plan-out how you will position your documents on console.
- Keep track of what is open/closed within the team.
- Track what needs to be worked on within the team and know who owes you what/when.
- Prepare a good handover to the next team?

**D. COMMUNICATIONS**

**The flight controller must effectively communicate system status information and recommendations, including rationale, to the Flight Director and flight control team.**

- This is the most important item of all!! This is the area where folks fall-short more than any other!
- Communication skills only come through hard work and a lot of experience/practice...yet, it is often a difficult skill to develop and acquire. Communication can result in either great success or disaster.
- It is important that the team remember that Flight Director has no data!!!
  - We are relying on the controllers for the “eyes and ears” relative to insight into the spacecraft.
  - Our data only comes through our verbal communications with the flight controllers! Hence, this category is critical for both safety and mission success.
- “Packaging” the verbal information to the Flight Director or crew is important (i.e. what you say and how you say it). This is an area consistently weak for new controllers.
- Here are the essential elements to “packaging”. You should think through the items below for each failure.
  - state what has failed/broken
  - what configuration am I now in
  - what capability have I lost
  - what capability do I still have
  - what is the appropriate flight rule reference? Does it impact today’s mission objectives?
  - what is the impact and is there any reconfiguration required?
  - what options do I have? List them 1,2,3,..
  - what are the pros and cons of each option
  - which option do you recommend and why (most critical!)

**E. PROBLEM RECOGNITION AND RESOLUTION**

**The flight controller must identify and assess the problem then work to resolve the situation in a systematic, logical and timely manner.**

- Do not “jump the gun” at the first glimpse of information. Make sure you understand the signature.
- Assess the options and understand the pros & cons of each approach (i.e. what is the worse thing that could happen if you choose this option? Is that an acceptable risk?).
- Identify the “best” option and the rationale for proceeding
- Do not ‘sit’ on a problem for a long period of time. At the earliest opportunity, provide a “heads up” to the Flight Director and the rest of the flight control team...even though you are still trying to characterize and understand the signature.

**F. SYSTEMS KNOWLEDGE**

The flight controller must be technically proficient in their area of responsibility and additionally understand the impacts of other systems and their failures on the systems operations.

**G. ATTITUDE/EFFORT**

The flight controller must display a professional team-oriented attitude along with an eagerness to participate in the mission activities and resolving problems as they occur. Additionally, they must exhibit confidence in their team and themselves.

- Know when to “get tough” versus “giving some slack”
- Promote teamwork and effective communications.

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## 2.2 SHUTTLE PRELAUNCH

The S0007 document is the controlling document for prelaunch procedures. The ascent Flight Director (FD) is responsible for reviewing the S0007 document before launch and identifying those steps pertinent to the MCC Flight Control (FC) team. The book is available electronically in MPV and a paper copy is also available. The Ascent FD highlights the pertinent steps paper clips pages for easy access. The following sections include a tabular summary of the pertinent steps for L-1 day, the prelaunch planning team, and the ascent team. These tables can be used as templates and allow space to fill in the appropriate time and step number if desired.

### 2.2.1 L-1 Day Checklist

#### Major Events

- MILA/GSFC/JSC I/F Checks
- L-1 day Crew Briefing (P/L, Sys, WX)
- MOC Confidence Run
- Comm Activation (INCO/GC/FLT)
- Prelaunch MMT (1/602)

Table 2.2.1-1. Launch – 1 Day (Ascent Team)

T-	L-	Sequence	Activity	FD Action
11h 00m Holding	~24h 00m	14- _____ thru 14- _____	MILA/GSFC/JSC INTERFACE TEST	On NTD's call (OIS 232): INCO and GC configure for JSC commanding and conduct interface test. 1hr after interface test begins: Monitor comm checks (UHF on OIS 211, A/G 1 on 212, A/G 2 on 213) When interface check complete (~2h): Call NTD (OIS 232): Interface checks complete
11h 00m Holding	~24h 00m		Systems and Cargo Briefing	Monitor briefing, questions/comments as reqd (GC ties OSB, crew quarters, AFD, OIS 231, LFP1, Prime Ops, Hou Consult)
11h 00m Holding	~24h 00m	14- _____ thru 14- _____	L-1 DAY FLIGHT CREW WX BRIEFING	Facilitate WX Briefing per OMI steps. CONUS WX TAL WX Each TAL Site for status (GOMs if TALCOMs not arrived) FDO for runway info (normally not briefed on L-1 day, just remind team it will be for launch day) When complete, call NTD (OIS 232) Call GC: Take down conference
11h 00m Holding	~24h 00m	14- _____	VERIFY FLIGHT CONTROL TEAM STATUS AND DATA LINKS	On NTD's call (OIS 232): Verify FCT on station On NTD's call (OIS 232): Verify receiving hardline data.
11h 00m Holding	~24h 00m	14- _____	ORB COMM SYSTEM ACTIVATION (ref OMI V1117 performed on ch 214)	On NTD's call (OIS 232): Verify ready to support comm act on OIS 214 (~1 ½ hrs)



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## 2.2.2 Prelaunch Planning Checklist

### Major Events/Activities

- Page 1 on DVIS: FD, A/Gs, OIS 232, OIS 161, SSPO, OPO
- Reboot DEC Alpha workstation at beginning of shift and call up WX application on L CRT before any other applications
- Complete major activities/checkouts per OMI S0007 as summarized in Table 2.2.2-1
- Update FDF/ODF with Errata Pack
- Configure or verify Console Logbook(s) on console
- Tagup with Shuttle/ISS FD counterpart (SDO if ISS FD not on console)
- √LSO for landing site status
- If launch scrub, use Prelaunch/Launch Scrub Checklist Table 2.2.2-2

Note: Ensure prelaunch planning flight controllers (non-Ascent certified) consult with an Ascent certified controller for any anomalies affecting ascent.

Table 2.2.2-1. Launch Day (Prelaunch Planning Team)

Local	T-	L-	Sequence	Activity	FD Action
	11h 00m	15h 50m	15-0000	VERIFY READY TO RESUME COUNT	On NTD's call (OIS 232): Verify ready to resume count.
	9h 00m	13h 50m	15-_____	COMM CMD TO LAUNCH CONFIG-MCCH (ref OMI V1117 performed on ch 214)	On NTD's call (OIS 232): Inform NTD Seq 15-_____in work. Request GC unsafe MOC or GCS Hand task over to INCO on FD Loop Log start in FD console log When complete, safe MOC or GCS
	7h 30m  (~1/2 hr prior to MCCH Abort Advisory Check)	12h 20m	N/A	Pre-MCCH Abort Advisory Check	Log onto GCS on both workstations (WFCR 9 and 28) and callup Command Summary Call GC to verify loop back and isolation plugs removed. Activate abort s/w on WFCR 9 and 28 (√gray GUI with red buttons). Instruct FDO to activate their abort s/w. When all activated, call GC to enable FD and FDO aborts. Enable abort s/w (√green GUI buttons and h/w pbi "ABORT A/B ON") Call GC to arm command system. Call GC to enable talk on FD A/G 1. Select "Options" on abort s/w to display A and B.
	7h 30m	12h 20m	15-_____	OMS GIMBAL PROFILE (ref S0007VL4 seq 43)	On NTD's call (OIS 232): √GNC, then verify ready <i>GNC needs to have application running.</i>
	7h 15m	12h 05m	15-_____	OPEN ORBITER LEEWARD VENT DOORS 1 AND 2 (CONTINGENCY)	Acknowledge NTD's call (OIS 232) <i>MCC has no constraint – courtesy call from NTD.</i>

Local	T-	L-	Sequence	Activity	FD Action
	7h 00m	11h 50m	15-_____ thru 15-_____	MCCH ABORT ADVISORY CHECK  NOTE: Complete COMM CMD TO LAUNCH CONFIG-MCCH before beginning Abort Advisory checks.	On NTD's call (OIS 232): Verify system armed and ready to perform check on OIS CH 212 On NTD's call put MCCH Abort Advisory Check in work and inform NTD (OIS 232). Move to ch 212 (A/G 1). Perform comm check with ASP. Perform Abort Advisory Check per OMI and FCOH SOP 3.1.3 (give marks when cmds sent) When complete, call NTD (OIS 232). Disable abort s/w (√red GUI buttons). Call GC to safe the command system. Call GC to inhibit talk on FD A/G 1. Log results in FD console log.
	6h 21m	11h 11m	15-_____	IMU OPERATE GYRO COMPASS ALIGN	FYI
	6h 20m	11h 10m	15-_____	CLEAR WHITE ROOM/CREW CMPT	Respond to NTD's call (OIS 232)
	6h 20m	11h 10m	15-_____	FAULT SUMM PAGE CLEAR	FYI
	6h 10m	11h 00m	15-_____	CONFIGURE FOR MMT/LD WX BRIEFING	Acknowledge NTD's reminder (OIS 232) that WX briefing will begin in 10 minutes. Inform team stepping off for WX Briefing. Call WX to verify moving to Action Center. Move to Action Center (Rm 225) If MOD not supporting, provide Go/No-Go status of LCC reqts in Annex: e.g. Remote POCs, long lines, MCC-H, TDRS network, GSTDN, ISS. When complete, review briefing with team.
	6h 00m	10h 50m	15-_____	ACTIVATE LCC MONITORING SOFTWARE	FYI
	6h 00m	10h 50m	15-_____	LAUNCH COMMIT CRITERIA VERIF (for tanking)	FYI
	6h 00m	10h 50m	15-_____	T-6 HR COUNDOWN HOLD <i>2 hour built-in hold</i>	Acknowledge NTD's hold announcement (OIS 232)
	6h 00m	8h 50m	15-_____	T-6 HR AND COUNTING	FYI
	6h 00m	8h 50m	16-_____	ET LO2/LH2 LOADING	Monitor Booster MPSR for info
	5h 25m	8h 15m	16-_____	IMU PREFLIGHT CALIBRATION	FYI
	4h 40m	7h 30m	16-_____	PASS PRE-FLT RCS QTY U/L (if reqd)	On NTD's call (OIS 232): Call GC to arm the command system PROP and INCO perform PASS Pre-flight RCS Qty Correction When complete, Call NTD (OIS 232)
	4h 30m	7h 20m	16-_____	MILA ANTENNA ALIGN <i>~1 hour</i>	√Command system armed On NTD's call (OIS 232): INCO Transmits DSM ____ (XPNDR FREQ) On NTD's call (OIS 232): INCO Transmits DSM ____ (PA STBY 2 – ON) When complete, call GC to safe the command system
	4h 00m	6h 50m	16-_____	VERIFY WEATHER AIRCRAFT COMM TO JSC	FYI

Local	T-	L-	Sequence	Activity	FD Action
	4h 00m	6h 50m	16-_____	MPS LH2 ET ULLAGE PRESSURE TRANSDUCER NUMBER 4 VERIF	On NTD's call (OIS 232): √Booster copied then call NTD and confirm Booster notified and give go to proceed
	3h 30m	6h 20m	16-_____	XPNDR SWITCH TO LAUNCH FREQ	On NTD's call (OIS 232): Call GC to arm the command system INCO transmits cmds and verifies tlm/voice Acknowledge NTD's status calls. When complete, call GC to safe the command system. <i>Normally low freq unless conflict with payload.</i>
	3h 05m	5h 55m	16-_____	LOX IN STABLE REPLENISH	FYI
	3h 05m	5h 55m	16-_____	VARIABLE ASCENT PARAMETER U/L LOAD	On NTD's call (OIS 232): Call GC to arm command system DPS uplinks VPs Call GC to safe command system
	3h 00m	5h 50m	16-_____	CRT COUNTDOWN TIMER SETUP	FYI
	3h 00m Holding	5h 50m	16-_____	T-3H00M HOLD <i>2 hour built-in hold</i>	FYI
	3h 00m Holding	~5h 50m	16-_____	GO FOR FLIGHT CREW WAKEUP	FYI
	3h 00m Holding	~5h 50m	16-_____	SIMO A/G A/A DELAY ADJUSTMENT	Call GC to enable A/G to FD and CAPCOM On NTD's call: CAPCOM performs long test count per ASP Record inserted delay.
	3h 00m Holding	~5h 25m	16-_____ thru 16-_____	FCO ABORT ADVISORY CHECKS	Repeat Pre-MCCH Abort Advisory Check steps as required to enable abort s/w. Call GC to arm command system and to enable talk on FD A/G 1. On NTD's call (OIS 232): Verify system armed and ready to perform check on OIS CH 212 On NTD's call put Fit Abort Advisory Check in work and inform NTD (OIS 232). Move to ch 212. Perform comm check with ASP. Perform Abort Advisory Check per OMI and FCOH SOP 3.1.3 (give marks when cmds sent) When complete, call NTD (OIS 232). Disable abort s/w (√red GUI buttons). Call GC to safe the command system. Call GC to inhibit talk on FD A/G 1. Log results in FD console log.
	3h 00m Holding	~5h 25m	16-_____	BFS TMBU TAGUP	On NTD's call (OIS 232): DPS performs tagup with KSC/VFS on ch 152.
	3h 00m Holding	~5h 25m	16-_____	JIMSPHERE RELEASE	FYI

Table 2.2.2-2 Pre-Launch/Launch Scrub Checklist

Action	Complete
<ul style="list-style-type: none"> <li>• Notify Ascent FD of scrub.               <ul style="list-style-type: none"> <li>○ Determine if Ascent FD will do weather brief with crew in crew quarters</li> <li>○ CAPCOM or FLIGHT notify crew/VITT team of weather briefing plan</li> <li>○ Ascent FD will coordinate with Ascent FDO for updated launch window data for future launch attempts. Data will be available later in the day (what would have been the Ascent shift).</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• Notify MOD, Orbit 2 FD, on console ISS FD (if applicable), Lead FD's (Shuttle and ISS) of scrub</li> </ul>	
<ul style="list-style-type: none"> <li>• Verify/confirm launch scrub duration with NTD               <ul style="list-style-type: none"> <li>○ If special MMT required, ensure proper support available</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• Determine new shift times for Pre-launch, Ascent, and Orbit 2 Teams. Get concurrence from Lead and/or Ascent FD before releasing new times.</li> </ul>	
<ul style="list-style-type: none"> <li>• Release flight control team except for INCO, GC, and EGIL.               <ul style="list-style-type: none"> <li>○ Announce new launch time on the FLIGHT loop (lots of folks will want to know)</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• If COMM CMD to LAUNCH CONFIG completed prior to scrub, hand command link back to KSC (OMI Volume III UPLINK COMMANDS FROM MCCH to CCMS). This is sequence 29 ~STEP 130.               <ul style="list-style-type: none"> <li>○ INCO released when comm link handed back to KSC</li> <li>○ Notify NTD that MCC-H support is complete when KSC has comm link.</li> <li>○ Have GC safe the MCC command system</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• Get updated launch hold capability and cyro margin from EGIL- release</li> </ul>	
<ul style="list-style-type: none"> <li>• GC update shift recorder with new on console times.</li> </ul>	
<ul style="list-style-type: none"> <li>• Planning FD or Lead FD update shift schedule, if required</li> </ul>	

Notes:

1. For 24-hour scrub turnaround, if COMM CMD to LAUNCH CONFIG and PRE MCC-H ADVISORY CHECKS have been successfully completed prior to scrub, these activities are not required for the next launch attempt.
2. If 48-hour or greater launch scrub turnaround, OMI pre-launch will be executed per the nominal timeline.

### 2.2.3 Prelaunch Ascent Team Checklist

Table 2.2.3-1. Launch Day (Ascent Team)

T-	L- (40m/10m T-9 Hold)	Sequence	Activity	FD Action
3h 00m Holding	~5h 30m	N/A	Ascent Team On Console	
3h 00m Holding		16-_____	FLIGHT CREW WEATHER BRIEFING	Facilitate WX Briefing per OMI steps. CONUS WX TAL WX Each TAL Site for quick status FDO for runway info Crew questions/comments then release crew TAL WX/TALCOM items for each site When complete, call NTD (OIS 232) Call GC: Take down conference
			SLF NAVAIDS ACTIVATION	
			GPS ACTIVATION FOR FLIGHT	
			CLEAR C/W MEMORY	
			LRD COMM CHECKS	
3h 00m			RESUME COUNT	
2h 55m	3h 45m/ 3h 15m	16-_____	CREW INGRESS WEATHER UPDATE	
			FLIGHT CREW DEPART	
		16-_____	COLA IDENTIFICATION	Monitor NTD/SRO (OIS 232) Report combos if any
2h 45m	3h 35m/ 3h 05m	16-_____	LAUNCH COMMIT CRITERIA VERIF	Poll MCC for LCC criteria verification
2h 40m	3h 30m/ 3h 00m	16-_____	REPORT LCC STATUS	Report to NTD (OIS 232)
		N/A	T-38 Weather Aircraft Takeoff	
			LANDING AIDS ACTIVATION	
2h 25m	3h 15m/ 2h 45m		FLT CREW INGRESS	
2h 00m	2h 50m/ 2h 20m		RTLS RUNWAY	LSO gives RTLS runway on LFP1
		16-_____	FIRST MOTION (SIM) SIGNAL TEST	Acknowledge NTD's call (OIS 232). Verify signal, give go to remove signal.
		N/A	MOC to Launch Phase for FDO Checks	
			SLF NAVAIDS STATUS	
			LANDING AIDS STATUS	
1h 50m	2h 40m/ 2h 10m	16-_____	IMU GYROCOMPASS ALIGN	On NTD's call (OIS 232): Verify ready
1h 30m	2h 20m/ 1h 50m	16-_____	MCC A/G VOICE CHECKS	On NTD's call (OIS 232): CAPCOM performs voice checks When complete, call NTD (OIS 232)
		16-_____	CONTROLLABILITY LIGHT TEST	On NTD's call (OIS 232): GNC performs test
1h 20m	2h 10m/ 1h 50m	16-_____	G9 LAUNCH POLYNOMIAL/TARGET	Perform update per OMI steps.

T-	L- (40m/10m T-9 Hold)	Sequence	Activity	FD Action
	1h 40m	thru 16-_____	UPDATE	GPO provides starting address for GMT L/O and DSMs per flight note. GPO and INCO coordinate uplinks on FD loop. DPS verifies GPC dump quality. GPO verifies GPC dump contents. Log results in FD console log.
			HATCH CLOSURE	
1h 10m	2h 00m/ 1h 30m		FINAL COLA UPDATE	Monitor NTD/SRO (OIS 232) Report combos if any.
			CABIN LEAK CHECK	
1h 05m	1h 55m/ 1h 25m		IMU GYROCOMPASS ALIGNMENT COMPLETE	
1h 00m	1h 50m/ 1h 20m		GLS INITIALIZATION COMPLETE	
		N/A	MOC/DSC Checkpoint (time is variable)	
0h 55m	1h 45m/ 1h 15m	16-_____	S-BAND SYS HI PWR/FM ACTIVATION	On NTD's call (OIS 232): INCO performs S-band to high power, FM activation. On NTD's call (OIS 232): INCO transmits DSMs Acknowledge activation complete (OIS 232).
0h 50m	1h 40m/ 1h 10m	N/A	STA Takeoff (TAL A/C 10 minutes later)	Monitor WX Aircraft loops
		16-_____	LAUNCH WINDOW INFORMATION UPDATE	Provide NTD with listed launch window info.
0h 40m	1h 30m/ 1h 00m		GLS PRE-SEQUENCING START	
		16-_____ 16-_____	LAUNCH DIRECTOR/FLIGHT DIRECTOR LAUNCH/RTLS WEATHER BRIEFING	Facilitate WX briefing When complete, inform NTD (OIS 232)
0h 35m	1h 25m/ 0h 55m		PASS/BFS TRANSFER PREP	
0h 25m	1h 15m/ 0h 45m	16-_____	SIMO A/G VOICE CHECK & ASCENT CREW DATA UPDATE	On NTD's call (OIS 232): CAPCOM performs voice checks and reads data updates. When complete, call NTD (OIS-232)
0h 22m			PASS – BFS TRANSFER	
			CLOSE VENT VALVES	
0h 20m	1h 10m/ 0h 40m		T-20 MINUTE HOLD	
		16-_____	REPORT LOX DRAINBACK PERFORMANCE HOLD TIME	Report hold time as provided by FDO (OIS 232)
		16-_____	ASCENT VARIABLE PARAMETERS	If reqd, On NTD's call (OIS 232): DPS uplinks ascent variable parameters
		16-_____	COMMUNICATIONS VERIFICATION CHECK OIS CH 212	OIS 212 (A/G 1) now command channel. √FD keyset ENA for A/G
		16-_____	PSP DEACTIVATION	If PSP powered up, on NTD's call (OIS 232): INCO transmits DSM When complete, call NTD (OIS 232)
			LRD FINAL STATUS CHECKS	
			T-20 MIN BRIEFING	
0h 20m	1h 00m/ 0h 30m		RESUME COUNT	

T-	L- (40m/10m T-9 Hold)	Sequence	Activity	FD Action
		16-_____	ACTIVATE VHF WX CIRCUIT	If WX briefing with crew desired, call NTD (OIS 212) to patch to ICOM-B per OMI steps.
			OPS TRANSITION	
18m 30s			BFS TO OPS	
			T – 20 MIN GPC DUMP	
			ALTERNATE TAL SITE SELECTION (CONTINGENCY)	CAPCOM reads update if required.
17m 00s			HORIZ SIT CONFIG	
			CONTINGENCY ABORT YAW STEER (PASS)	
16m 00s		16-_____	BFS PRE-FLT U/L LOADING	On NTD's call: Uplink BFS TMBUs, TDRS Vectors, and Launch Targets as required. When complete, call NTD.
		16-_____		
12m 00s			ANNOUNCE HOLD TIME	
		16-_____	OEX RECORDER ACTIVATION (OV-102 only) (ref S0007VL4 seq 38)	On NTD's call: Activate OEX recorder.
9m 30s			SINGLE SHOT VERIFY	
9m 00s			T-9 MINUTE HOLD	
		16-_____	FINAL LAUNCH WINDOW DETERMINATION	Confirm times per OMI steps. Tagup with NTD on OIS 212. Tagup with LD on OIS 231.
		16-_____	G1 LAUNCH TARGET UPLINK LOADING	Inform NTD if reqd. On NTD's go: GPO and INCO coordinate uplinks on FD loop.
		16-_____	G1 LAUNCH POLYNOMIAL UPDATE	Inform NTD if reqd. Perform per S0007VL5 seq 117.
		16-_____	BFS G1 LAUNCH TARGET UPLINK LOADING	On NTD's go: GPO and INCO coordinate uplinks on INCO loop When complete, call NTD.
			CLEAR CAUTION AND WARNING	
		16-_____	ASCENT DATA CREW UPDATE (-09M)	CAPCOM reads updates as reqd.
		16-_____	L-15M RECORDER ACTIVATION	On NTD's call (OIS 212): Activate recorder per S0007VL4 seq 38.
		16-_____	LAUNCH STATUS CHECK	Poll MCC for LCC Go/No-Go. Report to NTD (OIS 212).
9m 00s			COUNTDOWN CLOCK START	Ena aborts, DVIS page 2
		16-_____	DEACTIVATE VHF WX CIRCUIT	Acknowledge NTD's call (OIS 212).
8m 00s		16-_____	STORED PROGRAM PRE-LAUNCH COMMANDS	If hold after BFS SPC transmitted, INCO will transmit buffer clear then updated SPCs via 2 stage command.
			FUEL CELL/ESSENTIAL BUS SOURCE ON	
6m 15s			APU PRE-START	
5m 00s			APU START	
			HTR RECONFIG	
4m 55s			TERM LOX REPLENISH	
		16-_____	UPDATE TO LOX DRAINBACK HOLD TIME	If T-9 hold extended or hold after T-9, update NTD on OIS 212.



T-	L- (40m/10m T-9 Hold)	Sequence	Activity	FD Action
2m 30s			CLEAR CAUTION AND WARNING MEMORY	
2m 00s			CLOSE VISORS	
0m 31s			GLS GO FOR AUTO SEQUENCE START	
0m 28s			ORBITER VENT DOOR SEQ START	
0m 10s			GLS GO FOR MAIN ENGINE START	
0m 06s			MAIN ENGINE START	
0m 00s			SRB IGNITION/LIFTOFF	

#### 2.2.4 Launch Go/No-Go Checklist

- ❑ STS Systems & Onboard Instrumentation (LCC)
- ❑ Structural Loads Evaluation (LDO)
- ❑ Performance Evaluation (DOL Winds/I-loads, ET Loading)
  - Hold Time Inside Drainback
  - Abort Boundary Changes (FDF)
  - ADI Ascent Attitude (Report depressed/lofted, deviations)
  - DOLILU
  - Crew Info
    - Lofting/depression, East/West deviations
    - Performance Boundary Updates (DOL)
    - ADI Attitude Profile Updates
    - Vehicle Rates
- ❑ Ground Systems Equipment and Instrumentation (Ascent, RTLS, TAL, AOA (if reqd), 1<sup>st</sup> Day PLS)
  - A/G Voice (S-band & UHF)
  - TLM
  - Tracking
  - Command
- ❑ COMBO/COLA
  - Predicted conflicts – may hold to next even minute

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## 2.2.5 Abort Command Procedures

### A. Background

The Flight Director, FDO, and FCO can send commands, under circumstances described in the Flight Rules, to the space shuttle to request a mission abort or to confirm command link to the vehicle. These commands are processed through the DPS system by the primary or backup flight system computers and routed through PL MDM to the annunciator control assembly (ACA) to the Abort PBI on the commander's side of the forward instrument panel. The commands can either turn on or off the lights in the PBI. A lighted PBI is one of many ways to fulfill the Flight Rule requirement for two cues before the flight crew executes a mission abort during the ascent phase. In general, the FD will send the abort command (reference Flight Rule A1-5), but sometimes the FDO or FCO will send the command if the FD cannot or is under certain range safety cases (reference Flight Rules A4-253, A4-254, A4-257, and A4-259). The abort light is also used during the on-orbit phase of the mission by Comm SSR-1 loss of all voice comm malfunction procedure. The abort light is not currently used during the entry timeframe (e.g., a bailout call does not require abort request command).

The abort request command capability exists from the Eastern Range's Range Operations Control Center (ROCC) at Cape Canaveral Air Force Station (CCAFS). The Flight Control Officer (FCO) has two hardware PBIs that are directly linked via longlines to the MCC (reference Figure 2.2.5-1). The FCO left button is linked to the FDO console WFCR 10 and the FCO right button is linked to the FD console right CPU WFCR 28 or SVO 10. This capability is mandatory for launch as described in Flight Rule A3-151 part C. There is no abort light software at the ROCC; these PBIs are merely remote extensions tied directly to the two MCC consoles. The MCC software has been designed so that the FCO buttons blink on a regular period to provide a heartbeat indication to the FCO that the software is operational.

The Flight Director has a hardware PBI connected to CPU WFCR 9 and the FDO has a hardware PBI connected to CPU WFCR 29 that allows transmission of the abort request command without using the keyboard/mouse combination. The commands are initiated via the software in exactly the same manner regardless of whether the hardware button is pushed or the software button is clicked via the mouse. Initialization of the software allows the use of the hardware or software buttons.

Channelization for the abort light is shown on Space Shuttle Systems Handbook (SSSH) Drawing 9.10 FCS SW zones I-G, 5-8. There are two red bulbs in the F6 PBI which are driven by the Abort Advisory A Command V72X6070Y on PF1 MDM and Abort Advisory B Command V72X6072Y on PF2 MDM. Both commands go through Annunciator Control Assembly 1 and Annunciator Control Assembly 2. On both ACAs, the abort request light is channel 31. The ACAs are shown on SSSH drawing 4.3 Annun. ACA 1 is powered by MNA 014 and MNB 015 through circuit breakers on 014 and 015 and intensity control switches on 06 with lamp test switches on 06 and 08. Similarly ACA 2 is powered by MNB 015 and MNC 016. A list of other cockpit indicators channelized through the ACAs is given in SSSH table 4-1. Note that the failure of the abort request light to illuminate may be the result of a failure in the ACA, which would mean that other critical indicators may not illuminate when required.

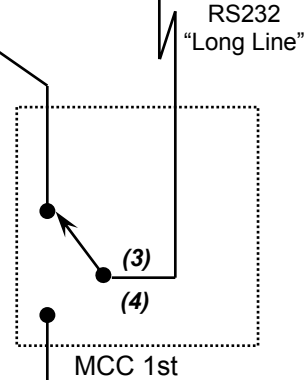
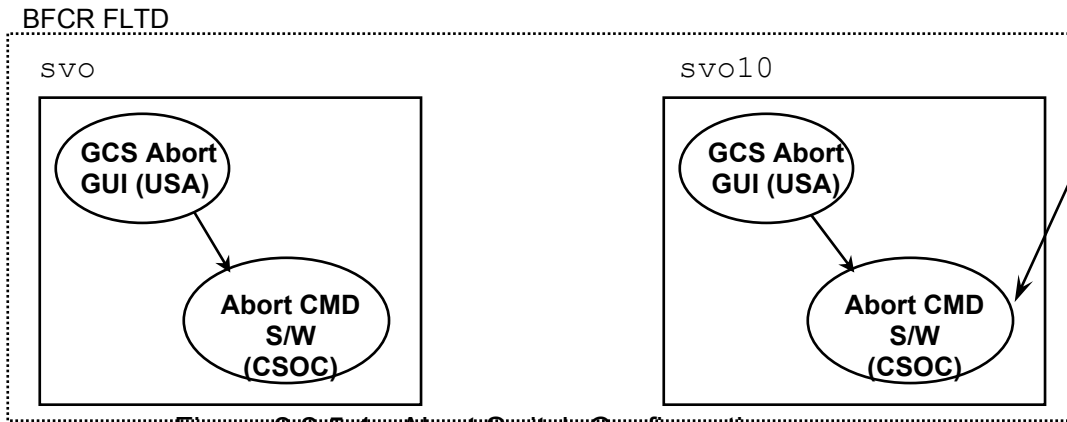
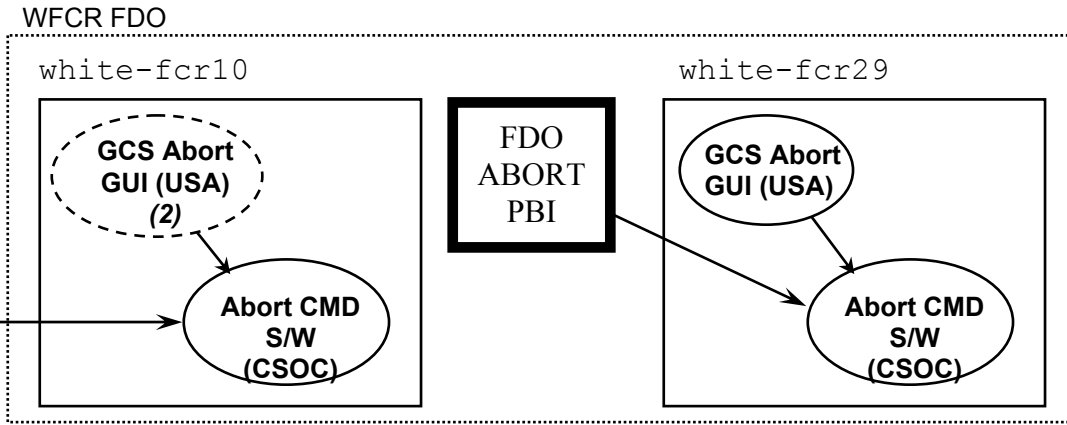
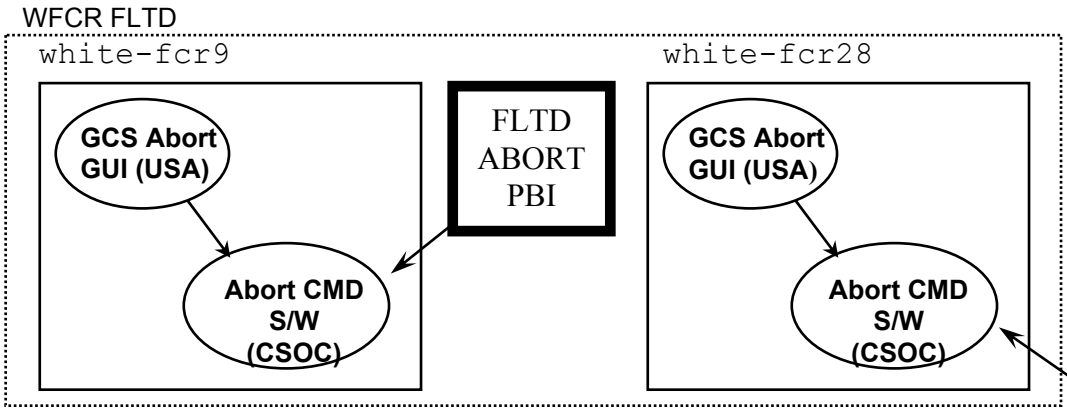
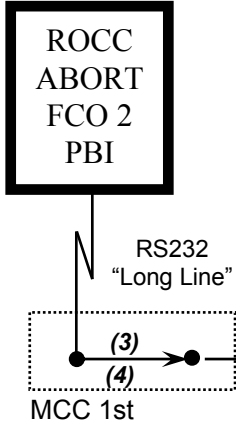
The abort request is tested twice each preflight launch countdown in S0007. First, on the tanking team shift there is the MCCH Abort Advisory Check during T-7 hour hold (approximately L-10.5 hours before launch) in sequence 15 step approximately 400 (varies by launch flow). Second, there is a FCO Abort Advisory Check on the ascent team shift at approximately 5 hours before launch. These two checks are an exhaustive test that sends the commands for on and off in virtually every sequence from nearly every location to determine that the entire system is in a state of launch readiness.

There are three commands that are actually sent by the ground software:

1. DSM 4054 Abort A/B On
2. DSM 4051 Abort A Off
3. DSM 4053 Abort B Off

Note that the individual A and B On commands cannot be currently sent by the ground software. A and B Off commands individually or both simultaneously can be sent. The ground software is set up with these commands as priority commands and they will interrupt any other commanding that is in process at the time they are sent. This interrupt capability is not true for the same command originating from two different consoles. For example, during the prelaunch timeframe for STS-114, the same abort command was sent from the FCO and the Flight Director console within 0.25 seconds of each other and caused the command manager to discard the command that arrived 0.25 seconds later because the first command was in progress. These are single stage commands that are addressed to all GPCs (they can be processed by PASS GNC, PASS SM, or BFS). The ground command software sends each requested command three times in succession (once per second) and then issues a priority command terminate message. Note that the hardware PBI blinks as the commands are issued.

(1) Each workstation runs the "Abort CMD S/W". This program interfaces directly to the Command Manager - Server which is able to light the abort light on the vehicle.



(2) Operationally, the Abort GUI may not be executed on white-fcr10 because it is not desired.

(3) There is a jumper which must be connected in order for the "long line" to be completed. Most of the time, this jumper is open. During missions, this jumper is closed..

(4) There are only 2 "long lines" available to the ROCC. These lines may be connected to either WF10, WF28 or SVO10. This diagram provides the nominal

Figure 2.2:5-1. Abort Switch Configuration

## B. Preflight configuration and general information

At approximately L-26 hours, the MCCH GC and Comm Tech will work with the ROCC comm tech personnel to establish the two longline interfaces to the FCO position in the ROCC. The loop-back plugs are removed from the longlines and the isolation plugs at the COMM control console are also removed. Until this time, the loop-back plug is in place to ensure that the longlines are working properly. With the loop-back plug in place, there is no indication at the FCO console that the abort request equipment is functioning and if the MCCH software is started, errors will result.

### **WARNING**

MCCH abort software cannot be initialized before longline configuration completion or errors in ROCC commands will result.

When the prelaunch tanking team comes on console, they can start the abort request software at their convenience, but in no case later than 30 minutes before the Abort Advisory Check sequence in S0007 seq. 15. The 30 minutes is an arbitrary time limit to ensure that the software and hardware are properly configured.

If the software on the FD and FDO console is started before the longlines to the ROCC is properly configured (i.e., the loop-back and isolation plugs removed), errors in the software initialization will result in the FCO being unable to command. If this occurs, the FDO and FD should deactivate the abort request software on their console and reactivate it after the longlines are properly configured.

## C. Abort Check and OPCL Loss of Comm Procedures

Reference Shuttle Ops FCOH SOP 3.1.3.

### **CAUTION**

This procedure contains safety critical steps. Improper implementation of these steps can be hazardous to equipment or personnel. A surrounding box annotates safety critical steps.

### Pre-MCCH Abort Check Procedures

#### 1. Log-on to workstation

*FD: WFCR 9 and 28, FDO: WFCR 29 and TRAJ: WFCR 10*

*Ref section 2.1.1 for Console Initialization procedures*

#### 2. Log-on to Command Server (both WFCR 9 and 28 for FD) and call up Command Summary display

*Ref section 2.9.4 for Command Server procedures*

*Command Summary displays when the FD and FDO "nodes" (workstation CPUs) are successfully registered and is also used to monitor the abort commands.*

3. Call GC to verify loop back plugs at the ROCC and isolation plugs at COMM CONTROL have been removed.  
*This step is required in support of the MCC-H Abort Advisory Check, FCO Abort Advisory Checks, and final configuration for launch but is not required for use of the abort light for loss of communications scenario. This action is performed at approximately L-26 hours per agreement with the ROCC. The command checks will not work if these steps have not been completed.*
4. Activate the abort software on WFCR 9 (Left CRT) and WFCR 28 (right CRT):  
FD DNAV ▸ Applications ▸ Abort Switch ▸ Activate Abort  
After ~4min, √gray GUI displayed  
√Hardware PBI “ABORT” in green letters  
√Command Summary: node (workstation CPU) registered  
*The abort software takes approximately 4 minutes to activate. Command registration is an automatic part of the software initialization and can be viewed on the Command Summary display.*
5. Instruct FDO and TRAJ to activate their abort software (TRAJ not required for MCC-H Abort Advisory Check)  
*There is no order required in activation (any console can start in any order) other than the constraint on the long line configuration with the ROCC.*
6. Once FD, FDO, and TRAJ (if required) activate abort software, call GC and request that COMMAND enable FD and FDO aborts.  
√GUI top two buttons red  
*When COMMAND enables the FD and FDO aborts, the top two buttons (ABORT A/B ON and ABORT A/B OFF) turn red.*
7. Enable the abort software via **ENABLE** button on the GUI  
√GUI top two buttons green  
√Hardware PBI “ABORT A/B ON”  
*When the FD enables the abort software via clicking on the software “ENABLE” button, the top two GUI buttons (ABORT A/B ON and ABORT A/B off) turn green and the hardware PBI nomenclature changes to ABORT A/B ON.*
8. Select **OPTIONS** on the GUI to display the expanded view.  
*There is a second expanded GUI that allows for the individual OFF commands (ABORT A OFF and ABORT B OFF) to be sent. This expanded GUI is obtained by clicking on the **OPTIONS** button on the basic GUI. To return from the expanded GUI, click on the **CANCEL** button.*
9. Call GC to arm the command system and enable talk on FD A/G 1  
*If the Command Server is armed to transmit commands, the abort required command can be sent via pushing the hardware PBI or clicking on the top GUI button. If the command was successfully transmitted (not necessarily received at the vehicle), the small indicator at the bottom of the GUI (ABORT ON OK) turns green. If the GUI indicator (ABORT ON ERROR) turns red, there is some problem transmitting the commands. To turn the abort light off (transmit the OFF commands), the FD clicks on the GUI ABORT A/B OFF button.*

#### MCC-H Abort Advisory Check

1. On NTD’s call (OIS 232): Verify system armed and ready to perform check on OIS 212.
2. On NTD’s call (OIS 232): Put MCCH Abort Advisory Check in work and inform NTD.
3. Move to ch 212 (A/G1) and perform comm check with ASP.
4. Perform MCCH Abort Advisory Check per OMI and FCOH SOP 3.1.3, providing marks when commands are sent (For example, in step a below, the terminology could be “On my mark, transmitting DSM four-zero-five-four, Abort A-B-On...three, two, one, mark”):
  - a. Send DSM 4054 ABORT A/B ON via hardware PBI  
ASP confirms abort light illuminated  
√ABORT A/B OK on status button  
Clear status



- b. Send DSM 4053 ABORT B OFF via WFCR 9 using **B OFF ENABLE**  
ASP confirms abort light still illuminated (may report it's dimmer)  
√ABORT A/B OFF OK on status button  
Clear status
  - c. Send DSM 4051 ABORT A OFF via WFCR 9 using **A OFF ENABLE**  
ASP confirms abort light is off  
√ABORT A/B OFF OK on status button  
Clear status
  - d. Send DSM 4054 ABORT A/B ON via WFCR 28 using **ABORT ENABLE**  
ASP confirms abort light is illuminated  
√ABORT A/B OK on status button  
Clear status
  - e. Send DSM 4051 ABORT A OFF via WFCR 28 using **A OFF ENABLE**  
ASP confirms abort light still illuminated (may report it's dimmer)  
√ABORT A/B OFF OK on status button  
Clear status
  - f. Send DSM 4053 ABORT B OFF via WFCR 28 using **B OFF ENABLE**  
ASP confirms abort light off  
√ABORT A/B OFF OK on status button  
Clear status
  - g. Instruct **FDO** to send DSM 4054 ABORT A/B ON via hardware PBI  
*Note this is the only command FDO sends during MCCH Abort Advisory Check – all others are done by FD.*  
ASP confirms abort light is illuminated  
√ABORT A/B OK on status button  
Clear status
  - h. Send DSM 4051 ABORT A OFF and DSM 4053 ABORT B OFF via WFCR 28  
using either of the following options: option1) **A/B OFF ENABLE** or option 2)  
**A OFF ENABLE** followed by **B OFF ENABLE**  
ASP confirms abort light off  
√ABORT A/B OFF OK on status button  
Clear status
5. Call NTD (OIS 232): MCCH Abort Advisory Checks Complete
  6. Disable abort software using **DISABLE**

*Top two GUI buttons (ABORT A/B ON and ABORT A/B OFF) turn red.*

#### NOTE

It is acceptable to deactivate, or shut down, the abort GUI software after this test is completed. Since FCO personnel at the ROCC are typically not manning their console during the tanking shift, their abort PBI hardware is usually inactive, which precludes the requirement to keep the Flight Director abort software running.

7. Call GC to safe the command system and inhibit talk on FD A/G 1.
8. Log results in FD log.

#### FCO Abort Advisory Checks

1. Repeat Pre-MCCH Abort Advisory Check steps as required to enable abort software.  
*If a workstation reboot was performed, the command manager must be restarted, abort software activated, and enabled. If no configuration changes were performed after the MCCH Abort Advisory Check, all that is required is to select the ENABLE button on the GUI.*
2. Instruct FDO to confirm with FCO that the ROCC reports a good heartbeat on both PBIs (hardware PBI flashing)

3. Call GC to arm the command system and to enable talk on FD A/G 1.
4. On NTD's call (OIS 232): Verify system armed and ready to perform check on OIS 212.
5. On NTD's call (OIS 232): Put FCO Abort Advisory Check in work and inform NTD.
6. Move to ch 212 (A/G1) and perform comm check with ASP and FCO.
7. Perform FCO Abort Advisory Check per OMI and FCOH SOP 3.1.3, providing marks when commands are sent:
  - a. Instruct **FCO** to send DSM 4054 ABORT A/B ON via LEFT hardware PBI  
ASP confirms abort light illuminated  
√ABORT A/B OK on status button  
Clear status
  - b. Send DSM 4051 ABORT A OFF and DSM 4053 ABORT B OFF via WFCR 9  
ASP confirms abort light off  
√ABORT A/B OFF OK on status button  
Clear status
  - c. Instruct **FCO** to send DSM 4054 ABORT A/B ON via RIGHT hardware PBI  
ASP confirms abort light illuminated  
√ABORT A/B OK on status button  
Clear status
  - d. Send DSM 4051 ABORT A OFF and DSM 4053 ABORT B OFF via WFCR 9 or 28  
ASP confirms abort light off  
√ABORT A/B OFF OK on status button  
Clear status
8. Call NTD (OIS 232): FCO Abort Advisory Checks Complete
9. Disable abort software

*Top two GUI buttons (ABORT A/B ON and ABORT A/B OFF) turn red.*

#### **NOTE**

It is desirable to keep the abort software running (i.e. do not deactivate) after this test through launch but this is NOT mandatory. Part of the rationale for keeping this abort software GUI running is associated with a software process that the GUI runs in the background. This background software process is called "Remote PBI" and serves as the software for the FCO's hardware PBI. By design, this "Remote PBI" software process will terminate if it fails to receive a signal, or heartbeat, after a certain time delta (~ 3 seconds). Currently, the only way to restart the "Remote PBI" software is for the Flight Director to deactivate and then reactivate the Abort GUI on WFCR-28.

10. Call GC to safe the command system and inhibit talk on FD A/G 1.
11. Log results in FD log.

#### Launch Configuration

1. Prior to coming out of T-9min Hold,  
Enable abort software via **ENABLE** button on GUI  
√Top two GUI buttons green  
√Command system armed

#### **CAUTION**

If an abort is required, FD will send DSM 4054 ABORT A/B ON with the call on the A/G to abort. FCO will send DSM 4054 ABORT A/B ON for cases where a manual MECO is required for limit line protection. FD will confirm ABORT A/B ON OK on status button for either case. Once the abort action has been taken, the FD will send the ABORT A/B OFF. This action allows subsequent abort downmode during flight. FD confirms ABORT A/B OFF OK on status button, then clicks on clear status.

2. After reaching safe orbit, Disable the abort software.
  - √Top two GUI buttons red
3. Call GC to disable FD and FDO aborts.
4. Deactivate abort software on WFCR 9 and WFCR 28:
  - FD DNAV ▸ Applications ▸ Abort Switch ▸ Deactivate Abort
  - √gray GUI disappears
  - √Hardware PBI blank
  - √Command Summary: node (workstation CPU) deregistered

#### Loss of Communications with the Crew

##### **NOTE**

If the crew has lost communications with the MCC, they will execute the OPCL COMM LOST procedure. If communication has not been recovered by step 10. of the procedure, the crew will utilize the scratch pad line to key in 88+888888. The MCC will then attempt command and if the crew sees flashing uplink on GNC display, they then key in 99+999999. The MCC then confirms good command uplink with a flashing abort light.

1. √Logged in to Command Server and call up Command Summary display
  - Ref section 2.9.4 for Command Server procedures*
  - Command Summary displays when the FD and FDO "nodes" (workstation CPUs) are successfully registered and is also used to monitor the abort commands.*
2. Activate the abort software on workstation with command manager running:
  - FD DNAV ▸ Applications ▸ Abort Switch ▸ Activate Abort
  - After ~4min, √gray GUI displayed
  - √Hardware PBI "ABORT" in green letters
  - √Command Summary: node (workstation CPU) registered
  - The abort software takes approximately 4 minutes to activate. Command registration is an automatic part of the software initialization and can be viewed on the Command Summary display.*
3. Once abort software activated, call GC and request that COMMAND enable FD aborts.
  - √GUI top two buttons red
  - When COMMAND enables aborts, the top two buttons (ABORT A/B ON and ABORT A/B OFF) turn red.*
4. Enable the abort software via **ENABLE** button on the GUI
  - √GUI top two buttons green
  - √Hardware PBI "ABORT A/B ON"
  - When the FD enables the abort software via clicking on the software "ENABLE" button, the top two GUI buttons (ABORT A/B ON and ABORT A/B off) turn green and the hardware PBI nomenclature changes to ABORT A/B ON.*
5. Toggle numerous times between ABORT A/B ON and ABORT A/B OFF at 2 second intervals (2 seconds on, then 2 seconds off) or until INCO reports the crew is working the MAL, COMM SSR-1, LOSS OF ALL VOICE COMM.
6. Disable the abort software.
  - √Top two GUI buttons red
7. Call GC to disable FD aborts.
8. Deactivate abort software:
  - FD DNAV ▸ Applications ▸ Abort Switch ▸ Deactivate Abort
  - √gray GUI disappears
  - √Hardware PBI blank
  - √Command Summary: node (workstation CPU) deregistered

D. Mission abort

If it becomes necessary to request a mission abort as described in the Flight Rules, the abort request command will be sent. Principally, it will be sent by the FD and typically the hardware PBI will be used.

After the requested abort mode has been acknowledged by the crew with an abort request, the FD will send the off commands to turn off the light and allow it to be used for subsequent abort downmoding.

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## 2.2.6 Preflight Checklist for Updating Shuttle Console Documentation

### PURPOSE:

Prior to each Shuttle flight, the Lead Flight Director or their designee should provide the following checklist to a member of the DA8 office support staff to ensure that the on-console MCC documentation is up to date prior to the mission. The intent is to ensure that paper copies of the latest version of all required reference documents are available to the on-console Flight Directors from launch through landing.

### PROCEDURE:

The documents listed on the following 5 pages (TABLE 1.1.13-1) should be updated no-later than Launch minus 3 days (L-3 days). Ideally, the Lead Flight Director or their designee will give this checklist to the DA8 office support staff at L-2 weeks and the required documents will be verified to be the latest version and/or updated in paper form by L-1 week. Updating the documentation by L-1 week will ensure that the prelaunch teams have access to the required documentation without interfering with the nominal prelaunch operations.

It is the responsibility of the DA8 support staff person assigned the task, to verify that the console documentation is the most recent version, and also acquire paper copies of updates as necessary. This applies for both the Space Shuttle Flight Director and Space Shuttle MOD consoles. Should difficulties arise in acquiring the latest version of a required documentation, the problems should be brought to the attention of the Prelaunch (Orbit 3) Flight Director so that they can work the issue during prelaunch timeframe.

Any miscellaneous binders found at the Flight Director and/or MOD console should be left in place unless approved for removal by the Lead Flight Director. Typically, the Lead Flight Director and/or MOD will have a binder of extra notes, preflight analysis work, and programmatic agreements that are placed on console for reference should that be necessary during the mission. Documents of this nature, or binders with contents not listed in the table below, should be left in place for those reasons. Should a question arise regarding the validity of a particular document on console, those questions should be directed to the Lead Flight Director and/or the MOD.

SHUTTLE FLIGHT DIRECTOR MCC CONSOLE DOCUMENTATION CHECKLIST - TABLE 2.2.6-1

DOCUMENT NAME	DOCUMENT NUMBER	HOW TO FIND LATEST VERSION	UPDATE REQUIRED AT WHITE-FCR FLIGHT DIRECTOR CONSOLE?	UPDATED REQUIRED AT WHITE-FCR MOD CONSOLE?
FCOH - SHUTTLE	JSC-26843	FLIGHT DIRECTOR WEBSITE  <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES	YES
FLIGHT RULES - VOLUME A (2 VOLS)	NSTS-12820, Volume A	FLIGHT DIRECTOR WEBSITE  <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES	YES
FLIGHT RULES - VOLUME B	NSTS-12820, Volume B	FLIGHT DIRECTOR WEBSITE  <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES	YES
FLIGHT RULES - VOLUME C	NSTS-12820, Volume C	FLIGHT DIRECTOR WEBSITE  <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES	YES
FLIGHT RULES – ANNEX (Current flight)	NSTS-18308  (STS-XXX Annex)	FLIGHT DIRECTOR WEBSITE  <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES	YES

SHUTTLE FLIGHT DIRECTOR MCC CONSOLE DOCUMENTATION CHECKLIST - TABLE 2.2.6-1 (CONTINUED)

DOCUMENT NAME	DOCUMENT NUMBER	HOW TO FIND LATEST VERSION	FLIGHT DIRECTOR CONSOLE UPDATE REQD IN WHITE-FCR?	MOD CONSOLE UPDATED REQUIRED IN WHITE-FCR?
FLIGHT DIRECTOR CONSOLE HANDBOOK	JSC-19612	FLIGHT DIRECTOR WEBSITE  <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES	YES
SPACE SHUTTLE SYSTEMS HANDBOOK	JSC-11174  (3 VOLS)	DF MASTER LIST/WEBSITE  <a href="http://stic.jsc.nasa.gov/dbase/iso9000/docs/DF/master.htm">http://stic.jsc.nasa.gov/dbase/iso9000/docs/DF/master.htm</a>	YES	NO
S0007 PRELAUNCH DOCUMENTS (6 Volumes)	S0007.100, S0007.200, S0007.300, S0007.400, S0007.500, S0007.600	SPACE SHUTTLE PROGRAM DOCUMENT CENTER WEBSITE  <a href="http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm">http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm</a>	YES, all 6 volumes.	S0007.600 is only document required at MOD console.



SHUTTLE FLIGHT DIRECTOR MCC CONSOLE DOCUMENTATION CHECKLIST - TABLE 2.2.6-1 (CONTINUED)

DOCUMENT NAME	DOCUMENT NUMBER	HOW TO FIND LATEST VERSION	FLIGHT DIRECTOR CONSOLE UPDATE REQD IN WHITE-FCR?	MOD CONSOLE UPDATED REQUIRED IN WHITE-FCR?
CONTINGENCY BINDER (numerous documents – see full list in next column)	CAP-450-EMCC (EMCC Activation & Ops Procedures)	GODDARD CONFIG MGMT WEBSITE <a href="https://gdms.gsfc.nasa.gov">https://gdms.gsfc.nasa.gov</a>	YES	YES
	SSP-50190 ISS Contingency Action Plan	ISS PROGRAM MGMT WEBSITE <a href="https://iss-www.jsc.nasa.gov/ss/issapt">https://iss-www.jsc.nasa.gov/ss/issapt</a>	YES	YES
	FCOH SOP 2.8 JSC Contingency Action Plan	FLIGHT DIRECTOR WEBSITE <a href="http://mod.jsc.nasa.gov/da8/">http://mod.jsc.nasa.gov/da8/</a>	YES, JSC-26843, SOP 2.8 only	YES, JSC-26843, SOP 2.8 only
	JSC-05900 HURRICANE CONTINGENCY ACTION PLAN	NC WEBSITE <a href="http://sma.jsc.nasa.gov/contingencyPlans.htm">http://sma.jsc.nasa.gov/contingencyPlans.htm</a>	YES	YES
	JPR-8621.1A JSC MISHAP RESPONSE PLAN	NC WEBSITE <a href="http://sma.jsc.nasa.gov/contingencyPlans.htm">http://sma.jsc.nasa.gov/contingencyPlans.htm</a>	YES	YES
	NSTS-07700, VOL VIII, APPENDIX R SPACE SHUTTLE OPERATIONS PROGRAM DEFINITION & REQUIREMENTS	SPACE SHUTTLE PROGRAM DOCUMENT CENTER WEBSITE <a href="http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm">http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm</a>	YES	YES

SHUTTLE FLIGHT DIRECTOR MCC CONSOLE DOCUMENTATION CHECKLIST - TABLE 2.2.6-1 (CONTINUED)

DOCUMENT NAME	DOCUMENT NUMBER	HOW TO FIND LATEST VERSION	FLIGHT DIRECTOR CONSOLE UPDATE REQD IN WHITE-FCR?	MOD CONSOLE UPDATED REQUIRED IN WHITE-FCR?
CONTINGENCY BINDER (numerous documents – see full list in next column)	AGENCY CONTINGENCY PLAN FOR SPACE OPERATIONS	NC WEBSITE <a href="http://sma.jsc.nasa.gov/contingencyPlans.htm">http://sma.jsc.nasa.gov/contingencyPlans.htm</a>	YES	YES
	DEPARTMENT OF DEFENSE MANAGERS SPACE SHUTTLE PROCEDURES DOCUMENT	DM/FLIGHT DYNAMICS OFFICE (FDO) is the point of contact to obtain latest version.	YES	YES
	3610-04 DEPARTMENT OF DEFENSE SPACE SHUTTLE CONTINGENCY FUNCTIONAL PLAN	DM/FLIGHT DYNAMICS OFFICE (FDO) is the point of contact to obtain latest version	YES	YES
SHUTTLE FINAL COUNTDOWN PHASE SIMULATION (SOO44)	SOO44	SPACE SHUTTLE PROGRAM DOCUMENT CENTER WEBSITE  <a href="http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm">http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm</a>	YES	NO
COMM ACTIVATION	V1117	SPACE SHUTTLE PROGRAM DOCUMENT CENTER WEBSITE  <a href="http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm">http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm</a>	YES	NO

SHUTTLE FLIGHT DIRECTOR MCC CONSOLE DOCUMENTATION CHECKLIST - TABLE 2.2.6-1 (CONTINUED)

DOCUMENT NAME	DOCUMENT NUMBER	HOW TO FIND LATEST VERSION	FLIGHT DIRECTOR CONSOLE UPDATE REQD IN WHITE-FCR?	MOD CONSOLE UPDATED REQUIRED IN WHITE-FCR?
LAUNCH COMMIT CRITERIA (2 VOLS)	NSTS-16007	SPACE SHUTTLE PROGRAM DOCUMENT CENTER WEBSITE  <a href="http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm">http://sspweb.jsc.nasa.gov/pdcweb/pdc.cfm</a>	YES	YES
FLIGHT DATA FILE (FDF)	NUMEROUS DOCUMENTS	DO MASTER LIST/WEBSITE  <a href="http://mod.jsc.nasa.gov/do3/">http://mod.jsc.nasa.gov/do3/</a>	NO - THIS IS NORMALLY DONE BY DO/FDF PERSONNEL AT L-2 DAYS BUT SHOULD BE VERIFIED TO BE ON CONSOLE	NO - THIS IS NORMALLY DONE BY DO/FDF PERSONNEL AT L-2 DAYS BUT SHOULD BE VERIFIED TO BE ON CONSOLE
STATION OPERATIONS DATA FILE (SODF)	NUMEROUS DOCUMENTS	DO MASTER LIST/WEBSITE  <a href="http://mod.jsc.nasa.gov/do3/">http://mod.jsc.nasa.gov/do3/</a>	NO - THIS IS NORMALLY DONE BY DO/SODF PERSONNEL AT L-2 DAYS, BUT SHOULD BE VERIFIED TO BE ON CONSOLE	NO - THIS IS NORMALLY DONE BY DO/SODF PERSONNEL AT L-2 DAYS BUT SHOULD BE VERIFIED TO BE ON CONSOLE

## 2.3 SHUTTLE ASCENT

### 2.3.1 Ascent Checklist

#### Continuous Intact Abort Coverage

RTLS – TAL – PTA  
 RTLS – PTA

PTA:  ATO Day 1 PLS (85)  
 ATO Steep  
 ATO Day 2 PLS (105)

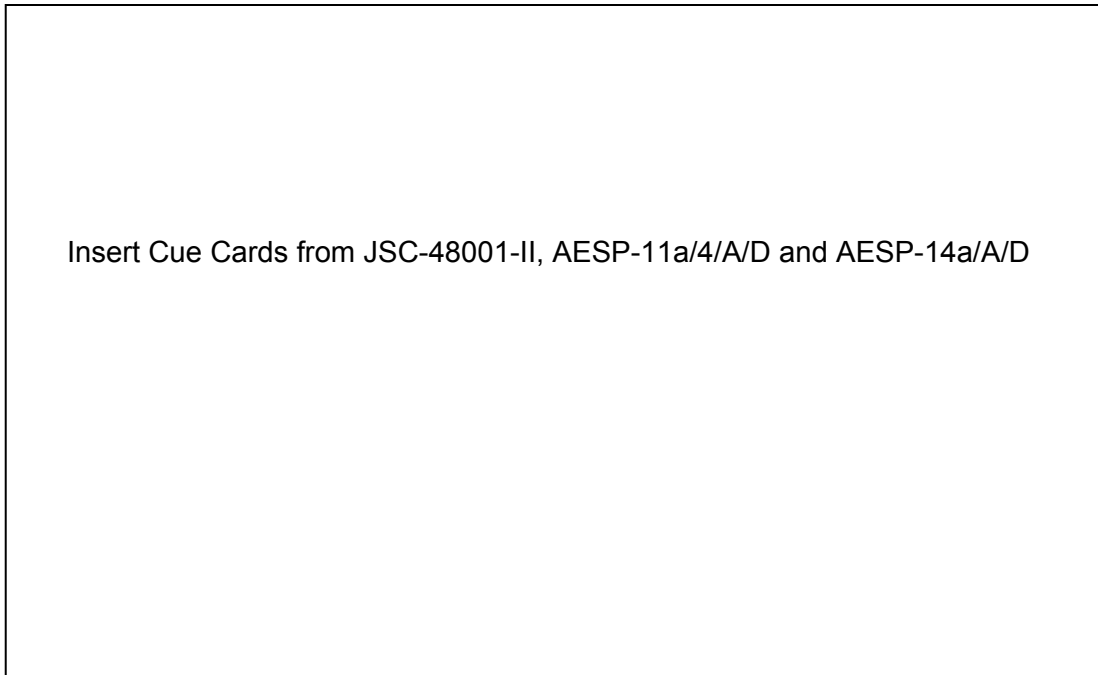
INCL	TAL SITES	AOA SITES	1 <sup>st</sup> Day PLS	2 <sup>nd</sup> Day PLS
28.5	BYD, BEN, MRN	EDW, NOR, KSC	EDW, NOR	EDW, NOR, KSC
39	BYD, BEN, MRN	EDW, NOR, KSC		
51.6	ZZA, MRN, BEN	NOR, KSC		
57	ZZA, MRN, BEN	NOR		

#### Abort Landing Site Evaluation (Need Go Obs & Go Forecast)

	RTLS	TAL			AOA	1 <sup>st</sup> Day PLS	2 <sup>nd</sup> Day PLS
WX OBS						NR	NR
WX Forecast							NR
Entry Analysis						NR	NR
<ul style="list-style-type: none"> <li>▪ A&amp;L Transition</li> <li>▪ TD Margin</li> <li>▪ Aimpoint</li> <li>▪ Speedbrake</li> <li>▪ Braking</li> <li>▪ NZ/QBAR</li> <li>▪ Wheel Speed</li> </ul>						↓	↓
Sun Angle						↓	↓
Sun Glare							
Ground NAVAIDS						ETRO	ETRO
<ul style="list-style-type: none"> <li>▪ TACAN</li> <li>▪ MLS</li> </ul>						↓	↓
Landing Aids						ETRO	ETRO
<ul style="list-style-type: none"> <li>▪ PAPI</li> <li>▪ Ball Bar</li> <li>▪ Lights</li> </ul>						↓	↓
Runway Conditions							
<ul style="list-style-type: none"> <li>▪ Dry, wet, ...</li> <li>▪ Shoulders</li> </ul>							
Daylight (unless crew trained)						NR	NR
TLM							
Voice							
Tracking		NA	NA	NA	NR		
WX Support							

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### 2.3.2 Ascent Cue Card Template



#### Hardover SSME TVC

ACT: DIR	1 <sup>st</sup> Stage	2 <sup>nd</sup> Stage
C: +P, +Y, -Y L: +P, -P, -Y R: +P, -P, +Y	Prior to 1:40	No Action
L: +Y R: -Y	Prior to 1:40	Single Engine Press
C: -P	Prior to 7:00	

#### Jets Required for Sep

Jet Group	NOM	RTLS
FWD DOWN	1	3
FWD YAW	-	1/SIDE
AFT L, R	1/SIDE	3/SIDE
AFT UP	1/SIDE	2/SIDE
AFT DOWN	1/SIDE	2/SIDE

#### SSME Limits Management

Condition (RL = redline sensor)	Limits Management	
2 2/3 SSME	Remain ENA	
1 SSME↓ & BFS engaged	INH thru MECO	
1 SSME↓ & BFS not engaged	1 RL↓ & either SSME 1 fail from erroneous S/D	INH until SE Limits/SE RTLS
	1 RL↓ & neither SSME 1 fail from erroneous S/D	ENA
	≥2 RL↓ same type (press, temp) & either running SSME 1 fail from erroneous S/D	INH thru MECO
1 SSME↓ & 1 Non-isol He Leak	≥2 RL↓ same type (press, temp) & neither running SSME 1 fail from erroneous S/D	ENA
	SE Limits/RTLS supported w/o ICNCT to good SSME	ENA
Data Path on running SSME	ICNCT to good SSME reqd	INH before violation of RL to prevent S/D (INH thru MECO)
	0 SSME↓	ENA
2 SSME↓	1 SSME↓	INH thru MECO
	Low LH2 NPSP	INH thru MECO
Low LH2 NPSP	Hard ENA unless low LH2 NPSP result of 1 FCV failed closed	
GPC Set Split & 2 SSMEs auto INH	Hard ENA	
3 SSMEs running and 1 SSME TVC↓	INH until 2E TAL or PPA complete	
3 SSME RTLS abort	Toggle before MET 8min	

#### Abort Priorities

- Powered Flight
  - PTM
  - PTA
  - TAL
  - RTLS
  - TAL to ACLS
  - AOA SH (ARCS Press Q & cont CG)
- Post-MECO
  - Nom, ST D/O
  - ATO/ATO ST
  - ATO Min Hp ST, ARCS Press Q
  - ATO Min Hp SH, ARCS Press Q & cont CG
  - AOA ST, ARCS press Q & cont CG
  - AOA SH, ARCS Press Q & cont

SYS Flight Rules		RTLS	TAL
<b>OMS</b>	- 2 He TKs		*
	- 1 OX & 1 FU TKs (diff pods)		X
	- 2 OX or 2 FU TKs		X
<b>APU/HYD</b>	- Impending loss of all capability	X	X
<b>CABIN LEAK</b>	- (-EQ dP/dT > .15)	X	X
<b>CRYO</b>	- All O <sub>2</sub> (H <sub>2</sub> )	X	X
<b>2 FREON LOOPS</b>	↓ [Accum Qty (↓ and decr) and/or Flow (↓)]	X	X
<b>2 MAIN BUSES</b>	↓	X	
<b>THERMAL WINDOW PANE</b>		X	

\* = ft specific based on ATO/AOA capability

**Lakebed Runway Required:**

- \*1 APU/HYD↓
- 2 APU/HYD↓ (NOR preferred)
- 2 LAT AAs↓
- 2 RGAs↓
- 2 FCS CHs↓
- 2 ADTAs↓
- 4 RHC R/P CHs
- 2 IMUs↓
- @1 IMU↓ (LKBD preferred)

\* Region II/III – EDW22/04 & WX  
 @EDW complex with LKBD avail;  
 Region II/III – EDW22/04

Restriring – Ascent/Entry			
Period	Capability	BFS Go	BFS No-Go
Powered Flight (Regain throttle to avoid RTLS/TAL/CA)	Avoid CA	X	X
	Restriring required to support RTLS/TAL abort (jets for sep, NWS, vent, ASA)	X	X
	Restriring not required to support RTLS/TAL abort	X	
Post-MECO to ET SEP	Jets for Sep (Nom/RTLS/TAL)	X	X
Post ET SEP	Maintain single fault tolerance (incl BFS)	X	
	Regain insight to known problem	X	X
	If OMS1 @ MECO+2m – to regain 2 OME	X	X
Deorbit – MM304	Regain all strings	X	*
MM304 – HAC	NWS – Dir Control Problem or RTLS/TAL/AOA abort (KSC)	X	X
	Vent doors (Nom @ TAEM, reqd by 70K ft) (fwd/aft – one side, mid – 6 of 8)	X	X
	ASA Command (require 2, except BF req 1)	X	X

\*Restriring only if MM304 – HAC restriring requirements are met.

### 2.3.3 LSO Interfaces During Aborts

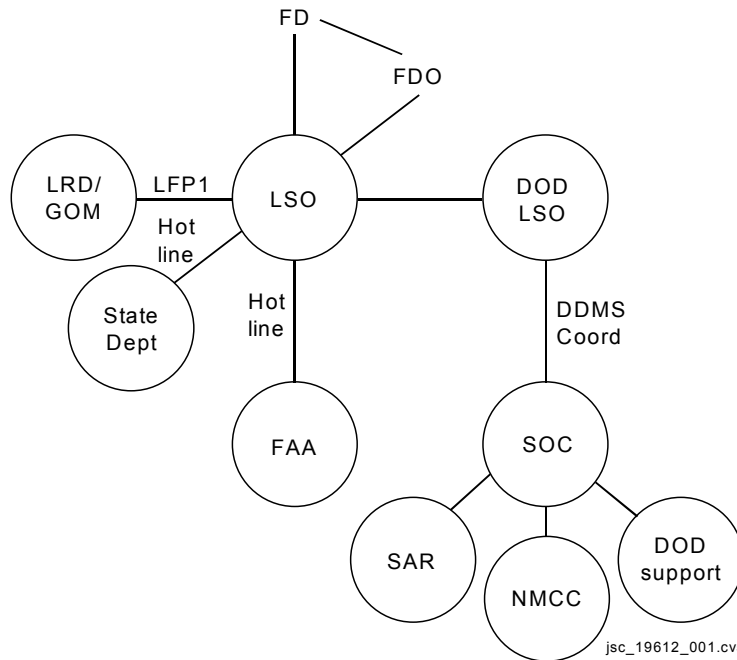


Figure 2.3.3-1. LSO Communications for an RTLS

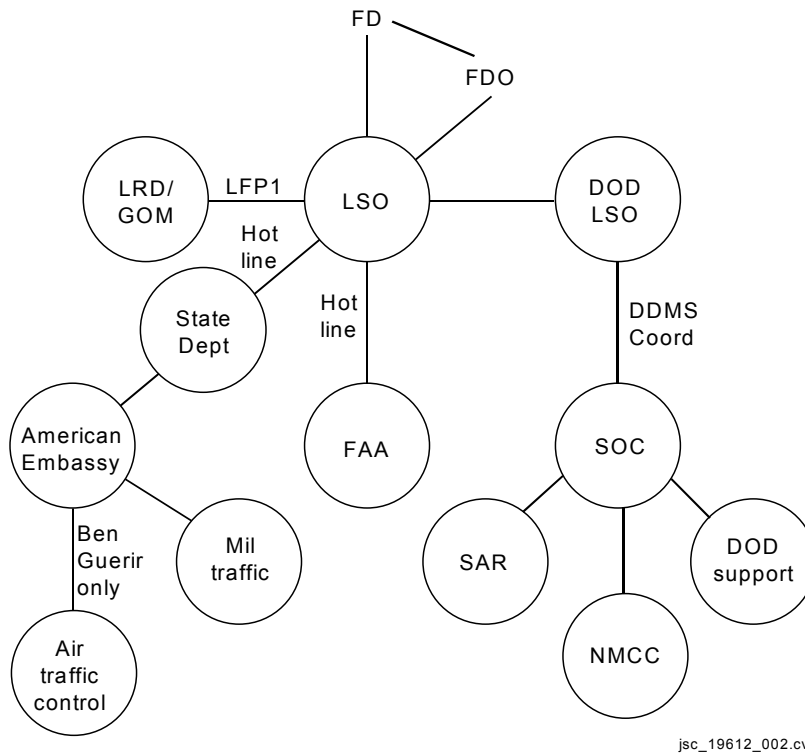
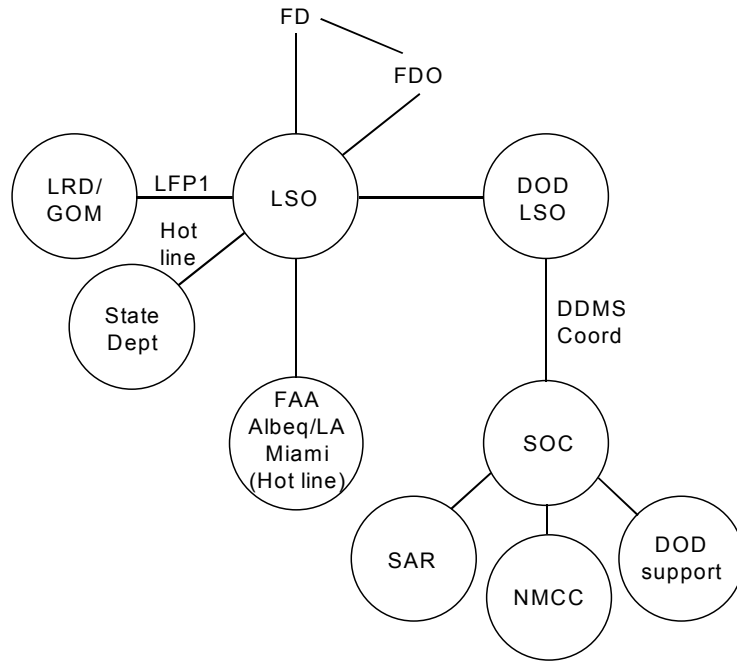


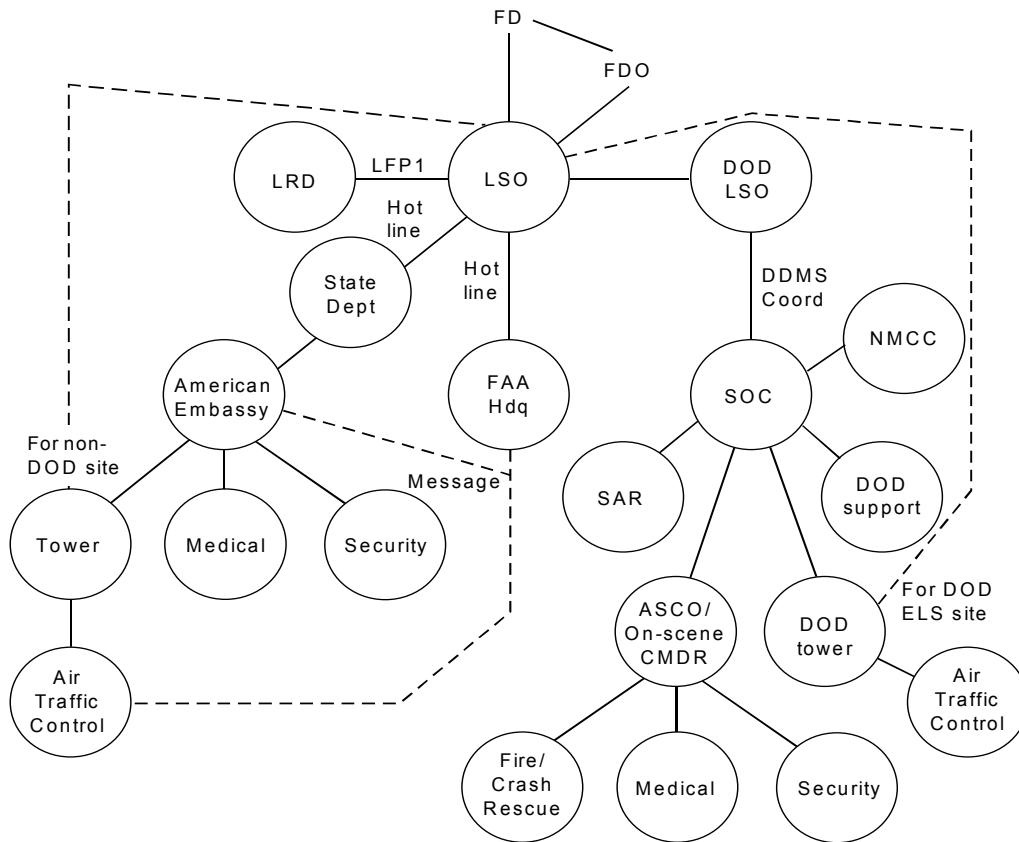
Figure 2.3.3-2. LSO Communications for TAL





jsc\_19612\_003.cv5

Figure 2.3.3-3. LSO Communications for AOA



jsc\_19612\_004.cv5

Figure 2.3.3-4. LSO Communications for an ELS Landing

## 2.4 SHUTTLE ORBIT

### 2.4.1 Private Medical Conference/Private Family Conference Checklist

#### A. Philosophy

A Private Medical Conference (PMC) is a private conference held periodically between crewmembers and the Surgeon to discuss crew health issues or status. These are generally scheduled in the flight plan, but can also be requested by the crew if necessary and may be conducted via A/G or OCA. A few minutes before the PMC is scheduled to start, the Surgeon will relocate to the BIOMED MPSR and inform the Flight Director when ready to support. A/G PMCs are generally held on A/G 1 but it is good practice to include the specific loop(s) when requesting GC configure the network so that all participants are cognizant of which A/G(s) will be used for the PMC. Unless needed, it is a good idea to secure both A/G 1 and A/G 2. Configuration of the network includes inhibiting the monitoring or recording of A/G voice and removing any voice patches made for external distribution. If video will be used during the PMC, White Sands will turn off Ku-band channel 3 TV monitor and inhibit voice and video recording. Once the network is configured and Surgeon is ready, CAPCOM will call the crew and ask if they are ready to support the PMC on A/G # or OCA. When the crew confirms they are ready, CAPCOM will tell them that the next voice they hear will be the Surgeons. At that time, request that GC secure A/G # if using A/G and once GC has confirmed A/G # is secure, give the Surgeon a go for the PMC.

Configuring the network and securing A/G is not required for a PMC via OCA but Surgeon must be aware of this in case OCA problems are experienced. Configuring the network is little impact and should be performed unless an approximately 5 minute delay to configure the network following OCA problems is acceptable. Securing the A/Gs only takes about 10 seconds so as long as the Surgeon is aware that A/G is not secure, there is no real driver for securing A/G for an OCA PMC.

Once the PMC is complete, Surgeon will call on the FD loop and announce the PMC is complete. At that time, A/G voice capability is re-enabled and the network reconfigured for normal operations.

A Private Family Conference (PFC) is similar to a PMC with respect to privacy but is scheduled to give the crewmember some personal time to communicate with family. The same steps for configuring the network and securing A/Gs if via A/G apply.

Refer to FCOH SOP 6.3 for more information.

#### B. A/G PMC checklist

1. ✓ Surgeon relocating to support PMC
2. Configure network for PMC on A/G 1 (2).

NOTE:

It is a good idea to secure both A/G 1 and A/G 2 if no impact to operations.

3. When network is configured and Surgeon is ready, have CAPCOM ask the crew if they are ready.

4. When the crew is ready, the CAPCOM will inform them that the next voice they hear will be the Surgeon's.
5. Call GC: Secure A/G 1 (2)
6. When GC confirms A/G 1 (2) is secure: Give Surgeon Go for PMC.

C. OCA PMC checklist

1. ✓ Surgeon aware of planned network and A/G config during PMC
2. ✓ Surgeon relocating to support PMC
3. Configure network for PMC on OCA if desired.

NOTE:

Configuring the network for an OCA PMC is not required but will eliminate about a five minute delay if OCA problems are encountered during the PMC.

4. When network is configured if desired and Surgeon is ready, have CAPCOM ask the crew if they are ready.
5. When the crew is ready, the CAPCOM will inform them that the next voice they hear will be the Surgeon's.
6. If secure A/G desired, Call GC: Secure A/G 1 (2)

NOTE:

Securing A/G for an OCA PMC is not required but the Surgeon must be aware that if OCA problems are experienced, A/G must be secured before continuing the PMC via A/G.

7. Give Surgeon Go for PMC.

## 2.4.2 Presleep Checklist

### A. Philosophy

The goals in the presleep timeframe are to supply the crew with any needed information to complete the presleep activities, ensure that the vehicle systems and alarm limits are configured so that the crew will not be awakened unnecessarily, provide the crew with a short summary of significant changes to tomorrow's plan and alert the crew to any activities which are occurring soon after wakeup, and to ensure that the ground has all required information from the crew so that tomorrow's plan and procedure updates (including any systems or payloads troubleshooting procedures) can be developed overnight during the crew sleep period. All positions should be asked early in the presleep period to access whether any unique crew actions are required before sleep, or whether there is any information required from the crew for planning shift activities.

To the extent practical, information the crew needs to configure the vehicle before sleep should be provided early in the presleep time period, and conversations with the crew should be minimized during the crew meal and the hour before sleep. Ideally, all information the crew needs to complete the Presleep Activity procedure in the Orbit Operations Checklist, as well as any other vehicle configuration changes the crew needs to make before sleep, should be provided at one time early in the presleep period. On shifts where the Flight Director is busy coordinating other activities immediately before the presleep timeframe, the Flight Director may assign another FCR position the task of collecting all the presleep inputs and generating an integrated flight note for FCT review and read up by the CAPCOM.

### B. Presleep checklist

1. Read up information to crew required for Presleep Activity (ORB OPS)
  - a. Supply water dump required? If yes, EECOM provides dump quantities.
  - b. EGIL provides Cryo Heater/Manf vlv config.
  - c. FAO provides time for CRT timer for wakeup.
  - d. INCO provides time for Ku-BD cable positioning.
2. FAO
  - a. Summarize significant updates to tomorrow's plan, including any activities required immediately after wakeup.
  - b. Any planned DEU equivalent maneuvers during crew sleep?
  - c. Check proper printer configuration (on if planned to uplink messages before wakeup, off if powerdown requires or no planned messages until after wakeup).

Note: No MCC insight into printer configuration.

Note: The time for morning messages to be uplinked (before or after wakeup) and the number of copies to be printed is agreed upon with each crew before flight.

- d. Check OCA configuration if OCA operations planned during crew sleep.  
Note: No MCC insight into OCA configuration.
- e. For ISS missions, uplink preliminary summary timeline for next day.
- 3. INCO - Wakeup Comm Quality Predictions (near ZOE, off nose/tail, Ku blockage)
- 4. DPS
  - a. Verify SM checkpoints performed (not required if no TMBUs since last checkpoint).
  - b. Verify CRT timer properly set for wakeup.
  - c. Verify CRT sleep configuration (one CRT off and in GNC, one CRT off and in SM). These CRTs are for DEU equivalents if required, and one CRT is off with BFC CRT sel sw selected to CRT so power cycles during crew sleep will not annunciate an alarm.
- 5. EECOM - Verify supply and waste water tanks have adequate capacity for the sleep period.
- 6. EVA - Voice up changes to tomorrow's EVA procedures, if required.
- 7. FDO - Update onboard state vector, if required.
- 8. GNC
  - a. Verify star trackers in track.
  - b. Verify flight controller power off and DDU cb's out.
  - c. Check DAP configuration.
    - (1) Vern or tail only.
    - (2) Properly configured for sleep maneuvers, if required.
    - (3) Confirm IMU switching not a problem.
  - d. Confirm IMUs will not exceed RM limits before wakeup.
- 9. PROP
  - a. OMS/RCS I'CNCT changes, if required.
  - b. OMS repress, if required.
  - c. OMS pod heater configuration changes, if required.
  - d. Verify Pri RJDs off.
- 10. Payloads
  - a. TMBUs to inhibit nuisance PL alarms during crew sleep.

b. PL Experiments operating during sleep

11. GC - Have GC inhibit A/G voice a few minutes after crew sleep begins (ref FCOH SOP 6.2).

C. Presleep Cue Card

### **PRESLEEP ITEMS**

#### **Presleep Crew Tagup**

- Supply Water Dump Qs if reqd (EECOM)
- Pre-sleep cryo config (EGIL)
- CRT Timer for wakeup (FAO)
- Ku-band antenna repositioning (INCO)

#### **FAO**

- Significant Updates to tomorrow's plan
- DEU Equivalent maneuvers during sleep
- Printer/OCA Config
- If joint ops, uplink prelim summary timeline

#### **INCO**

- Wakeup predicts (ZOE, nose/tail, Ku blockage)

#### **DPS**

- √SM ckpoints (not reqd if no new TMBUs)
- √CRT timer for wakeup
- √CRT sleep config

#### **EECOM**

- Supply/waste dump requirement

#### **EVA**

- Changes to next day's EVA procedures

#### **FDO**

- State vector update if required

#### **GNC**

- √Star trackers in track
- √Flight controller power off, DDU cbs - op
- √DAP config
- √IMUs won't exceed RM limits before wakeup

#### **PROP**

- OMS/RCS interconnect changes if reqd
- OMS repress if required
- OMS pod heater reconfig if required
- √PRI RJDs off

#### **Payloads/ACO**

- PL experiments operating during sleep
- TMBUs to inhibit nuisance alarms

#### **GC**

- INH A/G voice a few minutes before sleep

#### **TMBU's**

- EECOM
- GNC
- PROP
- INCO
- Payloads/ACO
- MMACS
- PDRS

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### 2.4.3 Shuttle Orbit Planning

#### A. Philosophy

The objective of the planning team is to prepare changes to the flight plan and procedures for the next day's activities. Timeline changes, FDF procedure changes, CAPCOM "happy words", mission summary message, Failure/Impact/Workarounds (FIWs), Earth observation opportunities, and payload/science summaries are provided to the crew in the form of an Execute Package. The goal is to have the Execute Package available to the crew by wakeup.

When the Execute Package is uplinked via OCA, messages can be uplinked throughout crew sleep as they are approved as long as auto print is disabled since the uplink is silent. However, if messages are uplinked via TIPS, uplink is usually delayed until crew wake depending on preflight agreements with the crew. In either case, if problems arise which delay uplink, the following priorities should be used:

1. Flight Plan Update (AM)
2. Flight Plan Overview
3. Mission Summary
4. Flight Plan Update (PM)
5. FIWs
6. Entry Block Data
7. IFM Procedure Change

#### Additional References:

FCOH SOP 2.3 Execute Package Assembly and Distribution

FCOH SOP 2.3.1 STS Flt Pln Replanning for Flight without an Interactive Planning POCC

FCOH SOP 2.3.2 STS Flt Pln Replanning for Flights with an Interactive Planning POCC

FCOH SOP 2.3.3 Real-time STS Flight Data File Change Process

FCOH SOP 2.3.4 Message Review and Uplink

CHB section 2.7 for Joint Shuttle/ISS Planning



## B. Mission Summary Message

The mission summary message is supplied to the FAO by FDO and includes inputs from PROP. This message includes the information on the next PLS opportunities, OMS leak procedures, and deorbit delta V capability.

```
YOUR CURRENT ORBIT IS: 192 x 190

NOTAMS
-----
      EDW LAKEBED RED
      NOR LAKEBED GREEN

NEXT 2 PLS OPPORTUNITIES
-----
      KSC ORB 21 - 01/07:45
      EDW ORB 38 - 02/09:40

OMS TANK FAIL CAPABILITY:
-----
      R OMS FAILS: YES (SHALLOW TARGETS)
      L OMS FAILS: YES (STEEP TARGETS)

LEAKING OMS PRPLT BURNS:
-----
      R OMS LEAK:          BURN OUT-OF-PLANE AN+15 < TIG < AN+44
                           OTHERWISE BURN RETROGRADE
      L OMS LEAK:          ALWAYS BURN OUT-OF-PLANE

CURRENT OMS QUANTITIES (%):
-----
      L OMS   OX:    43.09           R OMS   OX:    43.27
              FU:    47.51           R OMS   FU:    47.14

SUBTRACT INTERCONNECT COUNTER FROM CURRENT OMS QUANTITIES

DELTA V AVAILABLE:
-----
      OMS                420 fps
      AFT (TOTAL ABOVE QTY1) 42 fps
      -----
      TOTAL IN THE AFT      462 fps
```

Figure 2.4.3-1. Example Mission Summary Message

C. Planning Templates

The schedule for inputs, review, and approval of the Execute package contents with respect to crew wakeup time is based on whether there is an interactive planning POCC and whether the mission is single shift or dual shift. For ISS assembly Shuttle missions, refer to section 2.7 for the Joint Shuttle/ISS planning template.

<u>Wakeup</u>	<u>Crew</u>	<u>MCC (without interactive POCC)</u>	<u>MCC (with interactive POCC)</u>
-15			FCT Review of SSP Constraints Package
-14			SSP Constraints Package to POCC
-13	FDX		FAO/Customer Conference
-12		STS and P/L Δs to FAO	Science-P/L Planning Meeting
-11			Tentative Plan for P/L activities available
-10	Pre-Sleep	STS Δs to Customer	
-9			
-8		P/L incompatibility with STS Δs to FAO	
-7		Final attitude/timeline Δs & FIWs to FAO (begin msn summary)	Final attitude/timeline Δs & FIWs to FAO (begin msn summary)
-6		Execute Pkg inputs due (written)	Execute Pkg inputs due (written)
-5		Execute Pkg inputs due (electronic)	Execute Pkg inputs due (electronic)
-4	Sleep		
-3			
-2		Flight Plan Review	Flight Plan Review
-1		Final message approval (begin uplink)	Final message approval (begin uplink)
+0			
+1	Post Sleep	MCC distribution of Execute Package	MCC distribution of Execute Package
+2			
+3			
+4	FDX+1		
+5			

Figure 2.4.3-2. Single Shift Planning Template

<u>Red</u>	<u>Red Crew</u>	<u>Blue Crew</u>	<u>Blue</u>	<u>MCC Planning for Red Team</u>	<u>MCC Planning for Blue Team</u>
<u>Wake</u>			<u>Wake</u>		
<u>up</u>			<u>up</u>		
+7			-5		Execute Pkg inputs due for FDY (written)
+8			-4		Execute Pkg inputs due for FDY (electronic)
-15			-3		
-14	Red	Sleep	-2		Flight Plan Review for FDY
-13	FDX		-1		Final msg approval for FDY (begin uplink)
-12			+0	STS and P/L Δs to FAO for FDX+1	
-11		Post-sleep	+1		MCC distribution of Execute Pkg for FDY
-10		Handover	+2	STS Δs to Customer for FDX+1	
-9	Pre-Sleep		+3		
-8			+4	P/L incompatibility w/STS Δs to FAO for	
-7			+5	Final att/timeline Δs & FIWs to FAO for FDX+1	
-6			+6	(begin msn summary)	
-5		Blue	+7	Execute Pkg inputs due for FDX+1 (written)	
-4	Sleep	FDY	+8	Execute Pkg inputs due for FDX+1 (electronic)	
-3			-15		
-2			-14	Flight Plan Review for FDX+1	
-1			-13	Final msg approval for FDX+1 (begin uplink)	
+0			-12		STS and P/L Δs to FAO for FDY+1
+1	Post-sleep		-11	MCC distribution of Execute Pkg for FDX+1	
+2			-10		STS Δs to Customer for FDY+1
+3		Pre-sleep	-9		
+4	FDX+1		-8		P/L incompatibility w/STS Δs to FAO for
+5		Sleep	-7		Final att/timeline Δs & FIWs to FAO for FDY+1
+6			-6		(begin msn summary)

Figure 2.4.3-3. Dual Shift Planning Template without Interactive Planning POCC

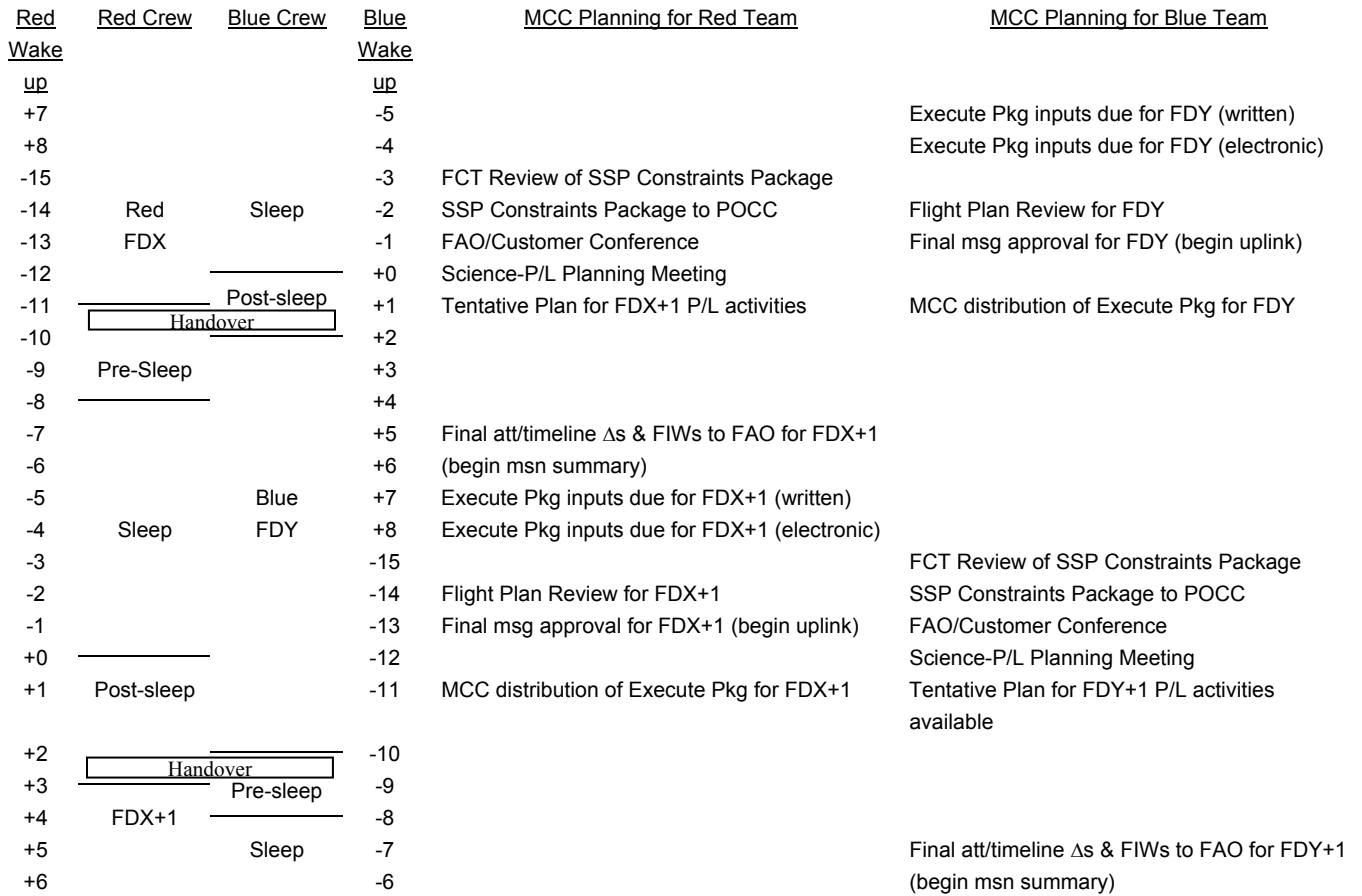


Figure 2.4.3-4. Dual Shift Planning Template with Interactive Planning POCC

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## 2.5 SHUTTLE DEORBIT/ENTRY

### 2.5.1 Entry – 1 Day Checklist

- ❑ FCS Checkout Review
- ❑ RCS Hot Fire Review
- ❑ Entry Messages Review
  - Entry C/L
  - EPCL
  - AESP
  - D/O Prep
  - D/O Backout
  - Post-landing (Hyd Load Test)
- ❑ Entry Trajectory Review (downtrack)
- ❑ Deorbit/Landing Data Sheets
- ❑ D/O Burn Flight Rules Review
- ❑ Water Plan Review
- ❑ Weather Brief/Tagup
- ❑ Contingency Procedures Review
  - Late PLBD Close
  - Re-open/re-close Doors (asc rev to desc rev)
- ❑ Items for Convoy

Deorbit/Landing Data Sheets are generated by FDO during the entry – 1 day shift for each of the opportunities being considered. This data along with corresponding groundtrack plots are delivered via distribution D and is also available electronically from the DEC Alpha by selecting from the Master DNAV: Shuttle > FDO > Applications > Deorbit-Landing Data Sheets.

Deorbit to EDW on Orbit 20  
Generated MET 000/19:46:23

Event	Time MET/Central	Latitude (D:M)	Longitude (D:M)	H	Velocity (KFPS)	Comments
Deorbit TIG	001/05:30:05 180/15:19:05	38 : 56 S	64 : 03 E	154.4 NM	25.4 VI	$\Delta V = 261$ fps $\Delta T = 05:26$ M:S XR = R 178 NM
TDRS-W AOS	001/05:34:45 180/15:23:45	35 : 10 S	85 : 39 E	152.5 NM	25.2 VI	EI Minus 22:53 MM:SS
EI	001/05:57:38 180/15:46:38	16 : 32 N	161 : 01 E	415.1 KFT	24.6 VREL	Range 4435 NM
MACH 2.5 TAEM	001/06:23:14 180/16:12:14	35 : 11 N	118 : 39 W	76.8 KFT	2.4 VREL	
MACH 1	001/06:25:21 180/16:14:21	35 : 06 N	117 : 59 W	45.5 KFT	.9 VREL	HAC I/C 01:28 MM:SS
HAC I/C	001/06:26:50 180/16:15:50	35 : 04 N	117 : 46 W	25.1 KFT	.7 VREL	Turn Angle 134 DEG
Landing	001/06:29:26 180/16:18:26					Runway EDW22
Roll Schedule				Roll (DEG)	VREL (KFPS)	GMT (H:M:S)
1 <sup>st</sup> Roll Command (To The Right)				80	24.5	180/20:52:09
1 <sup>st</sup> Roll Reversal (R to L)				55	19.4	180/21:00:30
2 <sup>nd</sup> Roll Reversal (L to R)					10.0	
3 <sup>rd</sup> Roll Reversal (R to L)					5.0	

Figure 2.5.1-1. Example Deorbit Landing Data

## 2.5.2 Entry Planning

TBS

### ENTRY MSG

- Pre-deorbit switch list
  - IFM
  - Deorbit Prep C/L
  - Flight Plan
  - Entry Checklist
  - Post-landing
  - Pre-deorbit Advisory (entry team)
  - Pre-deorbit Burn Rules (entry team)
  - MSN NOTE: R/T Advisory
- (System config, Time crit action)**



The Entry Summary message is sent to the crew on entry day. Generally, the planning team will have the message ready for review by the Entry team so that it may be uplinked soon after the entry team arrives on console. A dual site entry summary message may be generated for cases where KSC weather is marginal and Edwards opportunities will be considered. This message is the same as the single site message illustrated below but will have deorbit/landing information for both sites side by side.

```

GOOD MORNING COLUMBIA,
EVERYTHING IS GO FOR A NOMINAL DEORBIT PREP AND ENTRY. ORBIT IS 138 X 104. DEORBIT DELTA V
WILL BE APPROXIMATELY 215 FPS INPLANE. CROSS RANGE WILL BE 116 NM. AT THE DEORBIT BURN YOU
WILL HAVE:
L OX = 27.97%           R OX = 28.41%
L FU = 27.97%           R FU = 28.79%

THE PRDICTED POST DEORBIT BURN OMS QUANTITIES ARE AS FOLLOWS:
L OX = 8.99%           R OX = 9.30%
L FU = 8.86%           R FU = 9.96%

FORWARD RCS DUMP TO 0%

ROLL REVERSAL HISTORY:
V = 19800 FPS
V = 10100 FPS
V = 4500 FPS

CG AT EI: X = 1084.8
CG AT M3.5: X = 1083.0  Y = -0.7

ATMOS ITEM:           22
ELEV. SCHED:          AUTO
BODY BENDING FILTER:  ALTERNATE

DEORBIT TIG           13/22:23:52
LANDING APPROX.       13/23:16:52

KSC WX CURRENT        25 SCT 250 SCT
KSC WX FCST           25 SCT 250 SCT
KSC WIND FCST
50K    260/40
38K    270/30
28K    290/25
20K    270/20
12K    250/15
7K     250/10
SFC    210/5P10
ALTIMETER 30.03
DENSITY ALTITUDE -635 FT

HAC PROCEDURES: NOMINAL
R OVHD TO KSC 33
TURN ANGLE 212 DEG
NOMINAL AIM POINT
ALL NAV ADIS ARE OPERATIONAL
TD 2800 FT AT 205 KTS
3K SPEEDBRAKE: 15%

LAKEBED STATUS
EDW: RUNWAYS 15/33 ARE GREEN

```

Figure 2.5.2-1. Entry Summary Message

### 2.5.3 Deorbit Prep Checklist

<u>Site</u>	<u>Rev</u>	<u>TIG</u>
_____	_____	/ : _____
_____	_____	/ : _____
_____	_____	/ : _____
_____	_____	/ : _____

Flight Plan  
RCS Hotfire, FCS C/O  
PMC, FC Purge, Powerup  
**Entry Summary Message**  
**MCC Update:**  
**IMU Pad (stars & verify)**

*Flight Plan*

<u>TIG</u>	<u>Activity</u>	<u>TIG</u>	<u>WX Briefings/Reports</u>
-5:00	IMU Align		
-4:15	Mnvr Tail-sun	<b>-4:15</b>	<b>FD/STA PLT WX Brief (AFD/VITT)</b>
<i>Transition to D/O Prep C/L</i>			
-4:00	CRT Timer Setup ( <u>Block 1</u> ) <b>MCC Update:</b> TIG		
-3:56	Coldsoak Init ( <u>Block 2</u> ): Rad Out – Hi; FES PRI B - ON		
-3:48	Ku Stow: Deact TIPS, cable posn, stow		
-3:45	Rad Stow (if reqd)	-3:30	T-38 Takeoff
-3:29	DPS Config ( <u>Block 4</u> ): Dual G2, √BFS		
-3:25	APU/HYD Config ( <u>Block 5</u> ): HYD Therm Cond Term (circ pumps – off) APU Steam Vent Htr (3) – B, ON FCS CH (4) – AUTO, ATVC (4) – ON		
-3:20	<b>MCC Uplink:</b> PASS SV (if reqd)		
-3:15	Ded Disp Config ( <u>Block 6</u> ) <b>MCC Update:</b> Sw/cb deltas Partial Ent Switch List/Verify	<b>-3:00</b>	<b>WX Brief/Tagup (PLBD Close Go/No-Go)</b>
-2:55	Rad Byp/FES C/O: XOVR – OP; Rad Byp – Man, Byp √Sec Hi Load, Sec Topper, Pri B Hi Load PYLD Deact (if reqd)		
-2:51	Config for PLBD Close ( <u>Block 7</u> )		
-2:48	<b>MCC: Go/No-Go for PLBD Close:</b> WX, FDO, GPO, EECOM, MMACS, GNC, DPS √WX, TD & Rollout, Cooling, Mech <b>MCC: D/O Burn FR Review:</b> FD/CAPCOM copies from FAO		
-2:45	<b>MCC Update:</b> Comm Att		
-2:40	PLBD Close ( <u>Block 9</u> ) Single latch gang out – min G HAC, PTIs no-go <b>FD/NCC Phone Tagup (optional)</b>	<b>-2:40</b>	<b>T-38 Flight/Landing Report</b>
-2:27	<b>MCC: Go/No-Go for OPS 3</b>		
-2:25	Mnvr to Comm Att (D/O att if good comm)		
<i>Transition to EPCL</i>			
-2:15	DPS Entry Config ( <u>Block 12</u> )	<b>-2:15</b>	<b>√TD-4 hr balloon results</b>
-2:02	<b>MCC Uplink:</b> PASS/BFS SV & Tgts; Load Tgts <b>BFS:</b> IMU gyro/accel comps, TMBUs Config DVIS		
-1:58	Deact S/T & Door Close ( <u>Block 13</u> )		
-1:55	Ent Fwd/Aft/Mid (Blocks 14,15,16) Config:		

	Brakes/NWS – ON; VERNs OFF; FES PRI B – GPC; PCS O2/N2 Sys 1 – OP, 2 – CL; UHF Act		
	<b>MCC Update:</b> Sw/cb deltas Final Ent Switch List/Verify		
-1:45	<b>MCC Uplink:</b> TMBUs; D/O Burn Rule Deltas		
-1:42	DEORB PAD Update ( <i>Block 17</i> ): <b>MCC Update:</b> OMS PRPLT, D/O MNVR, DELPAD <b>MCC Uplink:</b> PASS/BFS SV&Tgts; Load Tgts		
-1:40	Final BFS Door Close Time	-1:40	STA Takeoff
-1:25	CDR/PLT Suit-up ( <i>Block 19</i> ) Take MOC Checkpoint		
-1:10	Others Suit-up ( <i>Blocks 20,21</i> )		
-1:06	IMU/IMU Align ( <i>Block 22</i> ) RM Reset – any deltas		
-1:03	<b>MCC Update:</b> Fluid Loading Deltas		
-1:00	FD/NCC/GOM Tagup post comm checks (Command Net) CDR/PLT Seat Ingress		
-0:55	LEH O2 – OP; LES Press Integrity Checks (CDR/PLT) <i>Transition to Ent C/L</i>	-0:50	WX Brief/Tagup
-0:46	Final Deorb Update/Uplink <b>MCC Update:</b> DEL & OMS PRPLT PADs <b>MCC Uplink:</b> PASS/BFS SV & Tgts; Reload Tgts		
	Verify atmosphere selection		
-0:42	OMS TVC GmbI Check APU Pre-start HORIZ SIT Config OVERRIDE (PASS/BFS Elev, SSME Repos, Wrap, BB Filt, BFS DES) √BFS Gimbal config same as PASS	-0:42	√TD-2.5 hr balloon results
-0:35	Galley/WCS Deact (by EI): Vac Vent – CL, Vac Vent Isol – CL, Noz Htr – OFF		
-0:30	OMS Burn Prep		
-0:25	Vent Door Close (before MM302)		
-0:22	<b>MCC: Go/No-Go for D/O Burn, OPS 302</b>		
-0:20	Mnvr to D/O Burn Att		
-0:05	Single APU Start (Attempt 1 or 2 APUs)		

If No-Go for D/O Burn:

HYD MN PUMP PRESS (3) – NORM

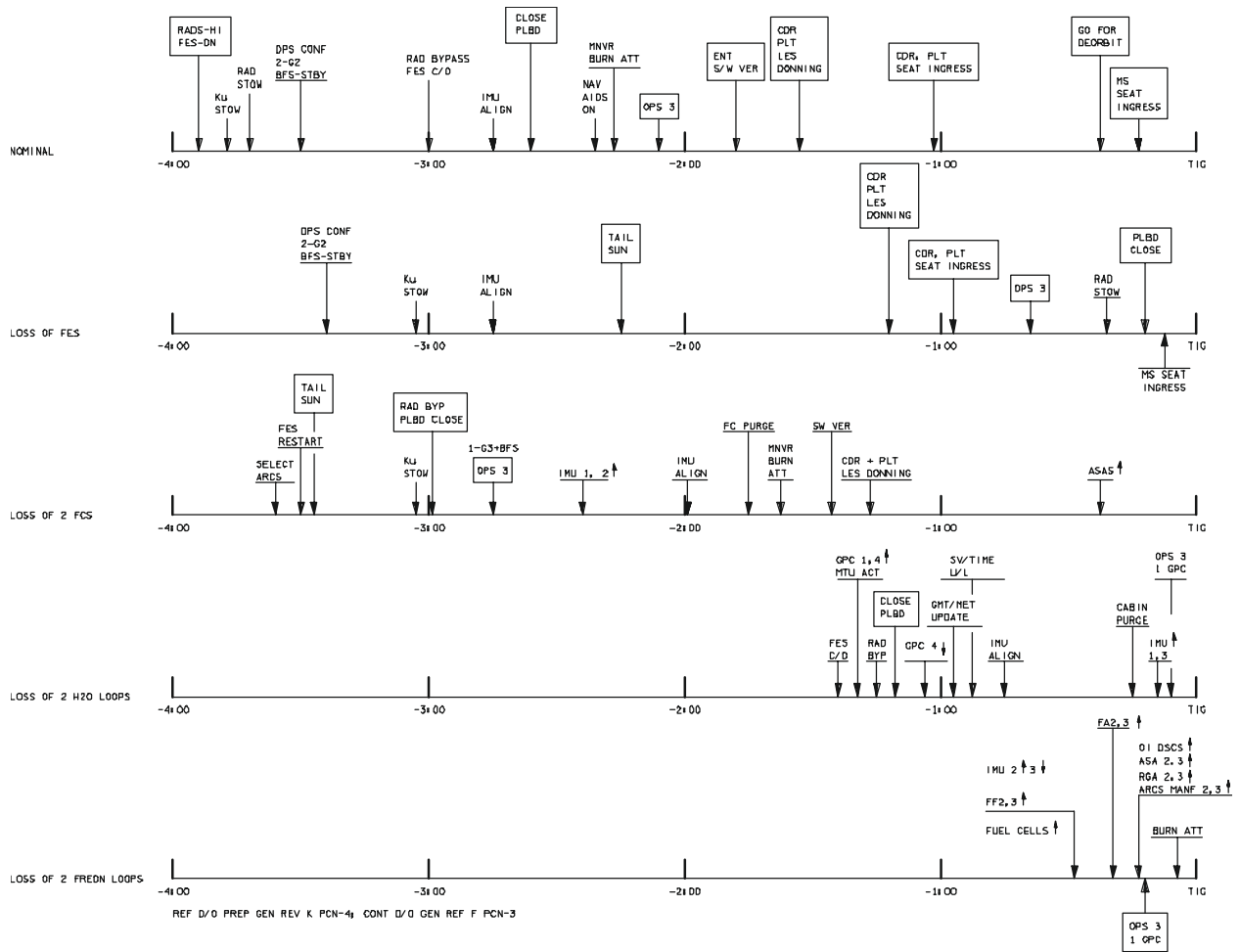
OPS 301 PRO

Then:

<u>TIG</u>	<u>1 Rev Delay</u>	<u>ET</u>	<u>24 Hr Delay</u>
	RCS/OMS Heater Config; Open H2O TK C	+0:00	RCS Reconfig
-1:10	IMU/IMU Align		<i>Transition to D/O Prep C/L and OPCL</i>
	Fluid Loading (1 orbit late)		Flight Deck MS egress
	Final Deorb Update/Uplink	+0:02	Config for PLBD Opening ( <u>Block 1</u> ):
	<b>MCC Update:</b> DEL & OMS PRPLT PADs		CRT4 – ON, Setup Lights
	<b>MCC Uplink:</b> PASS/BFS SV & Tgts; Reload Tgts	+0:03	Rad Act ( <u>Block 2</u> ): Auto A(B)
-0:15	RCS/OMS Heater Reconfig	+0:04	APU/HYD Config ( <u>Block 3</u> ):
-0:10	Mnvr to attitude		APU Shutdown, Bir N2 Sply (3) – OFF
		+0:05	PLBD Opening ( <u>Block 5</u> ): BFS
		+0:11	<b>MCC: Go/No-Go Group C</b> (at ~2:00)
		+0:15	Rad Deploy (if reqd)
		+0:19	Vernier Htr Act ( <u>Block 6</u> )
			LEH O2 – CL
			Seat Egress – middeck
		+0:23	Prelim Middeck Config ( <u>Block 7</u> ):
			Comm, Vac Vent htr config
		+0:24	Open Vent Doors
		+0:26	CDR/PLT Seat Egress
		+0:40	PYLD React if reqd
		+0:41	DPS Config to G2/SM ( <u>Block 11</u> )
			√Dual or single G2, Orbit TFL/DFL
		+0:45	Rad Verif and FES Config ( <u>Block 12</u> ):
			Rad flow, FES OFF
		+0:46	RMS Lts/Htr/C&W ( <u>Block 13</u> )
		+0:48	Ku Deploy/Act if reqd
		+0:52	Middeck Config ( <u>Block 14</u> ):
			WCS, galley, CO2, pole, flood lt config
		+0:53	<b>MCC: Go/No-Go for Verns</b>
			RJDs, A/AUTO/VERN
		+1:05	Brakes/FCS/Ded Display Config ( <u>Block 16</u> ):
		+1:20	Htr Config ( <u>Block 17</u> )
		+1:25	H2O Loop 2 Byp – Auto; Pump Loop 1 - GPC
		+1:30	Mnvr -ZLV -XVV
		+1:39	PCS 2(1) Config ( <u>Block 19</u> )
		+1:40	ST Act ( <u>Block 20</u> )
		+1:44	HYD Therm Cond Ena
		+1:51	Airlock Setup for Ingress ( <u>Block 21</u> )
		+1:58	<b>On MCC Call: Group C Pwrdrn</b>

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### 2.5.4 Deorbit Prep Equipment Fail Timelines



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DEORBIT PREP EQUIPMENT FAIL TIMELINE.

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## 2.5.5 Entry Checklist

<u>Site</u>	<u>Surface Winds</u>	<u>PRI TAC</u>	<u>SEC TAC</u>	Xcg (M=3)	_____
_____	_____/_____/_____P_____	_____	_____	Ycg (M=3)	_____
				Ldg Wt	_____

<u>Rwy</u>	<u>Lakebed</u>	<u>MLS</u>	<u>Winds</u>	<u>Aimpoint</u>	<u>S/B</u>	<u>3K ft</u>	<u>500 ft</u>
_____	Green/Red	JR/SR ch ____	____H/T____L/R	NOM/CLS	NOM/SF	____%	____%
_____	Green/Red	JR/SR ch ____	____H/T____L/R	NOM/CLS	NOM/SF	____%	____%

	<u>Nominal</u>	<u>Off-Nominal</u>
Post-burn	Flt Cntl Pwr – OFF, DAP – AUTO, OMS/RCS Reconfig OPS 303, OMS Gmb1 Pwrdown √Prebank, Sec Act Ck (EI-20), FRCS Dump Time (EI-18), Hyd Fluid Thermal Cond (EI-11) ENA FD A/G Loops	
EI-13	Remaining APUs Start Hyd Pump – Norm Press SSME Hyd Repress	<u>If 2 APUs:</u> Lo Press until EI-6, SSME Hyd Repress @EI-6 <u>If 1 APU:</u> Lo Press until MM304 @ EI-2, Delete Repress
EI-10	EI-5 Att (LVLH 0,40,0) √Flt Cntrl Pwr – ON √TD-1 hr balloon results	<u>If GPC↓ and BFS Go:</u> Restrng
EI-5	OPS 304 PRO (PTIs INH)	<u>If Prebank:</u> √Roll (R/Y CSS, Roll @ 1°/sec if reqd)
Qbar = 2	Elevon Cycle	<u>If OMS He/OX or RCS Ox Tk Leak:</u> G51 Vent Doors – OP
Qbar = 8	Closed Loop Guid Init	<u>If prebank:</u> P, R/Y – AUTO
Qbar = 10	Roll Jets Deact $\alpha = 40^\circ$	
Qbar = 20		<u>Go for No Yaw Jet</u> if reqd
Qbar = 40	Pitch Jets Deact	
V = 19K	<b>SSME Reposn Go/No-Go for V=8K</b>	<u>If SSME Reposn No-Go:</u> G51 INH
V = 15K	NAVAIDs – ON (I/O Reset if reqd)	<u>If ELS:</u> UHF Mode – G T/R
V = 12K	Rad Byp Vlv Mode (2) – AUTO Cntrl Loop (2) – AUTO B(A)	
V = 10K	SB 81% (begin ramp open)	<u>If Delta State reqd:</u> <u>If Delta State No Joy:</u>
Filter Call	<b>Energy, groundtrack, Nav Go/No-Go</b> (w/good filter)	INH D, CSS P&R/Y Sel TACAN on HSI Source Se GCA if reqd – PRIORITY Force: TACAN/AD as reqd
V = 9.5K	Handover to MILA/DFRC	<u>When NAV is Go:</u> Center needles, Sel AUTO P&R/Y
V = 7.5K	<b>Take TACAN</b> (PASS ____, BFS ____) SB 81%	Take TACAN, Air Data (Drag), Xfer SV to BFS
V = 7K	SSME Reposn (CP = +10, LP = 0, RP = 0)	<u>APU Cooldown</u> if reqd
V = 6.2K	√STA/WX/Runway	<u>Runway redes by V=6K</u> (10 min for night)
V = 5K	AD Probes – DPLY Rudder Act (√AIL Trim)	<u>AIL Trim &gt; 3°:</u> BF – MAN, UP
V = 4K	Hdot < 500 fps	
M = 3.2	<b>Take AD</b> (G&C ____, PASS NAV ____, BFS NAV ____) SB 65% (begin ramp from 81%)	PNL Trim – ENA, Roll Trim away from AIL Trim
M = 2.7	HUD Pwr – ON	



	Trim Sw Config (Panel – OFF, RHC/PNL – ENA)	
	Verify vent doors open (before 75K ft)	
M = 2.5	AD to G&C (P CSS to incorp)	<u>If 1 APU failed:</u> Sel Hi Spd
	TAEM (Roll to WP1), SB 65%	<u>If 2 AAs failed:</u> P CSS
M = 2.0	AD to G&C	<u>If no AD to G&amp;C:</u> P CSS, Theta Limits
	√BF – AUTO	
HAC Prep	<b>Changes to:</b> Winds/WX, Energy, TD spd, Chute Deploy, NWS/Brakes, Beep Trim, other GNC advisories	
M = 1.5		<u>If no AD to G&amp;C:</u> √Theta Limits
M = 1.0	Subsonic (Yaw Jets Deact)	
M = 0.9	CSS P, R/Y (CDR or PLT?)	
	R Fit Cntrl Pwr – ON (NWS)	
M = 0.7	LG Extend Isol Vlv – OP	
On HAC	E Calls: < 1K = ON, 1-2K = slightly low/hi, >2K = low/hi	
H = 15K	MLS incorporation	
H = 10K	A/L Trans, Visors – CL, LES O2 – ON (KSC)	
	On Centerline and GS, Surface Wind Update (_____)	
H = 5K	RAs good	If disagree, call is “Suspect RA’s”
H = 3K	SB Retract	<u>If BFS engaged:</u>
H = 500	SB Adjust	Man SB for 2K ft
H = 300	LG Down/Locked	Man SB full open at MGTD
MGTD	WOW, Chute Arm/Deploy, Derotate	
NGTD	WONG, GS ENA/Auto Load Relief	<u>B/U Wong:</u> SRB Sep (AUTO or MAN pb) – Push
	HYD Brake Isol Vlv (three) – OP	

## 2.5.6 Post-Landing Checklist

If APU Hydrazine, OMS, RCS, or MPS Leak: APU's OFF ASAP

If RTLs or TAL: Open ET doors early

If RTLs: √BSE: MPS Dump Complete then **Call LRD/GOM**: Nom MPS Dump Complete

If ELS: **MCC Go/No-Go**: Doff Suits (post safety assessment)

<u>Activity/Event</u>	<u>MCC</u>	<u>Crew</u>
Wheels Stop	√Post-landing updates: MMACS, PROP, EECOM, EGIL, GNC, DPS, INCO, BSE, PL, FAO <b>MCC Update</b> : Post Landing Delta's CDR & FCT confirmation Call NCC: RJDs off, Side hatch, drag chute, and landing gear safed. √INCO: S-band PM/FM on upper antenna Call LRD/GOM: S-band system on upper antennas If KSC: √INCO, GC: MILA to low power Call LRD/GOM: Go for MILA – low power	RCS, OMS Safing (RJDs) Drag Chute Safing (n/a for ELS) Landing Gear Safing (n/a for ELS) Side Hatch Safing
Crew call for ET doors	Call NCC: ET doors coming open. <b>MCC Update</b> : Hydraulic Load Test is (is not) required (5 <sup>th</sup> flight) √Go/No-Go for G9 transition: DPS, PROP, GNC (BF-trail), INCO INCO (BFS to STBY for recorder dump) <b>MCC Go/No-Go</b> : G9 Transition, BFS mode √DPS: G9 transition complete If KSC: √LRD/GOM: SSME position <b>MCC Go/No-Go</b> : SSME Reposn √NCC: GSE cooling is (is not) available √Go/No-Go for extended powerup: EECOM, EGIL, INCO, MMACS, BSE, DPS, GNC, PROP <b>MCC Go/No-Go</b> : Extended powerup <b>MCC Go/No-Go</b> : APU Shutdown	ET Umbilical Door Opening (12s dual mtr) Hydraulic Load Test          Set Bdy Flap DPS Transition – GNC 9 (If PASS)          SSME Repositioning
SSME Reposn Complete APU Shutdown Complete	Call NCC: SSME reposn, APU shutdown complete √NCC, MMACS: Vent door purge positioning <b>MCC Go/No-Go</b> : Vent door purge positioning Call NCC: Vent door purge positioning complete If No-Go for Ext Pwrup:  √DPS: GPCs – STBY, Halt	APU/HYD Shutdn Post Landing MPS Reconfig (shutdown + 1min) PCS Deactivation Vent Door Purge Positioning (n/a if ELS) RCS, OMS Valve Test If No-Go for Ext Pwrup:  GPC Deact PL Deact if reqd Pwrdn (FC/MN Bus, Ess Bus Source FC-OFF)
Vent Door Posn Complete RCS, OMS Valve Test Complete	If Go for Ext Pwrup: √DPS: Single G9 GPC	If No-Go for Ext Pwrup: Sys Deact for Ext Pwrup GPC Pwrdn Post-landing Payload Activities if reqd LRU Deactivation APU Heater Deactivation RCS/OMS Heaters Pwrdn
Prior to Crew Egress	Comm check with ASP √NCC: Ready to Init GSE cooling	Egress

NH3 Deactivation

MCC Go/No-Go: NH3 Deact  
Call NCC: NH3 Deact complete  
Handover to GOM When:  
Crew Egress Complete (CTV departs)  
√EECOM: Stable GSE Cooling  
√GOM/LRD/NTD: TLM @ LCC  
√NCC: Comm with ASP  
√LRD: Good Command (If KSC)  
Call NTD: MCC handing over vehicle

NH3 Deact (performed by ASP if post-egress)

## 2.5.7 Entry Cue Card Templates

POSTLANDING						
Condition		Emergency Pwrn		Expedited Pwrn Mode V Egress	APU S/D ASAP	SSME Repo No-Go
		Mode V Egress	Normal Egress			
Fire	Confirmed/Suspected with Halon Discharge			X		
	Smoke, Fire, or obvious structural damage	X				
	Wheel well or brake with potential for wheel well	X			X	
	Explosive, flammable conditions	X				
Leaks	OMS/RCS Ox Leak (isol or non-isol, jet leaks n/a)				X	
	OMS/RCS Fu Leak (jet leaks exempt)			*	X	
	APU Fu Leak (seal cavity drain exempt)			*	X	
	MPS Ox/Fu Leak				X	
	Non-isol hydrogen leak > 6.5 lbs/hr (5.5 lbs/hr if Spacelab)			X	X	
	Non-isol hydraulic leak				X	
Intolerable Crew Cabin (crew call)	X					
Cooling	Loss of both freon loops		X			
	Loss of both water loops		X			
	Loss of both NH3 systems and temps critical		X			
Comm/ TLM	Loss of comm between crew-NCC (including MCC relay and visual signals)			X		
	Loss of all TLM (MCC/LCC) and onboard systems monitoring (if comm avail, MCC will determine if Mode V reqd)			X		
Incomplete	MPS LH2 Dump (RTLS, TAL, AOA)			X		
APU Failures	APU shift to high speed				X	
	Insufficient lube oil or hydraulic cooling				X	
	2 APU/Hyd↓/Shutdown					X
Systems/ Avionics	BFS Engaged					X
						X
	Body Flap Anomaly (if unisolatable)					X
	Multiple aerosurf pfb's failed					X
	Both PCMMUs↓					X
	OI MDM OA1 or DSC OA1↓					X
ATVC Cmd/Actual position delta > 2.0 degrees						X

\*Expedited powerdown/Mode V Egress if leak is non-isol or isolated during RTLS, TAL, AOA, or post-D/O TIG.

Other Constraints	
Action	Condition
Side hatch Opening	Vent Cabin to > 3.2 PSID prior to opening
NH3 Activation	MCC Call or EVAP OUT T High H2O Pump Loop 1 – ON NH3 CNTLR A(B) – PRI/GPC (SEC/ON) Continue monitoring per Entry CL, pg 5-6
Handover to GOM/LRD	Nominal: crew egress or GSE cooling activation, whichever later ASAP: MCC loss of TLM/Comm with Orbiter Mode V or VI Egress EMCC

<b>Restraining – Ascent/Entry</b>			
Period	Capability	BFS Go	BFS No-Go
Deorbit – MM304	Regain all strings	X	*
MM304 – HAC	NWS – Leaking tire or aborts	X	X
	Vent doors (Nom @ TAEM, reqd by 70K ft) (fwd/aft – one side, mid – 6 of 8)	X	X
	ASA Command (require 2, except BF req 1)	X	X

\*Restraining only if MM304 – HAC restraining requirements are met.

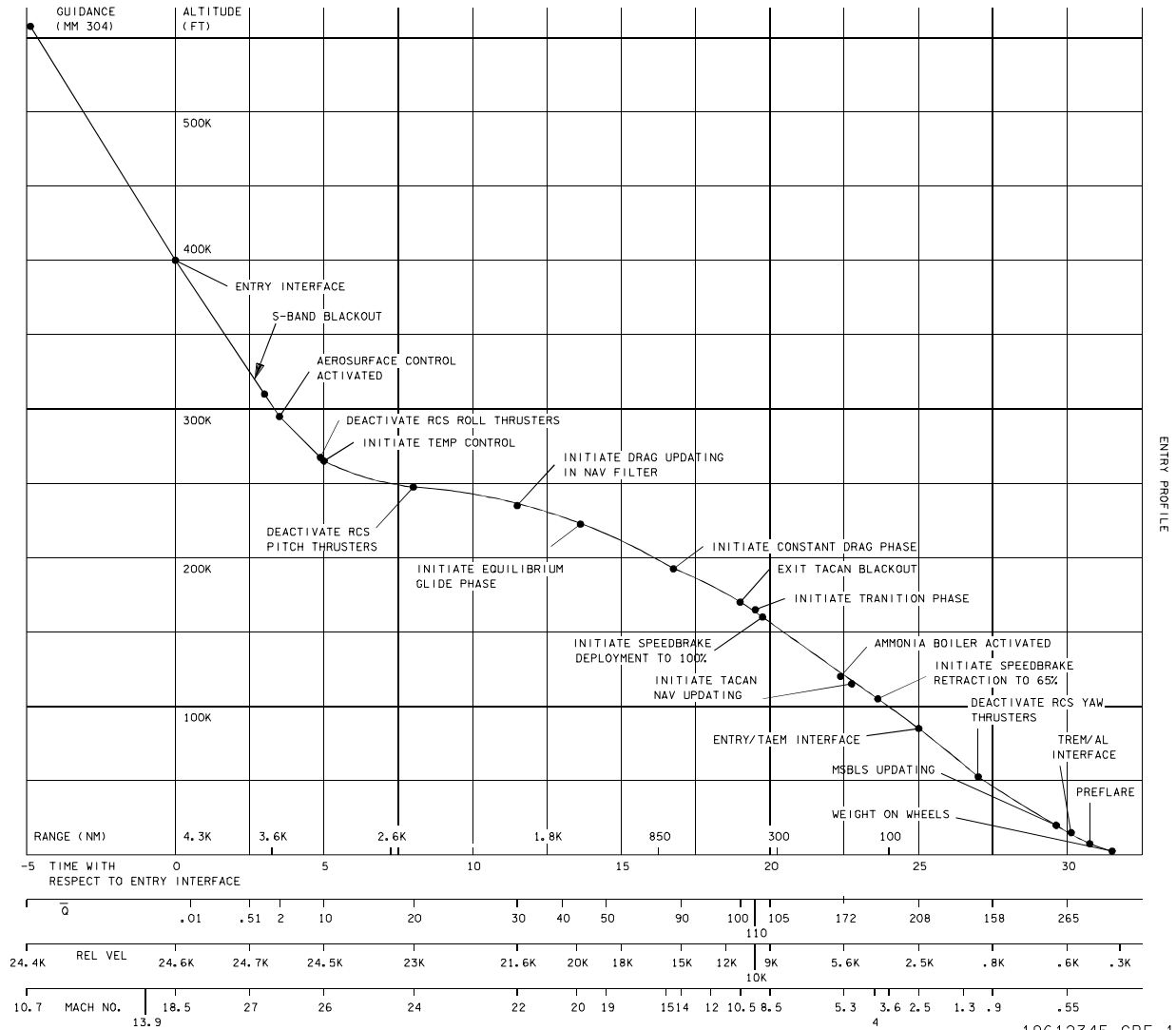
**Contingency (FCOH SOP 2.8)**

1. Notify MOD & JSC Director, NASA Centers via TWX
2. Notify: Deputy Director, Space Shuttle Program  
Director, MOD  
Director, FCOD  
Chief, Institutional Safety (NS3)  
GSFC, Network Director (declared contingency only)
3. Declare Contingency Plan per FCOH Procedure 2.8
4. Continue with Procedure

**Lakebed Runway Required:**

- \*1 APU/HYD↓
- 2 APU/HYD↓ (NOR preferred)
- 2 LAT AAs↓
- 2 RGAs↓
- 2 FCS CHs↓
- 2 ADTAs↓
- 4 RHC R/P CHs
- 2 IMUs↓
- @1 IMU↓ (LKBD preferred)

\* Region II/III – EDW22/04 & WX  
@EDW complex with LKBD avail;  
Region II/III – EDW22/04



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## 2.6 WEATHER PROCEDURES

### 2.6.1 Weather Interfaces and Responsibilities

#### 2.6.1.1 Launch

##### Weather Recon

- General evaluation of overall weather at and in the vicinity of the site
- Evaluation of upstream weather patterns
- Evaluation of environment data
  - Visibility to landing aids (fog, smoke, etc)
  - Potential sun angle/glare concerns
  - Clouds/cloud layers (tops/bottoms)
  - Rain Shower evaluation and tracking
  - Turbulence, shears, handling qualities
- Evaluation of landing approach and touchdown parameters (STA only)
  - A&L transition
  - Touchdown parameters
  - Speedbrake
  - Handling qualities
- Evaluation of specific issues identified during WEATHER briefs
- Go/No-Go for observations based on current conditions and trends, NOT a forecaster
- Interfaces
  - Weather Coordinator
  - Weather CAPCOM

##### Weather Coordinator

- Directs and coordinates KSC WX aircraft movement and items to be evaluated for launch and RTLS weather constraints
- Requires coordination with Weather CAPCOM for launch/RTLS evaluation (can relinquish direction of STA to Weather CAPCOM directly if only RTLS weather issues)
- Updates aircraft on STS timeline/decision points, open issues, and concerns.
- Interfaces:
  - KSC Weather (launch weather)
  - Weather CAPCOM (RTLS weather)
  - FD, FDO, SMG Weather indirectly via Weather CAPCOM

##### Weather CAPCOM

- Directs TAL WX Aircraft movement and items to be evaluated based on inputs from FD, FDO, and TAL Weather
- Coordinates KSC weather aircraft movements and items to be evaluated through the Weather Coordinator based on inputs from FD, FDO, and CONUS Weather
- Liaison between MCC team and weather aircraft
- Supplies runway, HAC turn, and aimpoint for STA approach and landing runs
- Records STA winds, approach and landing data
- Updates aircraft on STS timeline/decision points, open issues, and concerns.
- Interfaces



- Weather Coordinator/KSC WX Aircraft
- TAL WX Aircraft
- CONUS and TAL Weather
- FDO
- CAPCOM
- Weather FD
- Ascent FD

#### CONUS and TAL Weather

- Records and evaluates observations and develops forecasts (clouds, visibility, rain showers, TRW, upper level winds, surface winds).
- Distinguishes Go/No-Go for obs and forecast based on Flight Rule A2-6 Landing Site Weather Criteria
- Receives observations and data from ground observer(s), KSC weather office, WX Aircraft/Weather Coordinator, Weather CAPCOM, satellite, radar, etc.
- Supplies FDO with upper level and surface wind forecasts
- Supplies FD/MCC team with observation and forecast evaluations
- Interfaces
  - Weather CAPCOM for WX Aircraft data/eval
  - FDO/Winds Coordinator
  - Weather FD
  - Ascent FD
  - Ground Observers
  - KSC Weather

#### FDO

- Recommends specific runway and aimpoint/speedbrake selection based upon weather evaluation, landing and rollout evaluation
- Receives site/runway status (including NAVAIDs, landing aids, lights) from LSO
- Tracking of weather issues (RTLS, TAL, AOA, 1st day PLS) including rain/TRW storm tracking
- Interfaces
  - CONUS and TAL Weather
  - Weather CAPCOM
  - MPSR (Winds Coordinator, landing analysts, LSO, ...)
  - Ascent FD
  - Weather FD

#### Weather Flight Director

- Observer and data recorder
- Assists Ascent FD track multiple problems/issues mostly in weather arena
- Interfaces:
  - Weather CAPCOM
  - Weather Coordinator
  - CONUS and TAL Weather
  - FDO
  - Ascent FD

### 2.6.1.2 Landing

#### Weather Recon

- T-38 Flight
  - General evaluation of overall weather at and in the vicinity of the site
  - Evaluation of upstream weather patterns
  - Evaluation of STS downtrack
  - Evaluation of specific issues identified during weather briefs
- STA Flight
  - Evaluation of environment data
    - Visibility to landing aids (fog, smoke, etc.)
    - Potential sun angle/glare concerns
    - Clouds/cloud layers (tops/bottoms)
    - Rain Shower evaluation and tracking
    - Turbulence, shears, handling qualities
  - Evaluation of landing approach and touchdown parameters (STA only)
    - A&L transition
    - Touchdown parameters
    - Speedbrake
    - Handling qualities
  - Evaluation of specific issues identified during weather briefs
  - Information for STS CDR/PLT
  - Go/No-Go for observations based on current conditions and trends, NOT a forecaster
- Interfaces
  - Weather CAPCOM

#### Weather CAPCOM

- Directs WX Aircraft movement and items to be evaluated based on inputs from FD, FDO, and TAL Weather
- Liaison between MCC team and weather aircraft
- Supplies runway, HAC turn, and aimpoint for STA approach and landing runs
- Records STA winds, approach and landing data
- Develops STS CDR/PLT Info statement with STA and MCC Team (FD, CAPCOM, FDO)
- Updates aircraft on STS timeline/decision points, open issues, and concerns.
- Interfaces
  - WX Aircraft
  - CONUS Weather
  - FDO
  - CAPCOM
  - Weather FD
  - Entry FD

#### Weather

- Records and evaluates observations and develops forecasts (clouds, visibility, rain showers, TRW, upper level winds, surface winds.
- Distinguishes Go/No-Go for obs and forecast based on Flight Rule A2-6 Landing Site Weather Criteria

- Receives observations and data from ground observer(s), KSC weather office, WX Aircraft/Weather Coordinator, Weather CAPCOM, satellite, radar, etc.
- Supplies FDO with upper level and surface wind forecasts
- Supplies FD/MCC team with observation and forecast evaluations
- Interfaces
  - Weather CAPCOM for WX Aircraft data/eval
  - FDO/Winds Coordinator
  - Weather FD
  - Entry FD
  - Ground Observers
  - KSC Weather

#### FDO

- Recommends specific runway and aimpoint/speedbrake selection based upon weather evaluation, landing and rollout evaluation
- Receives site/runway status (including NAVAIDs, landing aids, lights) from LSO
- Tracking of weather issues including rain/TRW storm tracking
- Interfaces
  - Weather
  - Weather CAPCOM
  - MPSR (Winds Coordinator, landing analysts, LSO, ...)
  - Entry FD
  - Weather FD

#### Weather Flight Director

- Observer and data recorder
- Assists Entry FD track multiple problems/issues mostly in weather arena
- Interfaces:
  - Weather CAPCOM
  - Weather Coordinator
  - Weather
  - FDO
  - Entry FD

## 2.6.2 Console Preparation

### Prelaunch Prep

1. Prepare console documentation
  - Completed prelaunch weather timeline (Table 2.6.3-1)
  - Blank copies of STA/WX Recon Data Sheets (Section 2.6.5.2)
  - TALCOM Package
  - Balloon release schedule
  - LSO NAV/Landing Aids Reference Chart
2. Review Flight Rule A2-6 Landing Site Weather Criteria
3. Determine site requirements
  - Prime TAL and backups
  - AOA if PTM based on AOA
  - PLS if PTM based on PLS
  - Night/day limits

### Entry Prep

1. Prepare console documentation
  - Completed Deorbit weather timeline (Table 2.6.4-1)
  - Blank copies of STA Data Sheets (Section 2.6.5.2)
  - Deorbit opportunities
  - Balloon release schedule
  - LSO NAV/Landing Aids Reference Chart
2. Review Flight Rule A2-6 Landing Site Weather Criteria
3. Determine site call-up plan
  - Night/day limits
  - EDO limits

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### 2.6.3 Ascent Timeline and Procedures

Table 2.6.3-1. Pre-launch Weather Timeline

T- Time	L- Time		Event	Flight Specific CST/EST (CDT/EDT)
	Short Window	Long Window		
	L- 1 Day	L- 1 Day	FD/SMG/Crew/FDO Weather Brief	
T-3:00H	L-4:25	L-3:55	Crew Weather Brief	
T-2:30	L-3:20	L-2:50	FD/SMG/FDO/WX CAPCOM Tagup (if reqd)	
T-2:05	L-2:55	L-2:25	T-38 Weather Aircraft Takeoff	
T-0:50	L-1:40	L-1:10	STA Takeoff	
T-0:40	L-1:30	L-1:00	TAL WX ACFT Takeoff	
			FD/SMG/FDO/WX CAPCOM Tagup (if reqd)	
T-0:20H	L-1:10	L-0:40	LD Weather Brief (Go/No-Go call)	
T-0:20	L-1:00	L-0:30	Crew WX Update/TAL runway changes (as reqd)	
T-0:00	L-0:00	L-0:00	Launch	

#### ECAL/ELS Weather Notes:

1. ECAL/ELS forecasts listed by SMG are “site-generated” by forecasters at the ELS sites.
2. The LSO is responsible for monitoring and updating ECAL/ELS site weather after L- 5 ½ hours.
3. The LSO will provide real-time updates to the FCT in case of an ECAL or ELS landing.

#### **Ascent FD**

##### **Launch Day Weather Briefing (L-4:25/3:55; T-3:00 Hold)**

1. CONUS briefing with CONUS WX
2. TAL briefing with TAL WX
3. KSC SLF runway briefing and 15/33 selection (FDO)
4. Release flight crew. Keep TALCOMs online.
  - Status and comments from each TALCOM
  - Any comments from TAL WX for TALCOM
5. When complete, take down conference

## WX FD

1. Configure DVIS loops
  - OIS 232
  - OIS 231 (Cape WX)
  - Weather Net (CONUS WX, TAL WX, WX CAPCOM)
  - WX ACFT (KSC)
  - TAL ACFT/ORBITER (TAL)
  - Others (OPO, SSPO, OIS 161, OIS 135)
2. Start the WX application (select Applications ▸ WEATHER on DNAV)
  - Reference Section 2.9.9 for WX app information
  - **Reminder:** WX app should be started before any other application on the workstation
3. Prepare for Initial WX Briefing @L-4:25/3:55 (T-3:00 Hold)
  - Review WX forecast sheets
  - Listen to OIS 232 during the briefing
  - WX FD is PRIME on OIS 232 to listen for calls to Houston Flight during the briefing
4. Prep for T-38 launch (TO at L-2:55/2:25)
  - Configure for KSC WX A/C loop
  - Ask CONUS for anything they want the T-38 pilot to look at during recon flight
  - Pass to WX CAPCOM instructions for T-38 pilot
5. Talk the SLF runway selections for the STA dives
  - Aimpoint and SB selection from DDS analysis
  - Discuss recommended priorities with Ascent FD
6. Get CONUS Wx ready to talk to the FD for STA launch (TO at L-1:40/1:10)
7. STA Dives
  - Copy forecast winds next to STA winds for easy comparison
  - Copy STA dive data and STA winds (usually read on climbout)
  - Give next dive info to WX CAPCOM
  - Check with CONUS WX for any required WX recon post-dives
8. Postlaunch OI-232 Monitor
  - WX FD is PRIME for KSC advisory calls on OI 232 post-launch

**2.6.4 Entry Timeline and Procedures**

Table 2.6.4-1. Deorbit/Entry Weather Timeline

Landing Site: \_\_\_\_\_

D/O TIG: Rev \_\_\_\_\_ MET (CST): \_\_\_\_/\_\_\_\_:\_\_\_\_ (\_\_\_\_:\_\_\_\_)  
 Landing: Rev \_\_\_\_\_ MET (CST): \_\_\_\_/\_\_\_\_:\_\_\_\_ (\_\_\_\_:\_\_\_\_)

TIG	Event	Flight Specific CST (CDT)
-4:15	FD/STA PLT WX Brief	
-4:00	D/O Prep Start	
-3:30	T-38 Take-off	
-3:00	WX Brief/Tagup for PLBD close decision	
<b>-2:45</b>	<b>MCC: Go/No-Go PLBD Close</b>	
-2:40	PLBD Close	
<b>-2:30</b>	<b>MCC: Go/No-Go for OPS 3</b>	
<b>-2:00</b>	<b>MCC: Go/No-Go for Crew Suit Up</b>	
-1:40	STA Take-off	
-0:45	WX Brief/Tagup (if required)	
<b>-0:20</b>	<b>MCC: Go/No-Go for Deorbit Burn</b>	
0:00	Deorbit TIG	
~+1:10	Landing	

1 REV late available:

D/O TIG: Rev \_\_\_\_\_ MET (CST): \_\_\_\_/\_\_\_\_:\_\_\_\_ (\_\_\_\_:\_\_\_\_)  
 Landing: Rev \_\_\_\_\_ MET (CST): \_\_\_\_/\_\_\_\_:\_\_\_\_ (\_\_\_\_:\_\_\_\_)



## WX FD

1. Configure DVIS loops
  - Weather Net (CONUS WX, TAL WX, WX CAPCOM)
  - WX ACFT (KSC)
2. Start the WX application (select Applications ▸ WEATHER on DNAV)
  - Reference Section 2.9.9 for WX app information
  - **Reminder:** WX app should be started before any other application on the workstation
3. Prepare for Initial WX Briefing
  - Review WX forecast sheets
4. WX Briefing on AFD-1 w/Crew Quarters
  - CONUS briefing with WX (KSC and EDW for 3 days)
  - Decide when to launch T-38 and STA
5. Watch for convergence zone at Cape
6. Prep for STA Launch – make calls through WX CAPCOM
  - Check with FD on dives (15/33, HAC selection, Aimpoint/SB settings, etc.)
  - Verify PAPI and ball bar settings before STA launch
  - Confirm any WX recon for post-dives
7. Decision Process & Data – Don't decide before you have all of the data
  - WX input (Obs and F/C)
  - DDS analysis (3 DOF and 6 DOF)
  - T-38 and STA WX Recon flights
  - STA dives
  - Crew input
    - If both ends of KSC SLF are Go HACs and runways, get crew input on negative aspects of either end
    - Consider pre-flight crew preferences
8. Pass decision to KSC LRD for convoy placement

**2.6.5 Reference Material**

**2.6.5.1 Flight Rule Summaries**

**NOTE: Flight Rules listed here are for REFERENCE ONLY. Refer to the current version, as required for official use on console.**

**Table 2.6.5.1-1. FR A2-6 LANDING SITE WEATHER CRITERIA [HC] - Ceiling/Vis (Final 6/20/02)**

CEILING/VISCEILING / VISIBILITY (K FT)/(SM)			REDUNDANT MLS	SINGLE STRING-MLS	NO MLS
KSC, EDW, NOR, AOA, DAILY PLS SELECTION (ALL SITES)	CONCRETE	DAY	≥8/5 (WX RECON REQUIRED)	≥10/7	
		NIGHT		NO-GO	
	LAKEBED	DAY		≥10/7	
		NIGHT		≥15/7	NO GO
RTLS, TAL	CONCRETE	DAY	≥5/4 RTLS >5/5 TAL (WX RECON REQUIRED)	≥10/7	
		NIGHT		NO GO	
ACLS / ECAL / ELS			0/0		≥8/5
PREDEORBIT: ONE APU FAILED OR ATTEMPT TWO APU'S PROCEDURE			≥10/7		

**Table 2.6.5.1-2. FR A2-6 LANDING SITE WEATHER CRITERIA [HC] - Winds/Turbulence(Final 6/20/02)**

SURFACE WIND (KNOTS) AND TURBULENCE		CROSS PEAK	HEAD PEAK	TAIL AVG	TAIL PEAK	GUST	TURB
RTLS		≤15 *	≤25	≤10	≤15	≤10	≤MOD
DAY	EOM, TAL, AOA, DAILY PLS SELECTION	≤15					
NIGHT	EOM, DAILY PLS SELECTION	≤12					
	TAL, AOA	≤15					
CROSSWIND DTO		≥10					
		≤15					
NOMINAL DRAG CHUTE DEPLOY		≤15					
LANDING ≥ CDR FD19		≤12					
PREDEORBIT: 1 APU FAILED OR ATTEMPT 2 APU'S PROCEDURE		≤10					≤LGT
ECAL / ELS		≤15	N/A				

REQUIRES AN STA EVALUATION TO 17 KNOTS AND A GO FROM THE STA PILOT

**Table 2.6.5.1-3. FR A2-6 LANDING SITE WEATHER CRITERIA [HC] - Crosswind/Headwind Breakdown**

Kts \ Deg	10	12	14	16	18	20	22	24	26
10	2/10	2/12	2/14	3/16	3/18	3/20	4/22	4/24	5/26
20	3/9	4/11	5/13	5/15	6/17	7/19	8/21	8/23	9/24
30	5/9	6/10	7/12	8/14	9/16	10/17	11/19	12/21	13/23
40	6/8	8/9	9/11	10/12	12/14	13/15	14/16	15/18	17/20
50	8/6	9/8	11/9	12/10	14/12	15/13	16/14	18/15	20/17
60	9/5	10/6	12/7	14/8	16/9	17/10	19/11	21/12	23/13
70	9/3	11/7	13/5	15/5	17/6	19/7	21/8	23/8	24/9
80	10/2	12/2	14/2	16/3	18/3	20/3	22/4	24/4	25/5
100	10/-2	12/-2	14/-2	16/-3	18/-3	20/-3	22/-4	24/-4	25/-5
110	9/-3	11/-7	13/-5	15/-5	17/-6	19/-7	21/-8	23/-8	24/-9
120	9/-5	10/-6	12/-7	14/-8	16/-9	17/-10	19/-11	21/-12	23/-13
130	8/-6	9/-8	11/-9	12/-10	14/-12	15/-13	16/-14	18/-15	20/-17
140	6/-8	8/-9	9/-11	10/-12	12/-14	13/-15	14/-16	15/-18	17/-20
150	5/-9	6/-10	7/-12	8/-14	9/-16	10/-17	11/-19	12/-21	13/-23
160	3/-9	4/-11	5/-13	5/-15	6/-17	7/-19	8/-21	8/-23	9/-24

170	2/-10	2/-12	2/-14	3/-16	3/-18	3/-20	4/-22	4/-24	4/-26
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**NOTE: Flight Rules listed here are for REFERENCE ONLY. Refer to the current version, as required for official use on console.**

Table 2.6.5.1-4. FR A2-6 LANDING SITE WEATHER CRITERIA [HC] -  
Tstorms, Lightning, Precip (Final 6/20/02)

THUNDERSTORM, LIGHTNING, AND PRECIPITATION PROXIMITY LIMITS (NM)		PRELAUNCH (RTLS, TAL)	PREDEORBIT (EOM, DAILY PLS) PRELAUNCH (AOA)	REDESIG CRITERIA	ELS, ECAL, ACLS
TSTORM (INCLUDING ATTACHED NONTRANSPARENT ANVILS), AND LIGHTNING	RADIAL FROM CENTER OF PRIME RUNWAY	>20	>30	>15	NONE AT SITE
	LATERAL ALONG APPROACH PATH OUT TO 30 NM	>10	>20	>5	
	VERTICAL FROM TOP OF CLOUD	>2			
DETACHED NONTRANSPARENT ANVIL < 3 HRS OLD	RADIAL FROM CENTER OF PRIME RUNWAY	>15	>20	>15	N/A
	LATERAL ALONG APPROACH PATH OUT TO 30 NM	>5	>10	>5	
	VERTICAL FROM TOP OF CLOUD	>2			
PRECIPITATION *	RADIAL FROM CENTER OF PRIME RUNWAY	>20	>30	> 15	N/A
	LATERAL ALONG APPROACH PATH OUT TO 30 NM	>10	>20	> 5	
	VERTICAL FROM TOP OF CLOUD	>2			
CUMULUS CLOUDS PRODUCED BY SMOKE/FIRE UP TO 1 HR AFTER DETACHING	LATERAL ALONG APPROACH PATH	>0			N/A

\*EXCEPTIONS EXIST FOR RTLS, SEE RULE {A2-6C}.4.a-g, LANDING SITE WEATHER CRITERIA [HC]

Table 2.6.5.1-5. FR A2-207 LANDING SITE SELECTION (Final 6/20/02)

Inclination	Dependent	Priorities	Wt/Cg	Dependent	Priorities
28.5°	39°	51.6°, 57°	Region I (Day)	Region I (Night) Region II	Region III
TAL			<sup>2</sup> AOA		
BYD BEN MRN	BEN MRN ZZA <sup>1</sup> BYD	ZZA MRN BEN	EDW LKBD EDW22/04 KSC NOR	EDW22/04 EDW LKBD KSC NOR	EDW22/04 KSC NOR EDW LKBD
RTLS			EOM		
KSC15 KSC33	KSC15 = KSC33	KSC33 KSC15	KSC (PLS) EDW LKBD EDW22/04 NOR	KSC (PLS) EDW22/04 EDW LKBD NOR	KSC (PLS) EDW22/04 NOR EDW LKBD

<sup>1</sup>BYD generally not supported for 39°

<sup>2</sup>Available AOA Sites are inclination dependent:

28.5°, 39°: EDW, NOR, KSC  
51.6°: NOR, KSC  
57°: NOR

Table 2.6.5.1-6. FR A4-155 SUN ANGLE LIMITS AND GLARE CRITERIA FOR INNER AND OUTER GLIDE SLOPES

Criteria	Runway Status
Sun Angle Violation Azimuth < 10° from Runway CL AND Elevation < 20°	No-Go
Sun Glare Sun position between 30° and 50° of the normal to CDR or PLT front window	Go but consider if more than one acceptable runway

**NOTE: Flight Rules listed here are for REFERENCE ONLY. Refer to the current version, as required for official use on console.**

Table 2.6.5.1-7. Approach, Landing, and Rollout Criteria (Final 6/20/02)

Parameter	Constraint				Comments
TD Margin Ref FR A4-110	Standard: > 1000 ft	RTLS RS Rule Invoked: >2000 ft			<ul style="list-style-type: none"> <li>Select CLSE if reqd for TD margin</li> <li>Consider CLSE if SB closed at 3K and 500 ft and TD w/CLSE closer to 2500 ft than NOM</li> <li>For daylight LKBD landings, consider relaxing constraint if CLSE and Alt runway no-go</li> <li>Consider CLSE if QBAR violation below 3K.</li> </ul>
Evaluation TD EAS Ref FR A4-110	SB Option	Lightweight	Heavyweight		If wt < 200K lb and TD < 1000 ft w/CLSE, use 185 KEAS
	Nominal	195 KEAS	205 KEAS		
Tire Speed Ref FR A4-108	Shortfield	185 KEAS	Wt <245K: 195 KEAS	Wt ≥245K: 205 KEAS	If wt < 245K and TD margin is only factor constraining launch, use 195 KEAS
	≤214 KGS at evaluation TD EAS				Use SF if required for tire speed
Rollout Margin Ref FR A4-108	W/Barrier: ≥0 ft (Consider SF if < 600 ft)		W/O Barrier: ≥2000 ft		Use SF if required
Brake Energy Ref FR A4-108	NWS Operational (Both Constraints Must be Satisfied)				NWS failed
	Scenario	with NWS	w/o NWS		Pre-deorbit: 42M ft-lb
	RTLS, TAL, AOA	82M ft-lb	82M ft-lb		Post-deorbit if > 42M ft-lb: Consider redes rwy (same site) prior to M6 to reduce crosswind
	EOM, PLS	42M ft-lb	70M ft-lb		
HAC Selection Ref FR A4-156	3- DOF		6- DOF		<sup>1</sup> Max Qbar criteria only applies to HACs ≥300° and from HAC Init to 20K AGL.  Selection Option
	Alt Low	<sup>1</sup> Max Qbar	Alt Low	<sup>1</sup> Max Qbar	
	≥3700 ft	≥290 psf	≥4500 ft	≥315 psfi	
	≥2700 ft	N/A	≥3500 ft	N/A	
	≥1700 ft	N/A	≥2500 ft	N/A	
<1700 ft	<290 psf	<2500 ft	<315 psf	No Restrictions	
A/L Transition Alt Ref FR A4-156	≥9000 ft				If <9000 ft, consider: 24 hr waveoff SLS Highest priority rwy/HAC with A/L ≥ 6000 ft
Entry Limits Ref FR A4-207	NZ		Qbar		Angle of Attack
	Wt ≤ 211K: 2.5g Wt > 211K: f(wt) Fwd cg with subsonic QBAR ≥325: f(Qbar)	Mach <1: 350 psf Gear Deploy: 330 psf		f(Mach)	

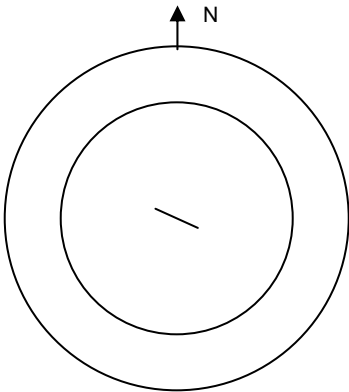
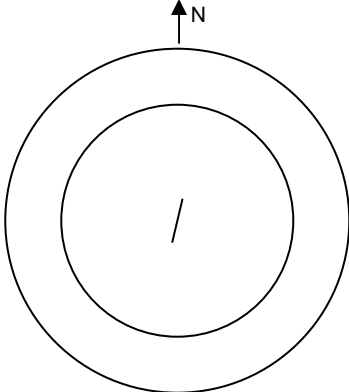
Other Flight Rule References:

- A2-259 CHASE AIRCRAFT OPERATIONS
- A2-263 STAWEATHER AIRCRAFT RUNWAY APPROACH OPERATIONS FOR SITES WITH ONLY ONE RUNWAY
- A4-107 PLS/EOM LANDING OPPORTUNITY REQUIREMENTS
- A4-109 DEORBIT PRIORITY FOR EOM WEATHER
- A4-111 RUNWAY ACCEPTABILITY CONDITIONS
- A4-112 UPPER AND LOWER LEVEL MEASURED WIND AND ATMOSPHERIC DATA

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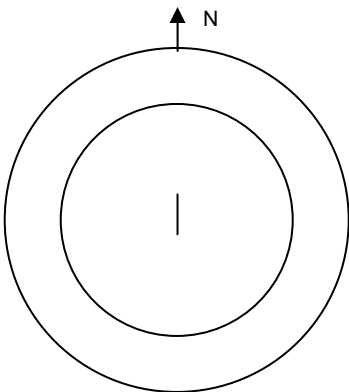
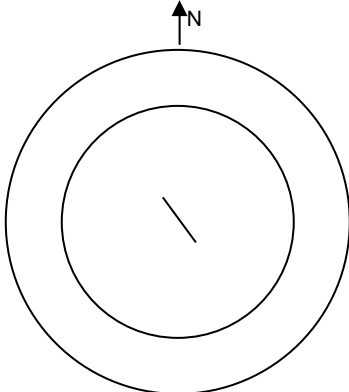
**2.6.5.2 Weather Recon/STA Data Sheets**

**TAL WX Recon**

Parameter	ZZA30/12	MRN20/02
Landing GMT		
Sunset/Sunrise GMT		
Lit/Dark		
Cloud/RS/TS Pictorial  Runway 20 nm circle (radial limit) 30 nm circle (lateral limit applicability)		
Observations (GMT, WX, Winds, Go/No-Go)	GMT	GMT
Forecast (GMT, WX, Winds, Go/No-Go)	GMT	GMT
TALCOM Comments Cloud/RS/TS Dir/DME Movement Tops/Bases/Thickness Ceiling (% , BKN, OVC,...) Rain/virga/TS Comments  Visibility  Winds	GMT	GMT
NAVAIDs/Landing Aids TACAN, MLS PAPI, Ball Bar Lights		
WX Recon Requests		

**TAL WX Recon (cont)**

Parameter	BEN36/18	BYD32/14
Landing GMT		
Sunset/Sunrise GMT		

<p>Lit/Dark</p> <p>Cloud/RS/TS Pictorial</p> <p>Runway 20 nm circle (radial limit) 30 nm circle (lateral limit applicability)</p>		
<p>Observations (GMT, WX, Winds, Go/No-Go)</p>	<p>GMT</p>	<p>GMT</p>
<p>Forecast (GMT, WX, Winds, Go/No-Go)</p>	<p>GMT</p>	<p>GMT</p>
<p>TALCOM Comments Cloud/RS/TS Dir/DME Movement Tops/Bases/Thickness Ceiling (% BKN, OVC,...) Rain/virga/TS Comments</p> <p>Visibility</p> <p>Winds</p>	<p>GMT</p>	<p>GMT</p>
<p>NAVAIDs/Landing Aids TACAN, MLS PAPI, Ball Bar Lights</p>		
<p>WX Recon Requests</p>		



**KSC33/15 WX Recon**

Parameter	T-38	STA
Landing GMT		
Sunset/Sunrise GMT		
Lit/Dark		
Cloud/RS/TS Pictorial  Runway 20 nm circle (radial limit) 30 nm circle (lateral limit applicability)		
Observations (GMT, WX, Winds, Go/No-Go)	GMT	
Forecast (GMT, WX, Winds, Go/No-Go)	GMT	
Pilot Comments Cloud/RS/TS Dir/DME Movement Tops/Bases/Thickness Ceiling (% BKN, OVC,...) Rain/virga/TS Comments Visibility Winds	GMT	GMT
NAVAIDs/Landing Aids TACAN MLS PAPI Ball Bar Lights		
WX Recon Requests		

TIME	WINDS
500 FT _____	_____

1000 FT _____
2000 FT _____

3000 FT	_____
4000 FT	_____
5000 FT	_____
*7000 FT	_____
*12,000 FT	_____
15,000 FT	_____
*20,000 FT	_____
*28,000 FT	_____
*38,000 FT	_____

STA WX AIRCRAFT LANDING SITE DATA

Run #	1	2	3	4
Time				
Runway				
HAC Turn				
Aimpoint/SB				
A&L Transition				
Max A/S				
Max Q Bar				
Max Altitude				
TD EAS				
TD X-Dist				
Nrmlzd X				
XCN				
S/B @ 3000'				
Retr % 3K'				
S/B @ 500'				
Gear Alt				
Turbulence				
Surf. Winds				

Visibility: PAPI's, ball bar/runway:

\_\_\_\_\_

Sun angle: any factor?

\_\_\_\_\_

Pilot Workload?

\_\_\_\_\_

Cross Winds, able to fix early?

**Run #2**

Winds @ altitude/on HAC:

\_\_\_\_\_

Wind shear/location:

\_\_\_\_\_

Turbulence:

\_\_\_\_\_

Visibility: PAPI's, ball bar/runway:

\_\_\_\_\_

Sun angle: any factor?

\_\_\_\_\_

Pilot Workload?

\_\_\_\_\_

Cross Winds, able to fix early?

**Run #3**

Winds @ altitude/on HAC:

\_\_\_\_\_

Wind shear/location:

\_\_\_\_\_

Turbulence:

\_\_\_\_\_

Visibility: PAPI's, ball bar/runway:

\_\_\_\_\_

Sun angle: any factor?

\_\_\_\_\_

Pilot Workload?

\_\_\_\_\_

Cross Winds, able to fix early?

STA COMMENTS FOR THE CREW

**Run #1**

Winds @ altitude/on HAC:

\_\_\_\_\_

Wind shear/location:

\_\_\_\_\_

Turbulence:

### 2.6.5.3 Weather Questions

#### Thunderstorms/rainshowers

- SkewT Plots (moisture, cloud decks, winds aloft)
- Convective temperature/current temperature and time to reach convective temperature
- Radar image
- Satellite image (what is upstream and heading our direction)
- Time for upstream weather to reach approach corridor
- Lightning strikes observed (if so when was the last one and start clock for TRW debris definition)
- If anvil clouds, are they attached or not (STA evaluation or satellite)
- If detached, are they opaque or transparent (STA evaluation)
- If convective activity, what is the life cycle of the storms (e.g. time from popping up to above the +5° C level)
- If Go forecast, when above convective temperature, what phenomena ensures no convective activity during time period of concern

#### Fog

- KSC
  - SLF 30 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
6 ft dewpoint spread \_\_\_\_\_
  - 200/ 54 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
500 54 ft dewpoint spread \_\_\_\_\_
  - 200/ 204 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
500 204 ft dewpoint spread \_\_\_\_\_
  - 500 492 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
492 ft dewpoint spread \_\_\_\_\_
  - Balloon 500 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
500 ft dewpoint spread \_\_\_\_\_
- EDW
  - SLF 30 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
6 ft dewpoint spread \_\_\_\_\_
  - Mate/ 120 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
Demate
  - Balloon 500 ft winds: \_\_\_\_\_ / \_\_\_\_\_ P \_\_\_\_\_  
500 ft dewpoint spread \_\_\_\_\_

#### Crosswinds

- Is an inversion present
- What temperature required to break the inversion
- What are the winds above the inversion (dir/mag)


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## 2.7 JOINT SHUTTLE/ISS PLANNING

The joint Shuttle/ISS planning process is documented in the JOIP, Section 2.3.11, which can be found at <http://mahogany.jsc.nasa.gov/do13/JOIP.html>. This procedure includes all the interaction between MCC-H and MCC-M, when the interactions take place, and the products exchanged. In addition, more details regarding the interactions between the Shuttle and Station Flight Control Teams are documented in the ISS FCOH, section 2.5.19 ISS/SHUTTLE JOINT OPS REPLANNING. Figure 2.7-1 is provided for reference only to illustrate the joint planning timeline.

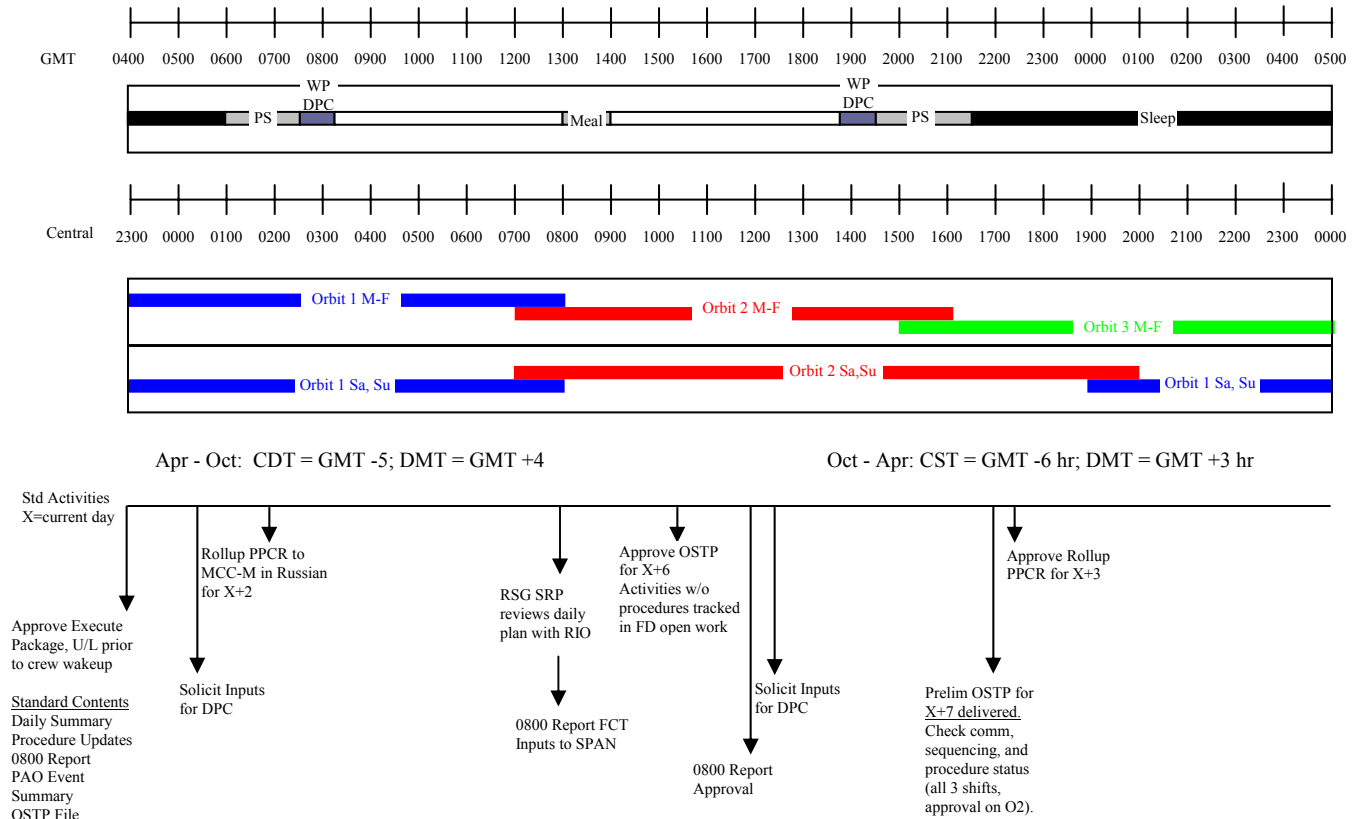
- The joint planning process is a work in Progress. It is important that we help the FAO and Ops Planners to continually improve the process including documentation of the procedure in the above sections of the JOIP. Therefore, provide comments when appropriate and follow up by ensuring the procedures get updated appropriately.
- It is critical for both the ISS and Shuttle FDs to communicate during the planning process. During complicated joint periods, it is fairly easy to become disconnected between teams, especially for the joint reviews. Heads up about upcoming reviews, comments on replanning that need to be taken into consideration, changes that you see coming that will effect the other team, etc should all be summarized in brief fashion over the FD Coord loop or one of the FD loops as appropriate.
- Remember that the ISS team has to provide their FINAL inputs to the Shuttle FAOs 5 hrs prior to crew W/U in the nominal procedure. For a big replanning day, this may be an impossible task since it requires coordination with Moscow and provision of the replanned day just a few hours after the Planning team arrives on console. Be aware of this and be prepared for some late planning activity on the FAO side if the ISS comments come in later than desired. The FAOs and FDs should precoordinate the overall plan for that day to ensure all understand the planning milestones and when late inputs are expected.
- Also, remember that the Station team has to review both the Daily Plan/OSTP as well as the flight plan.
- Procedure changes are generally reviewed and approved for uplink as individual messages throughout the planning period as they become available. The Shuttle FD must ensure joint and ISS procedures are reviewed and approved by the Station team prior to giving FAO approval for uplink.
- The FAO will conduct a final “walk-through” of the summary and detailed flight plan pages with the Shuttle and Station teams simultaneous for approval prior to uplink.

Table 2.7-1. Joint Shuttle/ISS Planning Template

<u>Wakeup</u>	<u>Crew</u>	<u>MCC Planning Process for FDX</u>	<u>Increment Planning</u>
-96 (-4 days)		MCC-M provides MCC-H final STP for FDX. MCC-M and MCC-H Exchange summary of scheduled communication/commanding events.	E = Execute Day
			
-24		———— Cutoff for electronic inputs from MCC-M, Δs via PPCR.	
-23			
-22			
-21			
-20		OPS Plan sends MCC-M electronic database for Flight Plan and Daily Plan	
-19		MCC-M provides HSG with non-English RODF procedure Δs	
-18	FDX-1		
-17			
-16		PPCR for FDX cutoff (MCC-M Δs via voice until wakeup)	
-15		OPS Plan/MCC-M Conference	
-14		Preliminary summary timeline and daily plan on STARXE	
-13			
-12			
-11		———— FCT preliminary summary timeline and daily plan review/approval	
-10	Pre-Sleep	Uplink preliminary summary timeline if required	
-9			
-8		———— HSG provides Ops Plan with English RODF procedure Δs	
-7			
-6		ISS FCT Execute Pkg inputs due to OPS Plan (ODF Δs, FIWs, HSG Status)	E-6 day daily plan U.S. inputs to OPS Plan
-5		ISS FCT Execute Pkg inputs (EFN) and daily plan review/approval (STARXE)	E-6 day daily plan input review (MEEP)
-4	Sleep	Final Execute Pkg inputs due to FAO	E-4 preliminary integrated daily plan review (MEEP)
-3		MCC-H detailed timeline and final daily plan review/approval (STARXE)	
-2		Final Russian Summary timeline and electronic database to MCC-M	
-1		MCC-M Shift FD final timeline approval	
+0		———— Execute Pkg uplink and distribution (STARXE followed by hard copy)	
+1	Post-Sleep		
+2			
+3			
+4	FDX		
+5			

## 2.8 ISS INCREMENT OPS

### ISS Increment Ops Activities



#### Other Daily On-Console Activities

Maintain log and handover  
Review flight notes  
File/review CHIT's and IFI's  
Approve PPCR's as required  
Approve ATL updates as required  
Review any integrated ops with SRP

#### Off-Console Meetings (Action Center)

(Generally supported by Lead Increment FD)

Monday	0800	FCT/MER/IMC Tagup
Tuesday	0800	IMMT
Thursday	0800	FCT/MER/IMC Tagup
Thursday	1030	Planning Mtg: LRP, IMC, FD, FCT
Friday	0730	IMMT

#### Planning Process

- E-7 Preliminary OSTP delivered to FCT NLT 1700 local  
FCT Review: LRP or OPS Plan walks FCT through the plan on ISS FD Loop (O3, O1, then O2)
    - √Comm critical events over comm (CATO)
    - √Procedures will be available, track in FD Open work
    - √Sequencing correct
  - E-6 O2 approves OSTP NLT 1030 local, subsequent changes will be added to rollup PPCR
  - E-4 Re-review OSTP and prepare supporting messages, track as required in FD Open work
  - E-3 Approve rollup PPCR NLT 1730 local  
Subsequent changes must meet the following criteria:
    - Deletions if we will not be ready or the crew has already completed the activity
    - Adding things into white space at crew request
    - Responding to failures
    - Preventing damage to hardware or risk to the crew
    - Preventing loss of science
    - Updating (including adds) the task list
- NOTE: small changes can be handled with real-time call during DPC
- E-2 Provide approved rollup PPCR to MCC-M in Russian NLT 1100 DMT (~2 am central)
  - E-1 Review OSTP for links only

## 2.9 CONSOLE TOOLS

### 2.9.1 DVIS

#### A. General

There are two DVIS panels located at both the WFCR and the BFCR flight director consoles. Sign onto DVIS may be performed using one of three methods but only two of these methods should be used during flight. These three methods include using the position ID alone (listed above the key set), position ID with your personal ID appended, or your personal ID alone. Your personal ID used alone is sometimes referred to as your virtual ID and can be used at any DVIS key set. However, your virtual ID is NOT recorded and therefore, should not be used for flight or any time key set recording is desired. Both the left and right FD DVIS key sets are recorded during flight as long as the position ID is included when signing on. Personal IDs may be obtained by contacting Houston Voice on the Voice Control loop.

There are 10 available pages for each DVIS position which are user configurable. When using the position ID without your personal ID appended, do not reconfigure pages 1 through 5 since they are configured for flight. Page 1 is reserved for pre-launch, page 2 for Ascent, page 3 and 4 for Orbit, and page 5 for Entry. Standard loops selected on the FD key set include FD, ISS FD, A/Gs, AFD CONF, ISS AFD, FD COORD, SIM CONF (during sims), and other discipline, site, or program loops as required. In general, the #1 loops are used for flight while the #2 loops are used for simulations or tests. The #1 ISS loops are no longer available for sims now that ISS is in orbit so integrated sims always use the #2 ISS loops, SIM HOUSTON SUPPORT, and SIM ISS OPS MH 34. The #1 Shuttle loops are normally used for sims, including dual program sims, unless a Shuttle flight is in progress. If a Shuttle flight is in progress, the #2 Shuttle loops are used for simulations.

#### B. Procedures

1. "Wake up" the key set by touching the key set screen
2. Select "Sign ON" and enter the position ID or position ID followed by your personal ID

**NOTE**

Your personal ID without the position ID (virtual ID) can be used at any console but only when keyset recording is not required.

3. Use the "Configure" button to configure/reconfigure loops



NOTES

Shuttle loops are under the MCC partition while ISS loops are under the SSC partition. Loops can be selected for Monitor (M), High Monitor (HM), Talk/Listen (T/L), or Talk/Listen/Monitor (TLM). Monitor setting will allow the user to monitor any conversations on that particular loop but the talk function is inhibited. The High Monitor selection is similar to the Monitor except that the volume level is several db higher than that of the monitor loops. The Talk/Listen setting will allow the user to monitor the loop only when the loop is selected for talking. When the loop is de-selected the monitor function is inhibited. The Talk/Listen/Monitor function allows the user to always monitor the loop, regardless of the enable/inhibit of the talk function.

4. Use the "Monitor" button with the ↑, ↓ keys to adjust the volume of the loops selected for monitoring.
5. Use the "Headset" button with the ↑, ↓ keys to adjust the overall volume of the headset.
6. Use the "Ring" button with the ↑, ↓ keys to adjust the volume of the key set ringer (activated for incoming calls).
7. Use "Multi Access" button to talk on more than one loop simultaneously.
8. Use "Release" to deselect a loop (deselects listen and talk).
9. Select "Release" then "Multi Access" to deselect talk capability on multi access loops.

## 2.9.2 Electronic Flight Note (EFN) Application

### A. General

Each console uses a PC to perform activities such as electronic flight notes, electronic console logs, e-mail, message review, and for other office environment applications. When EFN is started, the user must select an option to properly point to the Electronic Flight Note database. Read the options carefully to ensure proper configuration. Since the MCC PC's are connected to the JSCMODM server, JSCMODM support should be contacted for password reset or other system level problems. Phone numbers for JSCMODM support are taped to the monitor of each PC. Contact GC or MODM Support for Electronic Flight Note problems.

The Electronic Flight Note system is used to provide an electronic method to communicate written information. This system provides the capability to create, revise, view, and disposition flight notes.

### B. Procedures

1. From the PC, select Start ▶ MCC Menu ▶ Flight Items ▶ EFN – Flight & Capcom and select the appropriate activity.
2. EFN Setup

NOTE

EFN does not automatically refresh its screen when a new note is submitted. Periodically click the refresh button to view new notes.

- a. To delete all flights notes from database:
  - i. Select **Setup** ▶ **Reset Database**
  - ii. Select **OK** to confirm (refresh required to see empty list)
- b. Set Clock
  - i. Select **Setup** ▶ **Set Clock**
  - ii. Select desired time mode and method to set MET reference
  - iii. If sim mode, select method to set SGMT
  - iv. Enter times
  - v. Select **Compute** and then **Done**

- c. Set Flight or Increment ID (normally not required)
    - i. Select **Setup** ▶ **Set Flight ID** or **Set Increment ID**
    - ii. Select Vehicle ID if default incorrect
    - iii. Enter Flight or Increment ID if default incorrect
    - iv. Select **Done**
  - d. Select **Done/Cancel** to close Setup window
3. To create and send a new flight note:
- a. Select **New Note**
  - b. Enter title and select type of note
    - i. Working Note – working version visible only to your own position
    - ii. Internal Note – sent to inbox of FCR operators listed in “To”
    - iii. Flight Note – sent to FD and CAPCOM
  - c. If Internal Note, select recipient(s)
  - d. Select **Browse** for attachments
  - e. Select **Save**
4. To update the status of a flight note:
- a. Select check box next to desired flight note(s) in list
  - b. Select **Upd Status**
  - c. Select update option (closed, Exec Pkg, withdrawn, etc.)
  - d. Select **OK**
5. To view a flight note:  
Click on EFN# for note
6. To revise an existing flight note:
- a. View the note and select **Revise Note**
  - b. Make revisions
  - c. Select **Save**

7. To print a flight note:  
Single click on flight note in list and select **Print**
8. View List Options
  - a. Select **Refresh** to refresh manually
  - b. Select/deselect ISS check box to view/hide ISS notes
  - c. Select/deselect STS check box to view/hide Shuttle notes
  - d. Select GMT or MET as desired
  - e. View list by type of note: Select list next to "Type"
    - i. Flight Note (default) – lists notes saved as FLT\_NOTE
    - ii. Internal Note – lists notes saved to the Flight Director's FCR Inbox
    - iii. Working Note – lists notes you saved with WRK\_SAVE
  - f. View list by status of note: Select <ignore> for all (default), Open, Closed, App\_U/L, ExecPkg, etc.
  - g. View list by position: Select desired position or Select <ignore> for all (default)
  - h. View list by time period: Select list next to "View" and Select Last 7 days, Last 14 days, Last 30 days, or All
  - i. Limit number of notes displayed per page: Select list next to "Items/Pg" and select 10, 25, 50, or 100. Use the scroll bar to view notes within the selected range. Use the ▼ and ▲ symbols next to the **Setup** button to view the next or previous page of flight notes.
9. Sort Options
  - a. Default sort option is by Time Input
  - b. To modify sort option, scroll and select desired option (Time Input, MET Action, Note Title, Discipline, Status)
10. To search for a note, enter flight note number, discipline or text contained in flight note title.
11. To restore defaults, select the **Restore Defaults** button.

### C. General Operations

1. All open Flight Notes should be dispositioned as soon as practical. Flight Notes that have been dispositioned should not be left open for any reason.
2. During Shuttle missions, flight notes providing direction/procedures for activities that are submitted for a certain FD's execute package, should be dispositioned as Ex FD#, where # is the appropriate FD.
3. For ISS stage operations, flight notes providing direction/procedures for activities that are submitted for a certain day's execute package, should be dispositioned as Ex XXX, where XXX is the appropriate day of the week.
4. For ISS FN's defining a ground procedure, if the procedure will be utilized multiple times over a significant span of time, the Ops Plan team should convert the procedure to PDF and save it to the appropriate MPV ground procedure file. This MPV procedure should also be linked electronically to the activity when scheduled in the OSTP.

### 2.9.3 Joint Execute Package Development and Integration (JEDI)

#### A. General

JEDI is a web based application available from the Tools menu of the MCC web based planning page at <http://mod.jsc.nasa.gov/mcc/> used to view crew messages and execute packages. It is available to anyone with JIN access and replaces EDP and STARXE for message review.

#### B. Procedures

1. From the PC in the MCC, select Start ▶ MCC Menu ▶ Flight Items ▶ MCC-H or use the following link: <http://mod.jsc.nasa.gov/mcc/>
2. Select the  or appropriate  button
3. Select "Tools" and then either "ISS JEDI" or "STS JEDI"
4. To view a message, select the link under the "Eng" column for the English version or the "Rus" column for the Russian version.
5. To view a revised message or update the Message Status, select the "Update" button
6. To print, Use the button in the application tool bar.
7. To filter the messages displayed, select the "Increment" and/or a "Category" of messages
8. To search for a message, enter text contained in the title

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## 2.9.4 Command Server

### A. General

The flight director uses the command server to monitor command activity and during ascent aborts, to send the Abort Light command. This section only describes the command monitoring activity. Refer to Section 2.2.3 for Abort Light command procedures.

To monitor command activity, the flight director must first log onto the command server and then select the desired command display. The command displays must be selected from the appropriate menu depending on whether the Prime or Backup server is in use. The Prime server is nominally in use unless a failure to the Backup server has occurred.

### B. Procedures

1. To sign onto the Command Server:

**WARNING**

If first login attempt is unsuccessful (Ref Ops Note CMDGEN0038), contact GC and WSS. Do NOT attempt another login.

- a. From the DEC, Select Applications ▸ Command Server ▸ Start Command Manager
  - b. Select SSP or ISS as applicable and select
  - c. Move cursor into Access Code text box, enter access code (case sensitive), and return
  - d. Select "FD Commanding" then select
  - e. Select
2. To call up Command Summary display

Applications ▸ Command Server ▸ TELCOM Displays ▸ SSP (ISS) ▸ (ISS) Command Summary

3. To logoff or when command monitoring no longer required:

**WARNING**

Log off command server prior to logging off workstation.

- a. Close command displays
- b. Select Applications ▸ Command Server ▸ Stop Command Manager ▸ Yes
- c. √SSP or ISS selected as appropriate and select





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## 2.9.5 Manual Procedures Viewer (MPV)

### A. General




The Manual Procedures Viewer (MPV) application is used to view documents electronically and is available on the DEC Alpha and the PC. Documents are organized into libraries and shelves and are analogous to file folders or to directories and sub-directories. When MPV is started, a default library is automatically opened but can be changed to the desired library. Libraries are available for Flight Rules, US ODF, OMI, Ops Notes, Reference Documents, and FDF/ODF status sheets. The Shuttle FDF is not currently available in MPV but available electronically from the FDF server (reference section **TBD**). Each library includes various shelves or directories listed in the left column and a list of books in the selected shelf in the right column.


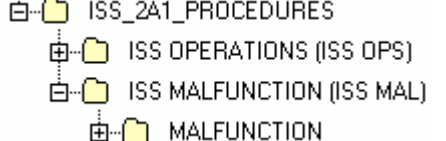
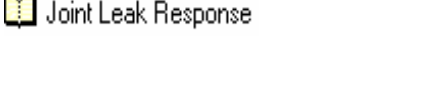
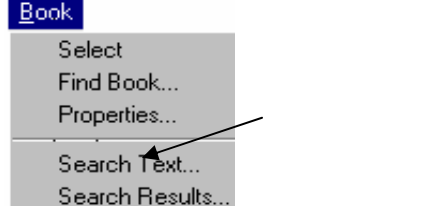
### B. Procedures

1. From the DEC, Select Applications ▶ MPV
2. √Library
3. If library other than default desired,  
    Select from Library pulldown menu
4. To change shelves: double click the desired shelf
5. To open a book: double click on the desired book
6. To close a book: In the desired book, Select File ▶ Close or click 
7. To exit MPV:
  - a. From the library window, Select File ▶ Quit or click  then select **Quit**
  - b. From an opened document, Select File ▶ Quit then select **Quit**

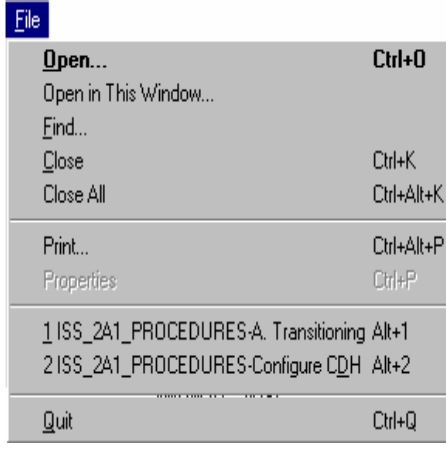
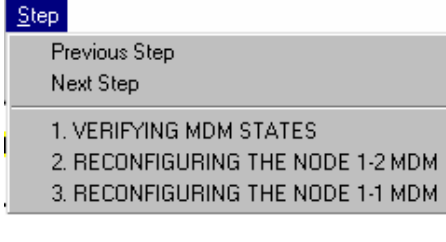

### C. Supplemental Information



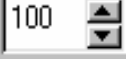





#### 1. Library Window

ICON	Description
	Brings up "Find Book" display.
	Reloads Library display information from the file server. Not used often.
	Alternate method to open a procedure. If a "book" is highlighted in the "Books on this shelf" pane, the user can click on this icon to open the highlighted procedure or "book." Multiple books can be highlighted and opened with the Select Book icon.





	Allows user to select which Library to view.
	"Shelves" pane lists folders of procedures. Click on – or + to hide/show contents of shelf. Click on folder for "Books" to appear in "Books on this shelf" pane.
	"Books on this shelf" pane lists "books" or procedures. Double click on desired "book" to open.
	Search Text allows the user to search text within selected books. A Search Text Display will appear allowing the user to enter the text to be searched for as well as the books in which the search is to occur.








## 2. Procedures Window

ICON	Description
	Allows user to open a new procedure in another window ( <i>Open</i> ) or the same window ( <i>Open in This Window</i> ). Selecting either of these options will bring up the Library Display. <i>Find</i> opens the Find Book Display. The document history (bottom of pull down) lists all procedures that have been opened in this window <u>and</u> other windows.
	Allows the user to go to Previous Step or Next Step <u>or</u> to jump to a specific major step within the procedure. All major steps (colored blue) will be listed here. This action will also move the yellow "step marker" to the selected step.
	Traverse/Select mode allows the user to toggle between modes. <i>Traverse</i> allows user to point again if a previously selected tool was in "focus" (double clicked on). <i>Select</i> is used to select an annotation to delete, move or edit it. These options are also available on the Tool Palette.

	<p>Brings up the Find Book display, which allows the user to find a book with a particular title or part of a title. The Find field does not recognize search strings and will search exactly what is typed.</p>
	<p>Prints the procedure.</p>
	<p>Zoom Control allows the user to zoom in or out with the up and down arrow keys. The user may also enter a value in the field.</p>
	<p>Bookmark List brings up a list of all the bookmarks on the procedure currently being viewed. Double click the name in the list to navigate to that location.</p>
	<p>Forward History/Back History remembers navigation history of procedures opened in this window.</p>
	<p>Step Up/Step Down moves between the major steps (colored blue) in the procedure. Also moves the yellow “step marker” to this step.</p>
	<p>Page Up/Page Down moves between pages within a procedure.</p>
	<p>Spacebar/Up Arrow/Down Arrow on the keyboard can be used to move the yellow “step marker” up or down through a procedure.</p> <p>Shift+Right Mouse Click is used to place the “step marker” anywhere in the procedure. To use, place the cursor at the point where the marker should be moved to and then press and hold the Shift key and Right Mouse Click.</p>

3. Tool Palette (available from Tools pulldown menu on Procedures displays)

	<p>Used to highlight text within a procedure. Select a color from the palette then select the Highlight tool. Click and drag across text to be affected. Note: this tool can be finicky, be sure to click on top of the first letter to be affected, not in front of it.</p>
	<p>Used to color text within a procedure. Select a color from the palette then select Color Text tool. Click and drag across text to be affected. Note: this tool can be finicky, be sure to click on top of the first letter to be affected, not in front of it.</p>
	<p>Used to strikethrough text within a procedure. Select the tool and then click and drag across text. Note: this tool can be finicky, be sure to click on top of the first letter to be affected, not in front of it.</p>
	<p>Used to add text within the procedure so that it appears as a part of the original procedure. Select the tool and then click at the point of insertion. A box will appear allowing small amounts of text to be typed.</p>

	<p>Used for small notes. Select the tool and then click and drag (for size) at the point of insertion. A dialog box will appear allowing a title and text to be added.</p>
	<p>Used to mark locations in the procedure that the user would like to return to. Select the tool and click at the point of insertion. A display will appear asking the user to name the Bookmark. A list of all bookmarks within a procedure is accessed by clicking the Bookmark icon on Procedure Display toolbar.</p>
	<p>Circle/Square are used by selecting the tool and then clicking and dragging (for size) at the point of insertion. The user may select the color.</p>
	<p>Used for large notes and is printable (future). Select the tool and click at the point of insertion. A display will appear allowing the user to select a title and add text. The procedure will display the Notepad icon when finished. Double clicking the icon will open the saved text.</p>
	<p>Link allows the user to link between locations within the same procedure <u>or</u> other procedures. To add a link, select the tool and click at the point of insertion. A Link Display will appear allowing the user to enter a title for the link and to select if the link is to be two-way or one-way. Do not edit any other field on this display at this time. The user must now navigate to the procedure where the link will navigate to. (Use whatever method is preferred) When the desired location is reached, click again at the point of insertion within the procedure. The Link Display should appear again. The user may now enter a title for the "Link To" location. Select the "okay" icon when finished.</p>
	<p>Command Pad allows the user to link to any application/file other than MPV (i.e., mediaplayer, excel, etc.). To use, select the Command Pad tool and click at the point of insertion. A Command Pad Display will appear. Enter a title. Enter the appropriate data in the window using the following format: Application Location (single space) File Location. Note: The Command Pad uses DOS for the link; therefore, filenames may not be longer than 8 characters. If the name is longer than 8 characters, enter the first 6 followed by ~1. Select Execute to attempt the link. (Nothing will happen if incorrect data has been entered). Select Save once the link has been established correctly.</p>
	<p>Icons are added by selecting the tool and then clicking at the point of insertion in the procedure. The icons themselves are not dynamic but can be associated with other annotations, which make them appear to be dynamic. Double clicking the icon will keep it as the focus so that multiple icons may be entered without re-selecting the tool. Note: To associate the Command Pad or Link tool with an icon, insert the icon <u>first</u> and then place the Command Pad or Link on top of it. Several associations can be made to the same icon in this fashion.</p>

## 2.9.6 Flight Director Status Application

### A. General

The Flight Director and ISS Flight Director Status applications are used to solicit non-verbal feedback from WFCR and BFCR flight controllers, respectively. For example, rather than requesting a verbal Go for checkpoint from each flight controller, the Flight Director can simply request a “Green” when go for checkpoint. When each operator is ready for a checkpoint, he can select the “Green” color from his workstation application. That operator’s light will then turn Green on the flight director’s status application.

The FD\_Status application is used for Shuttle operations and includes buttons for operators that may be sitting in the WFCR. The ISS\_FD\_Status application is used for ISS operations and includes buttons for operators that may be sitting in the BFCR. If a particular operator is not supporting the current activity (sim, flight, test, etc.), the flight director may “gray out” that operator’s button but clicking on it. The flight director also has a capability to reset the lights, request a color via the application, and to send a message.

### B. Procedures

1. For Shuttle ops: From the DEC, Select Applications ▶ FD\_Status
2. For ISS ops: From the DEC, Select Applications ▶ ISS\_FD\_Status
3. Select  in upper left hand corner, select configuration, then select
4. Click on unsupported positions to “gray out”
5. To request a color: Select Green, Amber or Red under “REQUEST”
6. To send a message: Type message into text box and then select
7. To clear a message: Select
8. To reset lights: Select

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## 2.9.7 Mission Information System

### A. General

The Mission Information System (MIS) is used to process CHITs and Anomaly Reports. CHITs are used to request and supply information between the flight control team and external interfaces, such as Engineering, CSR/payload customers, MCC-Moscow, etc. Anomaly Reports document in-flight failures, the impact, and resolution. The MOIR manager is responsible for reviewing each CHIT/anomaly to ensure that it is properly completed, appropriate responders are included, and publishing the standard logs. In an ideal situation, the Flight Director needs to provide very little input into the CHIT and Anomaly documentation process. However, in some cases the Flight Director may need to suggest that a CHIT is required, ensure a CHIT request is clear, or provide other guidance as necessary. The Flight Director receives hard copies of all opened, revised, or closed CHITs and Anomaly Reports in addition to hard copies of the CHIT and Anomaly Logs at periodic intervals. CHITs, Anomaly Reports, and Logs are typically posted on a clipboard behind the Flight Director. Only the most recent copy of each are kept to reduce the amount of extraneous paper. Periodically, the MOIR Manager will contact the Flight Director on the flight loop to announce an upcoming Anomaly cutoff. This simply means that the MOIR Manager is preparing to publish the Anomaly Log and is asking that any Anomaly Reports that are ready for submission, be submitted before the cutoff.

### B. Procedures

#### 1. To view CHITs

- a. From the DEC, Select Applications ▶ MIS ▶ CHIT Report
- b. Select File ▶ Open
- c. Select the mission if required, select the CHIT of interest, then select OK

#### 2. To view Anomaly Reports

- a. Select Applications ▶ MIS ▶ Anomaly Report
- b. Select File ▶ Open
- c. Select the mission if required, select the discipline and then anomaly of interest, then select OK



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## 2.9.8 Clocks/Timers

### A. General

The Timers/Clocks global application can be a very useful tool to display global timers or to create and display customized timers. For example, local timers may be set up to count down to significant events and provide a tone as an alert. These functions are available from the Master DNAV under Global Apps.

### B. Procedures

1. To display the wall clocks on your DEC console:
  - a. Toggle to Master DNAV if required
  - b. Select Global Apps ▶ Timers/Clocks ▶ Wall Clock Display
  - c. Select WFCR, BFCR, or TBD
2. To create an Event Timer:
  - a. Toggle to Master DNAV if required
  - b. Select Global Apps ▶ Timers/Clocks ▶ Control Panel
  - c. Select Clock Types ▶ Create ▶ Event Timer
  - d. Select SGMT/GMT/MET/MIR Time reference, enter label, and enter target expiration
  - e. If desired, select Notification option (none, DVIS 2 second tone, DVIS continuous tone)
  - f. Select
  - g. Clock will appear on the left monitor if created on the CPU with two monitors
  - h. To move the clock to the other monitor,
    - i. Select Options ▶ Customize
    - ii. Select Screen (0 for left monitor, 1 for right monitor)
    - iii. Select

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## 2.9.9 Weather Application

### A. General

The weather application provides images, winds data, surface observations, forecasts, Skew-T log plots, and briefing frames. The availability of these options depends on the selected flight phase. For launch, image loops, winds displays, surface observations, launch forecast images, briefing images, and upper air Skew-T diagrams are available for all CONUS and TAL sites. For landing, the same displays are available but only for the CONUS sites. For the orbit phase, image loops, winds displays, briefing frames, and Skew-T diagrams are available for CONUS sites but surface observations and forecast images are not.

There are several image sources available:

KSC Radar – data developed by Kavouras and distributed via satellite

KSC-visible – magnified visible spectrum Geosynchronous Operational Environmental Satellite (GOES) image of KSC [default image when weather application started]

KSC IR – magnified Infrared (IR) spectrum GOES image of KSC

KSC Radar – 1 x 1 km resolution mosaic of National Weather Service (NWS) radar reflectivity activity in the KSC area. Ground clutter, anomalous propagation false echoes, and rainfall reflectivities less than 20 DBZ are not included in these images.

SE CONUS IR – a GOES IR image of the southeastern portion of the U.S.

EDW Visible – a magnified GOES visible image of EDW.

SW CONUS IR – a GOES IR image of the southwestern portion of the U.S.

North TAL Visible – a Meteosat visible image of the northern TAL sites.

North TAL IR – a Meteosat IR image of the northern TAL sites.

South TAL Visible – a Meteosat visible image of the southern TAL sites.

South TAL IR – a Meteosat IR image of the southern TAL sites.

Winds data include KSC 1 minute and 5 minute wind towers, EDW portable and permanent towers, and WSSH 10 ft and 30 ft wind towers. The default Winds display is the KSC 5 minute wind tower data. Winds are updated every 5 minutes with new data and the charts are redrawn every hour.

Skew-T Log P plots are diagrams drawn using data from balloons launch from the various landing sites. It displays temperature, dew point, and winds as a function of pressure. For launch, these displays are available for the CONUS and TAL sites. For landing and orbit phases, they are available only at the CONUS sites. If no balloons have been launched in the past three days, an “Image Not Available” message will appear.

Briefing frames are special images created by SMG for briefings to show detailed information on potential problems. Briefing frames are controlled by SMG and can be changed at any time.

Reference the Weather Application User's Guide, SFOC-FL 1982 for additional information.

## B. Procedures

1. From the DEC, Select Applications ▸ Weather

<p><u>NOTE</u> Weather Application should be started before any other workstation applications.</p>
---

2. To reposition, right mouse click on blue border, select "Move", then left mouse click and hold while dragging to desired position.
3. Select the flight phase from the Flight Mode button on the top toolbar (Launch, On-orbit, or Landing)
4. If selecting Launch, select the proper inclination to drive the groundtracks.

<p><u>NOTE</u> High Inclination groundtracks (High - &gt;39 option) are for 57° inclination.</p>
--

5. Select a display using the "Current Display" menu item
6. To view image loops:
  - a. Select the desired image from Current Display ▸ Images ▸ <desired image>
  - b. Select the Load Loop button on the bottom toolbar
  - c. Use VCR type controls to start, stop, reverse, fast forward, or adjust speed
  - d. To erase the coastline map, select Erase All Maps button on the bottom toolbar
  - e. To view coastline map, select Base Map button on the bottom toolbar
  - f. To view other graphic options, select Approach, Thunder, 30 nm, and Rain buttons as desired.
  - g. To zoom in, select Zoom button on the bottom toolbar or Alt Z from the keyboard.
    - i. Press and hold the middle mouse button to move the zoomed image.
    - ii. Re-center by clicking the right mouse button

<p><u>NOTE</u> Zooming an image may take several seconds. The small box on the Zoom button turns red when Zoom is on, gray when Zoom is off. When Zoom is on, the image is magnified by a factor of 2.</p>
--

- h. Select Zoom or Alt Z from the keyboard again to restore original size
7. To view wind data:
  - a. Select Current Display ▸ Winds
  - b. Select the desired site, display, limits, magnetic versus true heading, approach, time range, and speed range from the corresponding buttons on the bottom toolbar
8. To view observations and forecasts: Select Current Display ▸ Obs/Forecasts
9. To view Skew-T Log P Diagrams: Select Current Display ▸ Upper Air SKEWT ▸ <desired site>

NOTE

Pressure on the left in milli-bars, Log P. The dashed line is dew point (°C) and the solid line is temperature (°C). The left to right diagonals from the bottom of the plot are isothermal lines or lines of constant temperature. The wind barbs are on the right hand side (jet stream ~30-40k ft).

10. To view SMG's Briefing charts: Select Current Display ▸ Briefing Graphics
11. To exit the Weather application,
  - a. Select the "Quit" button in the upper right hand corner
  - b. Select "Kill Weather"

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## 2.9.10 Shuttle/Station Displays

### A. General

The following displays contain information of general interest and are found under the Shuttle or Station Master menu for the position listed. Note that there are numerous displays available but this list was intended to include those displays/applications, which contain information for the crew (PADs), situational awareness tools, and overview information. This list does not include displays/applications under the Flight Director Applications menu since many are Flight Director specific applications and are easily found. The intent of the following reference material is to highlight which displays are available from other disciplines and either necessary or extremely useful to the Flight Director.

### B. Shuttle Master Displays

Position	Tool or Display	Location
EVA	EMU/Airlock Parameters	EVA ▸ EMU/Airlock Parameters
FAO	FAO MSG Status	FAO ▸ Timeline ▸ FAO MSG STATUS
	Contamination	FAO ▸ Timeline ▸ Contamination ( <i>Supply/waste H2O, FES, FC Overview Info</i> )
FDO	Maneuver PAD	FDO ▸ Maneuver/Rendezvous ▸ Maneuver Pad (new)
	1888 RNDZ/Prox Ops Proc	FDO ▸ Maneuver/Rendezvous ▸ 1888 RNDZ/PROX OPS PROC
	DELPAD	FDO ▸ Deorbit ▸ View DELPAD
	Deorbit Opportunities	FDO ▸ Deorbit ▸ View Deorbit Opportunities
	Deorbit-Landing Data	FDO ▸ Deorbit ▸ Deorbit-Landing Data Sheets
GC	TDRS SHO	GC ▸ View SHO
	TDRS Conflicts	GC ▸ View Conflicts
	TELCOM	GC ▸ Telcom Orbiter
INCO	Antenna Display	INCO ▸ Antenna Display
PDRS	PDRS Display	PDRS ▸ Run RDM
PROP	PROP Products	PROP ▸ NETSCAPE ( <i>PRPLT PAD, Consumables Status, etc.</i> )
Rendezvous	RNDZ Telemetry	Rendezvous ▸ Telemetry (Start First)
	3D Attitude	Rendezvous ▸ Attitude (3-D)
	DAP Panel	Rendezvous ▸ DAP Panel

### C. ISS Master Displays

Position	Tool or Display	Location
FLTD	Homepage	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Homepage
	ACS	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Acs_Modring
	CBM	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Cbm
	Early Comm	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Ecom
	FGB	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Fgb
	MCA	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Mca
	Node MDMs	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Mdm1(2)
	FGB MDM	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Mdm_Fgb1
	Node 1	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Node1
	RPCM	FLTD ▸ ISS_Applications ▸ CDDT Display – Version <X> ▸ Rpcm
ACO	ISS Overview	ACO ▸ Displays from ACO ISP Server ▸ ACO Support - MSKView
ECLSS	ECLSS Mega	ECLSS ▸ Displays on ECLSS Server ▸ MSK-View Displays ▸ ECLSS Mega
GC	TDRS SHO	GC ▸ ISS Displays ▸ ISS TDRS SHO
ODIN	C&W Overview	ODIN ▸ ODIN Server Displays ▸ Caution & Warning Summary
	C&DH Overview	ODIN ▸ ODIN Server Displays ▸ C&DH Overview
PAO	Rendezvous Overview	PAO ▸ PAO RNDZ Overview
PHALCON	EPS Data	PHALCON ▸ Displays on PHALCON Server ▸ <Version X> Displays ▸ EPS Overview
THOR	Thermal Data	THOR ▸ Displays on THOR Server ▸ MSK-View Displays ▸ <Version X> Mega



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## 2.9.11 TV Channel Assignments

### A. Description

The following channel assignments are based on the nominal Shuttle Mission Configuration released in January 1999. Channels 2-36 are center wide while 37-64 are for building 30 only.

Chan	Assignment
2	JSC Cable TV System Program Guide/IRIG Clock
3	JSC Events Calendar/JSC Emergency Messages
4	NASA Television (GE 2 transponder 9C)
5	DEMOS
6	MCC-H WFCR Clocks
7-13	Commercial channels (Normally blocked in B30S/MOW)
14	Shuttle Downlink/Pad Cameras/misc feeds (GE 2 transponder 5)
15	Request
16	Mission Video Playback #1
17	SMG Weather
18	Weather Radar
19	The Weather Channel
20	CNN
21	C-SPAN 1 (Normally blocked in B30S/MOW)
22	C-SPAN 2 (Normally blocked in B30S/MOW)
23	Request/U of H Television Courses
24	Request/Russian Space Agency/Russian Language News @ 12:00 & 16:00
25	Request
26	Video Teleconferences
27	NBL-1
28	NBL-2
29	NBL-3
30	NBL-4
31	Request (Reserved for ISS Downlink-1)
32	Request (Reserved for ISS Downlink-2)
33	Request (Reserved for ISS Downlink-3)
34	Request (Reserved for ISS Downlink-4)
35	Request
36	Television Test Signals
37	WFCR Camera 1
38	WFCR Camera 2
39	WFCR Camera 3
40	WFCR Camera 4
41	SVO Camera 1
42	SVO Camera 2
43	WFCR Capcom OCA
44	Proximity Operations Video
45	Robotics Console Video (30S/3307)
46	Orbiter Space Vision System
47	Unassigned (No Equipment)
48	Unassigned (No Equipment)

49	Unassigned (No Equipment)
50	Houston TV Channel 2
51	Houston TV Channel 3
52	Houston TV Channel 5
53	Houston TV Channel 6
54	Houston TV Channel 7
55	Houston TV Channel 8
56	Houston TV Channel 9
57	Houston TV Channel 10
58	Houston TV Channel 11
59	Houston TV Channel 13
60	MOIR VCR Playback
61	KSC Pad Cameras (w/GMT)
62	NASA Television (w/GMT)
63	Shuttle Downlink (w/GMT)
64	Unassigned (No Equipment)

The JSC Cable TV System channels 2-36 are configured from the Signal Validation & Adjustment System area of the JSC Information Systems Directorate (ISD) television control facility in B8 (Johnson TV). Many of these services are permanently configured (hardwired), but some channels are configurable for requested services.

Channel 4 (NASA Television) is programmed by Office of Public Affairs (PAO). Mission commentary by the PAO commentator in the FCR or SVO can be heard on this channel.

The program sources for channels 5, 6, 17, 18, 37-46 and 50-64 are within B30S/MOW. Some of the services are permanently configured. Programming for channels 50-59 can be configured from the MCC-H television control console in B30MOW (Houston TV).

Channels 7-13 and 21-22 are distributed Center wide and contain mostly commercial programs that are normally blocked from viewing in B30S/MOW during Shuttle missions. Upon request from the Flight Director the blocking filters can be switched out. The switching out of the blocking filters is a designed configurable feature and is performed in B30S. In the absence of a Flight Director, the authority to request commercial programs has been delegated to the GC or the Facility Operations Manager.

Channel 14 contains the processed, but unedited, Shuttle downlink accompanied by Sync A/G audio. Sync A/G audio is a selection, made by PAO, for the best audio that matches with a particular downlink image. This audio selection is made from either A/G1 or A/G2 and continues during LOS of video signal.

Television replays for the Flight Control Team are provided from the Master Record and Playback area of the JSC/ISD television control facility in B8 (Mission Video). The prime video circuit from B8 to B30 is Playback # 1. Video played on this circuit normally appears on channel 16 and can be viewed Center wide. The playback audio can also be heard in B30 over DVIS when configured by Houston Voice. Other playbacks can be sent on a second line from B8 to B30 (Playback #2) for viewing in B30 only. Distribution of the video from this second line within B30, either on the cable TV or baseband video systems, is controlled by Houston TV.

Programming for channels 17 and 18 originates from the JSC Spacecraft Meteorological

Group (SMG) office in B30.

Channel 24 contains all television signals sent to JSC from Russia including downlink video plus Russian and NASA media events. This video is converted to NTSC (the analog television signal standard for the United States), if necessary, by the international communication service provider.

Distribution of selected video teleconferences on channel 26 can be performed upon request to the GS4/IMPASS Video Teleconferencing Coordinator at extension 3-4755, during normal working hours.

NBL video scenes on channel 27-30 are configured at the SCTF.

During mission support periods, WFCR and BFCR cameras (channels 37-42) are controlled by PAO personnel in the Program Control Room (PCR) in B2. During non-mission periods, the cameras can be controlled from the Simulation Control Area in B30S. Johnson TV has access to a maintenance control panel for this system in B8.

The WFCR Capcom has the capability to distribute the display from their OCA laptop PC screen with the accompanying audio as a television signal. A similar capability is being provided for ISS OCA from the SVO room.

Personnel in the STS Mission Operations Integration Room (MOIR) control the selection of the KSC pad camera seen on channels 14 and 61. MOIR VCR playbacks on channel 60 are performed from a VCR in the MOIR. The GMT overlay on channels 61, 62 and 63, is hardwired in B30S. The GMT signal is derived from a WWV receiver in B8. (It is not the GMT from the Shuttle Orbiter.)

## B. Tips for Programming

Delete channels 7-13 and 21-22 on your television receivers.

Auto-programming a television receiver might not be fully successful since some channels, such as the downlink on channel 14, do not always have a carrier signal which the auto-programming circuitry needs to be able to recognize. Check to see if some channels need to be manually entered.

Most of the television receiver/monitors in B30S/MOW are managed and provided by the SFOC contractor. Users should call Houston TV (DVIS-TV loop, or ext. 35629) if you have a television receiver/monitor equipment problem. Requests for maintenance and repair services for ISD television systems or equipment within B30S/MOW can be reported to Johnson TV (DVIS TV loop, or ext. 3-7772). During non-mission periods call the Imagery Customer Services Desk, operated by the IMPASS contractor, at extension 3-7777. If you are in the MCC, the first person to call is Houston TV who can help you to determine which group will be able to chase down any television problems that may be encountered.

Permanent cable television system channel assignments and connections to the cable TV system are managed and provided by ISD. Refer requests for permanent channel assignments or new cable connections to the ISD Communications Branch/GT2.

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## **2.9.12 Orbital Communications Adapter (OCA)**

Reference Shuttle FCOH SOP 2.20 OCA Configuration

### **2.9.12.1 Overview**

The OCA is designed for high speed electronic transfer of files between the orbiter or space station and the MCC as well as transfer of digital video information. The OCA file transfer system replaced the Portable Audio Data Modem (PADM) file transfer system and greatly enhances electronic file transfer capability for shuttle and station missions. The color printer allows the crew to print files received via OCA. TIPS may also be flown depending on stowage and performance constraints for message traffic to the crew.

The types of files transferred using the OCA system can range from simple text to data and executable files for specific payload experiments. All files uplinked to the crew via the OCA, use of video conferencing capability, or use of digital graphics uplink are subject to approval by the flight director. In addition, certain capabilities are subject to approval by CAPCOM and MCC flight controller(s) as specified by the flight director position before uplink.

With the OCA system, file transfers can be initiated onboard by the crew. However, to minimize crew required OCA activity, the onboard OCA file transfer capability is nominally disabled and the MCC OCA operators are considered prime for all file transfers (uplink and downlink). The OCA onboard file transfer capability can be enabled in real-time by the crew if required.

On shuttle, OCA events nominally use Ku channel 2 or 3 and are performed across a ground router and flight router, which are connected via the TDRS link. The high bandwidth of these channels is required to support video conferencing. The high bandwidth also provides for high rate file transfers using the Ku File Transfer (KFX) software. If the Ku band is not available (e.g. after Ku stow), video conferencing is not possible. However, files may be transferred at a slower rate through one of the S-Band A/G audio channels using the Modem File Transfer (MFX) software.

On station, OCA events use the early comm S-Band system for both video conferencing and file transfers (via KFX). Once the Ku system is installed, OCA events will occur through the Ku system. The file transfers to the early comm system are performed using IPX in a point-to-point fashion since there is currently no router onboard the station to support TCP/IP. Once the onboard station router is installed, all KFX operations will be performed across the ground and flight routers.

OCA file transfers will be scheduled two to three times per crew day for a single-shift mission and may require additional transfers for dual shift missions. The actual frequency of these transfers depends on the amount of predicted and real-time file traffic for each mission, as well as comm availability. The MCC flight director can approve an OCA file transfer any time, but typical OCA file transfers are performed during crew sleep as Execute Package inputs are approved and after post-sleep and prior to pre-sleep for family mail.

### **2.9.12.2 MCC OCA Ground Network**

The OCA Ground Network in the MCC consists of routers and workstations that are connected to a LAN via hubs (or switches). There are currently three routers and seven workstations in place to support simultaneous shuttle, early comm, and station ops (sim or mission). Each router houses an OCA card and each OCA card is connected to the CDSS in the MCC.

Of the seven workstations, three are in the Planning MPSR, one is at the STS Capcom position in the White FCR, one is at the ISS Capcom position in the Blue FCR, one is at the Ops Plan console in the Blue FCR, and one is in the Aeromed MPSR. All of the workstations are standard desktop PCs except for the STS Capcom workstation, which is an IBM 760 thinkpad (identical to the PGSCs on orbit). An OCA card is installed in two of the workstations in the Planning MPSR to support shuttle MFX operations and early comm point-to-point KFX operations. Four of the workstations are configured to support video conferencing: both Capcom workstations, the Ops Planner workstation, and one of the Planning MPSR workstations.

During shuttle missions, the FAO position is the prime contact for all OCA system operations. During station missions, the Ops Planner position is the prime contact for all OCA system operations. The OCA Officer in the Planning MPSR manages OCA file transfers and file distribution onboard and on the ground. These files include crew personal mail, Worldmap/SPOC file updates, news, and digital camera system (DCS) (a.k.a. electronic still camera (ESC)) files.

The CAPCOM workstations are used to support IFM or procedure reviews using either the OCA whiteboard or video conferencing capability. All whiteboard and video conferencing operations with the crew except for private medical conferences (PMCs) are coordinated through the CAPCOM console position.

The Aeromed OCA workstation is used to support private medical and family conferences (PMCs and PFCs) with the crew. This workstation only supports the OCA video conferencing capability. PMCs are nominally scheduled each crew day during missions and can be completed without OCA support. OCA video conferencing support for the daily PMCs is scheduled based on comm link availability (Ku for shuttle, S-band for early comm). The surgeon/BME console position is the Aeromed OCA workstation point of contact for OCA PMCs and PFCs. This workstation does not support KFX or MFX file transfers.

### **2.9.12.3 Capabilities**

The current OCA boards are standard ISA bus interface boards for a common personal computer that allows the computer to communicate across any communications link. For the shuttle, the OCA board is set up to use the TDRSS network Ku-band link and the S-band audio link. This provides the capability for certain software in PCs located on the ground and onboard the orbiter to exchange data. There are currently two types of OCA boards – rev 0 for shuttle and early comm and rev 1 for station (post 5A). A next generation OCA board (rev 2) will utilize a PCI bus interface.

The OCA rev 0 board is comprised of two sections: the Ku-band section and the modem section. The OCA rev 1 board consists of a Ku-band section only. The OCA Ku-band section uses the orbiter 4 Mbps or 2 Mbps Ku-band channels for downlink. For uplink, it uses the 128

Kbps rate. The OCA modem section replaces the payload audio data modem (PADM) hardware that had been in operation on the GRID computers many years ago. It is designed to communicate over one of the air-to-ground audio channels. It provides approximately a 2,400 baud data rate with a half duplex data exchange. Currently, the OCA software utilizes both the Ku-band and the modem sections of the hardware. The following is a summary of each of the software applications that has been developed for the OCA system.

A. Ku-band File Transfer (KFX) Software

Version 2.0.1.1 allows the flight laptop user to send file(s) or directories of files to a PC located in the MCC. It also allows the ground user to manage files located on the flight laptop through the use of file management commands (copy, delete, move, rename, create directory) and to manage software running on the flight laptop through the use of task management commands (run windows application, list active tasks, terminate active task, execute DOS command line).

B. Modem File Transfer Software

This application uses the orbiter S-band audio channel and replaces the previous STSBBS/PADM capabilities. The software utilizes a commercial version of Procomm Plus for Windows and is written as a Procomm script. The software enables the ground user to view the contents of the flight PGSC, uplink files, and remotely downlink files. The ground has the capability to manage files located on the flight PGSC through the use of file management commands (copy, delete, move, rename, create directory). The ground also has the capability to manage software running on the flight PGSC through the use of task management commands (run windows application, list active tasks, terminate active task, execute DOS command line).

C. Intel's Proshare Software

The Proshare system consists of both software and hardware (video compression board) that is used to provide both video teleconferencing and electronic whiteboard (digital graphics uplink) between two workstations. With the custom OCA interface software, the commercial Proshare system (version 1.9a only) is able to provide these capabilities between the orbiter and the ground via the Ku-band link and between station early comm and the ground via the S-band link. While the video teleconferencing capabilities require the Proshare software and the installation of the Proshare video board into both flight and ground workstations, the electronic whiteboard capability requires only the Proshare software.

D. Electronic Whiteboard

This Proshare application allows the flight and ground computers to communicate over the TDRS link (Ku for shuttle, S or Ku for station) and display a whiteboard to both flight and ground users. This whiteboard or drawing area shares its data between the two computers such that any text or graphics input by one user are visible to the other user. This allows, for instance, flight and ground users to review a common document (including text and graphics) and redline/modify the document together. The whiteboard tool allows users to type text, draw rectangles, circles, or lines, and arcs. The users may also import drawings or documents into the whiteboard from other applications.

The whiteboard function also provides the capability to application share. This allows a flight user to select to share an application (such as File Manager). Once selected, the



ground user would see the same File Manager window that the flight user sees and would be able to interact with that window (command).

E. Video Teleconferencing

Proshare hardware and software provide the capability to send and receive color video (and accompanying audio) between the flight and ground workstations. The video system typically consists of the workstation (PC, PGSC, or SSC), Proshare board, video camera, and audio headset on both flight and ground. Users are able to connect, view remote and local video, and talk/listen with the remote users.

The software provides options to mute audio, video, or both as well as control of video settings (brightness, etc.). Capability also exists to send taped video, audio, and real-time television inputs from the CAPCOM workstations to the orbiter or station.

F. OCA Control Panel Applet

This applet is only located on the OCA routers (ground and flight) and provides status and configuration controls for the OCA device driver. It provides a small window to monitor the link status, rate, etc. It also provides commands to change the downlink rate (orbiter: 2 Mbps or 4Mbps - to match the PDIP panel) and to perform loopback tests on the hardware. Certain ground workstations (Planning MPSR, BME, Ops Planner) have an application (OCA Status Client) that displays the OCA status for a specified ground router on that workstation.

G. OCA Audio

This application provides a means to configure the OCA modem section to route audio only when MFX is not in use. It can configure the modem section to route PGSC audio to the orbiter ATU, route ATU audio to the PGSC, or route ATU audio to/from a PC audio/sound board. This feature has never been used in flight.

#### **2.9.12.4 File Distribution**

The MCC OCA Operators distribute the uplinked files (including payload specific files) to the appropriate directories on the onboard laptops (PGSC or SSC). If a particular laptop is not on the onboard LAN, files destined for that laptop may be uplinked to a diskette in the floppy drive or a PCMCIA card in the PCMCIA slot and then manually transferred by the crew to the correct laptop.

Downlinked payload files will be transferred from the OCA workstation(s) electronically to a pre-flight defined location. These files will either be retrieved from this location directly by the payload customer or distributed by payload support personnel to other network locations for further distribution. Downlinked ops notes will be transferred from the OCA workstation electronically to the FDCC directory on the MODM server in the MCC.

#### **2.9.12.5 Crew E-mail**

E-mail to and from the crew appears, to the end users, to work exactly like the e-mail system in the office or home. The crew's e-mail application is accessed in the offline mode where all mail in the standard folders (inbox, outbox) is saved to a crew specific offline file (.ost extension; one

file per crew member). The OCA Operator acts as a postman to route the ingoing and outgoing mail to the appropriate destinations.

When a crew member creates an e-mail message, the e-mail address of the recipient is specified in the "To" field (this may be a standard JSC e-mail address or an internet address of a friend or relative). When the message is "sent", it is placed in that crew member's Outbox (in the specific .ost file) where it sits until the postman arrives.

All earth based e-mail that is sent to the crew resides in the mail server Inbox for each crew member. There are restrictions as to who may send mail to the crew. For MCC mail, the Flight Directors, Capcoms, FAOs, and Surgeons may send mail directly to the crew (CDR, PLT, MS1, etc.). Special distribution lists, which are maintained by DO4 personnel, list the authorized Flight Controllers for each mission.

Mail that is generated by a crew member's relative or friend is sent to a special address that the Surgeons have set up. All mail that is sent to this address are screened by Surgeon personnel and then moved (not forwarded) to the appropriate crew member account on the ground.

Several times a day, the crew must close all mail applications onboard so that the OCA operator can downlink each crew member's .ost file and synchronize it with the appropriate .ost file on the ground mail server. During the synchronization process, all outbound mail in the crew's Outbox is automatically sent to the specified address. All inbound mail in the ground server Inbox is automatically placed in the appropriate crew member's Inbox. When the synchronization process is complete, the updated .ost file for each crew member is uplinked. After a successful uplink, the crew is free to open the mail applications and access their accounts.

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## 2.9.13 Onboard Short Term Plan Viewer (OSTPV)

### A. General

OSTPV is a tool, under development primarily for the onboard ISS crew, used to view short term plans. This tool is also available in the MCC but all features available to the crew may not be available on the ground.

### B. Procedures

1. From the PC, select

Start ▸ MCC Menu ▸ MOD Server Menu ▸ MOD-Wide Applications ▸ OSTPV (RO)

2. To open a timeline: double click the desired timeline or highlight the desired timeline and select  from the "Select Timeline Window"

#### NOTE

Naming Convention: *I\_name* where *I* = "R" for review or "O" for onboard and *name* is the unique identifier for the timeline.

3. To change the viewable area, use the Layout menu

- a. To change viewable timescale, select Layout ▸ <2 Hr, 4Hr, 8 Hr, 12 Hr, or 24 Hr as desired> or select Alt-1 through Alt-5 or select  or  at lower left corner.

- b. To change the visible activity bands, select

Layout ▸ Crew Bands or

Layout ▸ All Bands

- c. To add information for attitude, day/night, daily orbit, Station Mode, and communications coverage, select Layout ▸ <desired information>

#### NOTE

Activities on the timeline are color coded as follows.

White – activity is scheduled but not yet in work

Green – activity is currently in work

Gray – activity is complete

Purple – activity has aborted, failed, paused, expired, or scheduled-disabled.

Blue Border – time critical, must be performed at the scheduled time.

4. To move the current time to the center of the display or to the left edge of the display, select Options ▸ Current Time at (Left/Center) or use Alt-J or Alt-T respectively.

5. To view Activity Name, Start Time, Activity Location, or Execution Note, select Help ▸ Bubble Help or Alt-B and move the cursor over the activity.

6. To view additional activity information, right mouse click on the activity.
7. To view the procedure associated with an activity, double click the activity.
8. To view Task List activities (those that are not scheduled), select Options ▸ Task List or Cntl-J
9. To filter for activities with specific attributes,
  - a. Select Options ▸ Activity Filter
  - b. Select field(s) and value(s) to filter on and click Apply.
  - c. To sort the resulting list, Click on the title of the column to sort by. To reverse order, click the column again.
  - d. To display activity attributes, Select an activity and click on **More**
  - e. To view a filtered activity in the graphical timeline, Select an activity and then select **Goto** or double click the activity (activity will be highlighted in black).
  - f. To view the associated procedure of a filtered activity, Select the activity and then Select **Procedure**
  - g. To print the filter list, Select **Print**
10. To change preferences,
  - a. Select Layout ▸ Preferences (or Cntl-P)
  - b. Update preferences as desired and select **Apply**
  - c. To save preferences for future use, Select Preferences File tab, enter name, and select **Save**
  - d. To use a previously saved preferences file, Select Preferences File tab, select desired, and select **Apply**
  - e. To select a preferences file as the default, Select Preferences File tab, select the desired file and then select the Default Preferences File check box
11. To close OSTPV, Select File ▸ Quit or Select the **X** in the upper right hand corner, then Select **OK**

C. Supplemental Information

1. General Features and Keyboard Commands

Feature	Description
Vertical dashed red line	Current GMT or SGMT
Operator Bands	Row labels which indicate which operator(s) are performing the given activity
+/_ (lower left-hand corner)	Increases/decreases the visible timescale
Alt-1 through Alt-5	Selects 2, 4, 8, 12, and 24 Hr timescale, respectively
Alt-B	Same as Help ▸ Bubble Help Displays a yellow bubble with key information when the cursor is placed over an activity block on the timeline. Information displayed: <i>Activity Name, Start Time, Activity Location, Execution Note</i>
Alt-J	Moves current time to center of the display
Alt-T	Moves current time to left of the display
Cntl-P	Brings up Preferences window (reference C.3. below)
Cntl-J	Displays Task List Activities
Cntl-F	Brings up Activity Filter window (reference C.4. below)

2. Activity Edit Dialog (right mouse click an activity block to open)

NOTE: Features are Read Only except for planning personnel

<b>Tab</b>	<b>Feature</b>	<b>Description</b>
General	Activity Name	Activity name
	Activity ID	OSTP ID number used for identifying a specific activity even if it has the same name or other similar features
	Activity Status	Current execution status
	Activity Location	Physical location onboard ISS where the activity will occur (e.g. Lab, JEM, FGB, etc.)
	Procedure Location	Location of the procedure needed to perform the activity is located (e.g. Shuttle FDF, JEM JCP, Ops LAN Server, C&C MDM, etc.)
	Procedure Name	Short 20 character name given to the procedure
	Editable by Crew	Defines whether the activity is considered fixed at the current start time by the planning team or if it is acceptable for the crew to reschedule it
	Predecessor ID	Not in use
	Successor 1 ID	Not in use
	Successor 2 ID	Not in use
	Filter Category	Logically assigned to provide the ability to filter for a specific activity type or function
	Origination	Center or entity which created the activity
	Class	"Systems" or "Payloads"
	Automated Initiation	Denotes whether an automated activity is initiated manually or automatically by the Plan Manager software on the C&C MDM (Post-12A)
Time	Start Time	Activity start time.
	End Time	Estimated activity end time.
	Duration	Estimated activity duration.
	Slip Time	Amount of time the activity start time may slip.
Auto	Not Currently Used	Not necessary until post-12A.
Operators	Check box for individual operator	Identifies which crew or operators are assigned to complete a given activity
Reminder	Not usable by ground team	Allows crew to set a reminder for the activity
Notes	Execution Note	Short message with most important reminders or information
	Ops Notes	Notes from the ground team with specific reminders or descriptions about the activity
	Crew Notes	Crew member hints, reminders, data points, etc.

3. Preferences (Ctrl-P or Layout ▶ Preferences)

<b>Tab</b>	<b>Feature</b>	<b>Description</b>
All	Apply button	Changes current view settings without creating a preference file
	Default button	Returns settings to default (no condition data, all operator bands, GMT time reference 8 Hr timescale)
	Cancel button	Cancels changes
	OK button	Closes the window (does NOT save preferences to file)
Preferences File	Preferences File field	File name
	Default Preferences File Check Box	Sets the selected file as the default file
	Save	Saves the selected preferences in the entered file name
	Delete	Deletes the selected preferences file
Operator Bands	Add	Adds the selected operator band names for display
	Add All	Adds all operator band names for display
	Remove	Removes selected operator band names for display
	Remove All	Removes all operator band names for display
	↑	Moves the selected Displayed Band up in order displayed
	↓	Moves the selected Displayed Band down in order displayed
Time Bands	Time Band	Selects time reference (UTC, CST, DMT, Tokyo, Paris)
	Clock Mode	Selects 12 hr or 24 hr clock
	Hour Scale	Selects 2, 4, 8, 12, or 24 hour scale
Conditions Bands	Multiple Check Boxes	Displays attitude, day/night, daily orbit, station mode, and communications coverage as selected via check boxes
Reminders	Crew Use Only	Allows reminders to be set



4. Activity Filter (Ctrl-F or Options ▸ Activity Filter)

**NOTE**

The selections under each tab will be employed for each search and these are defaulted to the last search performed. When performing a new search, it is advisable to click on the 'Clear' button first to start fresh. The logic that exists when filtering is with an "OR" operator placed between multiple selections within the same field, and the "AND" operator placed between different fields even on different tabs within the 'Activity Filter' window.

<b>Tab</b>	<b>Feature</b>	<b>Description</b>
All	Apply button	Changes filter settings. If no filter options are selected, a tabular chronological list of all the activities in the timeline will be displayed.
	Clear button	Returns filter settings to default
	Cancel button	Cancel changes and closes window
Miscellaneous	Multiple Check Boxes	Filters for the types of activities as selected by check box
Activity Name/Time	Activity Name	Filters for all activities that have the entered text string within the activity name
	Before	Filters for all activities occurring before the entered time
	At/After	Filters for all activities occurring at or after the entered time
Opr/Loc/Cat	Operator	Filters on activities scheduled for the selected operator(s). Hold Ctrl key down to select multiple items or deselect a single item.
	Location	Filters on activities to be performed in the selected location(s). Hold Ctrl key down to select multiple items or deselect a single item.
	Category	Filters on the selected category(ies) of activities. Hold Ctrl key down to select multiple items or deselect a single item.
Stat/Exe/Orig	Status	Filters on activities with the selected status via check boxes.
	Executor	Filters on activities as executed by the C&C MDM or P/L MDM as selected via check boxes.
	Origination	Filters on activities originating from the control center(s) as selected via check boxes

## SECTION 3 ORBITER SYSTEMS

Section		Page
<b>3</b>	<b>ORBITER SYSTEMS .....</b>	<b>3-1</b>
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3.1.1	Failure Flip Card Summary .....	3.1.1-1
3.1.2	Orbiter Systems Data Table .....	3.1.2-1
3.1.3	Ascent/Entry Failure Summaries .....	3.1.3-1

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### 3.1 GENERAL

#### **ANOMALY REMINDERS**

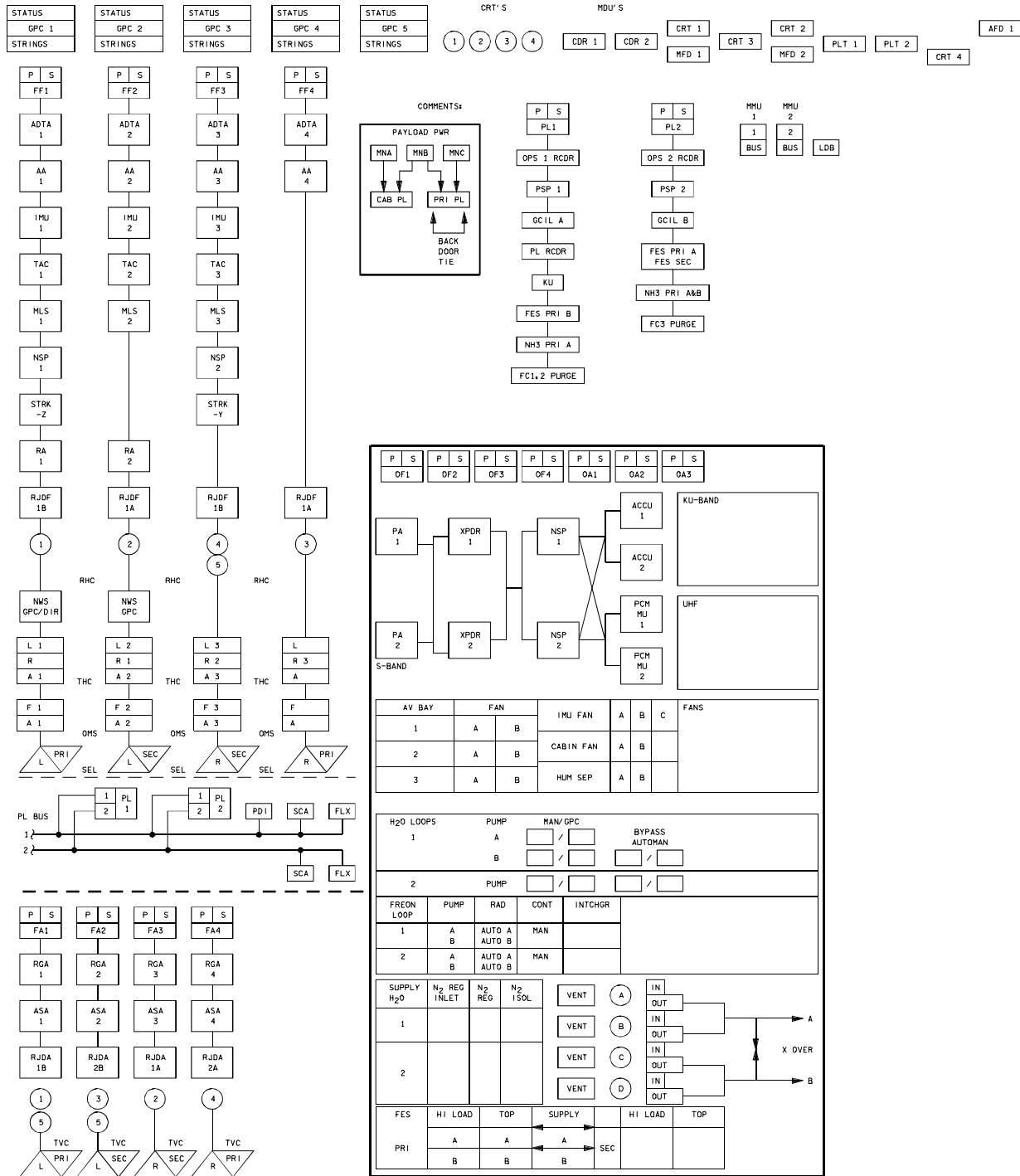
- Safe the System
- Prioritize
- Inform crew
  - Failure/Anomaly
  - Changes to timeline
- Follow-up
  - Combined losses
  - 2nd or 3rd party impacts
- Impacts
  - Sleep period
  - Entry
  - Redundancy
  - DPS/EPS/PROP

#### **IF SPACECRAFT EMERGENCY**

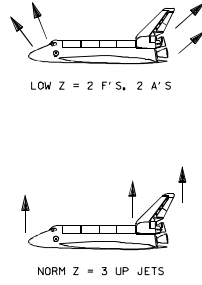
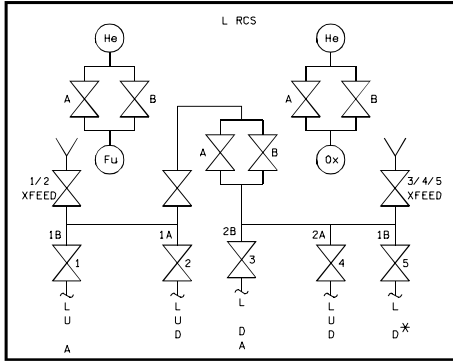
- Address the onboard problem
- Declare the Spacecraft Emergency on the Flight Director loop
- Have the GC notify the Network Director to maximize comm coverage
- Have FDO contact LSO and callup/notify landing sites as required (get copy of ELS DOPS)
- Notify MOD etc. per FCOH SOP 2.8
- Notify MER and SPAN Managers and Have them notify required Engineering personnel
- Have each flight controller notify required support personnel (e.g. entry team)
- Following the event, execute Contingency Action Plan

*Ref: CHB section 2.1.5 and FCOH SOP 2.8*

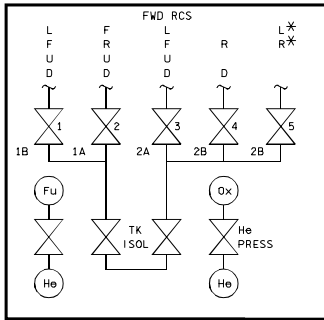
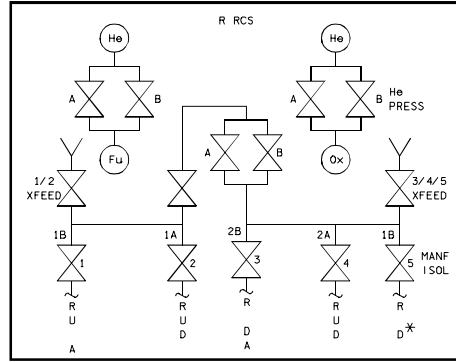
### 3.1.1 Failure Flip Card Summary



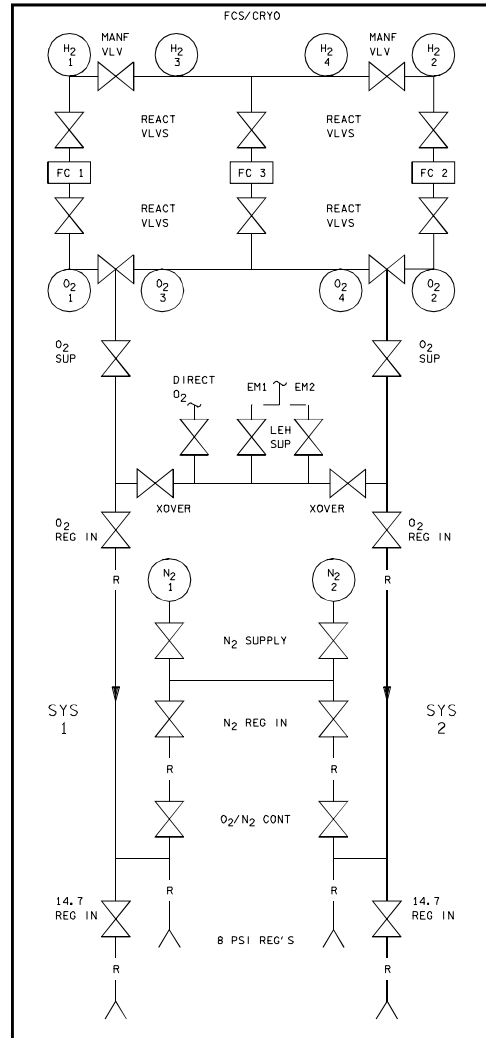
19612002, FLW# 1



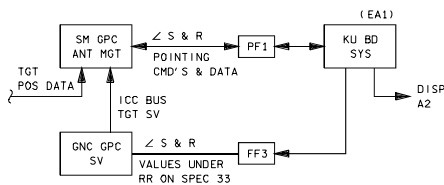
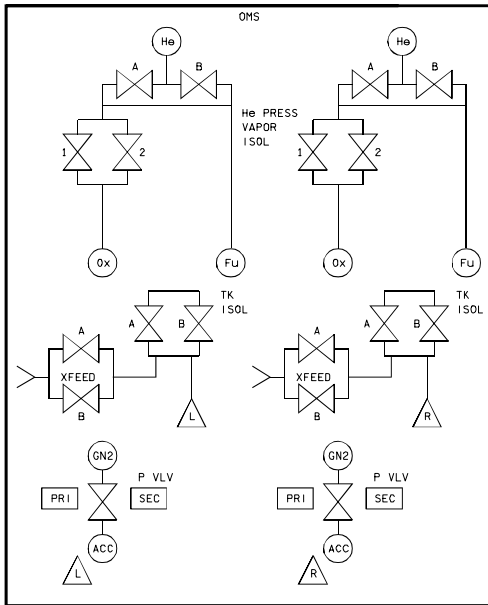
\* = NO GO VERN



APU/HYD				
SYS	WSB	APU	HYD	CIR PUMP
1				
2				
3				



19612001, SCH# 1

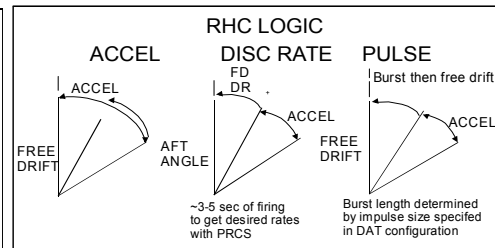


FAILURE SUMMARY FLIPCARD

### 3.1.2 Orbiter Systems Data Table

<u>PROPELLANT CONSUMPTION DATA</u>						
Propellant usages at 150 n.mi. (except as indicated), lb/hr						
	<u>Primary deadbands</u>			<u>Vernier deadbands</u>		
<u>Attitude</u>	0.5	3.0	10.0	0.1	1.0	5.0
IH, Y-POP	116.40	31.80	9.30	10.30	6.00	2.53
	(160 n. mi.)			(160 n. mi.)		
PTC. x at 45° (0.2 disc rate)	162.00	28.20	9.20	7.40	5.25	5.21
-ZLV, Y-POP	123.00	16.20	9.00	2.70	1.20	0.92
	(137 n. mi)			(160 n. mi.)		(160 n. mi)
<u>Raise/lower orbit (1 n.mi. = 4 ft/sec) (H<sub>P</sub> and H<sub>A</sub>)</u>						
OMS	89 lb/n.mi.		225k-lb Orbiter			
RCS (4+x)	106 lb/n.mi					
<u>Standard att mnvr Consumption per jet</u>						
Primary	25.64 lb	OMS	19.3 lb/sec/engine		1% = 129.51 OMS	
Vernier	21.40 lb	RCS primary	3.14 lb/sec/jet		22.0 RCS	
		RCS vernier	0.0923 lb/sec/jet			
<u>10 sec burn (2 jet) Total usage lb/fps</u>						
OMS (ΔV 17.4 fps)*	386 lb		22.2			
*RCS (2+x) (ΔV 2.29 fps)*	62.8 lb		27.5			
* Assumes 225,000 - lb Orbiter						

<u>EFFECTS (AT CG) OF MINIMUM IMPULSE RCS MANEUVERS</u>						
Axis	Linear ft/sec <sup>2</sup>			Angular deg/sec <sup>2</sup>		
	X	Y	Z	R	P	Y
Rotation maneuvers - vernier						
+P	-0.00026	.00000	-0.00573	.00032	.01922	.00001
-P	.00000	.00000	-0.00781	-0.00025	-0.1531	-0.00001
+R	.00000	.00390	-0.00400	.02526	-0.00788	-0.00664
-R	.00000	-0.00390	-0.00400	-0.02552	-0.00790	.00663
+Y	-0.00013	-0.00114	-0.00296	-0.00436	.00941	.01617
-Y	-0.00013	.00114	-0.00296	-0.00438	.00942	-0.01616
Rotation maneuvers - primary						
+P	-0.009	.00000	.076	.020	1.187	.0008
-P	.063	.00000	-0.045	-0.013	-0.790	-0.00005
+R	.034	.039	.048	.934	.086	-.022
-R	.034	-0.039	.048	-0.931	.082	.022
+Y	-0.004	.00008	.004	-0.222	-0.010	.667
-Y	-0.004	-0.0008	.004	.222	-0.009	-0.668
Translation maneuvers - primary						
+X	.279	.00000	.049	-0.0003	-0.021	-0.00001
-X	-0.286	.00000	.039	-0.002	-0.114	-0.00008
+Y	-0.004	.283	.004	.390	-0.009	.210
-Y	-0.004	-0.283	.004	-0.390	-0.010	-0.210
+Z(H)	-0.016	.00000	1.278	.003	.156	.00000
+Z(N)	-0.005	.00000	.426	.001	.041	-0.00000
-Z	.128	.00000	-0.583	.0003	.016	.00001



<u>THRUST/ENGINE DATA</u>			
<u>Engines</u>	<u>Accel</u>	<u>Thrust (lbf)</u>	
OMS (Both)	1.92 ft/sec <sup>2</sup>	6000	200K lb
RCS (2+X)	.278 ft/sec <sup>2</sup>	870 PRCS	Orbiter 24 VRCS
<u>Venting (lbf)</u>			
APU exhaust/vent	0 avg	30 peak	
Hydraulic H <sub>2</sub> O boilers		3 each max	
Flash evaps		0.129 max	
High load:	Ascent/entry	-1.35	
	On-orbit	-1.00	

<u>DEADBAND DATA</u>				
<u>DAP Attitude and Deadband Capabilities</u>				
Attitudes	<u>Minimum</u>		<u>Maximum</u>	
	<u>Pri</u>	<u>Vern</u>	<u>Pri</u>	<u>Vern</u>
Deadband attitude	0.10	0.010	40.00	40.000
Deadband rate	0.20	0.010	5.000	0.500
Discrete rate	0.050	0.002	2.000	1.000*

	<u>Freezing points</u>	<u>Detonation</u>	<u>Vapor P</u>
MMH (PROP)	-63° F	425° F	1.0
N2O4	+11° F	--	13.9
Hydrazine (APU)	+34° F	205° F	

<u>CG CONTROL</u>	
<u>Prop</u>	<u>Lb/in</u>
<u>X-Axis</u>	
OMS	750
Fwd RCS	280
Aft RCS	900
<u>Y-Axis</u>	
OMS	2000

\*Limited to 0.2 deg/sec for vernier lifetime

RADIATOR SYSTEM PERFORMANCE (15 - 16 kW avg)				
<u>Beta angle</u>	<u>Radiators</u>	<u>FES H<sub>2</sub>O use, lb/hr</u>	<u>Avg rad in, °F</u>	<u>Peak avg rad out, °F</u>
<u>-ZLV</u>				
0 - 45 (low)	Deployed	0 - 2	80 - 85	45
	Stowed	4 - 6	80 - 85	55
45 - 65 (medium)	Deployed	6 - 8	90 - 95	50
	Stowed	10 - 14	90 - 95	55
65 - 90 (high) 100% sunlight	Deployed	16 - 20	100 - 110	60
	Stowed	---	---	---
<u>PTC</u>				
Low	Deployed	0	85 - 90	38
	Stowed	0	85 - 90	38
Medium	Deployed	0	90 - 95	38
	Stowed	0 - 3	90 - 95	38
High	Deployed	5	100 - 110	43
	Stowed	---	---	---

Note: • All numbers are approximate and some are based on one flight.  
 • YVV attitude will be higher than XVV: 6-10 lb/hr (low β/stowed).  
 • OV 103 may use more H<sub>2</sub>O than OV 102/99; 6-8 lb/hr (total).

<u>AMMONIA BOILER CONSTRAINTS</u>
1) Must be <400K feet (G-load factor) Nominal use <120K feet
2) Max operating time 30 min each system at nominal entry loads

<u>FES PERFORMANCE</u>		
<u>PRI A or PRI B condition</u>	<u>Design BTU/hr</u>	<u>Dev. test BTU/hr max. capability</u>
Both evaps/both loops	131K	148.0K
Loop 1	67.5K	92.8K
Loop 2	67.5K	127.0K
Topping/both loops	30K	39K
Loop 1	N/A	26.6K
Loop 2	N/A	37.6K

<u>POWER LEVELS</u>	
<u>Nominal</u>	<u>kW</u>
Ascent	21 - 22
On-orbit	
Workday	15 - 16
Sleep	10 - 12
Entry	17 - 20
<u>Power Down Cases (Loss of)</u>	
Freon	15
High Load Evap	16
Fuel Cell	18

<u>WATER PRODUCTION/CONSUMPTION DATA</u>			
Production rate/fuel cell data: 0.8 lb/hr per kW			
<u>TOT kW</u>	<u>TOT H<sub>2</sub>O generated lb/hr</u>	<u>Time to fill tank- 165 lb. hr</u>	<u>Net dump using FES and RAD OUT HI, lb/hr</u>
10	8	20.8	14.5
12	9.6	17.2	12.8
15	12	13.8	10.5
16	12.8	12.9	9.7
20	16	10.3	6.5

FES use rate (net) deorb prep/entry ~ 60 lb/hr  
 Based on FES use of 26 lb/hr  
Metabolic H<sub>2</sub>O production:  
 5 - person crew ~ 30 lb avg.  
 7 - person crew ~ 40 lb avg.  
Water dump rate:  
 120 - 150 lb/hr  
 (Tank 100% full = 165 lb)

<u>CRYO CONSUMPTION</u>		
<u>Equipment</u>	<u>Watts</u>	<u>H<sub>2</sub> lb/day</u>
MADS	415	
MADS (on orbit)	<220 orbit	.46
Ltg pnl (LOVHD, L CTR)	486	
Ltg pnl (ROVHD, R)	347	MAX
Inst ltg (L/CTR, OVHD)	112	(full bright)
Inst ltg (R)	65	
Freon pump loop	480	1.0
GPC	620	1.3
CRT	290	.6
H <sub>2</sub> O pump loop	250	.52
FES	220	.46
ACIP & htr	180	.38
IMU	120	.25
ADI/DDU	120	.25
MDM	60	.13
Ku-band	580	1.2
S-band PA	380	.78
S-band FM	79	.16
H <sub>2</sub> →	.0874 lb/kW-hr	O <sub>2</sub> → 0.693 lb/kW-hr
	2.1 lb/kW-day	16.6 lb/kW-day

Typical Use (15.5 kW)	
H <sub>2</sub>	O <sub>2</sub>
1.3 lb/hr	10.7 lb/hr
32 lb/day	260 lb/day



### 3.1.3 Ascent/Entry Failure Summaries

<b>DPS</b> PASS GPC↓	FCS CHs OFF (OVRD as reqd), FDBKs 2 ON 2 Split: ET SEP – MAN Post MECO: STANDBY/HALT ET SEP – AUTO B/U LH2 vlv – OP √OMS GMBL
	If GPC↓ after ET SEP: FF MDM – OFF, ON (GPC1 – IMU1 – DESEL)
BFS GPC↓	Post SRB SEP: FES PRI A – ON Post MECO: Restart (STBY, HALT .. STBY, RUN) If recovered: OPS 302, Load TGTS, OUTPUT – B/U No comm.: Select Best Antenna
FA MDM I/O	I/O Reset FCS CHs OFF (OVRD), FDBKs Port Mode
FF MDM I/O	Post MECO: √OMS GMBLs I/O Reset Port Mode
	Post MECO: PWR Cycle √OMS GMBLs (GPC1 – IMU1 – DESEL)
PL MDM I/O	BFS I/O Reset Port Mode, BFS I/O Reset PL2: Post SRB SEP: FES PRI A – ON No Comm: Select Best Antenna
BCE STRG X	If IMU – DESEL I/O Reset If NSP & No comm: PNL, CMD Port Mode
SUMWORD ICC RESTRING	(B:AA, D: FDBK, RGA) Prior to OPS TRANS: Aff GPC – STBY, HALT Config NBAT √SURF FDBKs Aff GPC(s) – STBY, HALT OPS Mode Recall Config FCS CHs, FDBKs

<b>APU HYD</b>	
APU SHUTDOWN	SAFE APU AUTO Shutdown (three) – INH 1 APU↓: SPEED SEL HI (TEAM, Pwrld flt) 2 APU↓: SPEED SEL HI
APU COOLDOWN	(AT M=7) LO PRESS
APU RESTART	INJ Cooling LO PRESS Requires 3 ½ min cooldown or INJ T < 400 START/RUN & NORM PRESS

<b>COMM</b>	
COMM LOST:	AUT CTR – 2 UHF Sites STDN/SGLS: PNL, CMD TDRS: Config PNL TDRS, PNL, CMD Select best antenna ANT - GPC

<b>ECLS</b>	
CAB PRESS HI:	Isolate H2 & N2 (N2 REG INLETS & O2 SPL – CL)
CAB LEAK:	CAB RELIEFS – CL O2/N2 CNTLR VLV SYS 2 – OP O2 TKS 1,2 Htrs – AUTO (HI – DEACT PUMP) Post MECO: SW Pumps
H2O LOOP LO/HI	Post MECO: SW Fans
IMU/CAB FAN↓ AV BAY	No COMM: SW Fans Both Fans – ON No Joy – SW H2O Loops
FAN DELTA P:	1: TAC/MLS 1 – OFF
TEMP HIGH:	2: TAC 2, MLS 2,3 – OFF 3: TAC 3 – OFF
LOSS COOL:	≤2.7: Use SUIT O2 ≥3.6: SUIT O2 and O2 SPLY vlvs – CL
CAB PPO2	No Comm: SW Pumps Still LO – RAD Flow PUMP – OFF
FREON FLOW LO	Aff O2 SPLY – CL MSTR MADS – OFF 2 CRTs – OFF
LOSS 1 FCL	All L1 SWs OFF except H2O PUMP LOOP 2 MCC CMD Purge then BFS PWR OFF Post ET SEP: DC UTIL PWR – OFF FCS, GPC, FA, FF 4 – OFF
LOSS 2 FCL	
EVAP OUT T HI	√Sensor failure FES PRI A – OFF, B – ON No Joy: B – OFF, SEC – ON No Joy: MAN RAD Flow No Joy: MASTER MADS OFF
EVAP OUT T LO	√Sensor failure H2O PUMP LOOP 1 – ON, B (prevents freezing) If RAD Flow: OUT T-HI If FREON EVAP OUT T < 32 NH3 CNTLR A, B – SEC, ON No JOY: FCL2 – OFF NH3 B – OFF O2 2 SPLY – CL

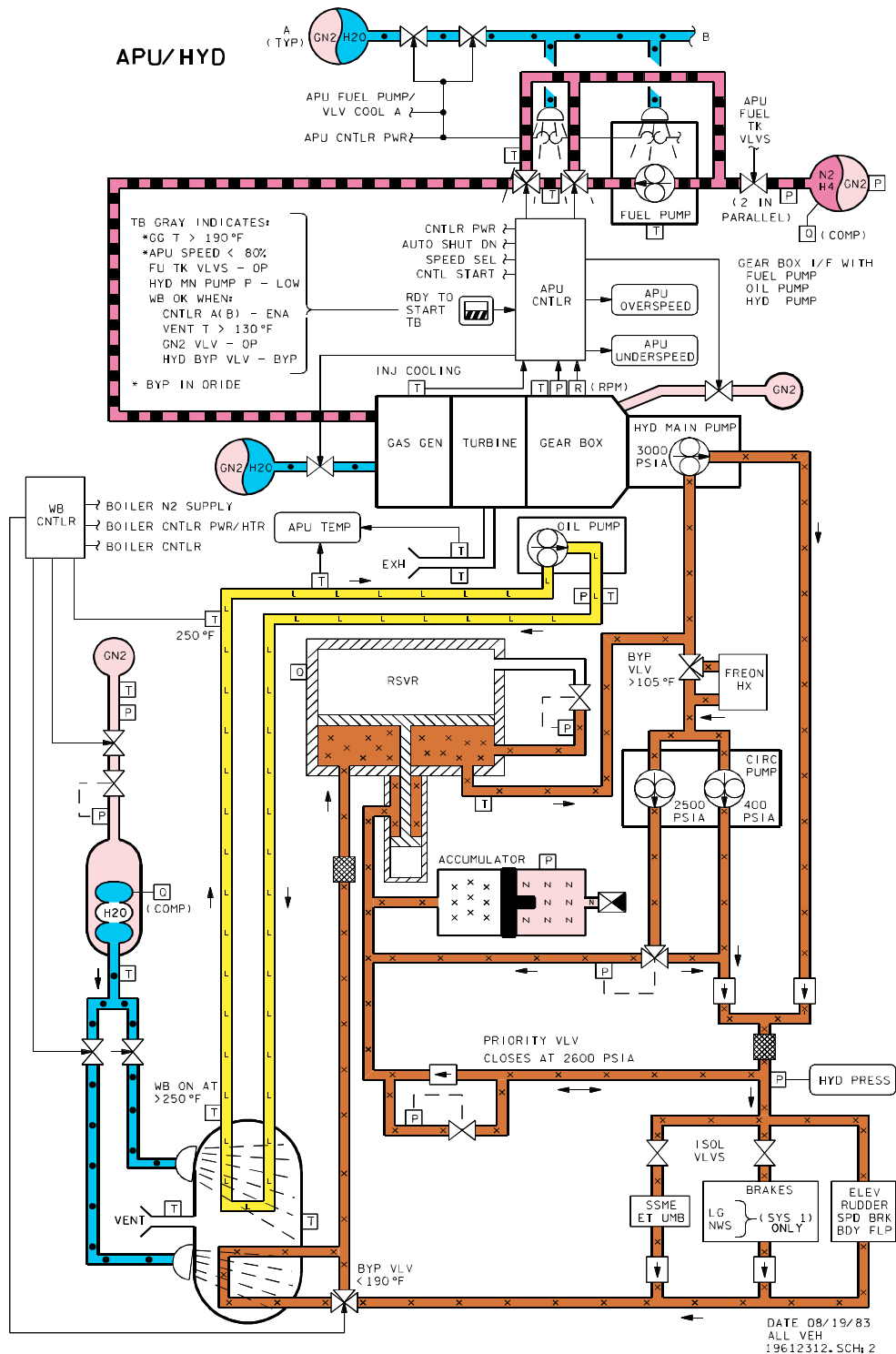
<b>FC PWRDN</b>	
1 FC:	PRI PL – OFF AFT PL – OFF 1 CRT – OFF
2 FC:	Select 1 FCL PUMP on Good FC (other FCL pumps – OFF) Turn OFF: HUM SEPs, IMU FANs, H2O Pumps, AV Bay Fans, CAB Fans, FES Htrs Post MECO: B/U LH2 VLV – OP All stinrgs GPC1 (other GPCs – OFF) PWRDN 1 IMU, all TAC/RA PWR UP 1: IMU Fan, H2O Loop AV BAY 1,2 FAN – ON ETC ...

<b>EPS</b>	
MN BUS UNDER V/ FC V	Short/Degraded FC: If Tied – Untie Bad AC V or Stack T: ESS BUS & MN BUS – OFF FC V < 32 (FC Short): FC REACT – CL, FC SHUTDN FC V > 32 (Bus Short): Go to BUS LOSS ACTIONS FC Disconnect: BUS TIE Post-MECO – FC SHUTDN
FC COOL PUMP DELTA P LOW	FC – START MSTR MADS OFF, Loss of 1 FC PWRDN Post MECO (within 9min of fail): √FC PUMP cbs (L4:C) No Joy – FC SHUTDN
FC PH OR DELTA V	PH & FC SS DELTA V > 150: BUS TIE, FC REACTs – CL MSTR MADS – OFF √PWRDN
FC STACK T	PH Only: Post SRB SEP: BUS TIE MSTR MADS – OFF Stack T > 243 & increasing: 2nd FC: Go to 2nd FC SHUTDN PL PRI – OFF IF FC A < 150 or > 360: √FC SHORT (MN BUS UNDER V PROC) BUS TIE No Joy: FC REACT – CL FC – STOP (when COOL P < 15)
FC EXIT T	MSTR MADS – OFF BUS TIE Post MECO: EXIT T BAD – FC SHUTDN
FC REAC VLV CLSOED	FC REAC – OP BUS TIE If FC COOL P < 50: FC SHUTDN BUS TIE If Reqd: FC REAC VLV – CL MSTR MADS – OFF √PWRDN Post MECO: If reqd: FC SHUTDN
AC VOLT LOW/OVRLD	AC BUS SNSR (three) – OFF Troubleshoot Inverter
AC VOLT HI	AC BUS SNSR (two) – OFF AC3 & V < 130: H2O LOOP 2 – OFF Post MECO: AC BUS SNSR – AUTO TRIP
3 PHASE MOTORS STOPPED	Determine AC Bus AC BUS SNSR (three) – OFF Aff FC – STOP Further ISOL
CRYO LEAK	MANF VLV 1,2 – CL TK 3 HTR A – AUTO Aff MN BUS TIE ...

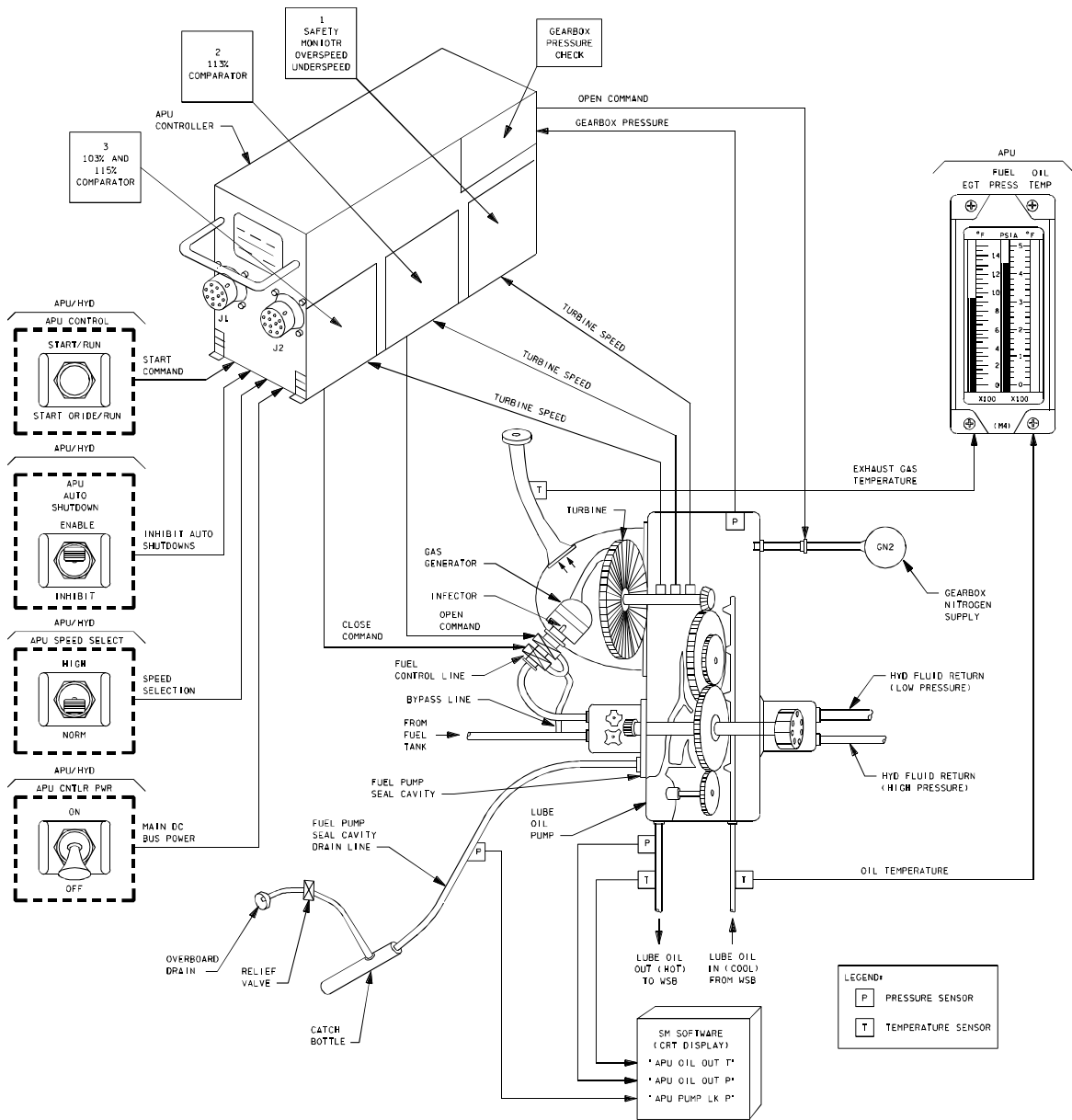
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3.2.2 APU Assembly Pictorial .....	3.2.2-1
3.2.3 Landing Gear Hydraulics.....	3.2.3-1
3.2.4 Switch Panel (R2) .....	3.2.4-1
3.2.5 Displays .....	3.2.5-1

### 3.2 APU/HYD

#### 3.2.1 Overview Schematic

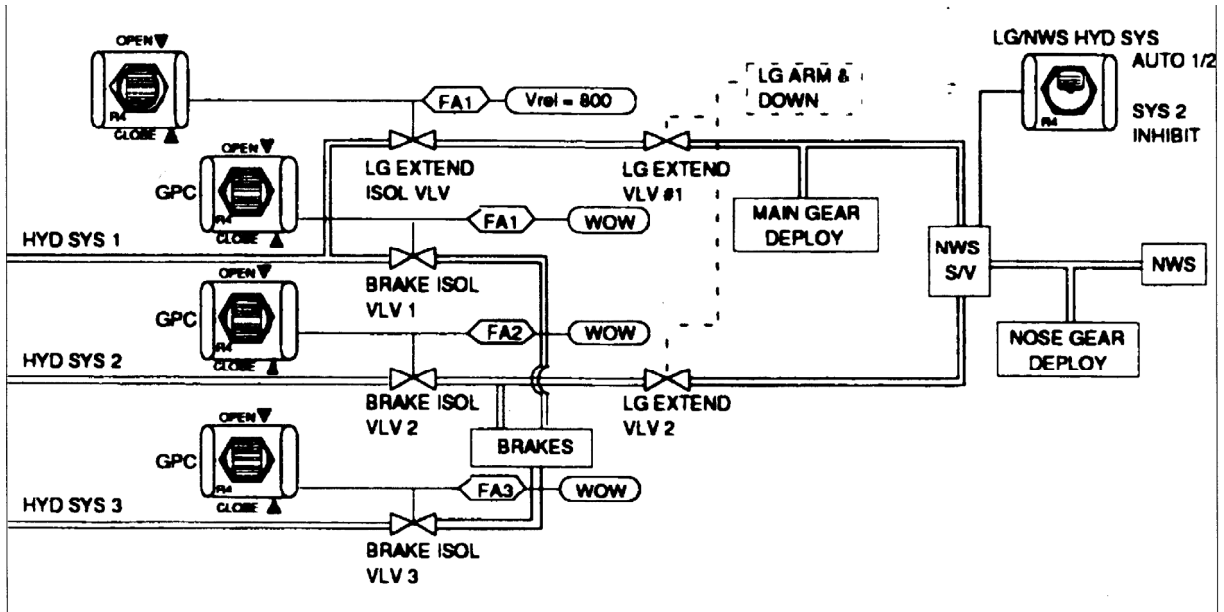


### 3.2.2 APU Assembly Pictorial

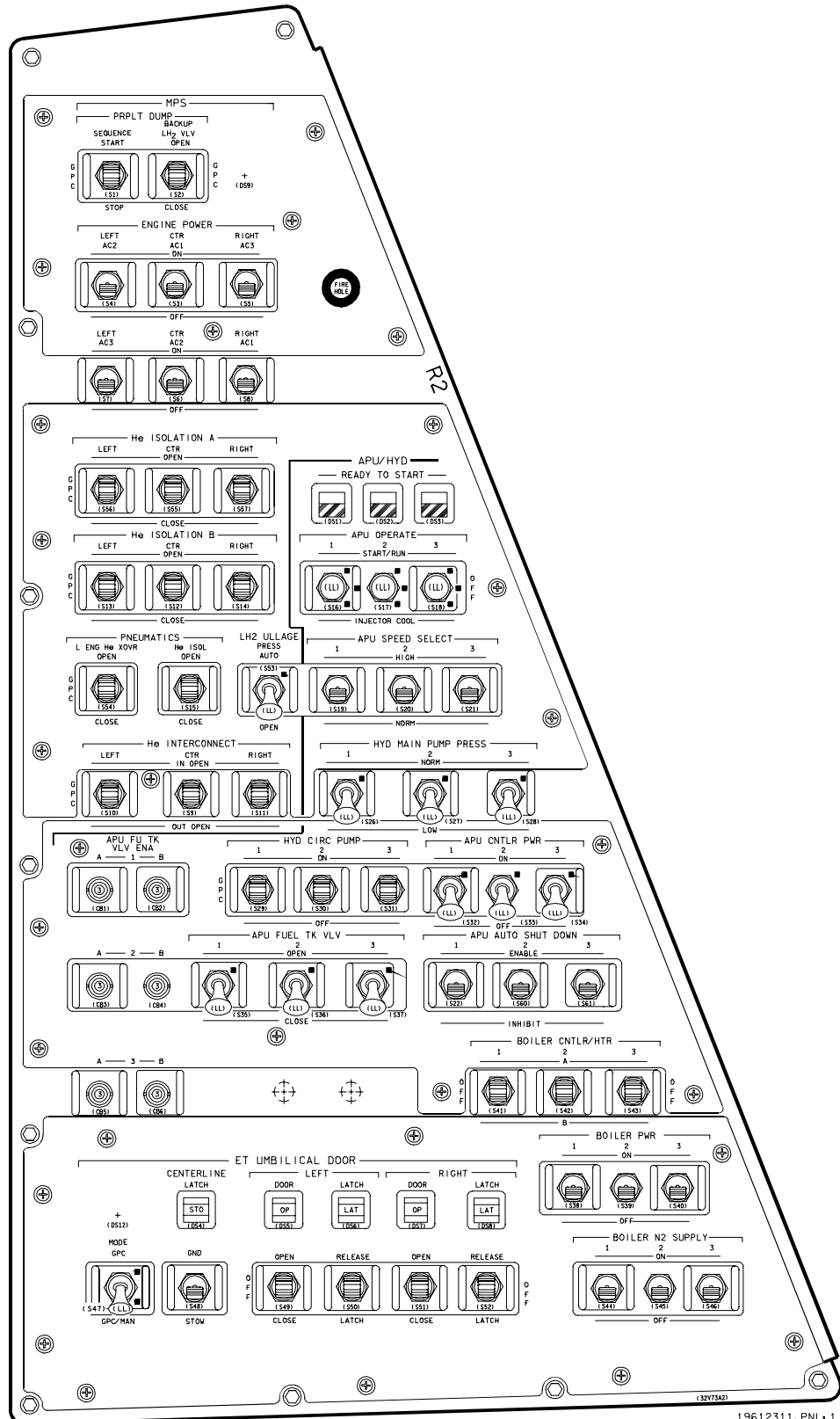


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### 3.2.3 Landing Gear Hydraulics



3.2.4 Switch Panel (R2)



3.2.4-1

### 3.2.5 Displays

XXXX/XXX/079 SM SYS SUMM 2 XX X DDD/HH:MM:SS DDD/HH:MM:SS									
CRYO TK	1	2	3	4	5	MANF1	MANF2		
H2 PRESS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
O2 PRESS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
HTR T1	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
T2	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
APU	1	2	3	HYD	1	2	3		
TEMP EGT	±XXXS	±XXXS	±XXXS	PRESS	±XXXS	±XXXS	±XXXS		
B/U EGT	±XXXS	±XXXS	±XXXS	RSVR T	±XXXS	±XXXS	±XXXS		
OIL IN	±XXXS	±XXXS	±XXXS	P	±XXXS	±XXXS	±XXXS		
OUT	±XXXS	±XXXS	±XXXS	QTY	±XXXS	±XXXS	±XXXS		
SPEED %	±XXXS	±XXXS	±XXXS	W/B					
FUEL QTY	±XXXS	±XXXS	±XXXS	H2O QTY	±XXXS	±XXXS	±XXXS		
PMP LK P	±XXXS	±XXXS	±XXXS	BYP VLV	±XXXS	±XXXS	±XXXS		
OIL OUT P	±XXXS	±XXXS	±XXXS						
AV BAY				THERM CNTL	1	2			
TEMP	±XXXS	±XXXS	±XXXS	H2O PUMP P	±XXXS	±XXXS			
FAN ΔP	X.XXS	X.XXS	X.XXS	FREON FLOW	±XXXS	±XXXS			
				EVAP OUT T	±XXXS	±XXXS			

(XX)

XXXX/XXX/079 SM SYS SUMM 2 XX X DDD/HH:MM:SS BFS DDD/HH:MM:SS									
CRYO TK	1	2	3	4	5	MANF1	MANF2		
H2 PRESS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
O2 PRESS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
HTR T1	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
T2	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS	±XXXS		
APU	1	2	3	HYD	1	2	3		
TEMP EGT	±XXXS	±XXXS	±XXXS	PRESS	±XXXS	±XXXS	±XXXS		
B/U EGT	±XXXS	±XXXS	±XXXS	ACUM P	±XXXS	±XXXS	±XXXS		
OIL IN	±XXXS	±XXXS	±XXXS	RSVR T	±XXXS	±XXXS	±XXXS		
OUT	±XXXS	±XXXS	±XXXS	QTY	±XXXS	±XXXS	±XXXS		
GG BED	±XXXS	±XXXS	±XXXS						
INJ	±XXXS	±XXXS	±XXXS	W/B					
SPEED %	±XXXS	±XXXS	±XXXS	H2O QTY	±XXXS	±XXXS	±XXXS		
FUEL QTY	±XXXS	±XXXS	±XXXS	BYP VLV	±XXXS	±XXXS	±XXXS		
PMP LK P	±XXXS	±XXXS	±XXXS						
OIL OUT P	±XXXS	±XXXS	±XXXS						
FU TK VLV	A T ±XXXS	±XXXS	±XXXS	THERM CNTL	1	2			
	B T ±XXXS	±XXXS	±XXXS	H2O PUMP P	±XXXS	±XXXS			
AV BAY	1	2	3	FREON FLOW	±XXXS	±XXXS			
TEMP	±XXXS	±XXXS	±XXXS	EVAP OUT T	±XXXS	±XXXS			
FAN ΔP	X.XXS	X.XXS	X.XXS						

SMSYS SUMM2 Display (BFS)

XXXX/XXX/086 APU/HYD XX X DDD/HH:MM:SS DDD/HH:MM:SS									
APU	1	2	3	HYD	1	2	3		
B/U EGT	±XXXS	±XXXS	±XXXS	B/U P	±XXXS	±XXXS	±XXXS		
EGT	±XXXS	±XXXS	±XXXS	RSVR T	±XXXS	±XXXS	±XXXS		
SPEED %	±XXXS	±XXXS	±XXXS	P	±XXXS	±XXXS	±XXXS		
FUEL QTY	±XXXS	±XXXS	±XXXS	QTY	±XXXS	±XXXS	±XXXS		
TK P	±XXXS	±XXXS	±XXXS	ACCUM P	±XXXS	±XXXS	±XXXS		
OUT P	±XXXS	±XXXS	±XXXS						
TK VLV A	±XXXS	±XXXS	±XXXS	W/B	1	2	3		
A T	±XXXS	±XXXS	±XXXS						
B T	±XXXS	±XXXS	±XXXS						
OIL	1	2	3	CNTLR	±XXXS	±XXXS	±XXXS		
OUT T	±XXXS	±XXXS	±XXXS	H2O QTY	±XXXS	±XXXS	±XXXS		
OUT P	±XXXS	±XXXS	±XXXS	T	±XXXS	±XXXS	±XXXS		
P	±XXXS	±XXXS	±XXXS	N2 P	±XXXS	±XXXS	±XXXS		
GBX	±XXXS	±XXXS	±XXXS	T	±XXXS	±XXXS	±XXXS		
N2 P	±XXXS	±XXXS	±XXXS	REG P	±XXXS	±XXXS	±XXXS		
BRG T	±XXXS	±XXXS	±XXXS	BYP VLV	±XXXS	±XXXS	±XXXS		
GG BED T	±XXXS	±XXXS	±XXXS	VENT T	±XXXS	±XXXS	±XXXS		
PUMP/VLV				TANK T	±XXXS	±XXXS	±XXXS		
PMP T	±XXXS	±XXXS	±XXXS	BLR T	±XXXS	±XXXS	±XXXS		
VLV T	±XXXS	±XXXS	±XXXS						

(XX)

XXXX/XXX/087 HYD THERMAL XX X DDD/HH:MM:SS DDD/HH:MM:SS									
HYD	1	2	3	LINE	1	2	3		
CIRC PMP	±XXXS	±XXXS	±XXXS	ELEVON	±XXXS	±XXXS	±XXXS		
PMP BDY	±XXXS	±XXXS	±XXXS	L OB	±XXXS	±XXXS	±XXXS		
RSVR	±XXXS	±XXXS	±XXXS	R IB	±XXXS	±XXXS	±XXXS		
ACCUM	±XXXS	±XXXS	±XXXS	ROB	±XXXS	±XXXS	±XXXS		
HX IN	±XXXS	±XXXS	±XXXS	RD/SB	±XXXS	±XXXS	±XXXS		
OUT	±XXXS	±XXXS	±XXXS	BDYFLP	±XXXS	±XXXS	±XXXS		
SW VLV	PR	S1	S2	FUS	±XXXS	±XXXS	±XXXS		
ELEV L	OB 3XS	1XS	2XS	L BRAKE	WHL	±XXXS	±XXXS		
	IB 2XS	1XS	3XS	FUS	±XXXS	±XXXS	±XXXS		
	R IB 3XS	1XS	2XS	R BRAKE	WHL	±XXXS	±XXXS		
	OB 2XS	1XS	3XS	FUS	±XXXS	±XXXS	±XXXS		
RUD/SPDBK	1XS	2XS	3XS	NG	UPLK	±XXXS	±XXXS		
TIRE PRESS				MFUS 1	±XXXS	±XXXS	±XXXS		
MG LEFT				MFUS 2	±XXXS	±XXXS	±XXXS		
IB ±XXXS	±XXXS	±XXXS	±XXXS	MG L	UPLK	±XXXS	±XXXS		
OB ±XXXS	±XXXS	±XXXS	±XXXS	MG R	UPLK	±XXXS	±XXXS		
NG ±XXXS	±XXXS	±XXXS	±XXXS	FUS	±XXXS	±XXXS	±XXXS		

(XX)

XXXX/XXX/088 APU/ENVIRON THERM XX X DDD/HH:MM:SS DDD/HH:MM:SS									
FREON LOOP	1	2	H2O LOOP	1	2				
ACCUM QTY	±XXXS	±XXXS	PUMP OUT P	±XXXS	±XXXS				
FREON FLOW	±XXXS	±XXXS	OUT T	±XXXS	±XXXS				
PL HX FLOW	±XXXS	±XXXS	AP	±XXXS	±XXXS				
AFT CP FLOW	±XXXS	±XXXS	ICH FLOW	±XXXS	±XXXS				
RAD IN T	±XXXS	±XXXS	OUT T	±XXXS	±XXXS				
RAD OUT T	±XXXS	±XXXS	CAB HX IN T	±XXXS	±XXXS				
EVAP OUT T	±XXXS	±XXXS	ACCUM QTY	±XXXS	±XXXS				
EVAP TEMP	DUCT	NOZ	APU FUEL T	1	2	3			
HI LOAD INBD	±XXXS	±XXXS	TK SURF	±XXXS	±XXXS	±XXXS			
OUTBD	±XXXS	±XXXS	TK HTR	±XXXS	±XXXS	±XXXS			
TOPPING FWD	±XXXS	±XXXS	TEST LN 1	±XXXS	±XXXS	±XXXS			
AFT	±XXXS	±XXXS	TEST LN 2	±XXXS	±XXXS	±XXXS			
L	±XXXS	±XXXS	FEED LN	±XXXS	±XXXS	±XXXS			
R	±XXXS	±XXXS	PUMP IN	±XXXS	±XXXS	±XXXS			
EVAP FDLN T	A	B	DRN LN 1	±XXXS	±XXXS	±XXXS			
FWD	±XXXS	±XXXS	DRN LN 2	±XXXS	±XXXS	±XXXS			
MID 1	±XXXS	±XXXS	OUT	±XXXS	±XXXS	±XXXS			
MID 2	±XXXS	±XXXS	BYP LN	±XXXS	±XXXS	±XXXS			
AFT	±XXXS	±XXXS	GG SPLY LN	±XXXS	±XXXS	±XXXS			
TOPPING	±XXXS	±XXXS	H2O LN INJ	±XXXS	±XXXS	±XXXS			
ACCUM	±XXXS	±XXXS							
HI LOAD	±XXXS	±XXXS							

(XX)

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### 3.3 COMM

#### 3.3.1 Comm System Overview Schematic

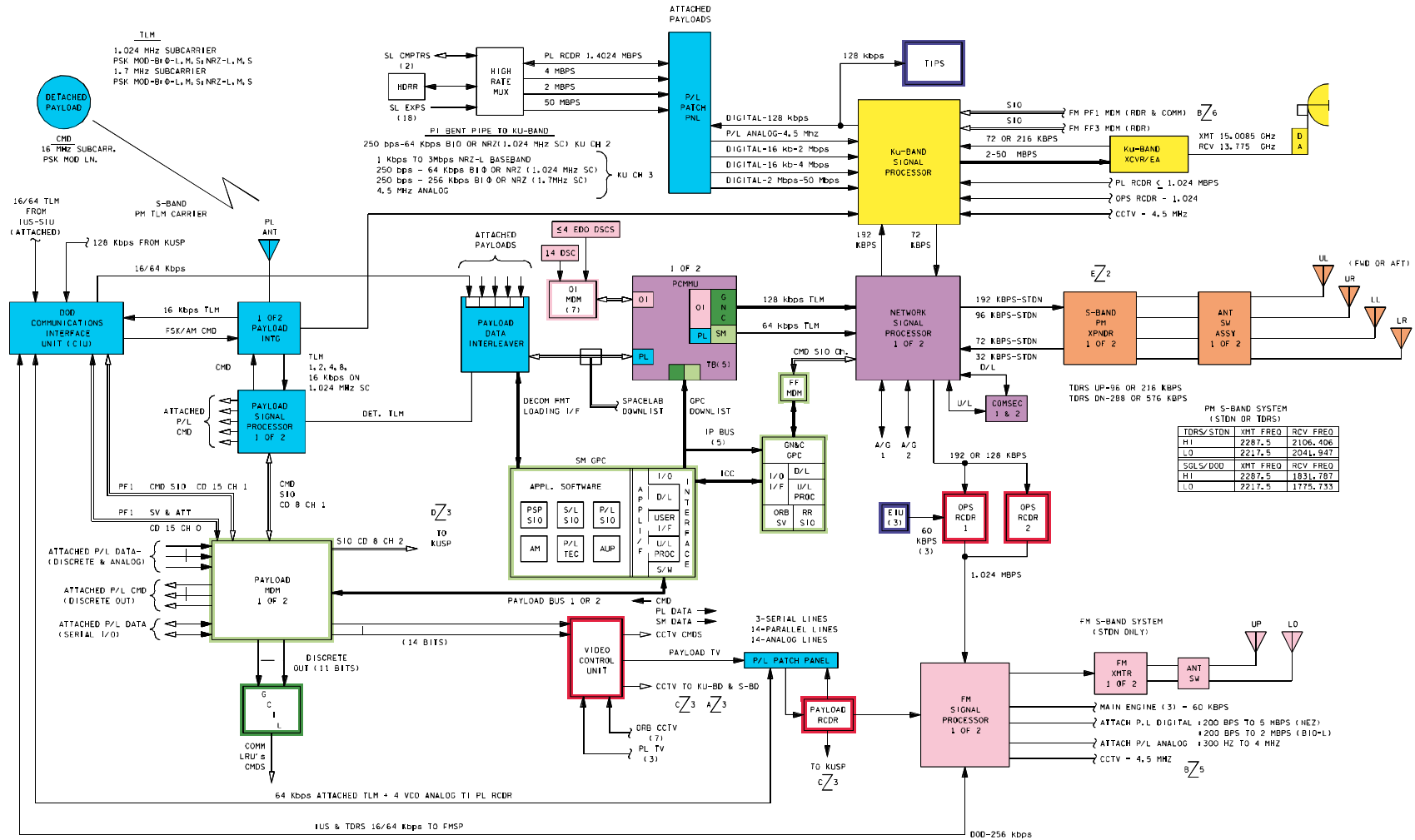


FIGURE 1-1. - Shuttle communications system overview.

### 3.3.2 S-Band PM Schematic

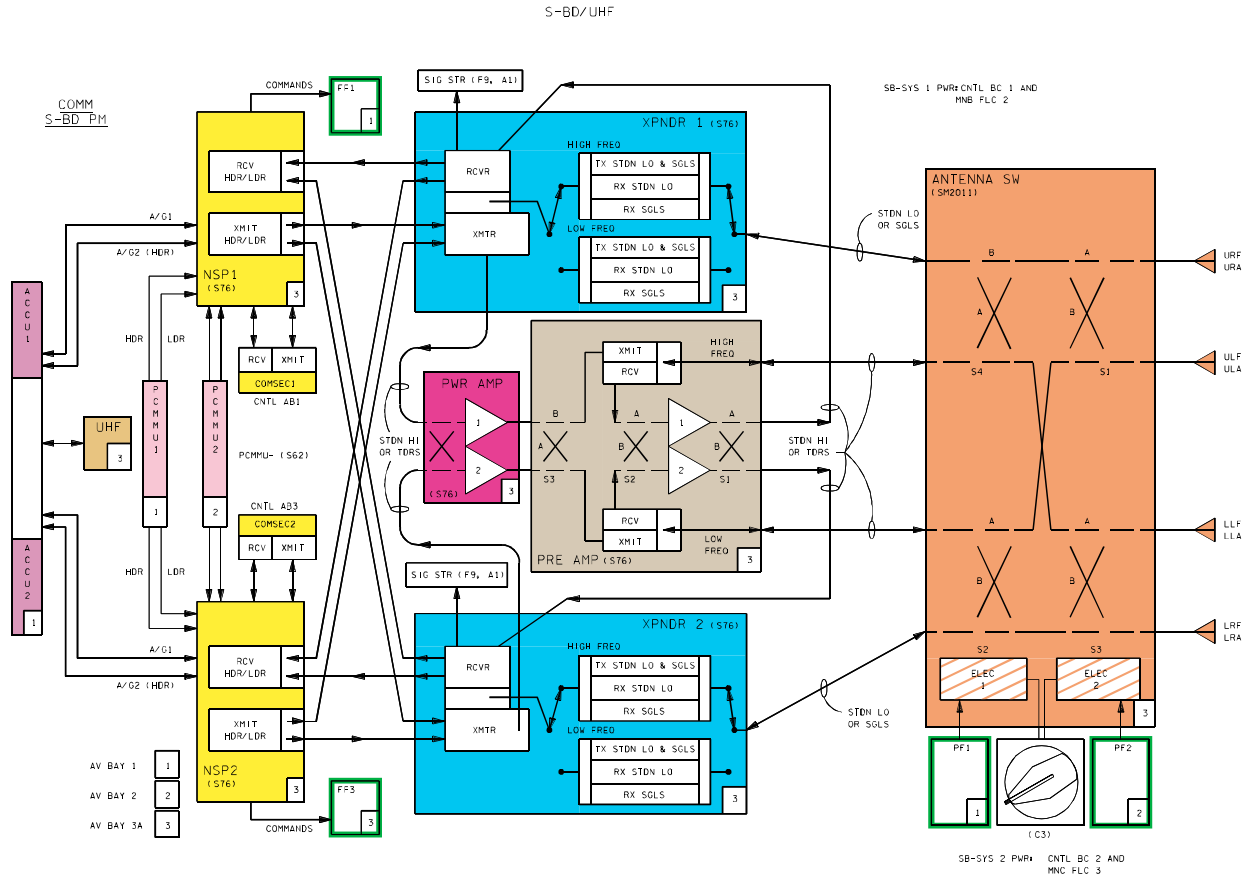
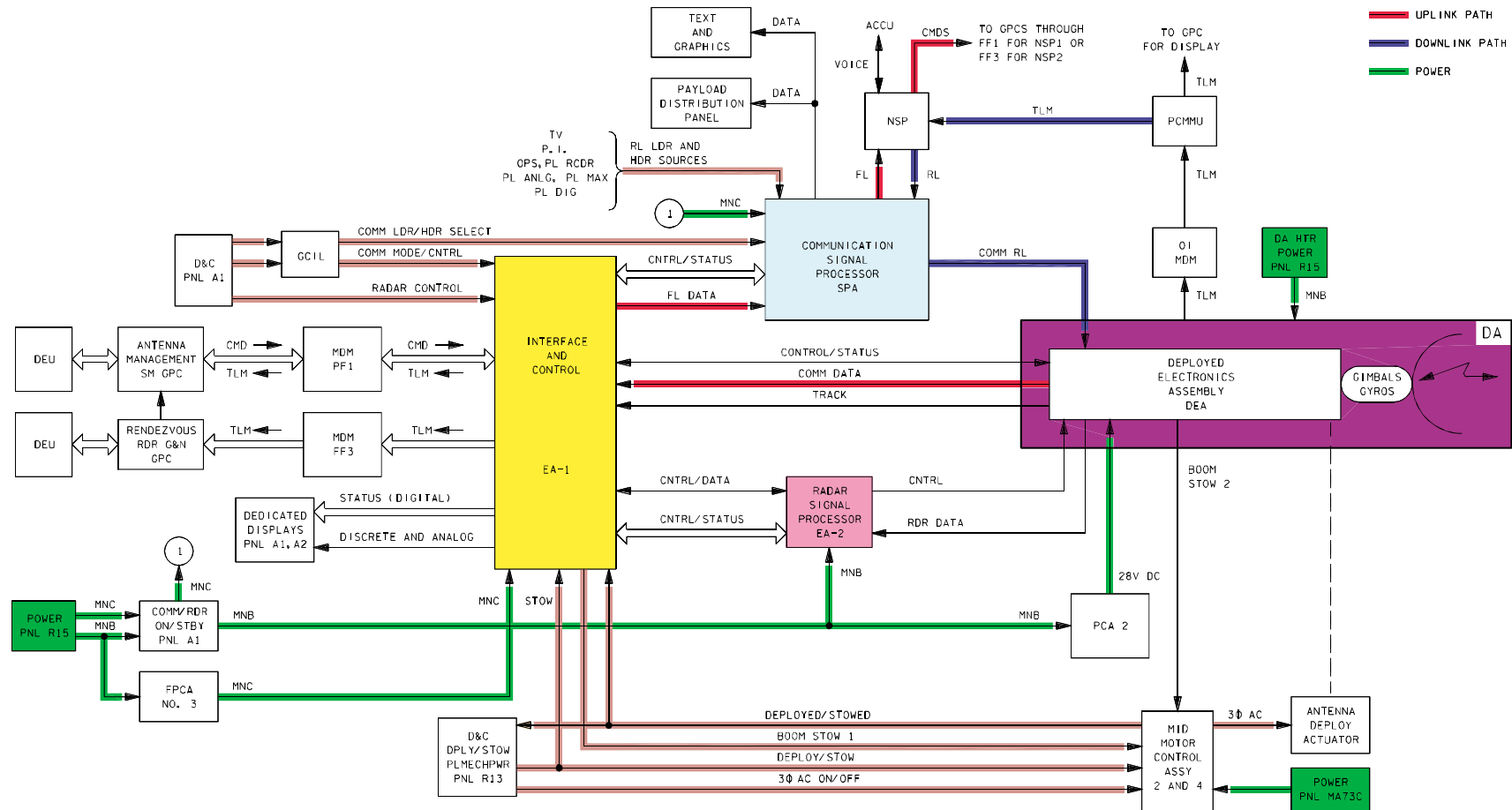


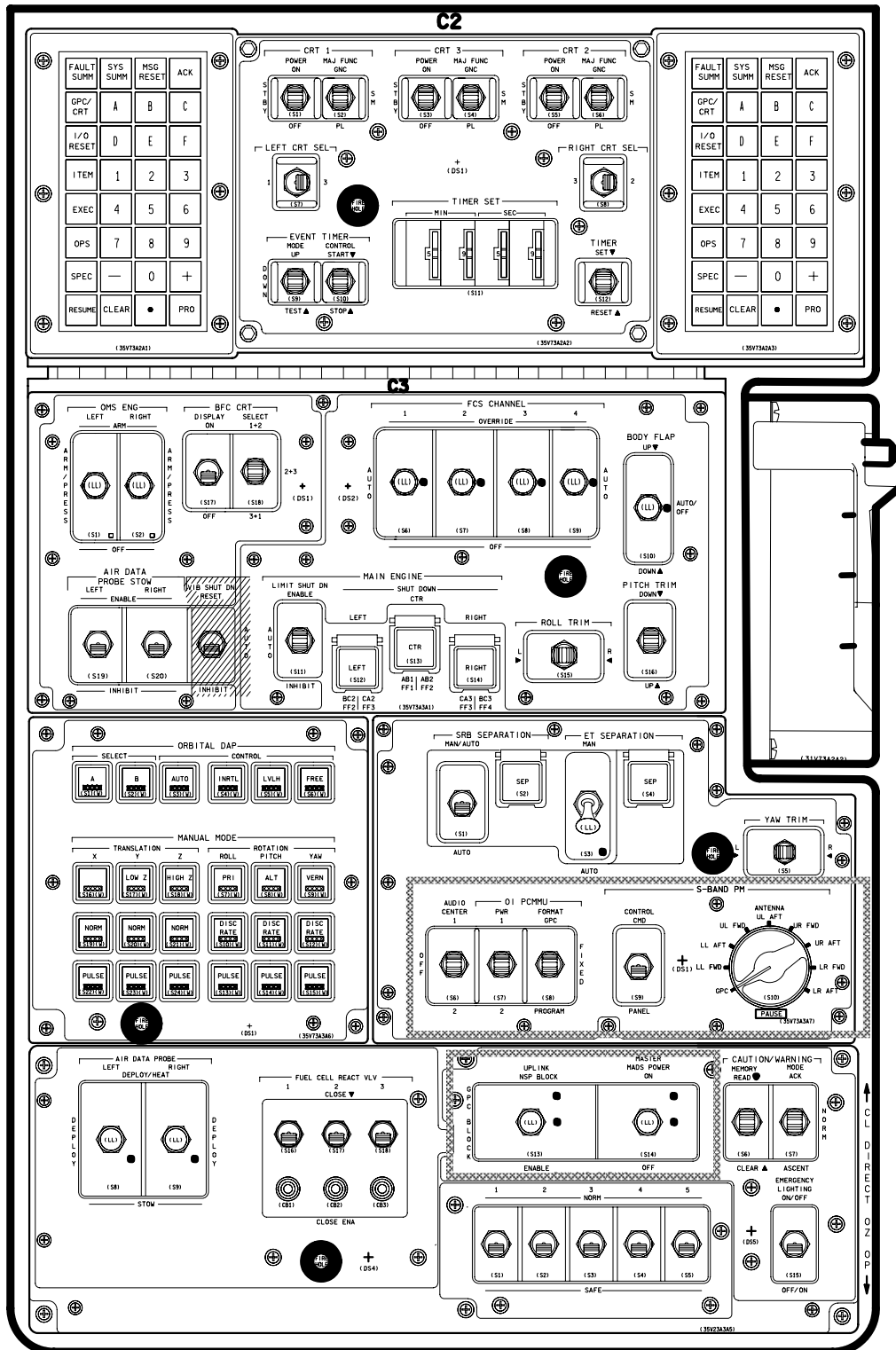
FIGURE 2.2-3- FLIGHT DIRECTORS CW3.

19612314.SCH 2

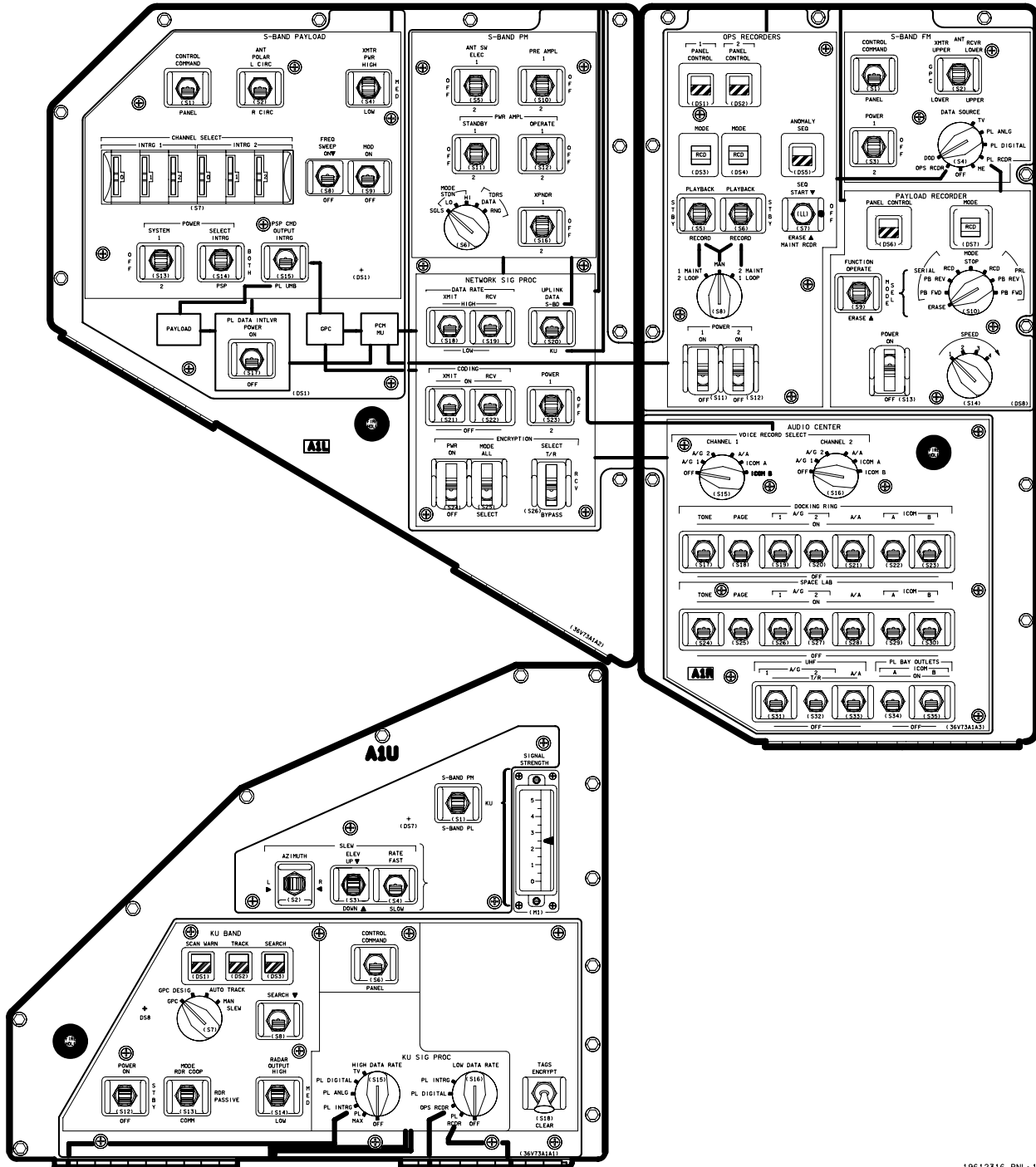
### 3.3.3 Ku-Band Schematic



### 3.3.4 Switch Panels (C2/C3, and A1L/A1R/A1U)

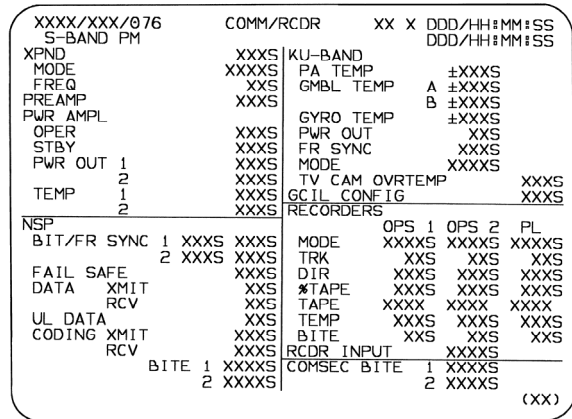
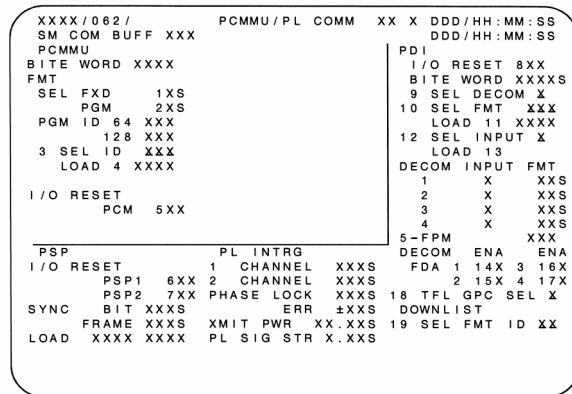
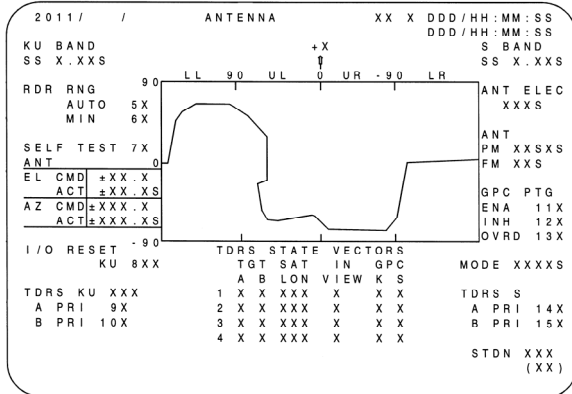


19612315, PNL 1 1



19612316, PNL 1

### 3.3.5 Displays



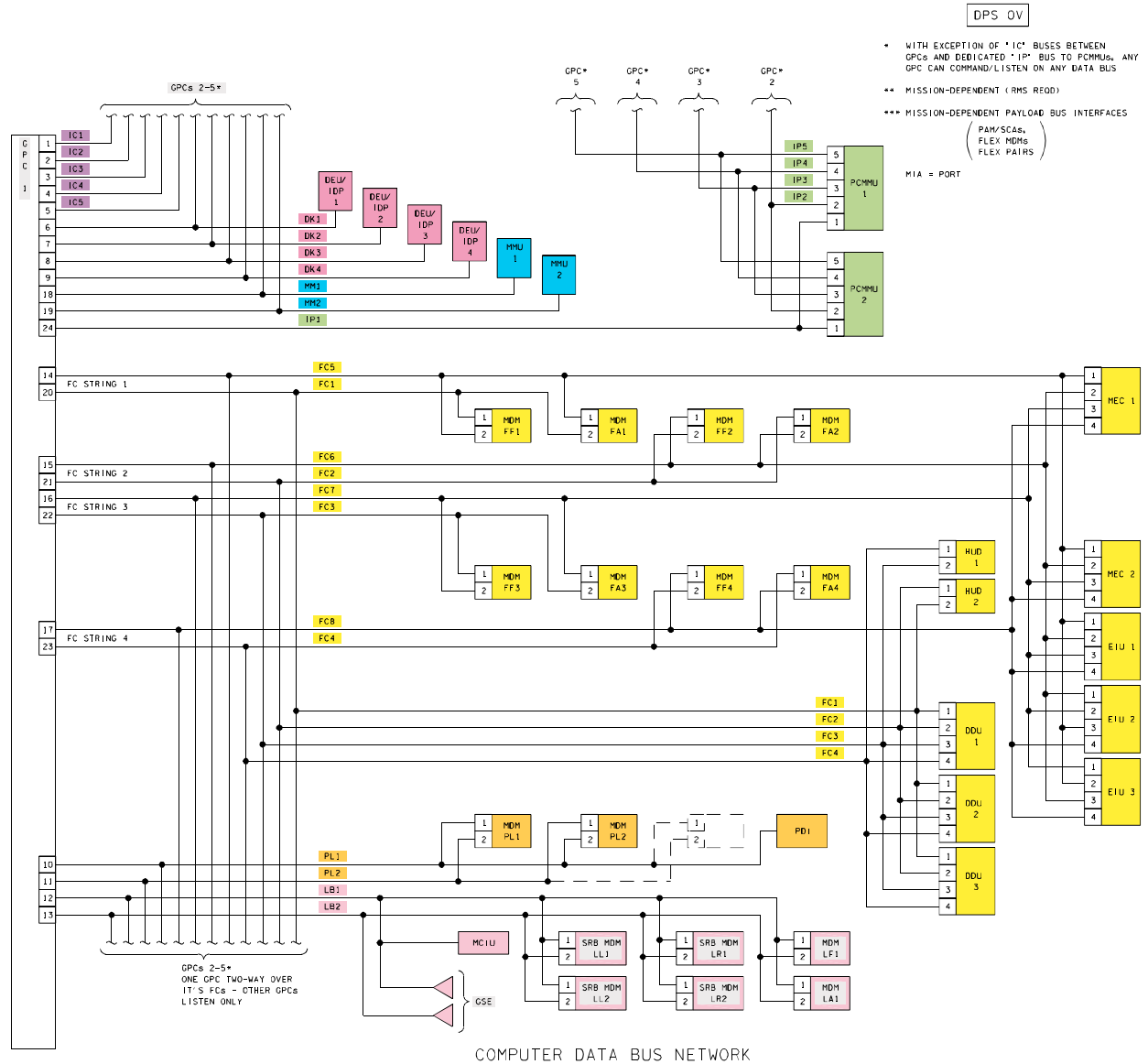
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### 3.4 DPS

#### 3.4.1 Data Bus Network

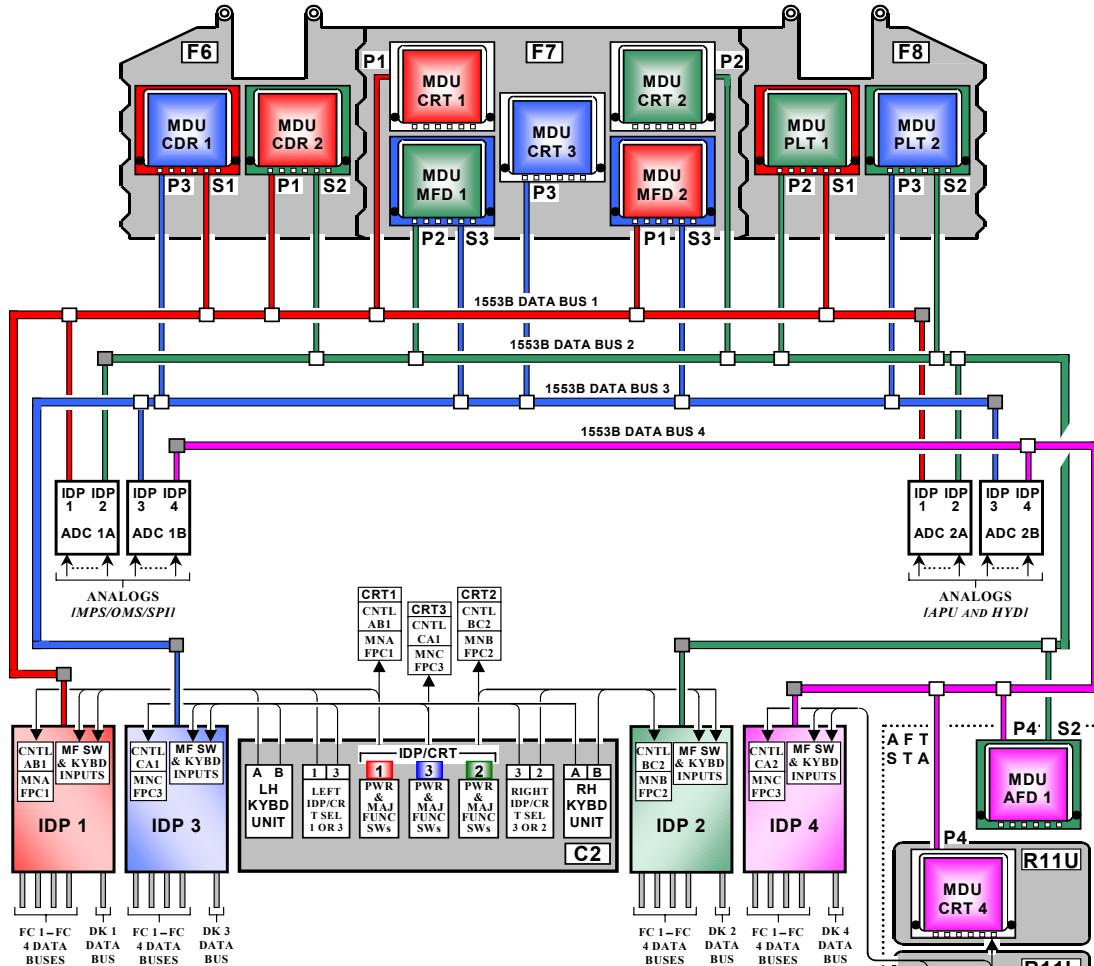


**DATA BUSES**

- FCs (8)** - CRITICAL TO FLYING ORBITER
- PL (2)** - PAYLOAD CONTROL AND SH FUNCTIONS
- MM (2)** - LINK GPCs TO MMUs
- FCC (5)** - GPC TO GPC SYNCHRONIZATION (ONE-WAY BUS; BFS GPC NOT IN RS OR CS SO DOESN'T USE - LISTENS OVER FCs)
- DK (4)** - LINK DEUS (WHICH DRIVE CRTs) TO GPCs
- IP (5)** - INSTRUMENTATION/PCMMU IS LINK BETWEEN GPCs AND PCMMUs
- LB (2)** - LAUNCH DATA BUSES ARE PRELAUNCH LINK BETWEEN GROUND SUPPORT EQUIPMENT, SRB MDMs AND LAUNCH MDMs. ON ORBIT LINK TO RMS

19612347.SCH2

Figure 3.4.1-1: Computer Data Bus Network



**MEDS**

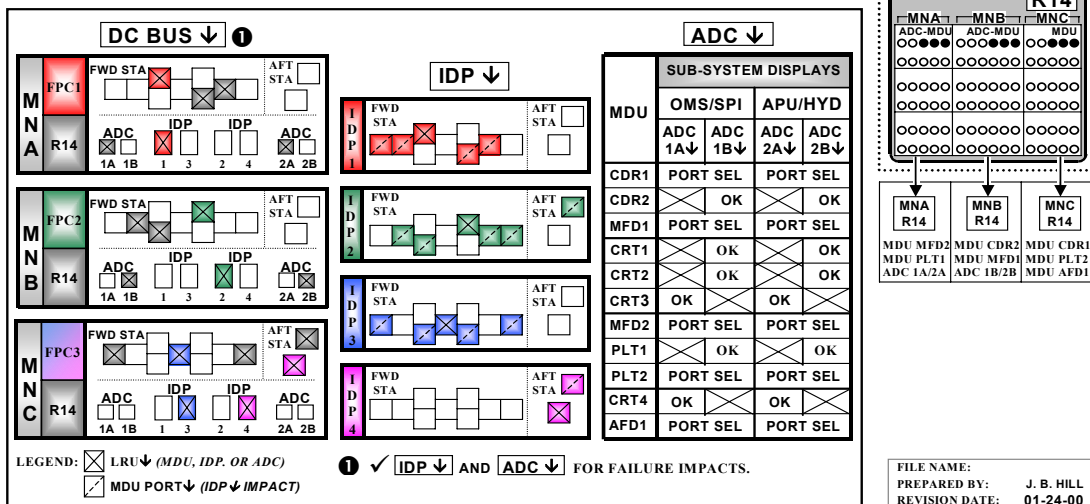


Figure 3.4.1-2: MEDS Overview

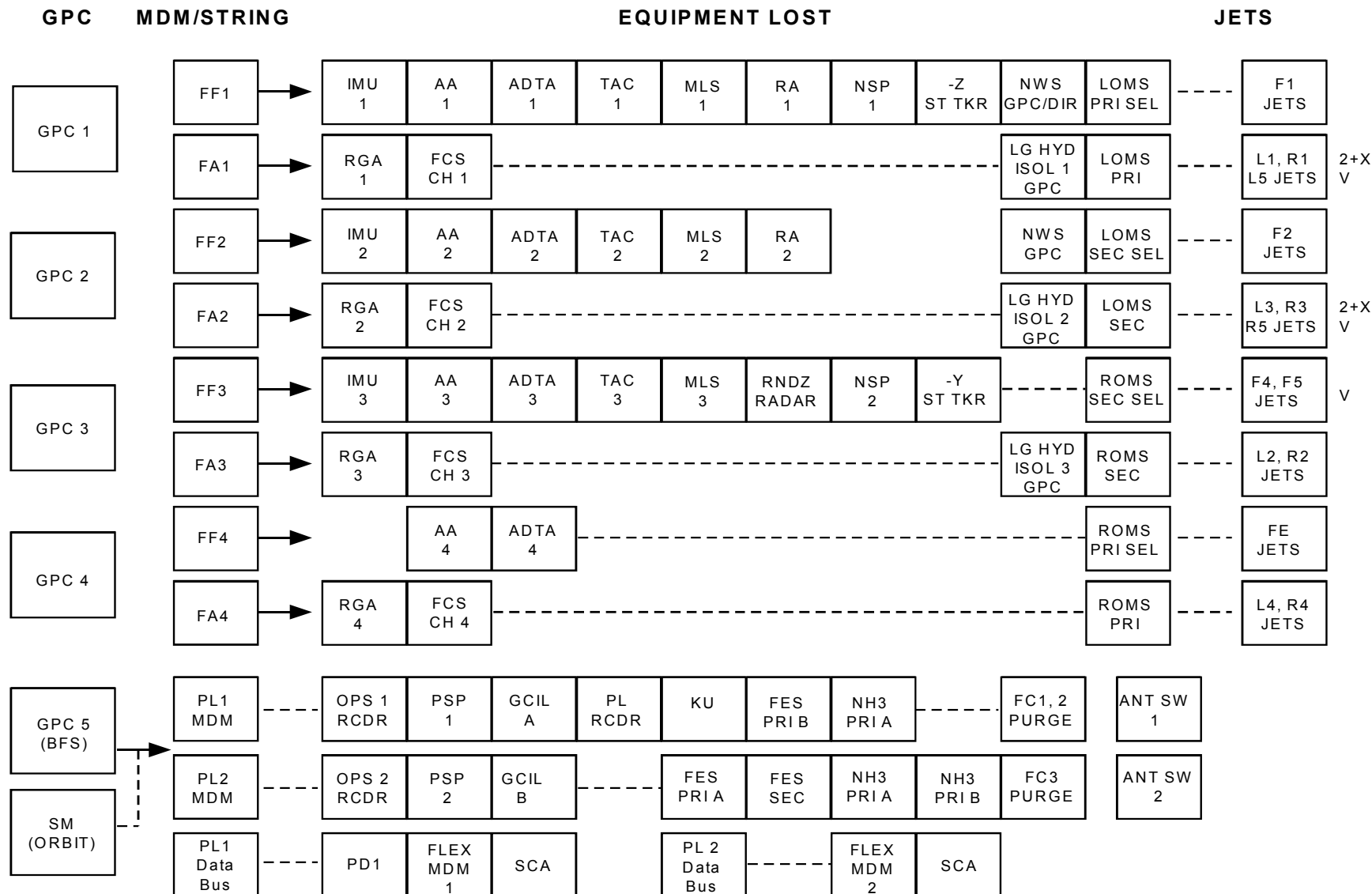
### 3.4.2 DPS Failure Signatures

Failure	Caution and Warning		Procedure	Comments
	Hardware	Software		
Fail to Sync	GPC light CAM lights	GPC Fail Message ↓ on SYS SUMM	GPC Fail	GPC continues to send commands over data bus
Fail to Halt	BP Output tb BP Mode tb CAM light GPC light CRT Big X Poll Fail	GPC Fail Message ↓ on SYS SUMM	GPC Fail	Dead GPC, no commands
Fail to Quit	GPC light CAM light CRT Big X	GPC Fail Message ↓ on SYS SUMM	GPC Fail	Like fail to halt, except talkbacks
Generic PF Fatal S/W Error	Fail to quit or halt on all four GPCs		BFS Engage	
Power Fail	BP Output tb BP Mode tb CRT Big X Poll Fail	GPC Fail message ↓ on SYS SUMM	GPC Fail	Like fail to halt, but no CAM lights or F7 GPC lights
I/O Term B fails ON		↓ on SYS SUMM for FF & FA FF and FA I/O Error messages	GPC Fail	GPC running, but commands inhibited on flight critical data buses
I/O Term A fails ON		↓ on SYS SUMM for PL1 & PL2 PL1 and PL2 I/O Error messages	BFS or SM GPC Fail	GPC running but commands inhibited on payload and launch data buses
MDM I/O Error at MDM	Varies with MDM	I/O Error message ↓ on PFS SYS SUMM M's on BFS SYS SUMM	MDM I/O Error	GPC good, MDM lost (at least on current port)
MDM I/O Error at GPC	Varies with MDM	PFS I/O Error message BFS BCE String PASS message ↓ on PFS for failed MDM M's on BFS SYS SUMM for FF and FA	MDM I/O Error	Port mode may cause loss of other MDM on string
Component comm problems		BCE String X message M's on PFS and BFS SYS SUMM	BCE String X	Use Ref Data book to find parameters lost and verify signature
OI MDM/DSC Fail	Varies with MDM/DSC	M's on SYS SUMM for MDM L's on SYS SUMM for DSC I/O Error PCM annunciated by BFS for PCM port problem or MDM problem PASS SM machine will annunciate S62 BCE BYP OF X or OA message	I/O Error PCM	

### 3.4.3 DPS FDF Procedure Summaries

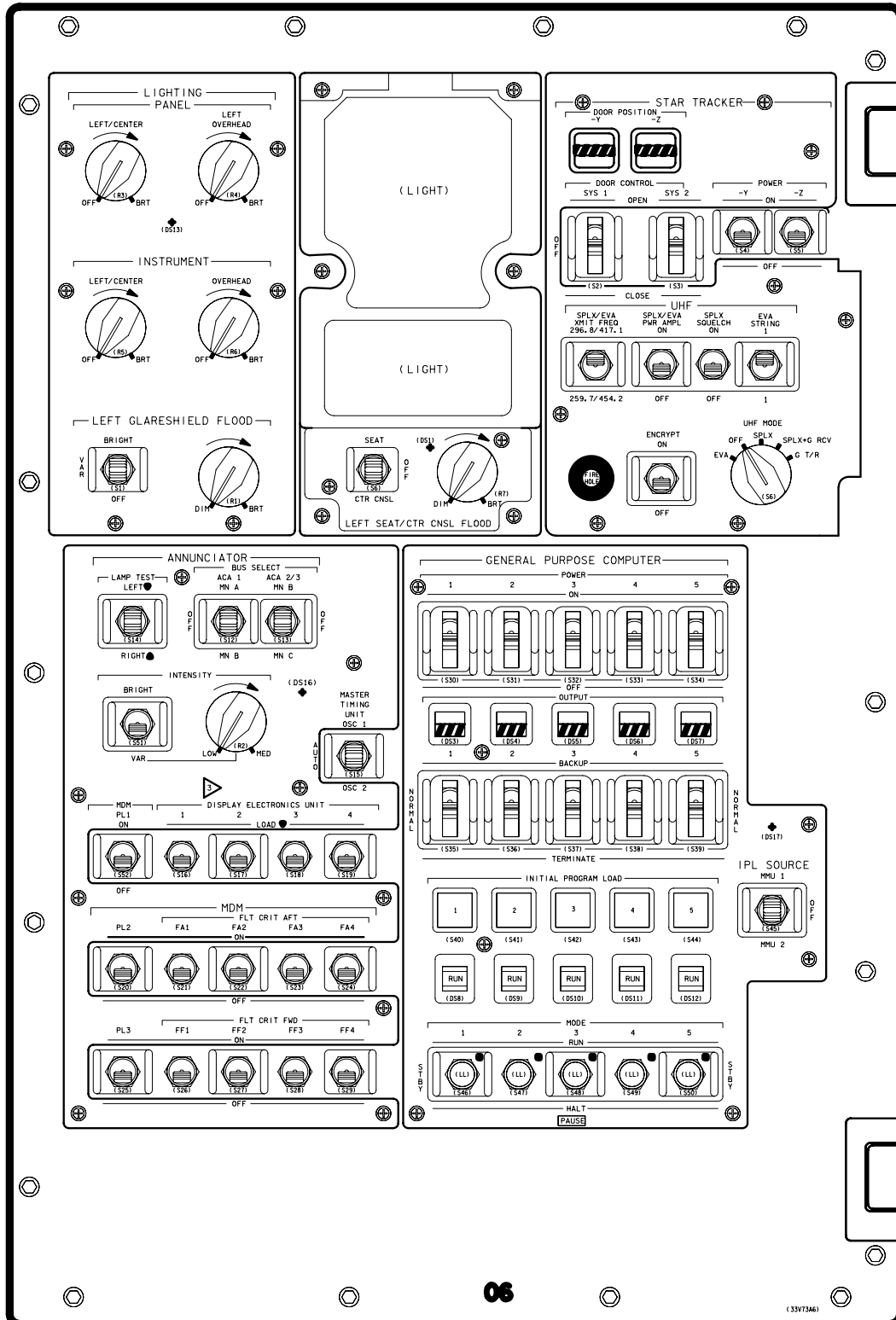
Procedure	Summary
PASS (GNC) GPC (1ST FAIL) 1-1 CS Split: MAL, DPS 5.1, 1.2 RS Split: MAL, DPS 5.1, 1.3	Maintain RCS attitude control. Activate G2FD if no active GNC GPC. Powered off GPC retains more dump data than STBY-HALT. If RNDZ NAV: Cancel Mnvr, DAP-FREE.
PASS SM GPC FAIL MAL, DPS 5.1, 1.2	Perform PL safing or SL MDM Link Disable. Powered off GPC retains more dump data than STBY-HALT. Manual antenna, uplink ENA
PASS GPC BITE	H/W: If single GPC logging. Run PASS SM (GNC) Fail S/W: If all GNC GPC's cyclically annunciate. Activate FD GPC If non cyclic, GPC's useable
SUMWORD ICC	GPC Failed: Single GPC annunciate Run PASS SM (GNC) Fail IF CS=2, difficult to determined bad GPC Run MAL, DPS 5.1, 1.7
BFS ENGAGE (on orbit) MAL DPS, 5.1, 1.5	√RGA's, FLT CNTLR PWR - ON; GPC OUTPUT-B/U BFS will take command of P/L busses BFS OPS 301 PRO Manual Antennas until U/L BFS State Vector
FD GPC ACTIVATE MAL DPS, 5.1, 1.4	Assumes no active GNC GPC's (bad state vector) Recover MTU Accum (TRY, ITEM 34) Manual antennas until uplink new state vector
ALL CRT'S ASSIGNED TO FAILED GPC	Activate FD GPC to recover MF interface
BCE STRG X MAL, DPS, 5.3, 1.2	I/O Reset, Port Mode, Pwr cycle
FF(FA) MDM I/O ERROR	If MDM: Port mode, Pwr cycle If @ GPC, restring (possible FTS if non-universal rcvr) If no restring: pick FF vs FA
FF(FA) MDM OUTPUT	GPC fail if not recover with Port Mode
PL MDM I/O ERROR PL MDM OUTPUT	SM GPC Fail- Mult/simo I/O error, MDM Output msg's Disable SL MDM Link Pwr cycle PL MDM

### 3.4.4 MDM Equipment Lost Chart



jsc\_19612\_006.cv5

3.4.5 GPC/MDM Switch Panel (O6)



O6

(33V7346)

19612317.PNL1 1

### 3.4.6 Displays

0001 / /		GPC MEMORY		XX X	DDD/HH:MM:SS
					DDD/HH:MM:SS
MEM/BUS CONFIG		READ/WRITE XXX			
1	CONFIG XX(XX)	DATA 20X BIT SET 22X SEQ ID 24			
2	GPC X X X X X	CODE 21X BIT RST 23X WRITE 25			
STRING 1		26 ENG UNITS XXX HEX 27X			
2	8 X	ADD ID DESIRED ACTUAL			
3	9 X	28 XXXXX 29 XXXX ±XXXXXXXXXXXX			
4	10 X	30 XXXXX 31 XXXX ±XXXXXXXXXXXX			
PL 1/2	11 X	32 XXXXX 33 XXXX ±XXXXXXXXXXXX			
CRT 1	12 X	34 XXXXX 35 XXXX ±XXXXXXXXXXXX			
2	13 X	36 XXXXX 37 XXXX ±XXXXXXXXXXXX			
3	14 X	38 XXXXX 39 XXXX ±XXXXXXXXXXXX			
4	15 X	MEMORY DUMP			
LAUNCH 1	16 X	40 START ID XXXXX		STORE MC=XX	
2	17 X	41 NO WORDS XXXXXX		45 CONFIG XX	
MM 1	18 X	42 WDS/FRAME XXX		46 GPC X	
2	19 X	DUMP 43		STORE 47	
OPS 3 UPLK 50X		44 DOWNLIST GPC X		MM AREA	
OPS 3 INIT 51		OPS 0 ENA 49 X		PL 52 X	
		ERR LOG RESET 48		GNC 53 X	
				SM 54 X	

0001 / /		BFS MEMORY		XX X	DDD/HH:MM:SS
					BFS DDD/HH:MM:SS
MEM/BUS CONFIG		READ/WRITE			
1	CONFIG XX(XX)	DATA 1X BIT SET 3X SEQ ID 5			
2	GPC X X X X X	CODE 2X BIT RST 4X WRITE 6			
STRING 1		7 ENG UNITS XXX HEX 8X			
2	8 X	ADD ID DESIRED ACTUAL			
3	9 X	9 XXXXX 10 XXXX ±XXXXXXXXXXXX			
4	10 X	11 XXXXX 12 XXXX ±XXXXXXXXXXXX			
PL 1/2	11 X	13 XXXXX 14 XXXX ±XXXXXXXXXXXX			
CRT 1	12 X	15 XXXXX 16 XXXX ±XXXXXXXXXXXX			
2	13 X	17 XXXXX 18 XXXX ±XXXXXXXXXXXX			
3	14 X	19 XXXXX 20 XXXX ±XXXXXXXXXXXX			
4	15 X	MEMORY DUMP			
LAUNCH 1	16 X	21 START ID XXXXX		LAUNCH BUS 1 26X TFL ENA	
2	17 X	22 NUMBER WDS XXXXX		2 27X 29X	
MM 1	18 X	23 WDS/FRAME XXX		OFF 28X	
2	19 X	DUMP 24		PASS/BFS XFER ENA 25X	
OPS 3 UPLK 50X		44 DOWNLIST GPC X		BFS TIME UPDATES UPDATE 38	
OPS 3 INIT 51		OPS 0 ENA 49 X		MISSION TIME	
		ERR LOG RESET 48		30 GMT Δ [XXXX/XX:XX:XX.XXX	
				34 MET Δ [XXXX/XX:XX:XX.XXX	
				MET 40X	

BFS Memory Display

XXXX/001/		DPS UTILITY		XX X	DDD/HH:MM:SS
					DDD/HH:MM:SS
MMU ASSIGN		PORT ASSIGN			
1	2	PRI SEC UL CNTL			
GNC 1X 2X	STRING 1	15X	16X	AUTO 35X	
SM 3X 4X	2	17X	18X	ENA 36X	
PL 5X 6X	3	19X	20X	INH 37X	
OPS 0 7X 8X	4	21X	22X	IPL SOURCE SW	
MMU STATUS	PL 1/2	23X	24X	MASK 38X	
1 XXX	VAR PARAM ID LIST				
2 XXX	25	XXXX			
MMU SOURCE/BUS	26	XXXX			
GPC/MMU 9X	27	XXXX			
MMU/MMU 10X	28	XXXX			
GPC/LDB 11X	29	XXXX			
CKPT RETRV	30	XXXX			
ENA 12X	31	XXXX			
RTC	32	XXXX			
13 XXXX XXXX	33	XXXX			
CMD 14	34	XXXX			
		G3 ARCHIVE			
		LOAD 48X			
		RETRIEVE 49X			
		GROUND OPS			
		GSE POLL ENA 50X			
		SM GSE INH 51X			
		SM C/O ENA 52X			
		GNC C/O ENA 53X			
		BFC C/O ENA 54X			
		ALT PL9 TB 55X			

XXXX/002/		TIME		XX X	DDD/HH:MM:SS
					DDD/HH:MM:SS
MISSION TIME		TONE			
GMT 1X	3	XX:XX:XX			MSN T
MET 2X	6	XX:XX:XX			
CRT TIMER	9	SET [XXXX/XX:XX:XX			
START 12	STOP 13	20 [XXXX/XX:XX:XX CRT T			
14	START AT XX:XX:XX	MSN T		23 DURATION XX	
17	COUNT TO XX:XX:XX	MSN I			
MTU		24 GMT Δ [XXXX/XX:XX:XX.XXX			
		28 MET Δ [XXXX/XX:XX:XX.XXX			
		UPDATE 32			
		MET RESET 33			
GPC TIME		GMT			
MTU ACCUM 1	[XXXX/XX:XX:XX.XXXS	TRY	1 XX		
2	[XXXX/XX:XX:XX.XXXS	34	2 XX		
3	[XXXX/XX:XX:XX.XXXS	35	3 XX		
GPC [XXXX/XX:XX:XX.XXXS		36	4 XX		
		37	5 XX		
TIME SYNC 38					

XXXX/XXX/006		GPC/BUS STATUS					XX X	DDD/HH:MM:SS
								DDD/HH:MM:SS
MODE	XXXX	XXXX	XXXX	XXXX	XXXX			
OPS	XX	XX	XX	XX	XX			
STRING 1	FF	XS	XS	XS	XS	XS		
FA	XS	XS	XS	XS	XS	XS		
2	FF	XS	XS	XS	XS	XS		
FA	XS	XS	XS	XS	XS	XS		
3	FF	XS	XS	XS	XS	XS		
FA	XS	XS	XS	XS	XS	XS		
4	FF	XS	XS	XS	XS	XS		
FA	XS	XS	XS	XS	XS	XS		
PL 1	XS	XS	XS	XS	XS	XS		
2	XS	XS	XS	XS	XS	XS		
LAUNCH 1	XS	XS	XS	XS	XS	XS		
2	XS	XS	XS	XS	XS	XS		
CRT 1	XS	XS	XS	XS	XS	XS		
2	XS	XS	XS	XS	XS	XS		
3	XS	XS	XS	XS	XS	XS		
4	XS	XS	XS	XS	XS	XS		



### 3.4.7 Notes

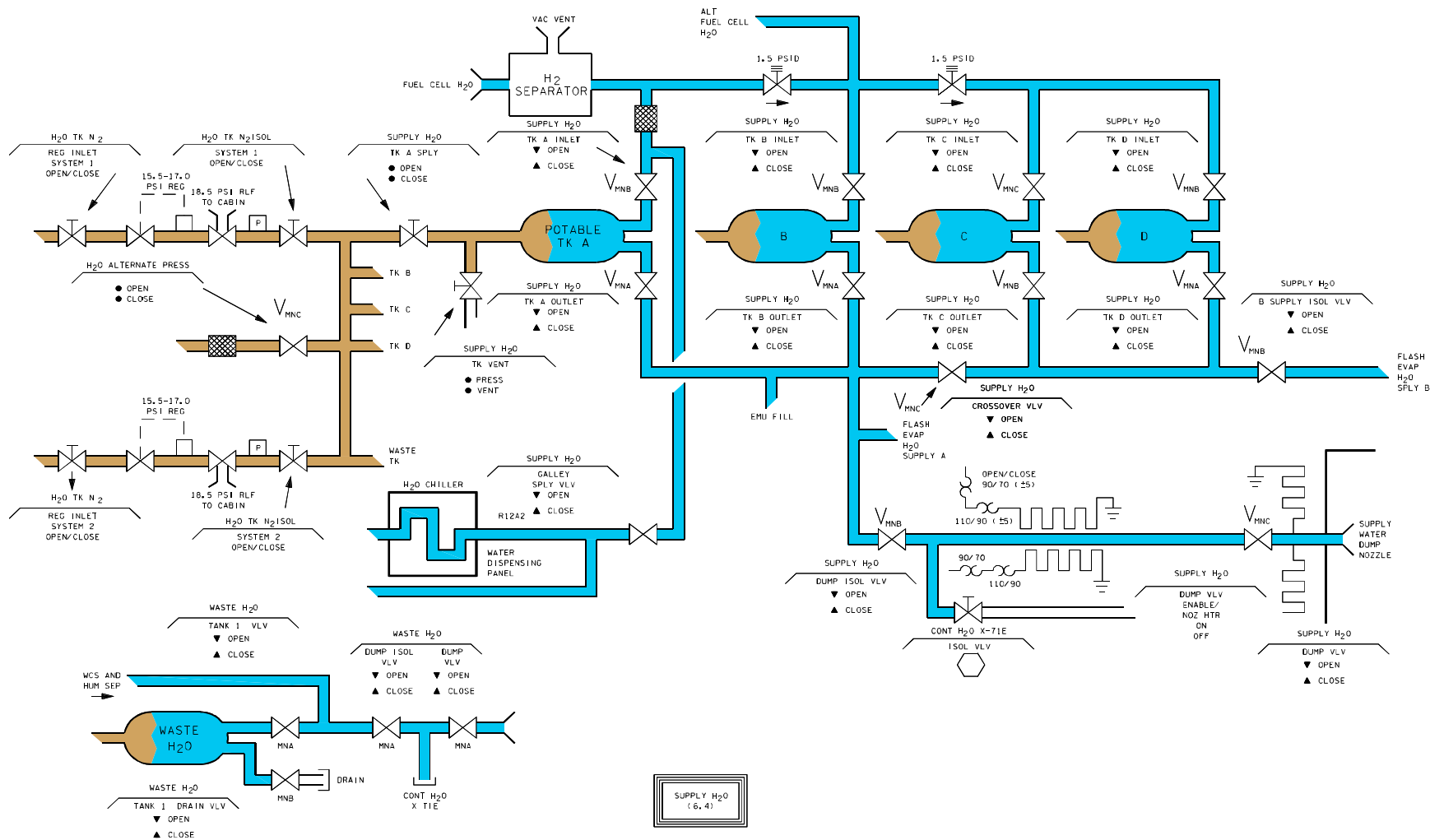
- Always deassign CRTs from fail to sync GPCs and reassign to good GPCs to avoid inadvertent entries (NBATs/restrings, burn targets, etc.).
- Before OPS transitions and restrings, √NBAT, major function, and GPC switch configuration.
- √correct memory configuration called up before making NBAT changes.
- During OPS transitions, “hands off” everything, including all switches and CRT entries.
- Crew should clear Fault Message line; otherwise, subsequent annunciations from other failures may be missed.
- Post BFS engage, check all active PASS GPCs recognized the engage (both *MODE* and *OUTPUT* talkbacks are barberpole). If not, take the offending GPC to *HALT* (or if this doesn't work, power it *OFF*) immediately to avoid I/O problems on the flight critical strings.
- Good practice to resume SPECs and DISPs from CRTs when not using them or before going to another major function on that CRT.
- It is important the crew identify GPC failures since MCC has less insight. The information provided will affect Mission Control analysis and its ability to plan for subsequent failures (both DPS and non DPS).
- Always hard assign CRTs (both PASS and BFS) via PASS CRTs (BFS will DK listen). Dual CRT commanders will result if BFS is assigned a CRT that a PASS GPC is still driving.
- Always distribute CRTs among different GPCs. On orbit, always be sure SM is not on all CRTs at the same time; if you lose SM, you also lose PASS CRT interface.
- When using the *GPC MODE* switch, hands off between positions. On past missions there have been problems with the switch being in two positions at the same time. This problem can occur on other orbiter switches too. It is a good idea to always pause slightly in each switch detent to ensure the contacts are made and recognized by the GPCs.
- Always check *CRT SEL* switch before making a keyboard entry. Check data on the CRT scratch line before entering.

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3.5.18 FDF Procedure Summaries.....	3.5.18-1
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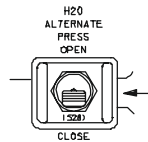
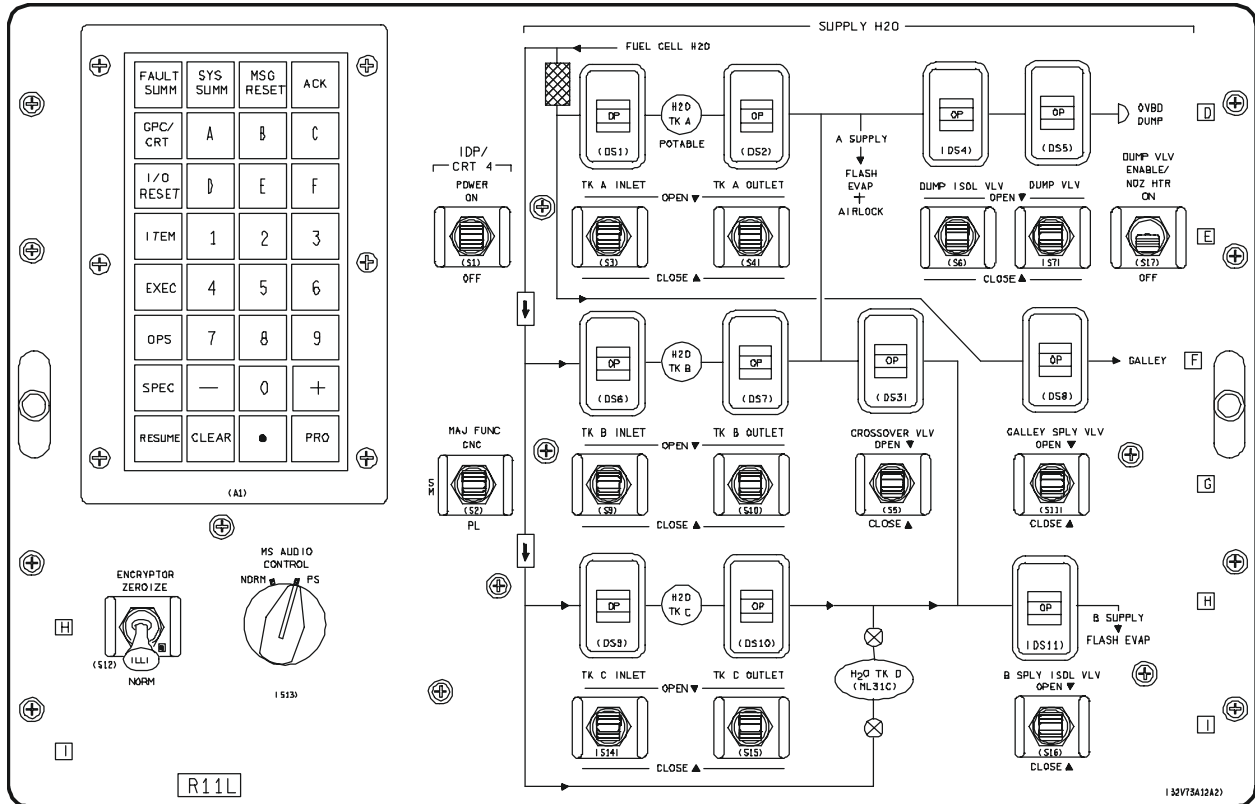
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### 3.5 ECLS

#### 3.5.1 Supply H2O Overview Schematic



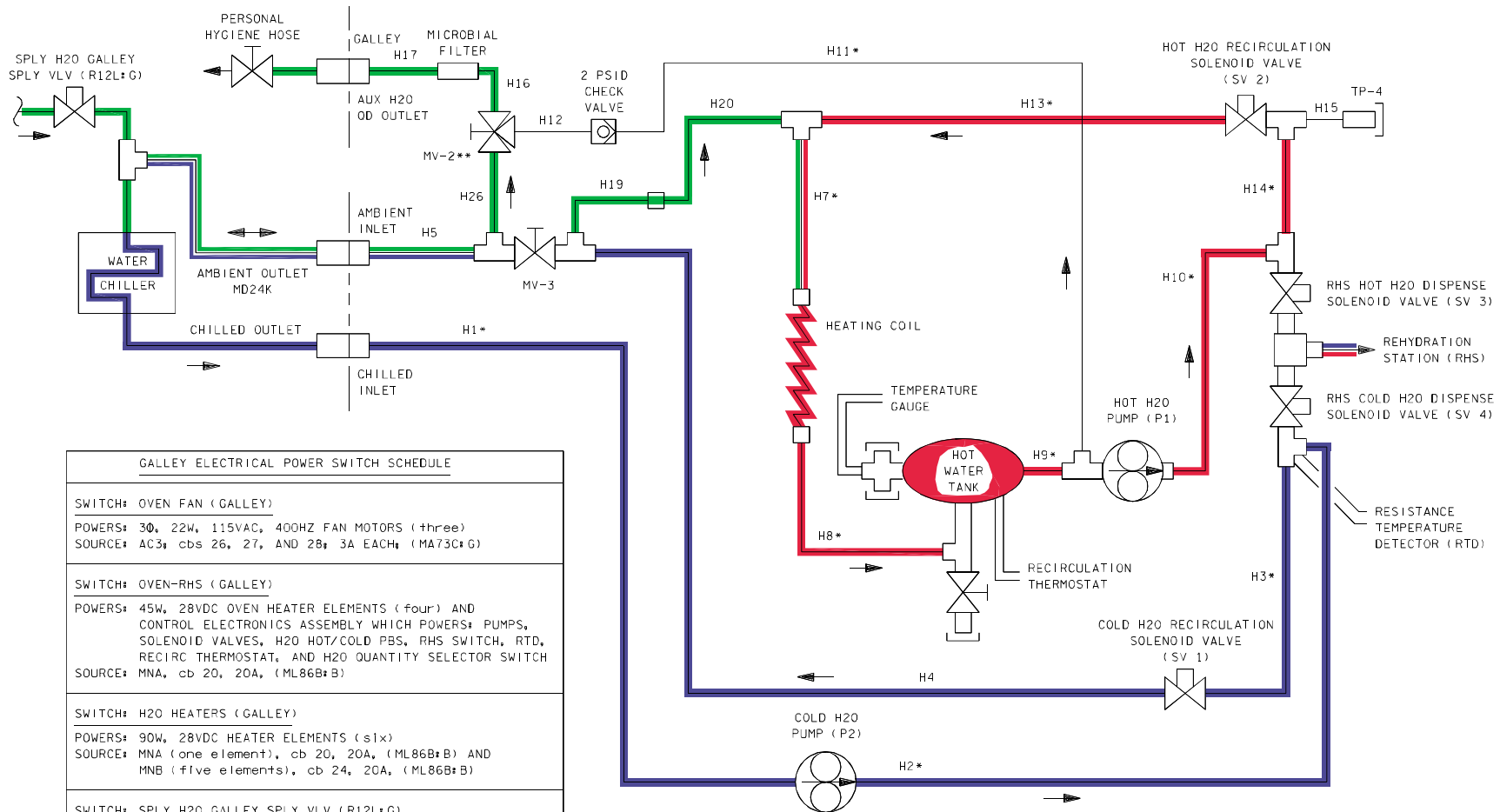
### 3.5.2 Supply H2O Switch Panels (L1, R12L)



L 1

19612318, PNL# 2

### 3.5.3 Galley Schematic

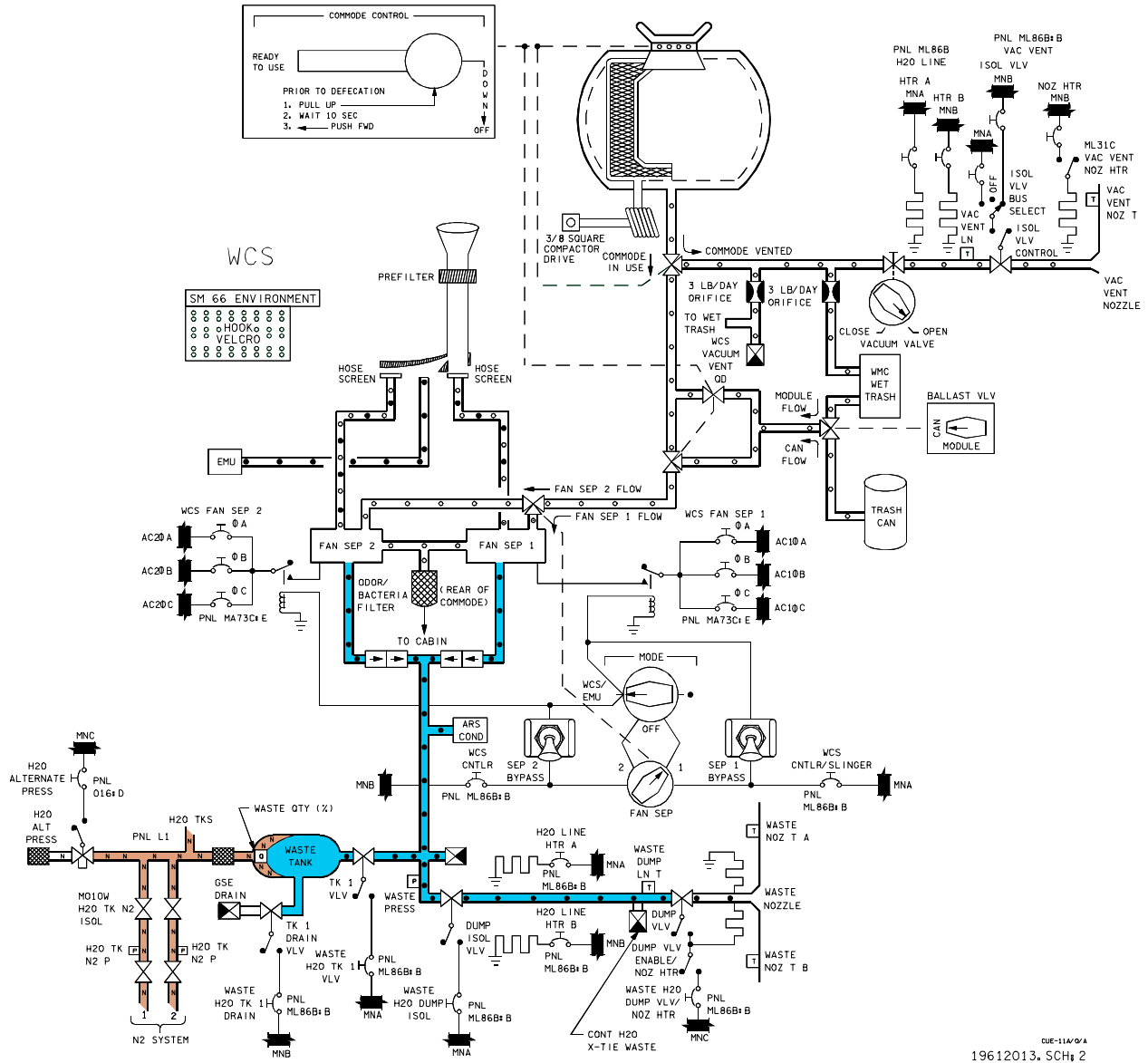


GALLEY ELECTRICAL POWER SWITCH SCHEDULE	
SWITCH:	OVEN FAN (GALLEY)
POWERS:	30, 22W, 115VAC, 400HZ FAN MOTORS (three)
SOURCE:	AC3, cbs 26, 27, AND 28, 3A EACH, (MA73C+G)
SWITCH:	OVEN-RHS (GALLEY)
POWERS:	45W, 28VDC OVEN HEATER ELEMENTS (four) AND CONTROL ELECTRONICS ASSEMBLY WHICH POWERS: PUMPS, SOLENOID VALVES, H2O HOT/COLD PBS, RHS SWITCH, RTD, RECIRC THERMOSTAT, AND H2O QUANTITY SELECTOR SWITCH
SOURCE:	MNA, cb 20, 20A, (ML86B+B)
SWITCH:	H2O HEATERS (GALLEY)
POWERS:	90W, 28VDC HEATER ELEMENTS (six)
SOURCE:	MNA (one element), cb 20, 20A, (ML86B+B) AND MNB (five elements), cb 24, 20A, (ML86B+B)
SWITCH:	SPLY H2O GALLEY SPLY VLV (R12L+G)
POWERS:	SPLY H2O GALLEY SPLY VLV
SOURCE:	MNC, cb 15, 3A, (ML86B+A)

— COLD  
— HOT  
— AMBIENT

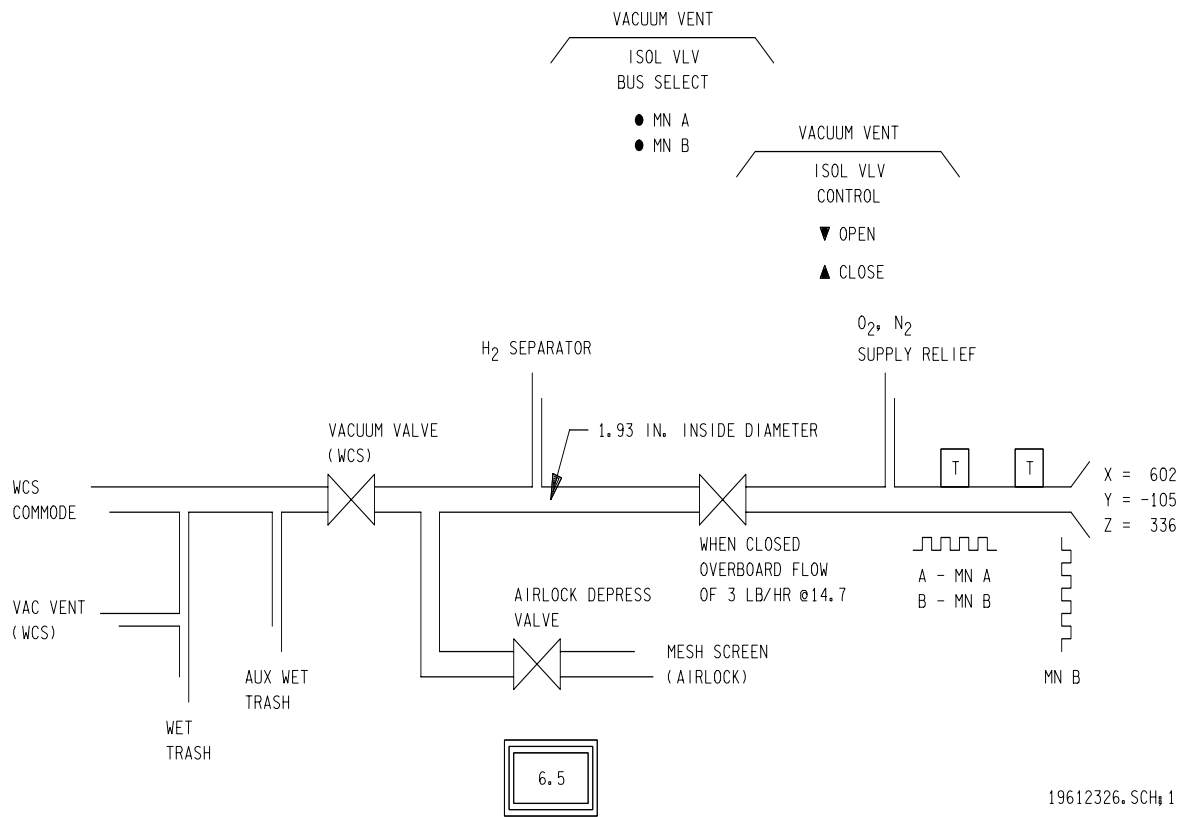
\*INSULATED HOSE. THE INSULATION COVERS THE HOSE LABELS ON INSULATED HOSE.  
 \*\*MV-2 VLV SHOULD BE LEFT TURNED TO FULL COLD POSITION, HOT WATER CANNOT BE ACCESSED THRU MV-2 BECAUSE THE HOT WATER PRESSURE IS TOO LOW TO OPEN THE CHECK VALVE

### 3.5.4 WCS Overview Schematic



03E-11A/0/A  
19612013, SCH 2

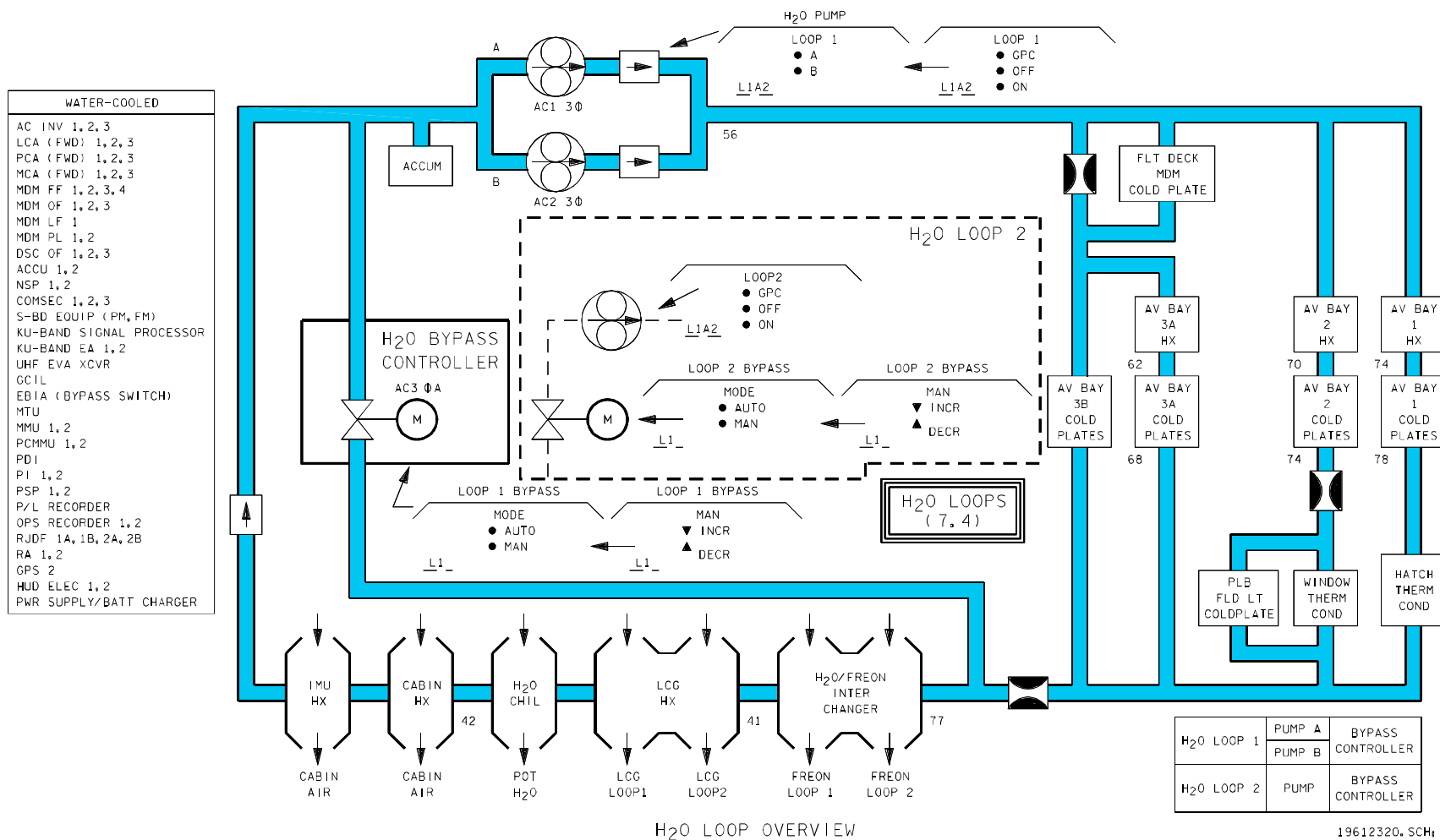
### 3.5.5 Vacuum Vent Schematic



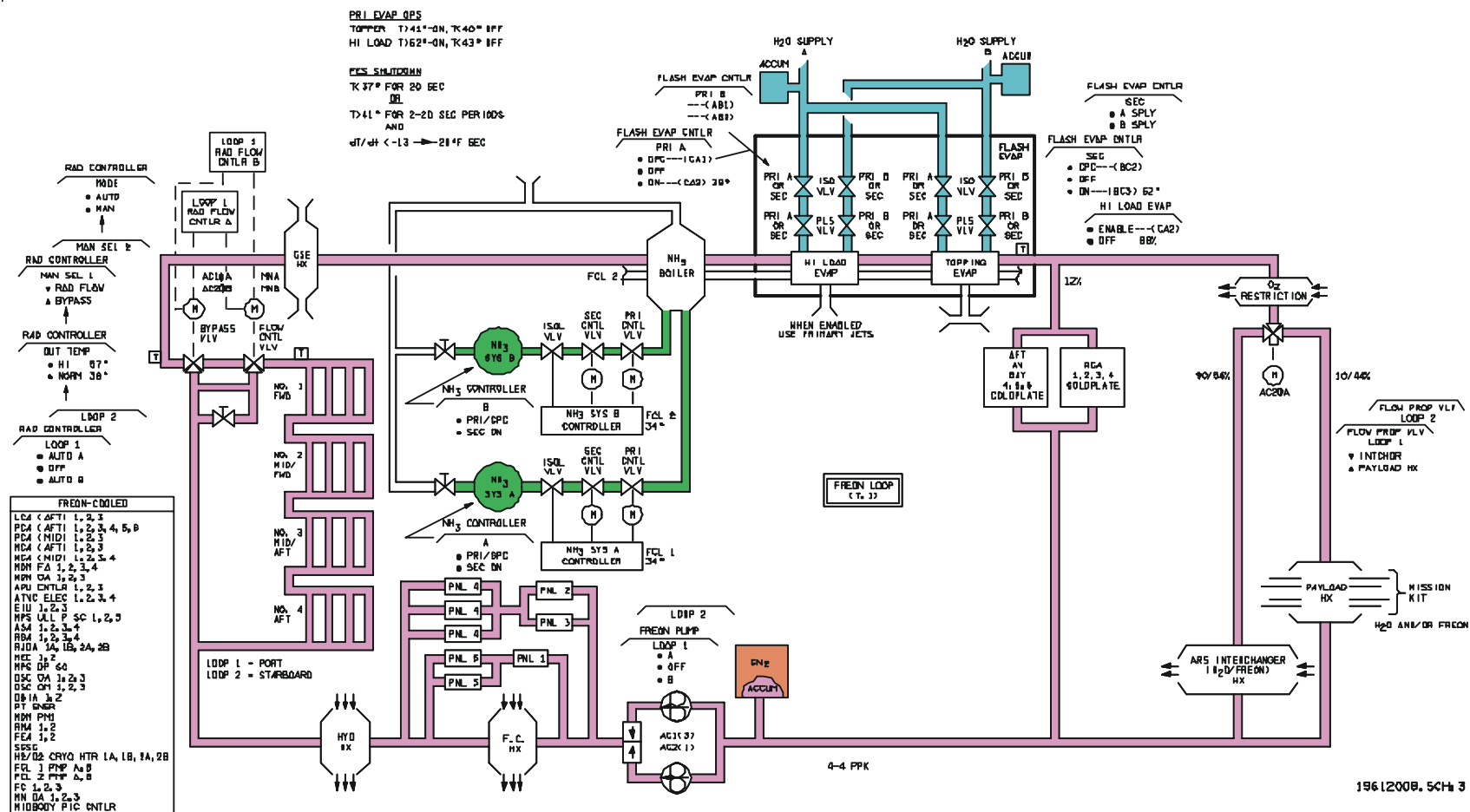


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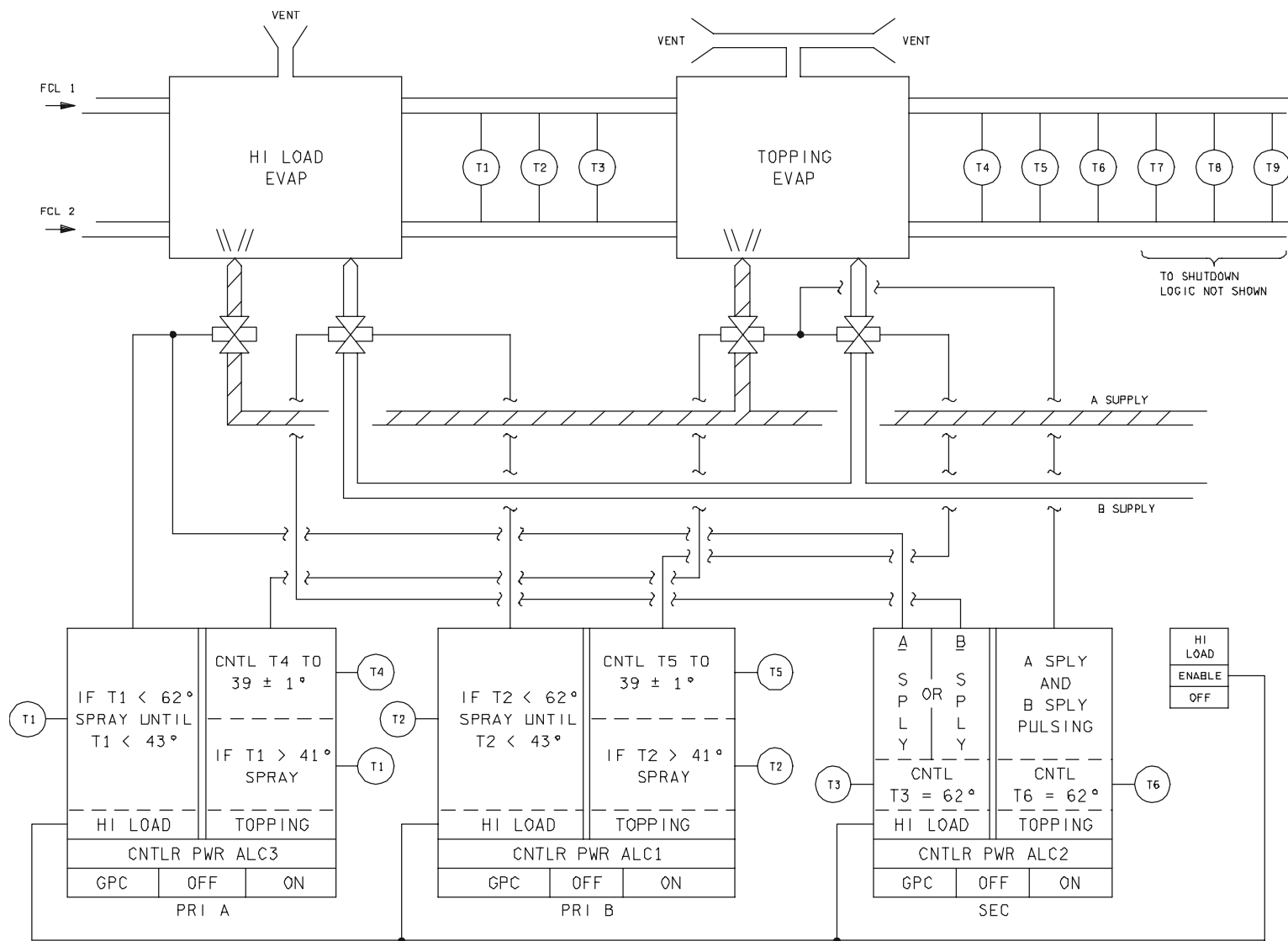
### 3.5.6 ATCS H2O Loop Overview Schematic



### 3.5.7 ATCS Freon Loop Overview Schematic

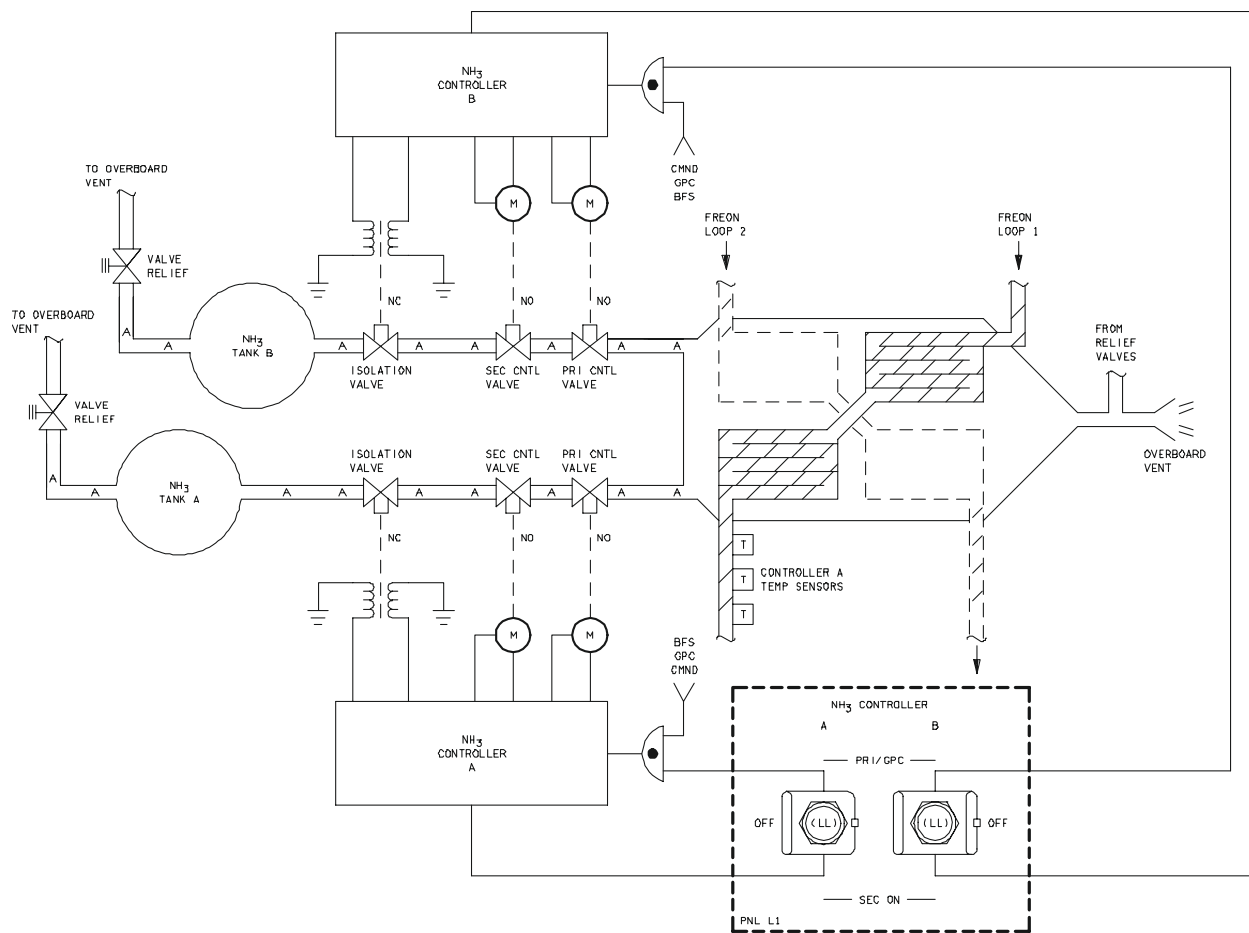


### 3.5.8 Flash Evaporator System



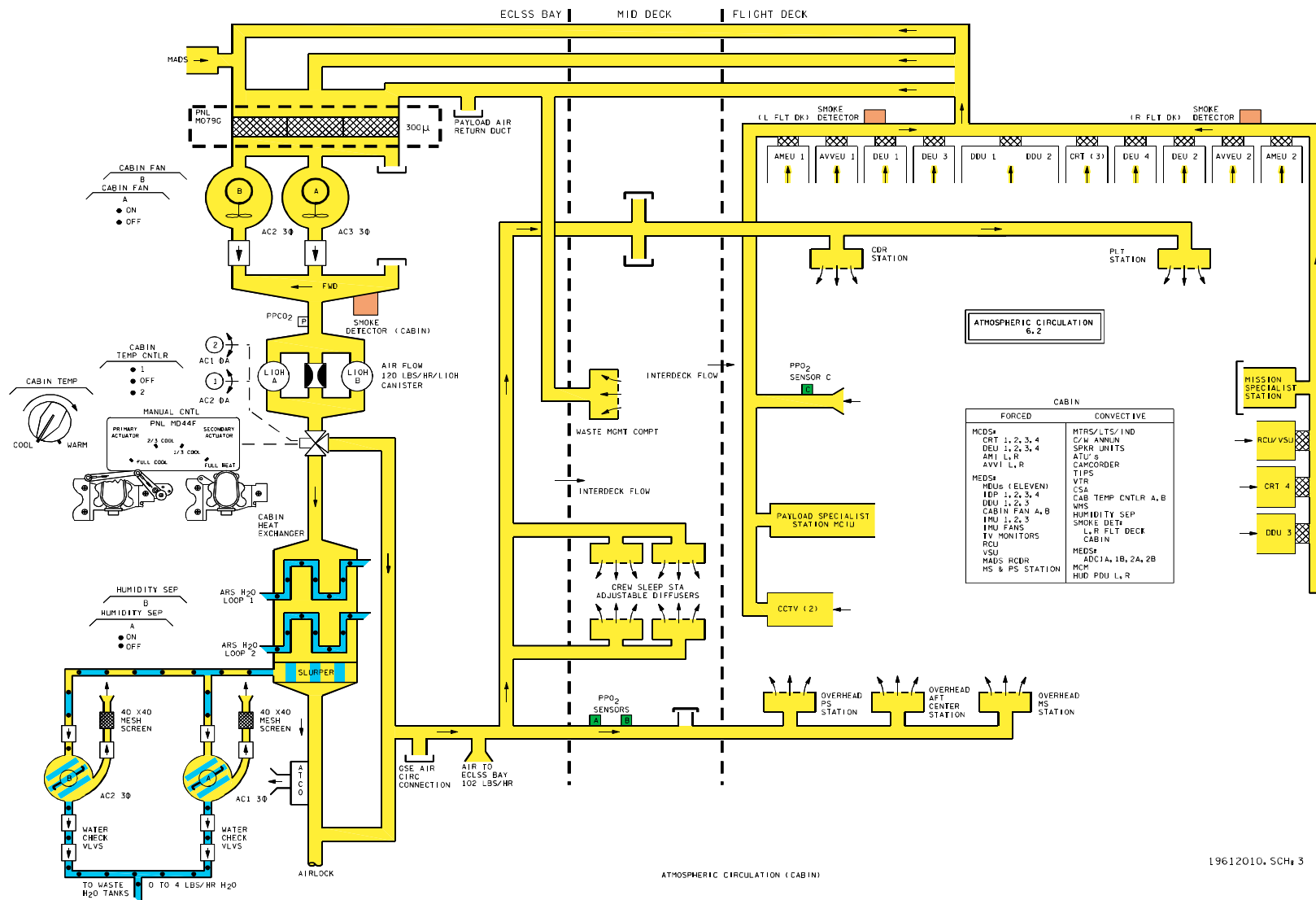
19612005, SCH 2

### 3.5.9 Ammonia Boiler System



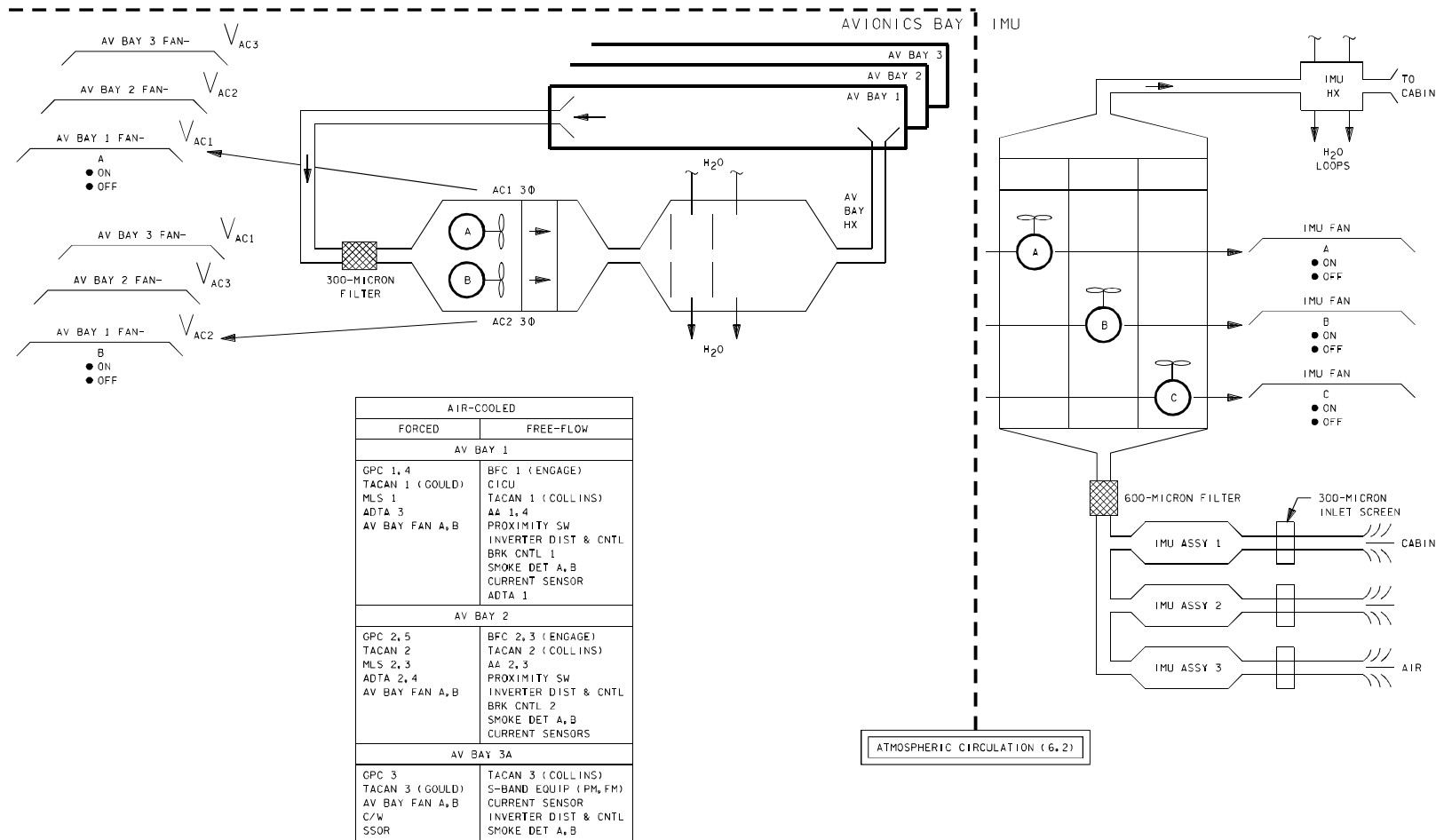
19612004, SCH 2

### 3.5.10 Cabin Atmosphere Circulation Schematic



19612010, SCH 3

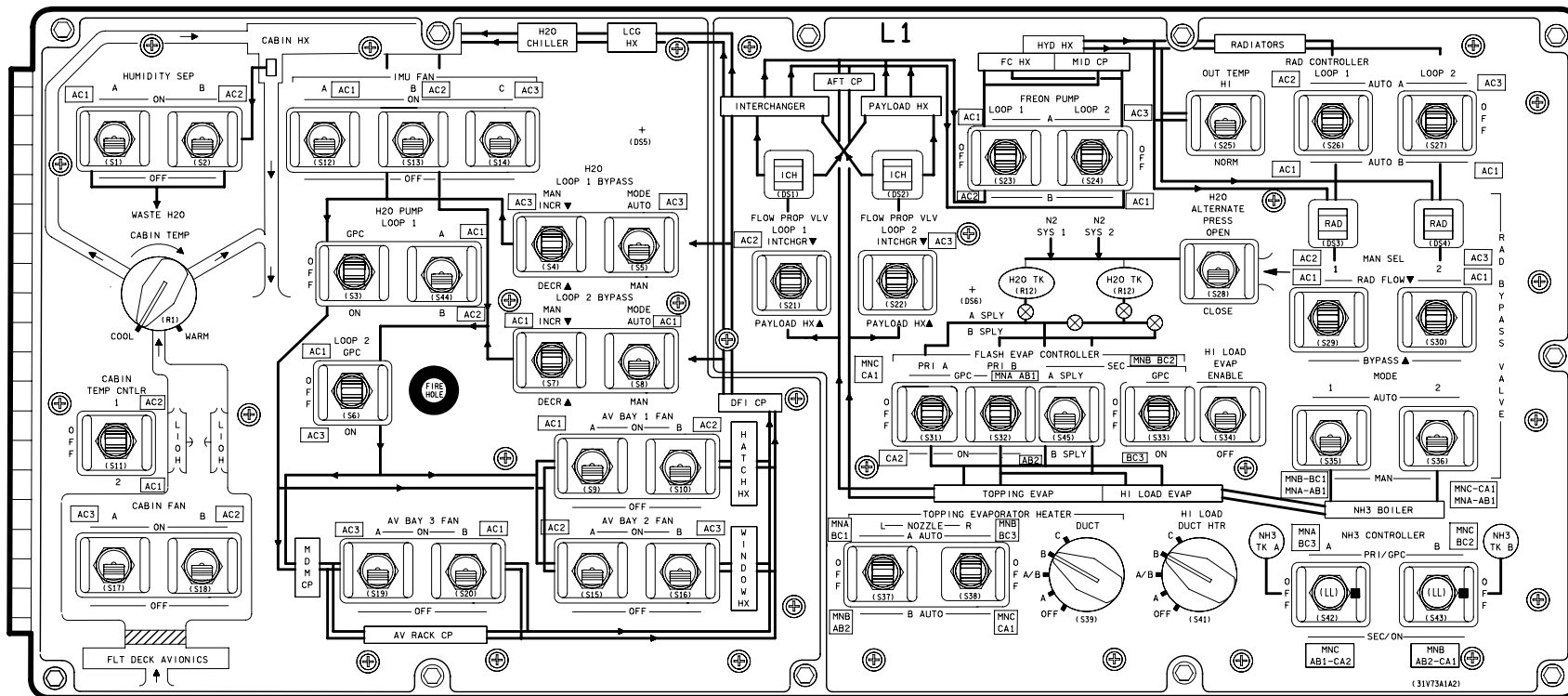
### 3.5.11 Av Bay/IMU Fan Circulation Schematic



ATMOSPHERIC CIRCULATION (AV BAY, IMU)

19612325, SCH# 2

3.5.12 ATCS Switch Panel (L1)

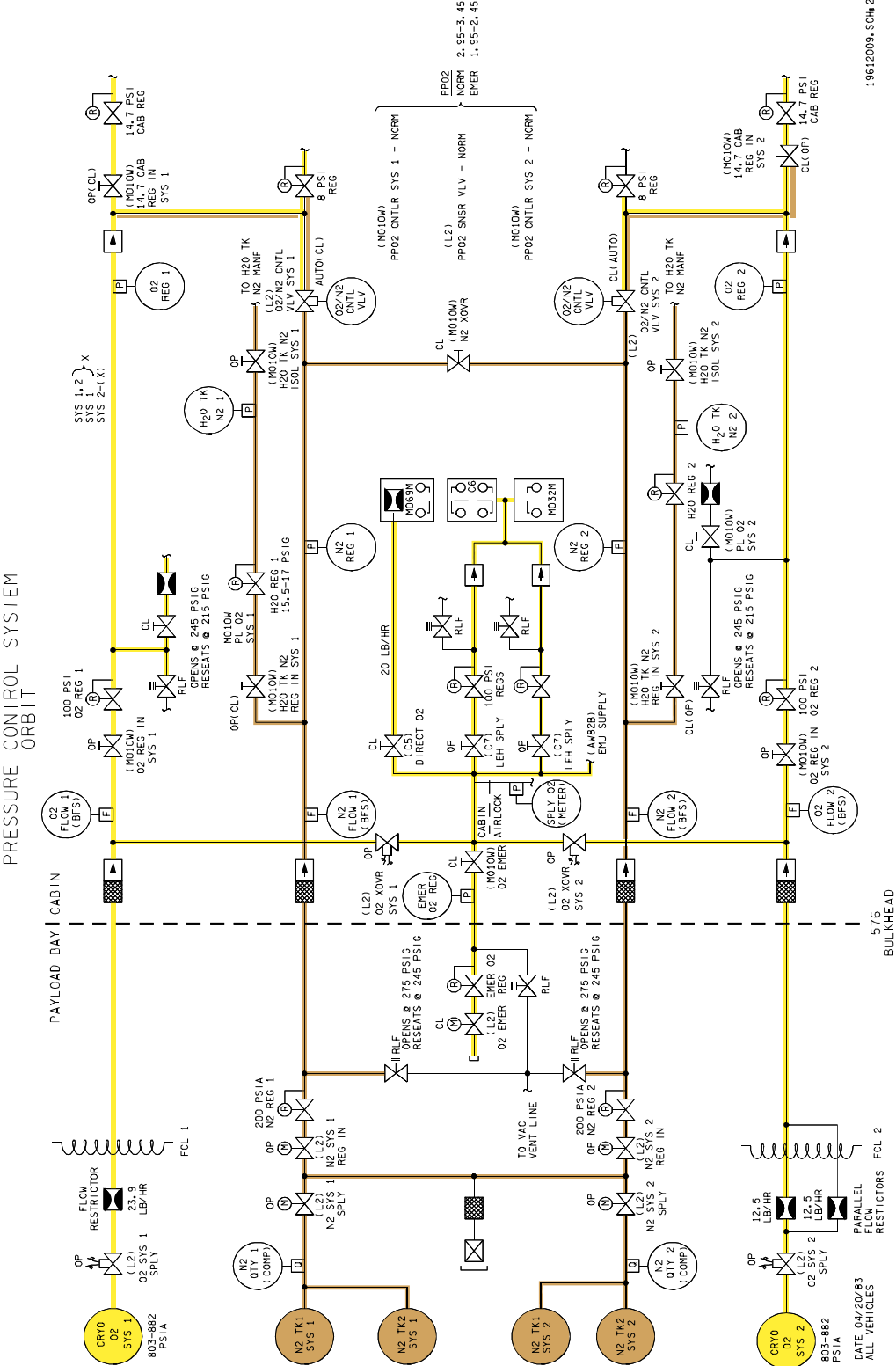


19612322.PNL 1



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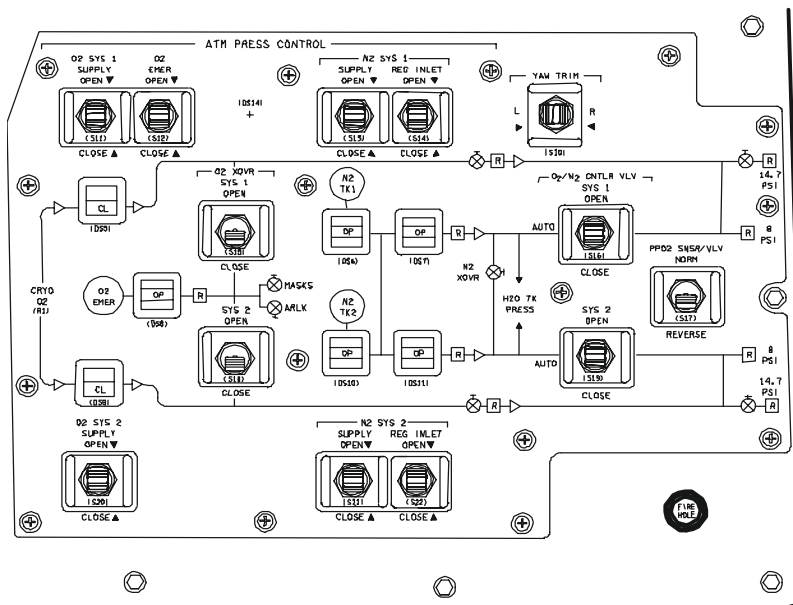
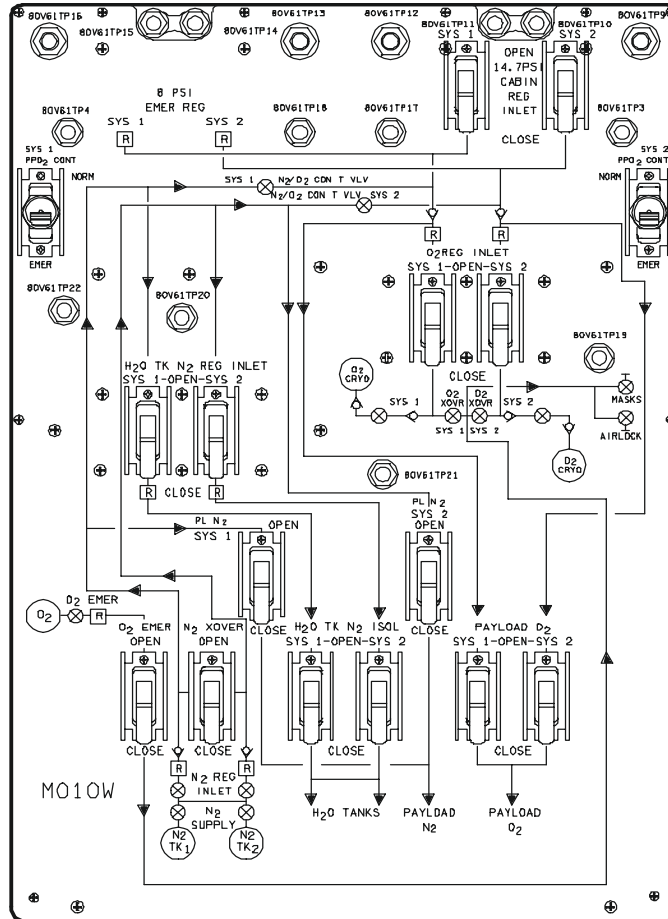
3.5.13 PCS Overview Schematic



19612009\_SCH 2

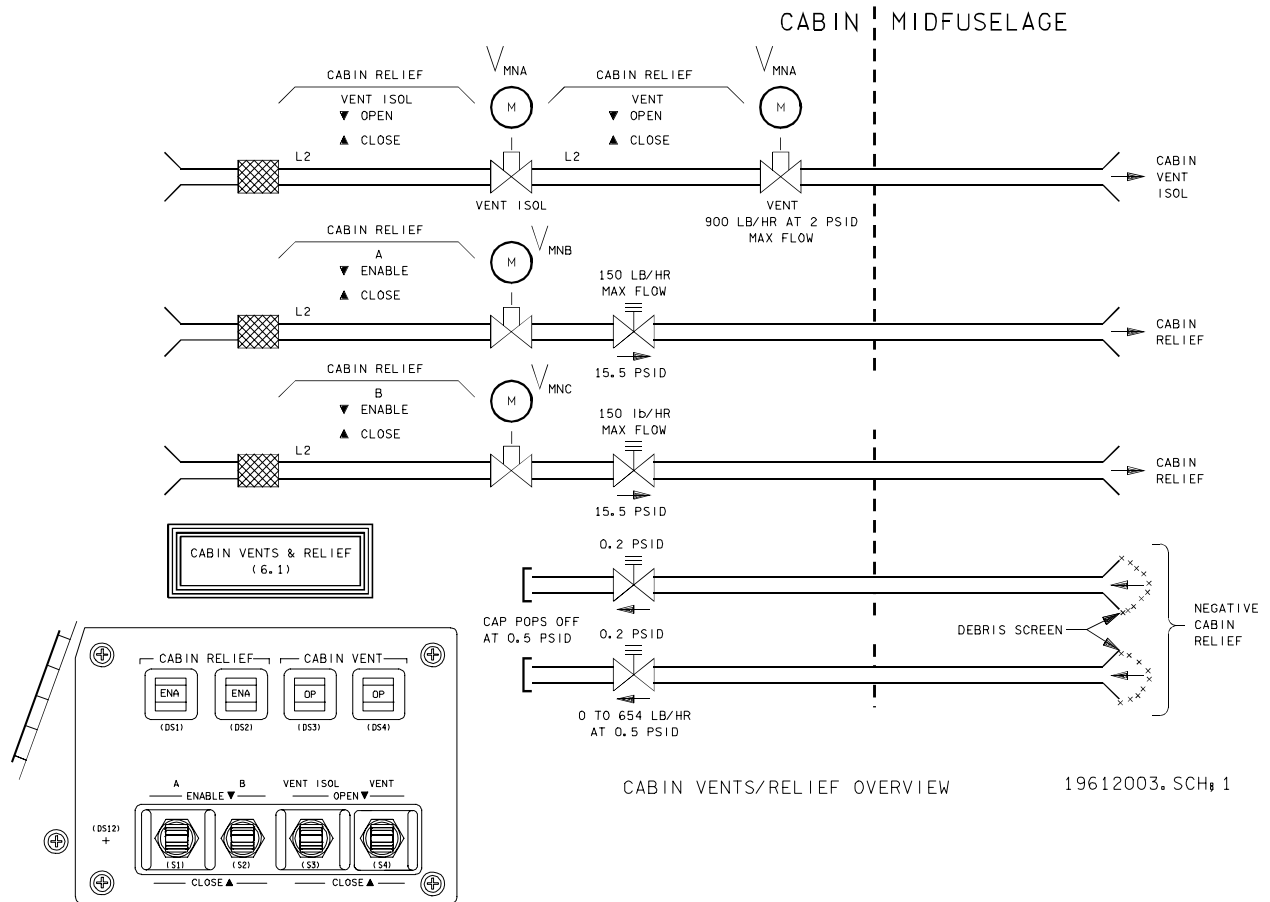
576  
BULKHEAD

3.5.14 PCS Switch Panels (L2, MO10W)

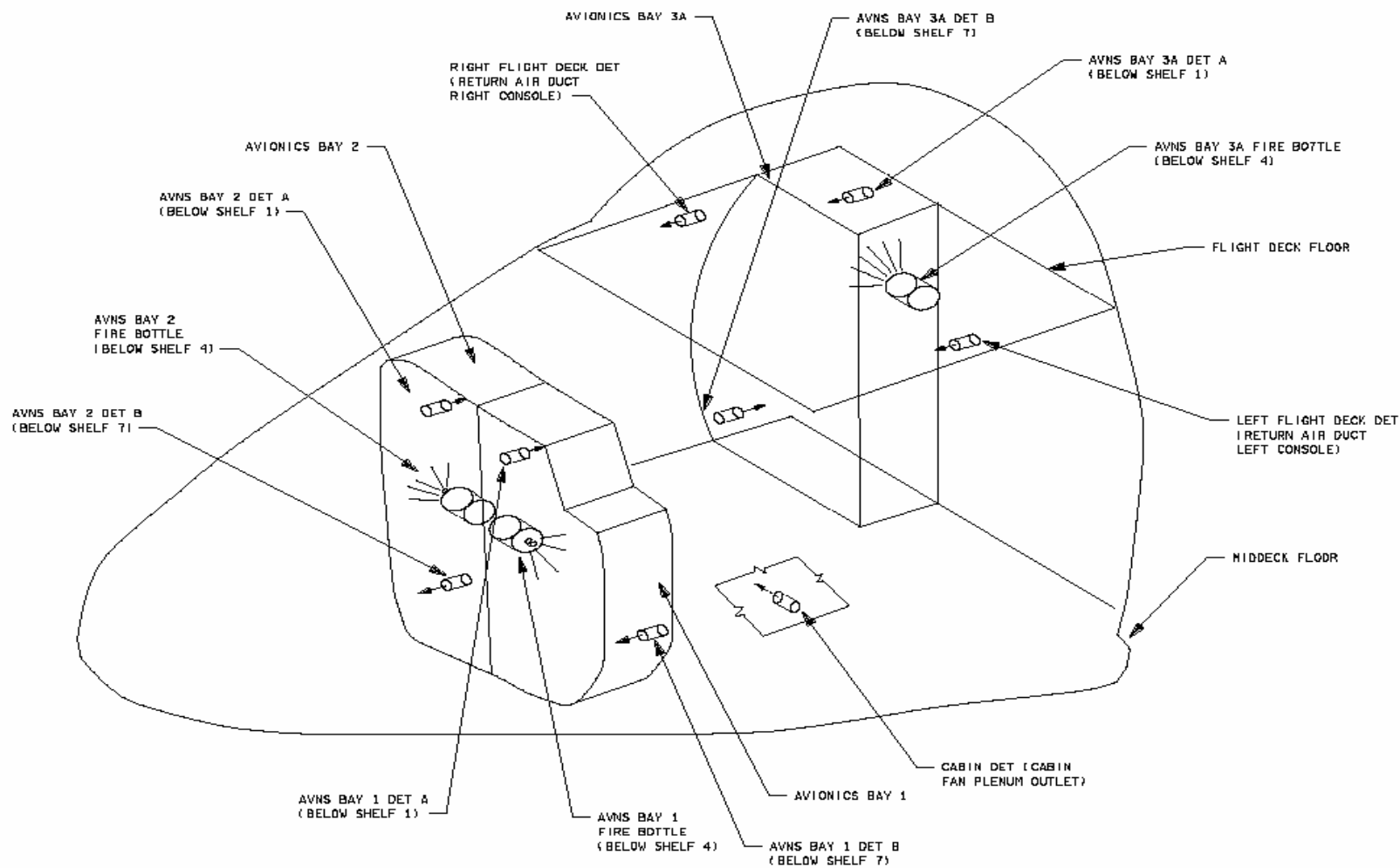


19612323.PNL, 2

### 3.5.15 Cabin Vents/Relief Overview



### 3.5.16 Smoke Detection Pictorial



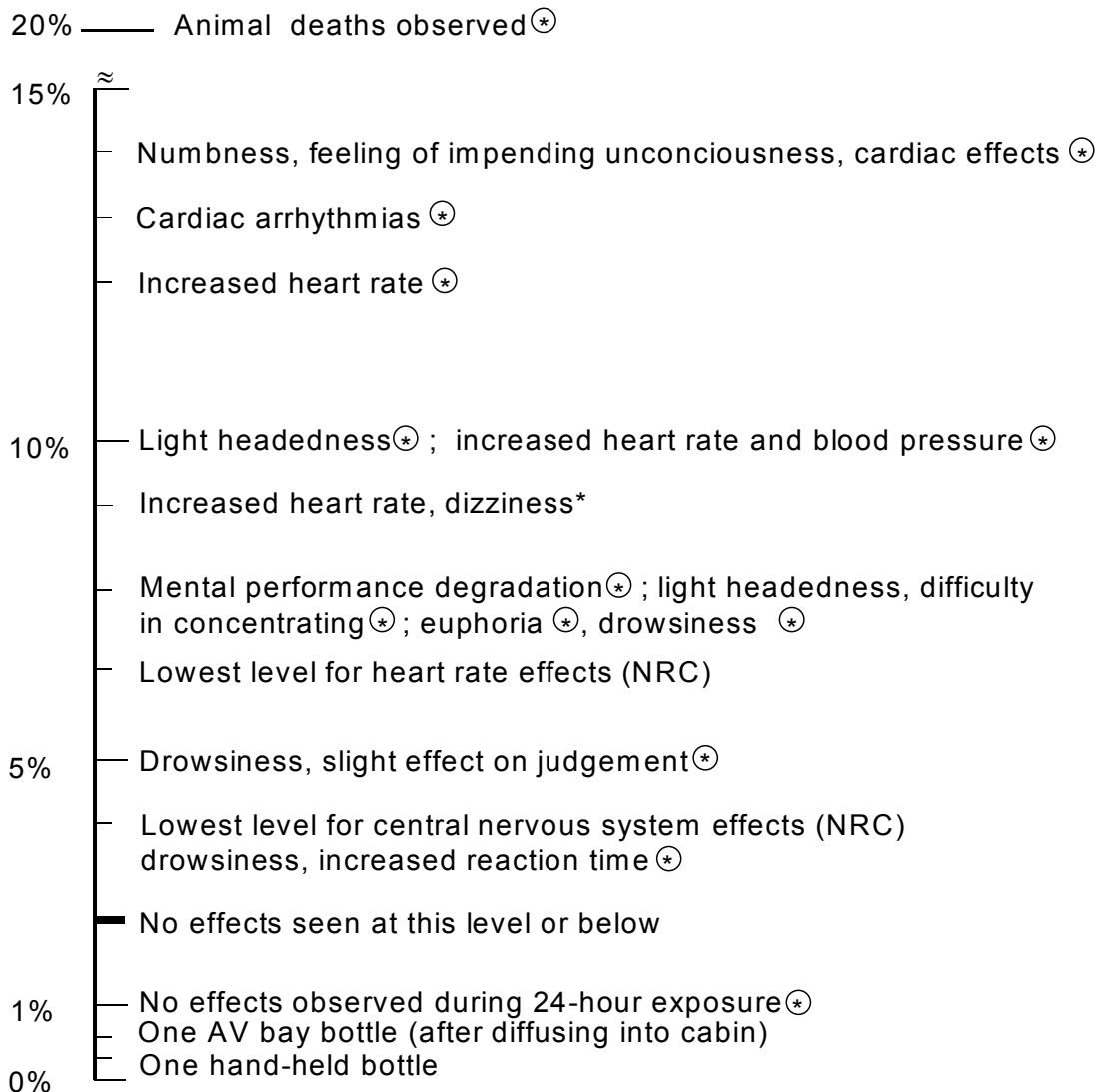
### 3.5.17 Halon Concentrations

#### HALON CONCENTRATIONS

Summarized from "Evaluation of the Effects on Human Subjects of Continuous, Low-dose Exposure to Halon 1301." Feb., 1988.

Effects Seen in Humans After Exposure To Various Halon Concentrations

Concentration



⊕ = Actual experiment results. All effects were observed after short (minutes) exposure. The longest test was 24 hours at one percent. All other data are for exposures less than 6 hours.

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Figure 3.5.17-1: Effects Seen In Humans After Exposure To Various Halon Concentrations

### 3.5.18 FDF Procedure Summaries

Procedure	Summary
Freon Flow Low (ECLS MAL 6.4, 1.3)	FDA: <1200 lb/hr flow. Switch pumps.
Freon Rad T Low (ECLS MAL 6.4, 1.4)	Config cooling sys to prevent freezing H <sub>2</sub> O in PL HX & ORB ICH. H <sub>2</sub> O loops (2) – ON, PL H <sub>2</sub> O loops – ON FES – OFF RAD CNTLR OUT - HI
Evap Out T High (ECLS MAL 6.4, 1.1)	FES control 32° to 65° Try alt CNTLR (PRI B, SEC – Hi Load/Topper) No joy: Establish RAD Flow. Loss of FES PWRDN
Evap Out T Low (ECLS MAL 6.4, 1.2)	H <sub>2</sub> O loops (2) – ON, PL H <sub>2</sub> O loops – ON FES – OFF RAD CNTLR OUT - HI
H <sub>2</sub> O Free in Cabin	Cabin, IMU fans – OFF FLT CNTL power – OFF Minimize CRT use
SPLY (Wast) H <sub>2</sub> O Qty Low and Decreasing (ECLS MAL 6.5, 1.1)	FES – OFF H <sub>2</sub> O TK N2 ISOL valve (2) – CL Depress H <sub>2</sub> O tanks (vent N2)
Cab O2(N2) Flow/Cabin Press/ Cabin dP/dT (ECLS MAL 6.2,1.1)	14.7 CAB REG INLET SYS 1,2 vlv (2) – CL (MO10W) Leak isol (cab rlf, vent isol, vac vent, A/L hatch) Non isol (O2 Tk heaters – AUTO, Flow Sys 1 – O2, Sys 2 – N2)
Sply H2O Pres High (ECLS MAL 6.5, 1.3)	FDA = 40 psia (nom 28-36 psia) √SPLY H2O TK A,B,C INLET (3) – OP If TK B Qty > 95%: SPLY H2O XOVR - OP
Sply H2O Pres Low (ECLS MAL 6.5, 1.4)	FDA = 10 psia (nom 28-36 psia) If TK A Qty < 5%: TK A INLET – CL, H2O TK N2 ISOL – CL, SPLY H2O GALLEY SPLY VLV – CL Protect galley h/w and tank A bellows from vacuum
Post Fire Cabin Clean-up (ECLS FRP-2)	Install fresh LiOH CAB TEMP CNTLR – full cool Engage WCS CPA – scan mode

### 3.5.19 Displays

XXXX/XXX/078		SM SYS SUMM 1		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
SMOKE	1/A 2/B	DC VOLTS	1/A 2/B 3/C		
CABIN	XX.XS	FC	XX.XS XX.XS XX.XS		
L/R FD	XX.XS XX.XS	MAIN	XX.XS XX.XS XX.XS		
AV BAY	1 XX.XS XX.XS	ESS	XX.XS XX.XS XX.XS		
	2 XX.XS XX.XS				
	3 XX.XS XX.XS				
CABIN		CNTL	1 XXX.XSXXX.XSXXX.XSX		
PRESS	XX.XS		2 XXX.XSXXX.XSXXX.XSX		
dP/dT-EQ	±.XXS±X.XXS	VOLT	⊕A XXXS XXXS XXXS		
O2 CONC	XXX.XS		⊕B XXXS XXXS XXXS		
PP02	X.XXS X.XXS		⊕C XXXS XXXS XXXS		
FAN ΔP	X.XXS	AMPS	⊕A XX.XS XX.XS XX.XS		
HX OUT T	XXXS		⊕B XX.XS XX.XS XX.XS		
O2 FLOW	XX.XS XX.XS		⊕C XX.XS XX.XS XX.XS		
N2 FLOW	XX.XS XX.XS	FUEL CELL			
IMU FAN ΔP	XXS BXS CXS	AV FC1 FC2 FC3	AMPS XXXS XXXS XXXS		
		REAC VLV	XX XX XX		
		STACK T	±XXXS ±XXXS ±XXXS		
		EXIT T	XXXS XXXS XXXS		
		COOL P	XXXS XXXS XXXS		
		PUMP	XXS XXS XXS		
					(XX)

XXXX/XXX/078		SM SYS SUMM 1		XX X DDD/HH:MM:SS	
		BFS DDD/HH:MM:SS		BFS DDD/HH:MM:SS	
SMOKE	1/A 2/B	DC VOLTS	1/A 2/B 3/C		
CABIN	XX.XS	FC	XX.XS XX.XS XX.XS		
L/R FD	XX.XS XX.XS	MAIN	XX.XS XX.XS XX.XS		
AV BAY	1 XX.XS XX.XS	CNTL AB	XX.XS XX.XS XX.XS		
	2 XX.XS XX.XS	BC	XX.XS XX.XS XX.XS		
	3 XX.XS XX.XS	CA	XX.XS XX.XS XX.XS		
CABIN		ESS	XX.XS XX.XS XX.XS		
PRESS	XX.XS	AC			
dP/dT	±.XXS	VOLT	⊕A XXXS XXXS XXXS		
B/U/EQ	±.XXS ±.XXS		⊕B XXXS XXXS XXXS		
PP02	X.XXS X.XXS		⊕C XXXS XXXS XXXS		
FAN ΔP	X.XXS	AMPS	⊕A XX.XS XX.XS XX.XS		
HX OUT T	XXXS		⊕B XX.XS XX.XS XX.XS		
O2 FLOW	X.XS X.XS		⊕C XX.XS XX.XS XX.XS		
N2 FLOW	X.XS X.XS	FUEL CELL	PH XXXS XXXS XXXS		
IMU FAN ΔP	X.XXS	AMPS	XXXS XXXS XXXS		
ΔV FC1 FC2 FC3		REAC VLV	XXS XXS XXS		
SS1	XXXS XXXS XXXS	STACK T	±XXXS ±XXXS ±XXXS		
SS2	XXXS XXXS XXXS	EXIT T	XXXS XXXS XXXS		
SS3	XXXS XXXS XXXS	COOL P	XXXS XXXS XXXS		
TOTAL AMPS	XXXS	PUMP	XXS XXS XXS		
KW	XXS				

SM SYS SUMM1 Display (BFS)

XXXX/XXX/079		SM SYS SUMM 2		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
CRYO TK	1 2 3 4 5	MANF1	MANF2		
H2 PRESS	XXXXS XXXXS XXXXS XXXXS XXXXS		XXXXS XXXXS		
O2 PRESS	XXXXS XXXXS XXXXS XXXXS XXXXS		XXXXS XXXXS		
HTR T1	±XXXXS ±XXXXS ±XXXXS ±XXXXS ±XXXXS				
T2	±XXXXS ±XXXXS ±XXXXS ±XXXXS ±XXXXS				
APU	1 2 3	HYD	1 2 3		
TEMP EGT	XXXXS XXXXS XXXXS	PRSS	XXXXS XXXXS XXXXS		
B/U EGT	XXXXS XXXXS XXXXS	RSVR T	XXXXS XXXXS XXXXS		
OIL IN	XXXXS XXXXS XXXXS	P	XXXXS XXXXS XXXXS		
OUT	XXXXS XXXXS XXXXS	QTY	XXXXS XXXXS XXXXS		
SPEED	% XXXS XXXS XXXS	W/B			
FUEL QTY	XXXXS XXXXS XXXXS	H2O QTY	XXXXS XXXXS XXXXS		
PMP LK P	XXS XXS XXS	BYP VLV	XXXXS XXXXS XXXXS		
OIL OUT P	XXXXS XXXXS XXXXS				
AV BAY		THERM CNTL	1 2		
TEMP	XXXXS XXXXS XXXXS	H2O PUMP P	XXXXS XXXXS		
FAN ΔP	X.XXS X.XXS X.XXS	FREON FLOW	XXXXS XXXXS		
		EVAP OUT T	XXXXS XXXXS		
					(XX)

XXXX/XXX/079		SM SYS SUMM 2		XX X DDD/HH:MM:SS	
		BFS DDD/HH:MM:SS		BFS DDD/HH:MM:SS	
CRYO TK	1 2 3 4 5	MANF1	MANF2		
H2 PRESS	XXXXS XXXXS XXXXS XXXXS XXXXS		XXXXS XXXXS		
O2 PRESS	XXXXS XXXXS XXXXS XXXXS XXXXS		XXXXS XXXXS		
HTR T1	±XXXXS ±XXXXS ±XXXXS ±XXXXS ±XXXXS				
T2	±XXXXS ±XXXXS ±XXXXS ±XXXXS ±XXXXS				
APU	1 2 3	HYD	1 2 3		
TEMP EGT	XXXXS XXXXS XXXXS	PRSS	XXXXS XXXXS XXXXS		
B/U EGT	XXXXS XXXXS XXXXS	ACUM P	XXXXS XXXXS XXXXS		
OIL IN	XXXXS XXXXS XXXXS	RSVR T	XXXXS XXXXS XXXXS		
OUT	XXXXS XXXXS XXXXS	QTY	XXXXS XXXXS XXXXS		
GG BED	XXXXS XXXXS XXXXS				
INJ	XXXXS XXXXS XXXXS	W/B			
SPEED %	XXXXS XXXS XXXS	H2O QTY	XXXXS XXXXS XXXXS		
FUEL QTY	XXXXS XXXXS XXXXS	BYP VLV	XXXXS XXXXS XXXXS		
PMP LK P	XXS XXS XXS				
OIL OUT P	XXXXS XXXXS XXXXS				
FU TK VLV		THERM CNTL	1 2		
A T	XXXXS XXXXS XXXXS	H2O PUMP P	XXXXS XXXXS		
B T	XXXXS XXXXS XXXXS	FREON FLOW	XXXXS XXXXS		
AV BAY		EVAP OUT T	XXXXS XXXXS		
TEMP	XXXXS XXXXS XXXXS				
FAN ΔP	X.XXS X.XXS X.XXS				

SM SYS SUMM2 Display (BFS)

XXXX/XXX/066		ENVIRONMENT		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
CABIN		AV BAY	1 2 3		
dP/dT	±.XXS CABIN P XX.XS	TEMP	XXXXS XXXXS XXXXS		
PP02	AIRLK P XX.XS	FAN ΔP	X.XXS X.XXS X.XXS		
A X.XXS	FAN ΔP X.XXS	SUPPLY H2O			
B X.XXS	HX OUT T XXXS	QTY A	XXXXS PRSS XXXS		
C X.XXS	CABIN T XXXS	B	XXXXS DMP LN T XXXS		
PPC02	XX.XS	C	XXXXS NOZ T A XXXS		
		D	XXXXS B XXXS		
O2 FLOW	X.XS X.XS	WASTE H2O			
REG P	XXXXS XXXXS	QTY 1	XXXXS PRSS XXXS		
N2 FLOW	X.XS X.XS		DMP LN T XXXS		
REG P	XXXXS XXXXS		NOZ T A XXXS		
O2/N2 CNTL VLV	XXS XXS		B XXXS		
H2O TK N2 P	XXXXS XXXXS	VAC VT NOZ T	XXXXS		
N2 QTY	XXXXS XXXXS	CO2 CNTLR	1XS 2XS		
EMER O2 QTY	XXXXS XXXXS	FILTER ΔP	X.XXS		
REG P	XXXXS XXXXS	PPC02	XX.XS		
		TEMP	XXX.XS		
IMU FAN	A B C ΔP	BED A PRESS	XX.XS XX.XS		
HUMID SEP	XS XS XS X.XS	B PRESS	XX.XS XX.XS		
		ΔP	X.XXS X.XXS		
		VAC PRESS	X.XS		
					(XX)



### 3.5.20 Notes

NOTE

Numbers presented here are for typical orbit power and heat loads and may vary significantly depending on attitude and power loading.

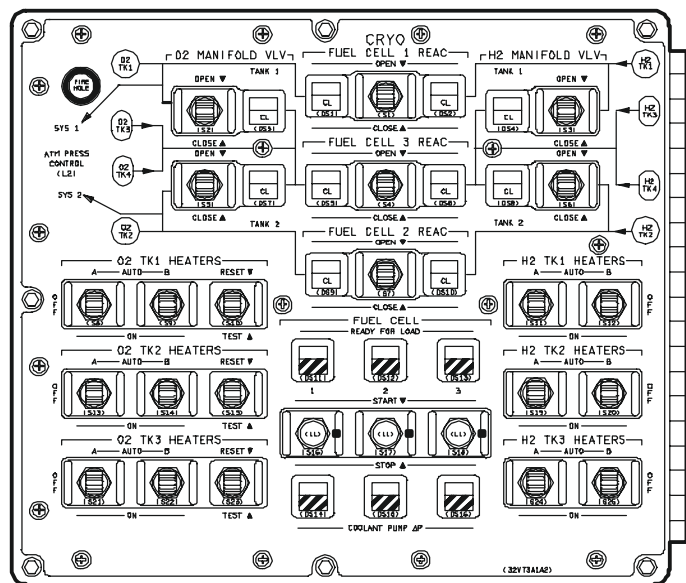
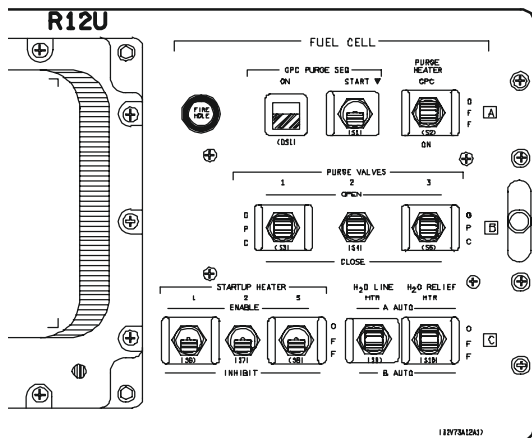
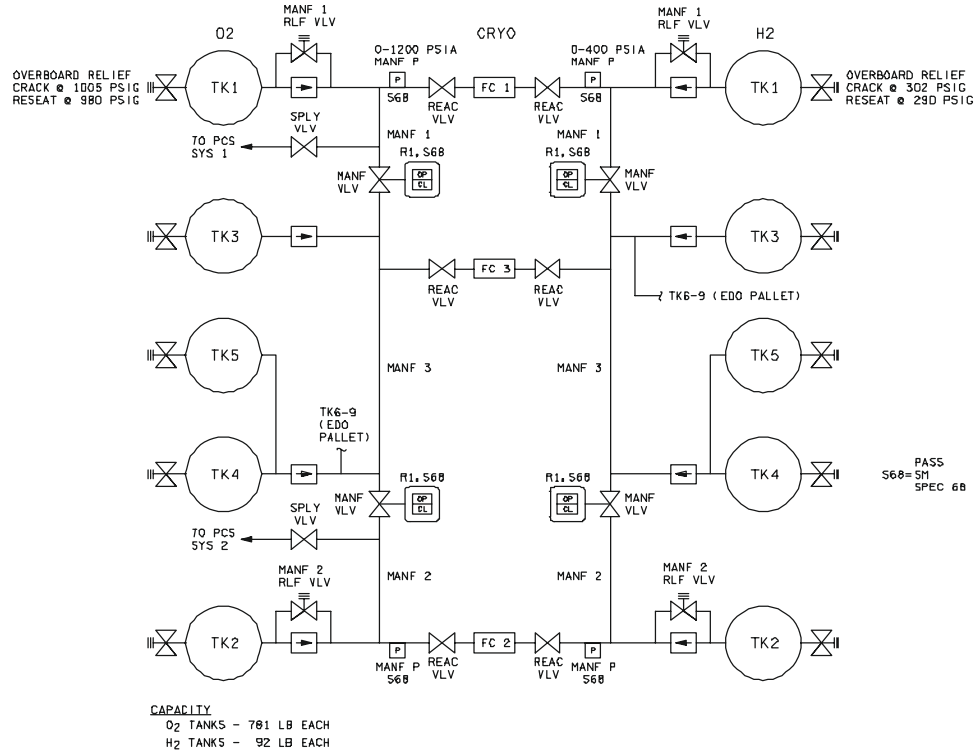
- Supply water tanks fill at about 1.5 percent per hour depending on fuel cell load (.8 lb/kW hr ÷ 16 lb over 1%; 14 kW typical orbit power load).
- Supply Water Dump Rate
  - ~100% per hour for a water dump
  - ~50% per hour when using the FES high load evaporator for cooling with payload bay doors closed
  - ~16% per hour when using the FES topping evaporator for supply water dumps on orbit with the doors open.
- On-orbit cold soak is good for 20 to 30 minutes of cooling. Prelaunch Freon conditioning is good for 2 to 3 minutes of cooling.
- NH<sub>3</sub> boiler supply is good for 25 minutes of ground cooling.
- A single cryo O<sub>2</sub> tank is good for about 2 to 3 days of orbit usage depending on crew size and power level. H<sub>2</sub> tanks are sized to match O<sub>2</sub> usage.
- A single LiOH canister is usable for about 48 man-hours.

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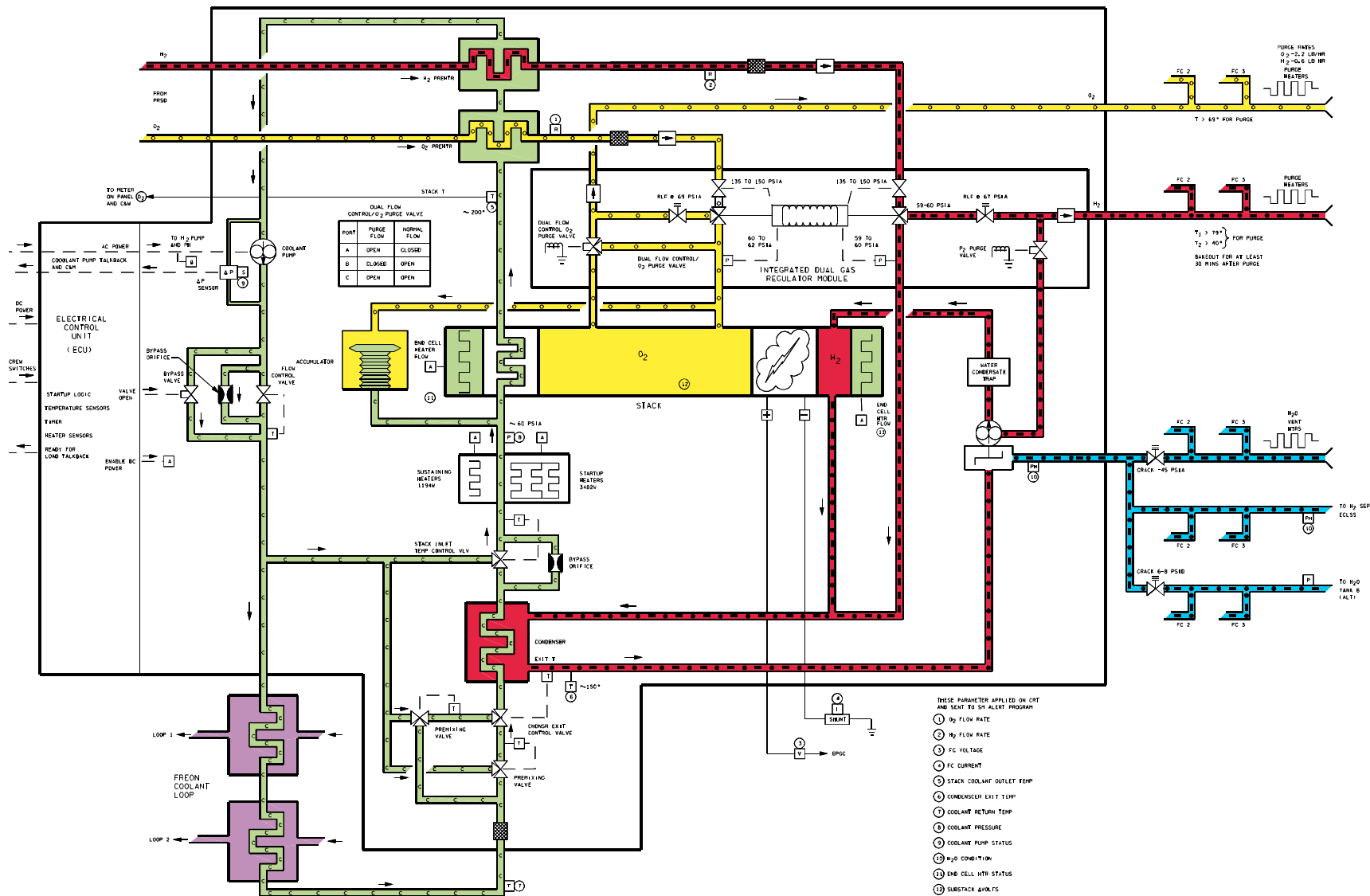
### 3.6 EPS

#### 3.6.1 Cryo System



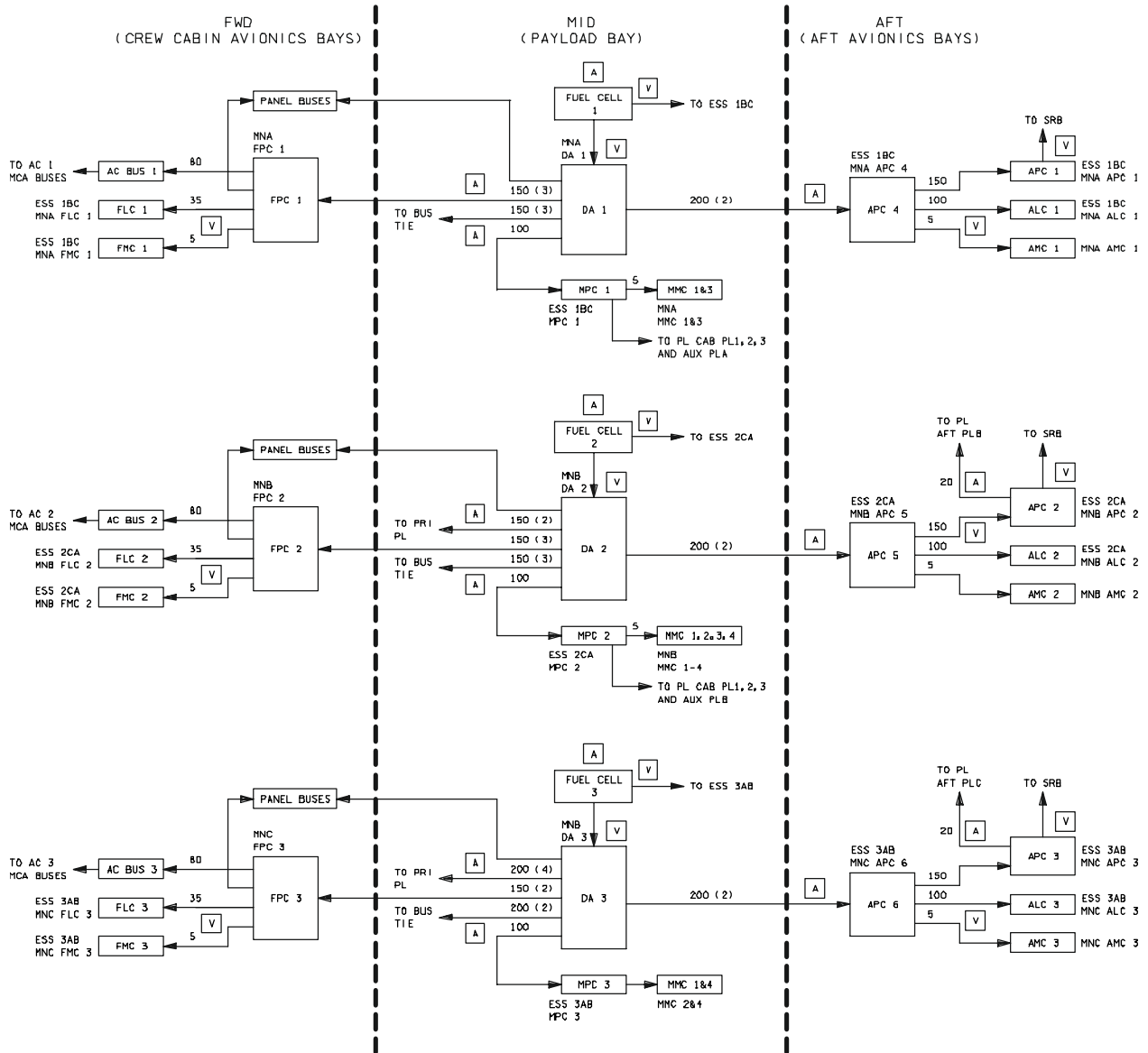
19612007. PNL; 2

### 3.6.2 Fuel Cell Overview Schematic



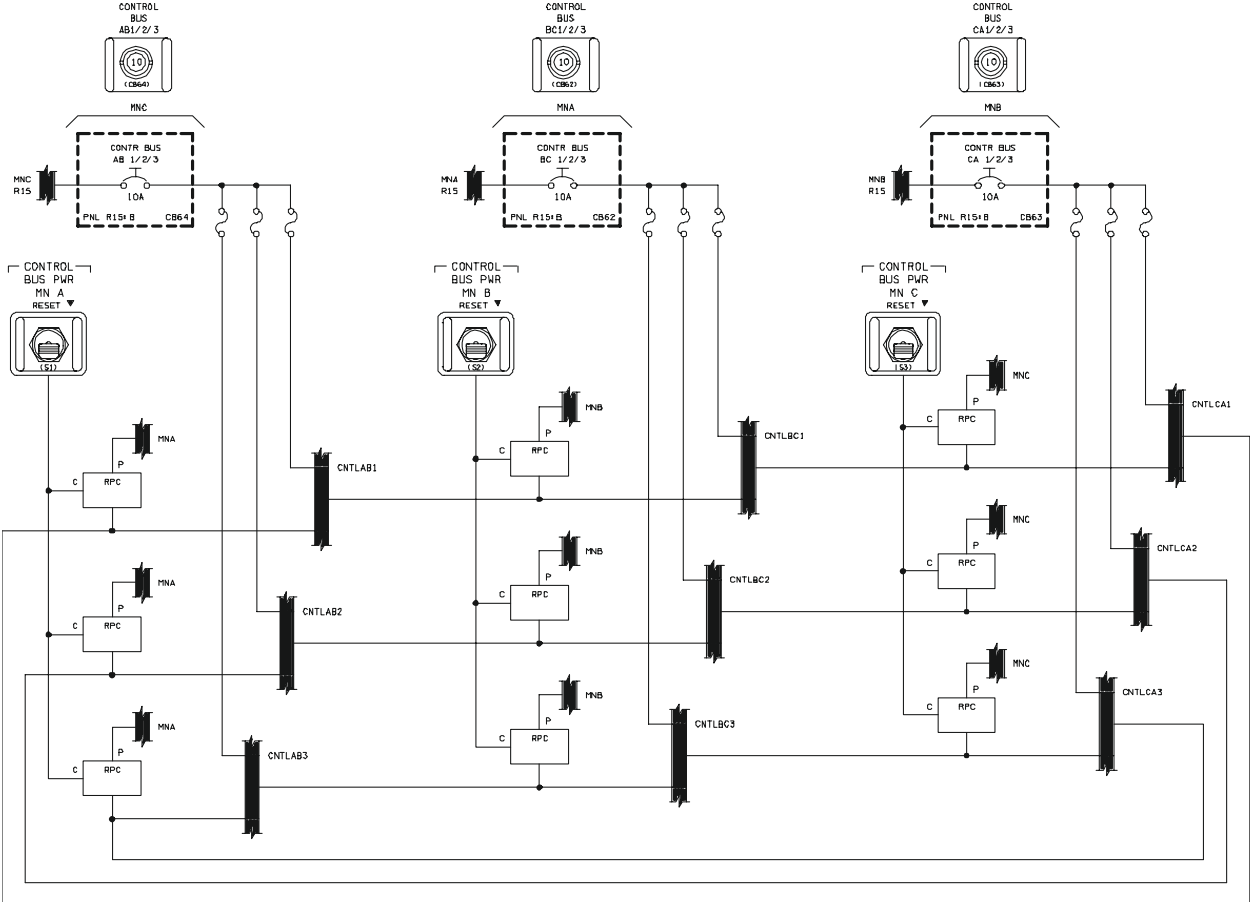
3.6.2-1

### 3.6.3 Power Distribution Overview Schematic



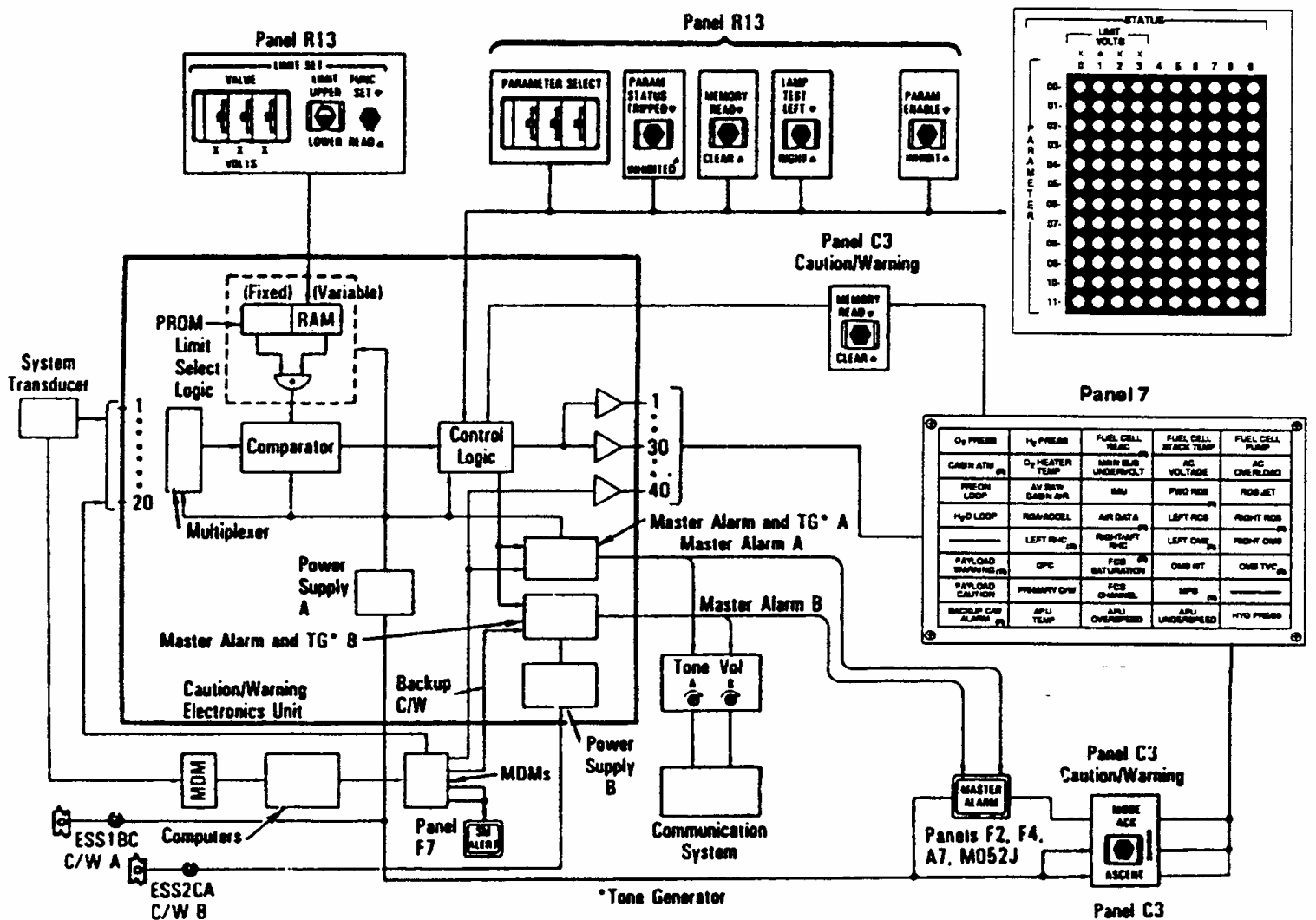
19612500, SCH 2

### 3.6.4 Control Bus Schematic



19612503, SCH 1

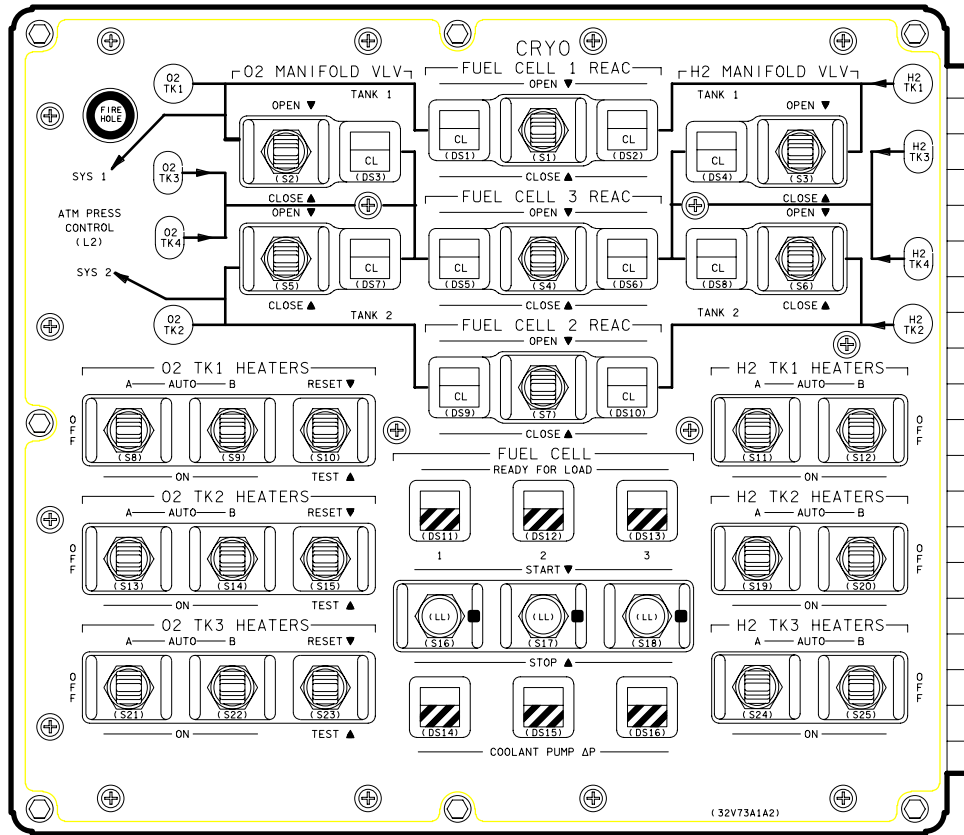
3.6.5 C&W Overview



Caution and Warning System Overview

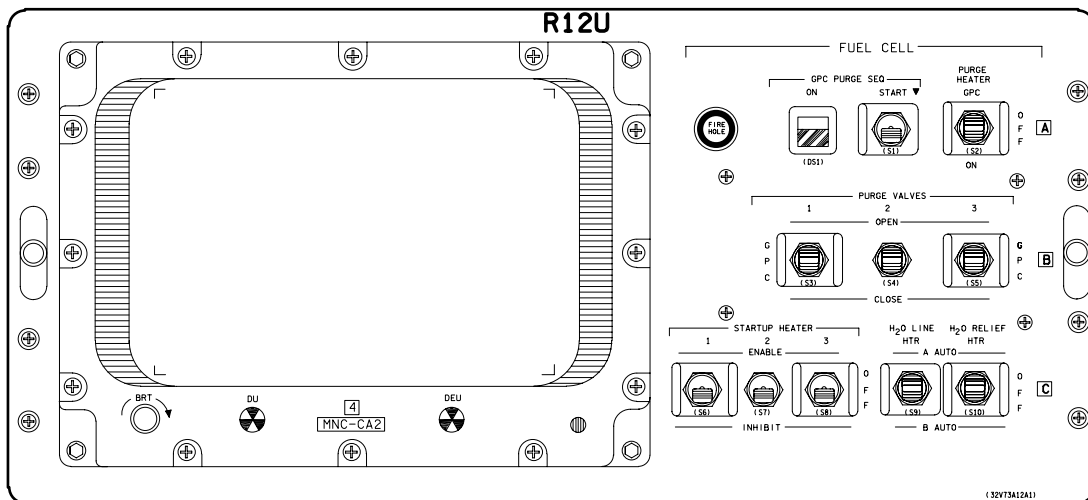


3.6.6 Switch Panels (R1 & R12U)



PANEL R1

19612007.PNL 1



19612014.PNL 1

### 3.6.7 Displays

XXXX/XXX/078		SM SYS SUMM 1		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
SMOKE	1/A 2/B	DC VOLTS	1/A 2/B 3/C		
CABIN	XX.XS	FC	XX.XS XX.XS XX.XS		
L/R FD	XX.XS XX.XS	MAIN	XX.XS XX.XS XX.XS		
AV BAY	1 XX.XS XX.XS	ESS	XX.XS XX.XS XX.XS		
	2 XX.XS XX.XS				
	3 XX.XS XX.XS	CNTL	1 XXX.XSXXX.XSXXX.XSX		
			2 XXX.XSXXX.XSXXX.XSX		
			3 XXX.XSXXX.XSXXX.XSX		
CABIN					
PRESS	XX.XS				
dP/dT-EQ	±.XXS±X.XXSAC	VOLT	ΦA XXXS XXXS XXXS		
O2 CONC	XX.XS		ΦB XXXS XXXS XXXS		
PP02	X.XXS X.XXS		ΦC XXXS XXXS XXXS		
FAN ΔP	X.XXS	AMPS	ΦA XX.XS XX.XS XX.XS		
HX OUT T	XX.XS		ΦB XX.XS XX.XS XX.XS		
O2 FLOW	XX.XS XX.XS		ΦC XX.XS XX.XS XX.XS		
N2 FLOW	XX.XS XX.XS	FUEL CELL			
IMU FAN	AXS BXS CXS	AV FC1 FC2 FC3	AMPS XXXS XXXS XXXS		
		REAC VLV	XX XX XX		
SS1	XXXX XXXS XXXS	STACK T	±XXXS ±XXXS ±XXXS		
SS2	XXXX XXXS XXXS	EXIT T	XXXX XXXS XXXS		
SS3	XXXX XXXS XXXS	COOL P	XXXX XXXS XXXS		
TOTAL AMPS	XXXXS	PUMP	XXS XXS XXS		
KW	XXS				

XXXX/XXX/078		SM SYS SUMM 1		XX X DDD/HH:MM:SS	
		BFS DDD/HH:MM:SS		DDD/HH:MM:SS	
SMOKE	1/A 2/B	DC VOLTS	1/A 2/B 3/C		
CABIN	XX.XS	FC	XX.XS XX.XS XX.XS		
L/R FD	XX.XS XX.XS	MAIN	XX.XS XX.XS XX.XS		
AV BAY	1 XX.XS XX.XS	CNTL AB	XX.XS XX.XS XX.XS		
	2 XX.XS XX.XS	BC	XX.XS XX.XS XX.XS		
	3 XX.XS XX.XS	CA	XX.XS XX.XS XX.XS		
CABIN					
PRESS	XX.XS	ESS	XX.XS XX.XS XX.XS		
dP/dT	±.XXS	AC			
BU/EQ	±.XXS ±.XXS	VOLT	ΦA XXXS XXXS XXXS		
PP02	X.XXS X.XXS		ΦB XXXS XXXS XXXS		
FAN ΔP	X.XXS		ΦC XXXS XXXS XXXS		
HX OUT T	XX.XS	AMPS	ΦA XX.XS XX.XS XX.XS		
O2 FLOW	X.XS X.XS		ΦB XX.XS XX.XS XX.XS		
N2 FLOW	X.XS X.XS		ΦC XX.XS XX.XS XX.XS		
IMU FAN ΔP	X.XXS	FUEL CELL			
AV FC1 FC2 FC3		AMPS	XXXX XXXS XXXS		
SS1	XXXX XXXS XXXS	REAC VLV	XXS XXS XXS		
SS2	XXXX XXXS XXXS	STACK T	±XXXX ±XXXX ±XXXX		
SS3	XXXX XXXS XXXS	EXIT T	XXXX XXXS XXXS		
TOTAL AMPS	XXXXS	COOL P	XXXX XXXS XXXS		
KW	XXS	PUMP	XXS XXS XXS		

SMSYS SUMM1 Display (BFS)

XXXX/XXX/079		SM SYS SUMM 2		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
CRYO TK	1 2 3 4 5	MANF1	MANF2		
H2 PRESS	XXXX XXXS XXXS XXXS XXXS	XXXX	XXXX		
O2 PRESS	XXXX XXXS XXXS XXXS XXXS	XXXX	XXXX		
HTR T1	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
T2	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
APU					
TEMP EGT	1 XXXS XXXS XXXS	HYD	1 2 3		
B/U EGT	XXXX XXXS XXXS XXXS	PRESS	XXXX XXXS XXXS		
OIL IN	XXXX XXXS XXXS	RSVR T	XXXX XXXS XXXS		
OUT	XXXX XXXS XXXS	P	XXXX XXXS XXXS		
SPEED	% XXXS XXXS XXXS	QTY	XXXX XXXS XXXS		
FUEL QTY	XXXX XXXS XXXS	W/B			
PMP LK P	XXS XXS XXS	H2O QTY	XXXX XXXS XXXS		
OIL OUT P	XXXX XXXS XXXS	BYP VLV	XXXX XXXS XXXS		
AV BAY					
TEMP	XXXX XXXS XXXS	THERM CNTL	1 2		
FAN ΔP	X.XXS X.XXS X.XXS	H2O PUMP P	XXXX XXXS		
		FREON FLOW	XXXX XXXS		
		EVAP OUT T	XXXX XXXS		

(XX)

XXXX/XXX/079		SM SYS SUMM 2		XX X DDD/HH:MM:SS	
		BFS DDD/HH:MM:SS		DDD/HH:MM:SS	
CRYO TK	1 2 3 4 5	MANF1	MANF2		
H2 PRESS	XXXX XXXS XXXS XXXS XXXS	XXXX	XXXX		
O2 PRESS	XXXX XXXS XXXS XXXS XXXS	XXXX	XXXX		
HTR T1	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
T2	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
APU					
TEMP EGT	1 XXXS XXXS XXXS	HYD	1 2 3		
B/U EGT	XXXX XXXS XXXS XXXS	PRESS	XXXX XXXS XXXS		
OIL IN	XXXX XXXS XXXS	ACUM P	XXXX XXXS XXXS		
OUT	XXXX XXXS XXXS	RSVR T	XXXX XXXS XXXS		
GG BED	XXXX XXXS XXXS	QTY	XXXX XXXS XXXS		
INJ	XXXX XXXS XXXS	W/B			
SPEED	% XXXS XXXS XXXS	H2O QTY	XXXX XXXS XXXS		
FUEL QTY	XXXX XXXS XXXS	BYP VLV	XXXX XXXS XXXS		
PMP LK P	XXS XXS XXS				
OIL OUT P	XXXX XXXS XXXS				
AV BAY	XXXX XXXS XXXS	THERM CNTL	1 2		
FAN ΔP	X.XXS X.XXS X.XXS	H2O PUMP P	XXXX XXXS		
		FREON FLOW	XXXX XXXS		
		EVAP OUT T	XXXX XXXS		

SMSYS SUMM2 Display (BFS)

XXXX/XXX/067		ELECTRIC		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
VOLT	1/A 2/B 3/C	AC	1 2 3		
FC	XX.XS XX.XS XX.XS	ΦA	XXXX XXXS XXXS		
MN	XX.XS XX.XS XX.XS	ΦB	XXXX XXXS XXXS		
PCA FWD	XX.XS XX.XS XX.XS	ΦC	XXXX XXXS XXXS		
AFT	XX.XS XX.XS XX.XS	AMP	ΦA XX.XS XX.XS XX.XS		
ESS	XX.XS XX.XS XX.XS		ΦB XX.XS XX.XS XX.XS		
			ΦC XX.XS XX.XS XX.XS		
CNTL	1 XXX.XSXXX.XSXXX.XSX	OVLD	XXS XXS XXS		
	2 XXX.XSXXX.XSXXX.XSX	NO/U V	XXS XXS XXS		
	3 XXX.XSXXX.XSXXX.XSX				
AMPS					
FC	XXXX XXXS XXXS	PAYLOAD DC AMPS			
FWD	XXXX XXXS XXXS	AFT B	XXX.XS		
MID	XXXX XXXS XXXS	C	XXX.XS		
AFT	±XXXX ±XXXX ±XXXX				
TOTAL AMPS					
KW	XXXXS				

(XX)

XXXX/XXX/068		CRYO SYSTEM		XX X DDD/HH:MM:SS	
		DDD/HH:MM:SS		DDD/HH:MM:SS	
P O2	1 2 3 4 5	TK	1 2 3 4 5		
TK P	XXXX XXXS XXXS XXXS XXXS				
QTY	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
HTR T1	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
T2	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
HTR					
1A	4/5				
1B	4/5				
2A	4/5				
2B	4/5				
MANF P	XXXX XXXS				
VLV	XXS XXS				
H2					
P	XXXX XXXS XXXS XXXS XXXS				
TK P	XXXX XXXS XXXS XXXS XXXS				
QTY	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
T	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
HTR T	±XXXX ±XXXX ±XXXX ±XXXX ±XXXX				
MANF P	XXXX XXXS				
VLV	XXS XXS				

(XX)

XXXX/XXX/069		FUEL CELLS			XX X		DDD/HH:MM:SS		DDD/HH:MM:SS	
		FC								
		1	2	3						
VOLTS		XX.XS	XX.XS	XX.XS	H2O RIF	LINE T			XXXS	
AMPS		XXXS	XXXS	XXXS		NOZ T A			XXXS	
									XXXS	
FLOW O2		XX.XS	XX.XS	XX.XS		HTR SW			XXXS	
H2		X.XS	X.XS	X.XS	PURGE LN	O2 T			XXXS	
REAC O2		XXS	XXS	XXS		H2 T1			XXXS	
H2		XXS	XXS	XXS		T2			XXXS	
					H2O LINE	PH			XXS	
STACK T		±XXXS	±XXXS	±XXXS						
EXIT T		XXXS	XXXS	XXXS						
COOL T		XXXS	XXXS	XXXS						
		XXXS	XXXS	XXXS						
PUMP		XXS	XXS	XXS	PH		1	2	3	
H2 PUMP		X.XS	X.XS	X.XS	ΔV	SS1	XXXS	XXXS	XXXS	
READY		XXXS	XXXS	XXXS		SS2	XXXS	XXXS	XXXS	
						SS3	XXXS	XXXS	XXXS	
H2O					ΔAMPS		±XXXS	±XXXS	±XXXS	
PRI LN T		XXXS	XXXS	XXXS						
VLV T		XXXS	XXXS	XXXS						
ALT LN T		XXXS	XXXS	XXXS						

(XX)

### 3.6.8 Powerdowns

These are the configurations reached after completing the referenced power down. They may not be in procedural order.

#### 3.6.8.1 2 Cabin Fans ↓

Impacts:

Tail Sun or install shades  
PL Safing  
RMS↓  
KU ↓  
MADS↓  
ADI/DDUs↓  
CRTs↓ (within 30 minutes – 1min on, 3min off)  
Event/mission timer (aft)↓  
Hum Seps↓  
L,R cabin smoke detectors↓  
TV↓  
Food warmer/galley↓  
Rad stow  
Set up for cabin purge

Deorbit:

Minimize CRT use  
TIG-20 start cabin purge  
TIG-15 use 2 CRTs/DDUs  
Post-burn use 1 CRT/DDU  
EI use 2 CRTs/DDUs  
M = 2.9 HUDs↑

Concerns:

1. Cabin humidity and temperature
2. Condensation on IMU HX
3. Cabin air cooled avionics temperatures during entry

Ops Notes:

1. Cannot power up to monitor cabin temp or humidity since not air flow over sensors.
2. IFM to capture water exiting IMU air outlet may be required.
3. Constant cabin purge delayed until visors down due to potential for nitrogen pocket build up
4. Cabin box fan can help with cabin air circulation on orbit, which should also help with humidity control.

### 3.6.8.2 2 H2O Loops ↓ (45m < TIG < 2.5h)

#### Impacts:

1 GPC and 1 IMU ↑ for att control  
Mnvr to tail sun  
Rad stow  
Bypass Rads/activate FES  
Close PLBDs  
KU↓  
RMS↓  
PL Safing  
GPC 2,3,5↓; Cycle between GPC 1↑ and 4↑  
CRTs↓ (use 1 as required)  
MMUs↓  
MADS↓  
Hum Seps↓  
Cabin fans↓  
Av bay 2,3 fans↓  
Freon loop 1↓, 2↑  
Circ pumps↓  
MCAs↓  
1IMU 1,3↓  
1FF 1,3,4 ↓  
1FRCS MANFs↓  
1RJDFs↓  
1GPC4↓  
1PL 1,2 ↓  
1Cycle cabin fan (PPCO2 control)  
210.2 cabin depress/repress  
ADI/DDUs↓ (use 1 as required)  
Event/mission timers↓  
Food warmer/galley↓  
OI OF DSCs 1,2,3,4↓  
S-band↓ (powered as required for comm)  
PCMMU↓ (powered as required for comm)  
UHF↓ (powered as required for comm)  
PDI↓  
TV↓

#### Concerns:

1. Cabin humidity and temperature
2. Cabin air, avionics air, and water cooled avionics temps

#### Ops Notes:

1. Av Bay 1 used as “heat sink” while waiting to deorbit.
2. GPCs 2,3,5 are not used on orbit to keep those bays cool to support entry.

<sup>1</sup>Perform if TIG > 50m after PLBD Close

<sup>2</sup>Perform if TIG > 90m after PLBD close

#### CONT D/O:

Repower to single fault tolerant config

TIG-30 IMU 1,3↑  
FF 1,3↑  
GPC 1(2)↓; GPC 3,5 ↑  
RGAs 2,3 ↑  
AAs 1,2,3 ↑  
Av bay fans 1↓; 2,3 ↑

TIG-15	Constant cabin purge
V=15K	TACANs 2,3↑
V=12K	COMM↑

### 3.6.8.3 2 H2O Loops ↓ (TIG > 2.5h)

#### Impacts:

This power down leaves all GPCs↓ and goes free drift.

Mnvr to tail sun, then free drift

PL Safing

KU↓

RMS↓

Rad stow

CRTs↓ (use 1 as required)

All GPCs↓

FF 1,3,4↓

PL 1,2↓

MMUs↓

MTU↓

IMU 1,3↓ (maintain IMU 2)

MADS↓

ADIs/DDUs↓

Hum Seps↓

Cabin fans↓

Freon loop 1↓, 2↑

Circ pumps (prevent MN Bus O/V)

Av bay fans (6) ↓

FRCS MANFs↓

RJDs↓

Event/mission timers↓

Smoke detectors↓

OI OF DSCs 1,2,3,4↓

OI OF MDMs 1,2,3,4↓

S-band↓ (powered as required for comm)

PCMMU↓

UHF↓ (powered as required for comm)

PDI↓

TV↓

#### CONT D/O:

Repower to single fault tolerant config.

T-1:30 MTU↑

T-1:25 FES↑

T-1:22 GPC 4(1)↑

T-1:13 PLBD Close

TIG-30 IMU 1,3↑

FF 1,3↑

GPC 1(2)↓; GPC 3,5↑

RGA 2,3↑

#### Concerns:

1. Cabin humidity and temperature
2. Cabin air, avionics bay air, and water cooled avionics temps.

#### Ops Notes:

1. One IMU and associated MDM left powered. Normally IMU2/FF2 but GNC may change in real-time based on IMU drift rates.
2. Operating IMU is aligned once per orbit during night pass, alternating between GPC 1 and 4 (off except during align).
3. Surgeon monitors cabin temperature and humidity and plots trends. ELS is possible if cabin becomes unacceptable.
4. Cabin depress/repress done during IMU alignment since active attitude control required due to propulsive venting.
5. Power comm as required.

	AA 1,2,3↑
	Av bay fans 1↓; 2,3↑
TIG-15	Constant cabin purge
V=15K	TACANs 2,3↑
V=12K	Comm↑



### 3.6.8.4 Loss of Cabin Press

#### Impacts:

PL Safing  
RMS↓  
KU↓  
Rad stow  
Activate FES  
CRTs↓ (use 1 as required)  
DDUs↓  
Hum Seps↓  
ADTAs↓  
MADS↓  
If TIG < 2h 40m then Emergency Deorbit  
If TIG > 2h 40m then  
    Install shades, go to Tail Sun  
    TV↓  
If TIG > 2h 40m AND < 4h then 8 psi D/O Prep  
If TIG > 4h then  
    GPC1↓ 2↑  
    Perform 8 psi D/O Prep

#### Deorbit:

This is a two fault tolerant configuration.

TIG-15   DDUs↑  
EI-       ADTAs↑  
V=15K    TACANs↑  
          MLS↑  
          RAs↑

#### Concerns:

1. Crew survival. Analysis says avionics will survive if crew does.

#### Ops Notes:

1. Cabin temperature and humidity are not a concern due to effects of constant cabin makeup.

### 3.6.8.5 Hi Load ↓

#### Impacts:

Payload ↓  
MADS ↓  
Use 1 CRT  
TV Heaters ↓

#### Deorbit:

Use DDU/ADI as required  
TIG-10 DDU ↑  
Post-burn L DDU ↓  
Use 1 CRT  
EI L DDU ↑  
Use 2 CRTs  
ADTA 1,2,3 ↑  
NWS ↑  
V=15K TACAN 2,3 ↑  
HUDs ↑  
M = 2.9 MLS (two) ↑  
RAs ↑

#### Ops Notes:

1. Next worst failure is loss of a freon loop.  
Loss of FES powerdown with minor modifications can deal with this case

### 3.6.8.6 FES↓

#### Impacts:

Go to Tail Sun  
Deploy Rads  
MADS↓  
Use 1 CRT as required  
DDUs↓  
Payload↓  
H2O Loops (both) ↑  
MMU2↓  
PDI↓  
Event/mission timers↓  
APU Lube Oil heaters↓  
Hyd heaters↓  
OMS/RCS Pod heaters↓  
TV↓

#### Deorbit:

TIG-45	GPC 3,5↑ (delayed from nom)
TIG-5	Use 2 CRTs/DDUs as required
EI-21	Circ pump (one)↑
EI-5	Circ pumps↓
EI	NH3↑
V=15K	TACANs (three)↑
M=2.9	MLS (three)↑
	RAs↑
	HUDs↑
M=.9	NWS↑

#### Concerns:

1. Vehicle cooling from PLBD closure until NH3 system activation.

#### Ops Notes:

1. PLBD closure delayed until just prior to TIG (for late failures, doors remain closed)
2. Rad coldsoak provides limited cooling until EI.
3. NH3 activated at EI (requires G field). Avionics activation delayed to allow NH3 system to catch up.

### 3.6.8.7 1 Freon Loop ↓

Impacts:

MADS↓

Use 1 CRT

DDUs↓

Payload↓

FES ↑ (topper)

If prior to deorbit preparation:

GPC2↓

MMU2↓

Maneuver to shade cabin

Perform priority power downs to <14kW

If already in Deorbit Prep:

TACANs↓

RAs↓

MLS↓

NWS↓

TV heaters↓

Deorbit:

Use 1 CRT/DDU/ADI as required

TIG-10 DDU↑

Post-burn L DDU↓

Use 1 CRT

EI L DDU↑

Use 2 CRTs

ADTA 1,2,3↑

NWS↑

V=15K TACAN 2,3↑

HUDs↑

M=2.9 MLS (two)↑

RAs↑

### 3.6.8.8 1 Fuel Cell ↓

Impacts:

If prior to Deorbit Prep: Power down < 18kW

If in Deorbit Prep:

Use only 2 CRTs

TACANs↓

RAs↓

MLS↓

TV↓

Cryo tank 4 heaters↓

### 3.6.8.9 2nd Fuel Cell ↓ (TIG < 4h)

#### Impacts:

PL Safing  
RMS↓  
KU↓  
Rad Stow  
GPC 2,3,5↓  
MMU2↓  
Use 2 CRTs (as required)  
MADS↓  
TACANs↓  
RAs↓  
MLS↓  
L,R RCS MANF 4↓  
RJDA 2A↓  
FF4↓  
FRCS↓  
FRCS heaters↓  
Tie 3 main buses  
Cryo 4 heaters↓  
APU lube oil heaters↓  
Hyd heaters↓  
TV↓  
PL Recorder↓  
OPS Recorder↓

#### Deorbit:

TIG-3:00 PLBD Close  
TIG-2:45 GPC4↓, 5↑  
TIG-2:25 IMU 1,2↑; FF 1,2↑  
TIG-0:20 ASAs↑  
FES Heater↓  
V=15K TACANs (two)↑  
M=4 FF4↑  
M=2.9 Cabin fans↓  
Av bay 2,3 fans↓  
TACANs↓  
1 HUD↑  
1 MLS↑  
1 RA↑  
M=.9 NWS↑

#### Ops Notes:

1. Designed to keep Orbiter power level level below 12kW
2. Vent doors left open (except L,R 1 and 2) during entry.
3. See flight rules for maximum duration at various power levels.

### 3.6.8.10 2nd Fuel Cell ↓ (TIG > 4h)

#### Impacts:

Go to GG attitude  
PL Safing  
RMS↓  
KU↓  
Rad stow  
MADS↓  
GPC 2,3,5↓  
FF 1,2,4↓  
FA 1,2,3,4↓  
Use 1 CRT, DDU as required  
MMUs↓  
Tie 3 main buses  
IMU 1,2↓  
TACANs↓  
RAs↓  
MLS↓  
RCS (all)↓  
FRCS heaters↓  
H2O BLR CNTR/HTRs ↓  
Circ pumps↓  
Cryo 4 heaters↓  
APU lube oil heaters↓  
Hyd heaters↓  
FES H2O line heaters↓  
Mid MCAs↓  
Av bay 2 fans↓  
TV↓  
Ops Recorders↓  
PL Recorder↓

#### Deorbit:

TIG-3:35 ARCS↑  
TIG-3:30 FES↑  
TIG-3:15 MCAs↑  
TIG-3:00 PLBD close  
TIG-2:45 GPC4↓, 5↑  
TIG-2:25 IMU 1,2↑; FF 1,2↑  
TIG-0:20 ASAs↑  
FES Heater↑  
V=15K TACANs (two)↑  
M=4 FF4↑  
M=2.9 Cabin fans↓  
Av bay 2,3 fans  
TACANs↓

#### Ops Notes:

1. Designed to keep Orbiter power level below 12 kW
2. Vent doors left open (except L,R 1 and 2) during entry.
3. See flight rules for maximum duration at various power levels.

M=.9  
1 HUD↑  
1 MLS↑  
1 RA↑  
NWS↑



### 3.6.8.11 2 Freon Loops↓

#### Impacts:

Rad stow  
KU↓  
PLBD close  
RMS↓  
PL Safing  
SL Emerg Pwr Down  
FC Purge heaters↑  
FC Purge valves open (continuous purge)  
GPC 1↑; 2,3,4,5↓  
FF 1,4↓  
FA 1,4↓  
MMUs↓  
Use only 1 CRT  
PL 1,2↓  
MTU B↓  
IMU 1,2↓  
DDUs↓  
Circ pumps↓  
Hum Seps↓  
Cabin fans↓  
Av bay fans 1A↑, others↓  
Cryo 4 heaters↓  
APU heaters↓  
Hyd heaters↓  
OMS/RCS heaters (all)↓  
FRCS↓  
RJDs (all)↓  
FES↓  
MCA Logic↓  
C&W↓  
Event/mission timers↓  
TV↓  
H2O line heater B ↓  
Galley/food warmer↓  
OI OF DSCs 1,2,3,4↓  
OI OA DSCs 1,2,3↓  
OI MDMs (all)↓  
S-band↓ (powered as required for comm)  
PCMMU↓  
UHF↓ (powered as required for comm)  
PDI↓  
Ops Recorders↓  
PL Recorder↓  
GCIL↓

#### Concerns:

1. Fuel cells lifetime. At projected power levels fuel cells will last 120minutes until reaching 250° stack temp. Lifetime beyond that point is questionable.

#### Ops Notes:

1. Do not delay starting this procedure if second loops starts to fail.
2. Get on the ground ASAP. Do not even wait a few minutes for a better site if pushing the 120m limit.
3. If cannot get to wheels stop within 120m, consider deorbit to bailout.

If TIG > 40m, shut down 2 FCs and 2 MN buses  
Alternate between GPC 1 &2 (1hr)  
FF 1,2,4↓  
FA 1,2,3,4↓  
1 OI DSC ↑ (FC STK T)

Deorbit:

This configuration is zero fault tolerant

TIG-30	IMU2↑, 3↓ FF 2,3↑ FCs (all three)↑
TIG-20	FA 2,3↑
TIG-15	OI DSCs↑ ARCS Manf 2,3↑ RGA 2,3↑ GPC 3↑, 1↓ DDU R↑
EI-5	FCS CH 1,4↓; 2,3↑ ASAs↑ APUs 1,3↑
V=10K	TACAN 3↑
M=4	FF 1,4↑
M=2.9	RA2↑

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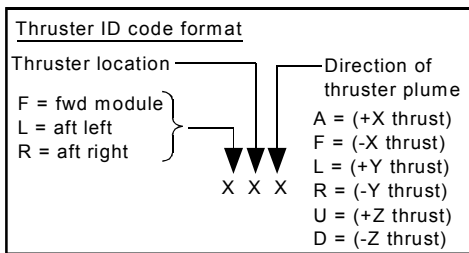
### 3.7 GNC

#### 3.7.1 RCS Jet Groups and Priorities

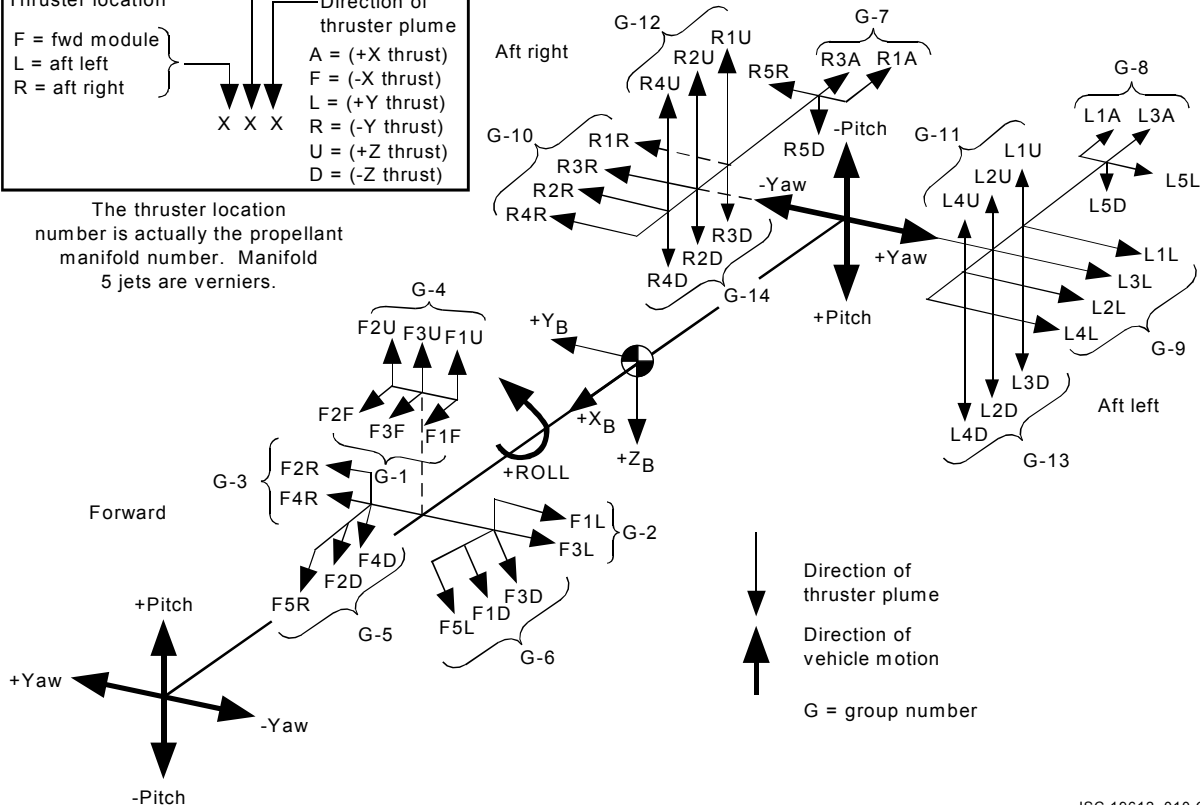
		FORWARD						AFT							
JET GROUP		1	2	3	4	5	6	7	8	9	10	11	12	13	14
PRIORITY		PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS	PASS / BFS
DAP	1	F1F F2F	F3L F3L	F4R F4R	F3U F3U	F4D F2D	F3D F1D	R3A R3A	L3A L3A	L1L L1L	R3R R1R	L1U L1U	R1U R1U	L3D L3D	R3D R3D
	2	F2F F1F	F1L F1L	F2R F2R	F1U F2U	F2D F4D	F1D F3D	R1A R1A	L1A L1A	L3L L3L	R1R R3R	L4U L2U	R4U R2U	L2D L2D	R2D R2D
	3	F3F F3F			F2U F1U					L4L L2L	R2R R2R	L2U L4U	R2U R4U	L4D L4D	R4D R4D
	4									L2L L4L	R4R R4R				

POWER PROTECTION  
DISCRETE CHG; LOOK AT COMPANION MANIFOLD;  
CHG ALSO ASSUME LAST STATUS

- |                                       |  |   |   |
|---------------------------------------|--|---|---|
| <b>FAIL ON</b>                        | <b>FAIL OFF</b>                                      | <b>FAIL-LK</b>  | <b>COMM FAULT</b>   |
| PASS - DRIVER OUTPUT<br>W/O CMD A (3) | PASS - CMD A AND<br>PC < 40 (3)<br>DESELECT - 2/POD. | PASS - INJ TEMPS<br>P- < 30° (<20° FUEL)<br>v- < 130° | <u>I/O ERROR</u><br>PASS - MAINFOLD STATUS CLOSED<br>BFS - ALL JETS DESELECTED            |
| BFS - PC < 40 WITH<br>NO CMD A (3)    | BFS - SAME EXC:<br>DESELECT 1                        | DESELECT 2<br>BFS - NONE                              | <u>BCE ELEMENT BYPASS</u><br>PASS OPS 1 - DESELECTS<br>OTHER - CONTINUE (CMDS OK; DATA ↓) |



The thruster location number is actually the propellant manifold number. Manifold 5 jets are verniers.



### 3.7.2 Rotation DAP Options

DAP	Jet group	FWD DN 5&6	FWD L/R 2/3	FWD UP 4	AFT DN 13&14	AFT L/R 9/10	AFT UP 11&12
Norm		√	√	√	√	√	√
LO -Z		√	√		√	√	
Tail only pitch			√		√	√	√
Tail only pitch (LO Z)		√	√		√	√	
Tail only yaw		√		√	√	√	√
Tail only yaw (LO Z)		√			√	√	
Tail only pitch/yaw					√	√	√
Tail only P/Y (LO Z)		√			√	√	
Nose only pitch		√	√	√	Roll	√	Roll
Nose only pitch (LO Z)		√	√		√	√	
Nose only yaw		√	√	√	√		√
Nose only yaw (LO Z)		√	√				
Nose only P/Y		√	√	√	Roll		Roll
Nose only P/Y (LO Z)		√	√		√		

**IMU DRIFT**

1 sigma = .02 deg/hr

Compensated (no torquing) ≈ 1-2 deg/hr

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### 3.7.3 LVLH Attitude and Omicron Pictorials

```

2011 / / UNIV PTG XX X DDD/HH:MM:SS
CUR MNVR COMPL XX:XX:XX DDD/HH:MM:SS
1 START TIME XX/XX:XX:XX
MNVR OPTION START MNVR 18 X X RBST 25 X X
5 R XXX.XX TRK 19 X X CNCL 26
6 P XXX.XX ROT 20 X X DURATION 27
7 Y XXX.XX CNCL 21 XX:XX:XX.XX
TRK/ROT OPTIONS ATT MON
8 TGT ID XXX 22 MON AXIS X XX
ERR TOT 23X
ERR DAP 24X
9 RA XXX.XXX
10 DEC XXX.XXX
11 LAT XXX.XXX
12 LON XXX.XXX
13 ALT XXX.XXX
14 BODY VECT X CUR ROLL PITCH YAW
RATE ±XX.XXX ±XX.XXX ±XX.XXX
15 P XXX.XX
16 Y XXX.XX
17 OM XXX.XX

```

#### Body Pointing Vector

- 1 = +X
- 2 = -X
- 3 = -Z
- 4 = -Y ST
- 5 = selectable

#### Target Options

- 1 = TGT
- 2 = Earth Center
- 3 = Earth Surface
- 4 = Sun Center
- 5 = Selectable Star
- 11-110 = NAV Stars

$\Theta_M$  = Angle Between Planes

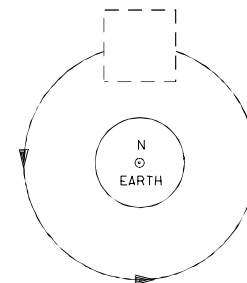
- -
- A (BV and -H)
- \_B (BV and +Y)

-  
If BV = ±Y, Use -Z  
If BV = ±H, Use Asc Node



INSTRUCTIONS

- SELECT ORIENTATION.
- REFERENCE CORRESPONDING OMICRON BLOCK FOR THE BODY POINTING VECTOR (BPV).
- OR
- CHOOSE DESIRED BPV.
- SELECT OMICRON.
- THEN
- PLACE PICTURE IN DOTTED SQUARE. (DO NOT ROTATE.)

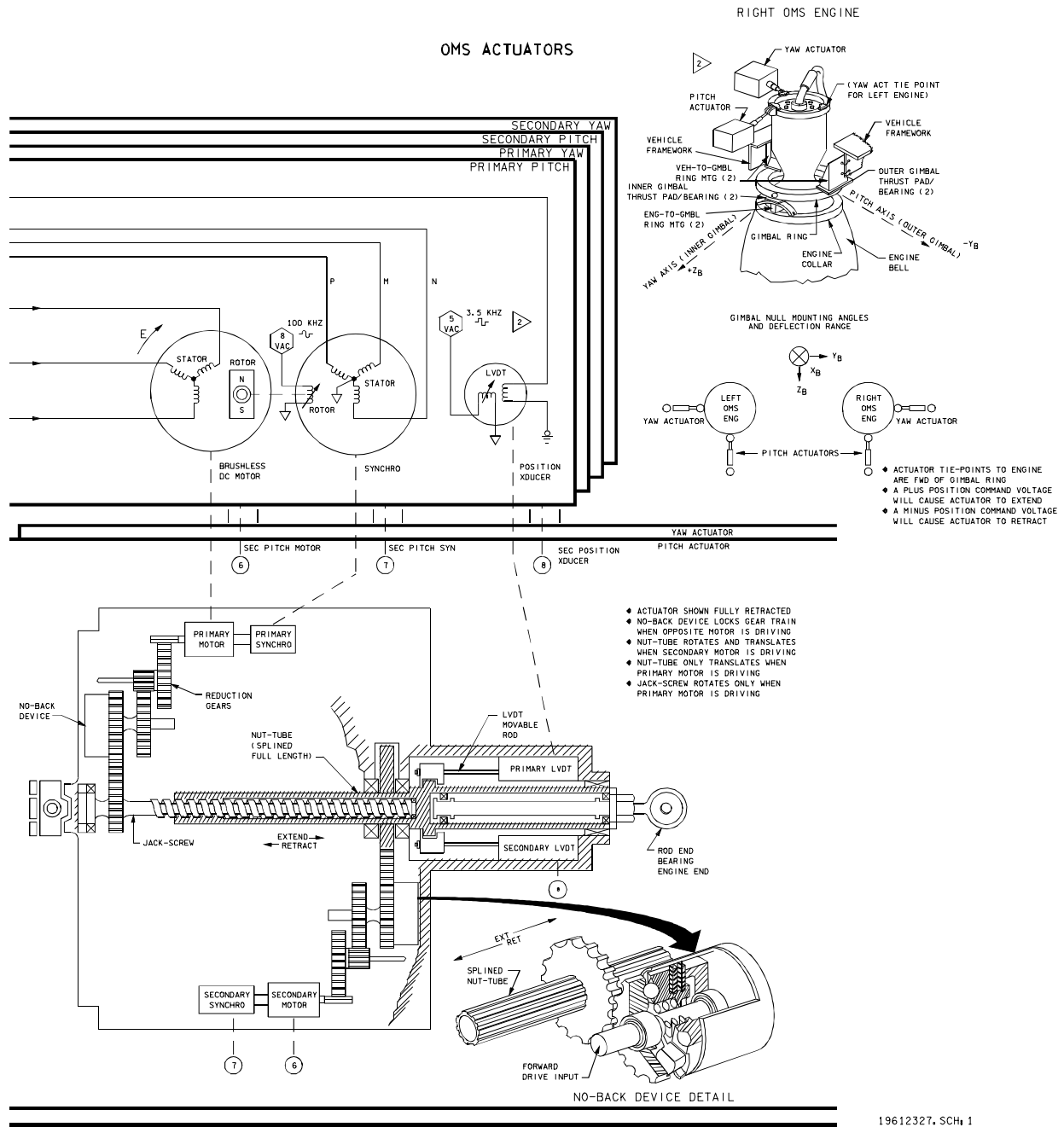


BLOCK	ORIENTATION	LVLH ATTITUDE, DEG (P, Y, R EULER SEQUENCE)			BPV	OMICRON			
		ROLL,	PITCH,	YAW,		1 0°	2 90°	3 180°	4 270°
1	+XLV Y-POP (PLBD FWD)	0°	270°	0°	+X P=0, Y=0				
2	+XLV Z-POP (PLBD SOUTH)	90°	270°	0°					
3	+XLV Y-POP (PLBD AFT)	180°	270°	0°					
4	+XLV Z-POP (PLBD NORTH)	270°	270°	0°					
1	-XLV Y-POP (PLBD AFT)	0°	90°	0°	-X P=180, Y=0				
2	-XLV Z-POP (PLBD NORTH)	270°	90°	0°					
3	-XLV Y-POP (PLBD FWD)	180°	90°	0°					
4	-XLV Z-POP (PLBD SOUTH)	90°	90°	0°					
1	+ZLV Y-POP (NOSE FWD)	0°	0°	0°	+Z P=270, Y=0				
2	+ZLV X-POP (NOSE SOUTH)	0°	0°	90°			REAR		FRONT
3	+ZLV Y-POP (NOSE AFT)	180°	180°	0°			FRONT		REAR
4	+ZLV X-POP (NOSE NORTH)	0°	0°	270°			FRONT		REAR
1	-ZLV Y-POP (NOSE AFT)	0°	180°	0°	-Z P=90, Y=0		FRONT		REAR
2	-ZLV X-POP (NOSE NORTH)	0°	180°	270°			FRONT		REAR
3	-ZLV Y-POP (NOSE FWD)	180°	0°	0°			FRONT		REAR
4	-ZLV X-POP (NOSE SOUTH)	0°	180°	90°			FRONT		REAR
1	+YLV Z-POP (PLBD SOUTH)	90°	0°	0°	+Y P=0, Y=90		REAR		FRONT
2	+YLV X-POP (NOSE SOUTH)	0°	90°	90°			REAR		FRONT
3	+YLV Z-POP (PLBD NORTH)	270°	180°	0°			REAR		FRONT
4	+YLV X-POP (NOSE NORTH)	0°	270°	270°			REAR		FRONT
1	-YLV Z-POP (PLBD SOUTH)	90°	180°	0°	-Y P=0, Y=270		FRONT		REAR
2	-YLV X-POP (NOSE NORTH)	0°	90°	270°			FRONT		REAR
3	-YLV Z-POP (PLBD NORTH)	270°	0°	0°			FRONT		REAR
4	-YLV X-POP (NOSE SOUTH)	0°	270°	90°			FRONT		REAR

\*CENTER-OF-EARTH TARGET

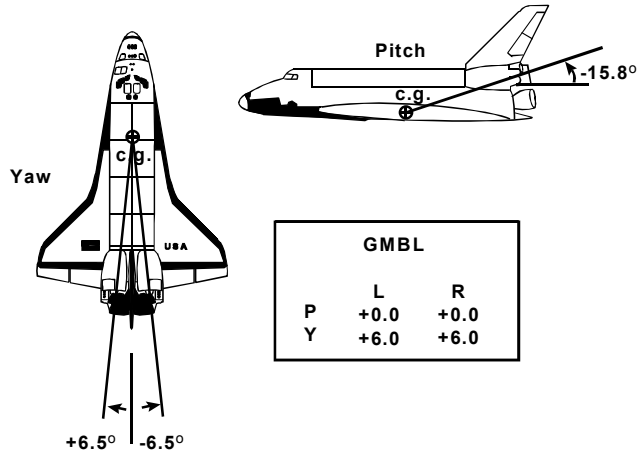
19612402. ART; 1

### 3.7.4 OMS Actuator Pictorial

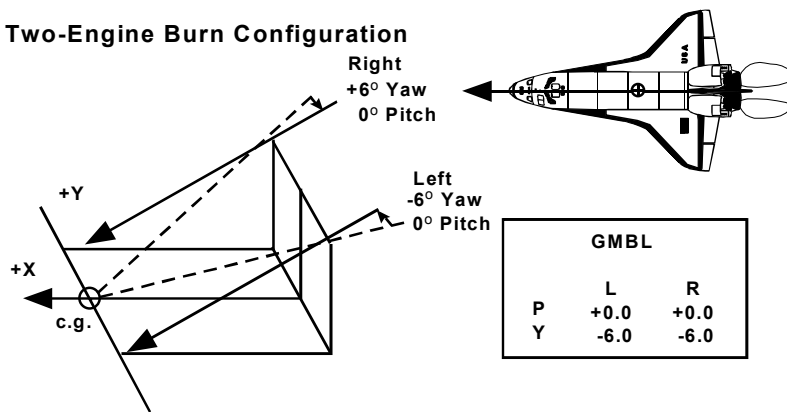


### 3.7.5 OMS Gimbal Positions

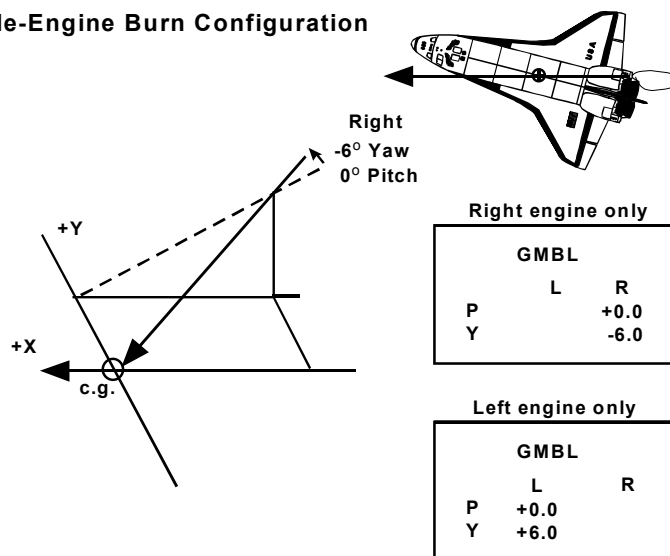
#### Null Position



#### Two-Engine Burn Configuration



#### Single-Engine Burn Configuration

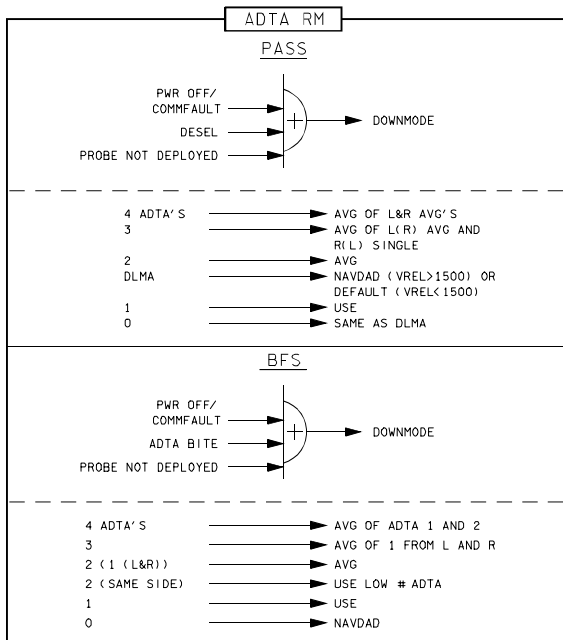
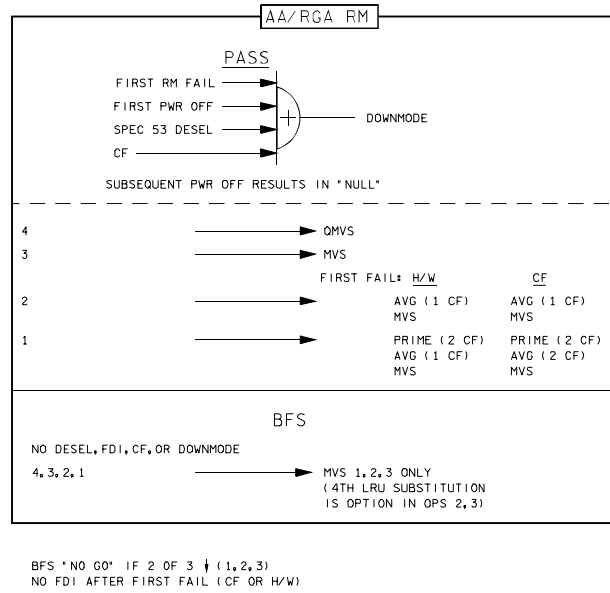
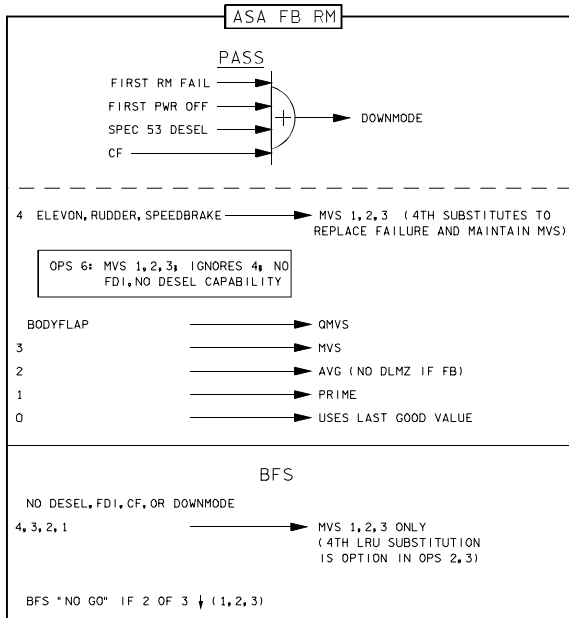


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No actuator movement unless error > 0.4°. Then engine will move to within 0.06°.

### 3.7.6 RM Overview

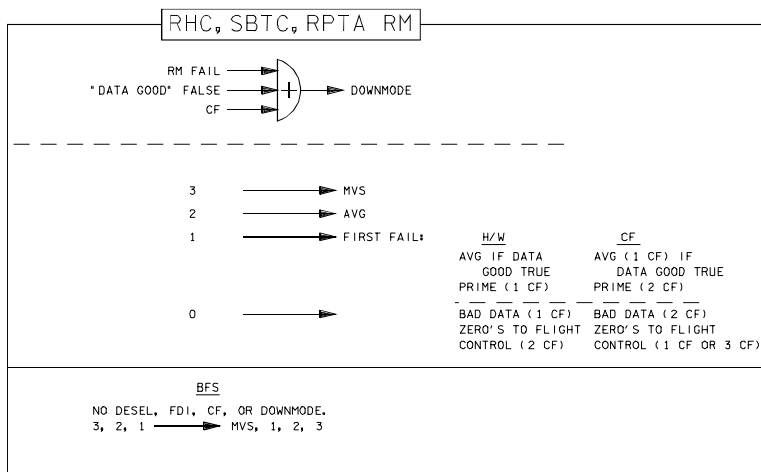
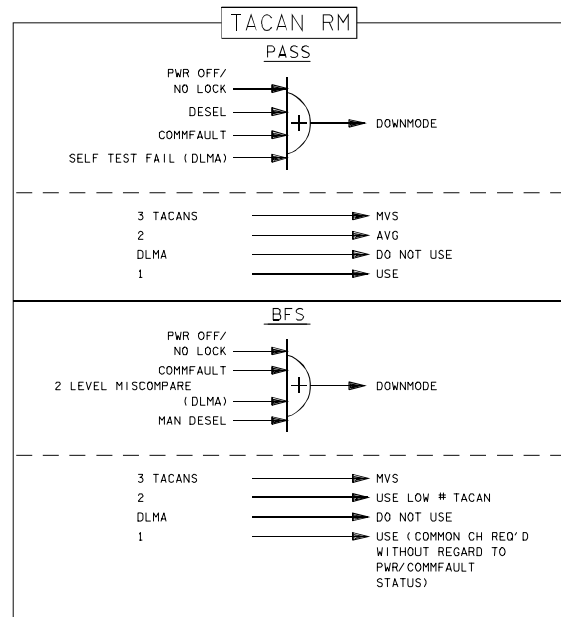
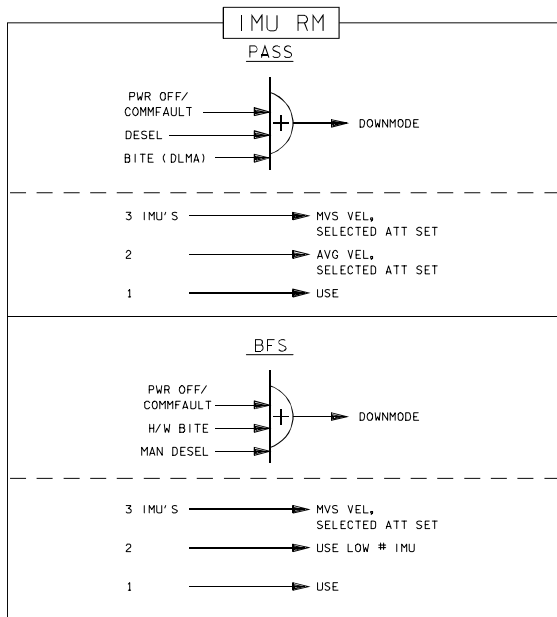
GNC



**NOTE**  
WHEN BFS ENGAGED, IF A FAILED ADTA IS A CANDIDATE FOR SELECTION, STOW APPLICABLE PROBE

19612006.FLW: 1

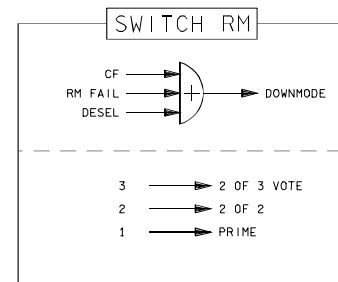
GNC (CONC.)



RHC: OPS 1/6 - NO FDI  
3 AXIS  
CF DOWNMODE ONLY

OPS 6 - NO FDI  
2 AXIS  
CF DOWNMODE ONLY

SBTC: OPS 1/6 - CF DOWNMODE ONLY  
RPTA



3.7.7 Displays

```

XXXX/XXX/018  GNC SYS SUMM 1  XX X DDD/HH:MM:SS
                DDD/HH:MM:SS

RCS  JET ISOL
MANFFAILVLV SURF  POS  MOM  DPS  1 2 3 4 5
F1XXX XXS  L OB  XXX.XS XXS  GPC S S S S S
2XXX XXS  1B  XXX.XS XXS  MDM FF S S S S
3XXX XXS  R 1B  XXX.XS XXS  FA S S S S
4XXX XXS  OB  XXX.XS XXS
5XXX XXS  AIL  XXX.X
L1XXX XXS  RUD  XXX.X      FCS CH 1 2 3 4
2XXX XXS  SPD BRK XXX.X      S S S S
3XXX XXS  BDY FLP XXX.X
4XXX XXS  XXXXXX
5XXX XXS

R1XXX XXS  CNTLR 1 2 3
2XXX XXS  RHC  L S S S
3XXX XXS  R  S S S
4XXX XXS  A  S S S
5XXX XXS  THC  L S S S
           A  S S S
           SRTC L S S S
            R  S S S

NAV  1 2 3 4
IMU  S S S
ACC  S S S S
RGA  S S S S
XXX  S S S
MLS  S S S
ADTA S S S S
    
```

```

XXXX/XXX/018  GNC SYS SUMM 1  XX X DDD/HH:MM:SS
                BFS DDD/HH:MM:SS

SURF  POS  MOM  DPS  1 2 3 4
L OB  XXX.XS XXS  MDM FF S S S S
1B  XXX.XS XXS  FA S S S S
R 1B  XXX.XS XXS  PL S S
OB  XXX.XS XXS
AIL  XXX.X
RUD  XXX.X      FCS CH 1 2 3 4
SPD BRK XXX.X      S S S S
BDY FLP XXX.X

MPS  L  C  R  NAV  1 2 3 4
HE TK P  XXXXS XXXXS XXXXS IMU  S S S
REG P A  XXXXS XXXXS XXXXS XXX S S S
        B XXXXS XXXXS XXXXS ADTA S S S S
dP/dT  XXXS XXXS XXXS

MPS PNEU HE P
ULL P LH2 XX.XS XX.XS XX.XS TK XXXXS
    LO2 XX.XS XX.XS XX.XS REG XXXXS
GH2 OUT P XXXXS XXXXS XXXXS MANF P LH2 XXXS
GO2 OUT T XXXXS XXXXS XXXXS LO2 XXXS
    
```

GNC SYS SUMM1 Display (BFS)

PASS GNC SYS SUMM 2  
same as  
BFS GNC SYS SUMM 2

```

XXXX/XXX/019  GNC SYS SUMM 2  XX X DDD/HH:MM:SS
                BFS DDD/HH:MM:SS

OMS AFT QTY  L  R  OMS  BFS  L  R
OXID XX.XS XX.XS  TK P  HE XXXXS XXXXS
FU XX.XS XX.XS  FU  OXID XXXS XXXS
FU INJ T  XXXS XXXS  FU  XXXS XXXS

RCS  OXID  FU  JET ISOL
FWD  HE P XXXXS XXXXS  FAIL VLV
TK P  XXXS XXXS
QTY  XXXS XXXS
MANF 1 P XXXS XXXS XXXS XXXS
    2 P XXXS XXXS XXXS XXXS
    3 P XXXS XXXS XXXS XXXS
    4 P XXXS XXXS XXXS XXXS
    5 P XXXS XXXS XXXS XXXS
    AFT HE P XXXXS XXXXS  HE P XXXXS XXXXS
    L  TK P  XXXS XXXS  R  TK P  XXXS XXXS
    QTY  XXXS XXXS  QTY  XXXS XXXS
MANF 1 P XXXS XXXS XXXS XXXS 1 P XXXS XXXS XXXS XXXS
    2 P XXXS XXXS XXXS XXXS 2 P XXXS XXXS XXXS XXXS
    3 P XXXS XXXS XXXS XXXS 3 P XXXS XXXS XXXS XXXS
    4 P XXXS XXXS XXXS XXXS 4 P XXXS XXXS XXXS XXXS
    5 P XXXS XXXS XXXS XXXS 5 P XXXS XXXS XXXS XXXS
    
```

```

XXXX/020/  DAP CONFIG  XX X DDD/HH:MM:SS
           DDD/HH:MM:SS

XXX 1 XXXXXX 2 XXXXXX PRI  DAP EDIT
ROT RATE 10 X-XXXX 30 X-XXXX 50 X-XXXX 3 DAP AX
ATT DB 11 XX-XX 31 XX-XX 51 XX-XX 4 DAP BX
RATE DB 12 X-XX 32 X-XX 52 X-XX 5 XXXX
ROT PLS 13 X-XX 33 X-XX 53 X-XX
COMP 14 -XXX 34 -XXX 54 -XXX
P OPTION 15 XXXX 35 XXXX 55 XXXX
Y OPTION 16 XXXX 36 XXXX 56 XXXX
TRAN PLS 17 X-XX 37 X-XX 57 X-XX
           ALT
RATE DB 18 X-XXX 38 X-XXX 58 X-XXX XJETS ROT
JET OPT 19 XXXX 39 XXXX 59 XXXX ENA 7X
# JETS 20 X 40 X 60 X
ON TIME 21 X-XX 41 X-XX 61 X-XX REBOOST
DELAY 22 XX-XX 42 XX-XX 62 XX-XX 8 CFG X
           9 INTVI
           XXX-XX
           VERN
ROT RATE 23 X-XXXX 43 X-XXXX 63 X-XXXX
ATT DB 24 XX-XX 44 XX-XX 64 XX-XX
RATE DB 25 -XXX 45 -XXX 65 -XXX
ROT PLS 26 X-XXX 46 X-XXX 66 X-XXX
COMP 27 -XX 47 -XX 67 -XX
CNTL ACC 28 X 48 X 68 X
           NOTCH FLTR
           ENA 6X
    
```

```

XXXX/025/  RM ORBIT  XX X DDD/HH:MM:SS
           DDD/HH:MM:SS

THC TX TY TZ DES RHC R P Y DES
L 1 XS XS XS 1X L 1 XXXS XXXS XXXS 7X
  2 XS XS XS 2X L 2 XXXS XXXS XXXS 8X
  3 XS XS XS 3X L 3 XXXS XXXS XXXS 9X
A 1 XS XS XS 4X R 1 XXXS XXXS XXXS 10X
  2 XS XS XS 5X R 2 XXXS XXXS XXXS 11X
  3 XS XS XS 6X R 3 XXXS XXXS XXXS 12X
A 1 XXXS XXXS XXXS 13X
  2 XXXS XXXS XXXS 14X
  3 XXXS XXXS XXXS 15X
           SW RM INH 16X
    
```

```

XXXX/021/          IMU ALIGN          XX X DDD/HH:MM:SS
IMU                DDD/HH:MM:SS

1S      2S      3S
STAT XXXX XXXX XXXX
TEMP  XX  XX  XX
STBY  21X 22X 23X
OPER  4X  5X  6X
DES   7X  8X  9X

          ALIGN XXX
          IMU 1 10X STAR ALIGN 13X
          2 11X 14 IMU/IMU  X
          3 12X MATRIX  15X

          EXEC 16X
          TERM 17

ACC      1      2      3
X ±X.XX ±X.XX ±X.XX
Y ±X.XX ±X.XX ±X.XX
Z ±X.XX ±X.XX ±X.XX

          IMU BITE MASK
          1 XXXX 24X
          2 XXXX 25X
          3 XXXX 26X

ANG      1      2      3
X XXX.XX XXX.XX XXX.XX
Y XXX.XX XXX.XX XXX.XX
Z XXX.XX XXX.XX XXX.XX
ΔX ±XXX.XX ±XXX.XX ±XXX.XX
ΔY ±XXX.XX ±XXX.XX ±XXX.XX
ΔZ ±XXX.XX ±XXX.XX ±XXX.XX

          NAV ΔV THRESH
          10 XXXXXXXX

          MM READ 19X
    
```

```

XXXX/022/          S TRK/COAS CNTL  XX X DDD/HH:MM:SS
          DDD/HH:MM:SS

S TRK CNTL  Y  Z          S TABLE  1  2  3
SELF TEST  1X 2X          TRK ID    XXX XXX XXX
STAR TRK   3X 4X          Δ MIN    XXX XXX XXX
TGT TRK    5X 6X          ANG DIF  XXX X XXX X XXX X
BREAK TRK  7  8          ERR  XX XX XX XX XX XX
TERM/IDLE  9X 10X        SEL      17X 18X 19X
          S TABLE CLR 20

S TRK      -Y      -Z      COAS
REQD ID    11 XXX 12 XXX  REQD ID    21 XXX
TRK ID     XXX     XXX     ADEG X     ±X.X
S PRES     X       X       Y           ±X.X
ΔANG       ±X.XX  ±X.XX  SIGHT MODE 22X
THOLD      13  X   14  X   ACCEPT     23
SHUTTER    XX     XX     CAL MODE    24X
MAN OP     15X    16X    DES          25X
STATUS     XXXXXXXX XXXXXXXX POS  +X 26X -Z 27X
          XXXX     XXXX     ABIAS  X.XX  XX
          UPDATE 28 29
    
```

```

XXXX/051/          OVERRIDE          XX X DDD/HH:MM:SS
          BFS DDD/HH:MM:SS

ABORT MODE          ENTRY FCS
TAL 1X          ELEVON  FILTER  ATMOSPHERE
ATO 2X          AUTO 17X  NOM 20X  NOM 22X
ABORT 3X        FIXED 18X  ALT 21X  N POLE 23X
THROT MAX 4X    SSME REPOS 19 XXX  S POLE 24X
          ABT 50X
          NOM 5X

PRPLT DUMP          IMU DES ATT  AA  RGA  SURF
XXX ICNCT 5 XXXX  1 25X X  LRU  DES  DES  DES
OMS DUMP          2 26X  1 31X 35X 39X
ARM 6X           3 32X 36X 40X
START 7X         ET SEP  3 33X 37X 41X
STOP 8X          AUTO 28X
9 QUAN/SIDE XXX  SEP 29X          ROLL MODE
OMS DUMP TTG XXX          WRAP MODE 45 XXX

AFT RCS 13 XXX  ET UMB DR          CMM  XXXX
14 TIME  XXX  CLOSE 30X          TDRS 46X
FWD RCS 15 XXX  VENT DOOR CNTL  STDN-HI 47X
16 TIME  XXX  OPEN 43X XX        STDN-LO 48X
          CLOSE 44X XX          SGLS 49X
    
```

```

XXXX/051/          OVERRIDE          XX X DDD/HH:MM:SS
          DDD/HH:MM:SS

ABORT MODE          ENTRY FCS
TAL 1X          ELEVON  FILTER  ATMOSPHERE
ATO 2X          AUTO 17X  NOM 20X  NOM 22X
ABORT 3X        FIXED 18X  ALT 21X  N POLE 23X
MAX THROT 4X    SSME REPOS 19 XXX  S POLE 24X

PRPLT DUMP          IMU STAT ATT DES  PRL
XXX ICNCT 5 XXXX  1S XXXX X 25X  SYS AUT DES
OMS DUMP          2S XXXX XXX 26X  1S 28X 31X
          3S XXXX 27X  2S 29X 32X
          3S 30X 33X

ARM 6X           ADTA  H  α  M  DES
START 7X         L 1S XXXXXX ±XX.X X.XX 34X
STOP 8X          3S XXXXXX ±XX.X X.XX 35X
9 QUAN/SIDE XXX  R 2S XXXXXX ±XX.X X.XX 36X
OMS DUMP TTG XXX 4S XXXXXX ±XX.X X.XX 37X

ET SEP          ROLL MODE XXXXXXXX
AUTO 38X        AUTO SEL 42X
SEP 39X         WRAP MODE 45 XXX
ET UMB DR          VENT DOOR CNTL
CLOSE 40X       OPEN 43X XX
RCS RM MANF     CLOSE 44X XX
CL OVRD 41
    
```

```

XXXX/053/          CONTROLS          XX X DDD/HH:MM:SS
          DDD/HH:MM:SS

SEC ACT CK          AERO PORT STAT          SSME PORT STAT
          1 2 3 4          1 2 3 4
CH1 1X  L OB 1 S S S S  L P S S S S
2 2X  1B 2 S S S S S  Y S S S S
3 3X  R IB 3 S S S S S  C P S S S S
4 4X  OB 4 S S S S S  Y S S S S
START 5X  HUD 5 S S S S  H P S S S S
STOP 6X  SPD BRK 6 S S S S  Y S S S S

NEG STIM          ACT/CH
ENA 7X          8 BYPASS XX
          9 RESET  XX

LRU  AA  RGA  SURF  FDBK
DES  DES  DES
1 10X S 14X S 18X S
2 11X S 15X S 19X S
3 12X S 16X S 20X S
4 13X S 17X S 21X S
    
```

```

XXXX/055/          GPS STATUS          XX X DDD/HH:MM:SS
          DDD/HH:MM:SS

I/O 10 X GPS1S  GPS2S  GPS3S
STAT  XXXX  XXXX  XXXX          GPS MINUS NAV
MODE  XXXX  XXXX  XXXX          ΔH ±XXXXXX ΔH ±XXX.XX
S/TEST 11XG 12XG 13XG          ΔDR ±XXXXXX ΔDR ±XXX.XX
INIT  14X  15X  16X          ΔCR ±XXXXXX ΔCR ±XXX.XX
NAV  17X  18X  19X
RESTART 20X 21X 22X          X LAT X LON ALT
IMU  23 XX 24 XX 25 XX          XX.XX XXX.XX XXX.XXXX
GDOP  XX  XX  XX

DG FAIL  S  S  S
DES RCVR 26X 27X 28X          GPS TO G&C S32X 33X 34X
QA OVRD 29XS 30XS 31XS          GPS TO NAV S35X 36X 37X
SF CAND  X  X  X          METERING OVERRIDE 38X

QA1 P 1±XXXXXXXXXXXXXXXXXXXXXXXXX
QA2 POS X.XXS X.XXS X.XXS          SATELLITES
VEL X.XXS X.XXS X.XXS          TRKD C1 C2 C3 C4 C5 C6
QA3 POS X.XXS X.XXS X.XXS          GPS1 XX XX XX XX XX XX
VEL X.XXS X.XXS X.XXS          GPS2 XX XX XX XX XX XX
          1-2 2-3 3-1          GPS3 XX XX XX XX XX XX
QA4 POS X.XXS X.XXS X.XXS          DES 43 XX XX XX XX
VEL X.XXS X.XXS X.XXS          XX XX XX XX
XXX.X LAST SEL FIL UPDATE
    
```

### 3.7.8 Gravity Gradient

The following is a discussion of the forces acting on the Orbiter when in free drift and the Orbiter attitudes, which will tend to stabilize in free drift. For the purposes of this subject, stabilized attitude means one that will provide predictable deviations about the initial attitude not to exceed  $45^\circ$  in any axis. This stabilized attitude with the Orbiter in free drift will be referred to as a gravity gradient (g.g.) attitude.

There are three forces that act on an orbiting vehicle: (1) gravity gradient - forces which tend to resist misalignment of the principal vehicle axis ( $\approx 2^\circ$  pitch down from Orbiter X-axis) with, or perpendicular to, the Earth gravity vector, (2) gyroscopic - forces which tend to keep the principal (Orbiter X) and secondary (Orbiter Y) vehicle axes in the orbital plane, and (3) aerodynamic - torques on the vehicle which are induced by atmospheric drag on vehicle surfaces.

With respect to the g.g. force on the vehicle, there are two Orbiter attitudes which would be stable if all other forces are neglected: (1) X-axis parallel to the Earth gravity vector and (2) X-axis perpendicular to the Earth gravity vector. Any excursions from these stable attitudes will tend to be restored to the original attitude by a force of approximately 12 ft/lb ( $45^\circ$  misalignment).

Gyroscopic forces tend to produce a vehicle attitude restoring force of approximately 0.2 ft/lb. The preferred attitude is +YVV or -YVV with -XLV or +XLV. If a vehicle is at or above an altitude where aerodynamic forces are vanishing small, gyroscopic forces would also allow stabilization at an attitude of +YLV or -YLV with +XVV or -XVV. The Orbiter cannot reach a sufficient altitude; this would also be only marginally stable.

Aerodynamic forces (drag) on the vehicle will provide only two stable attitudes if gyroscopic forces on the vehicle are neglected: (1) +XLV,  $\pm ZVV$ , and (2) -XLV,  $\pm ZVV$  (i.e., nose up or down along the R-bar with the +Z-axis of the Orbiter in the velocity vector). All other attitudes will allow unsymmetrical surfaces to be presented to the atmospheric drag, which induce unbalanced torques to the vehicle. Vehicle attitudes with the tail/bay into the velocity vector are not considered stable since any variation in the atmospheric density or any rates in the initial attitude setup could cause the tail, payload bay door ends, wings, etc., to be presented to the aerodynamic forces as unbalancing surfaces.

To select a stabilized vehicle attitude in free drift, it is necessary to balance the g.g. and gyroscopic forces with the aerodynamic forces. Since the aerodynamic force will vary with altitude due to changes in atmospheric density, it is necessary to select an attitude that will provide enough of the available gyroscopic force as a balancing torque to the induced atmospheric drag. This is accomplished by rolling the vehicle out-of-plane such that aerodynamic forces on the tail surface area and the bottom section of the exposed wing area null out the gyroscopic restoring force. For nose up/down attitudes, the g.g. forces will stabilize the X-axis with only small deviations on the order of  $\pm 4^\circ$  due to aerodynamic uncertainty. This is due to the relative magnitudes involved (g.g. force approximately 12 ft/lb and the aerodynamic and gyroscopic forces approximately 0.2 ft/lb).

This method works well if we can assume a homogenous atmosphere, which, of course, we cannot. Atmospheric density varies as a function of altitude, latitude, time of year, time in the solar activity cycle, and daylight versus darkness. In addition, some minor variations occur at a given altitude. Currently, we are still in a learning cycle for modeling of planetary atmospheres,



and our density predictions are analogous to predicting the weather. Therefore, our selection of a given g.g. attitude for a flight is only as good as our atmospheric density model and we must, in general, select a mean rather than actual density and attitude.

Due to the selection of a mean density and thus a mean attitude, there will be variations in each axis proportional to the deviation from the mean to actual atmospheric density. The present thinking concludes that this deviation is smaller at greater altitudes due to the reduced influence of aerodynamic forces and, therefore, the uncertainty in the initial attitude is less. For example, in a 175 n. mi. circular orbit, the deviation in roll from the release point is predicted to be  $\pm 10^\circ$  and for a 160 n. mi. circular orbit, the deviation in roll is on the order of  $\pm 25^\circ$ .

Each of the following other factors needs to be considered when selecting a gravity gradient attitude on a given flight:

1. Thermal requirements for payload bay experiments
2. Vernier jet temperature requirements
3. Window seal temperature requirements
4. Star tracker/Inertial measurement unit align requirements
5. Supply/waste water dump requirements
6. Flash evaporator system (FES) operations
7. Entry thermal conditioning requirements
8. Ku-band acquisition requirements

As an example, consider a launch late in the year that requires that the bay be pointed north away from the Sun to shade the payload. Due to the high beta angle, a -XLV, -YVV g.g. attitude would cause a violation of both vernier jet and Orbiter window seal thermal requirements. By selecting a +XLV, +YVV attitude, the payload bay can continue to be pointed north for payload thermal requirements and the vernier and window seal temperatures will also remain in limits due to the warming provided by the Earth.

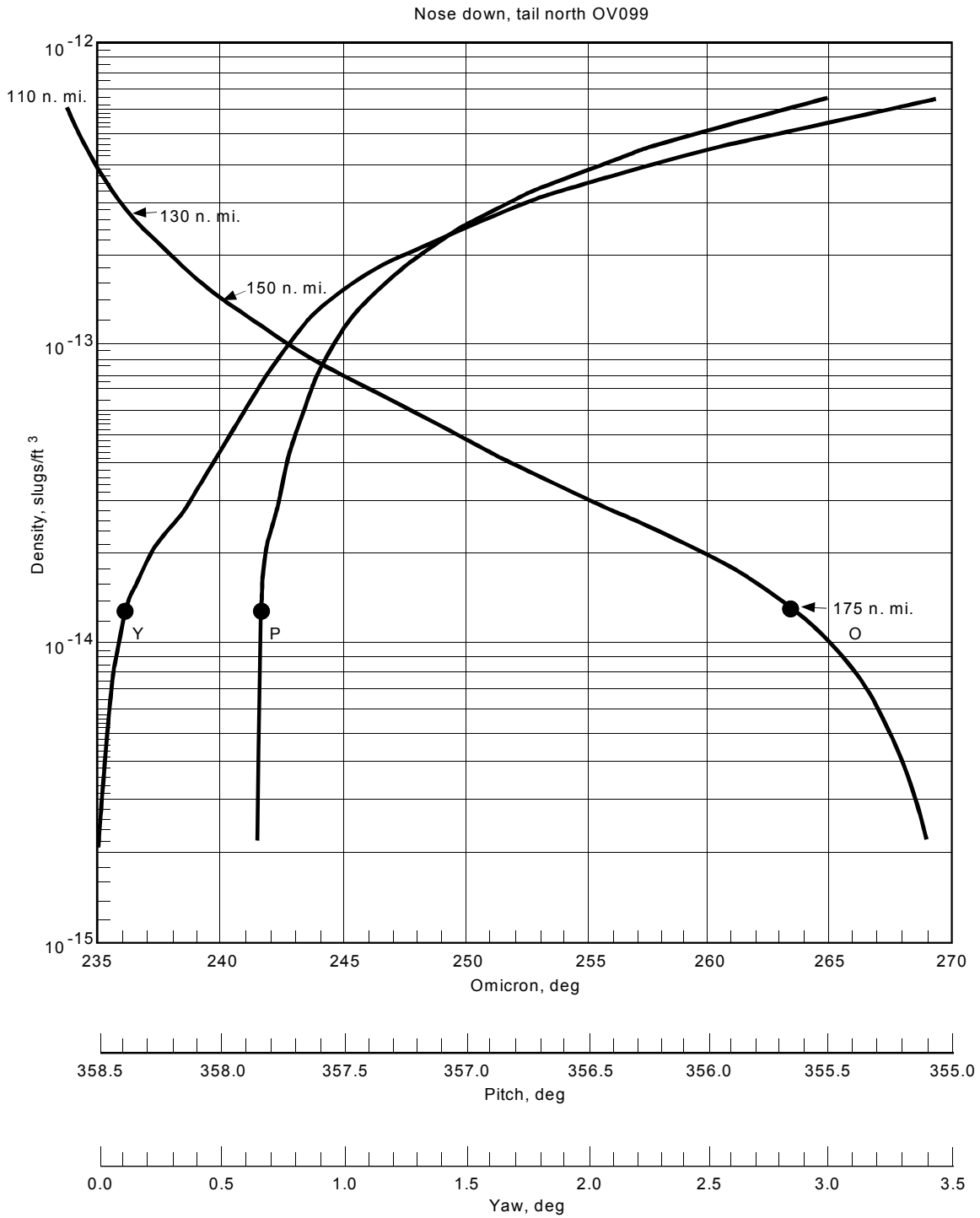
The reason for water dump and FES operation considerations is due to their influence on the attitude deviation when the Orbiter is in free drift at a g.g. attitude. Predictions show that a water dump causes significant oscillations in the roll attitude and if it continues long enough (longer than 1 hour), it can actually cause the attitude to rotate through  $360^\circ$ . The FES operations, on the other hand, can cause a bias to the initial pitch attitude of approximately  $+5^\circ$  to  $+8^\circ$  but are not expected to cause a total loss of stability.

Star tracker operations are a consideration because a nose-down g.g. attitude may not provide as good a chance to acquire stars of opportunity as a nose-up attitude. This is because the star tracker shutter closes when viewing a sunlit horizon, keeping in mind that the star trackers are slightly offset from the primary Orbiter axis.

The entry thermal conditioning requirements primarily address those missions flown at high beta angles with a g.g. attitude required close to the end of the mission. Certain g.g. attitudes may cause a large temperature gradient to develop between the payload bay sill and the bottom of the Orbiter, thus causing payload bay door closure problems.

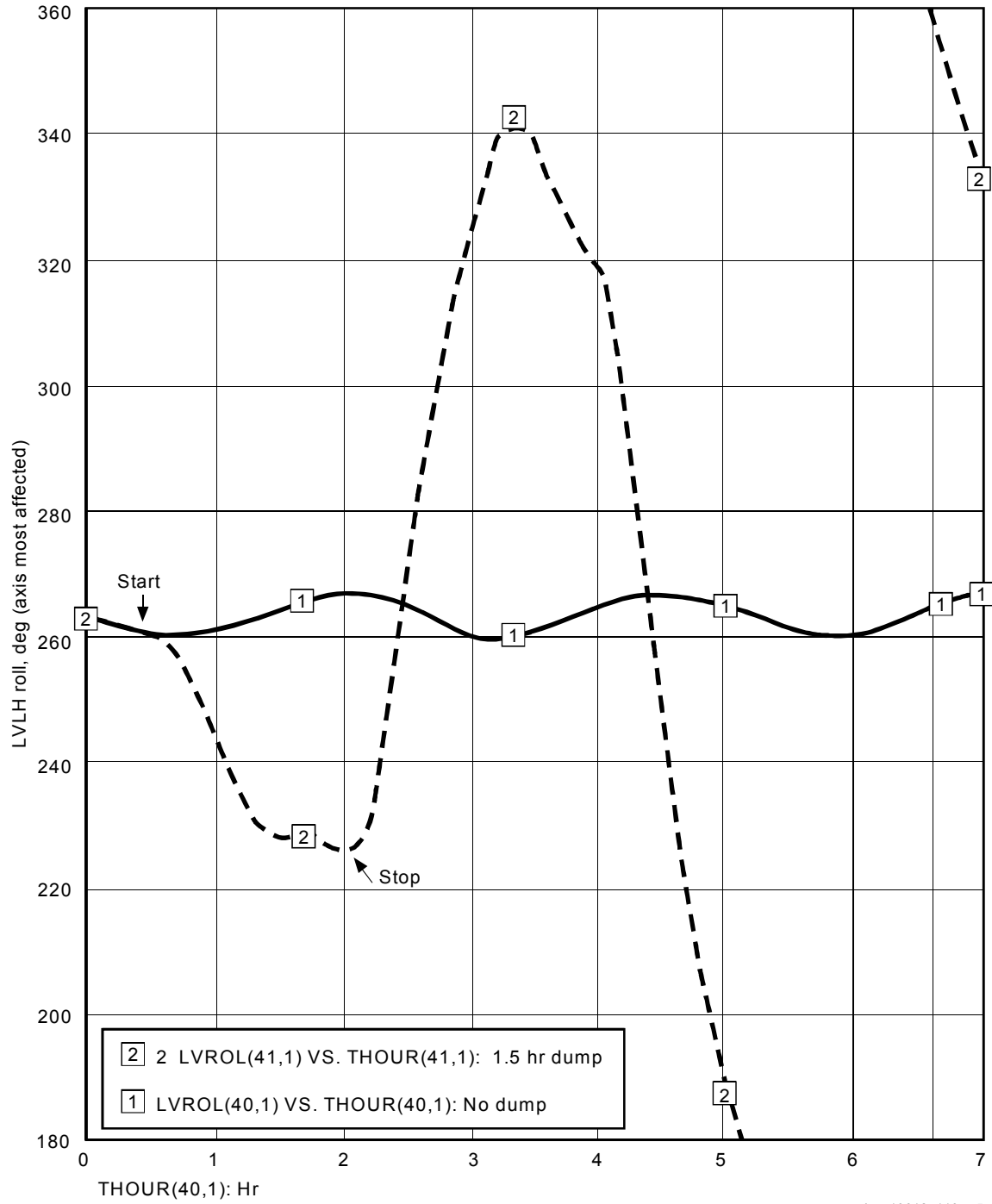
Setup of the initial g.g. attitude is very important with regard to rates remaining in all axes after the maneuver is complete. The direction of the initial deviation in an axis is usually due to any attitude rates remaining after setup. This can be very important to Ku-band acquisition since the initial deviation direction has a 50/50 chance of going either way. As a result, predicting Ku-band acquisition of signal can be difficult. For payloads which require Ku-band for high rate payload real-time data, this can cause problems in scheduling experiment start times and real-time and data playback time allocations.

Ref: C. Alford: 11/19/88



jsc\_19612\_118.cv5

Figure 3.7.8-1: STS 61-A Gravity Gradient Trim Angles (Typical)



jsc\_19612\_119.cv5

Figure 3.7.8-2: Typical Water Dump Response

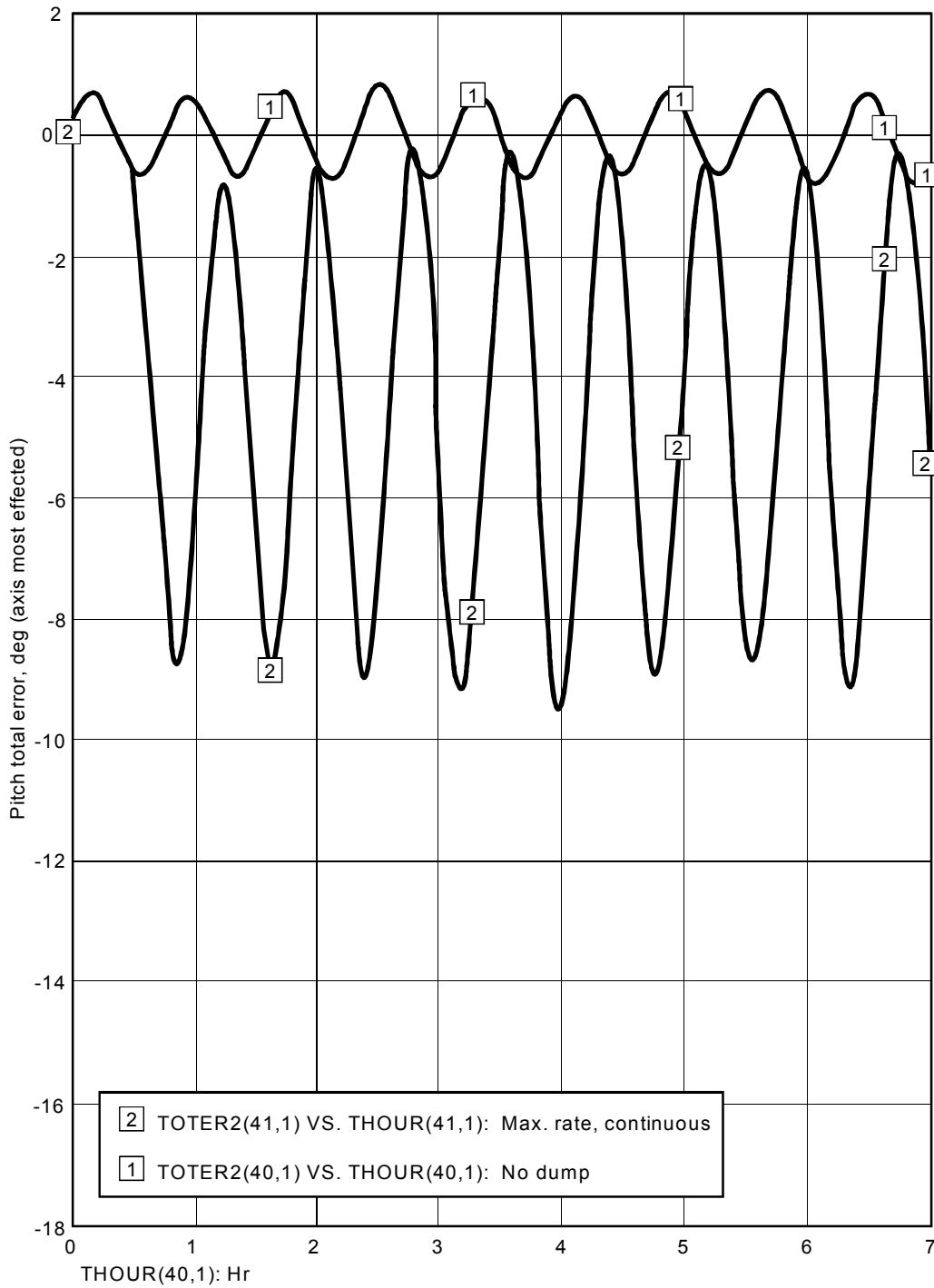
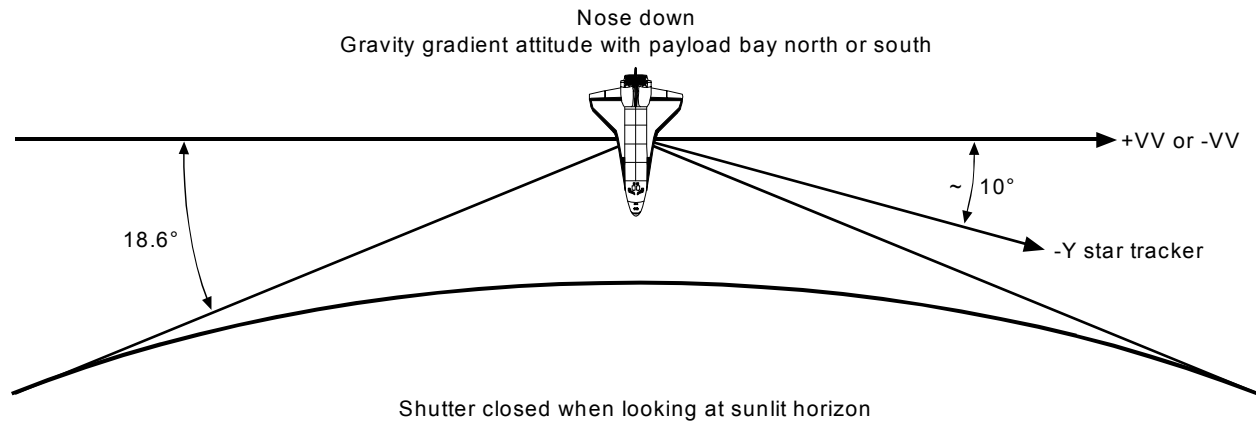
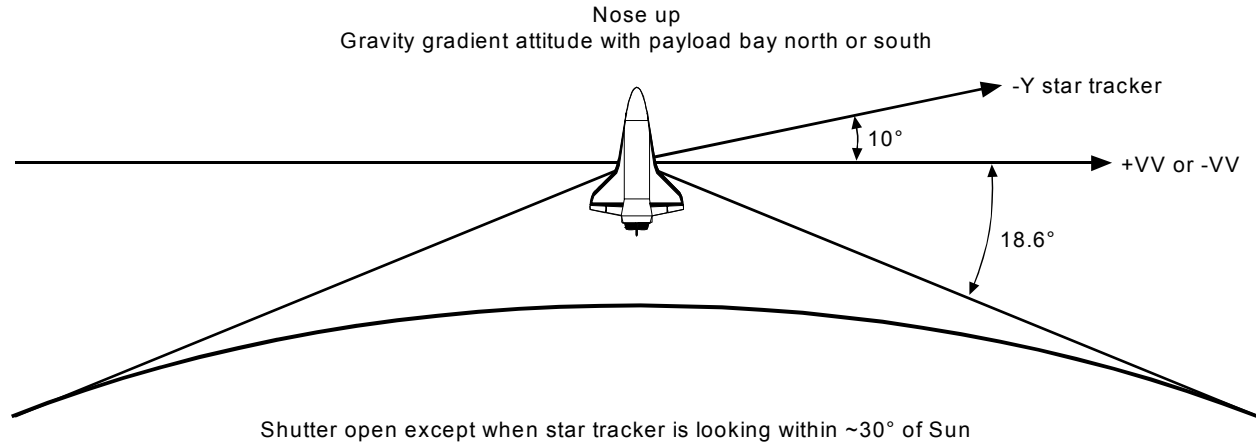


Figure 3.7.8-3: Typical Flash Evaporator Response



The roll oscillation will help the -Z star tracker to acquire stars

jsc\_19612\_121.cv5

Figure 3.7.8-4: Star Tracker View Restrictions

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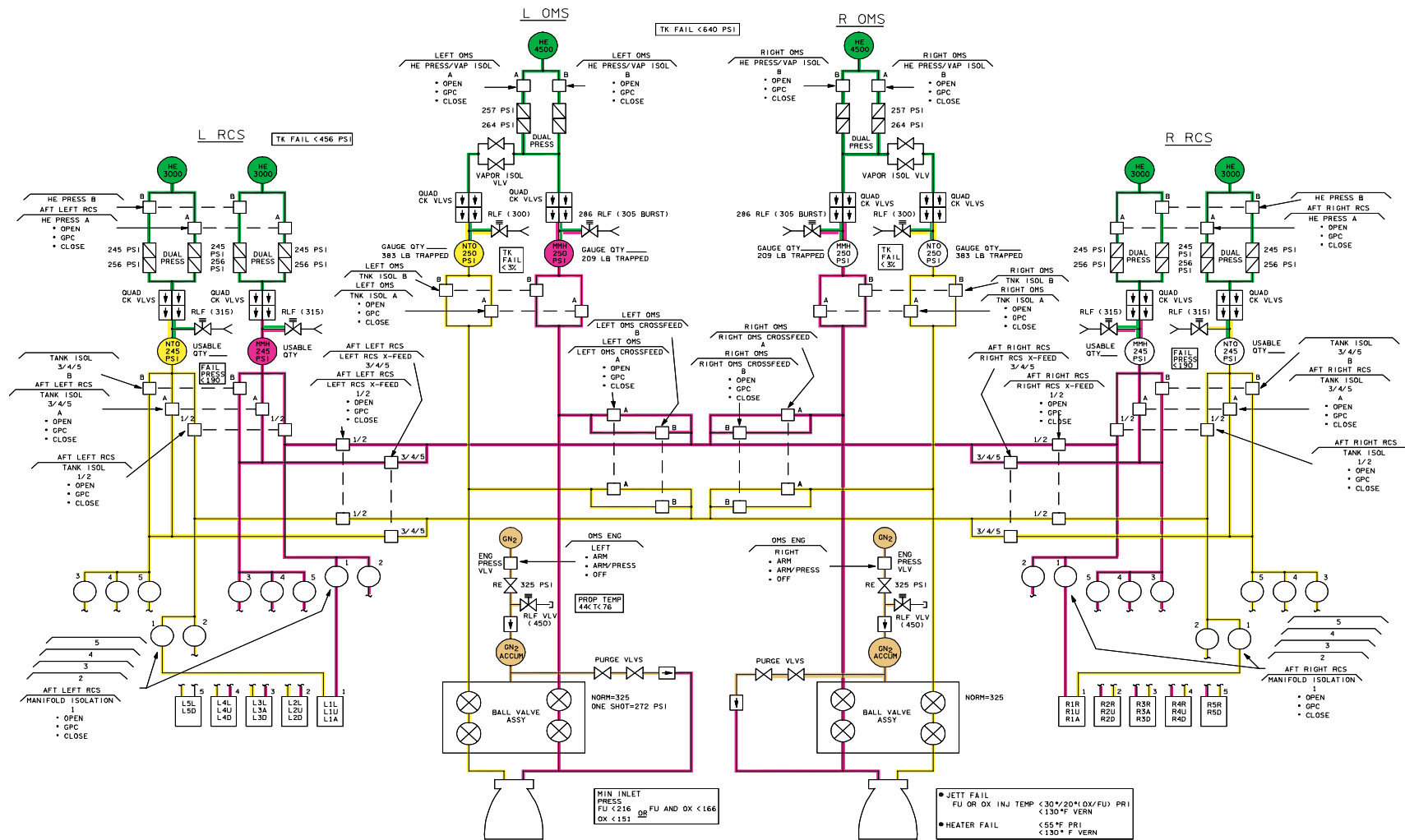
<b>Section</b>		<b>Page</b>
3.8	OMS/RCS .....	3.8.1-1
3.8.1	OMS/Aft RCS Schematic .....	3.8.1-1
3.8.2	Forward RCS Schematic.....	3.8.2-1
3.8.3	OMS Command Path Schematic .....	3.8.3-1
3.8.4	RCS Identification Overview .....	3.8.4-1
3.8.5	Aft RCS Valve Microswitches.....	3.8.5-1
3.8.6	Propellant Redlines and Aft RCS Quantities 1 & 2 .....	3.8.6-1
3.8.7	Switch Panels (O7, O8).....	3.8.7-1
3.8.8	Displays.....	3.8.8-1



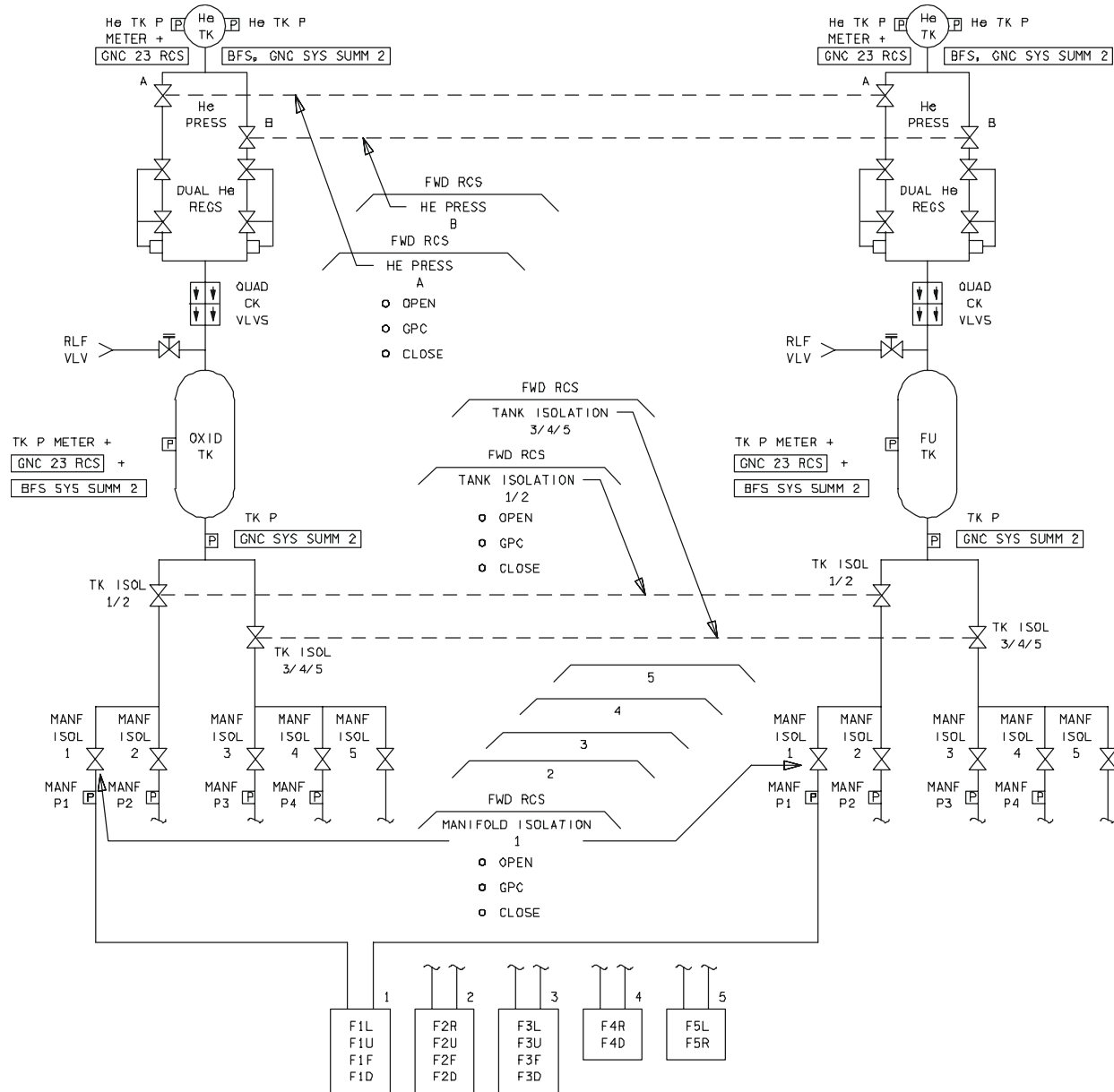
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### 3.8 OMS/RCS

#### 3.8.1 OMS/Aft RCS Schematic

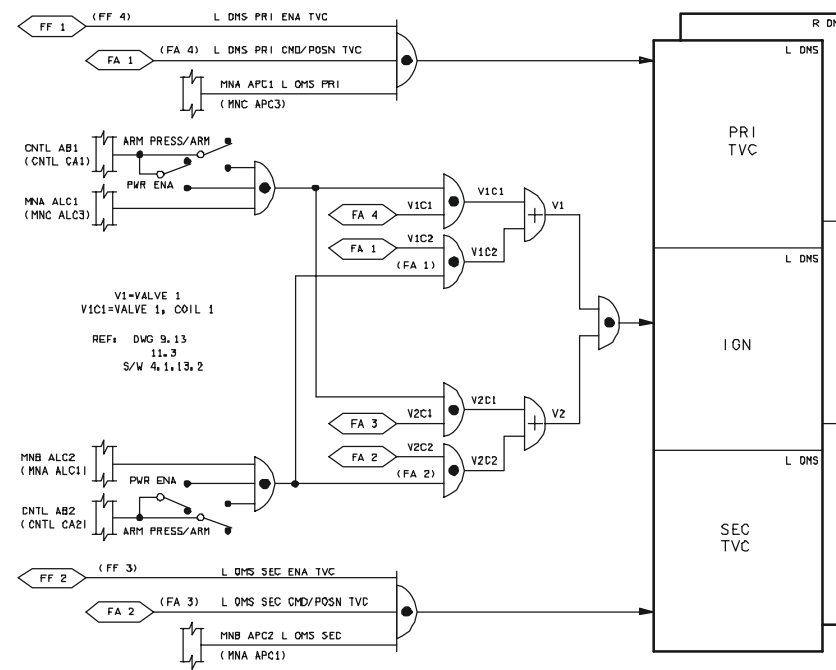
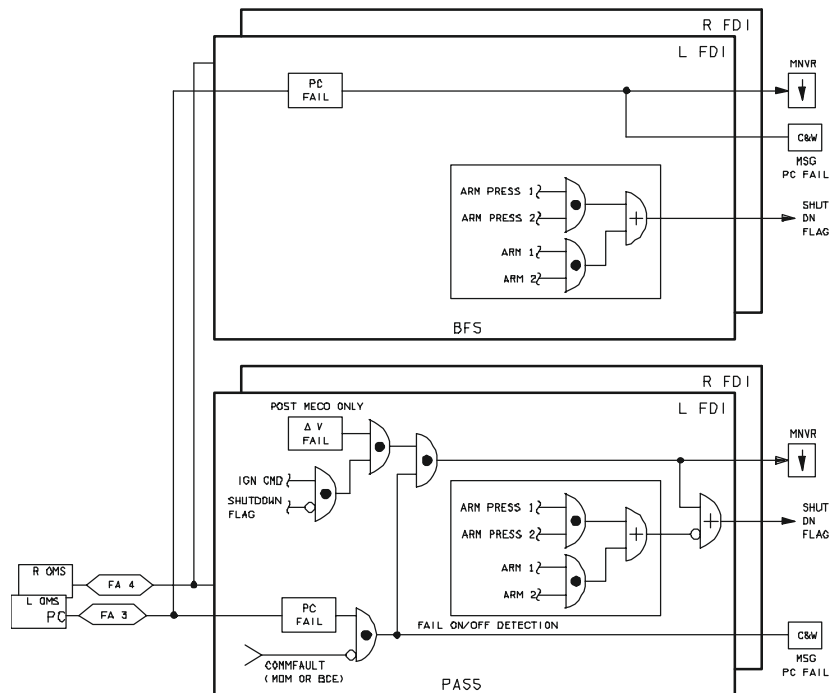


### 3.8.2 Forward RCS Schematic



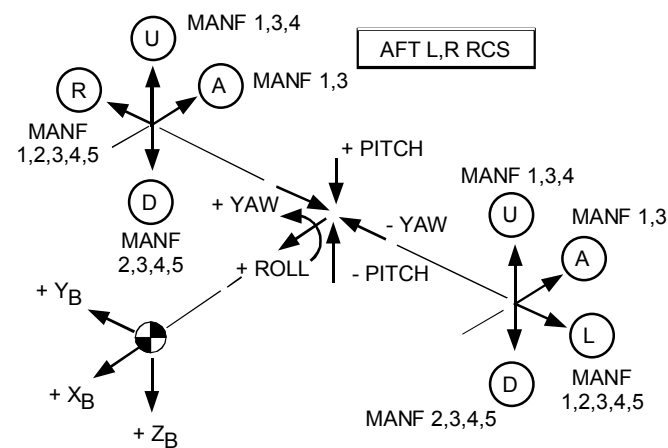
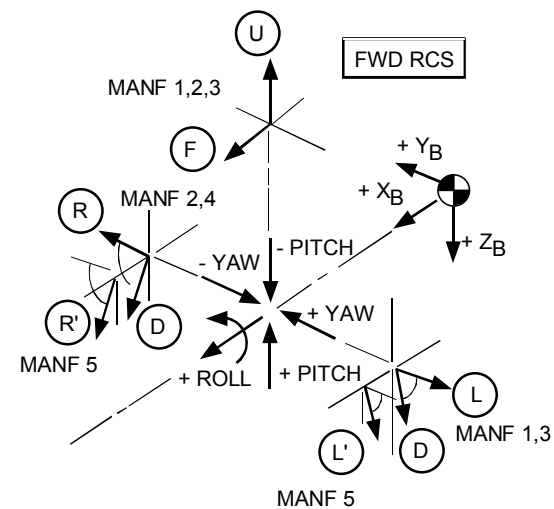
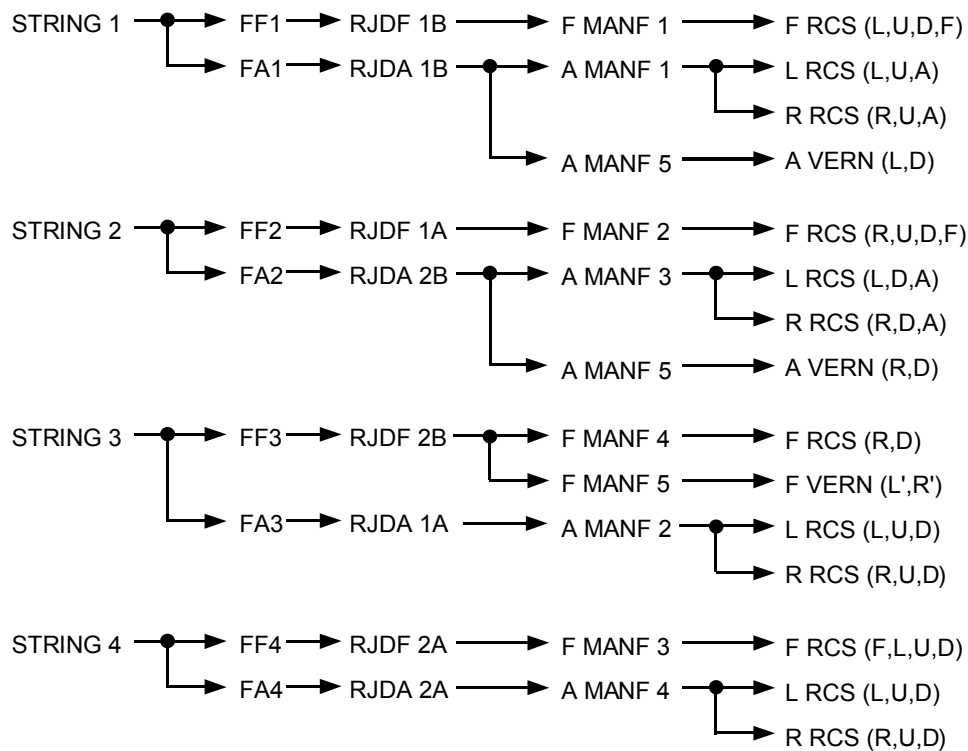
19612501, SCH 2

3.8.3 OMS Command Path Schematic

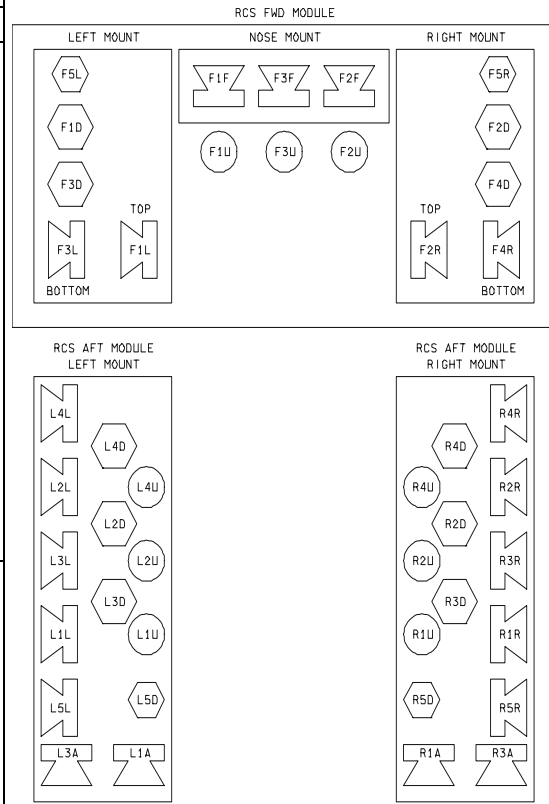


19612332, SCH 2

### 3.8.4 RCS Identification Overview



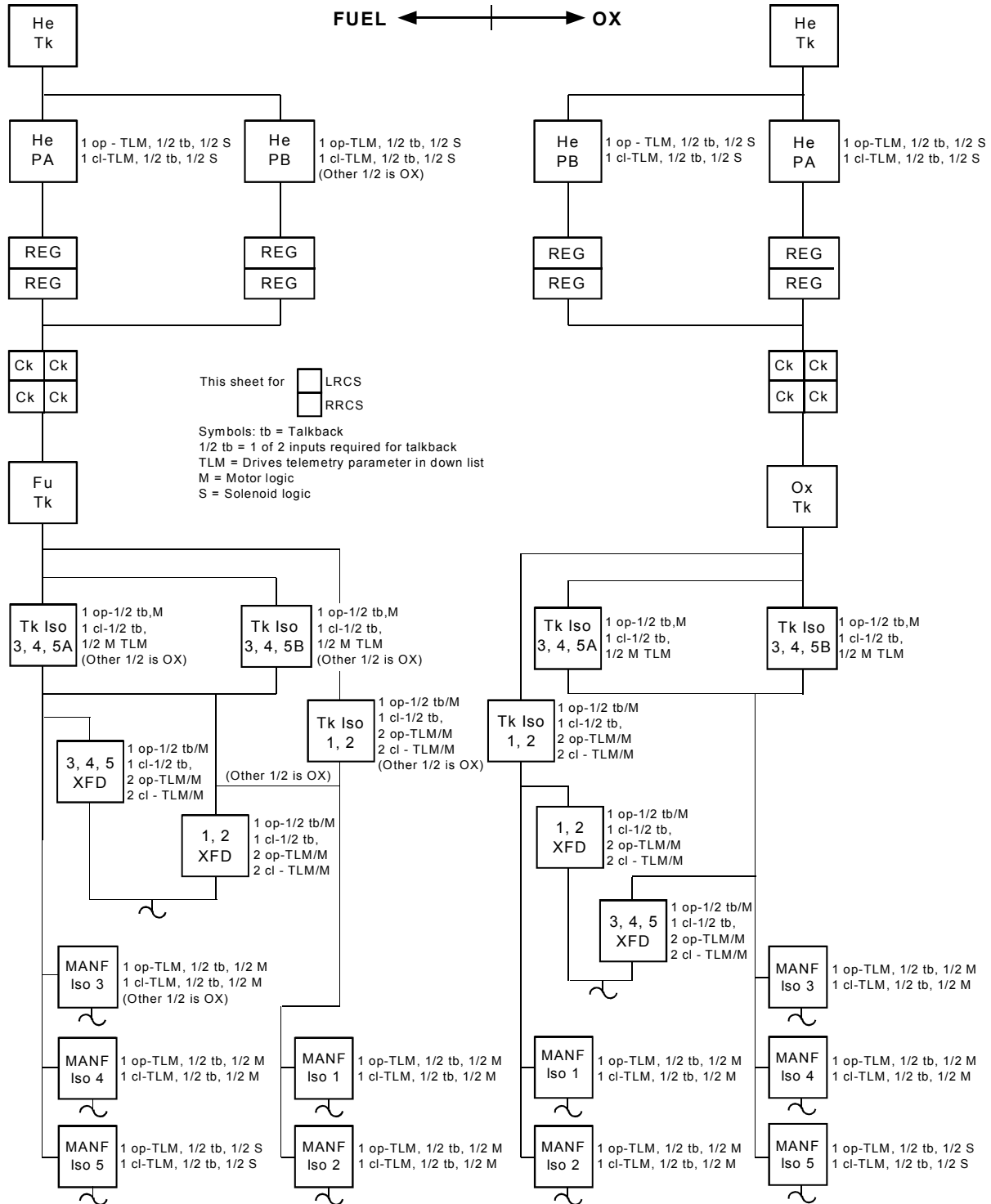
POD	MANF/JET	JET PRIORITY		RJD	MDM
		TRANS			
		PRI	BFS		
FWD	F1L	2	2	RJDF-1B	FF 1
	F1U	2	3		
	F1F	1	2		
	F1DL	2	1	RJDF-1A	FF 2
	F2DR	2	1		
	F2U	3	2		
	F2F	2	1	RJDF-2A	FF 4
	F2R	2	2		
	F3L	1	1		
	F3DL	1	2	RJDF-2B	FF 3
	F3U	1	1		
	F3F	3	3		
	F4DR	1	2		
	F4R	1	1		
	F5R				
F5L					
LEFT	L1L	1	1	RJDA-1B	FA 1
	L1U	1	1		
	L1A	2	2	RJDA-1A	FA 3
	L2L	4	3		
	L2U	3	2	RJDA-2B	FA 2
	L2D	2	2		
	L3L	2	2	RJDA-2A	FA 4
	L3D	1	1		
	L3A	1	1	RJDA-1B	FA 1
	L4L	3	4		
L4U	2	3			
L4D	3	3			
L5L					
L5D					
RIGHT	R1R	2	1	RJDA-1B	FA 1
	R1U	1	1		
	R1A	2	2	RJDA-1A	FA 3
	R2R	3	3		
	R2U	3	2	RJDA-2B	FA 2
	R2D	2	2		
	R3R	1	2	RJDA-2A	FA 4
	R3D	1	1		
	R3A	1	1	RJDA-2B	FA 2
	R4R	4	4		
	R4U	2	3		
	R4D	3	3		
	R5D				
R5R					



19612403, ART 2

If both logic and driver are ON, logic may be turned OFF (or input from switch fail) and RJD will stay on.  
AC valves - 2 SIGs to CLOSE, 1 to OPEN.

### 3.8.5 Aft RCS Valve Microswitches



jsc\_19612\_028.cv5

3.8.6 Propellant Redlines and Aft RCS Quantities 1 & 2

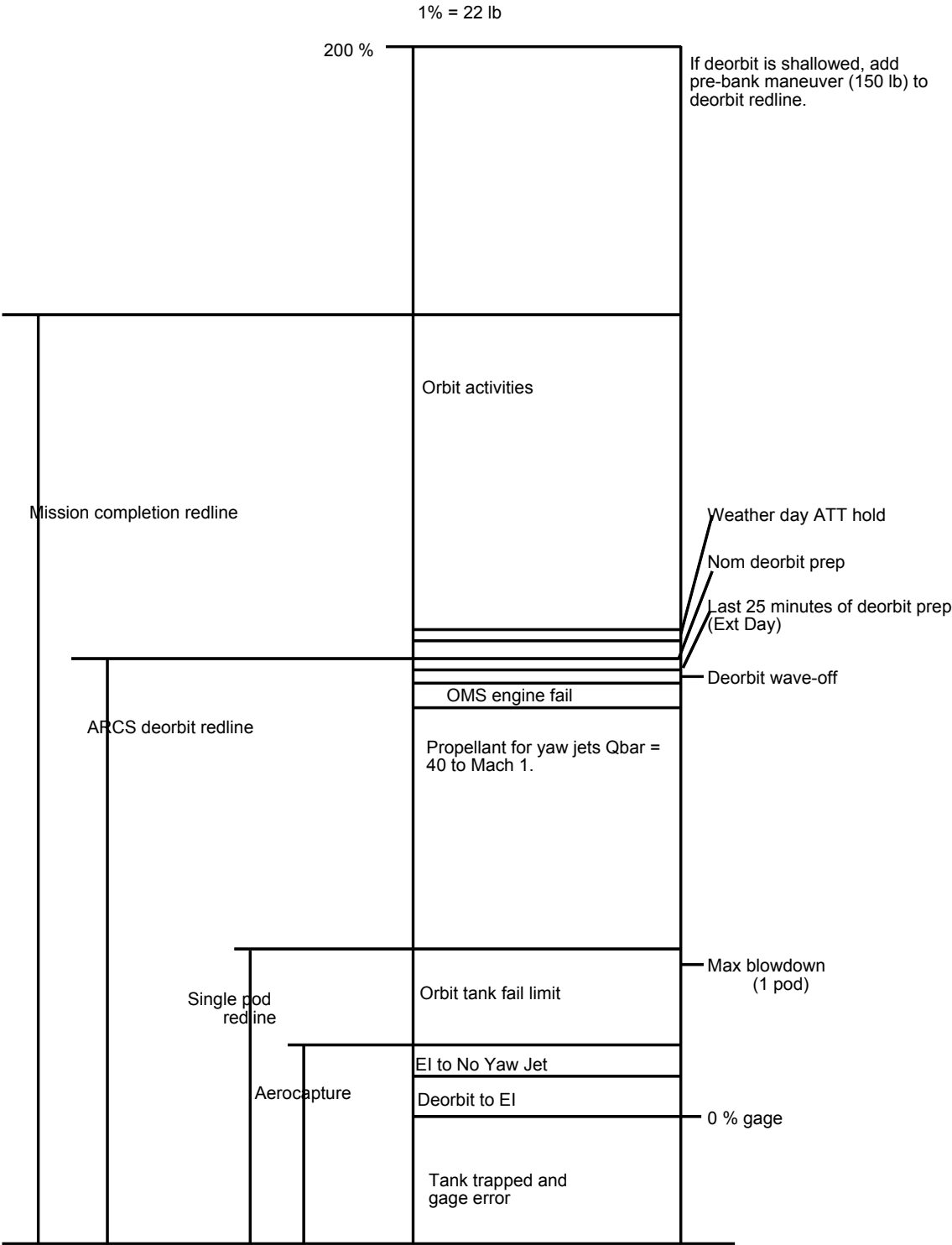


Figure 3.8.6-1: ARCS Redlines



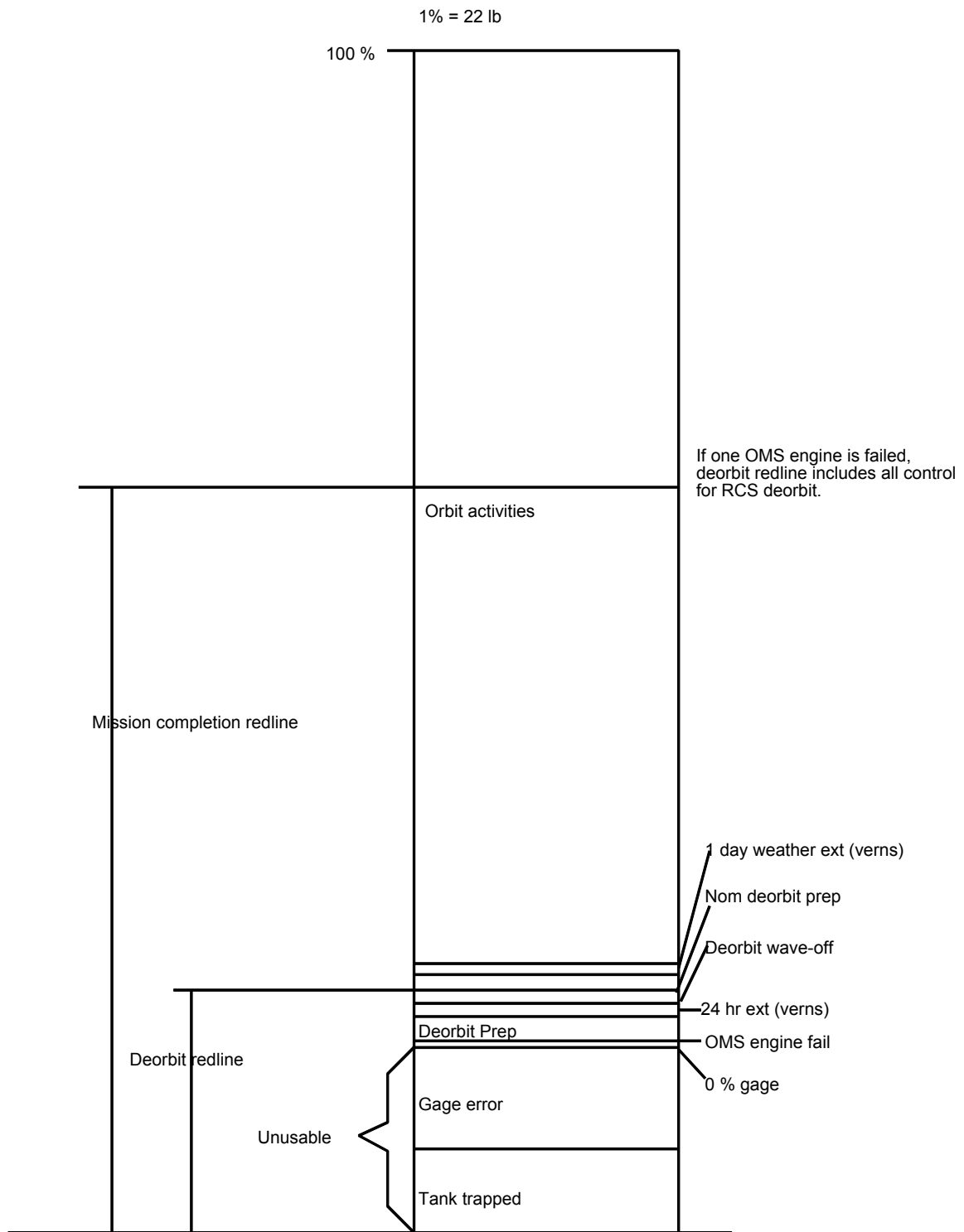
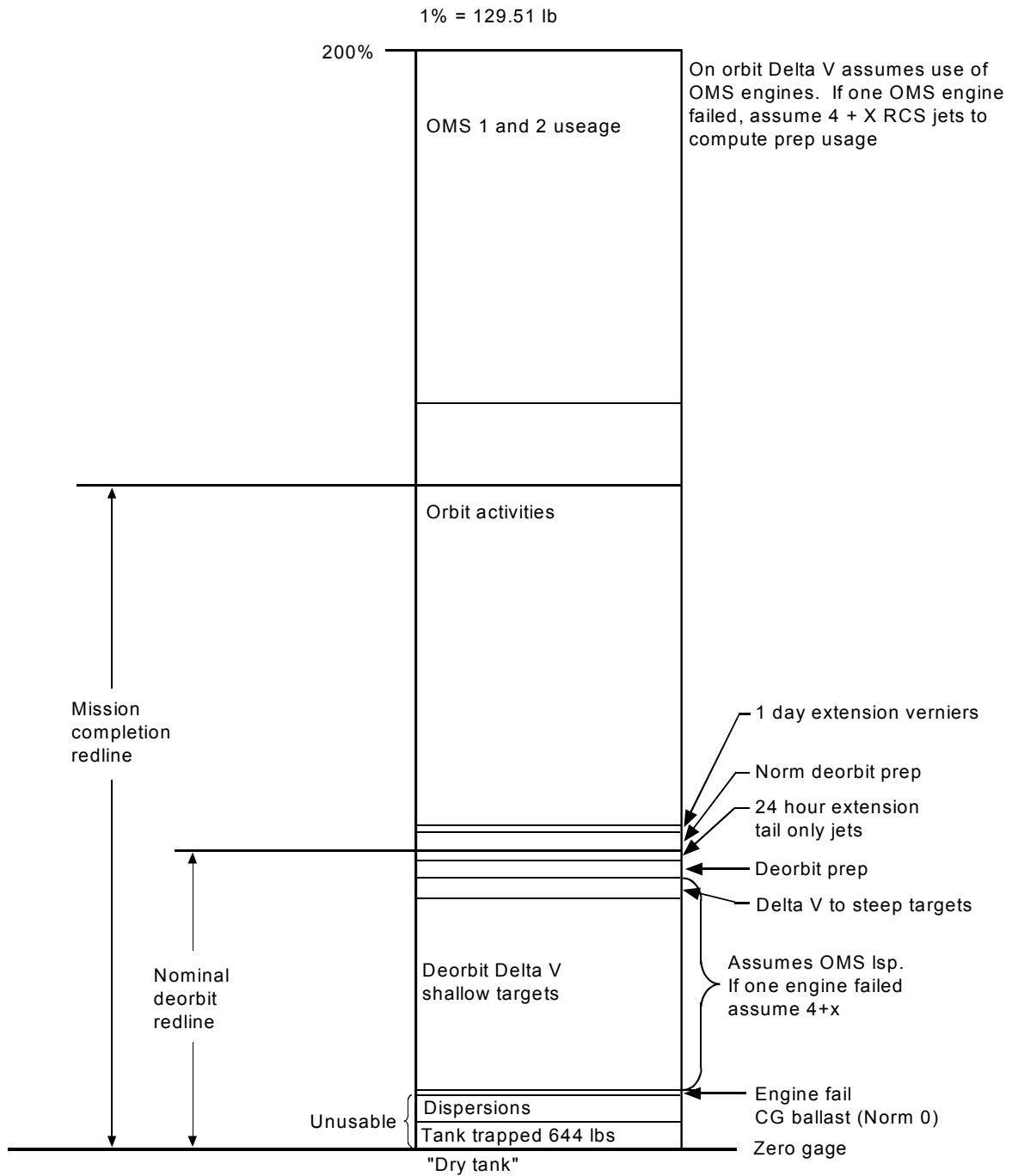


Figure 3.8.6-2: FRCS Redlines



j19612\_126.cv5

Figure 3.8.6-3: OMS Redlines

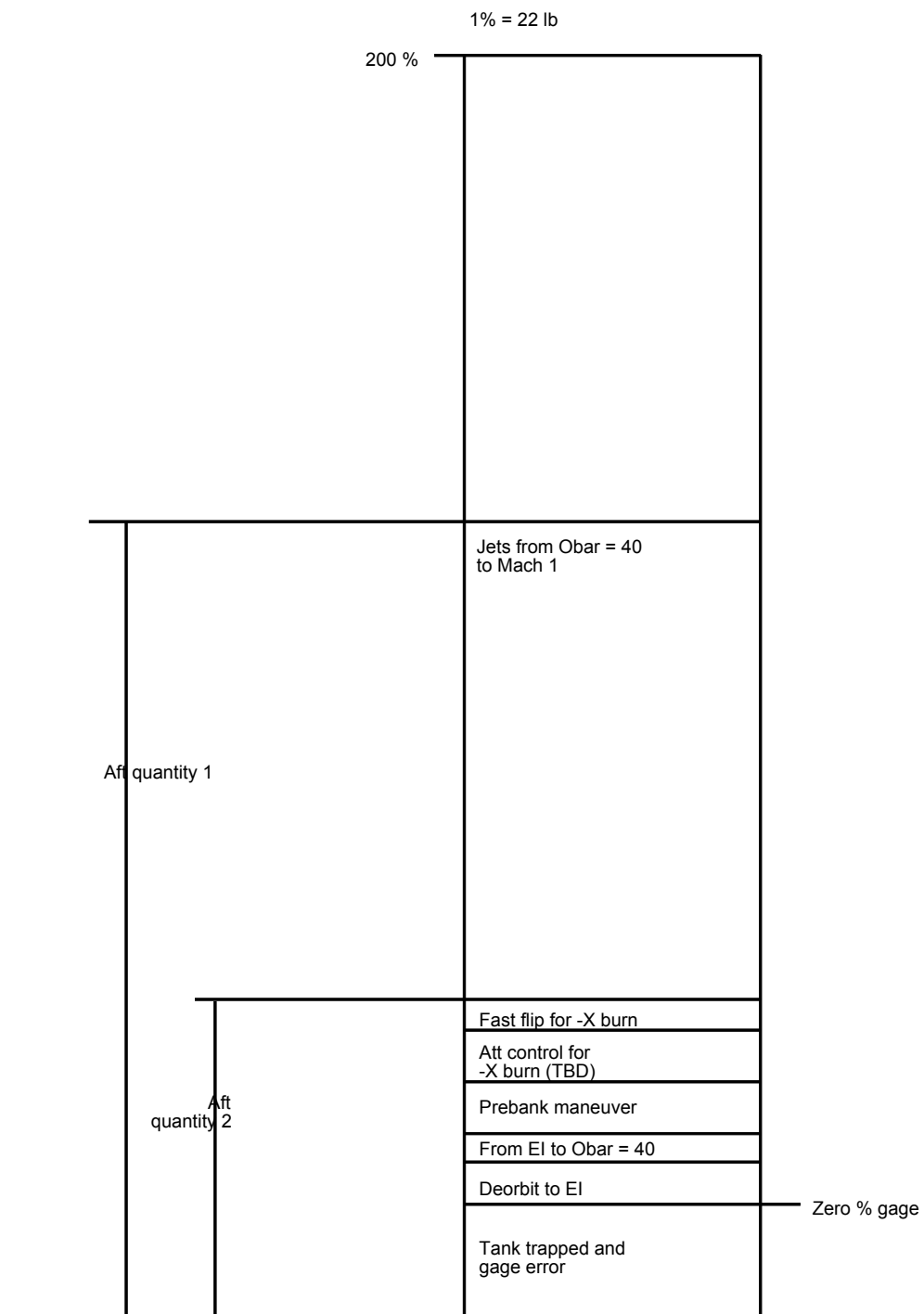
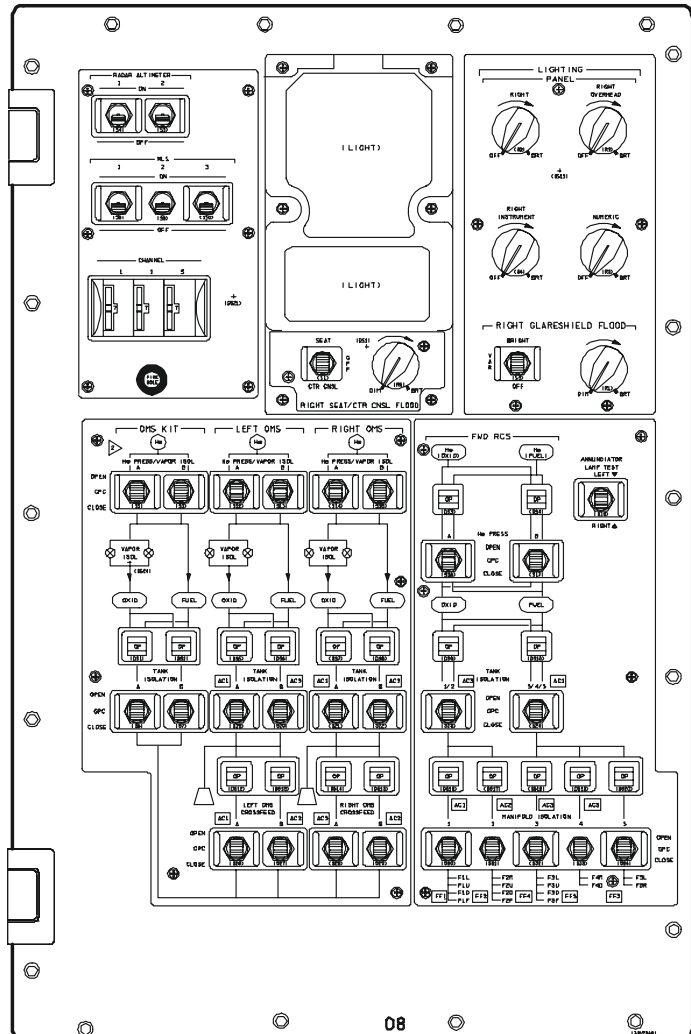
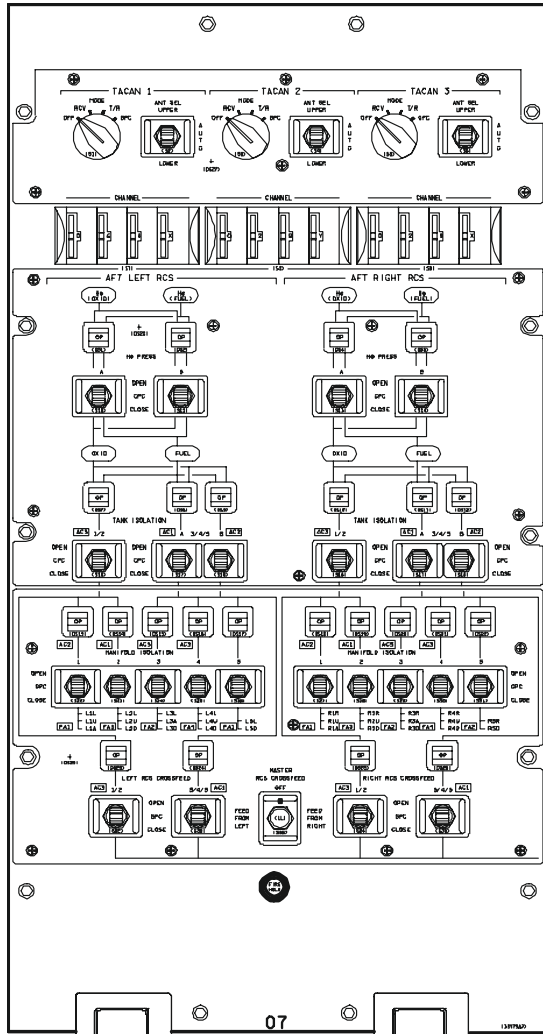


Figure 3.8.6-4: Aft Quantity 1 and 2

### 3.8.7 Switch Panels (O7, O8)



19612329, PNL 1 2

### 3.8.8 Displays

```

XXXX/XXX/018   GNC SYS SUMM 1   XX X DDD/HH:MM:SS
                DDD/HH:MM:SS
RCS JET ISOL
MANFFAILVLV SURF POS MOM DPS 1 2 3 4 5
F1XXX XXS L OB XXX.XS XXS GPC S S S S S
2XXX XXS 1B XXX.XS XXS MDM FF S S S S
3XXX XXS R 1B XXX.XS XXS FA S S S S
4XXX XXS OB XXX.XS XXS
5XXX XXS AIL XXX.X
L1XXX XXS RUD XXX.X FCS CH 1 2 3 4
2XXX XXS SPD BRK XXX.X S S S S
3XXX XXS BDY FLP XXX.X
4XXX XXS XXXXX
5XXX XXS
R1XXX XXS IMU S S S
2XXX XXS CNTLR 1 2 3 ACC S S S S
3XXX XXS RHC L S S S RGA S S S S
4XXX XXS R S S S XXX S S S
5XXX XXS A S S S MLS S S S
THC L S S S ADTA S S S S
A S S S
SBTC L S S S
R S S S
  
```

```

XXXX/XXX/019   GNC SYS SUMM 2   XX X DDD/HH:MM:SS
                BFS DDD/HH:MM:SS
OMS AFT QTY L R OMS L R
OXID XX.XS XX.XS TK P HE XXXS XXXS
FU XX.XS XX.XS OXID XXXS XXXS
FU INJ T XXXS XXXS
RCS JET ISOL N2 TK P XXXS XXXS
FWD HE P XXXS XXXS REG P XXXS XXXS
TK P XXXS XXXS P VLV XXXS XXXS
MANF QTY XXXS XXXS ENGIN P OXID XXXS XXXS
1 P XXXS XXXS XXXS VLV 1 XXXS XXXS
2 P XXXS XXXS XXXS 2 XXXS XXXS
3 P XXXS XXXS XXXS 3 P XXXS XXXS XXXS
4 P XXXS XXXS XXXS 4 P XXXS XXXS XXXS
5 P XXXS XXXS XXXS 5 P XXXS XXXS XXXS
AFT HE P XXXS XXXS HE P XXXS XXXS
L TK P XXXS XXXS R TK P XXXS XXXS
MANF QTY XXXS XXXS QTY XXXS XXXS
1 P XXXS XXXS XXXS 1 P XXXS XXXS XXXS
2 P XXXS XXXS XXXS 2 P XXXS XXXS XXXS
3 P XXXS XXXS XXXS 3 P XXXS XXXS XXXS
4 P XXXS XXXS XXXS 4 P XXXS XXXS XXXS
5 P XXXS XXXS XXXS 5 P XXXS XXXS XXXS
  
```

Same display for PASS and BFS GNC SYS SUMM 2

```

XXXX/051/   OVERRIDE   XX X DDD/HH:MM:SS
                DDD/HH:MM:SS
ABORT MODE ENTRY FCS
TAL 1X ELEVON FILTER ATMOSPHERE
ATO 2X AUTO 17X NOM 20X NOM 22X
ABORT 3X FIXED 18X ALT 21X N POLE 23X
MAX THROT 4X SSME REPOS 19 XXX S POLE 24X
PRPLT DUMP IMU STAT ATT DES PRL
1S XXXX X 25X SYS AUT DES
2S XXXX XXX 26X 1S 28X 31X
3S XXXX 27X 2S 29X 32X
3S 30X 33X
XXX ICNCT 5 XXXX
OMS DUMP ADTA H α M DES
ARM 6X L 1S XXXXXX ±XX.X X.XX 34X
START 7X 3S XXXXXX ±XX.X X.XX 35X
STOP 8X R 2S XXXXXX ±XX.X X.XX 36X
9 QUAN/SIDE XXX 4S XXXXXX ±XX.X X.XX 37X
OMS DUMP TTG XXX ET SEP ROLL MODE XXXXXX
AUTO 38X AUTO SEL 42X
SEP 39X WRAP MODE 45 XXX
ET UMB DR VENT DOOR CNTL
CLOSE 40X OPEN 43X XX
RCS RM MANF CLOSE 44X XX
CL OVRD 41
AFT RCS 13 XXX
14 TIME XXX
FWD RCS 15 XXX
16 TIME XXX
  
```

```

XXXX/051/   OVERRIDE   XX X DDD/HH:MM:SS
                BFS DDD/HH:MM:SS
ABORT MODE ENTRY FCS
TAL 1X ELEVON FILTER ATMOSPHERE
ATO 2X AUTO 17X NOM 20X NOM 22X
ABORT 3X FIXED 18X ALT 21X N POLE 23X
THROT MAX 4X SSME REPOS 19 XXX S POLE 24X
ABT 50X
NOM 51X
PRPLT DUMP IMU DES ATT LRU DES DES DES
XXX ICNCT 5 XXXX 2 26X 1 31X 35X 38X
OMS DUMP 3 27X 2 32X 36X 40X
ARM 6X 3 33X 37X 41X
START 7X ET SEP 4 34X 38X 42X
STOP 8X AUTO 28X
9 QUAN/SIDE XXX SEP 29X ROLL MODE
OMS DUMP TTG XXX WRAP MODE 45 XXX
AFT RCS 13 XXX ET UMB DR COMM XXXX
14 TIME XXX CLOSE 30X TDRS 46X
FWD RCS 15 XXX VENT DOOR CNTL STDN-HI 47X
16 TIME XXX OPEN 43X XX STDN-LO 48X
CLOSE 44X XX SGLS 49X
  
```

```

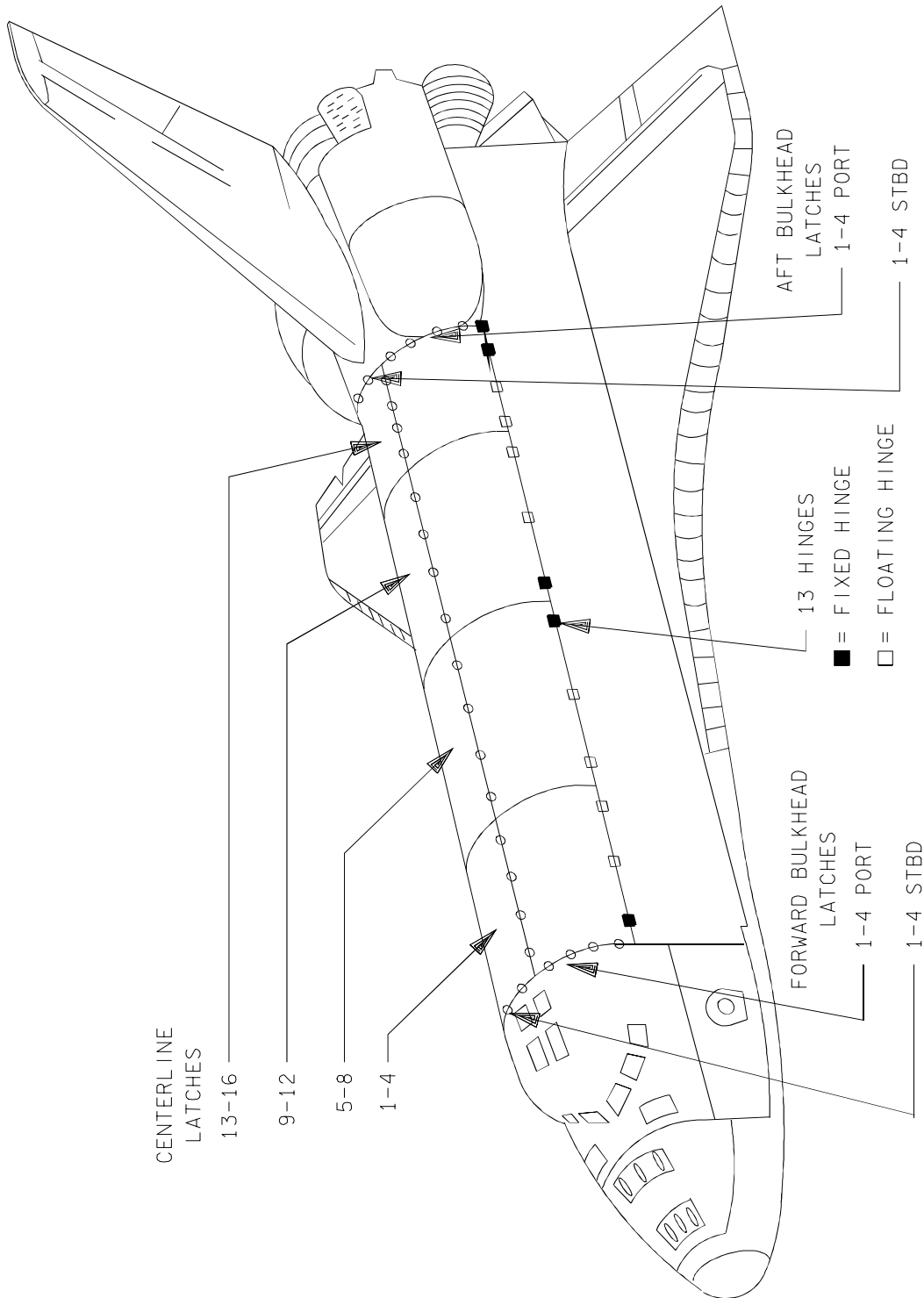
XXXX/023/   RCS   XX X DDD/HH:MM:SS
                DDD/HH:MM:SS
RCS FWD 1X PRI JET OMS PRESS ENA
L 2X 4 FAIL LIM X L OMS 5X OMS=RCS QTY
R 3X R OMS 6X L XX.XXS
OFF 7X R XX.XXS
JET FAIL DES JET PTY
INH DES DES
XXX XXX 8X 9X X
XX XXX 10X 11X X
Y XX XXX 12X 13X X
XX XXX 14X 15X X
XXU XXX 16X 17X X
XU XXX 18X 19X X
Z XU XXX 20X 21X X
XXX XXX 22X 23X X
XD XXX 24X 25X X
2D XXX 26X 27X X
XD XXX 28X 29X X
XXX XXX 30X 31X X
X XX XXX 32X 33X X
XX XXX 34X 35X X
X5X XXX 36X 37X X
V 5X XXX 38X 39X X
OXID FU
HE P XXXS XXXS
PRPLT TK P XXXS XXXS
T XXXS XXXS
QTY XXXS XXXS
MANF P 1 XXXS XXXS
2 XXXS XXXS
3 XXXS XXXS
4 XXXS XXXS
MANF VLVS STAT OVVRD
1 XXS 40
2 XXS 41
3 XXS 42
4 XXS 43
5 XXS 44
XFEED P XXXS XXXS
JET RESET 45
  
```

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3.9.5	Mech Displays.....	3.9.5-1

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### 3.9 MECH

#### 3.9.1 Payload Bay Door Latch Locations

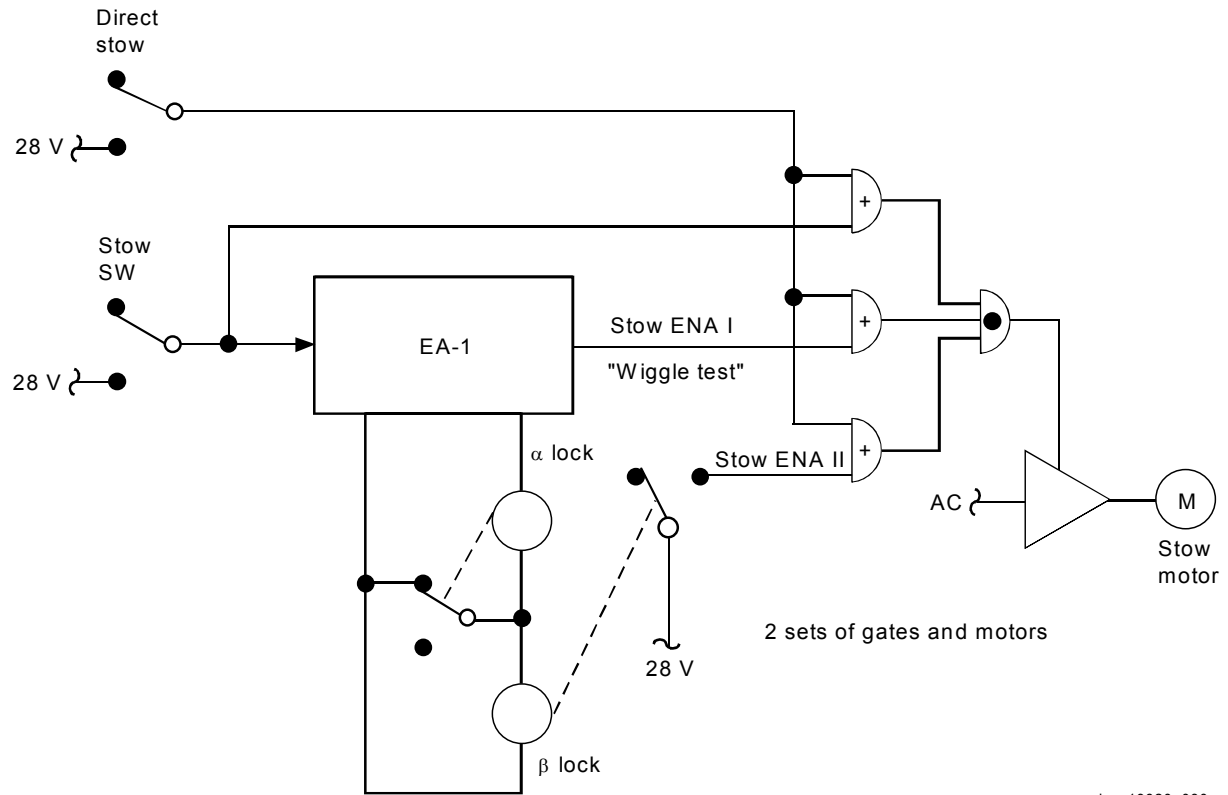


PAYLOAD BAY DOORS LATCH LOCATIONS

19612344, ART 1



### 3.9.2 Ku-Band Gimbal Stow Overview



jsc\_19620\_030.cv5

### 3.9.3 Vent Doors

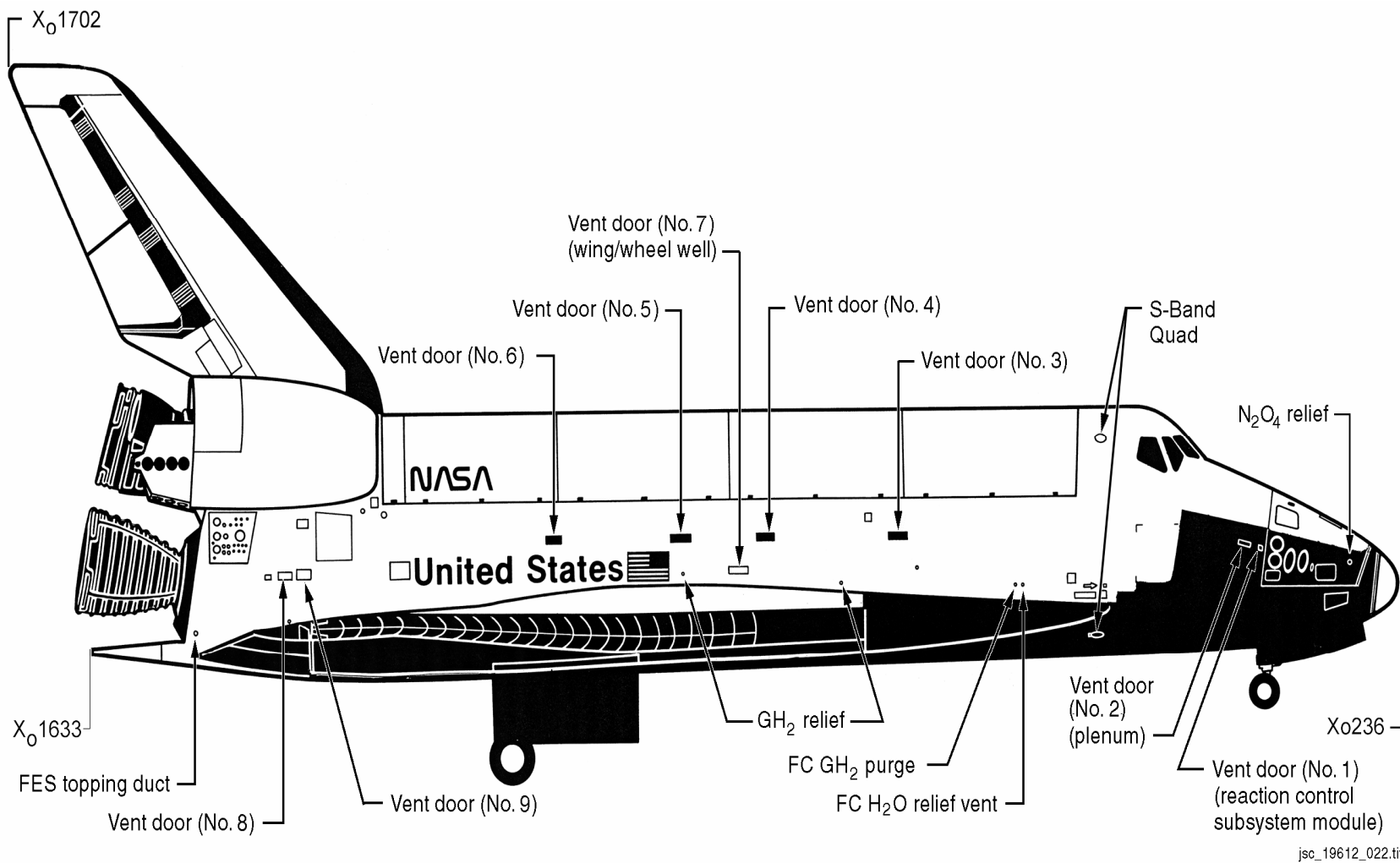
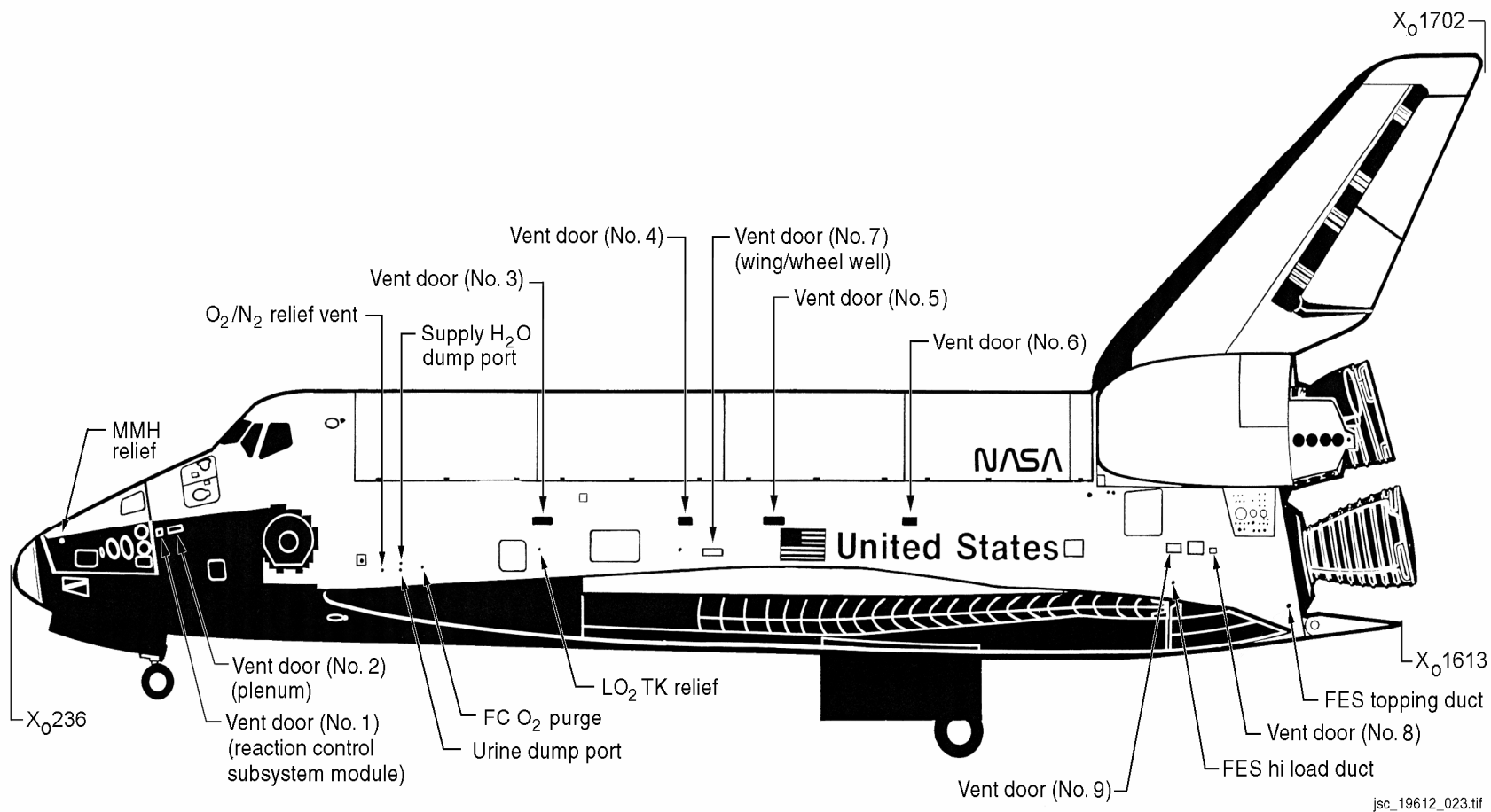
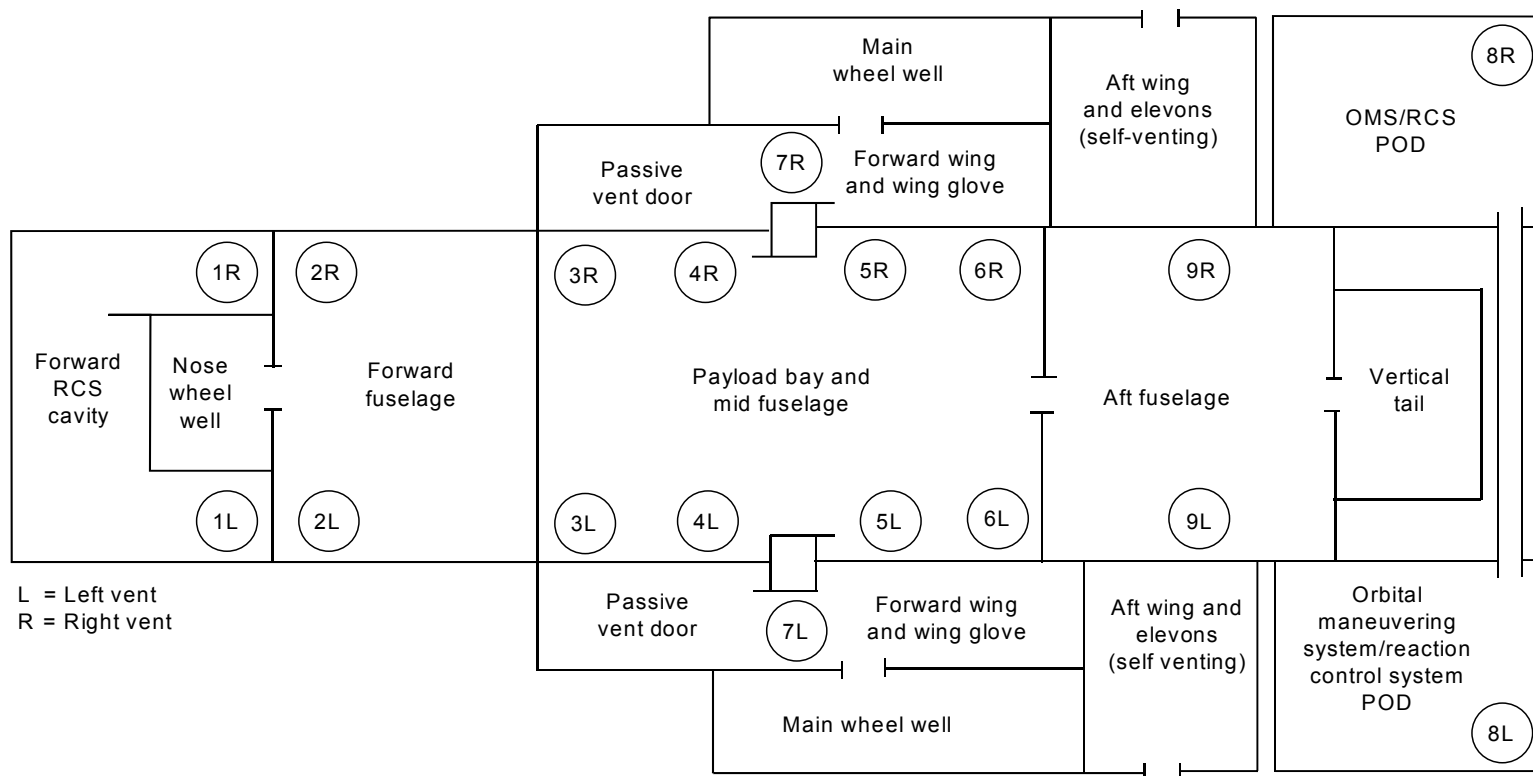


Figure 3.9.3-1: Starboard Vent Door Locations



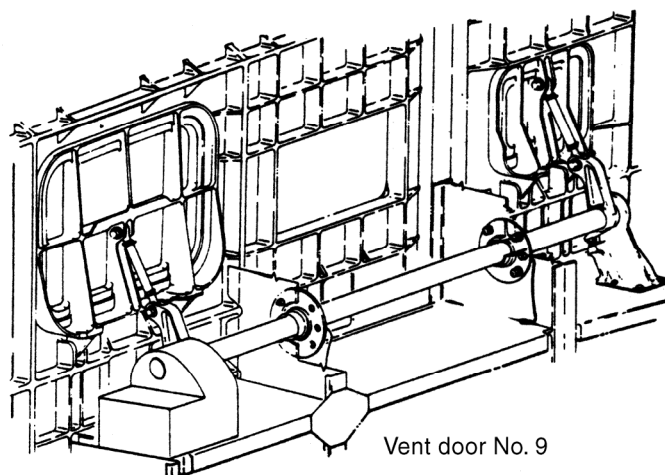
jsc\_19612\_023.tif

Figure 3.9.3-2: Port Vent Door Locations

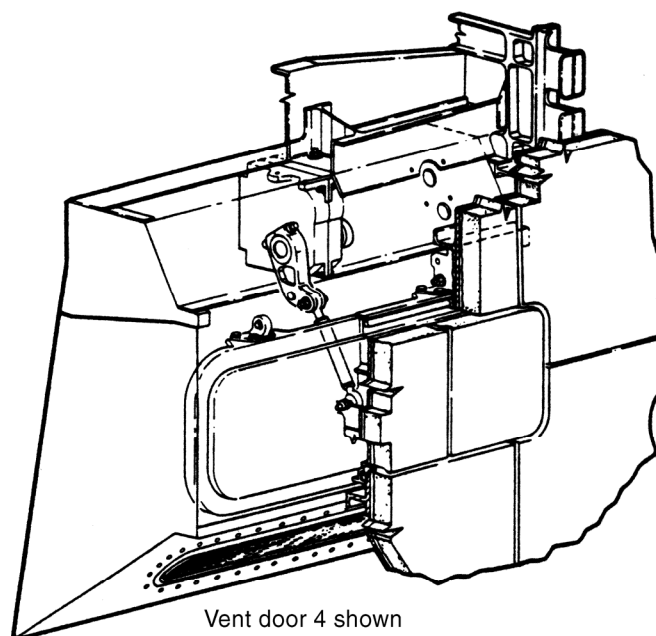


j\_19612\_031.cv5

Figure 3.9.3-3: Vent Door Locations



jsc\_19612\_024a.tif



jsc\_19612\_024b.tif

Figure 3.9.3-4: Vent Door Pictorials

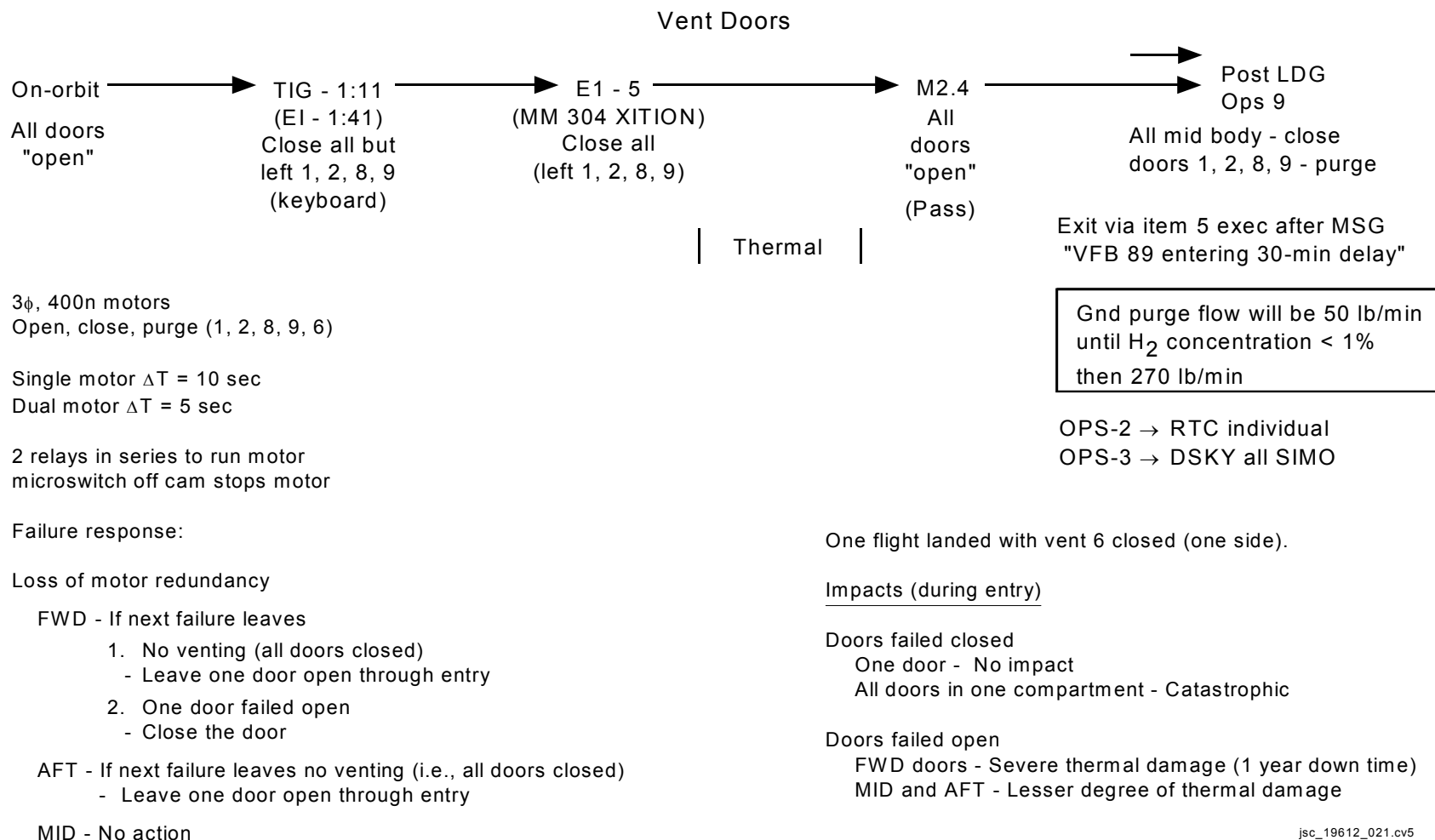
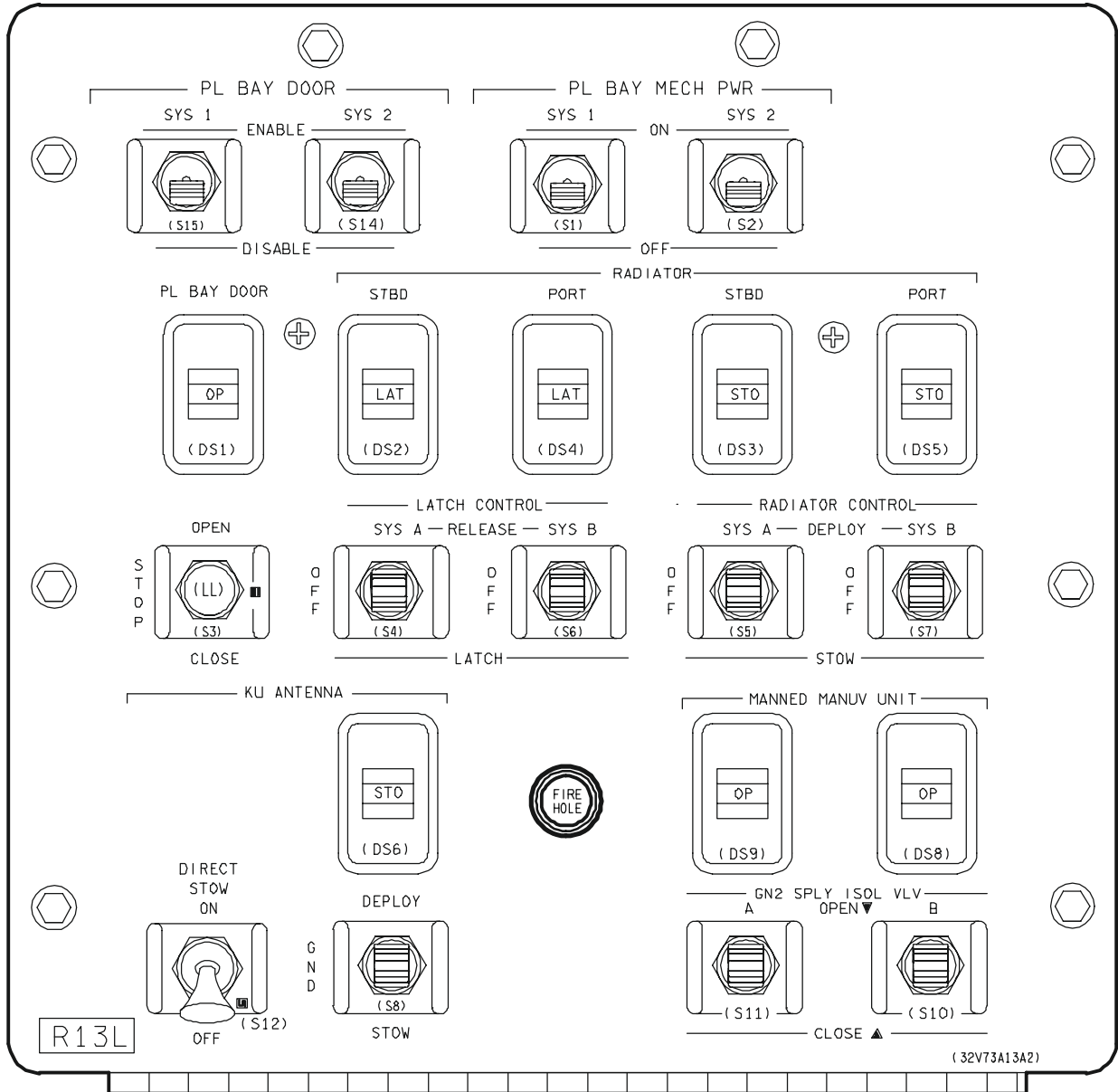


Figure 3.9.3-5: Vent Door Timeline

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3.9.4 Panel R13L Switches



19612504. PNL B 1



### 3.9.5 Mech Displays

```

2021 / / PL BAY DOORS XX X DDD/HH:MM:SS
BFS DDD/HH:MM:SS

AC POWER ON 1X
OFF 2X
AUTO MODE SEL 3X PBD SW-XXXXX

MICRO-SW STAT
LATS DOORS
CCOO CRRRO
ABAB ABC

CENTER LATCHES MAN OP/CL AUTO SEQ
SEL 4X XXS X XXXX
5-8 4X XXS X XXXX
9-12 5X XXS X XXXX
1-4 6X XXS X XXXX
13-16 7X XXS X XXXX

STBD
FWD LATCHES 8X XXS X XXXX XXXXX
AFT LATCHES 9X XXS X XXXX XXXXX
DOOR 10X XXXS X

PORT
FWD LATCHES 11X XXS X XXXX XXXXX
AFT LATCHES 12X XXS X XXXX XXXXX
DOOR 13X XXXS X

OPEN 15X
PBD SW BYPASS 14X STOP 16X
CLOSE 17X
  
```

Payload Bay Door Display (PFS/BFS)

```

XXXX/XXX/097 PL RETENTION XX X DDD/HH:MM:SS
DDD/HH:MM:SS

LATCH LATCH LATCH LATCH LATCH
1 2 3 4 5
AB/AB AB/AB AB/AB AB/AB AB/AB

PL SEL 1
RDY-FOR-LAT XX XX XX XX XX
LAT/REL XX/XX XX/XX XX/XX XX/XX XX/XX

PL SEL 2
RDY-FOR-LAT XX XX XX XX XX
LAT/REL XX/XX XX/XX XX/XX XX/XX XX/XX

PL SEL 3
RDY-FOR-LAT XX XX XX XX XX
LAT/REL XX/XX XX/XX XX/XX XX/XX XX/XX
  
```

(XX)

```

XXXX/051/ OVERRIDE XX X DDD/HH:MM:SS
DDD/HH:MM:SS

ABORT MODE ENTRY FCS
TAL 1X ELEVON FILTER ATMOSPHERE
ATO 2X AUTO 17X NOM 20X NOM 22X
ABORT 3X FIXED 18X ALT 21X N POLE 23X
MAX THROT 4X SSME REPOS 19 XXX S POLE 24X

PRPLT DUMP IMU STAT ATT DES PRL
1S XXXX X 25X SYS AUT DES
2S XXXX XXX 26X 1S 28X 31X
3S XXXX 27X 2S 29X 32X
3S 30X 33X

ADTA H α M DES
L 1S XXXXXX ±XX.X X.XX 34X
3S XXXXXX ±XX.X X.XX 35X
R 2S XXXXXX ±XX.X X.XX 36X
4S XXXXXX ±XX.X X.XX 37X

ET SEP ROLL MODE XXXXXXXX
AUTO 38X AUTO SEL 42X
SEP 39X WRAP MODE 45 XXX
ET UMB DR VENT DOOR CNTL
CLOSE 40X OPEN 43X XX
RCS RM MANF CLOSE 44X XX
CL OVRD 41
  
```

```

XXXX/051/ OVERRIDE XX X DDD/HH:MM:SS
BFS DDD/HH:MM:SS

ABORT MODE ENTRY FCS
TAL 1X ELEVON FILTER ATMOSPHERE
ATO 2X AUTO 17X NOM 20X NOM 22X
ABORT 3X FIXED 18X ALT 21X N POLE 23X
THROT MAX 4X SSME REPOS 19 XXX S POLE 24X
ABT 50X
NOM 51X

PRPLT DUMP IMU DES ATT AA RGA SURF
1 25X X LRU DES DES DES
XXX ICNCT 5 XXXX 2 26X 1 31X 35X 39X
OMS DUMP 3 27X 2 32X 36X 40X
ARM 6X 3 33X 37X 41X
START 7X ET SEP 4 34X 36X 42X
STOP 8X AUTO 28X
9 QUAN/SIDE XXX SEP 29X ROLL MODE
OMS DUMP TTG XXX WRAP MODE 45 XXX

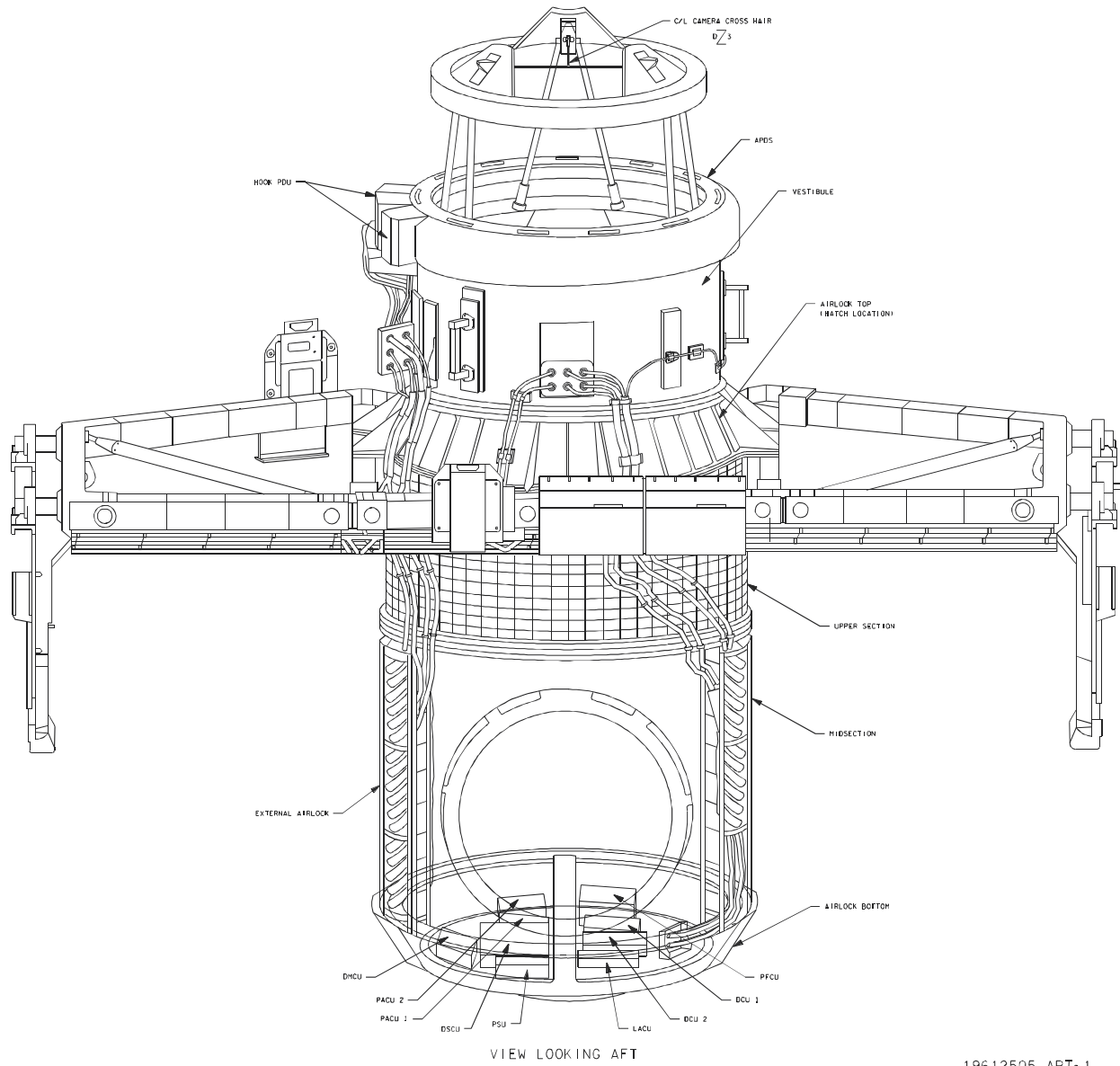
ET UMB DR
AFT RCS 13 XXX CLOSE 30X COMM XXXX
14 TIME XXX TDRS 46X
VENT DOOR CNTL STDN-HI 47X
FWD RCS 15 XXX OPEN 43X XX STDN-LO 48X
16 TIME XXX CLOSE 44X XX SGLS 49X
  
```

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3.10.2	Androgynous Peripheral Docking System (APDS) .....	3.10.2-1
3.10.3	APDS Controls.....	3.10.3-1
3.10.4	APDS CRT Display .....	3.10.4-1

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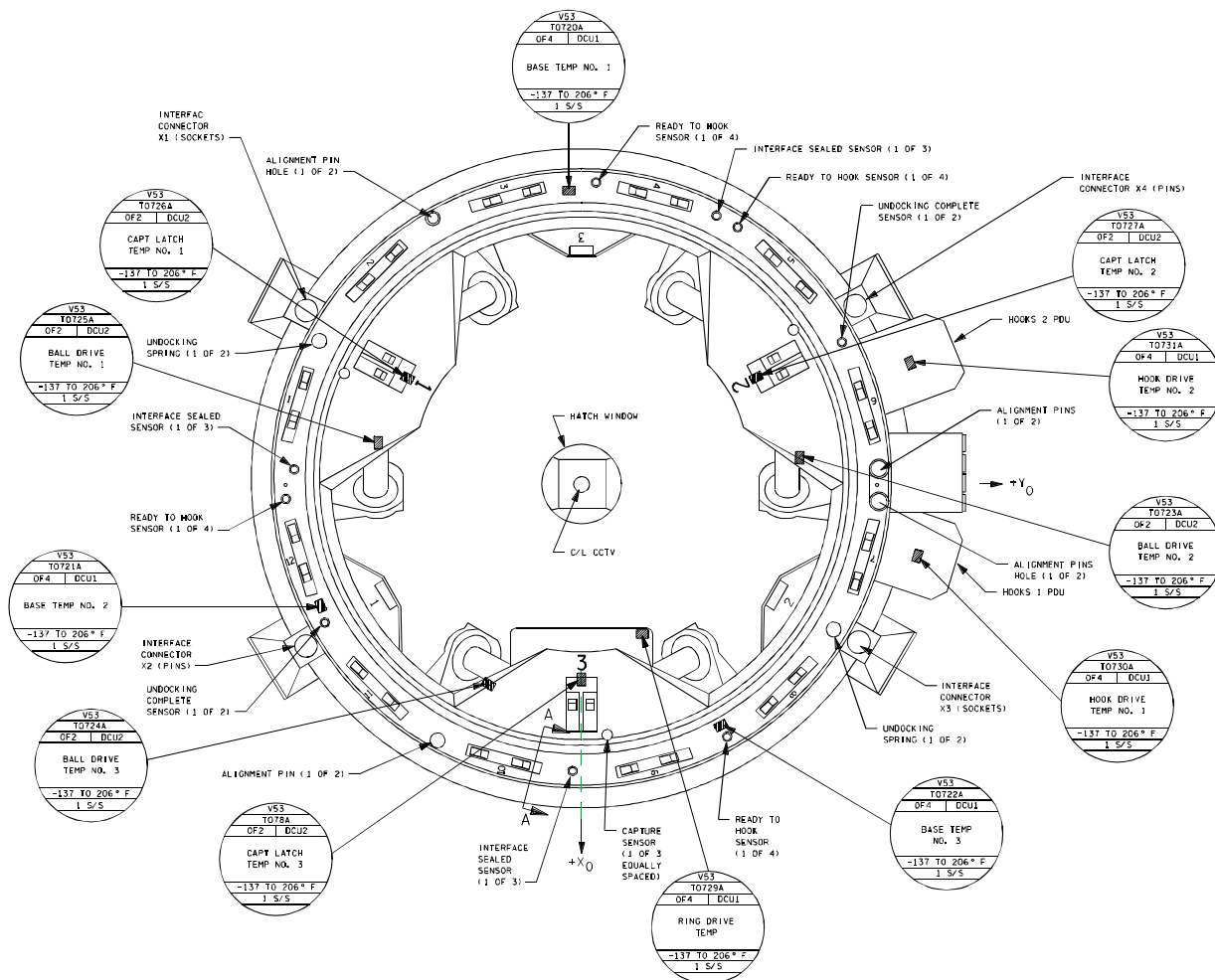
### 3.10 ORBITER DOCKING SYSTEM

#### 3.10.1 Structural Overview



19612505, ART 1

Figure 3.10.1-1: Orbiter Docking System Structural Overview



STRUCTURAL RING/DOCKING SENSOR LOCATIONS

19612506. ART; 1

Figure 3.10.1-2: Structural Ring/Docking Sensor Locations

### 3.10.2 Androgynous Peripheral Docking System (APDS)

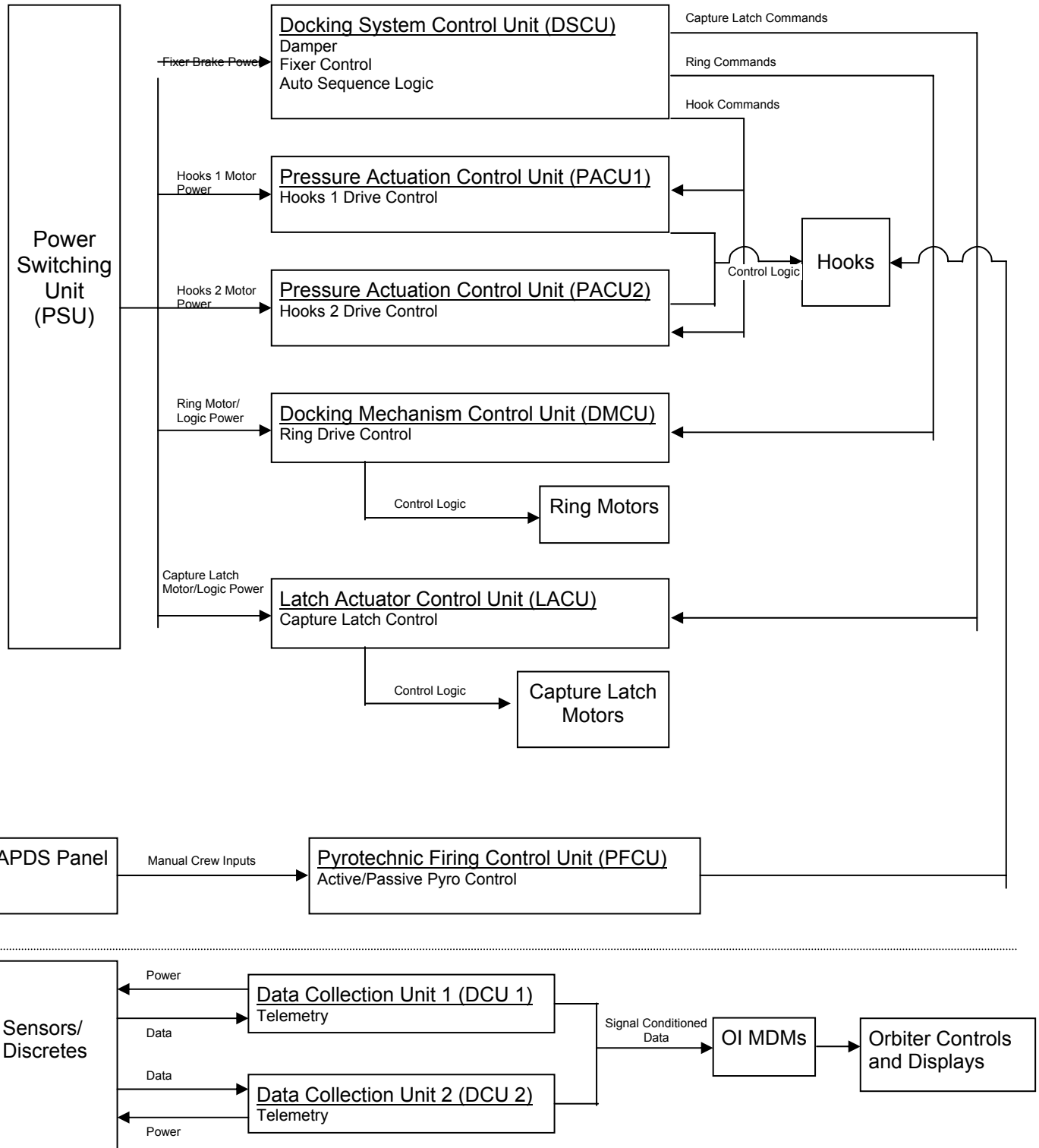


Figure 3.10.2-1: Androgynous Peripheral Docking System (APDS) Schematic

Table 3.10.2-1: Undocking Timeline (from MMACS CHB SCP 2.21)

Event	Time	Description	Key Points/Constraints
Docking Mech Pwrup/Undocking Prep	Undock -27 min	Docking mechanism avionics powered up and 2 hour timer started (heat rejection constraint).	
Undocking Operations	Undock - 2:20	Hooks begin driving open. Nominal drive time is 2:30 min. MMACS watches hook potentiometer measurements (92% to 5%). 4 springs push vehicles apart.	Hooks begin driving open. Vehicles separate.
Mechanism Power down	Post Undocking	De-energized avionics latching relays. Ends 2 hour power on time constraint.	
Docking Mech Pwrdn	Undocking Seq Complete + ~15 min	Powers down avionics and docking panels.	

Table 3.10.2-2: Docking Timeline (from MMACS CHB SCP 2.21)

Event	Time	Description	Key Points/Constraints
Docking Mechanism Initialization	Post-Insertion	Circuit Breakers on A6L for docking pushed in, docking power applied to A6 and A7 panels.	
Docking Mech Pwrup/Prep	Typically FD2	Docking mechanism avionics powered up and 2 hour timer started (heat rejection constraint).	
Docking Ring Extension	Typically FD2	Ring driven from Final to Initial Position (76 + 3%). Maximum stroke available to attenuate and react to docking loads are at initial position. Clutch goes to slip preventing high loads being transmitted to the ring.	Maximum stroke available to attenuate and react to docking loads are at initial position. Clutch goes to slip.
Docking Mech Pwrdn	Ring Extension Complete	Powers down avionics and docking panels.	

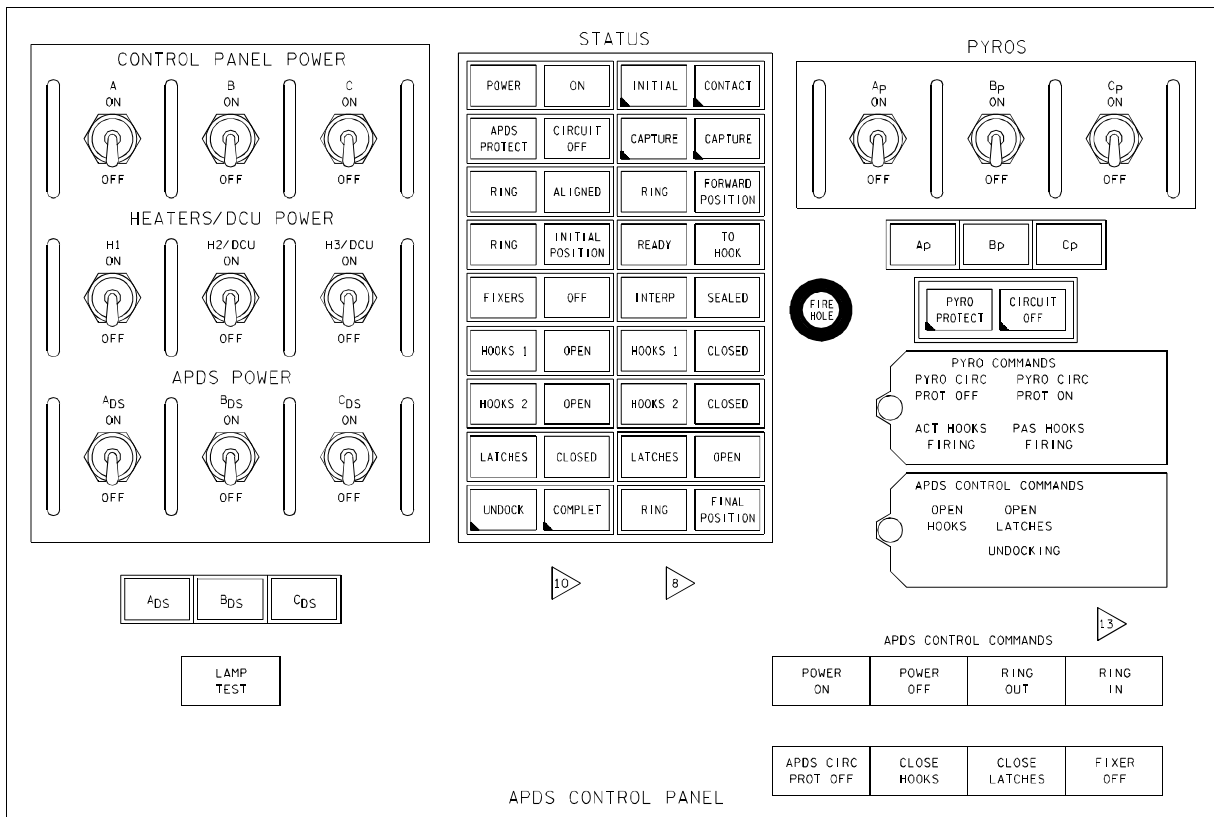
Table 3.10.2-3: Docking Sequence (from MMACS CHB SCP 2.21)

Event	Time	Description	Key Points/Constraints
Docking Mech Pwrup/Prep	Dock -37 min	Docking mechanism avionics powered up and 2 hour timer started (heat rejection constraint).	
Contact Status Light/ Telemetry	Dock +0	Contact noted in Ring Alignment sensors, Contact sensors, and base potentiometers (~72%).	
Capture Status Light	Dock +~0	Three capture sensors on ring depressed. Receipt of capture starts auto docking sequence (enables capture bus).	Receipt of capture starts auto docking sequence (enables capture bus).
Damping Telemetry	Capture +5 sec	Initiation of active damping indicates the capture bus has been enabled and, therefore, is confirmation of capture in the MCC. Active damping acts as a shock absorber to absorb energy and damp relative motion caused by contact. Damping must NOT be on at contact as the mechanism would be too rigid and damage could occur.	Confirmation of capture in the MCC.
Free Drift	Capture +TBD sec.	ISS must not have ACS on at this point or possible damage to ODS mechanism. (ADCO call). Perform failed capture if ACS still on.	Possible damage to ODS mechanism if not in free drift. Perform failed capture if ACS still on.
Relative Motion Damped	Up to 2 min post-contact	If ring is aligned MMACS gives GO to deactivate dampers and retract (Ring Alignment for 60 sec continuous required prior to commanding ring retraction.) If ring is not aligned, MMACS gives GO to extend ring to force alignment at forward position hard stop.	Ring Align and no relative motion required to retract ring.
Force Alignment (if req'd)	Contact +2 min	Ring is driven out to FWD position (98%) with dampers on to align the ring at the hard stop. Nominal drive time from ~1" below INIT (72%) to FWD (98%) is 1:50 min. Drive rate is slower because dampers are left on to inhibit relative motion.	Ring Align and no relative motion required to retract ring.
Disable Dampers		Dampers are disabled after the ring is aligned. Dampers may only be powered on for a maximum of 5 minutes and must be disabled to prevent overheating of the dampers.	Dampers may only be powered on for a maximum of 5 minutes.
Retract Ring	After ring align for 60 sec.	Retracts ring to bring interfaces together. Clutch goes to lock. MMACS watches ring base potentiometer measurements decrease to ~7%. Nominal drive time from just below INIT to RDY-TO-HOOK is 3:15 min. Nominal drive time from FWD to RDY-TO-HOOK is 4:05 min.	Clutch going to lock is required to drive ring.
Close Hooks	Ring retracted to RDY-TO-HOOK position (~7%)	Hooks begin driving closed. Nominal drive time is 2:30 min. MMACS watches hook potentiometer measurements. (5% to 92%) Ring drive stops shortly after hooks begin driving. Interface Sealed status light illuminates mid-way through hook closure, when interface seals are compressed indications are typically made at the RDY-TO-HOOK position.	Hooks begin driving closed.



Go For Attitude Control	Hooks Closed (Hard Mate)	With hooks closed, the interface is rigidized for attitude control loads. 12 hooks closed is the nominal configuration and allows for PRCS. 6 hooks closed allows VRCS attitude control only (PMA 2/3 hooks will be driven closed if required to get a minimum of 12 hooks. X3/X4 connector mate is required for this.)	12 hooks closed is the nominal configuration and allows for PRCS. 6 hooks closed allows VRCS attitude control only (PMA 2/3 hooks will be driven closed if required to get a minimum of 12 hooks. X3/X4 connector mate is required for this.)
Extend Ring	Hooks Closed	The ring is extended for 10 sec to relieve the load on the capture latches and make it easier to open the latches.	
Open Capture Latches	Hooks Closed +10 sec	Opens capture latches to allow ring retraction to Final position. Necessary for interface separation once hooks are opened for undocking.	Necessary for interface separation once hooks are opened for undocking.
Retract Ring to FNL POS	Latches Open	Retract ring to Final position (5%). Capture indication disabled.	
Power Off	Sequence Complete with Ring at FNL pos	De-energized avionics latching relays. Ends 2 hour power on time constraint.	
Docking Mech Pwrn	Docking Seq Complete + ~15 min	Powers down avionics and docking panels.	

### 3.10.3 APDS Controls

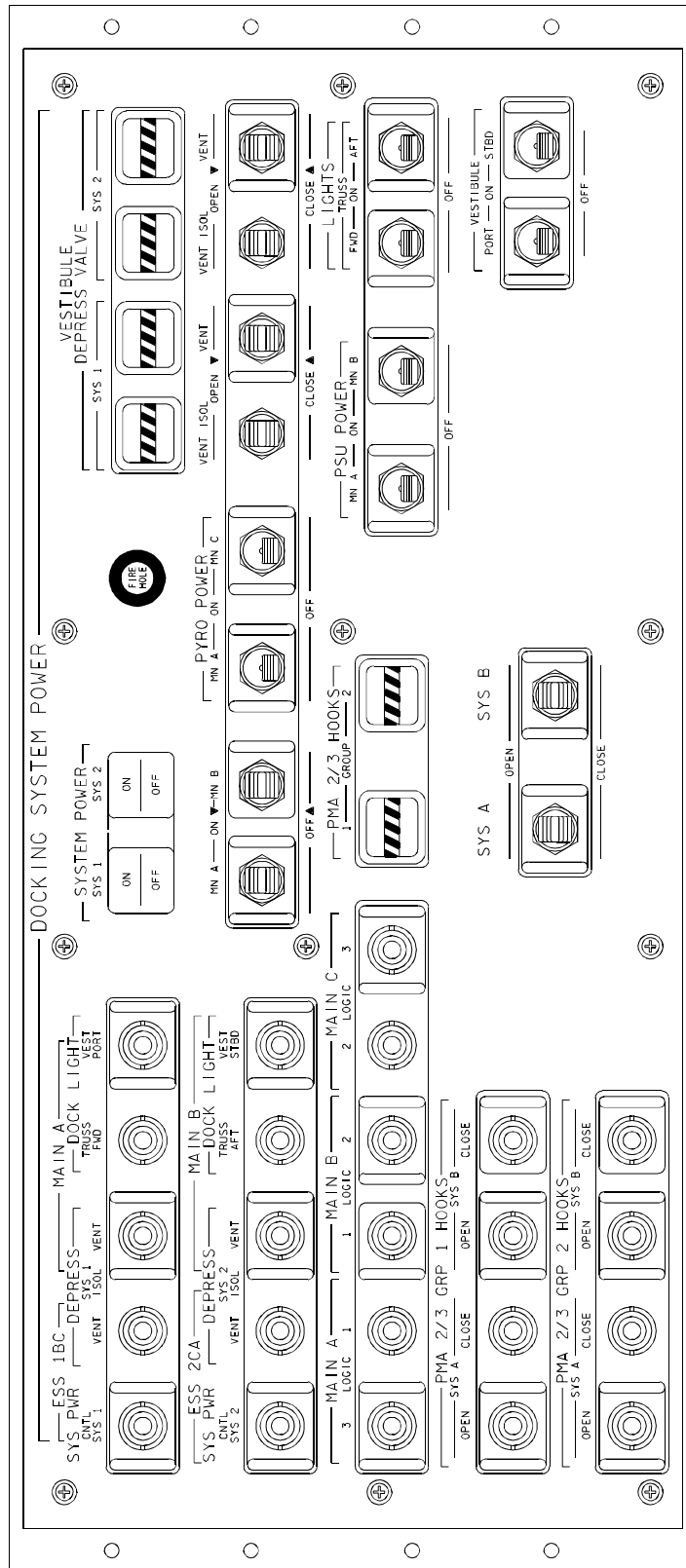


APDS CONTROL PANEL

PANEL A7A3

19612507, PNL 1

Figure 3.10.3-1: APDS Control Panel



19612508, PNL # 1

PANEL A6A3

Figure 3.10.3-2: Docking System Power

### 3.10.4 APDS CRT Display

XXXX/XXX/167		DOCKING STATUS XX X		DDD/HH:MM:SS	DDD/HH:MM:SS
RNG ALIGN	XXX	CNTL PNL	PWR X/X/X	RING DR BUS	X/X
CONTACT	XXX	HTR/DCU	PWR X/X/X	HOOK DR BUS	X/X
CAPTURE	XXX	APDS PWR	X/X/X	DAMPER BUS	X/X
DAMPING	XXX	CNTL CMD	PWR XXX	FIXER BUS	X/X
		APDS CIRC	PROT XXX		
RING POS	XXXX/XXX/XXX	HOOK PYRO	LOGIC PWR	X/X/X	
DRV CMD	XXX	PYRO CIRC	PROT	XXX/XXX	
FIXERS	XXX				
PETAL POS	1 2 3	BASE T	1 2 3	XXX XXX XXX	
RING	XXX XXX XXX	CAP LAT T		XXX XXX XXX	
BASE	XXX XXX XXX	BALL DR T		XXX XXX XXX	
RDY TO HOOK	XXX	HOOK DR T		XXX XXX	
HOOK1 DRV CMD	XXX	RING DR T		XXX	
POS	XXX	VESTIBULE			
IND	XX/XX	DEP VLV 1		XX/XX	
HOOK2 DRV CMD	XXX	ISOL VLV 1		XX/XX	
POS	XXX	DEP VLV 2		XX/XX	
IND	XX/XX	ISOL VLV 2		XX/XX	
UNDOCK CMLPT	XXX	TEMP 1/2		XXX/XXX	
CAP LAT CMD	XXX	EXT AIRLOCK T		XXX	
IND	XX/XX	EXT AIRLOCK P		XX.XXS	
MAN REL	XX	AIRLOCK-VEST ΔP		XX.XXS	
				(XX)	

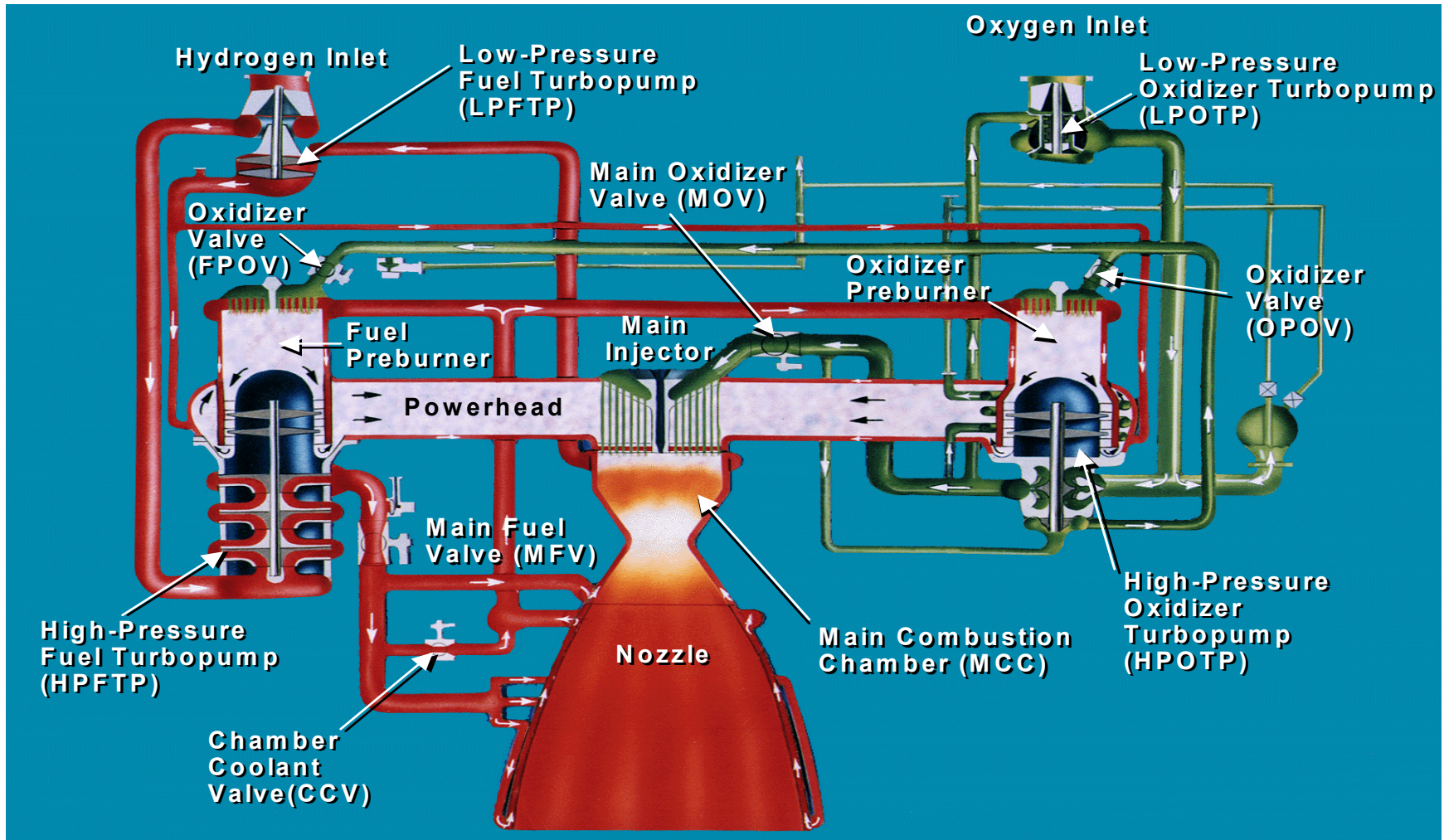
Figure 3.10.4-1: Docking Status Display

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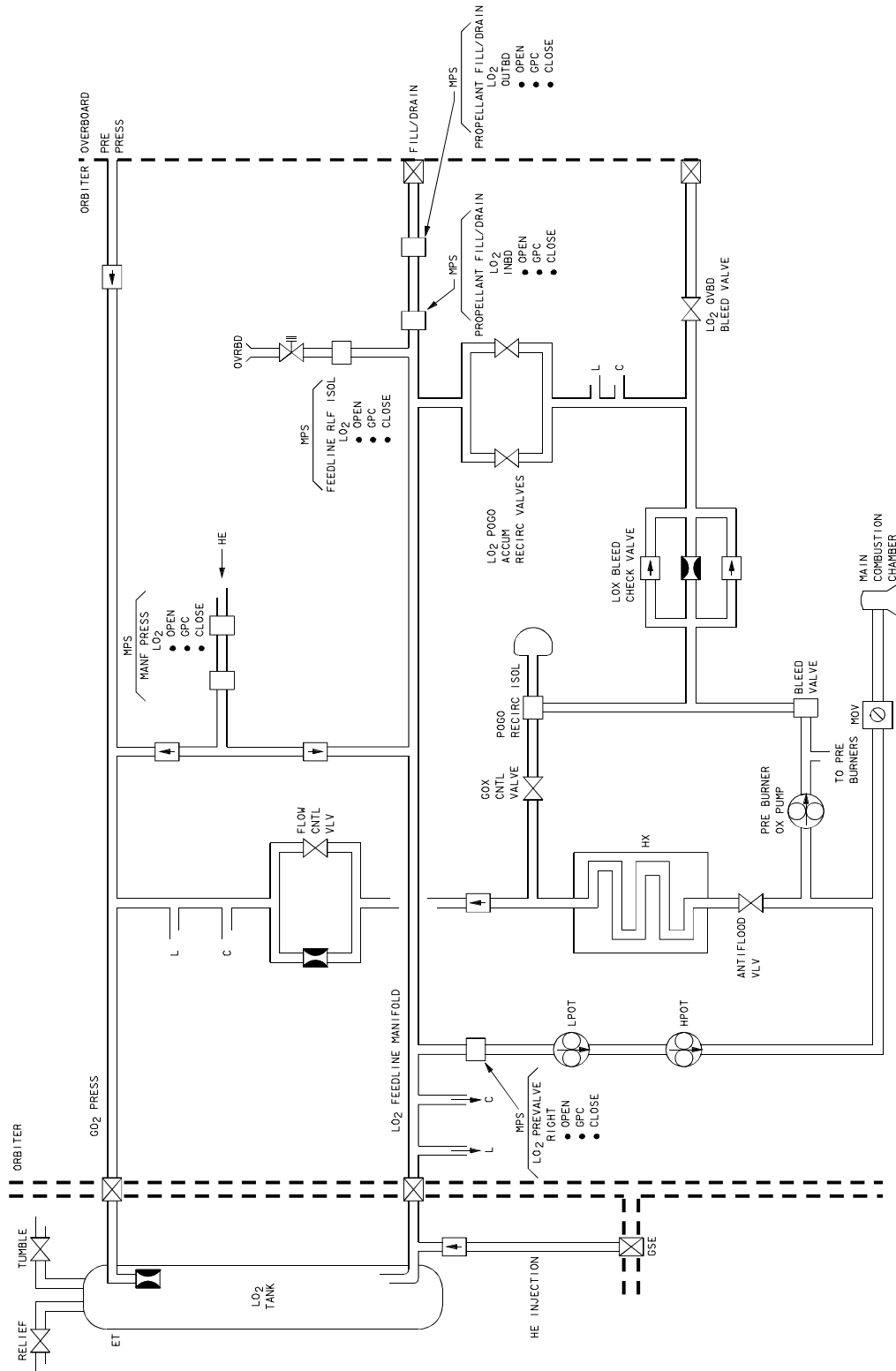
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3.11.1 Main Engine Schematic	3.11.1-1
3.11.2 MPS Propellant Schematics	3.11.2-1
3.11.3 MPS Helium System Schematic	3.11.3-1
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3.11.5 Switch Panels (C3, R2, R4)	3.11.5-1
3.11.6 Displays	3.11.6-1
3.11.7 Notes	3.11.7-1

### 3.11 MPS

#### 3.11.1 Main Engine Schematic



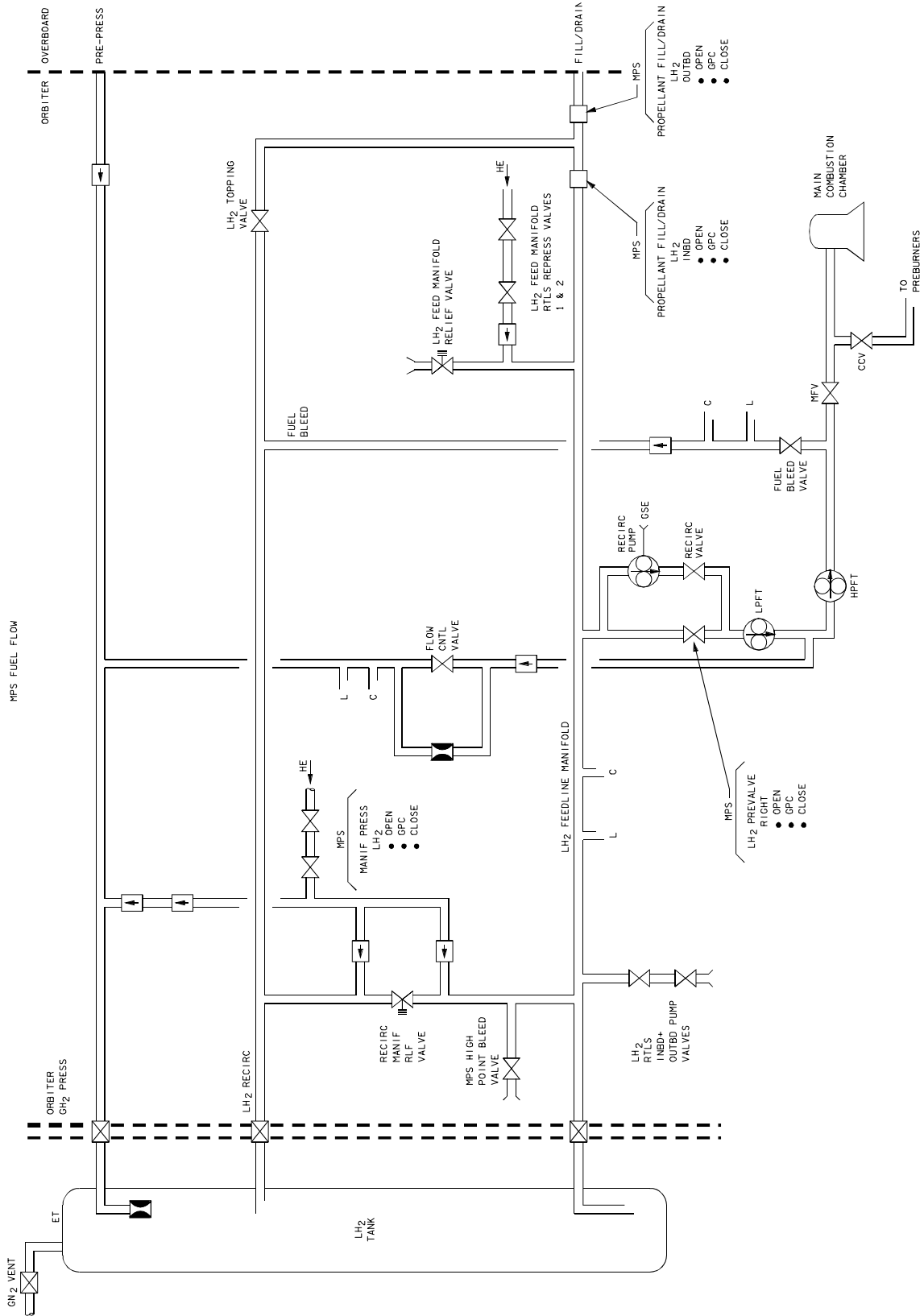
### 3.11.2 MPS Propellant Schematics



19612334, SCH 1

Figure 3.11.2-1: OX Flow



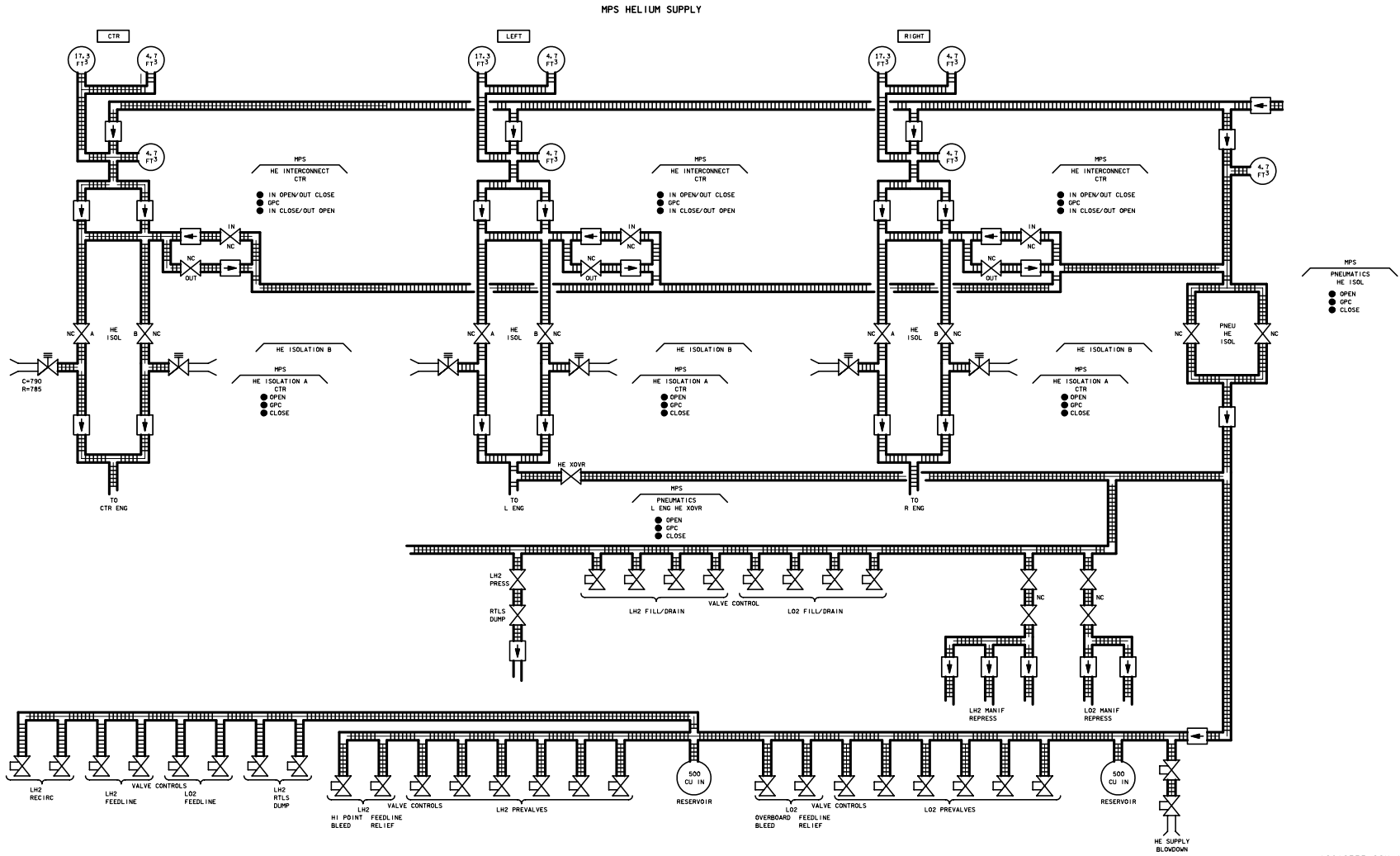


19612333, SCH.1

FIGURE 2.8. - MPS FUEL FLOW.

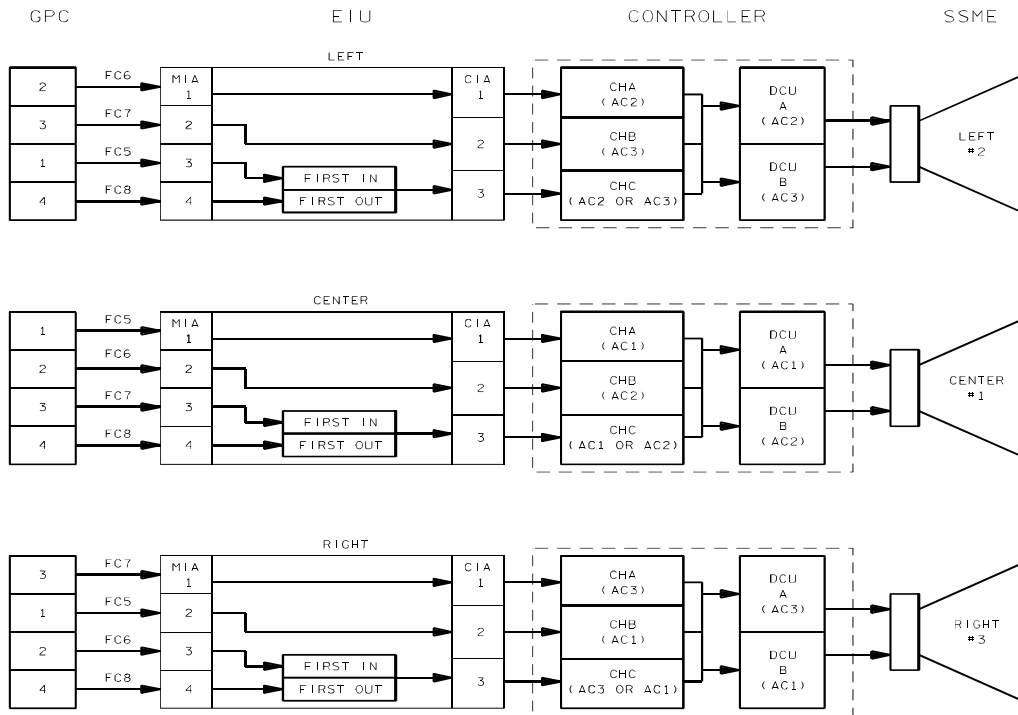
Figure 3.11.2-2: Fuel Flow

### 3.11.3 MPS Helium System Schematic

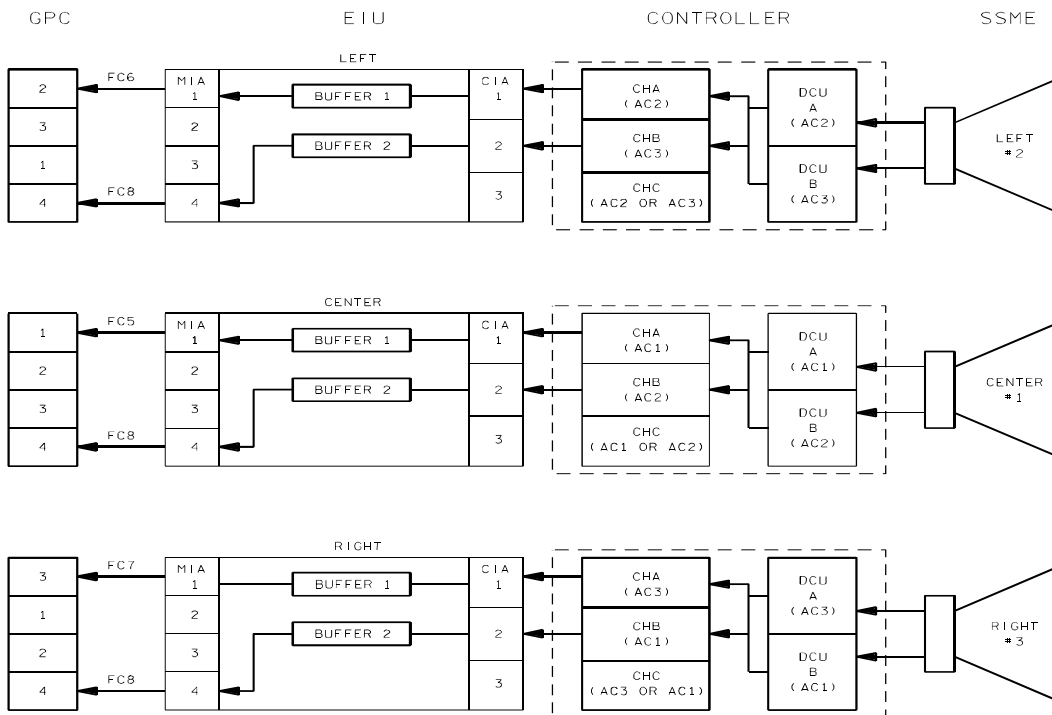


19612335, SCH 1

### 3.11.4 Main Engine Command and Data Flow

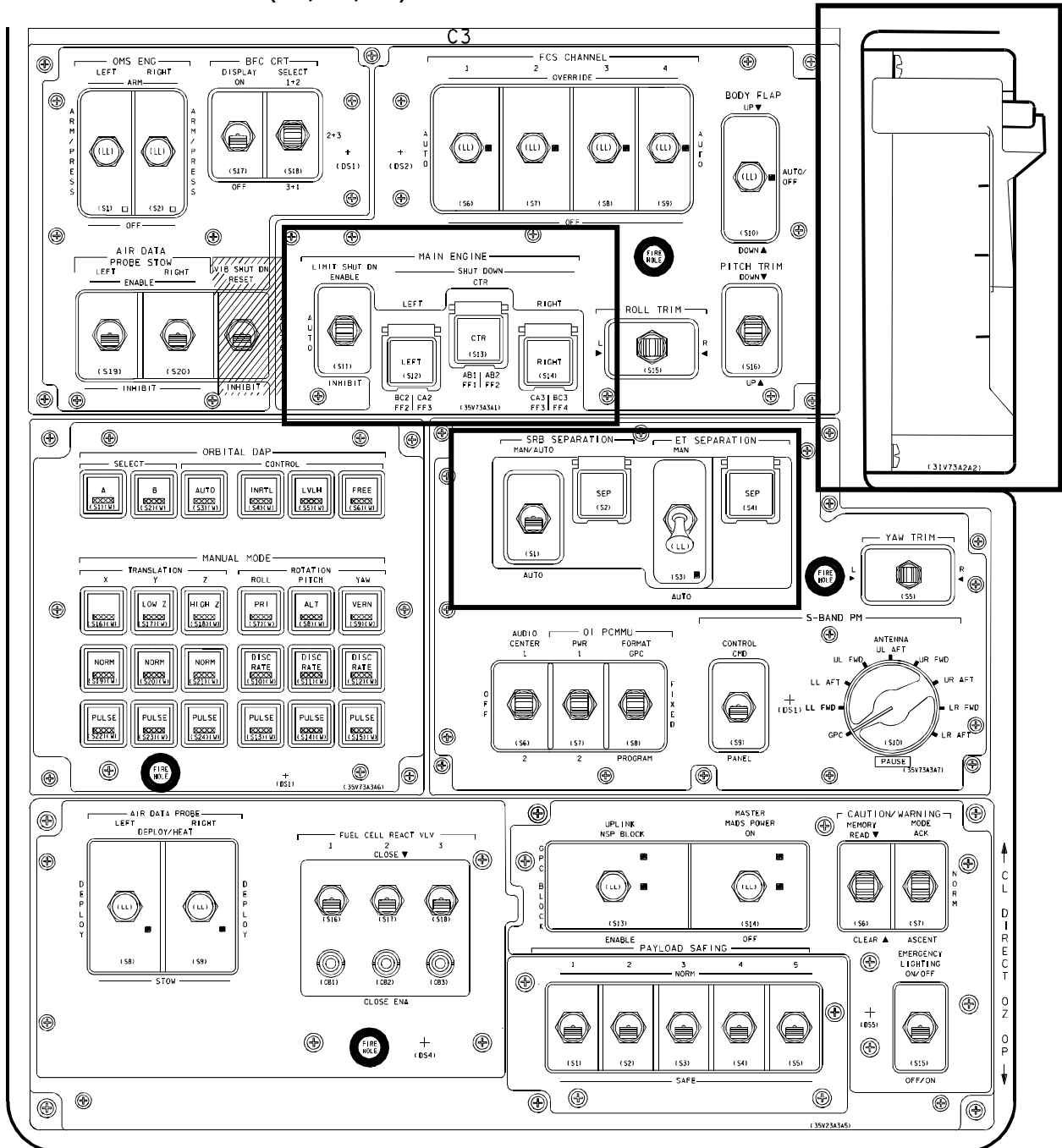


19612509, SCH: 1

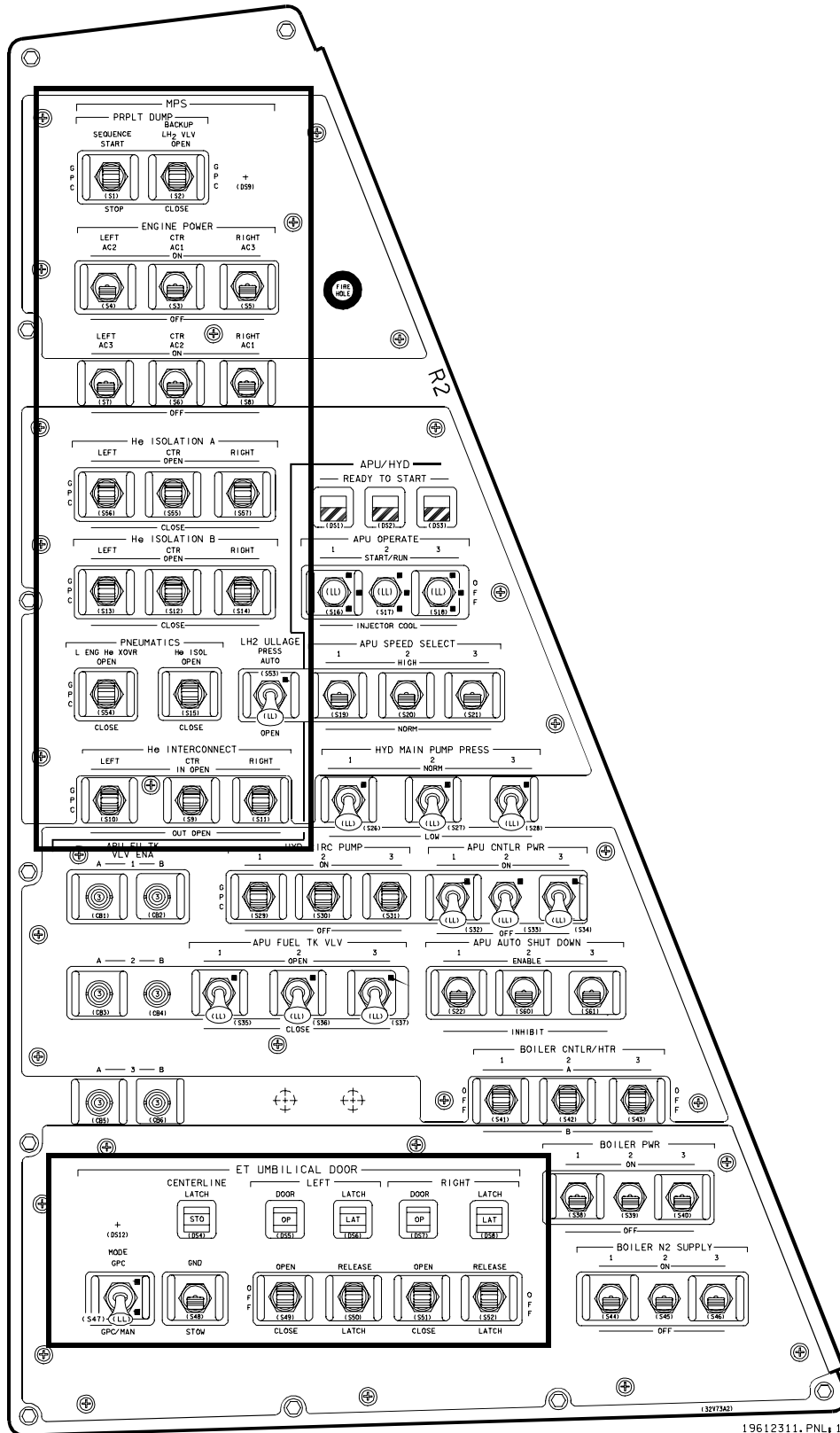


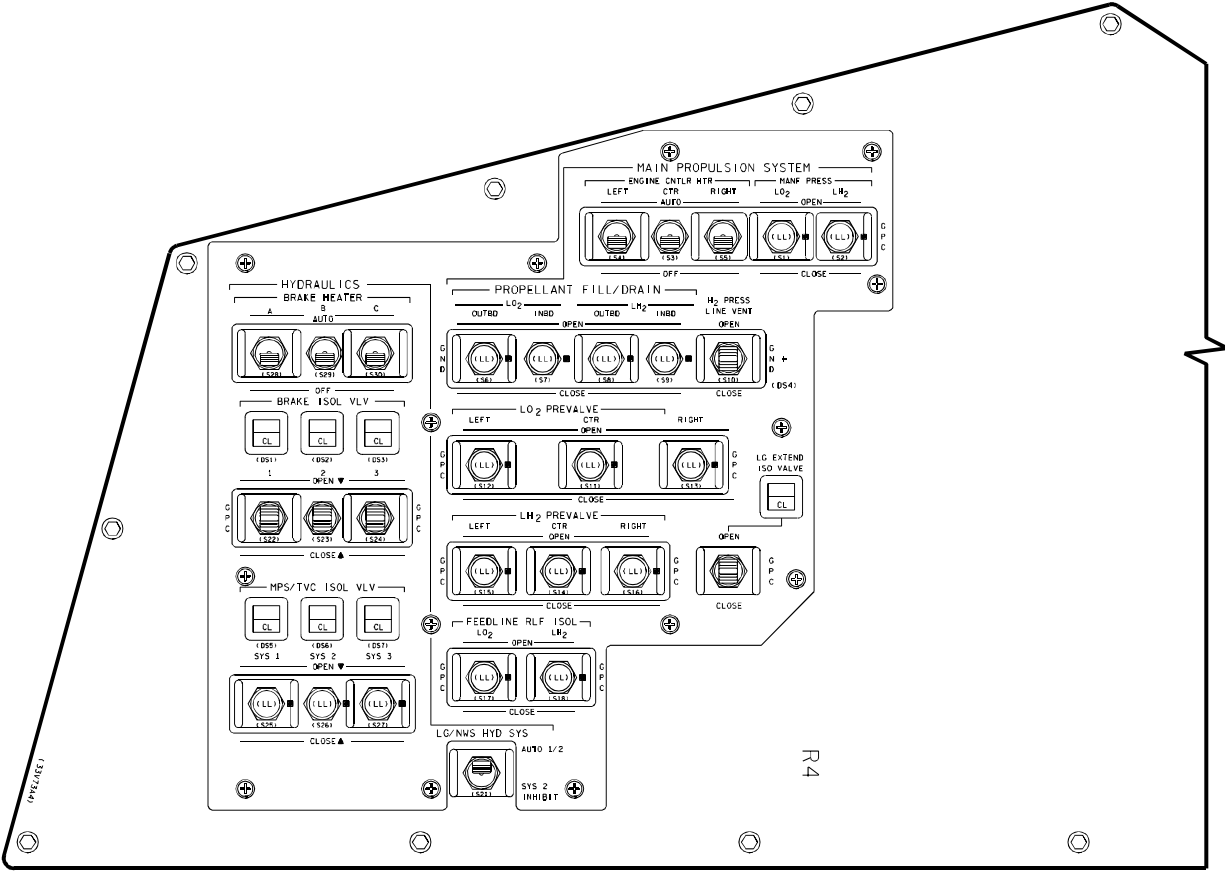
19612510, SCH: 1

### 3.11.5 Switch Panels (C3, R2, R4)



19612511.PNL 1





19612512.PNL:1

### 3.11.6 Displays

```

XXXX/XXX/018  GNC SYS SUMM 1  XX X DDD/HH:MM:SS
                BFS DDD/HH:MM:SS

SURF      POS      MOM      DPS      1 2 3 4
L OB      XXX.XS  XXS      MDM FF S S S S
I B      XXX.XS  XXS      FA S S S S
R IB      XXX.XS  XXS      PL S S
OB      XXX.XS  XXS
AIL      XXX.X
RUD      XXX.X      FCS CH 1 2 3 4
SPD BRK  XXX.X      S S S S
BDY FLP  XXX.X

MPS      L      C      R      NAV 1 2 3 4
HE TK P  XXXXS XXXXS XXXXS IMU S S S
REG P A  XXXXS XXXXS XXXXS XXX S S S
      B  XXXXS XXXXS XXXXS ADTA S S S S
dP/dT   XXXS  XXXS  XXXS

ULL P LH2 XX.XS XX.XS XX.XS  MPS PNEU HE P
      LO2 XX.XS XX.XS XX.XS   TK XXXXS
      REG XXXXS
      ACUM XXXXS
GH2 OUT P XXXXS XXXXS XXXXS MANF P LH2 XXXS
GO2 OUT T XXXXS XXXXS XXXXS   LO2 XXXS

```

GNC SYS SUMM1 Display (BFS)

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### 3.11.7 Notes

- Direct insertion MECO  $\approx$  8 minutes 30 seconds.
- Actual throttle levels on the first stage throttle bucket can vary due to SRB thrust level dispersions. This is an artifact of “first stage adaptive guidance.”
- Fuel consumption
  - 4% per engine per minute @104%
  - 3 SSMEs @ 104%: 1%/5 seconds
  - 3 SSMEs @ 65%: 1%/8 seconds
  - Propellant remaining is displayed on the ASCENT TRAJ display and is a guidance-calculated number.
- When an engine fails, the helium dP/dT is greater than 40 for several seconds, due to engine shutdown, and then it goes to zero. This is a good crosscheck to confirm engine shutdown.
- The selection of max throttle is not to be taken lightly. It increases the risk of catastrophic failure of an SSME by 10 times.
- Five ways to set MECO confirmed are:
  - 3 Pc's < 30
  - 2 Pc's < 30 plus one data path failure
  - 3 SSME PBs
  - OPS 104 PRO
  - FAST SEP
- An OPS 602 PRO does not set MECO confirmed.
- Main Engine Limits
  - There are no direct indications to the crew of limit shutdown enable/inhibit status. The status is available to Mission Control, or it can be deduced by the crew.
  - Limits must be enabled on an engine when the helium regulator pressure begins to decay due to a helium leak. An SSME will almost certainly fail catastrophically if there is insufficient helium, and limit shutdown is inhibited.
- SSME Malfunctions
  - An SSME command path failure must always be shut down manually with the A/C switches and PBs.
  - An SSME FAIL C (L, R) message indicates that the GNC software has recognized an engine shut down. Two of these messages will enable single engine roll control mode.
  - An engine in data path failure will never display a red MAIN ENGINE STATUS light, pre-engage.
  - Manual shutdown of hydraulically or electrically locked SSME is dependent on which issues the performance call, due to low-level C/O sensor timing.
  - Loss of an APU means hydraulic lockup. SSME CMD C (L, R) messages are possible post-MECO. No action is necessary.
- Main Engine Shut Down PBs

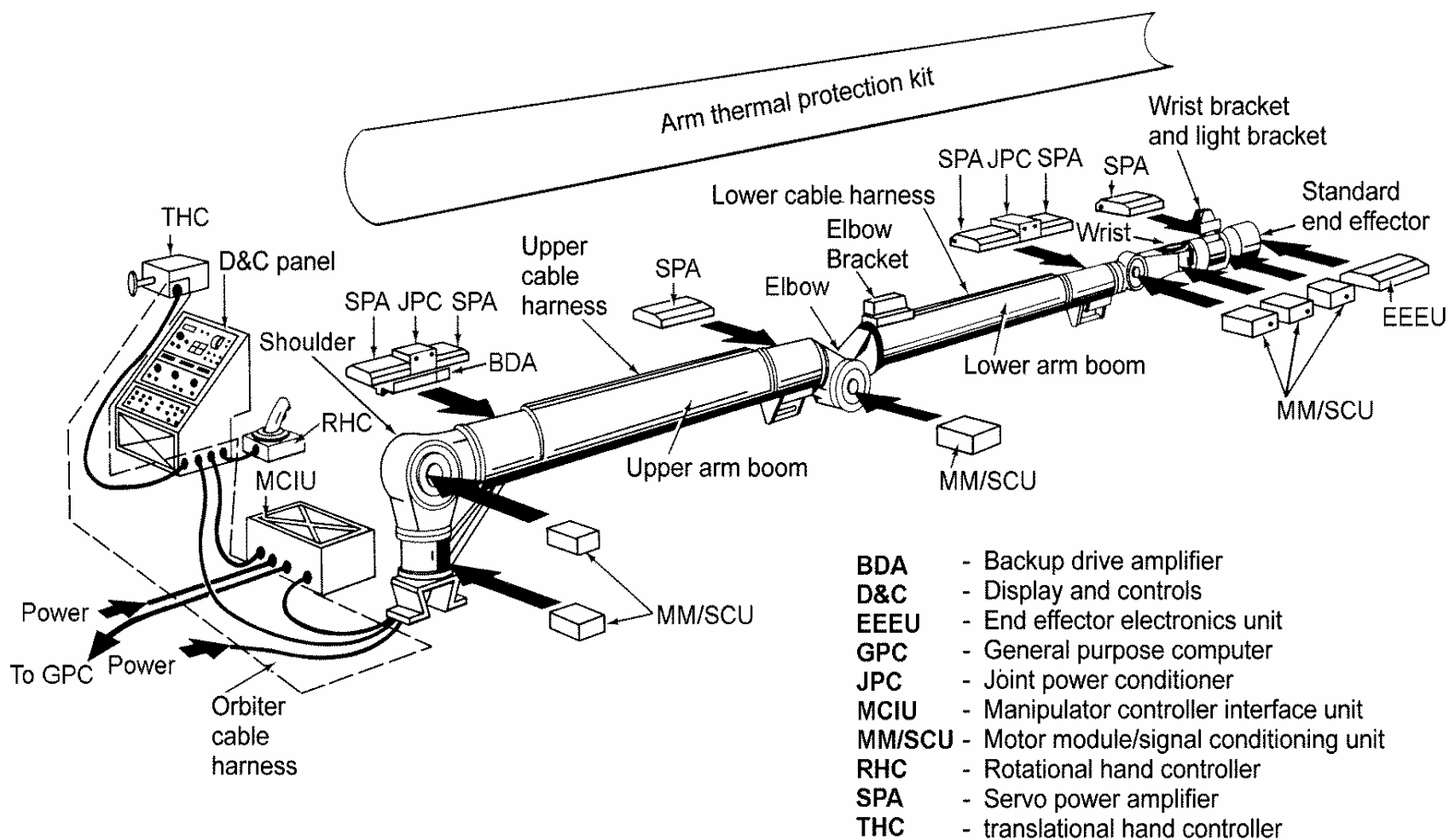
- PASS will downmode a commfaulted MAIN ENGINE SHUT DOWN push button and allow the push button to safe an engine under a data path failure. BFS does not allow this. If a MAIN ENGINE SHUT DOWN push button is commfaulted in BFS, it is inoperative.
  - BFS requires all three MAIN ENGINE SHUT DOWN push buttons SIMO to set MECO confirmed; PASS only requires to see the PBs once.
  - To shut an engine down, both contacts on the MAIN ENGINE SHUT DOWN push button must be good. If one contact is commfaulted, the button can be used to set the safing flag on an engine that failed under a data path failure. If a contact is power-failed, the button is inoperative unless it is commfaulted.
- Manual SSME Shutdown
    - 23 k, 22.5 k, and 24.5 k VI are about 30 seconds before MECO on the three-engine uphill, TAL, and two-engine uphill cases respectively. Note that VI indication is lost to the crew post-engage.
    - Shutdown with A/C switches will always cause a data path failure.
- SSME Helium Isolation
    - MPS ENGINE POWER switches look very similar to He ISOLATION switches and are located close together on panel R2. **Use caution.**
    - Loss of ALC 1, 2, 3 (APC 4, 5, 6) will cause SSME helium isolation A to close on the C, L, R SSME with no direct indication to the pilot. Do not attempt subsequent helium leak isolations.

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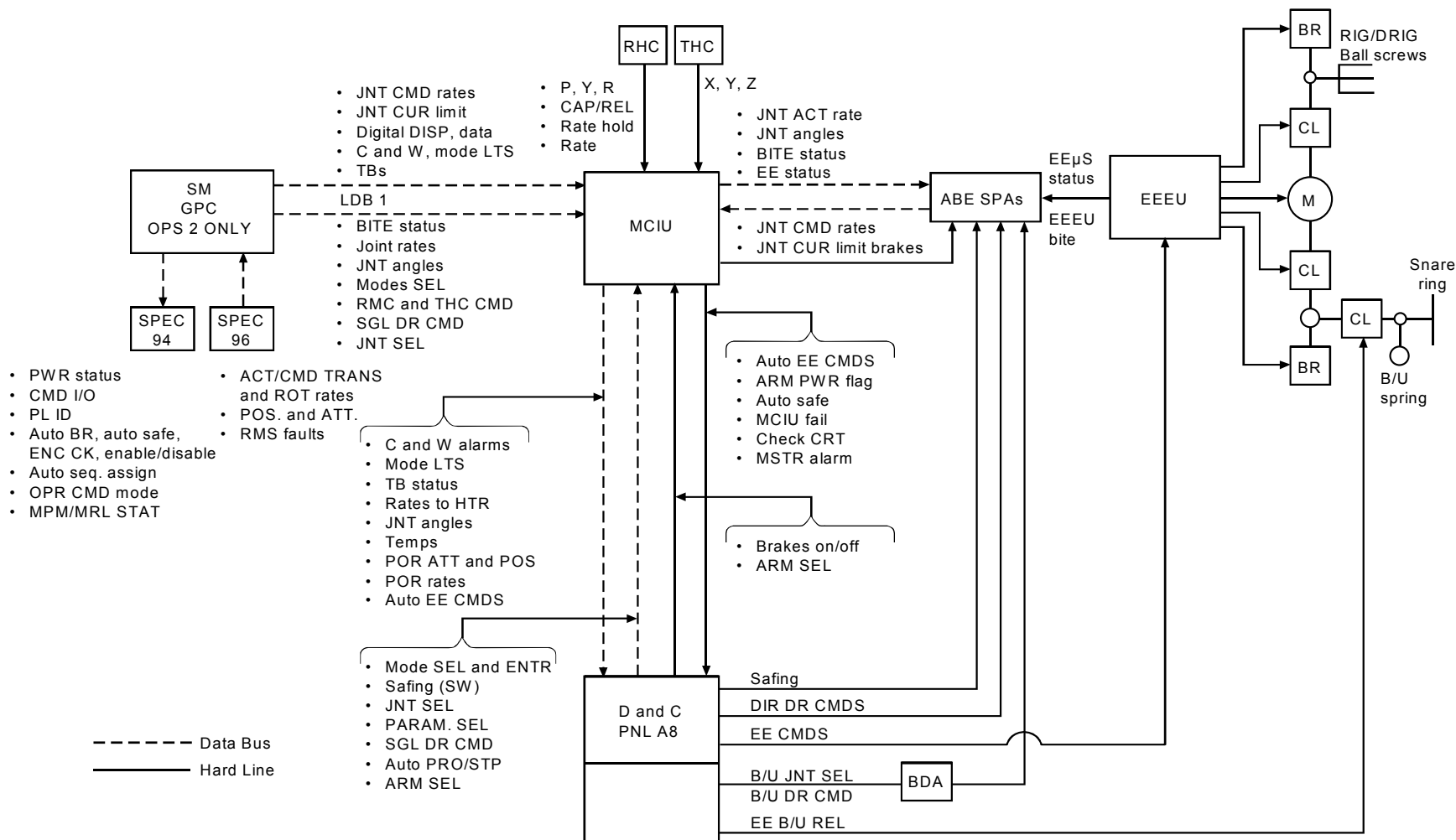
### 3.12 RMS

#### 3.12.1 RMS Components



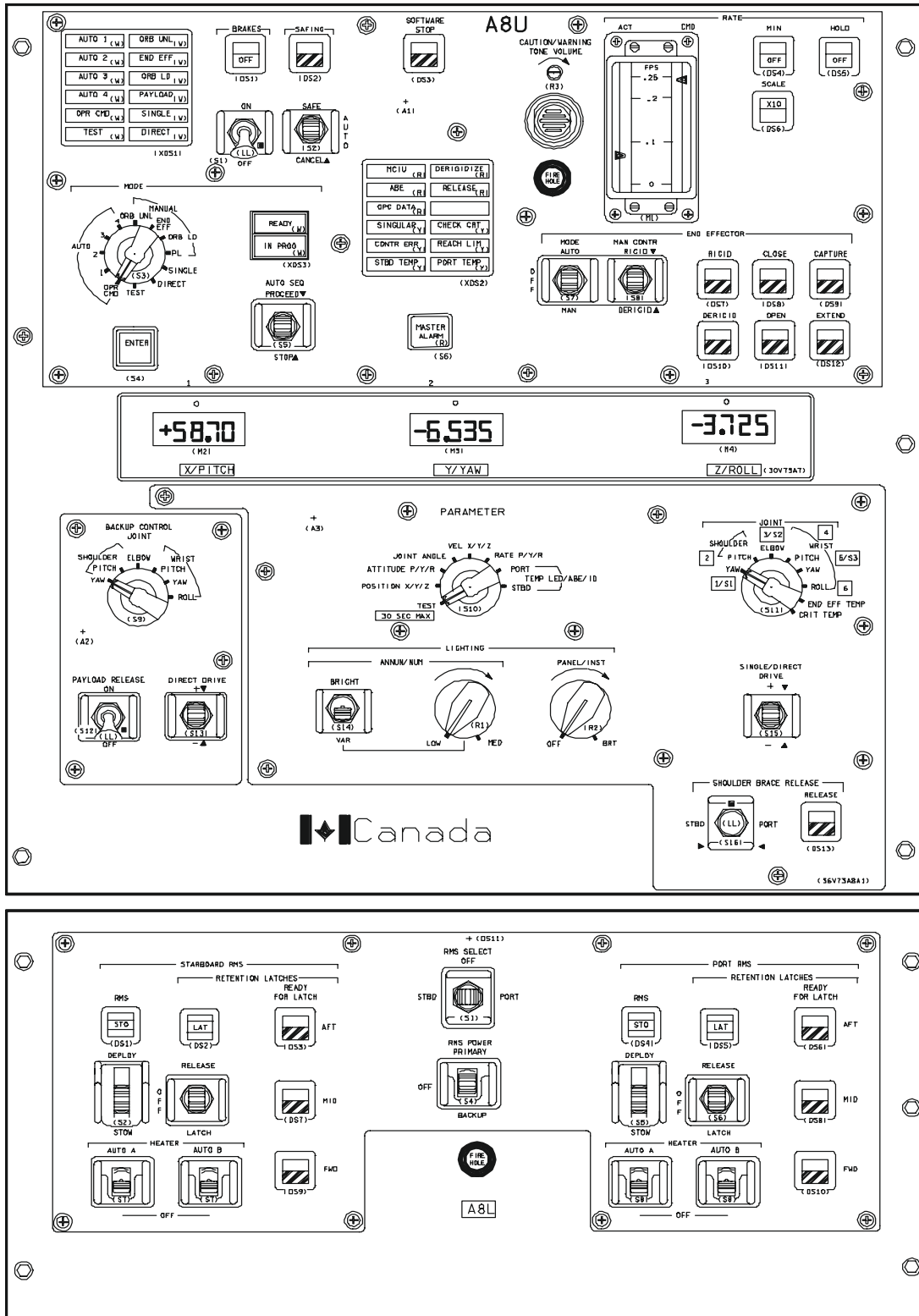
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### 3.12.2 Overview Schematic



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### 3.12.3 Switch Panel (A8U and A8L)



19612336, PNL, 2

### 3.12.4 Displays

```

XXXX/094/          PDRS CONTROL    XX X DDD/HH:MM:SS
                      DDD/HH:MM:SS
RMS SEL: XXXX      RMS PWR XXX      ENA INH
PORT 1X
STBD 2X          I/O ON 5X        AUTO BRAKE 9X 10X
3 PL ID XX       OFF 6X          POS ENC CK 11X 12X
4 END EFF X      POHS CNTL 28X 29X

                AUTO MODES
1          2          3          4          17 START PT XXX
13 XX     14 XX     15 XX     16 XX     LAST PT XXX

END POS          END ATT          24 PL INIT ID XX
18 X  XXXXX     21 P  XXXX
19 Y  XXXXX     22 Y  XXXX     CMD CK 25 XXXX
20 Z  XXXXX     23 R  XXXX

RMS  STO/DPLY
SHLD X X X X

RMS  LAT/REL/RDY
AFT  X X X X X
MID  X X X X X
FWD  X X X X X

                ORB LD CMD REF
                NORM FLY-CAMR FLY-PL
                31X      32X      33X

                26 WR RANGE X
                AUTO BRAKE CK 27X
    
```

```

XXXX/095/XXX      PDRS OVERRIDE    XX X DDD/HH:MM:SS
                      DDD/HH:MM:SS
MODE SW OVRD 1X
MODE SEL IND
ORB UNL 2X X     JNT SW OVRD 17X   RATE SW OVRD 26X
SINGLE 3X X      JOINT SEL VERNIER 27X
END EFF 4X X    SH YAW 18X      COARSE 28X
ORB LD 5X X     SH PITCH 19X
PL 6X X        EL PITCH 20X   AUTO SW OVRD 29X
OPR CMD 7X X   WR PITCH 21X   PROCEED 30
AUTO 1 8X X    WR YAW 22X    STOP 31
AUTO 2 9X X    WR ROLL 23X   HC AXIS CHG 32X
AUTO 3 10X X   EE TEMP 24X      THC 33X
AUTO 4 11X X   CRIT TEMP 25X    RHC 34X
TEST 12X X
ENTER 13

MCIU OVERRIDE
SAFING CAN 35X
ABE OVRD A 36X
ABE OVRD B 37X
ABE OVRD C 38X

LOADED RATE 14X
STOWED OPS 15X
SIN/DIR SW
REASSIGN 16X
    
```

```

XXXX/XXX/096      PDRS FAULTS     XX X DDD/HH:MM:SS
                      DDD/HH:MM:SS
ABE#              SY SP EP WP WY WR
MCIU#
MDA O/C X X X X X X MADC X
SPA CMTR X X X X X X MCPC X
TACH PLL X X X X X X ICF X
TACH TCO X X X X X X
CPU X X X X X X
MDA DMND X X X X X X
A/D CONV X X X X X X
BRAKE X X X X X X
POS ENC X X X X X X
DIR DRV X X X X X X
B/U RELAY X X X X X X
CHECK CRT#
DC/MCTU X
EXT FS X
EE FLAG X
EEEE X
EE CMDS X
HC X
MCIU HC X
TMP CKT X

CONTR ERROR X X X X X X
CKCRT - POS X X X X X X
REACH LIMIT X X X X X X

CKCRT - SPA# SY SP EP WP WY WR
BITE TEST XXXX XXXX XXXX XXXX XXXX XXXX
    
```

```

XXXX/XXX/169      PDRS STATUS     XX X DDD/HH:MM:SS
                      DDD/HH:MM:SS
RMS SEL: XXXX
POR REF SEL: XXX

POHS POS REF      X/P          Y/Y          Z/R
±XXXXXS          ±XXXXXS          ±XXXXXS
POHS ATT REF      ±XXX.XS          ±XXX.XS          ±XXX.XS

POSITION          ±XXXXXS          ±XXXXXS          ±XXXXXS
ATTITUDE          ±XXX.XS          ±XXX.XS          ±XXX.XS

TRANS RATES      ACT ±XX.XXS          ±XX.XXS          ±XX.XXS
                  CMD ±XX.XX           ±XX.XX           ±XX.XX

ROT RATES        ACT ±XX.XXS          ±XX.XXS          ±XX.XXS
                  CMD ±XX.XX           ±XX.XX           ±XX.XX

JOINT ANGLES
SY SP EP          END EFFECTOR
±XXX.XXS ±XXX.XXS ±XXX.XXS RIGTD CLOSE CAPTURE
WP WY WR          X X X
±XXX.XXS ±XXX.XXS ±XXX.XXS DERIG OPEN EXTEND
X X X
    
```

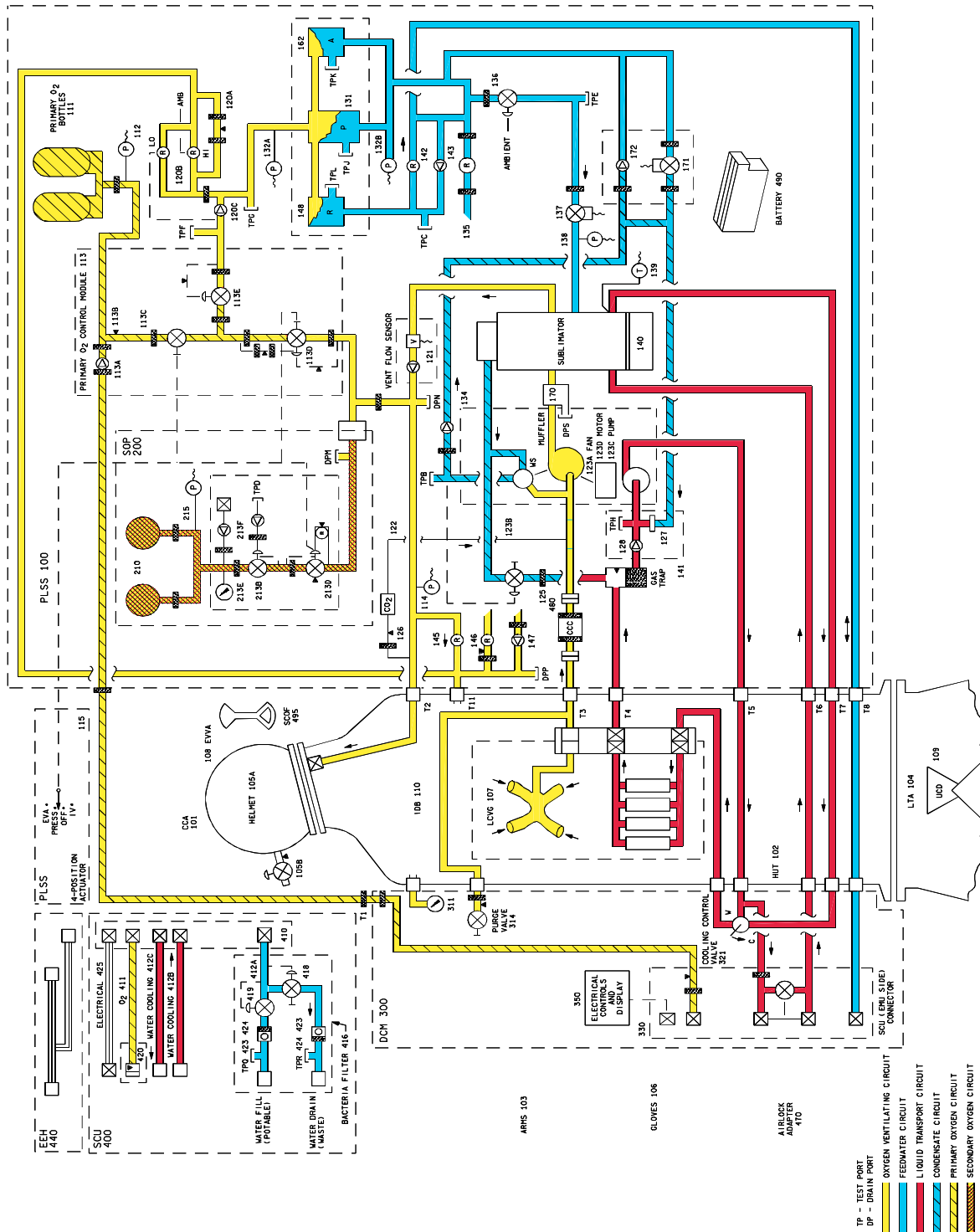


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### 3.13 EVA

#### 3.13.1 EMU Schematic



19612338-ART1.1

### 3.13.2 EVA Systems Summary

#### Communications

MODE	XMIT VOICE	RCV VOICE	CREWMAN
A	259.7	296.8 / 279.0	EV1
B	279.0	296.8 / 259.7	EV2
BACKUP	259.7	296.8 / 259.7	(Both)

#### Oxygen System

Primary		Secondary	
Description	Specification	Description	Specification
Storage Quantity	1.217 lb @ 850 psia and 90°F	Storage Quantity	1.217 lb @ 850 psia and 90°F
Storage Pressure EVA mode IVA mode	75 to 1050 psia 850 to 1050 psia	Storage Pressure EVA mode IVA mode	75 to 1050 psia 850 to 1050 psia
Regulated Outlet P EVA/PRESS mode IVA mode	4.3 ± 0.1 psid 0.9 ± 0.5 psid	Regulated Outlet P EVA/PRESS mode IVA mode	4.3 ± 0.1 psid 0.9 ± 0.5 psid
Use rate	0.02 to 0.33 lb/hr	Use rate	0.02 to 0.33 lb/hr
Feedwater tank regulated pressure	15.0 ± 1.0 psid	Feedwater tank regulated pressure	15.0 ± 1.0 psid

#### O2 Actuator Operations

<b>OFF</b>	Shutoff valve closed. No O2 flow into ventilation loop
<b>IV</b>	O2 flow from primary O2 tanks through O2 shutoff valve and suit pressure regulator. Maintain pressure between 0.4 - 1.4 psid. SOP cannot flow. There is flow through the water pressure regulator. Reg at 15 psid.
<b>PRESS</b>	Increase suit pressure to 4.3 ± 0.1 psid. SOP cannot flow. There is flow through the water pressure regulator. Reg at 15 psid.
<b>EVA</b>	Pressure maintained at 4.3 ± 0.1 psid. SOP comes on-line automatically if suit press falls below 3.9 psid. There is flow through the water pressure regulator. Reg at 15 psid.

#### LiOH Cartridge Specifications

Description	Specification
Max operating pressure	6.7 psig (8.8 psig for 2000 series cartridge)
Leakage	10 ssc/hr (max) at 6.5 psig
CO <sub>2</sub> removal	1.48 lbs (max)
CO <sub>2</sub> partial pressure	<7.6 mmHg for 1 hr at 1600 Btu workload <15 mmHg for 15 min at 2000 Btu workload
Weight	6.4 lb

#### CO2 Transducer

Parameter	Range
Partial Pressure Range	0.1 - 30 mm Hg (normal ~0.3 mm Hg)
Error Band	±2.5% FS (±.7 mm Hg) from 2-10 mm Hg ±5% FS (±1.5 mm Hg) from 1-2 and 10-30 mm Hg
Response Time	4 min maximum to reach 63% of output when exposed to step change in CO <sub>2</sub>

**Liquid transportation system**

Description	Specification
Flow	2.0 to 240 lb/hr
Nominal pressure	15.0 ± 1.0 psi above ambient
Maximum operating pressure	22 psid
Pressure drop	2.0 psi at flow rate of 240 lb/hr (includes both sides of multiple water connector)
Leakage	0.58 cm <sup>3</sup> /hr at 17.7 psid
Metabolic heat rejection through sublimator Minimum	400 Btu/hr for 30 min followed by 700 Btu/hr for 30 min
Maximum	1600 Btu/hr for 1 hr 2000 Btu/hr for 15 min

**Feedwater/Reserve water tanks**

Description	Specification
Pressure (primary/reserve)	~15 psig
Capacity Primary	9.0 lb H <sub>2</sub> O
Reserve	1.0 lb H <sub>2</sub> O (about 30 min of use)
Storage quantity (deliverable)	10.0 lb (including reserve)
Storage pressure	15.0 ± 1.0 psid (as regulated by primary O <sub>2</sub> system)
Maximum operating pressure	19.0 ± 1 psid
Recharge pressure	8 to 15 psig (PLSS) 11 psig nominal

**EMU Battery Specifications**

Description	Specification
Voltage	16.5 - 16.8 V dc (nominal)
Current	3.6 - 3.8 amp (nominal)
Power	26.6 amp-hr (minimum)
Weight	9.6 lb (wet)
Leakage	0.58 cm <sup>3</sup> /hr at 17.7 psid

**Hatches**

Attributes	A	B	C	D
General	Can open against .2 psi delta P 4" window 2 A/L equalization valves, operable either side Delta P Gauge each side ( $\pm 3$ psi error) Removable handles (rotate 440° CW/CCW to unlatch/latch from high pressure side) Dual pressure seals			
Pressure	Pressure assist for sealing Opens toward primary pressure source			Holds pressure either side
Latches	6 on low pressure side			17 on SH side
Locations	Internal A/L inner hatch	Internal A/L outer hatch, External A/L inner and outer hatch	Tunnel adapter ceiling	Between SH and Tunnel adapter, ODS hatch

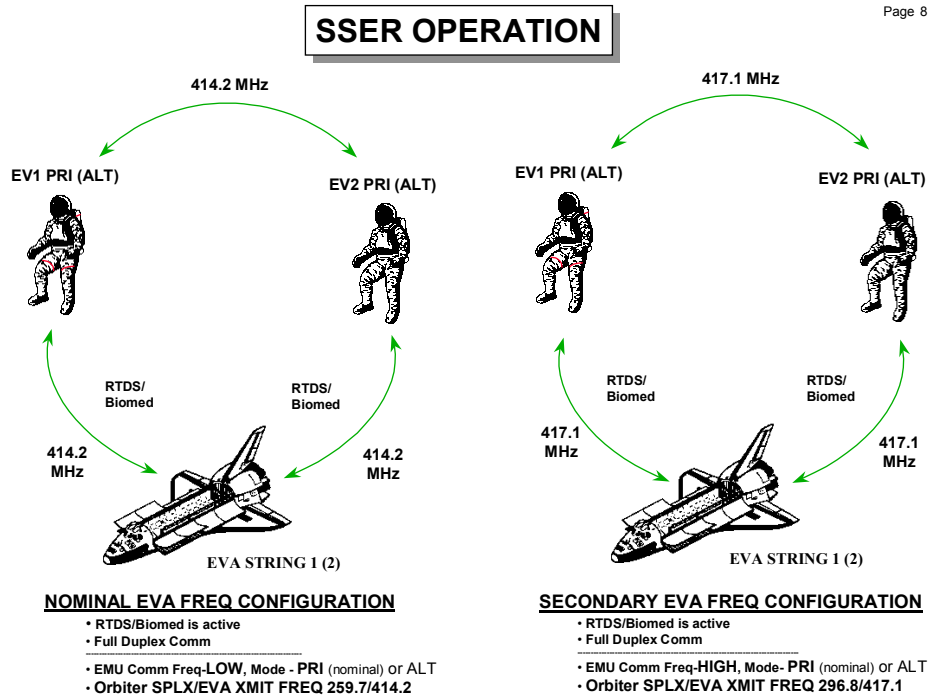
### **3.13.3 EMU/Airlock Water Collection Mode**

To configure the WCS for the EMU/Airlock water collection mode, the MODE switch is moved to the WCS/EMU position. A guard is rotated over the MODE switch to preclude WCS use, or deactivation, during the dump.

An airflow of 8 ft<sup>3</sup>/min enters the urinal, and a ballast airflow of 30 ft<sup>3</sup>/min enters the system via the debris screen. The EMU waste water is dumped through the waste water valves in the airlock, through the WCS fan separator, and into the waste tank. The WCS urinal cannot be used during the EMU dump due to possible separator flooding.

Verify Urinal Protective Screen Cap is installed prior to EMU/Airlock water collection.

### 3.13.4 EVA Comm Overview





### 3.13.5 Prebreathe Protocol

- EV 1 and EV 2 - LES prebreathe for minimum of 60 minutes.
- Cabin depress to 10.2 psia - Not initiated until EV 1 and EV 2 have completed at least 45 minutes of LEH prebreathe.
- If prebreathe is broken add 2 minutes to prebreathe for each 1 minute of interruption.
- Maintain 10.2 psia cabin for minimum of 12 hours prior to airlock depress.
- Final prebreathe

Initial prebreathe	Time at 10.2	Final prebreathe
60 minutes	24 hours	40 minutes
60 minutes	20 hours	50 minutes
60 minutes	16 hours	60 minutes
60 minutes	12 hours	75 minutes

#### 10.2 PSIA CABIN TEMP REQUIREMENTS (NORMAL 75° TO 76° F)

- Maximum temperature limits
  - Flight deck avionics - Fwd box outlet air temp limit = 130° F
  - Cabin temp maximum limit for avionics conditions above = 80° F
- Loss of FES analysis
  - Attitude for EVA: -ZLV with +XVV and -XVV (beta \_ 36°)
  - Typical radiator performance (Rad out temp)

	<u>Cool side, °F</u>	<u>Warm side, °F</u>	<u>Cabin, °F</u>
Both stowed	42.5	45.5	79-80
Both deployed	39.0	45.0	76-78
Warm side deployed	42.5	45.0	78.5-79.5
Cold side deployed	39.0	45.5	77-78

#### PRESSURE ALT VERSUS PSIA

Alt (Kft)	P (psi)
0	14.7
10	10.2
15	8.0
20	6.4
30	4.3
40	2.7
50	1.6

### 3.13.6 Decompression Sickness

TBS (include BTA operation on page 2.11-5 of Final, Rev B)

#### A. Background

Test data show incidence of bends symptoms vary with prebreathe protocol, activity after depress, and the individual. Statistical predictions are based on test results and nitrogen bubble theory referenced to a mean tissue number (the R value). Predictions show that with the Shuttle 10.2 or 4-hour protocol the probability of mild symptoms, such as simple limb pain, is 30 percent; the probability of severe symptoms, enough to abort an EVA and/or require hyperbaric treatment, is about 5 percent. This is consistent with JSC chamber trials where the mild symptoms were all in the legs. All EVA astronauts have two chamber runs prior to flight. No bends symptoms have been reported on any Shuttle EVA to date.

JSC chamber testing (3 days at 10.2 with EVA's every day) showed incidence of bends symptoms went down over time. This suggests that the longer the stay at 10.2 the better, and EVA's on subsequent days are not a problem.

There have been 13 EVA's and 123 chamber runs with astronaut subjects. One EVA used the 4-hour protocol and the other EVA's the 10.2 psia cabin. Roughly 50 chamber runs used 3-hour prebreathe while the rest of the chamber runs used 10.2. All chamber runs were in EMU's. No bends symptoms have been reported; however, mild bends symptoms may have been masked by EMU pressure point discomfort.

There is no statistically significant data indicating a difference between male and female susceptibility to bends symptoms.

JSC chamber data on 14.7 pure O2 prebreathe show

O2 prebreathe time	Percent mild symptoms	Percent severe symptoms
3.5 hours	30	7
6.0 hours	10	0
8.0 hours	0	0

Air Force data show that most bends symptoms are relieved by a return to normal pressure (14.7). Severe symptoms may require hyperbaric treatment and may occur after repress. Usually 1.5 to 2 atmospheres is sufficient but up to 6 is the standard treatment. The bends recovery apparatus (BRA) can reach 1.6 atmosphere.

Ref:

Lambertsen: Minutes, Environmental Science Review Committee. 12/2/86

Waligora: Review of Altitude Decompression Sickness Protection Plan Prior to EVA. SD5 memo, 10/22/86.

#### B. Treatment Plan

(Summarized from MED Checklist, Generic, 1/25/88)

1. Notify MCC (surgeon) of symptoms
    - a. Type I - Abnormal sensation in arms and legs, followed by dull or throbbing pain in joints, muscles, and bones, numbness, and tingling
    - b. Type II - Dizziness, visual defects, speech defects, uncoordinated movement, loss of consciousness
    - c. Type III - Chest pain, difficulty in breathing
    - d. Other - Skin rash, itching, swelling
  2. Terminate EVA
  3. Repress airlock to cabin press (press in suit = 4.3 psig, 14.5 psia)
  4. If symptoms resolved
    - a. Doff EMU
    - b. Limit activity
    - c. Drink fluids (32 ounces minimum)
    - d. Administer supplemental O<sub>2</sub> for 2 hours
  5. If symptoms not resolved
    - a. Repress cabin to 14.7 (press in suit = 4.3 psig, 19.0 psia)
    - b. If symptoms resolved, treat per step 4
    - c. If symptoms persist
      - i. Drink fluids (32 ounces minimum)
      - ii. Don EMU (except helmet)
      - iii. Treat with BRA (suit press 8 psig, 22.7 psia) OR
      - iv. If BRA not available, don helmet, press to 4.2 psig (19.0 psia)
      - v. Continue treatment for 2 hours
      - vi. Contact MCC surgeon
      - vii. Early deorbit may be required
- C. Bends Treatment Apparatus

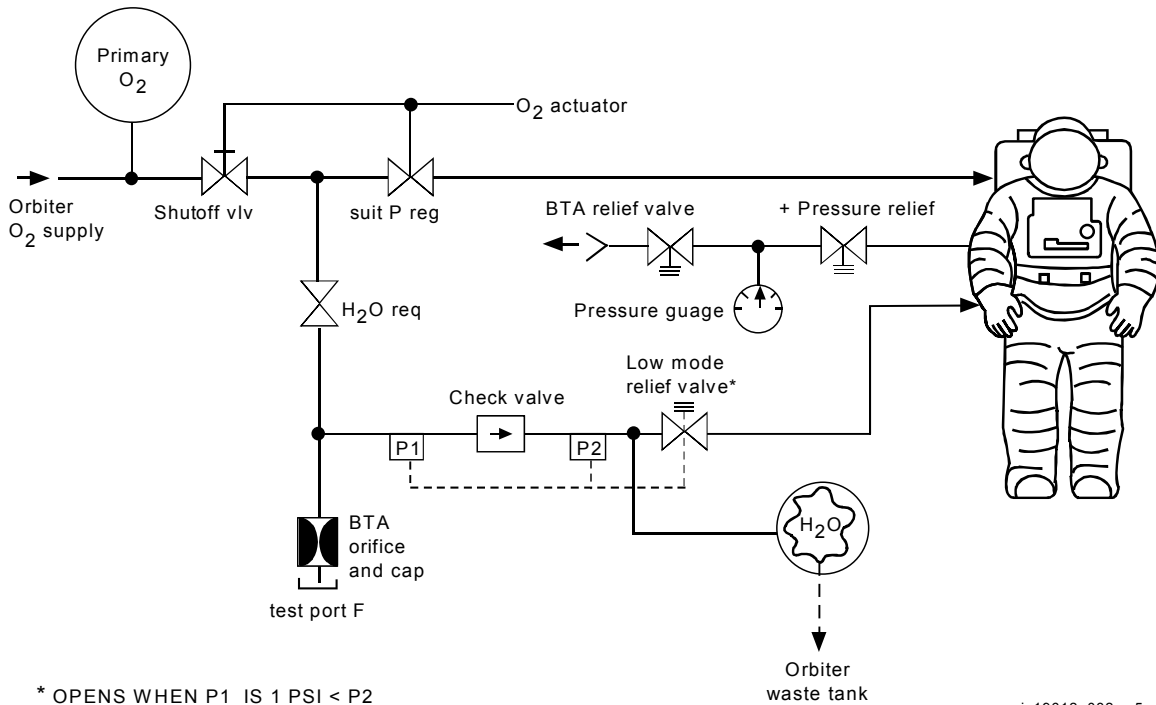


Figure 3.13.6-1: Bends Treatment Apparatus

The bends recovery apparatus (BRA) has been replaced by the bends treatment apparatus (BTA). The BRA consisted of a special helmet and regulator and was only flown when an EVA was planned. The BTA consists of an 8-psi relief valve and a capped orifice. It is flown on all flights.

#### BTA Operation

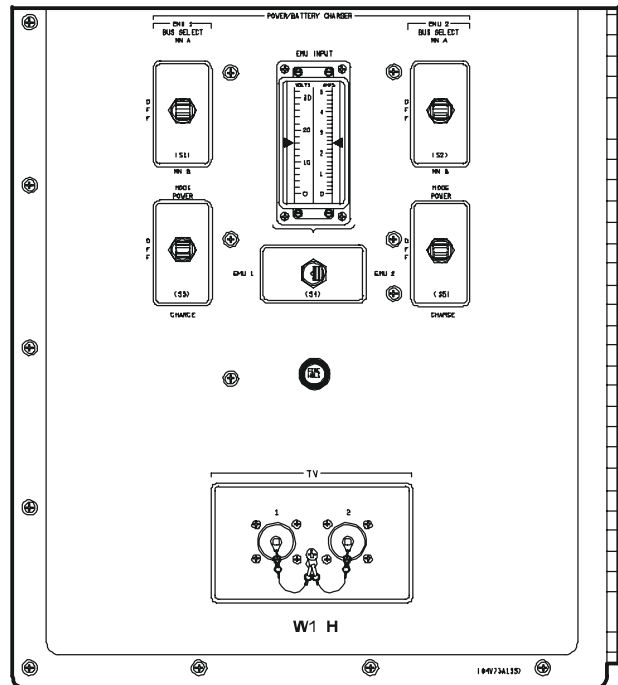
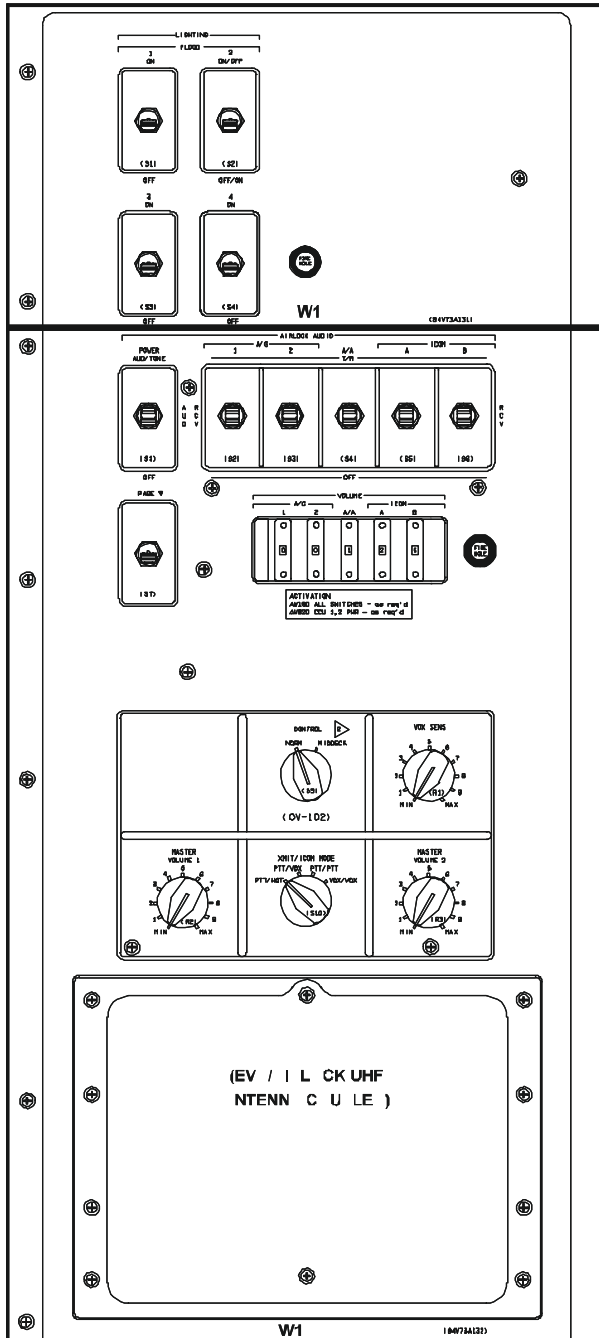
1. Install the BTA 8-psi relief valve over the normal 5.1-psi relief valve.
2. Remove the cap on the BTA orifice located at test port F.

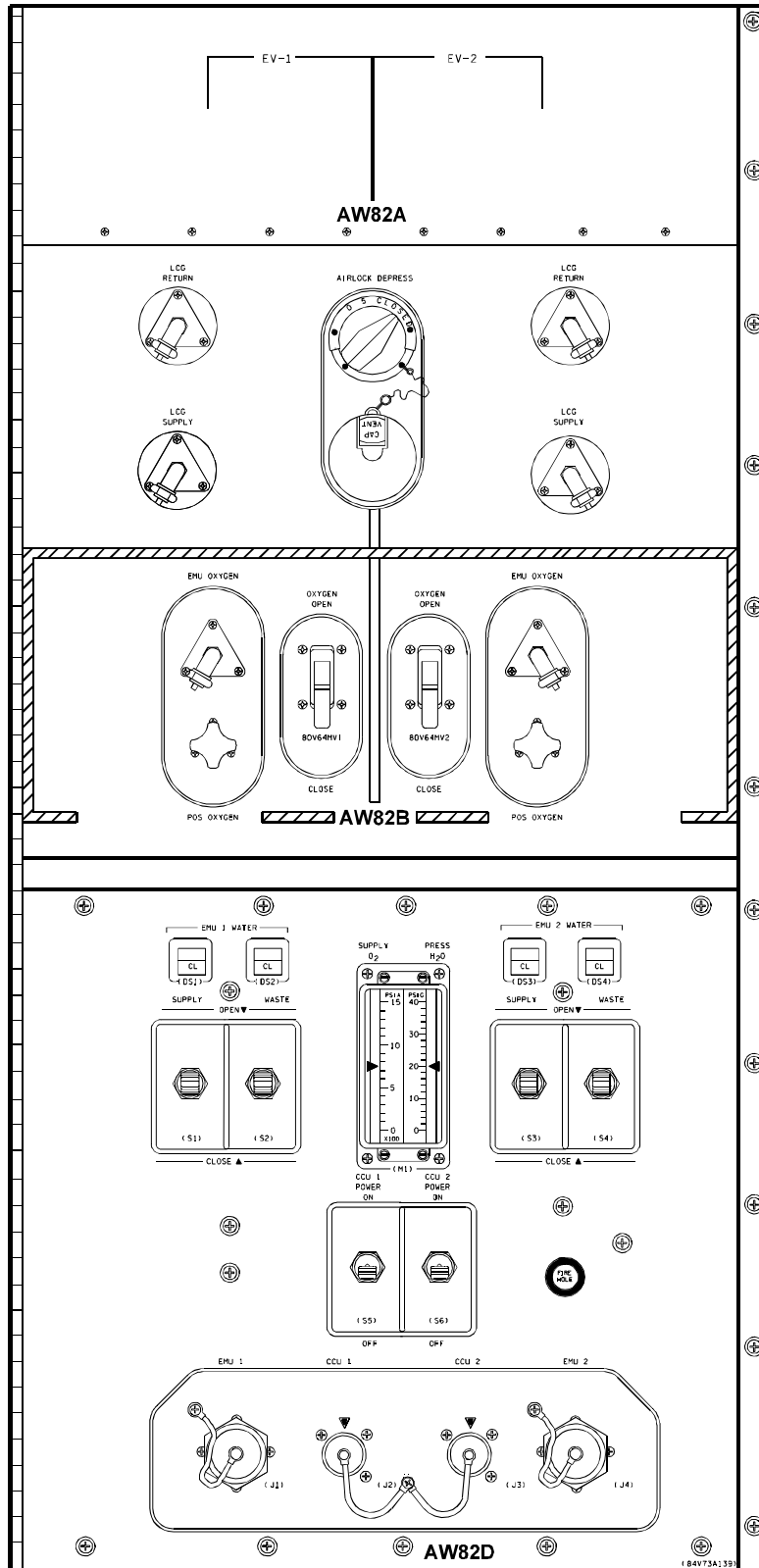
The orifice causes the H<sub>2</sub>O tank pressurization O<sub>2</sub> to relieve into the suit when O<sub>2</sub> actuation is OFF. The 8-psi relief valve causes the suit to relieve at 8 psi versus the normal 5.1 psi. Moving the O<sub>2</sub> actuator to ON changes the H<sub>2</sub>O tank to 15 psi. Moving it to OFF relieves the tanks into the suit. By cycling the O<sub>2</sub> actuator suit pressure can be built up to 8 psi.

### **3.13.7 Decontamination**

TBS

3.13.8 Switch Panels (AW18A, AW18D, AW18H, AW82A, AW82B, AW82D)





19612513, PNL 8 1

### 3.13.9 Displays

XXX/XXX/177		EXTERNAL AIRLOCK XX X		DDD/HH#MM#SS	DDD/HH#MM#SS
EXT A/L PRESS	XX.XXS	VESTIBULE			
A/L-VEST ΔP	XX.XXS	DEP VLV 1	XX/XX		
		ISOL VLV 1	XX/XX		
INTERNAL TEMP		DEP VLV 2	XX/XX		
UPR BKHD T	XXXS	ISOL VLV 2	XX/XX		
LWR BKHD T	XXXS	TEMP 1/2	XXX/XXX		
EXTERNAL TEMP					
AFT STRUC T	XXXS				
H2O LINE TEMP					
	ZN1	ZN2			
H2O SPLY T	XXXS	XXXS			
LCG2 SPLY T	XXXS	XXXS			
QD PNL T		XXXS			
H2O LINE PRESS					
	1	2			
LCG SPLY P	XX.XXS	XX.XXS			
H2O XFER P	XX.XXS				

(XX)

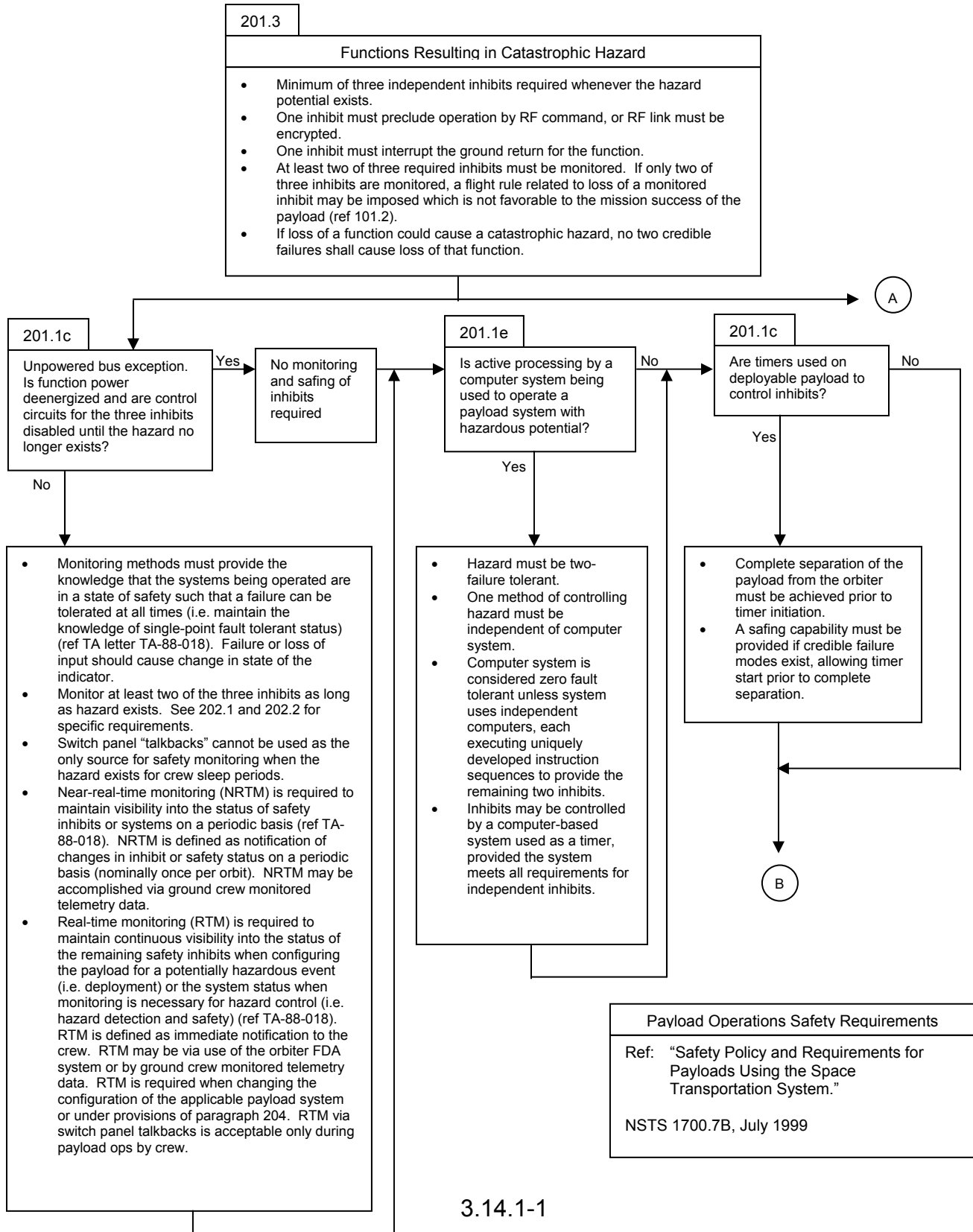


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### 3.14 P/L GENERAL

#### 3.14.1 P/L Safety Requirements Overview



201.1c

Unpowered bus exception. Is function power deenergized and are control circuits for the three inhibits disabled until the hazard no longer exists?

No

- Monitoring methods must provide the knowledge that the systems being operated are in a state of safety such that a failure can be tolerated at all times (i.e. maintain the knowledge of single-point fault tolerant status) (ref TA letter TA-88-018). Failure or loss of input should cause change in state of the indicator.
- Monitor at least two of the three inhibits as long as hazard exists. See 202.1 and 202.2 for specific requirements.
- Switch panel "talkbacks" cannot be used as the only source for safety monitoring when the hazard exists for crew sleep periods.
- Near-real-time monitoring (NRTM) is required to maintain visibility into the status of safety inhibits or systems on a periodic basis (ref TA-88-018). NRTM is defined as notification of changes in inhibit or safety status on a periodic basis (nominally once per orbit). NRTM may be accomplished via ground crew monitored telemetry data.
- Real-time monitoring (RTM) is required to maintain continuous visibility into the status of the remaining safety inhibits when configuring the payload for a potentially hazardous event (i.e. deployment) or the system status when monitoring is necessary for hazard control (i.e. hazard detection and safety) (ref TA-88-018). RTM is defined as immediate notification to the crew. RTM may be via use of the orbiter FDA system or by ground crew monitored telemetry data. RTM is required when changing the configuration of the applicable payload system or under provisions of paragraph 204. RTM via switch panel talkbacks is acceptable only during payload ops by crew.

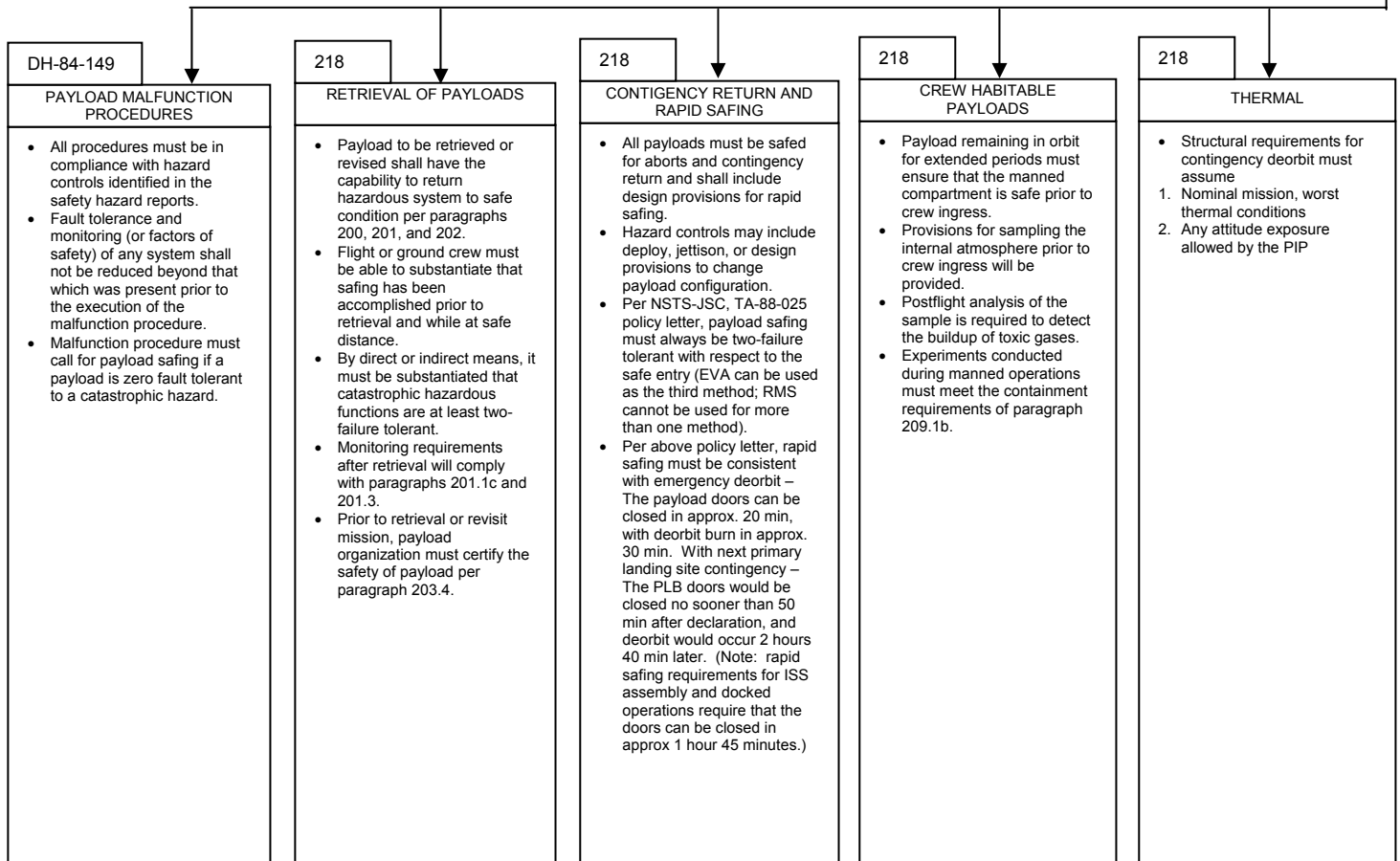
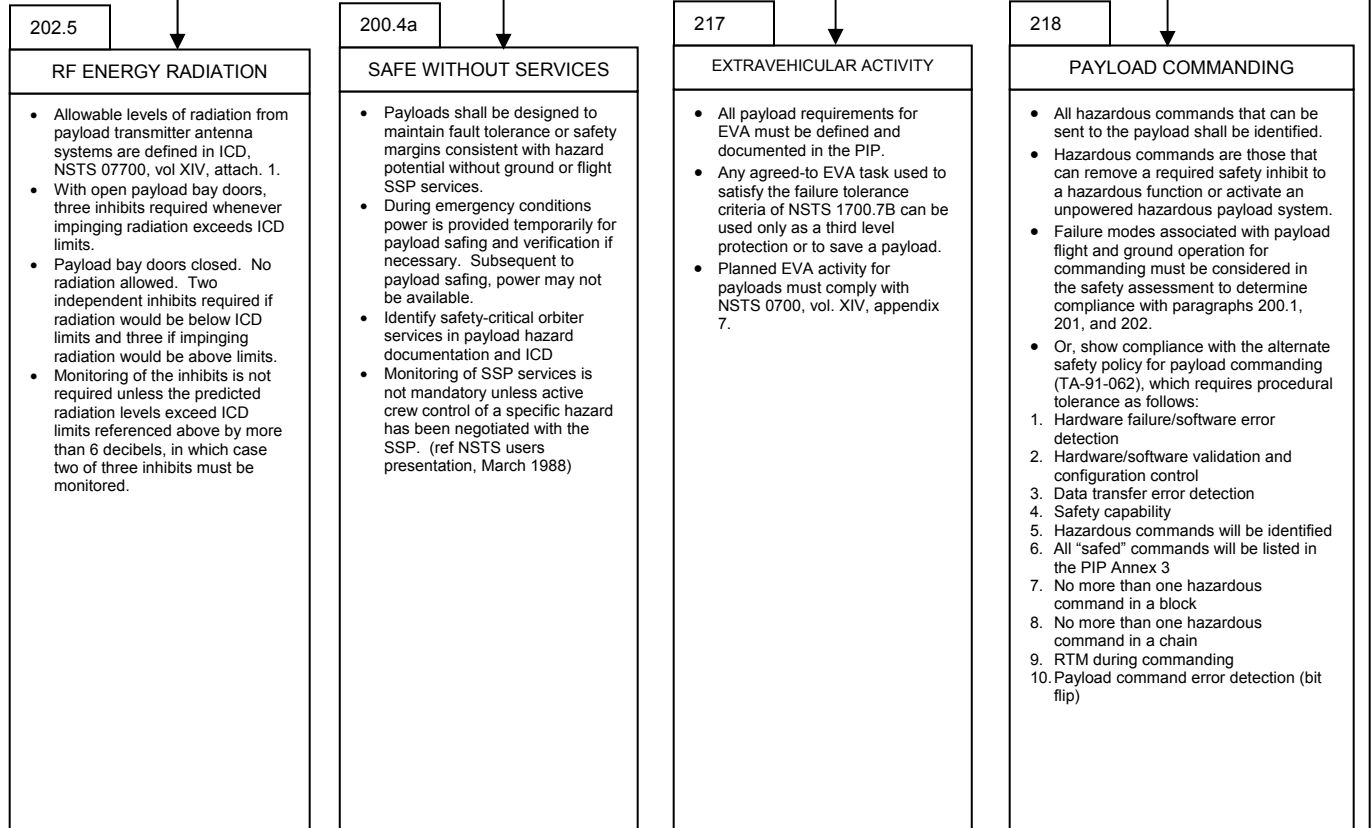
Payload Operations Safety Requirements

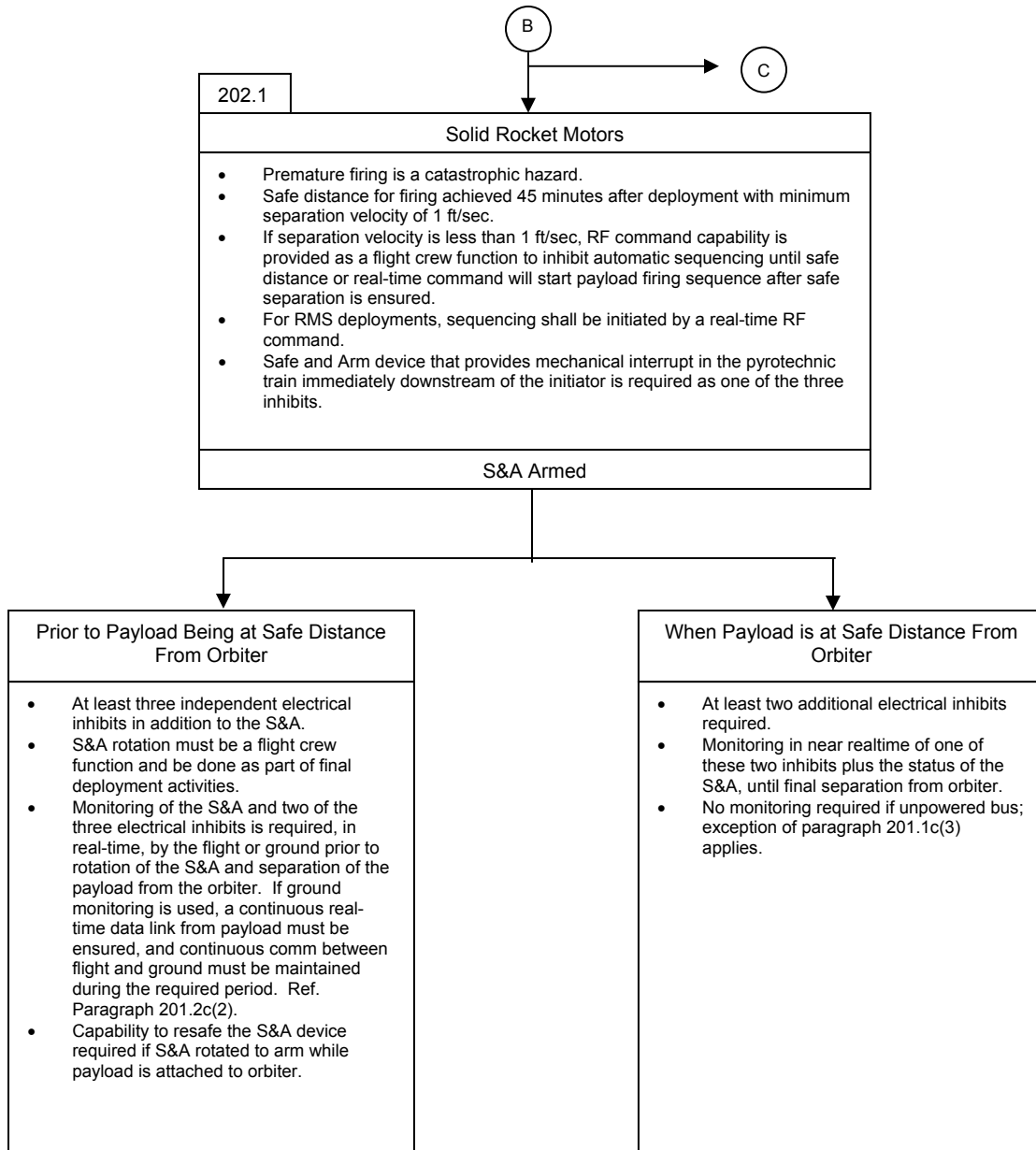
Ref: "Safety Policy and Requirements for Payloads Using the Space Transportation System."

NSTS 1700.7B, July 1999

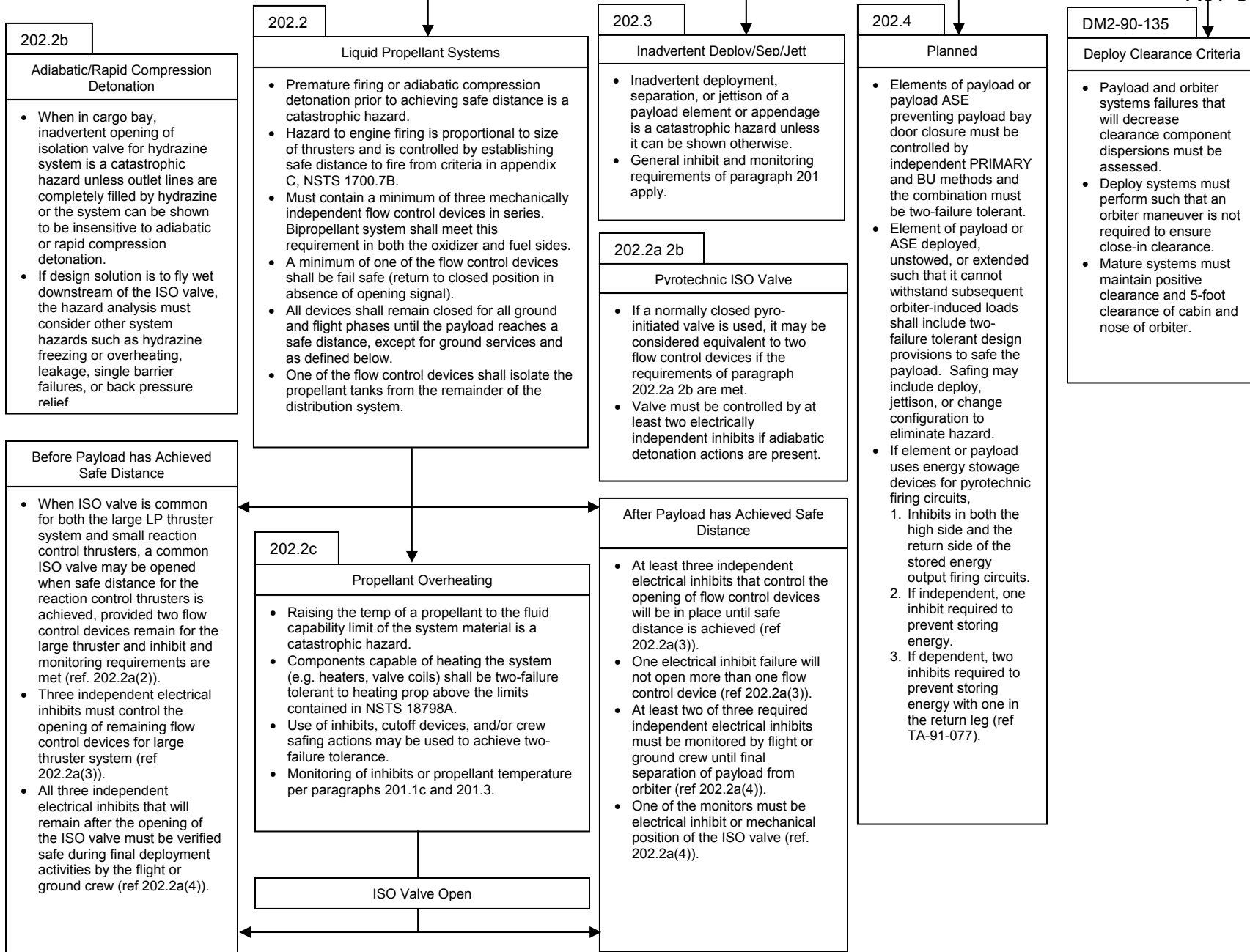
3.14.1-1

A



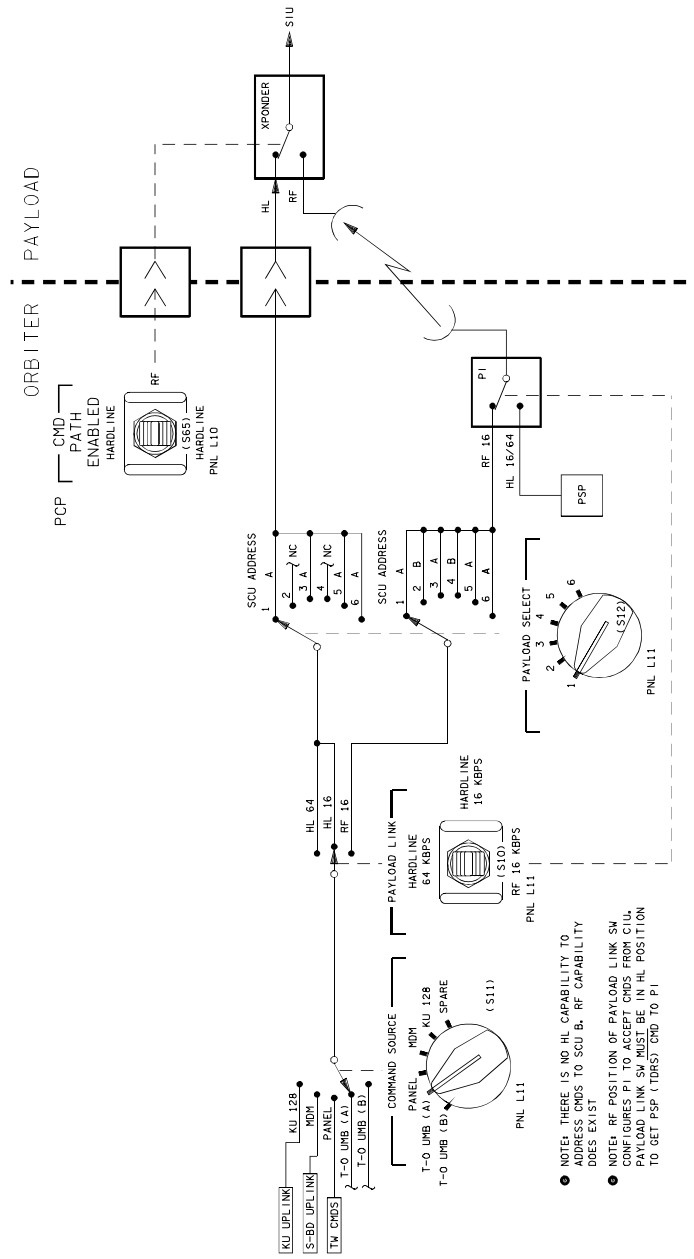


C



### 3.14.2 CIU Uplink and Downlink

CIU UPLINK FUNCTION



19612341, SCH 1

Figure 3.14.2-1: CIU Uplink Function

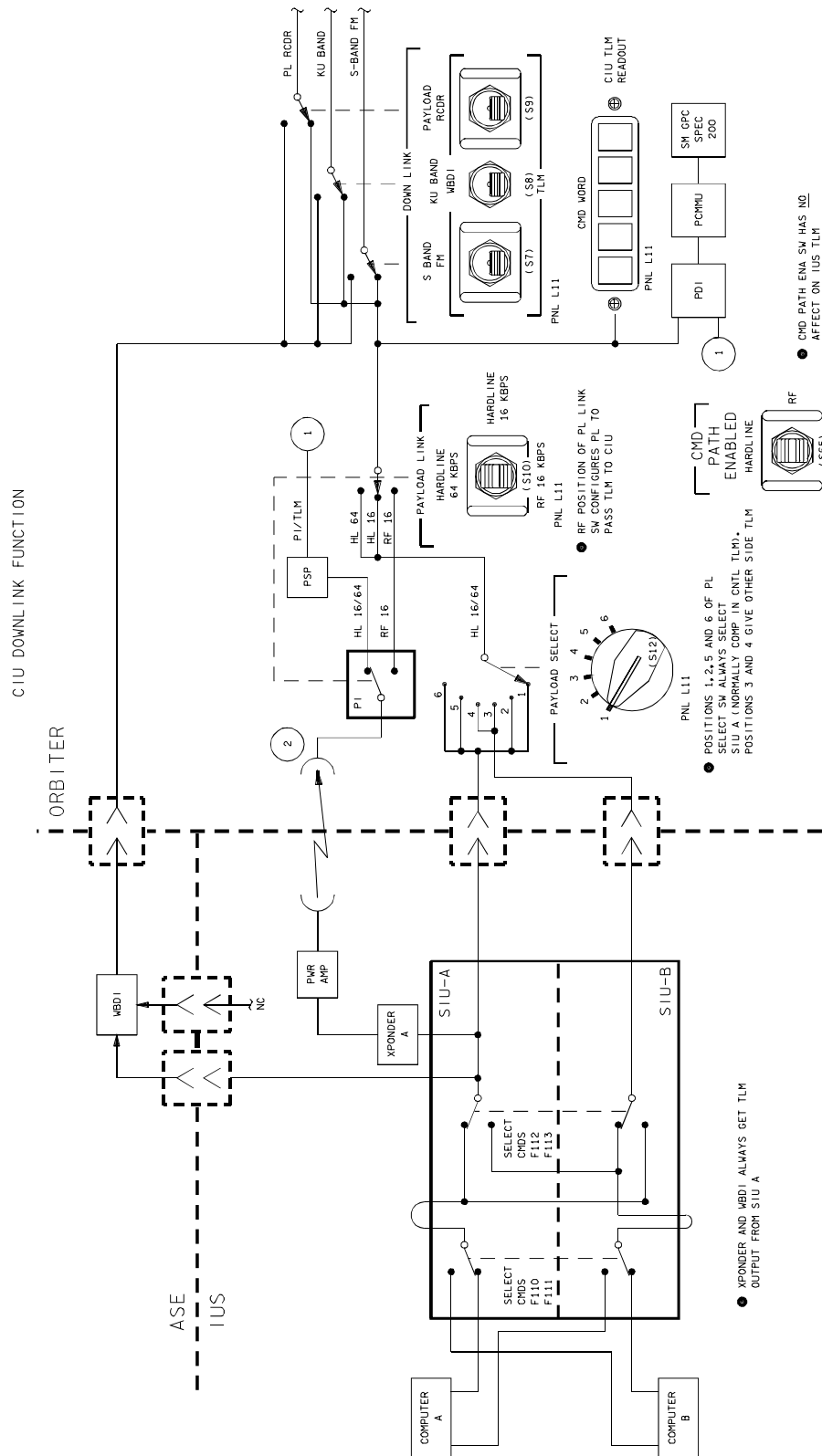


Figure 3.14.2-2: CIU Downlink Function



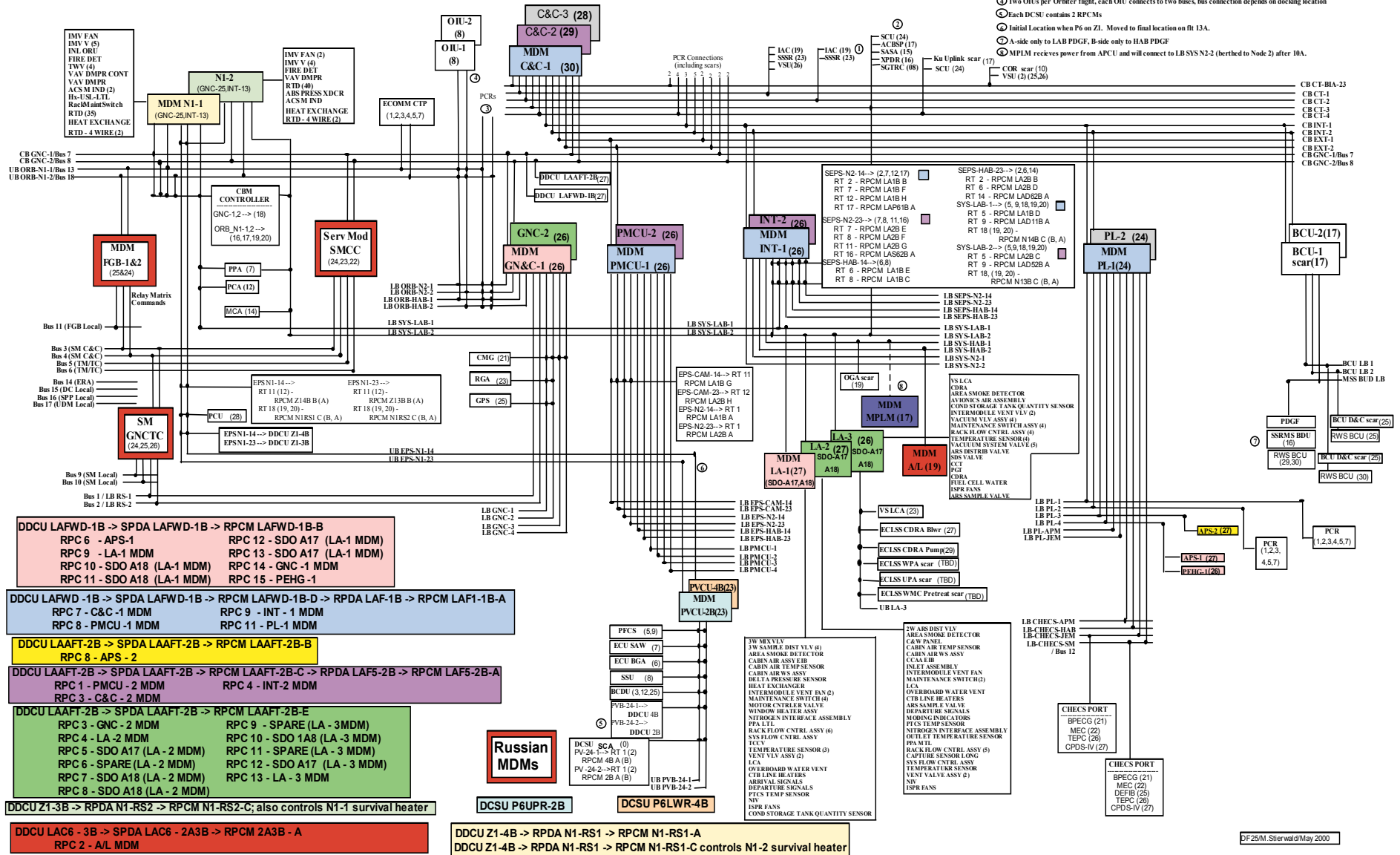
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4.1.1 7A C&DH Configuration

ISS HW/SW Integration - Flight 7A - C&DH Config.

- NOTES: Not Included: Audio, Video, PL Ethernet, HRDL, JEM, APM, Node 2, S-Band Internal Com & Ku Band Internal Com
- ① Final Location of S-Band-2 on P1
  - ② Initial Location of S-Band-2 on ZI/P6, SCU & VBSF do not move to P6
  - ③ Two PCRs per Orbiter flight, bus connection depends on docking location
  - ④ Two OUIs per Orbiter flight, each OUI connects to two buses, bus connection depends on docking location
  - ⑤ Each DCSU contains 2 RPCMs
  - ⑥ Initial Location when P6 on ZI. Moved to final location on ft 13A.
  - ⑦ A-side only to LAB PDGF, B-side only to HAB PDGF
  - ⑧ MPLM receives power from APCU and will connect to LB SYS-N2-2 (berthed to Node 2) after 10A.
  - ⑨ COR scar (10)
  - ⑩ VSI (2) (25,26)



#### 4.1.2 Crew Interface Computers at 8A

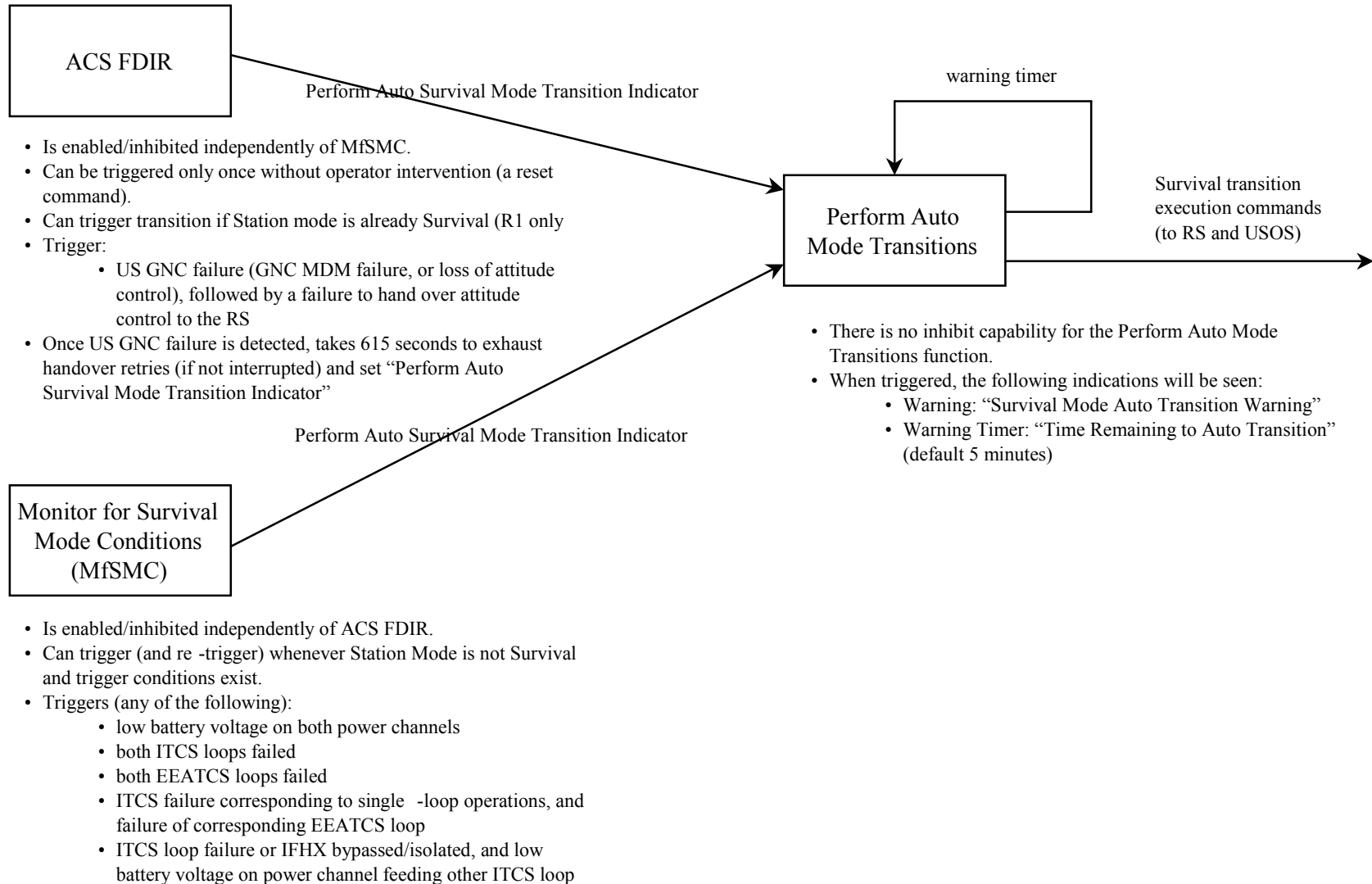
Type of crew i/f computer	Purpose	Hardware/software description	8A location
PCS	<ul style="list-style-type: none"> <li>- Execute Station mode changes</li> <li>- Manage Station C&amp;W</li> <li>- Command and Control U.S. systems</li> </ul>	<ul style="list-style-type: none"> <li>- IBM Thinkpad 760XD laptop at 8A</li> <li>- Data and Power cables</li> <li>- Various PC cards</li> <li>- 6 PCSs on Station at 6A</li> <li>- 2 general purpose printers available in U.S. lab</li> <li>- Solaris UNIX operating system</li> </ul>	PCS Ports: <ul style="list-style-type: none"> <li>- 4 in lab</li> <li>- 2 in SM</li> <li>- 2 in FGB</li> <li>- 2 in airlock</li> <li>- 2 in orbiter</li> </ul>
SSC	<ul style="list-style-type: none"> <li>- View U.S. and multi-segment electronic procedures</li> <li>- Use inventory management system</li> <li>- View and edit onboard short term plan</li> <li>- Provide standard office automation tools and other crew support software</li> </ul>	<ul style="list-style-type: none"> <li>- IBM Thinkpad 760XD laptop at 8A</li> <li>- Power cables</li> <li>- Radio Frequency (RF) PC cards</li> <li>- 1 SSC on Station at 6A (Note: 7 “early” SSCs are also available at 6A, but use an earlier version of the laptop - the IBM 760ED)</li> <li>- Windows 95 operating system</li> <li>- Additional Thinkpad will serve as file server for RF Local Area Network that allows SSCs to communicate to server</li> </ul>	<ul style="list-style-type: none"> <li>- A minimum of 3 RF Access Points are placed strategically throughout the modules to maximize RF coverage.</li> <li>-- Access Points include power supply connections.</li> </ul>
Control Post Computer (CPC)	<ul style="list-style-type: none"> <li>- C&amp;C Russian systems using combination of software and hardware switches</li> <li>- Manage Station C&amp;W</li> </ul>	1 Fixed console with interfacing laptops	SM
Russian laptop	<ul style="list-style-type: none"> <li>- Command and control Russian systems</li> <li>- Manage Station C&amp;W</li> </ul>	<ul style="list-style-type: none"> <li>- IBM Thinkpad 760ED</li> <li>- Data and power cables</li> <li>- Various PC cards</li> <li>- 1 General purpose printer for Russian segment</li> </ul>	Russian laptop ports: 4 in SM
Payload laptops and Payload rack computers	Command and control payloads	<ul style="list-style-type: none"> <li>- TBD</li> <li>- Many payload laptops run independently from the computer systems; don’t require port connectivity</li> </ul>	Payload ports: <ul style="list-style-type: none"> <li>- 4 U.S. payload ports and</li> <li>- 1 NASDA port in U.S. lab</li> <li>- TBD ports in RS</li> </ul>
RWS	<ul style="list-style-type: none"> <li>- Command and control robotics</li> <li>- Manage Station C&amp;W</li> </ul>	<ul style="list-style-type: none"> <li>- 2 fixed robotic workstations include 2 Hand Controllers and dedicated processing computers</li> <li>- A PCS connects to the robotic workstation or to various robotics ports</li> </ul>	Robotics ports for use with PCS: <ul style="list-style-type: none"> <li>- 2 in lab</li> </ul>
CHeCS	Monitor crew health	IBM Thinkpad 760XD	Crew health ports: <ul style="list-style-type: none"> <li>- 6 in SM</li> <li>- 3 in lab</li> </ul>

### 4.1.3 Station Modes

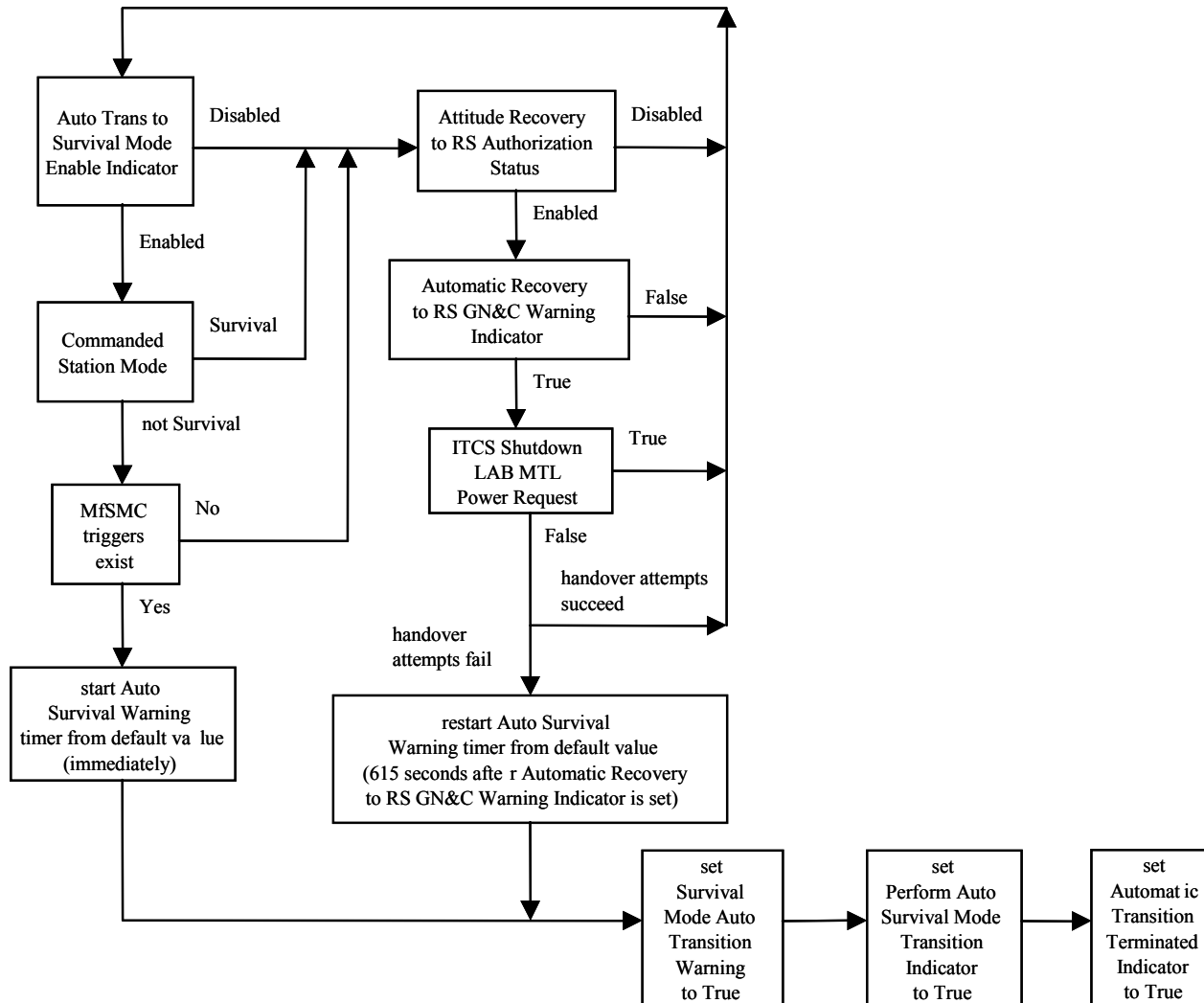
Station mode	Characteristics	Example system configuration changes
Standard	<ul style="list-style-type: none"> <li>- Supports all nominal housekeeping, internal maintenance, and nonmicrogravity payload operations.</li> <li>- Entered automatically by the software from microgravity mode, or manually by the crew or ground. Serves as gateway between microgravity, reboost, proximity operations, and external operations modes.</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to standard mode</li> <li>- Power on and activate payload computer</li> <li>- Shutdown EVA operation support equipment</li> <li>- Shutdown ARIS</li> <li>- Shutdown Mobile Transporter (MT)</li> </ul>
Microgravity*	<ul style="list-style-type: none"> <li>- Supports all microgravity payload operations.</li> <li>- Entered manually by crew or ground</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to microgravity mode</li> <li>- Shutdown Space-to-space subsystem radio</li> <li>- Startup ARIS</li> <li>- Configure GNC to CMG attitude control mode</li> </ul>
Reboost *	<ul style="list-style-type: none"> <li>- Supports Station orbit reboost operations</li> <li>- Entered manually by crew or ground</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to reboost mode</li> <li>- Configure GNC to CMG TA control mode</li> </ul>
Proximity Operations *	<ul style="list-style-type: none"> <li>- Supports all nominal rendezvous and departure operations for the orbiter, Soyuz, Progress-M and all other external vehicles.</li> <li>- Entered manually by the crew, ground or external vehicle</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to Prox Ops mode.</li> <li>- Configure space-to-space subsystem radio to orbiter mode</li> <li>- Configure GNC to CMG TA control mode.</li> </ul>
External Operations *	<ul style="list-style-type: none"> <li>- Supports all external assembly and maintenance operations involving EVAs and external robotics.</li> <li>- Entered manually by the crew or ground.</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to external ops mode</li> <li>- Configure space-to-space subsystem radio to EVA mode</li> <li>- Configure GNC to CMG TA control mode</li> </ul>
Survival *	<ul style="list-style-type: none"> <li>- Supports long-term Station operations in the presence of a major failure and lack of operator control.</li> <li>- Entered manually by crew, ground, or external vehicle OR automatically upon detection of a complete failure of critical Station functions</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to survival mode</li> <li>- Shutdown user payload support equipment</li> <li>- Shutdown ARIS</li> <li>- Shutdown EVA operation support equipment</li> </ul>
Assured Safe Crew Return *	<ul style="list-style-type: none"> <li>- Supports emergency separation and departure of the Soyuz vehicles for an unplanned crew return.</li> <li>- Entered manually by crew, ground or external vehicle</li> </ul>	<ul style="list-style-type: none"> <li>- Transition IP segments to ASCR mode</li> <li>- Shutdown user payload support equipment</li> <li>- Shutdown ARIS</li> <li>- Shutdown EVA operation support equipment</li> <li>- Command GNC to attitude selected for Soyuz departure</li> </ul>

\*Mode also supports all housekeeping, internal maintenance and non-microgravity payload operations that are compatible with the mode.

#### 4.1.4 Auto Mode Transition Initiation Process (CCS R1)



4.1.4 Auto Mode Transition Initiation Process (CCS R1) (Continued)

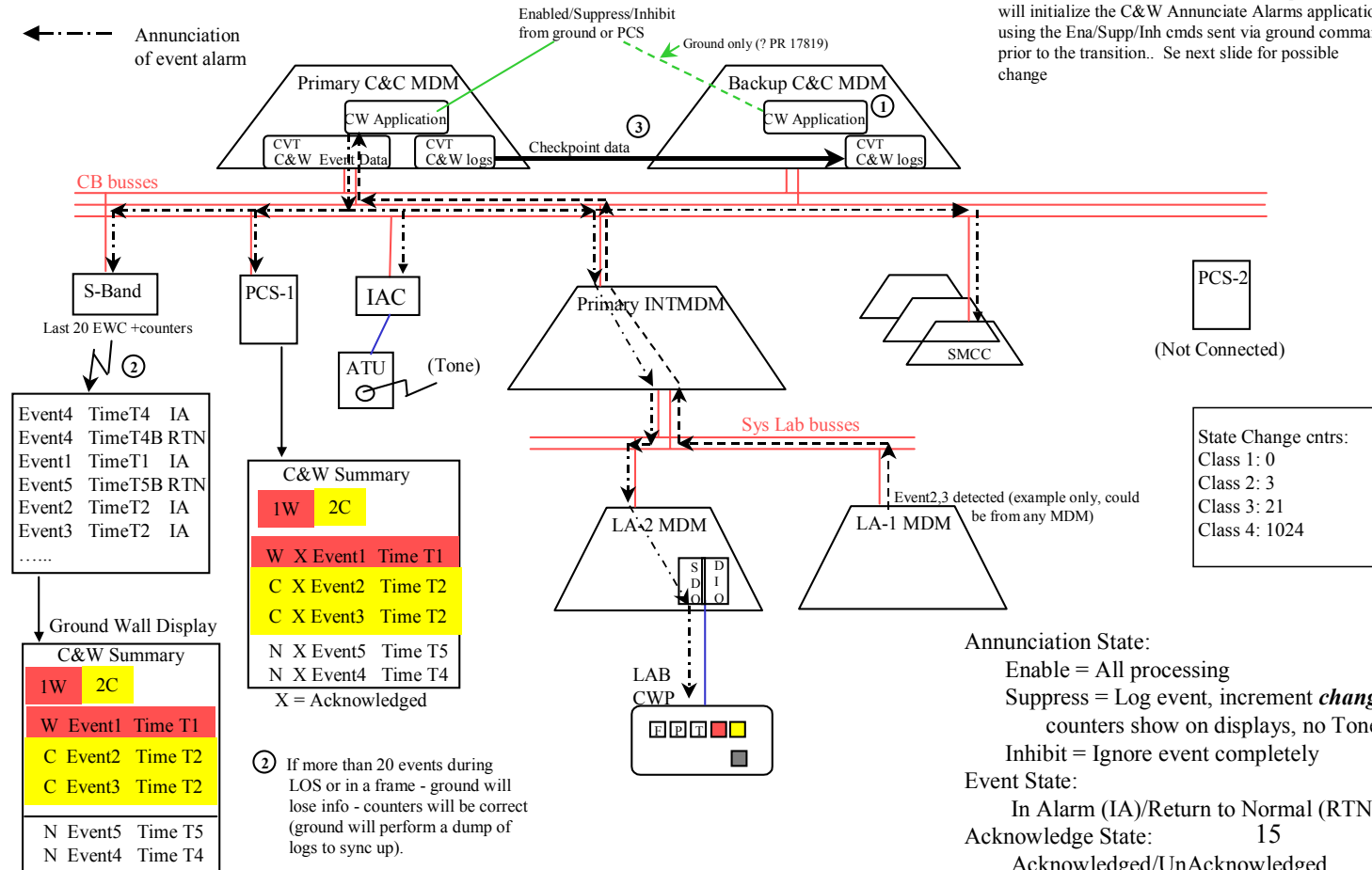


### 4.1.5 Examples of Nominal CCS C&C Configuration

#### Example of Nominal CCS C&W Config (Time = T0):

-----> Detection of alarm event - trigger here from PCS, CWP, MDM or RSOS - example shown is LA-1 MDM event

←----- Annunciation of event alarm





#### 4.1.6 C&W Definitions

Classes of alarms:

- Class 1 (Emergency), means all crew members must respond immediately and represents a threat of loss of crew or ISS

Fire

Rapid Depress

Toxic Atmosphere

Crew is prime and ground is backup

- Class 2 (Warning), means one crew member must respond immediately (“quick response”) to avoid serious loss of crew or equipment

- Crew is prime and ground is backup

- Class 3 (Caution), represents loss of functionality that has potential to threaten crew or ISS redundant equipment (this is fuzzy - some cautions such as a MTL fail require action in less than 90 minutes)

Ground is prime for cautions and crew backup

- Class 4 (Advisory), general info
- Class 5 (Robotics Advisories), as in class 4 but for Robotics only

NOTE: For CCS R1 there are approximately 71 Emergency events , 400+ Warnings, 1000+ Cautions and 1550+ Advisories

States:

- Events can be In Alarm (IA) or Return to Normal (RTN) - this is the Event State
- Events can be Enabled, Suppressed or Inhibited - this is the annunciation state - all classes including Advisories can be Inhibited/Suppressed/Enabled
- Acknowledge State (Ack) whether an operator has acknowledged or not acknowledge an event.

NOTE: The ground gets the ack state for events in the Last 20 EWC events buffer. This buffer is only updated when an event goes IA or RTN - therefore, the ground will never see the ack state until the messages RTN or performs a dump.

Counters:

- For each class:
  - Event Counter
  - Non Russian Event Counter
    - Used by the Russians to indicate location of events on the RS CWP which has additional buttons over the USOS CWP.
  - State Change Counter

### 4.1.7 ISS ATU

- Emergencies are annunciated at the full volume of 75 dB
- C&Ws can be annunciated at a variable volume of 20-75 dB

LED Display Panel - gives visual feedback to the user when a button on the key pad is pressed. Also shows call configuration ATU is in

- #1 - Enters into Public call 1; Dials Hab ATUs; 2nd 1 dials Ground channels
- #2 - Enters into Public call 2; 2nd 2 dials UHF system
- #3 - Enters into Public call 3; Dials Node 2 ATUs; 2nd 3 Dials IVA ATU in Airlock

- #4 - Enters into Public call 4; Dials Lab ATUs; 2nd 4 dials Docked Air to Ground channel
- #5 - Enters into Public call 5; Dials Centrifuge; 2nd 5 dials Docked Air to Air channel
- #6 - Dials Cupola ATU; 2nd 6 dials Docked Intercom A channel

- #7 - Dials Japanese Experiment Module; 2nd 7 dials EMU ATUs in Airlock
- #8 - Dials Columbus Orbital Facility; 2nd 8 - turns on exclusion feature (mutes that ATU speaker)
- #9 - Dials Russian segment; 2nd 9 - turns off the exclusion on feature

LOG - allows user to Log into the ATU; 2nd LOG - used with #1-7 to change brightness of that ATU display

PIN - Pressed before dialing another crew members PIN number

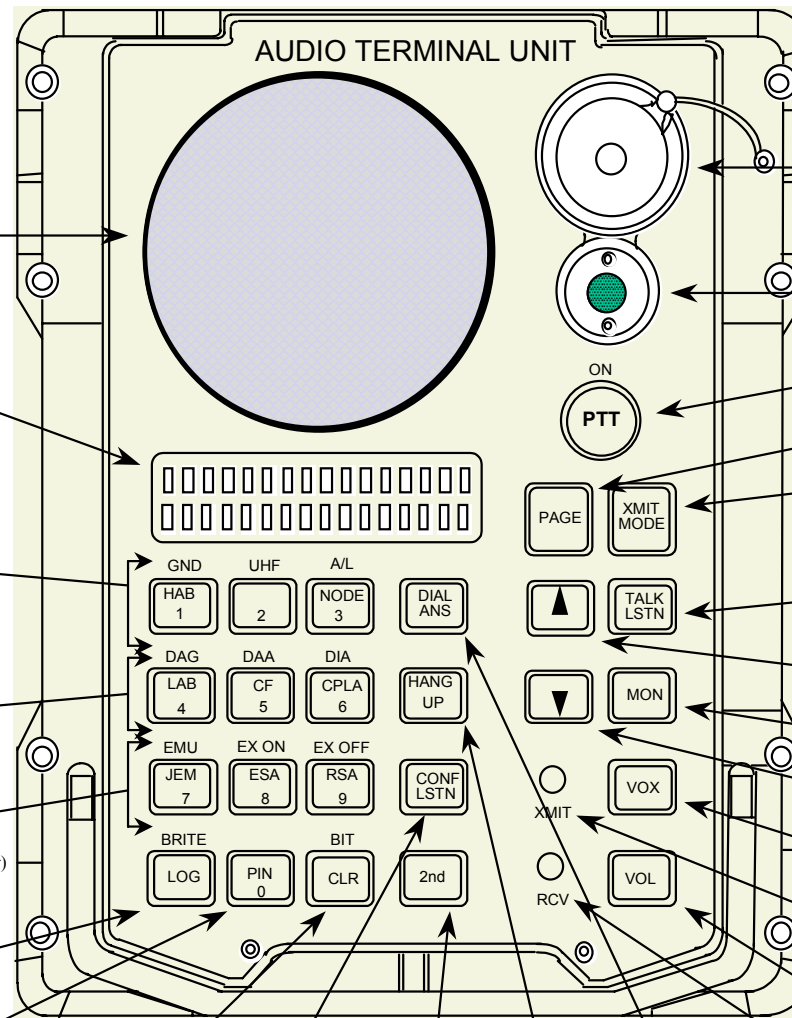
CLR - Clears any buttons pressed (like a calculator); 2nd CLR performs Built In Test on that ATU

CONF/LSTN - Pressed 1st to dial into a conference as listen only

2nd button allows each number button to have a second function (like a calculator)

HANGUP - Hangs up private call - with #, hangs up public call

DIAL/ANS - Pressed to dial into a private call or answer an incoming private call



Headset Jack

Microphone

PTT - Push To Talk - Must be held in while speaking in PTT mode  
Brings ATU to full power

PAGE - Broadcasts to all ATUs, Russian segment and Orbiter

XMIT Mode - sequences through the 3 transmit modes

TALK/LSTN - Allows adjustment of volume balance between the active public calls and the listen-only calls

Up arrow key used with TALK/LSTN, MON, VOX and VOL

MON - Used with up/down arrow keys to allow adjustment of the monitor (listen only) calls

Down arrow key used with TALK/LSTN, MON, VOX and VOL

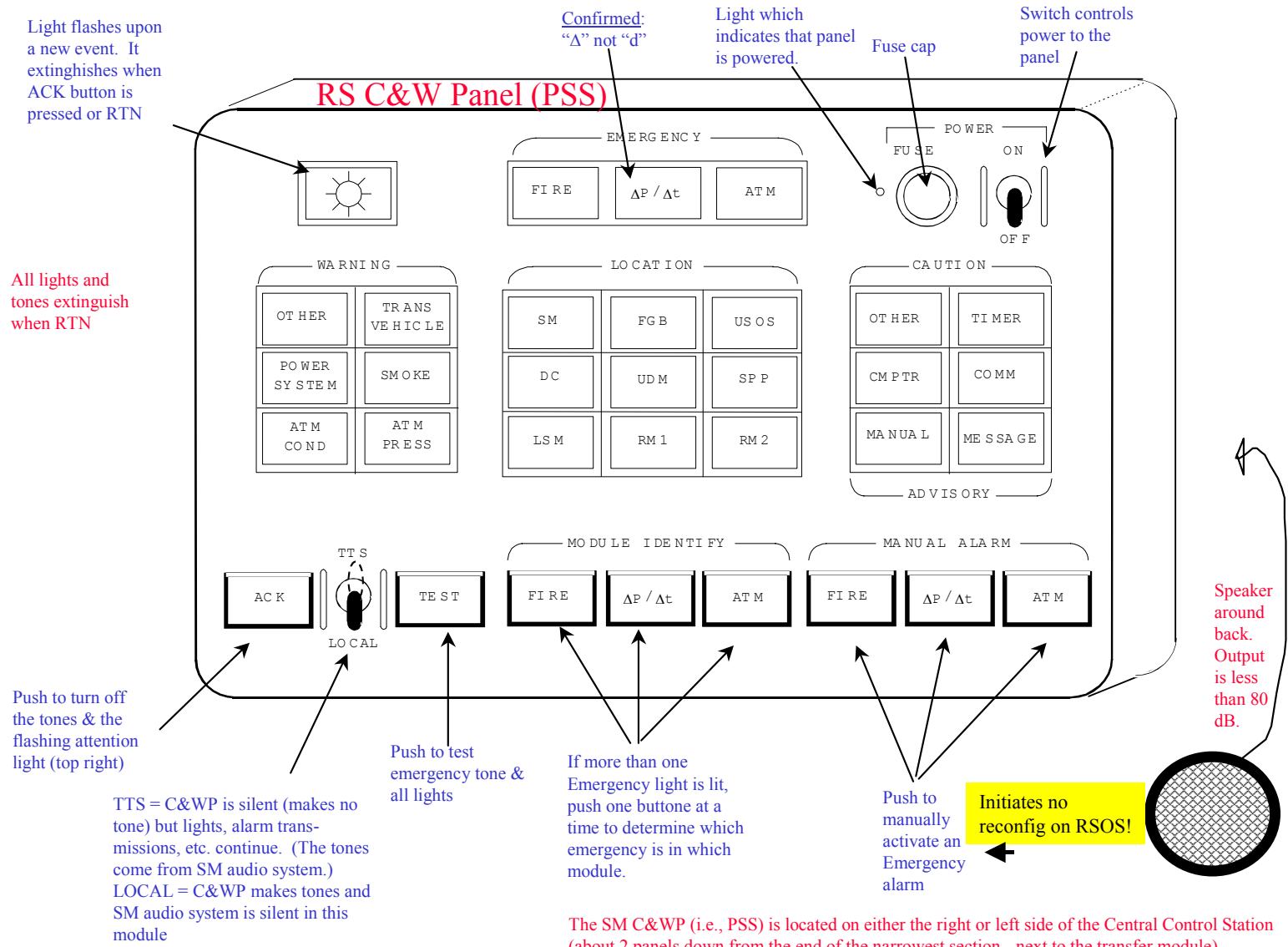
VOX (Voice activation) Used with up/down arrow keys to control the microphone sensitivity for VOX mode. More bars means more sensitive

XMIT LED is used as visual feedback of audio transmitted to the audio bus

VOLUME - Used with up/down arrow keys to control output level of speaker

RCV LED is used as visual feedback of audio received from audio bus

### 4.1.8 RSOS C&W Panel



The SM C&WP (i.e., PSS) is located on either the right or left side of the Central Control Station (about 2 panels down from the end of the narrowest section - next to the transfer module)

#### **4.1.9 RS C&W System**

Events on the RS side are annunciated by the SMCC and reported to the CCS. Non-RS events will be annunciated in 1.85 within of receipt from the CCS.

The USOS will provide Tone state & Light State at 10Hz.

NCS R1 will provide at 10Hz counter for number of events in alarm for each E,C,W, A.

CCS & NCSR2 there are two counters for each class - Station events in alarm and non-RS events in alarm.

Silencing tones on either side will set the tone state bit sent to the other sided where tones will simultaneously be silenced.

The last 20(10) EWC events are provided by CCS to SMCC via BAD.

The USOS cannot inhibit or suppress RS C&W events.

Upon a USOS MDM swapover, the SMCC will continue to annunciate tones and the USOS counters will all be re-initialized to zero.

**Section**

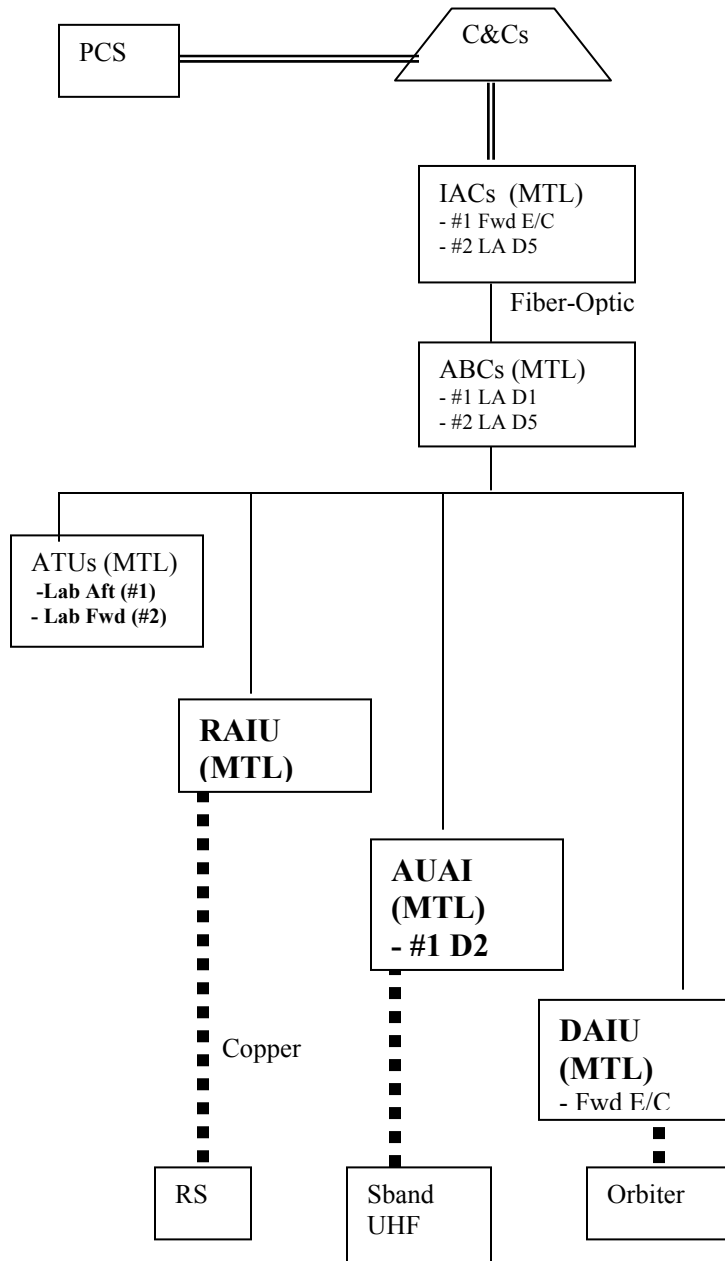
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## 4.2 COMMUNICATION SYSTEM

### 4.2.1 U.S. Audio



Internal Audio Controllers  
- Only one active at a time

Audio Bus Couplers  
- No tlm, i/f, and no ext s/w i/f  
- Only ind. for dual fail is dark ATUs  
- The system will use these as necessary  
- Powers itself off for overtemp

Audio Terminal Units  
- duplex mode requires headset  
- 5 Public calls with 12 members/call  
- Goes to stdby in 2 min. if no calls active  
- If C&C Interface is lost, Autonomous mode allows S/G comm..

Russian Audio Interface Unit  
- Identical box as DAIU (requires a "personality plug")  
- 2 duplex comm. channels  
- 2 channels for VTRs  
- Goes to stdby in 2 min. if no calls active

ACS/UHF Audio Interface  
- 2 duplex S band channels  
- 1 duplex UHF channel  
- Goes to stdby in 2 min. if no calls active  
- Either unit may be jumpered to Sband

Docked Audio Interface Unit  
- Identical box as RAIU (requires a "personality plug")  
- 4 duplex comm. channels  
- Goes to stdby in 2 min. if no calls active

### 4.2.2 RS Communications System

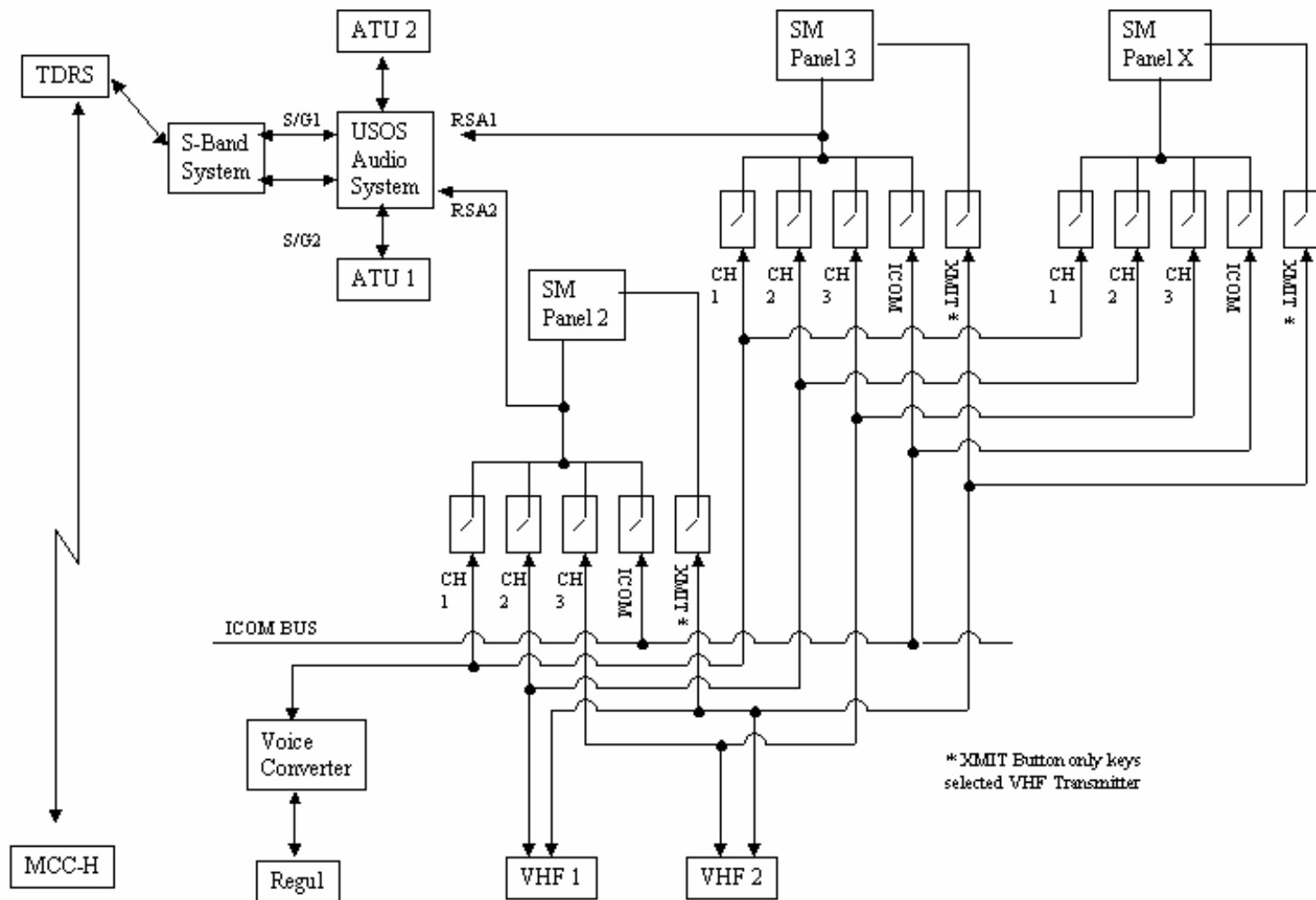


Figure 2. US/RS Audio Architecture



### 4.2.3 U.S. S-band System

- Low Data Rate (LDR): 12 Kbps telemetry (return link), 6 Kbps command forward link
- High Data Rate (HDR): 192 Kbps telemetry return link, 72 Kbps command forward link
- HDR and LDR operation requires that onboard, TDRSS and MCC all be configured correctly.
- For both data rates, coordination with the TDRSS must take place

ORU or Software	Functions
Baseband Signal Processor (Z1)	Compresses/decompresses audio, multiplexes audio and core systems data to make Channel Access Data Units (CADUs) also called Transfer Frames (fill data added as necessary), demultiplexes same data, Reed-Solomon encodes/decodes, Decrypts
Transponder (P6)	Creates a Radio Frequency (RF) carrier, receives RF signal, modulates/demodulates RF signals
Radio Frequency Group (P6)	Amplifies transmitted and received signals, transmits/receives RF signals through High Gain Antenna or Low Gain Antenna, Points HGA at TDRSS with pointing angles received from flight software
S-band Flight Software	Interfaces with GNC for pointing angles, calculates Azimuth and Elevation angles (open loop pointing), determines automatic/manual pointing, use of TDRS satellites, Handover modes. Commands automatic recovery, if <u>S-band FDIR</u> is enabled. Commands automatic recovery for Extended Loss Of Communications (ELOC).

- String 2 currently available. String 1 scheduled for 9A.
- Beam is 4.5.deg half cone.
- The antenna electrical stops are azimuth –1 deg and +136 deg (0 deg Az is straight up), elevation +236 deg (right) to –236 deg (left).
- Decryption key updates performed daily during non-critical operations per Flight Rules.
- Essential (LDR and HDR), Housekeeping 1 & 2, and Normal Data Dump (HDR only). LDR is default as Essential only, but CATO can add HK1 and HK2 at the expense of update frequency. In HDR and LDR, CATO can swap to a Contingency packet.
- Occasional temperature upper or lower limit violations of gimbals will require parking HGA to either shade with the HGA or move it aside to allow solar heating of the gimbals.
- Extended Loss of Communications is a C&C feature that will attempt to reestablish comm. if no HDR signal received within a commandable period. It may mode to LDR and/or swap between TDRS for a commandable period of time. This software has been effectively disabled by commanding the period to about 30 years, the largest value possible.

#### 4.2.4 U.S. Ku-band System

- Selectable Data Rate Options: 0, 25, 50, 75 or 150 Mbps (ground limitations allow only 50 Mbps)

##### **There are four Ku-band Antenna Pointing Modes:**

Autotrack [Nominal Mode] - The TRC will use the received TDRSS signal to identify it as a TDRS signal and automatically track the TDRS. If Autotrack Continuous Retry is enabled, the flight software will periodically check to see if the Antenna Group is communicating with a TDRS. If it is not, the flight software will mute the transmitted RF radiation and attempt to “search” for a TDRS. If the Antenna Group does not receive a TDRSS signal in three search attempts, the SGANT will stop moving. If it does find a TDRSS, it will lock on, automatically track, and begin transmitting to this satellite.

Open-Loop - The TDRSS pointing vectors are calculated in the GNC application flight software and this information is used by the Ku-band flight software to automatically point the SGANT. The flight software will continuously point the SGANT even during periods of signal blockage. SGANT RF radiation is manually muted by an operator.

Park - An operator can command the TRC to move the SGANT to a specific pointing direction at specific angular rates. Once the antenna arrives at this location, the SGANT stops, and the gimbals are still continuously commanded to maintain this position in case an external force is applied to the antenna.

Inhibit - An operator can command the TRC to immediately stop the SGANT movement. Once the SGANT stops, the gimbals are not continuously commanded to maintain the position.

In any of the pointing modes, the TRC prevents the SCANT from exceeding Elevation and Cross Elevation Gimbal stop limits stored within the TRC. The default Electrical Gimbal limits, which can be over-ridden by an operator, are  $\pm 122$  degrees Elevation and  $\pm 62$  degrees Cross Elevation. The Mechanical Gimbal limits, which is the farthest the SGANT can move, are  $\pm 125$  degrees Elevation and  $\pm 65$  degrees Cross Elevation.

Ku-band operation also requires that Ku-band bandwidth (or capacity) be configured to optimize the data transferred from payloads and the Video Subsystem which is not to exceed the maximum configured output data rate. This means the sum of all the video (and payload data) must be less than 43.2 Mbps.

The HRFM cannot accept more data than it can output. The sum of all the Bandwidth Assignment values of all the HRFM input data channels must not exceed the HRFM’s commanded output data rate, else the command will be rejected. In this example, all four of the HRFM video data channels can be commanded to 12.5 Mbps for a combined total of 50.0 Mbps. If some of the HRFM video data channels were commanded to 12.5 Mbps and other channels were commanded to greater than 12.5 Mbps, then the HRFM would reject the command from the Ku-band application flight software. Video would continue to flow according to the last valid HRFM commanded configuration.

For all Ku-band subsystem data rates, coordination with the TDRSS must take place.

VBSP Field Rate (Fields per sec)	VBSP Resolution (Bits)	HRFM VBSP CH Rate (Mbps)
60	8	64
30	8	32
15	8	16.5
7.5	8	8.5
1.875	8	2.5
0	8	0
60	6	48
30	6	24.5
15	6	12.5
7.5	6	6.5
1.875	6	2
0	6	0

There are four methods of minimizing the amount of video data to be transmitted through the Ku-band Subsystem:

Command the VBSP every time 1 video frame is needed (i.e. Freeze Frame) Continuously commanding the Ku-band to output Freeze Frames saves less than 93 percent of the Ku-band resource.

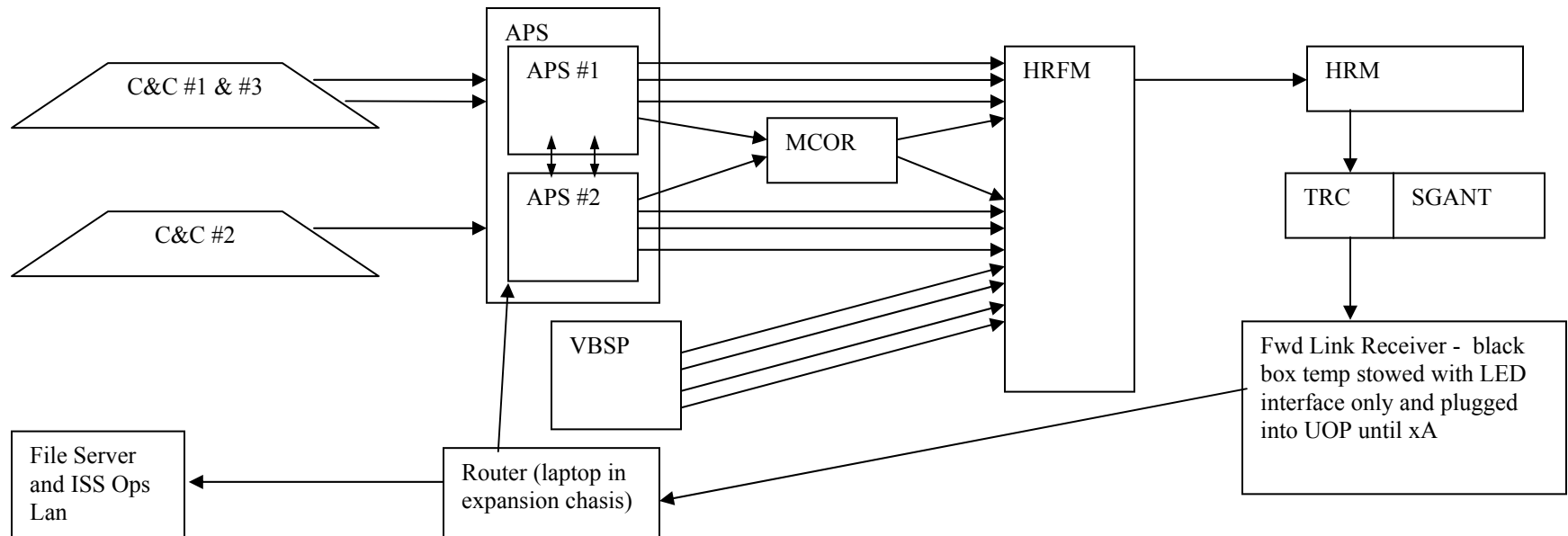
Command the VBSP to reduce the number of video frames transmitted per second for any VBSP channel. Commanding the VBSP to the lowest frame rate compared to the fastest frame rate save about 93 percent of the Ku-band resource, but only displays about 2 pictures per second on a monitor.

Command the VBSP to transmit only the odd video field for any VBSP channel. To the casual observer, the video quality differences between a half frame (odd frame only) configuration and a full frame (odd and even frames) configuration is not perceivable and it will save 50 percent of the Ku-band resource.

Command the VBSP to reduce the number of sampling levels (i.e. resolution). To the casual observer, the video quality between the 6 bit and 8 bit modes usually goes unnoticed. However, commanding video to the 6 bit mode will save 25 percent of the Ku-band resource when compared to the 8 bit mode.

While within the Ku band mask, radiation will be muted. Once outside the mask, the Ku will attempt to reacquaint by initiating the 2 deg spiral search pattern. It's possible that the Ku will spiral back into the mask and announce the Warning associated with radiating in a mask, then shutdown. The masks are built 2 deg bigger to protect for this and CATO also attempts to prevent this with time tags.

Video Baseband Signal Processor (LA D2; MTL)	demodulates an optical video signal into an analog electrical signal, digitizes, and processes this data into CCSDS packets for up to four separate Video Distribution Subsystem video channels.
High Rate Frame Multiplexer (LA D2; MTL)	Multiplexes the data into frames, and encodes data from up to 12 different sources into one continuous hi data rate bit stream.
High Rate Modem (LA D2; MTL)	converts the multiplexed digital signal received from HRFM into an analog signal and modulates the signal onto a IF carrier for transfer to the TRC.
Transmitter Receiver Controller (Z1)	equalizes the frequency of the signal received from the HRM, converts this signal from IF to a TDRSS compatible RF signal, amplifies this RF signal for transmission to the TDRSS and mutes the radiated signal when operationally necessary. The TRC also receives the TDRSS signal usually used to point the SGANT and commands the SGANT gimbal motors to physically move the antenna.
Space to Ground Antenna (Z1)	high gain gimballed antenna that receives data from the ground in the form of RF radiation from a TDRS, sends this forward link received signal and another pointing signal generated within the SGANT to the TRC to automatically track this TDRS used to communicate data to and from this TDRS.
Fwd Link Receiver (temp stow/UOP)	demodulates and decodes the data received from a TDRSS, converts it into bitstream data, and forwards this data to the Ku-band Router.
Ku-band Router (a.k.a OCA Router)	I/F with the Ku-band Fwd Link Rcvr to receive and decode data and with the Automated Payload Switches (APS) to transmit and encode data to the ground. It also i/f with the ISS Ops LAN to send and receive data to the fileserver.
Medium Rate Communications Outage Recorder (LA D2; MTL)	interfaces to the HRFM and the Automated Payload Switches (APS) to record and playback payload data during Ku-band subsystem communication outages.

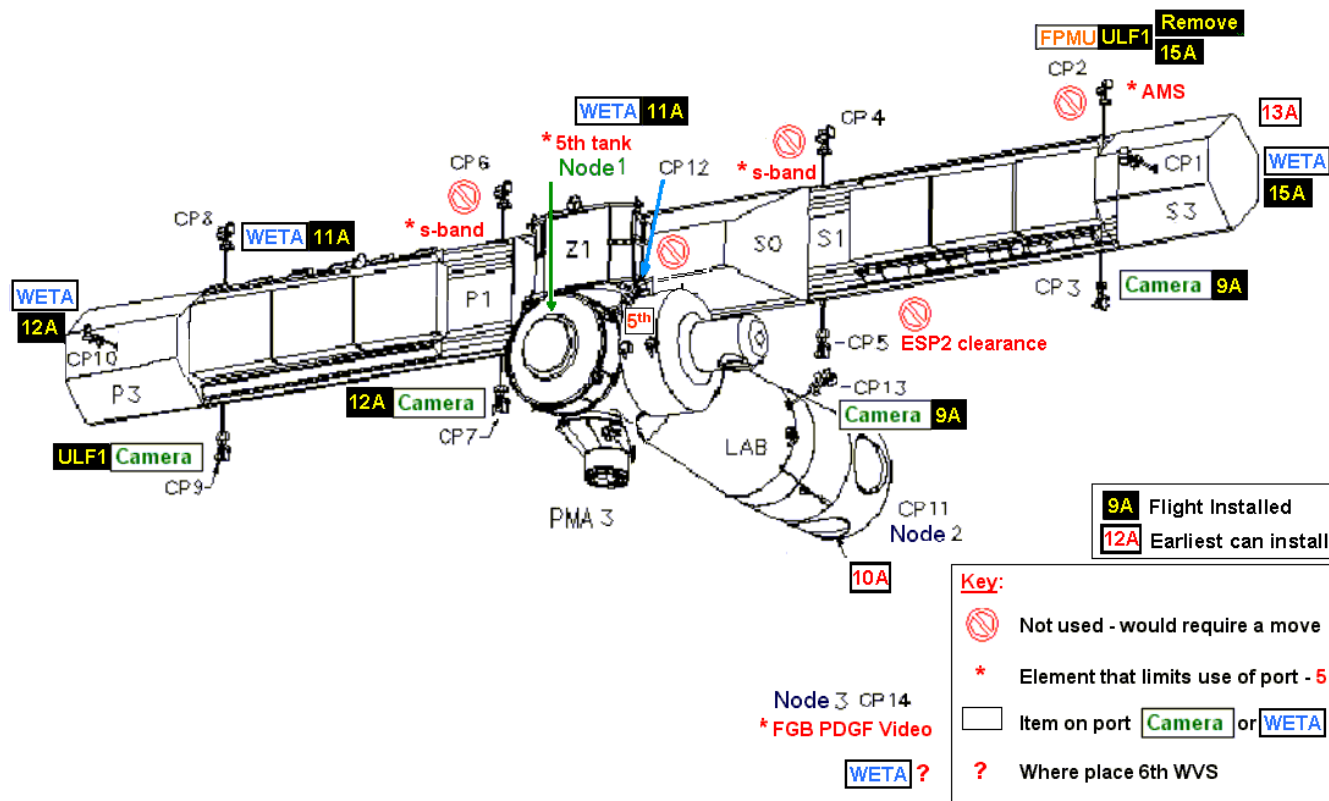


4.2.5 U.S. Video System

# External Camera Ports

D014/Neldon Costin - July 9, 2002

## ISS External Camera and Wireless Video System (WVS) Antenna Planning





#### **4.2.6 U.S. UHF System**

Both SSSR's are located within the same box in rack Deck 5. Only one SSSR should be powered at a time.

There are two external antennas per SSSR. The first set of antennas is on a boom located on the forward nadir starboard side of the lab. This was installed during 6A. This boom has one antenna per SSSR. The second boom will be installed on the P1 truss. These antennas are passive and have no power or thermal requirements.

There are internal antennas in each of the U.S., Japanese and European modules. The airlock antenna is automatically enabled, along with the external antennas, when the system is activated. There is an additional command required to activate the Internal Antenna Assembly. These antenna are intended to be used only if an internal EVA is required to a depressed module.

In order to receive commands from the orbiter UHF (SSOR), the UHF system must be configured to the Orbiter mode. In this mode, voice with the orbiter and commands from the orbiter are possible. In the EVA mode, voice with EVA is received along with suit and biomedical data.

The SSSR's can handle up to 5 users at a time. They can transmit in high or low power (though current FCC limitations prevent use of the high power mode).

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4.2.7 RS Ground Site Capabilities (FGB, SM, Soyuz, Progress)

Site #	Acronym	Name	Lat / Long	Komparus	BP9-ЦУ8	Regul	БИТС2-12	SM VHF-1	SM VHF-2	Kvant	BP8-ЦУ5	Soyuz VHF-2	TV	State Vector Determination [PKO]
				FGB Cmd	FGB TLM	SM Cmd	SM TLM	Voice	Voice	S/P Cmd	S/P TLM	Voice^		
21	DJS / ДЖС	Djusali / Джусали (colocated with site 25)	45.7 N / 63.5 E	X		X	X	X	X	X	X	X	X	X
24		Yeniseisk/Енисейск	58 N / 92 E	X	X		X						X	X
25	DJS / ДЖС	Djusali / Джусали (colocated with site 21)	45.7 N / 63.5 E		X		X			X				
26	PPK / ППК	Petro-Pavlosk Kamchatski / Петропавлоск–Камчатский	53.0 N / 158.7 E		X	X	X	X	X	X	X	X		X
27	BRN / БРН	Barnaul / Барнаул	53.3 N / 83.4 E		X		X	X	X				X	X
29	SPB / СПб	St. Petersburg / Ст. Петербург	60.0 N / 30.0 E		X		X	X	X				X	X
32	KLP / КЛП	Kolpashevo / Колпашево	58.2 N / 82.9 E	X	X		X	X	X	X	X	X		X
33	ULD / УЛД	Ulan-Ude / Улан–Уде	51.8 N / 107.6 E	X	X	X	X	X	X	X	X	X	X	X
34	SHK / МСК	Shelkovo / Щёлково	55.7 N / 37.6 E	X	X	X	X	X	X	X	X	X	X	X
35	USK / УСК	Ussurisk / Усурийск	43.9 N / 131.6 E	X	X	X	X	X	X	X	X	X	X	X
37 17*		Yakutsk/Якутск (used only for emergencies)			X		X	X	X					X
38		Vorkuta/Воркута (used only for emergencies)					X							X
53		ОБНИНСК (used only for science; not part of military network)												
	WAL/WPS	Wallops Island	37.9 N / 284.5 E					X				X^		
	WHS/WSC	White Sands Complex	32.5 N / 253.4 E					X				X^		
	DRY/DFRF	Dryden	34.7 N / 242.1 E					X				X^		

Komparus = FGB commands and command responses  
 Regul = SM commands and command responses (site capability is planned to be available by the end of the month shown)  
 Kvant = Soyuz/Progress commands and command responses  
 BP9-ЦУ8 = FGB telemetry  
 БИТС2-12 = SM telemetry  
 BP8-ЦУ5 = Soyuz/Progress telemetry  
 TV = TV downlink  
 State Vector = State vector determination (position and velocity)  
 VHF = Voice

^The three U.S. sites can only be used for Soyuz VHF-2 comm during spacecraft emergencies

\* KhSC uses 17 for this site, Energia uses 37

Last updated 11/20/00 by DO13/K.Zimmerman

SM data updated by Energia during STS-92/3A on 10/15/00; FGB data reviewed by Krunichev in May 1999; Soyuz/Progress data reviewed by M. Severance in July 1999

4.2.8 OIU

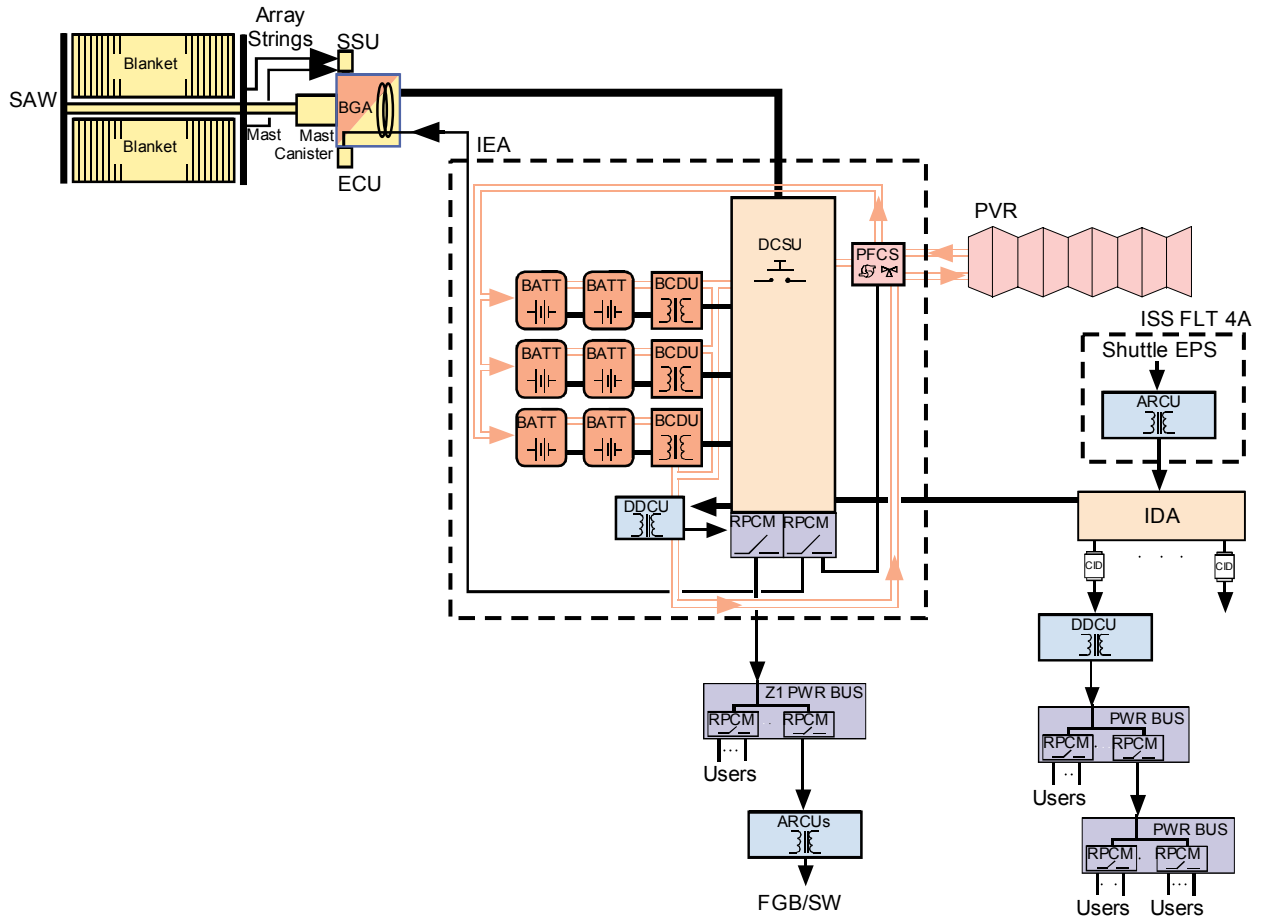
TBD

#### **4.2.9 Zone of Exclusion Recorder**

The ZOE Recorder is software resident within the C&C combined with a section of memory on the MSD. The ZOE Recorder is three continuous recording loops 107 minutes each. The three loops are the Essential, HK1 and HK2 telemetry. The Essential packet is always recorded. HK1 can also include the Russian Segment Contingency Telemetry Packets or the EMU Telemetry Packets (when this telemetry is enabled). HK2 packets can be preempted by Command Response, OSTP and APM packets. Data Dump, Extended Data Dump and File Transfer telemetry packets are not recorded. The saved data is the same data that is sent to the ground in the S-band system (not the entire CVT). If recorded data is desired, CATO can lock that piece of the loop so that it will not be recorded over the next time around. This data can then be dumped to the ground for analysis via S band or Ku band. Once the desired data is retrieved, CATO can unlock that piece of the loop and restore the available loop recording to its full 107 minutes.

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### 4.3 EPS



**Legend:**

Primary Power Flow	Secondary Power Flow	Thermal Cooling Flow
Power Generation	Primary Power Distribution	Power Conversion
Power Storage	Secondary Power Distribution	Photovoltaic Thermal Control System (PVTCS)
		Circuit Interrupter Device

**Acronyms:**

APCU - Assembly Power Converter Unit	IEA - Integrated Equipment Assembly
ARCU - American to Russian Converter Unit	PFCS - Pump Flow control Subassembly
BCDU - Battery Charger/Discharge Unit	PVR - Photovoltaic Radiator
BGA - Beta Gimbal Assembly	RPCM - Remote Power Controller Module
DCSU - Direct Current Switching Unit	RPDA - Remote Power Distribution Assembly
DDCU - DC to DC Converter Unit	SAW - Solar Array Wing (aka PVA - Photovoltaic Array)
ECU - Electronic Control Unit	SPDA - Secondary Power Distribution Assembly
IDA - Integrated Diode Assembly	SSU - Sequential Shunt Unit



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4.4.2 ISS Flight 7A RS Configuration.....	4.4.2-1

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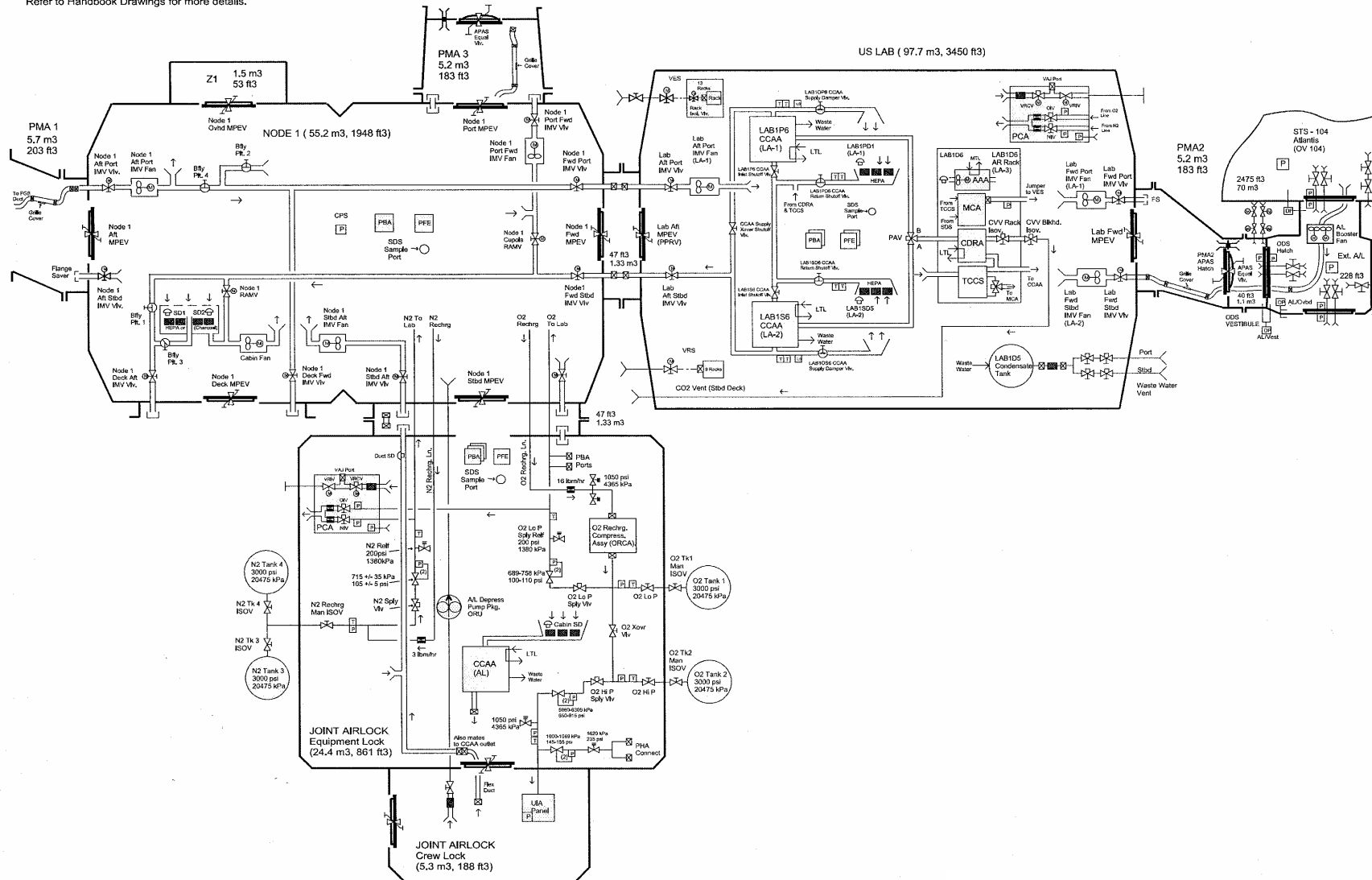


4.4 ECLS

4.4.1 ISS Flight 7A USOS Configuration

**International Space Station - Flight 7A USOS Configuration**

FOR REFERENCE ONLY  
This drawing represents basic ECLSS functionality and is highly simplified.  
Refer to Handbook Drawings for more details.

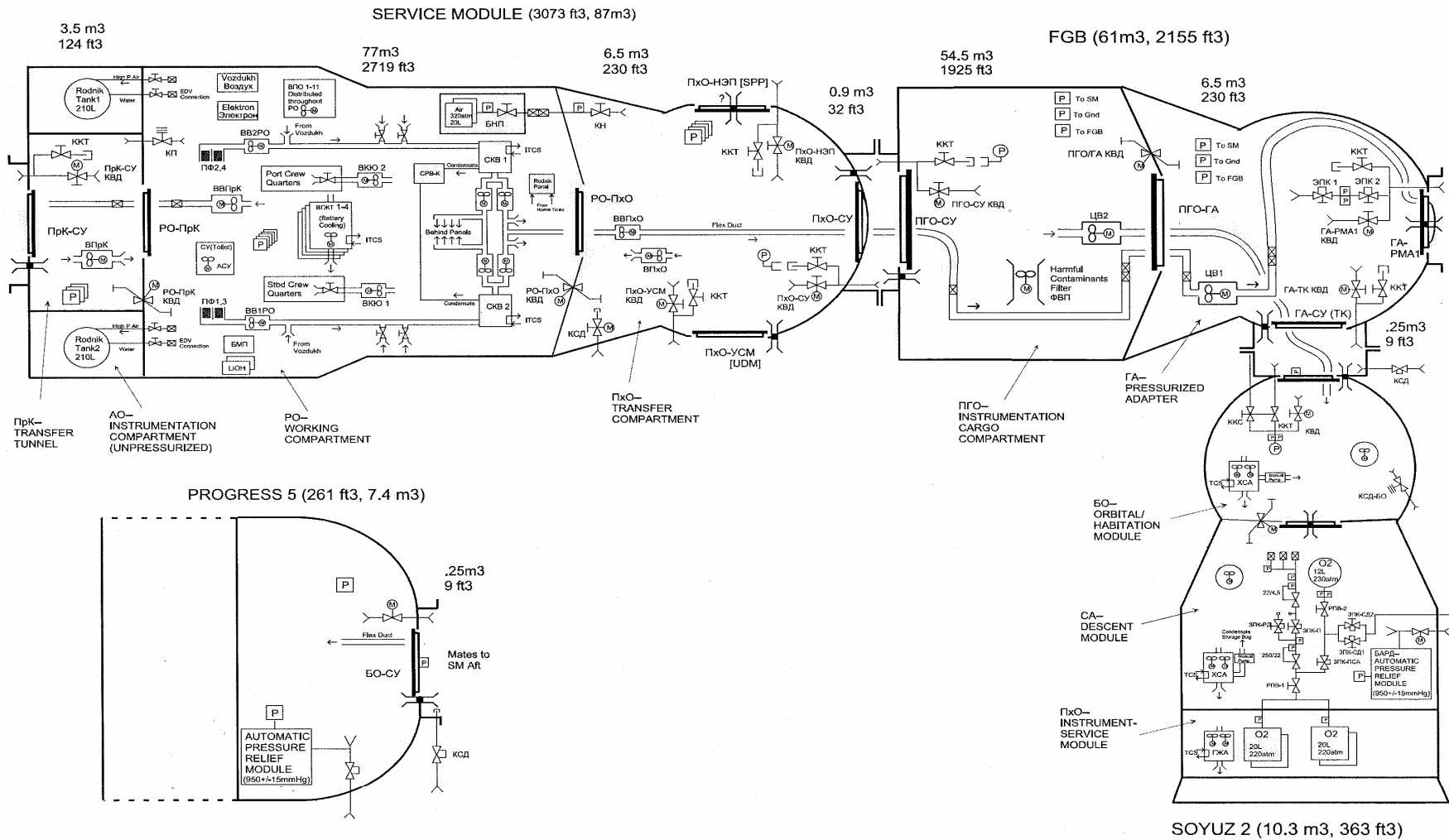


### 4.4.2 ISS Flight 7A RS Configuration

#### International Space Station - Flight 7A RS Configuration

FOR REFERENCE ONLY

This drawing represents basic ECLSS functionality and is highly simplified.  
Refer to Handbook Drawings for more details.



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## 4.5 MOTION CONTROL

### 4.5.1 GNC MDM

Unique features:

- The GNC UAS is too big (1.6M) to fit into EEPROM (1M). ODIN loads it to DRAM (8M) each time the box is power cycled. R2 (8A) s/w may fix this by zipping the UAS files into EEPROM.
- The backup will only come up to UDG when the primary fails. The ADCO must then run Recovery of Pri GNC MDM which is a 3 hour procedure on average.
- There's no "Checkpointing" so the backup MDM knows nothing about the primary.

Modes:

Diagnostic and Wait - ODIN owned. Similar to other MDM's. The backup MDM will be in Wait.

Standby – No pointing or attitude control, though you can spin up the CMG's and manually gimbal them about (but it's hard to imagine why).

User Data Generation (UDG) - Receives attitude, rate, and state information from the RS and provides pointing data to the USOS. Normal mode to spin up and manually gimbal CMG's (aka position servo). Spinning CMG's will apply a momentum bias on the vehicle.

Drift - The GNC is actively controlling the CMG's to a commanded momentum vector and reference frame. The Steering Law (name for software that actually determines all 8 gimbal angles in order to satisfy torque requests from Attitude Control s/w) will maintain the vector regardless of attitude input. This mode is also described as Momentum Servo. When the commanded reference frame is Inertial (which it always will be), think of the station as rotating around the CMG's in inertial space. If the reference frame is Body or LVLH, then the CMG's may exert a small torque (< 20 ft-lbs).

CMG Thruster Assist - Provides attitude control to the station by steering the CMG gimbals to compensate for torques on the station (aero and gravity gradient). There are two submodes determined by the CCBDB being used:

*Attitude Hold - Maintains the commanded attitude at the expense of momentum.* Depending on the attitude commanded, may require frequent desats (every few minutes) or hardly any at all (hours?).

*Momentum Management - Maintains momentum at the expense of attitude (it's more complicated than that, but that's close enough for the big picture).* LVLH takes an orbit or two to settle out and then the spec requires no desats for 30 days. The orbit-to-orbit wobbles are on the order of 1-4 degrees, depending on the current atmosphere. MM is theoretically stable and could go indefinitely without desats assuming no vents or other significant disturbances. The XPOP controller will take several orbits (up to 10 per design) to settle out and will have larger orbit to orbit wobbles (2-6 degrees).

CMG Only - Requires Station Mode of Microgravity, but we are not supposed to use in R1 due to FDIR problems. Specifically, the FDIR will mode you back to Standard and CMG TA if it needs a desat, but this FDIR gets confused sometimes and hangs up the CCS command sequencer (a bad thing). However, in my opinion, we can satisfy the intent of CMG Only with CMG TA and desat inhibits (like we do today with RMS ops), it's just manual to enable a desat if required.

#### 4.5.2 SM Terminal Computer

This computer has three lanes. A lane is an independent CPU. Only one lane is needed to perform it's function. The SMTC has the following modes: Indicator, Thrusters, Orbital Correction (Reboost), CMG TA, and some Gyrodine modes. The SMTC provides attitude, rate and state data to the GNC. The SMTC software has two main software pieces: the kinematic loop and the dynamic loop. The kinematic loop assesses the current attitude and the dynamic loop commands necessary attitude changes.

The SMTC controls in the following reference frames:

- Inertial Coordinate System [ИСК] - Standard J2000 equatorial inertial coordinate system. ИСК (0,0,0) = J2000 (180,0,-90)
- Current Inertial Coordinate System [ТТ] - At the moment of transition to this mode, the body inertial attitude is saved as the inertial reference frame.
- Orbital Coordinate System [ОСК] - Standard LVLH coordinate reference frame. ОСК (0,0,0) = LVLH (180,0,0)
- Current Orbital Coordinate System [ТОСК]- At the moment of transition to this mode, the body LVLH attitude is saved as the LVLH reference frame.
- Solar Coordinate System [СО] - SM body X axis pointing at the sun, SM body Z axis perpendicular to the plane of the ecliptic, and SM body Y axis completing the Cartesian coordinate system.
- Equilibrium Orbital Coordinate System [ПОСК] - This could really be called "TEA Seek," as the software continually computes a TEA, and uses it as an ordered maneuver rotation around the LVLH reference frame. In other words, it performs an attitude hold around a continuously changing attitude.
- Damping - This uses whatever the current internal SINS "platform" may be at the time and sets the maneuver error to a constant to help drive body to inertial rates to zero.
- Spin - This maintains a (changeable, i.e. not hard-coded) constant ordered body rotation rate.

### 4.5.3 Momentum Vectors, Desats and Maneuver Manager

Momentum Vectors - Think of the 4 CMG's as a system with a single momentum vector. This vector can be anywhere within the available momentum sphere (the "radius" of the sphere is determined by the number of CMG's in the Steering Law which will be 2 –4 CMG's at 4881 NM-s per CMG). If all CMG's are saturated, all of their spin vectors are pointed along the same axis. For example if they all saturated in the +X direction, all 4 vectors would be pointing along the +X axis and total momentum vector would be in the +X direction with a magnitude of 19552 NM-s. A desat could be targeted to 0, 0, 0 with a magnitude of 100%. This would essentially make your total momentum vector 0 NM-s as the Steering Law would command the gimbals such that the 4 parallel CMG's "peeled" apart like a 4 leaf flower to be anti-parallel. So, for instance, the spin vectors of CMGs 1 and 4 are now pointed opposite each other in the y axis, and CMG 2 and 3 are pointed opposite each other in the x axis (one didn't need to move at all).

So for any desats, think of your current total momentum vector and your target momentum vector (both origins in the center of the sphere, but any two vectors within the sphere). The desat will move the total momentum vector towards the target vector some percentage up to 100%.

Desats - A desat is a torque request to the RS. The RS will fire thrusters to cause the requested torque. At the same time, the CMG Gimbals will be commanded to a targeted momentum vector that causes an equal, but opposite torque on the vehicle. This all transpires in 10 sec (current design, though could be changed within CCDB). The magnitude of the requested torque varies. A CCDB will have a unique magnitude and target and a manual desat can desat to anywhere within the momentum vector sphere.

Similarly, all commanded auto desats will be commanded when they hit the near-sat threshold (typically 50% for AH and 85% - 95% for MM, as determined by the CCDB) towards a designated target vector and X% towards that target vector. Typically, the desat with an AH CCDB will reduce the total momentum vector from 50% to about 35% ( I say about because desats get somewhere within about 5% total momentum of your target due to thruster cross couplings). A MM CCDB will only reduce the momentum vector from about 90% to about 75%. It does not go all the way because it is trying to balance all torques out and wants to get there a little at a time to be in the "right" place, momentum wise.

Further, we've seen auto desats in both MM and AH and the attitude of the vehicle moves less than a couple tenths of a degree. So a lot of our concerns about desats causing problems during RMS ops and such are, in my opinion, not necessary and based on a heritage of thrusters and DAPs. In fact I could argue that CMG control with desats is more stable than Free Drift.

Maneuver Manager - The GNC software that does maneuvers is an open loop controller is not designed for maneuvers larger than a few degrees. Per current Flight Rules, CMG TA maneuvers should be less than 25 degrees. This number was a line in the sand and will likely be updated. There are two maneuver rates currently available: 0.1 deg/s and 0.01 deg/s. With a 25 degree maneuver at 0.1 deg/s, expect an overshoot of several degrees and tens of minutes to settle out. With the 0.01 deg/s maneuver rate, overshoot and prop consumption is minimized.

#### 4.5.4 Attitude Controllers

Most of the variables of the controllers are buried in the Configuration Controller Database (CCDB) which is a PPL with ~460 variables loaded into the GNC. There are 5 “slots” to put CCDBs within the GNC MDM. Everything but the attitude command is CCDB specific. So reference frame, maneuver rates, bandwidth, and more are all design parameters specific to a particular CCDB. In order to change any of them, a different CCDB (slot) must be chosen.

Some notable parameters are:

RCS Assist (on or off) - RCS assist will request additional thruster firings if required for things such as plumbing by the orbiter.

Bandwidth (AH only: 7, 10, or  $20 \omega_0$ ) - Not actually a specific parameter within the CCDB, but affects the design of the other variables. The bandwidth determines what frequencies the controller uses for input to its control algorithms, thus a higher bandwidth controller will control to a “tighter” attitude.

Reference Frame - AH can be Inertial, LVLH or XPOP; MM can be LVLH or XPOP

Maneuver Rate – The largest maneuver rate is 0.1 deg/sec and the other currently available maneuver rate is 0.01 deg/sec. The slower maneuver rate will use less prop.

Desat data – Near saturation thresholds, saturation thresholds, targets for desats, time for desats, desat delay times (all 0 for now), and more about the details of what kind of desat will be commanded if required.

Attitude Error thresholds - If attitude errors or attitude rates errors exceed these limits for the specified time, then the GNC will give up trying to control the attitude and handover to the RS. (Typically 30 deg attitude error for 100 sec; rate errors are 0.2 deg/s for 100 sec).



#### **4.5.5 Loss of Communication Scenarios**

Between GNC and C&C - GNC does not need C&C to perform. So if the C&C failed, the GNC and SMTC would continue to function normally. However, if C&C detects the loss of comm. due to a bus failure or GNC fail, it will command the Int MDM to pull the RPC to that GNC MDM and bring the backup to UDG.

Between GNC and SMTC - GNC losses all pointing data and will annunciate Loss of U.S. Attitude Control. You will lose data within ~7 minutes as the now fixed S band tracks away from TDRSS. Ku Band should continue to track until the TDRSS becomes blocked and the signal is lost (assuming Ku in Autotrack). The SMTC sends a loss of comm. with GNC to the C&C via the SMCC. The C&C treats this as a failed GNC and will command the Primary GNC to Wait (with comm., it commands to Wait rather than pull the RPC) and bring the backup to UDG.

Between GNC and a CMG - If the bus is down between them, the CMG will zero it's gimbal rates after 5 sec and await further commanding. The GNC will initiate auto retries that will power cycle the CMG. As mentioned above, the retries likely won't be successful due to the gimbal overrate SPN.

#### 4.5.6 CMG's

The CMG's are double gimbaled and provide rotation in all three axis (unlike Skylab). The 218 pound wheel spins at 6600 rpm, though there are 15 other command-able speeds available (6269 rpm to 6932 rpm) and hard coded into the CMG firmware. The extra wheelspeed options were provided in case 6600 rpm turned out to be a natural frequency of the system. The whole CMG weighs about 600 pounds and is about the size of an RCS tank. There are two basic parts: the Electrical Assembly (EA) and the Mechanical Assembly (MA). Both parts are replaceable on orbit. The EA is a box about the size of a desktop PC CPU and it's bolted to the outside of the MA. Most of the brains of the CMG are in 14 cards located in the EA. Much of the self-test software is designed to pin point the failure to the EA or the MA.

When the EA is power cycled, it comes back in its default state. If the power cycle is part of a retry effort by the GNC MDM and it's a successful retry, the GNC will restore the CMG to its previously commanded state. Unfortunately, the retry probably won't work, as we saw during 5A. There is a SPN condition that detects a false overrate and fails the retry attempt. As on 5A, a second retry will likely get by this problem, but by then the GNC MDM takes action on the overrate by commanding the gimbal torquers off. So, the CMG will stay on the second time. With the power cycle, the CMG goes to a default state (heaters off, spin motor off, etc). So manual commands are necessary to keep the CMG spinning and bring it back into the Steering Law.

The CMG Wheelspeed sensors (aka Hall Effects Resolvers) are two identical sensors that are used in two different ways. The Digital Wheelspeed sensor (aka. Sine Sensor or Calculated Wheelspeed) is averaged over 15 sec before the CMG publishes the value. This sensor is used by the software for momentum calculations. The Analog Wheelspeed sensor (aka. Cosine Sensor or Circuit Wheelspeed) is not averaged and looks very ratty. It is used, along with the Digital sensor, by the internal circuitry to keep the wheel spinning at the commanded speed within 2 rpm (PPL value).

It takes about 8 hours to spin up a CMG from 0 to 6600 rpm and about 14 hours to spin down in Active Break mode (much longer in Spin Motor disconnect mode).

#### 4.5.7 SM Attitude Sensors

The MCS software supports several methods for initializing the “platform”, corresponding to the various sensors available and their limitations. Those methods are:

- [CM-8M] Magnetometer (2) - The change in magnetometer attitude is compared to the computed Magnetic field of the Earth to derive an inertial attitude. Accuracy is  $\pm 3$  degrees and this operation takes less than 30 minutes.
- [BOK3] Star Tracker (3) - The Star Tracker takes a “picture” of the sky, based on several identified stars in the FOV of the tracker, derives the inertial attitude. The primary source of error is the gyro rates that are used to make all of the vectors to all of the stars coincident in time (it does take about 5-10 minutes to scan and match stars to the catalog). Accuracy is  $\pm 10'$ , and this operation takes up to five minutes.
- [256K] Horizon Sensor (4) - The horizon sensor determines the SM orientation with respect to an orbital coordinate system by detecting the differential between the warm earth and cold space. They typically will operate in concert with a magnetometer.
- [251K] Scanning Sun Sensors (3) - The scanning sun sensors provide a solar vector. These will also typically operate in concert with a magnetometer.

4.5.8 SM Rate Sensors

**High-Accuracy  
Rate Sensor (GIVUS)**

**Medium-  
Accuracy Rate  
Sensor (ORT)**

	NOMINAL OPERATIONS	BACKUP OPERATIONS IF GIVUS FAILS
1. PURPOSE		
2. NUMBER OF MEASUREMENT CHANNELS (AXES)	4	3
3. MEASUREMENT RANGE, DEG/SEC	± 0.5	± 10
DRIFT STABILITY (DEG/HR, 1 SIGMA) TURN ON TO TURN ON AFTER STD WARMUP	± 0.4 ± 0.02 (2 MIN AVG) ± 0.005 (15 MIN AVG) ± 0.006 (1000 HR AVG)	±2.2  ± 0.2 (90 MIN AVG) 0.36 (UNKNOWN BANDWIDTH)
5. BIAS (ARC SECONDS, 1 SIGMA)	± 0.3	± 6
6. SCALE FACTOR STABILITY ( 1 SIGMA)	0.005% (OVER 3 MONTHS) 0.1% (LIFETIME)	<0.075% (NOMINAL) ± 0.13% (MAX)
7. OUTPUTS: O DIGITAL, ARC SECOND/BIT O ANALOG, VOLT/(DEG/SEC) O ANALOG, VOLT/DEG	0.035 - 0.05 - -	6.29 1 1
8. POWER, WATT	50 - 70 (STARTUP/ STEADY STATE) 300 (WARM UP)	40
9. MASS, KG	12	10
10. LIFETIME, HOURS	90,000	> 1,000
11. PROBABILITY OF FAILURE	<0.01 OF TWO CHANNELS, 10 YRS	<b>TBD</b>
11. WARMUP/STARTUP TIME	20 MIN/20 MIN (40 MIN TOTAL) IF COLD PLATE TEMP > 5 DEG C. (41 DEG F)	<b>TBD</b>
12. OPERATING RANGE, DEG C	5 - 28 DEG C (41 - 82 DEG F)	0 - 40 DEG C (32 - 104 DEG F)

#### 4.5.9 Some quick and dirty numbers

100 N. mile of State Vector downtrack error = ~1 deg of pitch error (in LVLH)

1 NM of circ reboost = ~10 NM downtrack error/orbit

Prop Use:

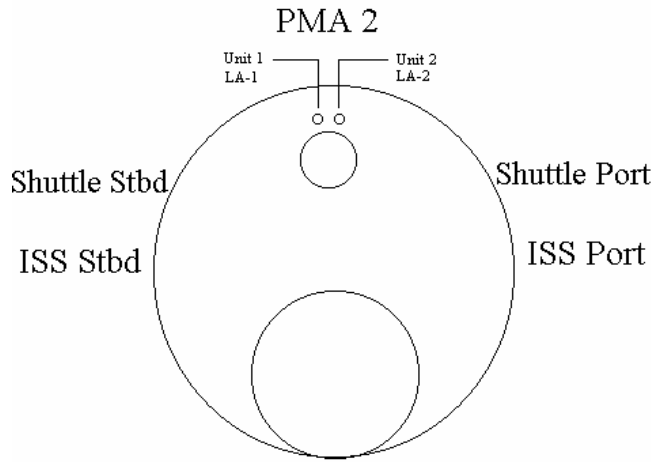
7A config: kg prop/day in RTEA LVLH - **TBD**

kg prop/day in RTEA XPOP - **TBD**

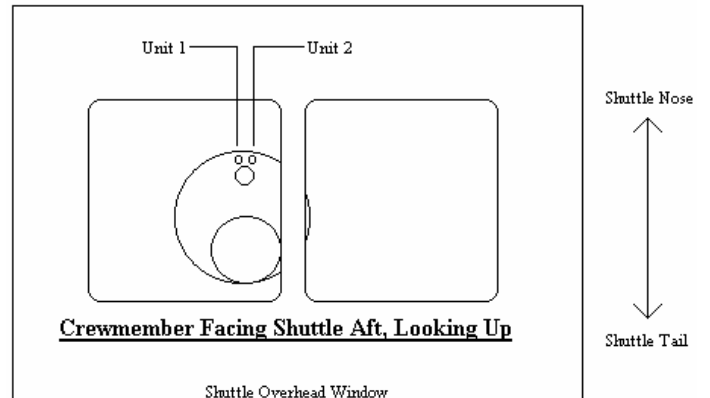
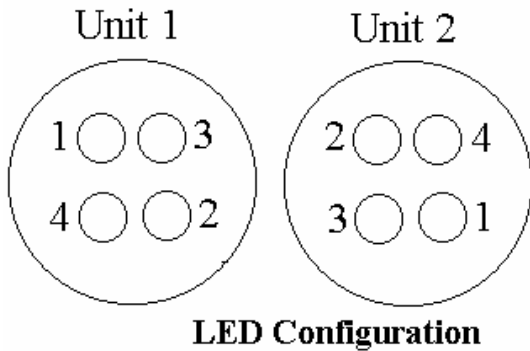
Delta V/kg for reboost - **TBD**

Average desat cost (function of magnitude of requested torque and vehicle config) - **TBD**

**4.5.10 ACS Moding Light Orientation Diagrams:**



**Docking Diagram for 5A.1 and subs**



**Shuttle Perspective**

**Steady On = Active Control**

**Flashing = Free Drift**

ACS Moding Sensors and Lights Table:

<b>N1-1</b>		<b>LA-1</b>	
<b>Capture Long</b>	N1-1 DIO Card Slot 4 Channel 23	<b>Capture Long</b>	LA-1 DIO Card Slot 4 Channel 22
<b>Capture Short</b>	N1-1 DIO Card Slot 4 Channel 24	<b>Capture Short</b>	LA-1 DIO Card Slot 4 Channel 23
<b>Undock Complete</b>	N1-1 DIO Card Slot 4 Channel 25	<b>Undock Complete</b>	LA-1 DIO Card Slot 4 Channel 24
<b>Interface Sealed</b>	N1-1 DIO Card Slot 4 Channel 26	<b>Interface Sealed</b>	LA-1 DIO Card Slot 4 Channel 25
<b>Unit 2 LEDs 1 &amp; 2</b>	N1-1 DIO Card Slot 4 Channel 29	<b>Unit 1 LEDs 1 &amp; 2</b>	LA-1 DIO Card Slot 4 Channel 13
<b>Unit 2 LEDs 3 &amp; 4</b>	N1-1 DIO Card Slot 4 Channel 30	<b>Unit 1 LEDs 3 &amp; 4</b>	LA-1 DIO Card Slot 4 Channel 14
<b>N1-2</b>		<b>LA-2</b>	
<b>Capture Long</b>	N1-2 DIO Card Slot 4 Channel 23	<b>Capture Long</b>	LA-2 DIO Card Slot 4 Channel 22
<b>Capture Short</b>	N1-2 DIO Card Slot 4 Channel 24	<b>Capture Short</b>	LA-2 DIO Card Slot 4 Channel 23
<b>Undock Complete</b>	N1-2 DIO Card Slot 4 Channel 25	<b>Undock Complete</b>	LA-2 DIO Card Slot 4 Channel 24
<b>Interface Sealed</b>	N1-2 DIO Card Slot 4 Channel 26	<b>Interface Sealed</b>	LA-2 DIO Card Slot 4 Channel 25
<b>Unit 1 LEDs 1 &amp; 2</b>	N1-2 DIO Card Slot 4 Channel 29	<b>Unit 2 LEDs 1 &amp; 2</b>	LA-2 DIO Card Slot 4 Channel 13
<b>Unit 1 LEDs 3 &amp; 4</b>	N1-2 DIO Card Slot 4 Channel 30	<b>Unit 2 LEDs 3 &amp; 4</b>	LA-2 DIO Card Slot 4 Channel 14

### 4.5.11 SM Prop

#### Propellant Tanks (about as much usable prop as the FRCS)

QUANTITY	4	
NOMINAL PRESSURE RANGE (KGF/CM <sup>2</sup> )	21 ± 2	
MAX WORKING PRESSURE	26.5	
MAX STORAGE VOLUME IN EACH TANK (L)	193 +1/-3 WITH DIAPHRAGM IN NOMINAL DOWN POSITION 223 ± 6 WITH DIAPHRAGM IN REVERSED (UP) POSITION	
NOMINAL FILL AT 15°C (EACH TANK)	OX (KG)	253
	FUEL (KG)	137
UNUSABLE PROP IN EACH TANK (L)*	~1.75	

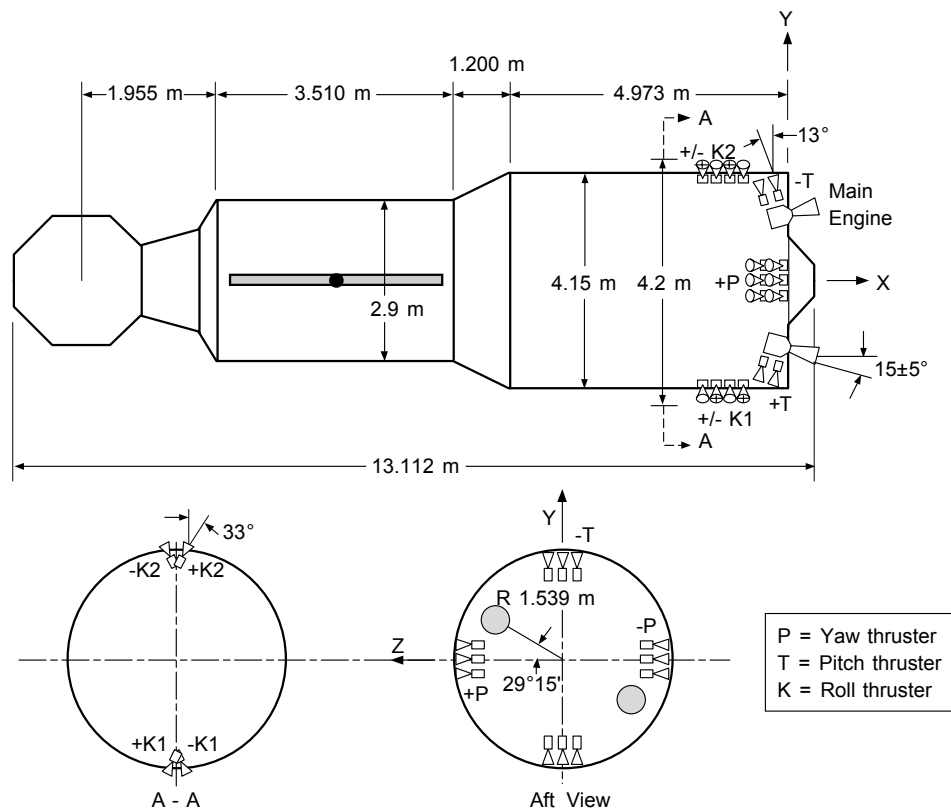
\* IN ADDITION TO THE UNUSABLE PROP IN THE TANKS, THERE IS ~ 64 L OF UNUSABLE PROP USED TO FILL THE THRUSTER MANIFOLDS AT SYSTEM ACTIVATION FOR A TOTAL OF ~71 L (~ 80 KG) OF UNUSABLE PROP IN THE SYSTEM.

NOTE: DENSITY OF FUEL = 0.796 KG/L, DENSITY OF OXIDIZER = 1.458 KG/L

#### Engine Design Parameters

	MAIN ENGINE [KД]	TRANSLATION AND ACS THRUSTER [ДO]	ROLL CONTROL THRUSTER [ДO]
QUANTITY	2	24	8
THRUST (KGF)	335*	13.3 ± 0.6	13.3 ± 3
SPECIFIC IMPULSE (SEC) -MAX TOLERANCE	300 +5/-7	285 +5/-20	250 ± 5
MIXTURE RATIO (M <sub>OX</sub> /M <sub>FU</sub> )	1.85 +.26/- .22	1.85 +.45/- .35	1.85 +.45/- .35
ENGINE ON TIME LIFE SPECIFICATION (S)	25,000	45,000	45,000
MIN. ENGINE OFF TIME BETWEEN FIRINGS (S)	10	0.03	0.03
MAX. NUMBER OF FIRINGS	250	450,000	450,000

\* THIS ENGINE IS LABELED AS "315 KGF" THRUST IN MOST DOCUMENTATION. WHEN THE ENGINE WAS USED IN ANOTHER VEHICLE THE INLET PRESSURE WAS LOWER (17.5 KGF/CM<sup>2</sup>) RESULTING IN THE 315 KGF THRUST LEVEL. SINCE THE SM MAIN ENGINES ARE NOMINALLY OPERATED AT 21 ± 2 KGF/CM<sup>2</sup> THE THRUST PRODUCED IS CLOSER TO 335 KGF.



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#### 4.5.12 FGB Prop

##### Propellant Tanks

	LONG TANKS	SHORT TANKS
QUANTITY	8	8
NOMINAL PRESSURES	21 □ 2 KGF/CM <sup>2</sup>	21 □ 2 KGF/CM <sup>2</sup>
LENGTH (M)	3.528	2.923
DIAMETER (M)	0.48	0.48
MAX STORAGE VOLUME IN EACH TANK (L)	0.407	0.33
NOMINAL FILL AT 15°C OX (KG)	548	440
(EACH TANK) FUEL (KG)	301	241
UNUSABLE PROP IN EACH TANK (L)**	~10	~9

\*\*IN ADDITION TO THE UNUSABLE PROP IN THE TANKS, THERE IS ~ 40 L OF UNUSABLE PROP USED TO FILL THE THRUSTER MANIFOLDS AT SYSTEM ACTIVATION FOR A TOTAL OF ~ 192 L OF UNUSABLE PROP IN THE SYSTEM.

NOTE: DENSITY OF FUEL: 0.796 KG/L, DENSITY OF OXIDIZER: 1.458 KG/L.



### 4.5.13 Progress Prop

#### Design Parameters

	PROGRESS - M		PROGRESS – M1	
	MAIN ENGINE [CKД]	TRANSLATION AND ACS THRUSTER [ДПО]	MAIN ENGINE [CKД]	TRANSLATION AND ACS THRUSTER [ДПО]
Quantity	1	28	1	28
Thrust (kgf)	300 ± 30	13.3 +3/-3.5	300 ± 30	13.3 +3/-3.5
Specific Impulse (s)	302 +5/-7	250 ± 5	302 +5/-7	285 +5/-20
Mixture Ratio – Steady State Pulse	1.85 ± .15 ± .45	1.85 ± .15 ± .45	1.85 ± .15 ± .45	1.85 ± .15 ± .45
Engine on time life specification (s)	880	5000	880	20,000
Min engine off time between firings (s)	10	0.03	10	0.03
Max number of firings	30	40,000	30	40,000
Duration of single activation (s) Min Max	0.5 400	0.03 600	0.5 400	0.03 2000*
Prop tank nominal operating pressure (kgf/cm <sup>2</sup> )	14 - 22		14 - 22	

\* EACH THRUSTER CAN TOLERATE AT LEAST 5 FIRINGS OF 2000 S DURATION

#### Propellant Management Information

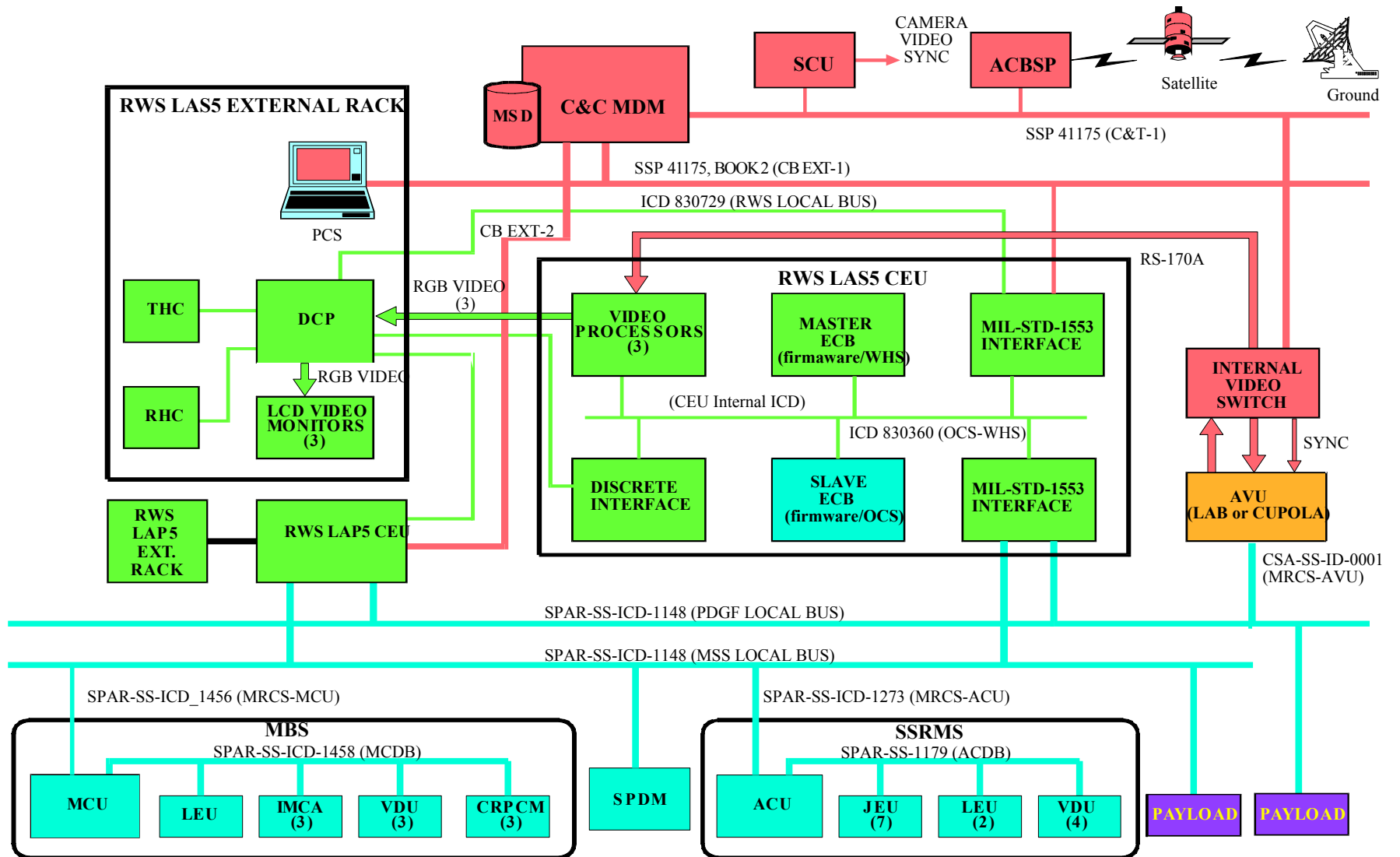
	Progress - M	Progress – M1
<b>Max propellant for Station Use (kg)</b>	<b>1073</b>	<b>1870</b>
<b>Propulsion System</b>		
Quantity of propellant tanks	4	4
Max loaded mass (kg)	880	880
Amt of non-usable propellant (kg)	50	50
Amt used for orbit transfer & docking - 410 km (kg)	417	480
Amt of propellant used for deorbit - 410 km (kg)	190	190
Amt of propellant available for reboost (kg)	<b>223</b>	<b>160</b>
<b>Resupply System</b>		
Quantity of propellant tanks	4	8
Max loaded mass (kg)	870	1740
Amt of non-usable propellant (kg)	20	30
Amt used for orbit transfer & docking - 410 km (kg)	0	0
Amt of propellant used for deorbit - 410 km (kg)	0	0
Amt of propellant available for reboost (kg)	<b>850</b>	<b>1710</b>
<b>Altitude Adjustment Parameters</b>		
Increase in prop needed for increase in docking alt (kg/km)	1.37	1.58
Increase in prop needed for increase in deorbit alt (kg/km)	0.55	0.55

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4.6.1 MSS Bus Connectivity Schematic



#### 4.6.2 Mobile Servicing System (MSS) Overview

The Mobile Servicing System (MSS) is comprised of the following components:

- Robotics Workstation (RWS)
  - U.S. Lab racks LAP5 (Lab RWS) and LAS5 (Cupola RWS)
  - Names are derived from the final (future) location of the external components of the LAS5 rack to the Cupola (ISS 2 J/A)
  - Each RWS also contains the Artificial Vision Unit (AVU), which is functionally equivalent to the Orbiter Space Vision System (SVS)
  - Launched on 5A.1
- Space Station Remote Manipulator System (SSRMS)
  - Seven-jointed robotic manipulator
  - Launched on 6A
- Mobile Transporter (MT)
  - Moves along tracks on the truss segment to allow the SSRMS, MBS, and SPDM to access other areas of the Station
  - Launched on 8A, pre-integrated to the S0 truss
- Mobile Remote Servicer Base System (MBS)
  - Working base platform for the SSRMS and SPDM that attaches to the MT
  - Contains 4 base points (Power and Data Grapple Fixtures) for the MSS robotic arms, and two attach mechanisms for payloads
  - Launched on UF-2
- Special Purpose Dexterous Manipulator (SPDM)
  - Dexterous, two-armed robotic manipulator capable of performing fine-detail tasks such as ORU replacement
  - Launched on UF-4

### 4.6.3 Robotics Workstation (RWS) Overview

There are two identical RWS units in the U.S. Lab. One is located in LAP5 and is called “the Lab RWS”. The other is directly opposite in LAS5 and is called “the Cupola RWS”. The names are derived from the fact that after 2J/A the external components of the LAS5 RWS will be moved into the Cupola. The components with which the operator interfaces are referred to as “external” components, while the avionics boxes inside the racks are called “internal” components.

#### External Components

The external components of the RWS include: Three monitors, a Translational Hand Controller (THC), a Rotational Hand Controller (RHC), a Display and Control Panel (DCP), structural equipment, an AVU Cursor Control Device (CCD – basically a trackball) and a standard PCS.

Monitors: The three monitors provide the operator a place to display camera views during robotics operation. When the RWS is not being used to perform robotics operations, the monitors can also be used to display any video in the ISS video system. Until mission <TBD>, the RWS monitors are the only place for crew to view ISS video. A cooling fan is located on the back of each monitor.

The monitors also display various overlays that are used as cues. Many of these overlays duplicate PCS data, however their update frequency is higher, and latency is lower, than the PCS. For this reason the monitor overlays are prime cues in most cases. Overlays include:

- Frame Of Resolution (FOR): Indicates the position of the end effector or attached payload relative to a defined display frame (coordinate system).
- Joint Angle Display: Indicates the angular value of each of the 7 joints.
- Actual vs. Commanded FOR: Shows how fast the SSRMS FOR is moving compared to hand controller inputs.
- Force Moment Accommodation (FMA) display: FMA is a new technology on the SSRMS. Sensors detect forces and moments applied at the Latching End Effector (LEE). The system can automatically hold or backdrive away from forces and moments, or it can allow the operator to drive the arm by reading the display. (Note: Significant data collection and analysis will be needed to characterize the on-orbit behavior of the FMS before FMA will be available for use.)
- Target overlays: Cross hairs used to align the SSRMS tip with a grapple fixture.
- Camera overlays: Provide pan, tilt, zoom, focus and iris data for the camera routed to the monitor.

Hand Controllers: There are two handcontrollers on each RWS, a Translational Hand Controller (THC) and a Rotational Hand Controller (RHC). The RHC also includes switches that allow the operator to:

- Set rate scales to coarse or vernier
- Set a rate hold feature, which retains the last command even if the operator removes their hands from the hand controllers (both THC and RHC).

- Trigger to command LEE operations. The trigger is equipped with a guard to prevent inadvertent operation.

The THC is also used to command Single Joint movement. This is a departure from the Orbiter design where a binary switch is used. For SSRMS, the operator has the ability to vary the rate of Single Joint movement by changing the deflection of the THC.

The RHC is also used to command a Pitch Plane Change. This a mode of operation unique to seven joint robots wherein the “tip” and “base” of the arm maintain position while the rest of the arm (the elbow) rotates around the line between them.

Display and Control Panel (DCP): The DCP performs two functions, camera control and arm control.

DCP camera control switches:

- High/Low Rate switch, used to select pan and tilt speeds
- Focus far/near
- Zoom in/out
- Iris open/close switch and an automatic iris push button
- Tilt up/down
- Pan left/right
- ‘MONITOR SELECT’ push buttons for monitors 1, 2, and 3
- ‘MULTIPLEX UNIT’
  - Push buttons to activate the MUX (split-screen) functions.
  - The system is capable of having 2 split-screen views
- ‘CAMERA SELECT’ push buttons (0 through 9) to select monitor video inputs

To route video to a monitor, the operator selects the monitor followed by a two digit camera number. To adjust the view from a camera, the operator first selects the monitor number displaying the view to be adjusted.

DCP arm control:

- ‘JOINT SELECT’ rotary switch for selection of individual joints.
- ‘BRAKES’ On/Off switches for the SSRMS, the SPDM Body, and SPDM arms 1 & 2.
- ‘AUTO SEQ’ Pause/Proceed switch.
- ‘SPDM TORQUE DRIVE’ switch, used to extend and retract the SPDM tools as well as determine the direction of rotation (CW, CCW) for the tool.
- ‘SAFING’ switch that allows the operator to command the MSS into a safe configuration. Safe mode has SSRMS brakes applied and End Effector operations inhibited.
- ‘STOP’ push button. For emergency stop use only. Performs the same function as the safe switch but also opens the RPCs supplying power to the SSRMS, MBS, and SPDM.
- ‘PANEL/INST LIGHTING’ rotary switch for adjusting the backlighting intensity on the DCP itself.



Rack Support Structure: This structure contains all of the external equipment and is secured to the seat track of the rack itself. The original design was used to allow the external portion of the Cupola rack to be relocated to the cupola. Other implementations may include moving the external portion of the rack, without disconnecting the cables, to allow other racks to be translated between the two RWS. Cable lengths are long enough to allow the external portion of the racks to be collocated on either the port or starboard side of the Lab.

**Internal Components (TBS)**

**CEU Software (TBS)**

**AVU (TBS)**

#### 4.6.4 Space Station Remote Manipulator System (SSRMS) Overview

SSRMS comparison to SRMS:

SSRMS	SRMS
7 JOINT ARM, CAN OPERATE AS 6	6 JOINT ARM
OFFSET JOINTS	INLINE JOINTS
2 ROBOTICS WORKSTATIONS	1 WORKSTATION IN AFT FLIGHT DECK
3 MONITORS PER WORKSTATION	2 MONITORS PER WORKSTATION
MUX ON 2 MONITORS	MUX ON 2 MONITORS
EMERGENCY STOP BUTTON	NO EMERGENCY OFF SWITCH, CAN REMOVE POWER FROM SYSTEM
SELF-COLLISION DETECTION	NO COLLISION DETECTION
2 EE CAMERAS, 2 BOOM CAMERAS	1 EE CAMERA, 1 BOOM CAMERA
56 FEET (17 METERS)	50 FEET (15.2 METERS)
255,200 LBS MAX (116,000 KG)	65,000 LBS MAX (29545 KG)
1.21 FPS (0.36 MPS) MAX; 4.0 DEG/S MAX	2.0 FPS (0.6 MPS) MAX; 4.7 DEG/S MAX

Operational Modes:

- **Manual Augmented Mode (MAM, or simply “Manual”):** The primary mode of operation for the SSRMS is Manual mode. The operator at the RWS controls the motion of the SSRMS via the hand controllers.
- **Single Joint Rate Mode (SJRM, or “Single”):** As the name implies the operator moves one joint at a time. The operator selects the joint to be driven from a rotary switch on the Display and Control Panel (DCP) and commands the motion using the Translational Hand Controller (THC). The SRMS single joint mode is commanded using a three-position switch, which does not allow the operator an easy ability to make single joint motions at varying rates. Because the THC is used to command the motion, the operator has the ability to “ramp” single joint commands. Because of the redundant string in the SSRMS, single joint maneuvers are used nominally, per mission design, and not as a contingency for loss of Manual capability. Thus, unlike SRMS, single joint contingency operations are not trained.
- **Joint Operator Commanded Auto Sequence (Joint OCAS):** In this mode the operator types in a desired set of joint angles and uses the auto sequence pause/proceed switch on the DCP to move the arm into that configuration. Any number from one to seven joints can be moving at the same time in this mode. Once the destination point is reached, the operator must type in a new set of joint angles to go to another position.
- **Joint Autosequence (Joint Auto):** This mode is similar to Joint OCAS but instead of typing in the joint angles, the operator selects a file from a menu. This file can consist of one or several sets of joint angles that the arm will fly to. Each set of joint angles is referred to as a point and those points can either be pause points or fly-by points. As the name implies a pause point is a set of joint angles where the arm comes to rest and waits for the operator to command proceed again. When the arm reaches a fly-by point it continues to the next set of joint angles without stopping.
- **FOR OCAS:** Similar to Joint OCAS, in this mode the operator types in a position and orientation for the FOR and commands the arm to go there using the DCP Pause/Proceed switch.
- **FOR Auto:** Similar to Joint Auto, the operator selects a file from a menu. FOR Auto points can also be pause or Fly-by.
- **Standby:** This is default mode the SSRMS is in when the SSRMS is powered to Operational.

The arm also goes to standby when the system safes.

- Limp: As the name implies the SSRMS joints are brakes off and not being driven at any rates. Limp is probably a misnomer for the SSRMS because the friction of the gears in each joint is not inconsiderable (~150 ft-lb). The SSRMS automatically selects limp when an automatic capture is executed. During handoff from the SSRMS to the SRMS, the operator will manually select Limp on the SSRMS to release any forces created by the SRMS grapple, or vice versa.
- Arm Pitch Plane Change (APPC, or “Pitch Plane”): This is a mode of operation unique to 7 DoF arms. When the SSRMS performs a pitch plane, the tip of the arm remains stationary and the elbow rotates around an imaginary line from between the Tip LEE and the Base LEE. When the SSRMS is in its stowed configuration with the base on the Lab PDGF and the tip on the Lab FRGF, the elbow is maneuvered up using APPC to clear the view from the window on the Lab Nadir side.

Major SSRMS components:

- Dual control strings called Prime and Redundant. Regardless of the names, the strings are actually functionally equivalent and will be interchanged with no procedural or operational deltas.
- Each string contains:
  - An Arm Control Unit (ACU) that is an RT to the RWS CEU. The ACU is essentially the BC for the electronics on the SSRMS.
  - Seven Joint Electronics Units (JEU's). These units host the Joint Control Software (JCS).
  - Two LEE Electronics Units (LEU). These units host the LEE Control Software (LCS). Only one LEE is ever powered at a time, while the other LEE serves as the base (shoulder).
  - Seven joint motors and two sets of LEE motors. Again, only one LEE is powered at a time with the other LEE acting as the base of the SSRMS. Note that each LEE has separate motors for snare open/close, carriage retract/extend, and latch mate/demate.
- Additional hardware components that are controlled by the operational string:
  - Four Video Distribution Units (VDUs). Distribute video from the camera attached to it as well as “boosting” video signals from the “tipward” cameras. Because VDU's provide a signal boost, all four are nominally powered on.
  - Four cameras. All cameras have light assemblies, and the boom cameras have pan/tilt units.
  - Joint mechanical components: Each joint has one gearbox that is shared by the Joint Motor Modules (JMM) on each string. The motor that is on the un-powered string is backdriven through the shared gearbox. The backdriven motor (acting as a generator) is electrically isolated from the system.
  - LEE mechanical components: Each LEE has one set of snares, carriage and latches, with two sets of umbilicals on the latches (one for each string).

### Latching End Effector (LEE)

The SSRMS LEE uses the same basic design as the SRMS EE to capture a payload. That is, there are three “snare” cables inside the LEE with one attached to a rotating cylinder and one end fixed end. As the mechanism rotates, the snare cables close over the grapple pin.

After the pin is captured, the inner portion of the LEE (the carriage) retracts inside the outer housing moving the face of the LEE closer to the base of the grapple fixture. The large cams on the grapple fixture provide coarse alignment. Eventually the face of the LEE contacts the base of the grapple fixture where the curvic coupling provides fine alignment for a PDGF. The carriage continues to retract. This eventually puts a tension on the snare cables. For the SRMS, there is a microswitch that determines how far the carriage should retract. On the SSRMS a load cell attached to one of the snare wires determines that distance, by stopping the carriage motion once a predetermined tension value is detected.

If the SSRMS has grappled a PDGF, the latches are then driven. These extend through the doors on the PDGF and form a secure attachment. The last motion of the LEE is the command to mate the PDGF umbilicals. These provide power, data and video connections to the two SSRMS strings. If the PDGF will be acting as a base point for the SSRMS for an extended period of time, the Carriage is extended slightly to reduce (wear) stretch on the cables.

The LEE umbilicals can also be used to provide a power, video and data path to an attached payload. The Special Purpose Dexterous Manipulator (SPDM) is commanded through this path while attached to the SSRMS.

### LEE Motor Modules

There are actually six motors on each LEE, three for each string. Those motors drive the Snare, Carriage and Latch mechanisms. All three motors on a single string are controlled by a single power source with switches between the power source and the motors to isolate them as required.

### LEE Calibration

The LEE must be calibrated to perform Automatic and Semi-Manual operations. The term Semi-Manual derives from the fact that the operator must hold the trigger down during the operations. The design philosophy of the LEE is to avoid, as much as possible, making contact with hard stops. Wear on the mechanisms is created by such contact and each LEE will need to spend years on orbit. To avoid hard stop contact, the LEE must be in a calibrated state before operations. This allows the software to “know” how far to drive each of the mechanisms to complete the grapple or un-grapple but avoid hitting the hard stops.

Because the LEE mechanisms move when the LEE is calibrated, it cannot be calibrated while there is a payload attached. Additionally, as mentioned earlier, the LEE must be calibrated to perform Automatic and Semi-Manual operations. If the LEE becomes uncalibrated while attached to a payload the operator can use manual commands to drive the individual mechanisms. However, manual commands with an uncalibrated LEE run the risk of making hard stop contact.

Joints (**TBS**)

Cameras (**TBS**)

Control Units (**TBS**)

FMA (**TBS**)

#### **4.6.5 Mobile Transporter (MT) Overview**

**TBS**

#### **4.6.6 Mobile Remote Servicer Base System (MBS) Overview**

##### **TBS**

#### **4.6.7 Special Purpose Dexterous Manipulator (SPDM) Overview**

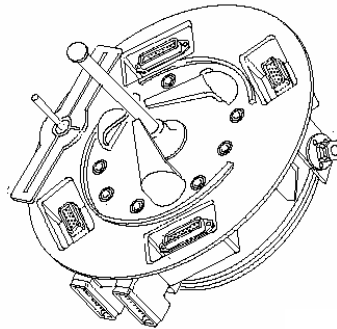
**TBS**



#### 4.6.8 Grapple Fixtures

##### Power and Data Grapple Fixture (PDGF)

A PDGF was installed on the U.S. Lab during 5A. This will be the base point of the SSRMS between ISS 6A and UF-2. As the name implies, the PDGF provides power and data connectivity for the SSRMS, including video. The connections are made behind the four doors on the PDGF. When the SSRMS grapples a PDGF, latches that contain power, data and video connectors are mated to the receptacles in the PDGF.



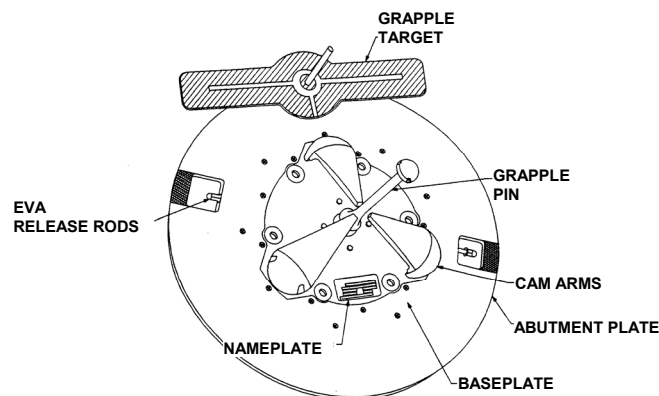
In the event of SSRMS failures that render the LEE inoperable, an EVA crewmember can remove the grapple pin of a PDGF as well as retract the SSRMS latches.

In the illustration, the large arcs between the four latch doors and the three coarse alignment cams are the “curvic coupling” (actually small gear teeth). When the SSRMS attaches to a PDGF these teeth mesh with similar gear teeth on the LEE to provide fine alignment and a stronger interface.

The SRMS and the Japanese Experiment Module (JEM) RMS can also grapple a PDGF. To get an idea of the size differential between the SSRMS and SRMS end effectors, the SRMS EE fits just inside the curvic coupling. The two gaps in the ring allow for the SRMS EE handrail and the SRMS electrical connector (Special Purpose End Effector electrical connector).

##### Flight Releasable Grapple Fixture (FRGF)

The FRGF is the standard payload handling grapple fixture used for years in the Shuttle program. There is an FRGF on the U.S. Lab as well as a PDGF. The FRGF was used to install the Lab on Station and the SSRMS will occasionally attach to this FRGF in certain stowed configurations where both ends of the arm need to be attached. On mission 7A the Airlock and Oxygen Nitrogen Tank ORU's (ONTO's) use FRGF's as well. While the SSRMS can grapple an FRGF it cannot latch to it, nor can it transmit/receive power or data with it.



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# SECTION 5 MCC

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## 5.1 MCC FUNCTIONAL DATA FLOW

### 5.1.1 MCC Overview

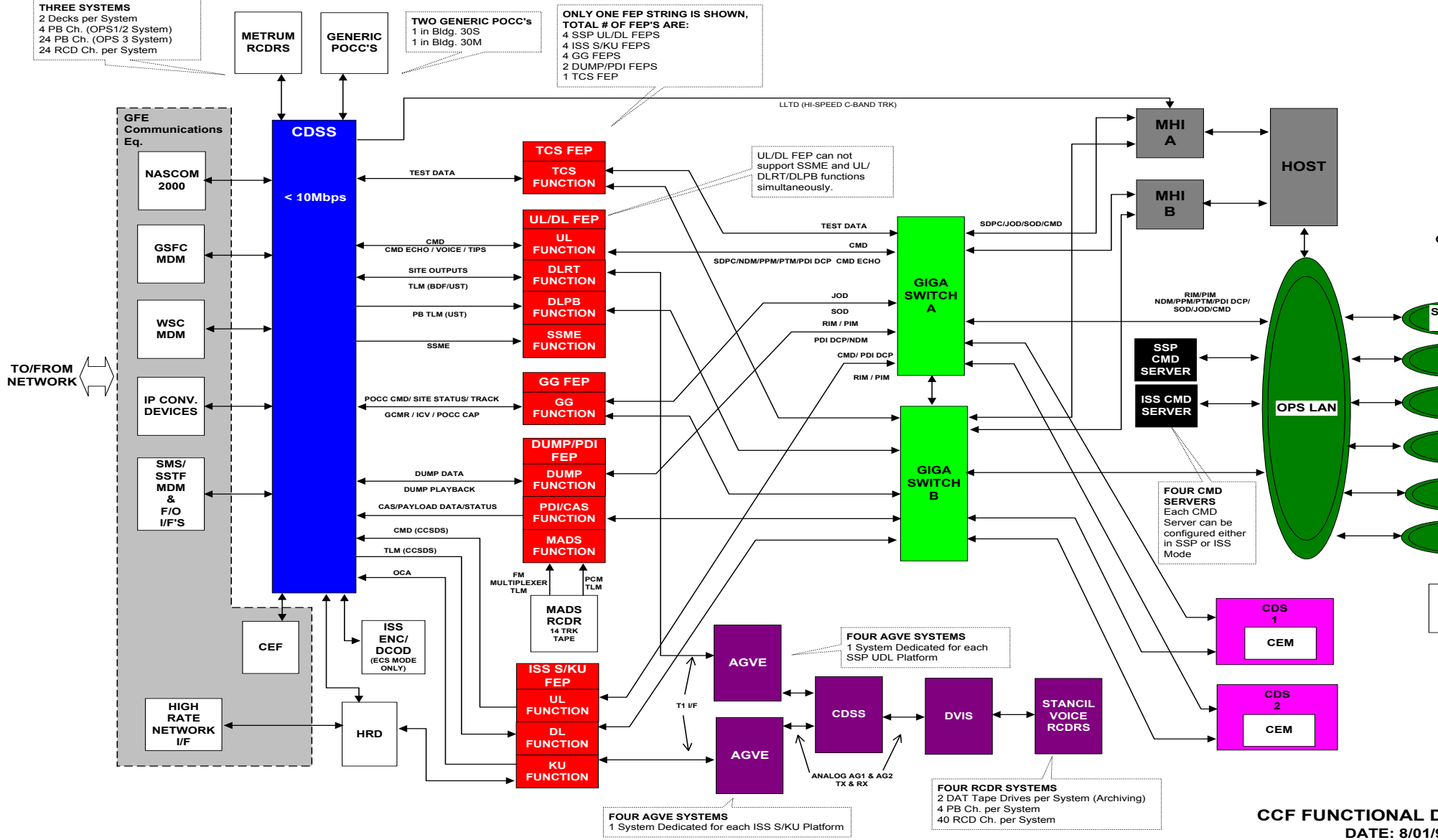


Figure 5.1.1-1: MCC Functional Flow

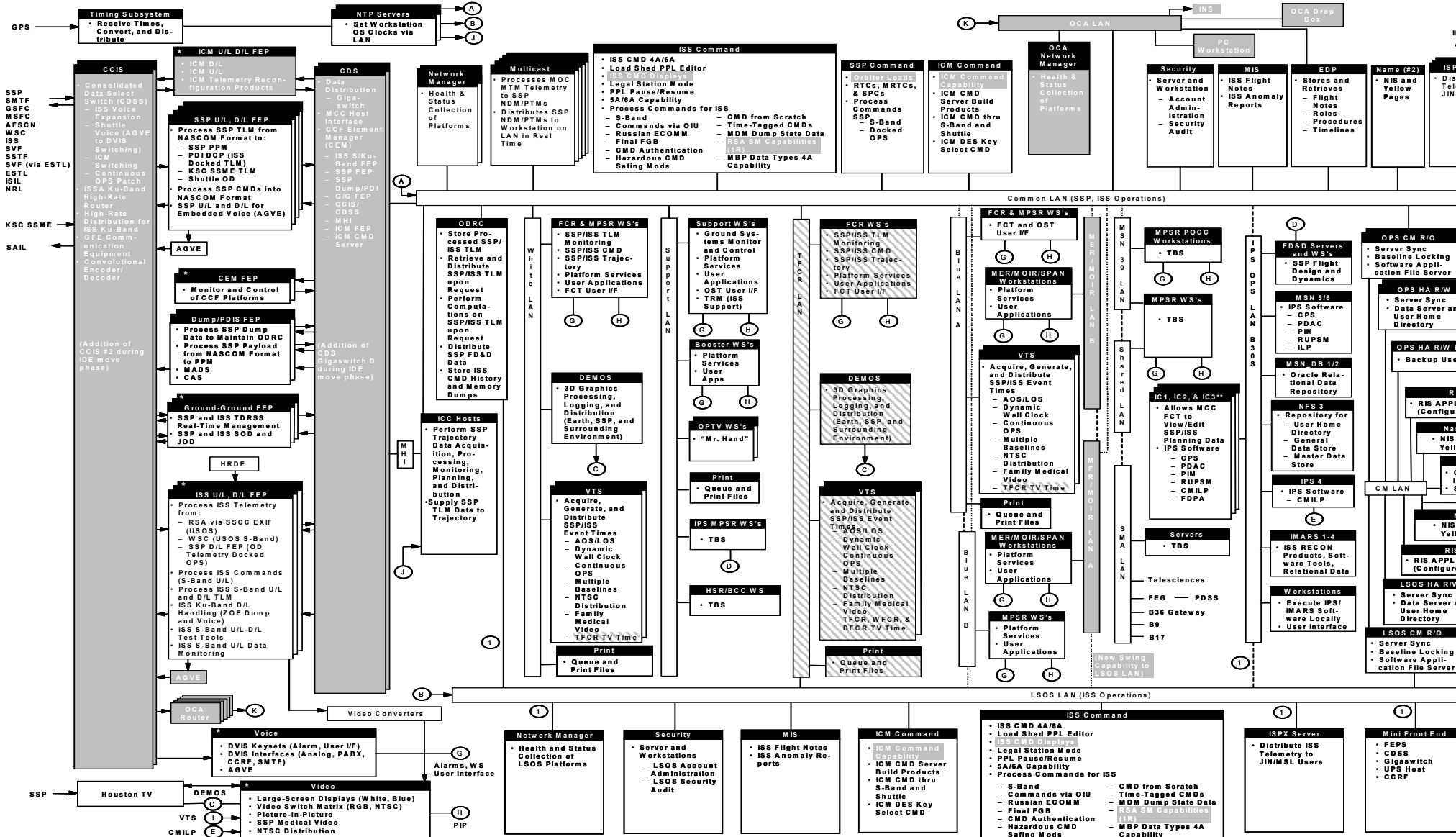


Figure 5.1.1-2: MCC Functional Architecture Overview (Io) REF: CSOC-JSC-REV-000678, 2/17/2000

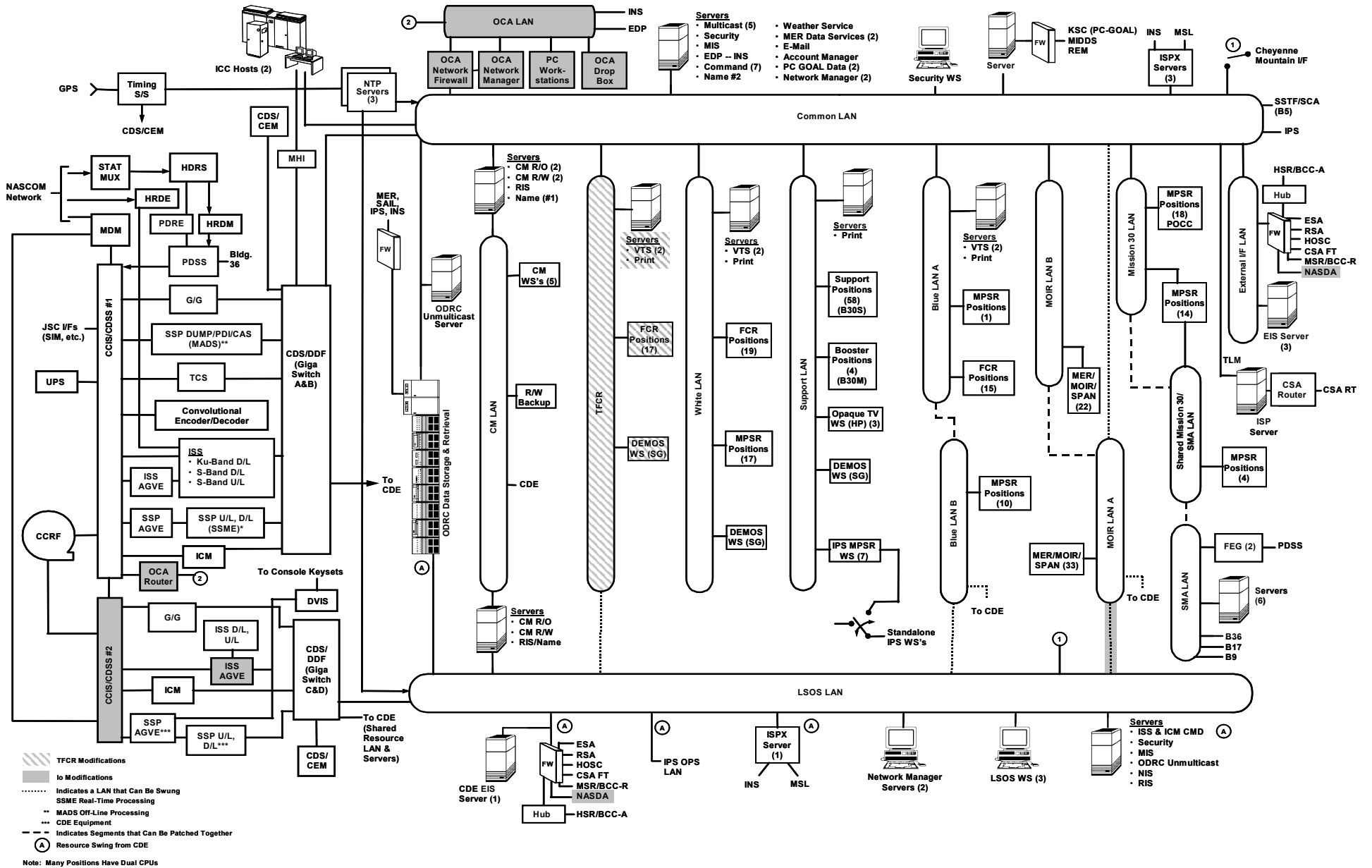


Figure 5.1.1-3: MCC Hardware Architecture Overview (Io) REF: CSOC-JSC-REV-000678, 2/17/2000

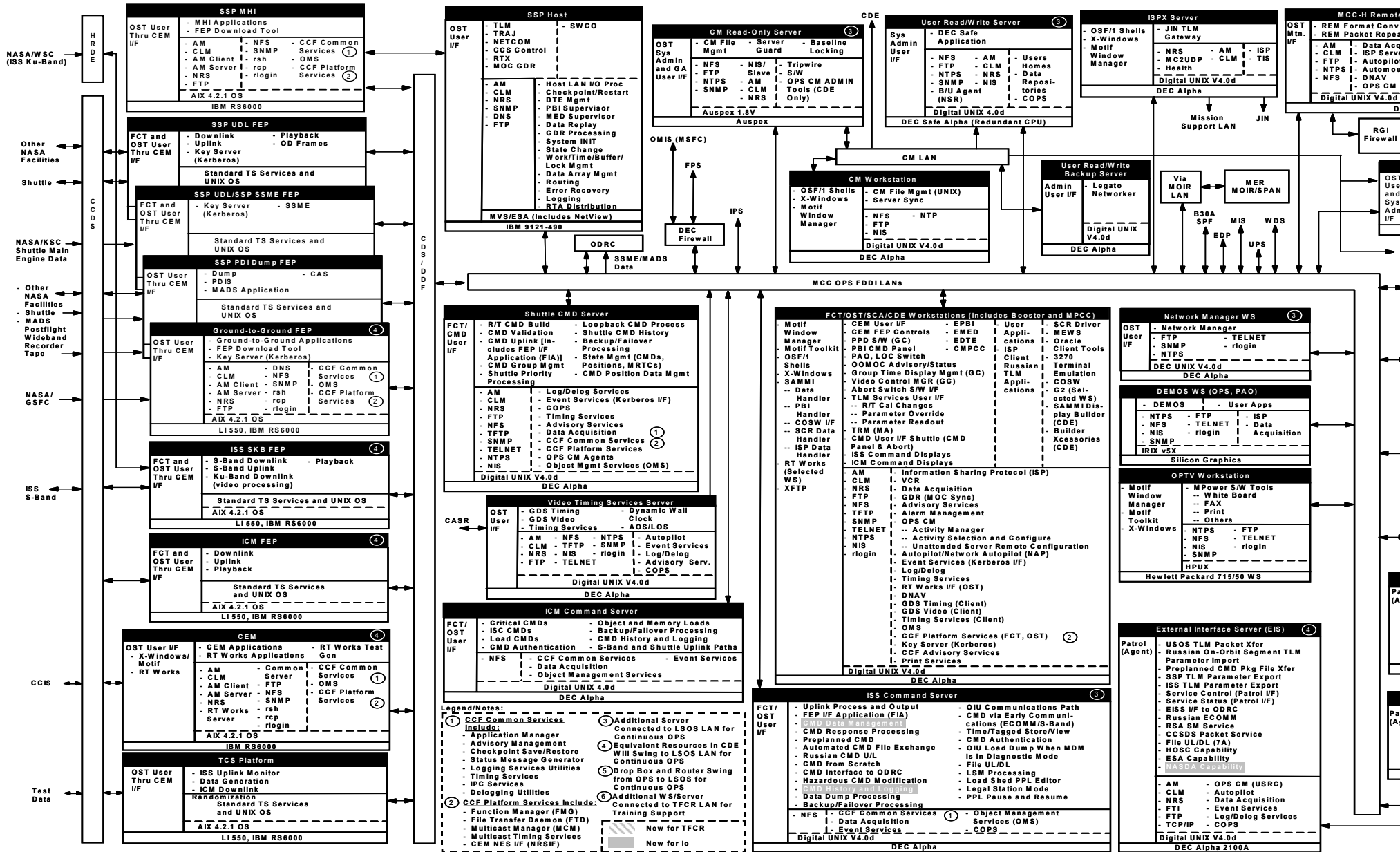


Figure 5.1.1-4: MCC Software Architecture Overview (Io) REF: CSOC-JSC-REV-000678, 2/17/2000

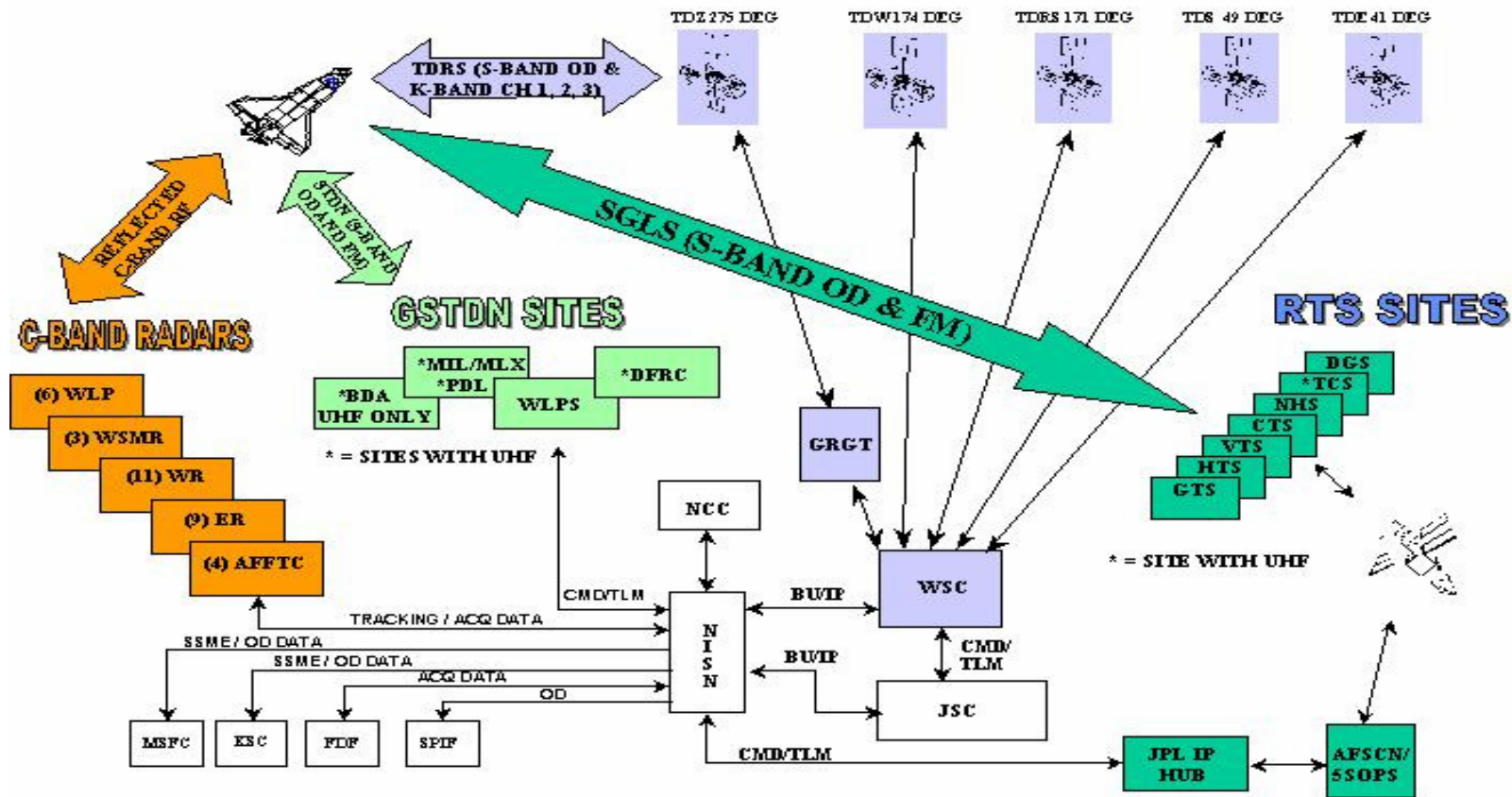


**5.1.2 External Interface Server**  
TBS

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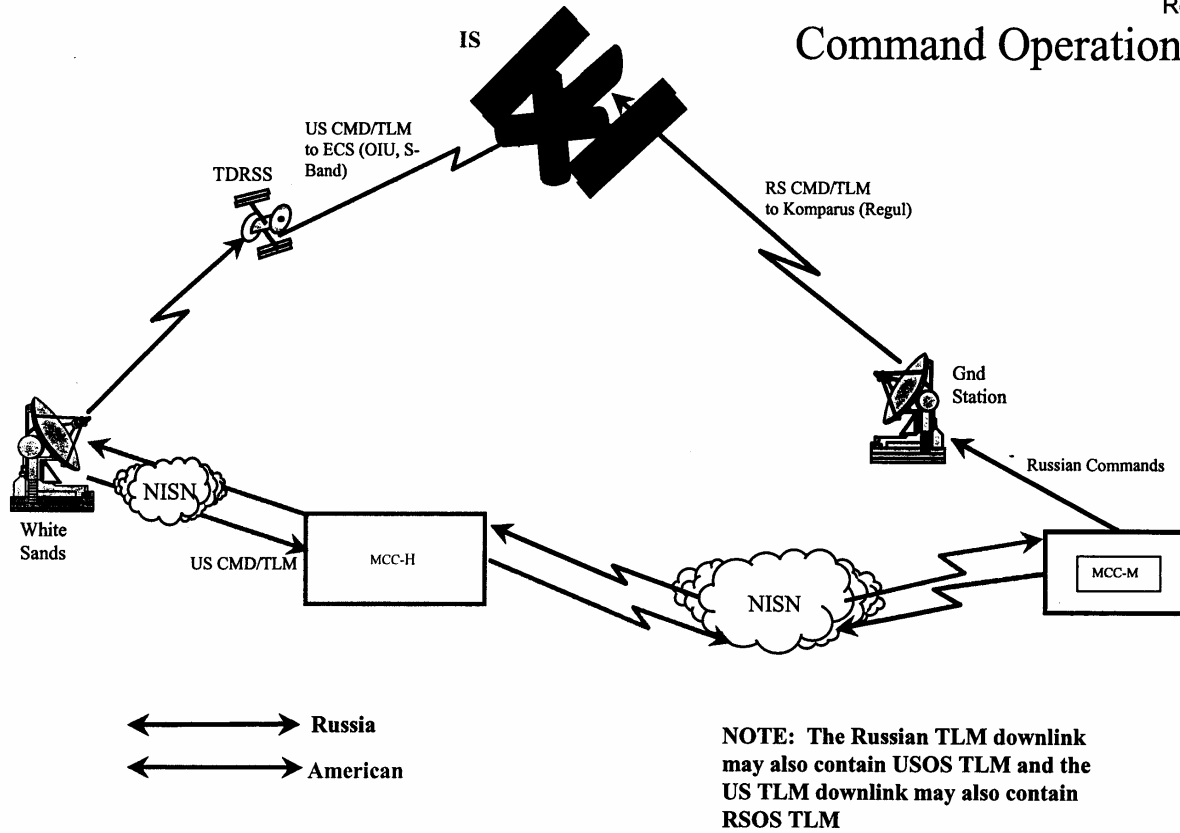
## 5.2 NETWORK

### 5.2.1 Integrated Networks



JSC-19612  
Rev C

# Command Operations



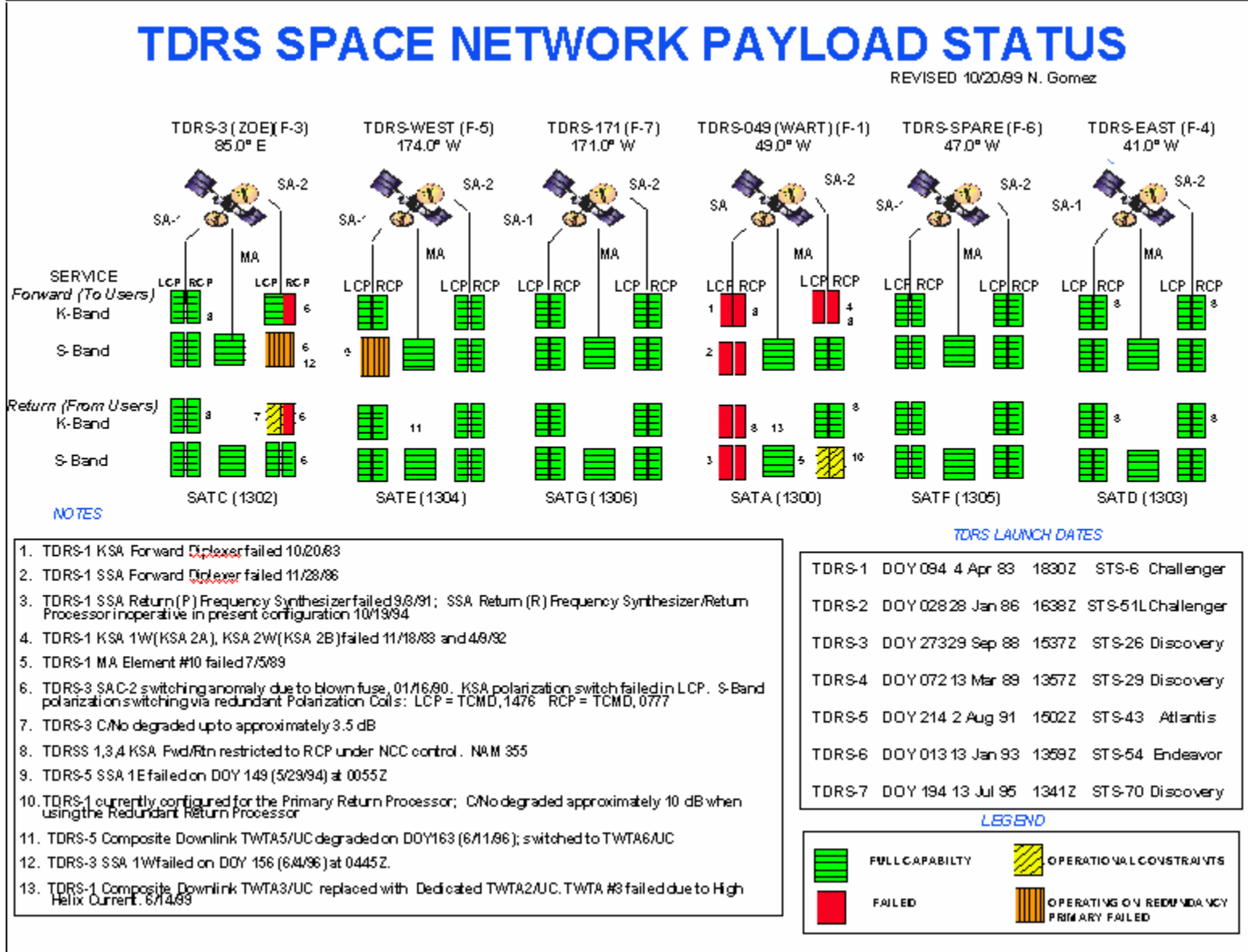
Reference [https://mod.jsc.nasa.gov/df/df25/ODIN\\_docs.html](https://mod.jsc.nasa.gov/df/df25/ODIN_docs.html) for latest version and additional information.

DF25/M. Allyn  
Original Drawing by DB/E. Klein

5.2 1-2

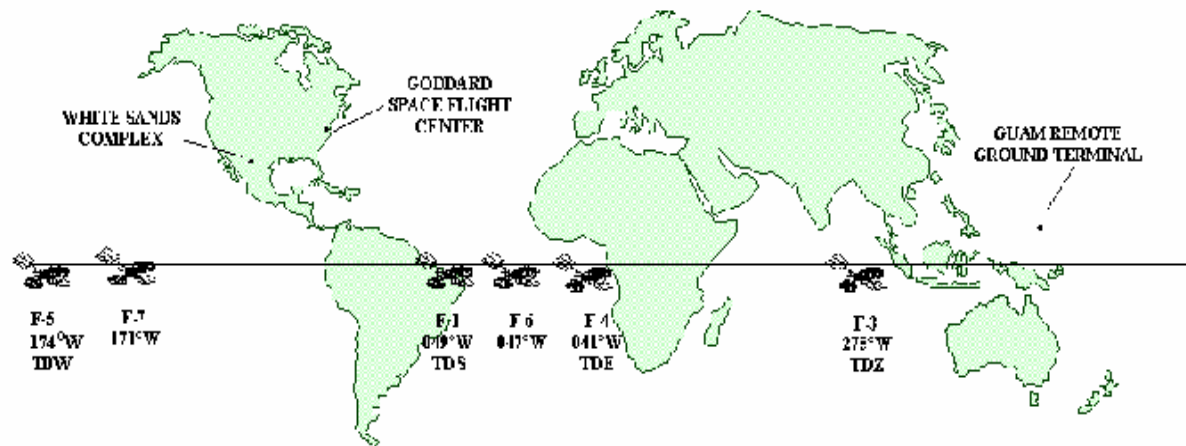
5.2.1-2

5.2.2 TDRS Network Status



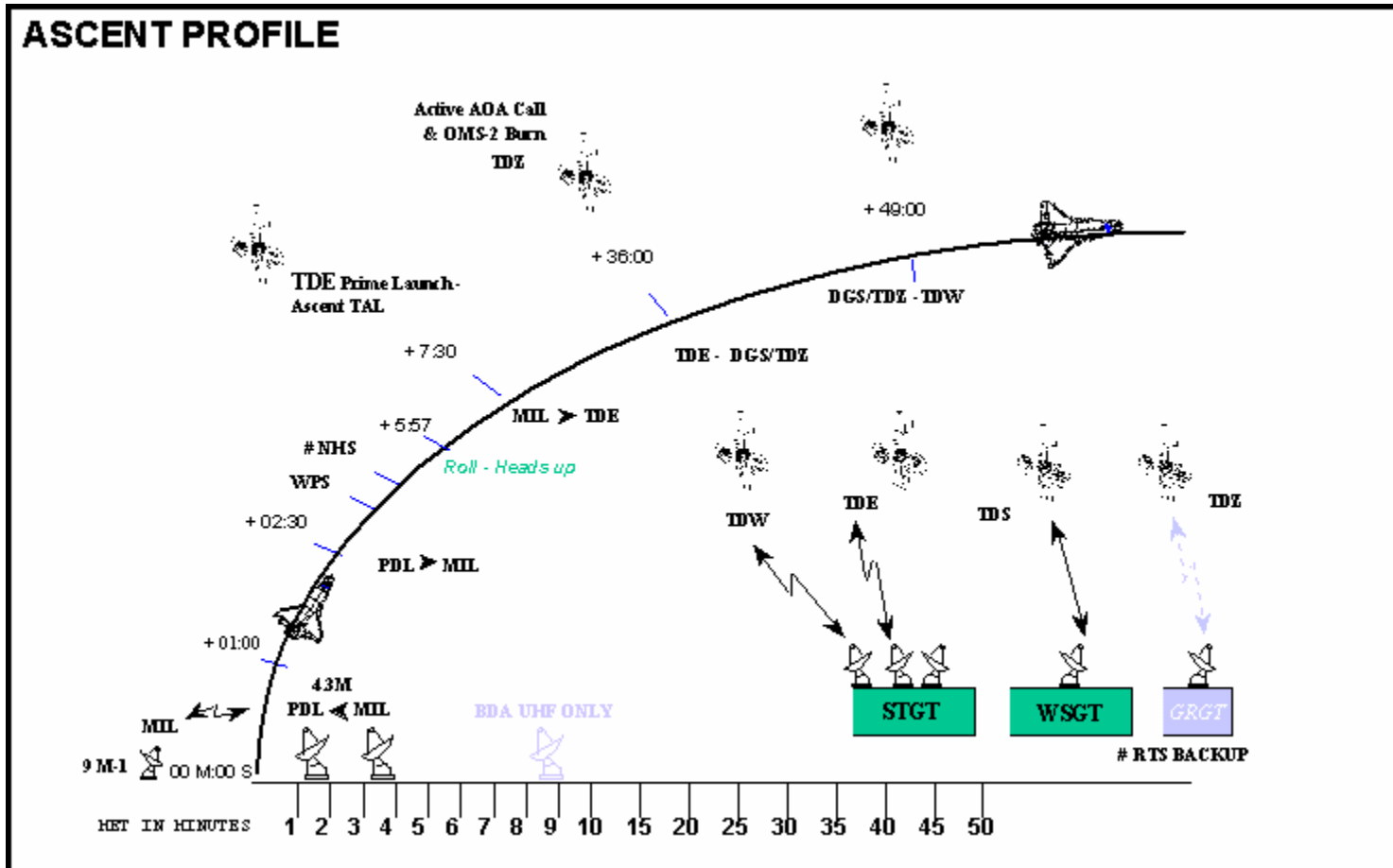
### 5.2.3 TDRS Constraints

## TDRS Map / Constraints / Impacts

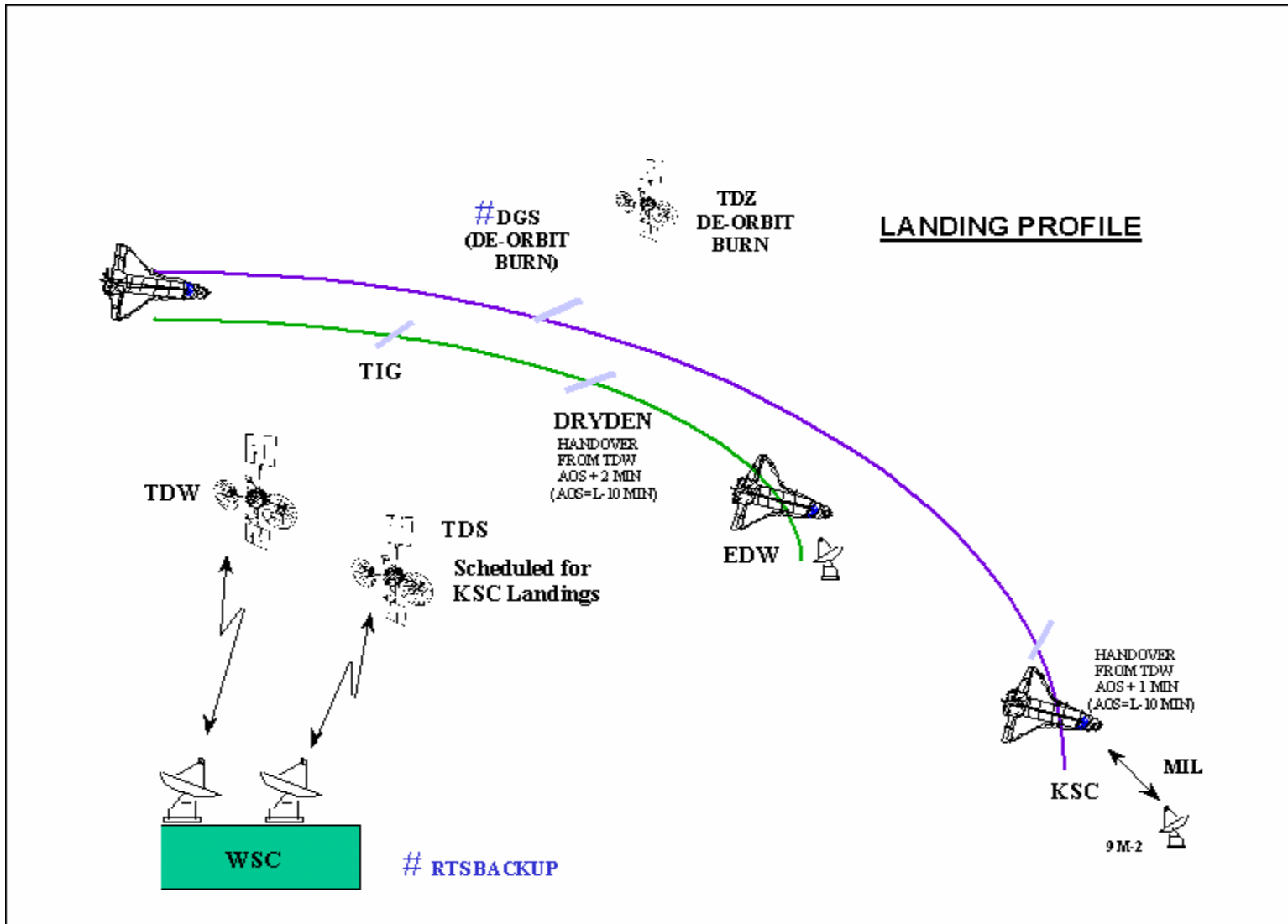


- When using 171 vice 174 (TDW), AOS is ~1 min later.
- When using 49 (TDS) vice 41 (TDE), LOS is ~2 min earlier.
- 49 (TDS) does not have K-band forward capability.
- 275 (TDZ) K-band channel 2 data rate limited to maximum of 1024 Kb.
  - No K-band channel 3 capability.
- No more than 2 overlapping events at any time.
- A schedule request must be accepted at GSFC 7 minutes prior to its start time or it will be

5.2.4 Ascent Profile

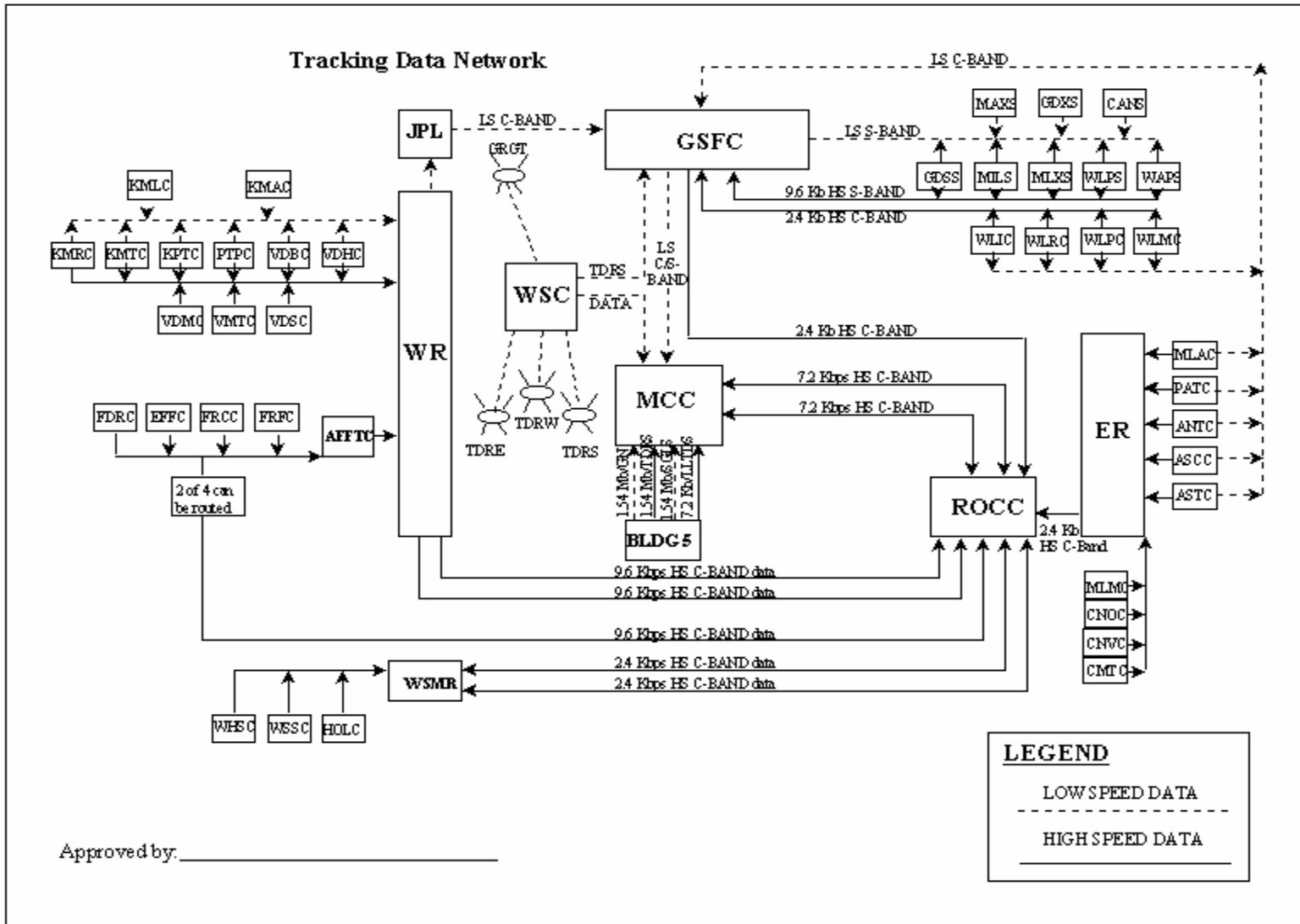


### 5.2.5 Landing Profile



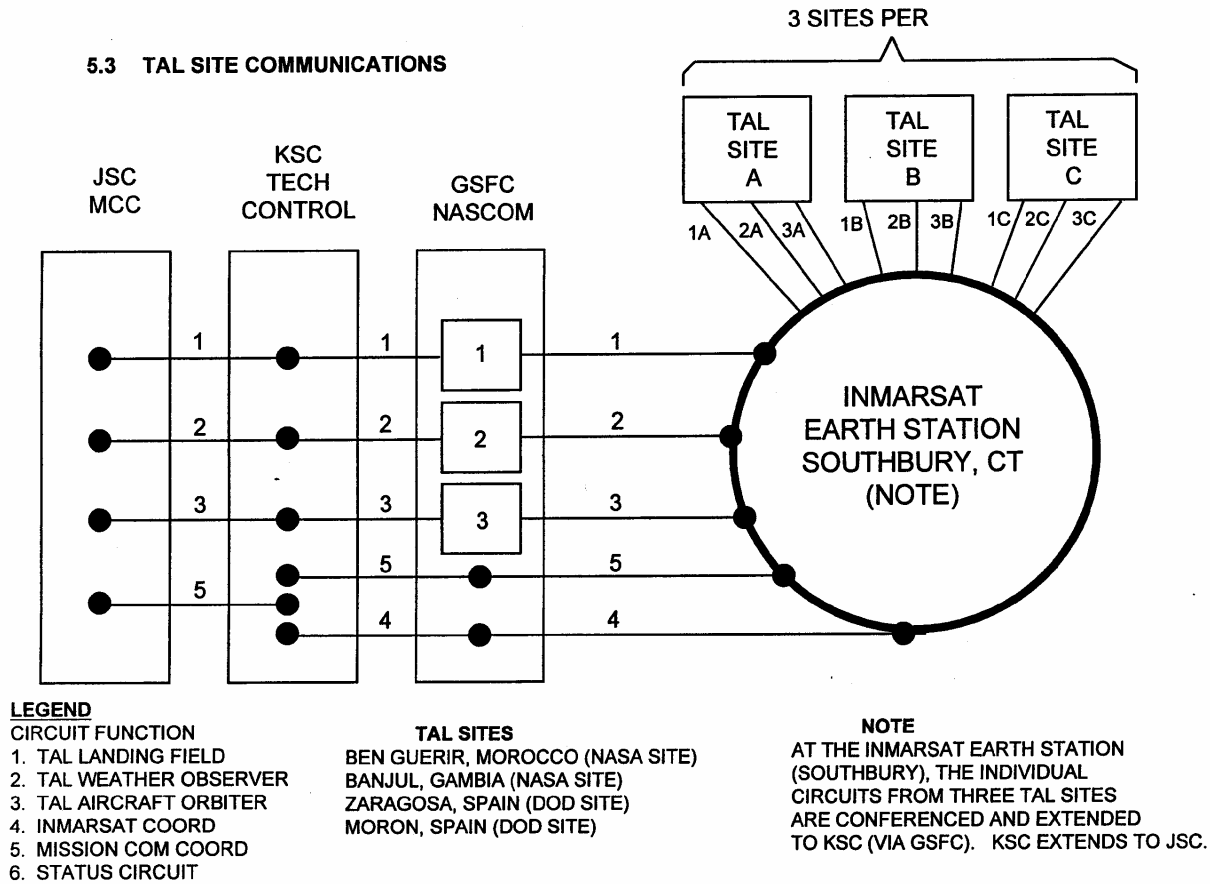


5.2.6 Tracking Network



5.3 TAL SITE COMMUNICATIONS

JSC-19612  
Rev C



**TAL 4-Wire Voice Circuit Distribution**

5.3-1

## 5.4 MCC TERMS AND ACRONYMS

### 5.4.1 Terms

ABEND - The system issues an ABEND when it determines that a task or address space cannot continue processing or produce valid results. For example, a task may try an invalid operation, or an input/output operation may fail.

Checkpoint/restart - Is a method of recording information about a job at programmer-designated checkpoints so the job can be restarted at one of these checkpoints. In our case, only the MOC application is dumped to tape. The system allows for two types of restarts, automatic step restart and deferred step restart. A type 'A' checkpoint is a deferred step restart; this allows us to "freeze" the MOC at a certain point. A type 'B' checkpoint is an automatic step restart; it is restarted automatically once the checkpoint is complete.

Direct access storage device (DASD) - Disk drives accessed by our five host computers.

Initial microcode load (IML) - Reinitializes the processor controller.

Job entry subsystem (JES) - Used to control the input, execution, and output of all jobs within the host.

Loops - A loop is the repeated execution of a sequence of instructions until a terminal condition occurs. If the terminal condition does not occur, the sequence of instructions will be executed endlessly. The operator may need to terminate such endless loops by canceling the looping jobs.

SDUMP - Dumps specific application; may or may not take down MOC depending on what application is dumped and to what extent the problem has affected the MOC job.

Set slips - Sets sliptraps. These can be set for any type of ABEND.

Sliptrap - Automatically dumps ABENDS to dump data set.

Stand alone dump - Dumps entire host memory; will require a re-IPL.

Type A checkpoint - Dumps only MOC application to tape with a deferred resume. Used for freezing the MOC at a certain point.

Type B checkpoint - Dumps only MOC application to tape with an automatic resume.

Virtual telecommunications access method (VTAM) - Directs transmission of data between application programs and MEDS.



#### 5.4.2 MCC Acronyms

AAT	Application and Advanced Technology
ABEND	Abnormal End
ACN	Ascension Island (STDN)
AED	Analog Event Display
AES	Analog Event System
AFSCN	Air Force Satellite Control Network
AGO	Santiago, Chile (STDN)
AGVE	Air-to-Ground Voice Equipment
AI	Action Item
AIT	Application Integration Test
AIX	Application Interactive Executor (IBM O/S)
AM	Application Messaging
ANT	Antigua Island (ETR)
AOS	Acquisition Of Signal
API	Application Program Interface
APM	Attached Pressurized Module
Apps	Applications
AR	Anomaly Report
ASCII	American Standard Code for Information Exchange
ATV	Automated Transfer Vehicle
B/L	Baseline
B/U	Backup
BCC	Backup Command and Control
BCC-R	Backup Command and Control – Russia
BDA	Bermuda Island (STDN)
BDF	Block Data Format
BFCR	Blue Flight Control Room
C&W	Caution and Warning
CAP	Command Acceptance Pattern
CAS	Customer Ancillary Services
CASR	Countdown And Status Receiver
CAW	Cluster Allocation Word
CBM	Common Berthing Mechanism
CBP	Command Build Product
CC	Control Center
CCF	Consolidated Communications Facility
CCIM	Command Computer Input Multiplexer
CCIS	Consolidated Communications Interface Subsystem
CCRF	Consolidated Central Recording Facility
CCS	Command and Control System
CCSDS	Consultative Committee for Space Data Systems
CDDT	Common Display Development Team
CDE	Consolidated Development Environment
CDS	Consolidated Distribution Subsystem

CDSS Consolidated Data Select Switch  
 CDU Command Decoder Unit  
 CEA Customer Expectation Agreement  
 CEM CCF Element Manager (piece of equipment not a person)  
 CHeCS Crew Health Care System  
 CICU Computer Interface Control Unit  
 CIM Computer Input Multiplexer  
 CLM Connectionless Messaging  
 CM Configuration Management  
 CMD Command  
 CMILP Consolidated Maintenance, Inventory, and Logistics Planning  
 COM Computer Output Microfiche  
 COPS Computerized Oracle and Password System  
 COSW Checkout Software  
 COTS Commercial Off The Shelf  
 CPS Consolidated Planning System  
 CPU Central Processing Unit  
 CR Change Request  
 CRP Configuration Requirements Processing  
 CSA Common Storage Area; Canadian Space Agency  
 CSCI Computer Software Configuration Item  
 CSOC Consolidated Space Operations Contract  
 CST Central Standard Time  
 CTD Common Type Definition

D/L Downlink  
 DAPS Decommutation And Processing System  
 DAQ Data Acquisition  
 DASD Direct Access Storage Device  
 DB Database  
 DCN Document Change Notice  
 DCP Data Cycle Packet  
 DCS Display Control System  
 DDD Digital Display Device  
 DDF Data Distribution Function  
 DDH Dump Data Handler  
 DEC Digital Equipment Corporation  
 DEMOS Distributed Earth Model Orbital System  
 DES Data Encryption Standard  
 DFRC Dryden Flight Research Center  
 DI Display Interface  
 DIU Display Interface Unit  
 DICE AFSCN Mission Controller  
 DKR Dakar, Senegal (STDN)  
 DLSM Data Link Summary Message  
 DLT Digital Linear Tape  
 DNAV Display Navigation

DNS	Domain Name Service
DPIS	Distributed Planning Interface Specification
DPS	Data Processing Systems
DQM	Dump Quality Monitoring
DRK	Display Request Keyboard
DSC	Dynamic Standby Computer
DSCIM	Display Select Computer Input Multiplexer
DTD	Data Transfer Diagram
DTE	Digital Television Equipment
DTO	Detailed Test Objective
DUI-III	Data Integration Unit-III
DVIS	Digital Voice Intercommunications System
ECD	Estimated Completion Date
ECG	Electrocardiogram
ECOMM	Early Communications
ECIO	Experiment Computer Input/Output
ECOS	Experiment Computer Operating System
EDD	Event Data Distributor
EDP	Electronic Documentation Project
EDTE	Emulated Digital Television Equipment
EECOM	Electrical, Environmental, and Communication Engineer
EHROCS	ESTL High-Rate Optical Communication System
EIRP	Effective Isotropic Radiated Power
EIS	External Interface Server; External Interface Subsystem
EMED	Emulated Manual Entry Device
EMU	Extravehicular Mobility Unit
EPBI	Emulated Push Button Indicator
EPS	Electrical Power System
ESA	European Space Agency
ESO	Event Sequence Override
ESTL	Engineering Support Test Laboratory
ESW	Equipment Status Word
EXIF	External Interface
Ext	External
F/W	Firewall
FAO	Flight Activities Officer
FCA	Format Converter
FCR	Flight Control Room
FCT	Flight Control Team
FD&D	Flight Design and Dynamics
FDDI	Fiber Distributed Data Interface
FDPA	Flight Dynamics Planning and Analysis
FEG	Front-End Gateway
FEP	Front-End Processor
FEPS	Front-End Processor Subsystem
FGB	Functional Cargo Block

FIA	FEP I/F Application
FMG	Function Manager
FMT	File and Memory Transfer
FSW	Flight Software
FT	File Transfer
FTD	File Transfer Daemon
FTF	File Tracking Form
FTP	File Transfer Protocol
G/G	Ground-to-Ground
G/W	Gateway
G&N	Guidance and Navigation
GA	Group Administrator
GC	Ground Controller
GCMR	Ground Control Message Request
GCS	Generic Command Server
GD	Group Data
GDB	Ground Data Base
GDR	Generalized Data Retrieval
GDS	Goldstone, California (STDN); General Data Store
GFE	Government Furnished Equipment
GIANT	Globally Interconnected Advanced Network Telepresence
GN&C	Guidance Navigation and Control
GPC	General Purpose Computer
GPS	Global Positioning System
GRC	Ground Rules and Constraints
GRT	Ground Receipt Time
GS	Ground Segment
GSCB	Ground Segment Control Board
GSDE	Ground System Development Environment
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
HA	High Availability
HDRS	High Data Rate Switch
HEDS	Human Exploration and Development in Space
HISAM	Hardware Initiated Standalone Memory
HOSC	Huntsville Operations Support Center
HRDE	High Rate Distribution Equipment
HRDM	High Rate Demultiplexer
HRFM	High Rate Frame Mux
HRM	High Rate Multiplexer
HSG	Houston Support Group
HSR	Houston Support Room
HTV	H2 Transfer Vehicle (NASDA)
HW	Hardware
I/F	Interface



I/O	Input/Output
IBM	International Business Machines
ICD	Interface Control Document
ICM	Interim Control Module
IDA	Intermediate Data Array
IDSD	Institutional Data Systems Division
IES	Information Extraction Software
IFA	In-flight Anomaly
ILP	Inventory and Logistics Planning
IMARS	ISS MOD Avionics Reconfiguration Subsystem
IMS	Inventory Management System
IMU	Inertial Measurement Unit
INIT	Initialization
INS	Integrated Network Services
IOP	Increment Operations Plan
IP	International Partner
IPL	Initial Program Load
IPS	Instrument Pointing System; Integrated Planning System
IRIG	Interrange Instrumentation Group
ISA	Intermediate Storage Array
ISC	ICM Spacecraft Controller
ISDN	Integrated Services Digital Network
ISP	Information Sharing Protocol
ISS	International Space Station
JCL	Job Control Language
JCP	JEM Control Processor
JES	Job Entry Subsystem
JIN	JSC Information Network
JPL	Jet Propulsion Laboratory
JVM	Java Virtual Machine
KCA	Ku-band Communications Adapter
KMR	Kwajalein Missile Range
LAB	Laboratory Module
LAN	Local Area Network
LCM	Local Controlling Monitor
LDP	Logical Data Path
LLTD	Launch/Landing Trajectory Determination
LOC	Logistics Operations Center
LOS	Loss Of Signal
LSM	Logistics Support Manager
LSOS	Limited Station Operations Support
LVLH	Local Vertical/Local Horizontal
MADS	Modular Auxiliary Data System
MAPS	Multipurpose Attitude and Pointing System

MBF	Mission Build Facility
MCC	Mission Control Center
MCM	Multicast Manager
MDM	Multiplexer/Demultiplexer
MDRF	Mission Data Request Form
MDS	Master Data Store
MED	Manual Entry Device
MEIT	MCC Element Integration Test
MER	Mission Evaluation Room
MEWS	Mission Evaluation Workstation Systems
MHI	MCC Host Interface
MIDDS	Meteorological Interactive Data Display System
MIL	Merritt Island, Florida (STDN)
MIS	Management Information System
MITS	MOD IPS TACAN Subsystem
MMU	Mass Memory Unit
MOC	Mission Operations Computer
MOIR	Mission Operations Integration Room
MOW	Mission Operations Wing
MPSR	Multipurpose Support Room
MPT	Mission Planning Table
MRTC	Multiple Real-Time Command
MSBLS	Microwave Scanning Beam Landing System
MSC	Mission Systems Contract
MSFC	Marshall Space Flight Center
MSID	Measurement Stimulation Identification
MSK	Manual Select Keyboard
MSL	Mission Support LAN
MSR	Moscow Support Room
MuDPIS	Multilateral Distributed Planning Specification
MUI	Mission Unique Identifier
MUX	Multiplexer
MVS	Multiple Virtual System
NAP	Network Autopilot
NASCOM	NASA Communications Network
NASDA	National Aeronautics/Space Development Agency
NBL	Neutral Buoyancy Laboratory
NCIC	Network Communication Interface Common
NCIU	Network Communication Interface Unique
NCS	Node Control System; Node Control Software
NDD	Network Data Driver
NDM	Network Data Message
NETCOM	Network Communications
NFS	Network File System
NGT	NASA Ground Terminal
NIP	Network Interface Processor
NIS	Network Information System

NISN	NASA Integrated Support Network
NOM	Network Output Multiplexer
NRL	Naval Research Laboratory
NRS	Network Registration Server
NRSIF	NES I/FNRT (near R/T telemetry)
NSS	Network Support System
NTP	Network Time Protocol
NTPS	Network Timing Protocol Service
NTSC	National Television Standards Committee
OCA	Orbiter Communications Adapter
OCS	Operational Control System
OD	Operational Downlink
ODRC	Operational Data Reduction Complex
OIU	Orbiter Interface Unit
OMS	Object Management System
OOMOC	On-Orbit Mission Operations Computer
OPTV	Opaque Televisor
OS	Operating System
OSF	Open Systems Foundation
OST	Operations Support Team
OSTP	Onboard Short Term Plan
OTU	Onboard Time Update
P/B	Playback
P/L	Payload
PADS	Pilot Atmospheres Data System
PB	Playback; Pushbutton
PBI	Pushbutton Indicator
PCD	Program Change Document
PDAC	Procedures Development And Control
PDF	Portable Data Format
PDI	Payload Data Interleaver
PDIS	Payload Data Interleaver Serializer
PDLS	Ponce de Leon Inlet, Florida (S-band station)
PDR	Preliminary Design Review
PDRE	PDDC Data Recording Equipment
PDSS	Payload Data Select Switch
PDU	Power Distribution Unit
PE	Project Engineer
PET	Phase Elapsed Time
PIM	Planning Information Management; Processed Independent Message
PIP	Picture-In-Picture
PIRN	Programmatic Interface Revision Notice
POCC	Payload Operations Control Center
POIC	Payload Operations Integration Center
PPCP	Pre Plan Command Package
PPD	Projection Plotting Display

PPL	Prepositioned Load
PPM	Processed Payload Message
PPR	Project Planning Review
PS	Platform Services
PSCN	Program Support and Communications Network
PSS	Planning and Scheduling Subsystem
PTM	Processed Telemetry Message
PUI	Program Unique Identifier
QT	Qualification Test
QUEST	Qualification and Utilization of Electronic Systems Technology
R/O	Read Only
R/T	Real-Time
R/W	Read and Write
RAID-5	Redundant Array of Inexpensive Disk – Format 5
RCM	Remote Controlling Monitor
RECON	Reconfiguration
RECP	Request for Engineering Cost Proposal
REH	Remote Extension Houston
REM	Remote Extension Moscow; Resource Envelope Management
RF	Radio Frequency
RGI	Remote Gateway Interface
RGO	Range to Go
RID	Madrid, Spain; Review Item Disposition
RIM	Raw Independent Message
RIS	Renaissance Infinite Storage; Remote Install Service
Rlogin	Remote Login
ROS	Russian On-orbit Segment
RPF	Robotics Planning Facility
RS	Russian Segment
RSA	Russian Space Agency
RT	Real-Time
RTA	Real-Time Accumulator
RTC	Real-Time Command
RTX	Real-Time Transfer
RUPSM	Resource Utilization Planning and System Modeling
S/G	Space/Ground
S/S	Subsystem
S/W	Software
SAIL	Shuttle Avionics Integration Laboratory
SAMMI	SSI Advanced Man-Machine Interface
SAR	Single Activity Record
SAS	Statistical Analysis System
SCA	Simulation Control Area
SCE	Spacecraft Command Encoder
SCL	Spacecraft Command Language

SCR	Strip Chart Recorder
SCS	Status and Control System
SCU	System Configuration Unit
SDO	Station Duty Officer
SDPC	Shuttle Data Processing Computer
SDR	System Design Review
SDSS	Shuttle Data Select Switch
SEI	Software Engineering Institute
SFOC	Space Flight Operations Contract
SGI	Silicon Graphics, Incorporated
SGLS	Space Ground Link Subsystem
SIC	Support Identification Code
SIOT	System Integration and Operations Test
SKB	S-/Ku-band
SKR	Separator-KG-Recombiner
SM	Service Module
SMA	Science Management Area
SMEK	Summary Message Enable Keyboard
SNMP	Simple Network Management Protocol
SOB	Checkpoint Failed
SOD	Site-Originated Data
SPAN	Spacecraft Analysis
SPC	Stored Program Command
SPF	Spacelab Processing Facility
SPOM	Scheduling and Planning Optimizing Module
SR	Service Request
SRR	System Release Review
SSA	S-band Single Access
SSM	Site Status Message
SVF	Software Verification Facility; Station Verification Facility
SWCO	Software Checkout
TBP	Telemetry Build Product
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TCS	Thermal Control System; Test and Checkout Subsystem (FEP)
TDRS	Tracking and Data Relay Satellite
TELECOM	Telecommunications
TELNET	Telephone Network
TFCR	Training Flight Control Room
TFTP	Trivial File Transfer Protocol
THRIFT	Telemetry History Report In Formatted Tabulation
TIM	Technical Interchange Meeting
TLM	Telemetry
TPC	Telemetry Processing Computer
TPS	Tactical Planning System
TRM	TDRSS Real-time Manager
TS	Telecommunications System

TT	Time Tagged
TTY	Teletype
TV	Television
U/L	Uplink
UDL	Uplink/downlink
UDP	Universal Datagram Protocol
UPS	User Planning System
USOS	U.S. On-orbit Segment
USRC	Unattended Server Remote Configuration
UST	Unblocked Serial Telemetry
UTC	Universal Time Coordinated
VAT	Vector Administration Table
VBSP	Video Baseband and Signal Processor
VCR	Video Cassette Recorder (Workstation Software)
VID	Vehicle Identification
VMDB	Vehicle Master Data Base
VOLSER	Volume Serial Number
VPN	Virtual Private Network
VREL	Relative Velocity
VSM	Video Switch Matrix
VSMBM	VSM Buffer Multiplexer
VTAM	Virtual Telecommunication Access Method
VTS	Video and Timing Services
W/S	Workstation
WAN	Wide Area Network
WFCR	White Flight Control Room
WS	Workstation
WSC	White Sands Complex
WSGRT	White Sands Ground Receipt Time
WSOS	Workstation Operating System
WSS	Workstation Support
WSSA	Workstation Support Application
XPOP	X-axis Perpendicular to Orbital Plane
YAR	Yarragadee, Australia (GSTDN)
ZOE	Zone Of Exclusion

## SECTION 6 FLIGHT SPECIFIC ANNEX

Section		Page
<b>6</b>	<b>FLIGHT SPECIFIC ANNEX .....</b>	<b>6-1</b>
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6.1.2	Runway/NAVAIDs/Landing Aids Chart .....	6.1-1
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6.1.4	Deorbit Opportunities .....	6.1-1
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6.2.3	Middeck Locker Layout .....	6.2-1
6.2.4	P/L Displays .....	6.2-1
6.2.5	Experiment Synopsis .....	6.2-1
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## 6.1 ASCENT/ENTRY

### Section

### Source

6.1.1 Launch Window

FDO

6.1.2 Runway/NAVAIDs/Landing Aids Chart

LSO

6.1.3 Abort Boundary Charts

FDO, GPO

6.1.4 Deorbit Opportunities

FDO

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## 6.2 SHUTTLE ORBIT

<u>Section</u>	<u>Source</u>
6.2.1 Orbiter Bay Pictorial	SSSH
6.2.2 Standard Switch Panel Layout	SSSH
6.2.3 Middeck Locker Layout	tbd
6.2.4 P/L Displays	Lead PLO/ACO
6.2.5 Experiment Synopsis	Lead PLO/ACO
6.2.6 Comm Planning Memo	Lead INCO
6.2.7 Contingency EVA Requirements	Lead EVA

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## 6.3 ISS

### Section

### Source

6.3.1 ISS Configuration

ECLS

6.3.2 C&DH Summary

ODIN

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## **APPENDIX CHANGE CONTROL**

The Flight Director Console Handbook is under configuration control. The purpose of this appendix is to delineate change control procedures for the Flight Director Console Handbook. This will ensure the proper coordination of changes and provide a record of proposed changes, rationale, and disposition.

Proposed changes will be processed from any of the Flight Directors in the DA8/Flight Director Office. Individuals desiring to submit a change should complete all applicable items on the Change Request Form (Figure A-1). This form should be typed or neatly printed. Additional pages may be used if the space provided is not adequate. The original completed form should then be forwarded to the Flight Director Console Handbook Book Manager, who will obtain formal concurrence and comments from the peer review personnel within DA8. All proposed modifications to the CR will be coordinated with necessary personnel prior to disposition. The Book Manager will retain a copy of all CRs for future reference.

Upon obtaining the required concurrence, the book manager will present the proposed change to the Chief of the Flight Director Office for final disposition. The Book Manager will compile all approved changes and any typographical errors and incorporate them into a revision or PCN to the document. The Chief of the Flight Director Office will approve any revisions or PCNs to the document, which will be made on an as-required basis.

<b>NASA - JOHNSON SPACE CENTER CHANGE REQUEST FORM</b>	
CR NUMBER:	
SECTION(S) AFFECTED:	
CHANGE:	
RATIONALE FOR CHANGE:	
ORIGINATOR NAME _____ ORGANIZATION _____ TELEPHONE _____ -	
BOOK MANAGER NAME _____ DATE _____ RECOMMENDATION _____ INCORPORATED _____ DATE _____	<input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED <input type="checkbox"/> APPROVED WITH CHANGES <hr/> SUPERVISOR _____ DATE _____

Figure A-1: Change Request Form