National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
2101 NASA Road 1
Houston, Texas 77058-3696

January 14, 2003

Reply to Attn of: DA8-03-007

TO: Distribution

FROM: DA8/Chief, Flight Director Office

SUBJECT: STS-107 Flight Rules Annex, Final, PCN-1, Pen and Ink #1, dated January 14, 2003

FLIGHT RULE ACTION
IMMEDIATE ATTENTION

The enclosed flight rules changes were approved and should be inserted into the Space Shuttle Operational Flight Rules, STS-107 Flight Specific Annex Document (JSC-18308), Final, PCN-1, dated December 19, 2002.

RULE NO	CR NO	TITLE
107_1A-12	5895A	Deletion of SIMPLEX
107_1A-13	5895A	Deletion of SIMPLEX
107_1A-14	5895A	Deletion of SIMPLEX
107_2A-2	5895A	Deletion of SIMPLEX
107_2A-15	5898	TAL Rainshower Exceptions
107_2A-22	5895A	Deletion of SIMPLEX
107_2A-23	5895A	Deletion of SIMPLEX
107_2A-61	5895A	Deletion of SIMPLEX
107_2A-63	5895A	Deletion of SIMPLEX
107_2A-64	5895A	Deletion of SIMPLEX
107_4A-11	5895A	Deletion of SIMPLEX

These flight rules changes, with this cover letter, should be retained in the above document until specifically replaced by a subsequent formal PCN.

Questions should be addressed to NASA JSC, DA8/B. A. Levy, at 281-483-8586.

J. Milton Heflin
Chief, Flight Director Office

Kelly B. Beck
STS-107 Lead Flight Director

Enclosure
DA8/NEDunn:ned:01/14/03:33628

NSTS - 18308

Space Shuttle Operational Flight Rules Annex

Flight STS-107

Mission Operations Directorate

Final

June 20, 2002

PCN-1

December 19, 2002

Pen and Ink #1

January 14, 2003

Verify that this is the correct version before use.

National Aeronautics and
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SPACE SHUTTLE OPERATIONAL FLIGHT RULES ANNEX

STS-107

FINAL, PCN-1, P&I #1

JANUARY 14, 2003

THIS DOCUMENT INCORPORATES CHANGES TO THE FOLLOWING RULES (SINCE THE FINAL, PCN-1, DATED DECEMBER 19, 2002) BY THE APPLICABLE DISCREPANCY NOTICES (DN'S) AND CHANGE REQUESTS (CR'S).

RULE NO.	CR NO.
107_1A-12	CR 5895A
107_1A-13	CR 5895A
107_1A-14	CR 5895A
107_2A-2	CR 5895A
107_2A-15	CR 5898
107_2A-22	CR 5895A
107_2A-23	CR 5895A
107_2A-61	CR 5895A
107_2A-63	CR 5895A
107_2A-64	CR 5895A
107_4A-11	CR 5895A

BOOK MGR	BAL 01/14/03
FINAL QA	ned 01/14/03

107_1A-12 MISSION MANAGEMENT TEAM (MMT) (CONTINUED)

Every attempt will be made preflight to predict potential anomaly and contingency situations and establish the best course of action. However, for those contingencies not covered in the preflight documentation, a structure exists to provide customer inputs and decisions to the mission management and the Flight Control Teams (FCT's). This structure is the Mission Management Team (MMT).

The MMT at JSC consists of NASA mission management and payload management representatives. The NASA mission management includes the Manager, Space Shuttle Program, or his designated representative, the Director of Mission Operations, the Cargo Management Team, and other appropriate NASA management. The Cargo Management Team is physically located at JSC and is chaired by the Space Shuttle Flight Manager (Space Shuttle Program Integration Office). The payload management representative includes the Payload Mission Manager(s), or his designated representative. ®[DN 13]

The purpose of the MMT is to provide management direction and decisions when mission events fall outside the scope of predefined real-time operations roles and responsibilities. If mission circumstances require an unanticipated change in the major mission objective or operations policy, the operations team will recommend a course of action and identify options to the MMT. The MMT evaluates the operations team's recommendation and provides direction to implement the agreed course of action.

B. THE MISSION MANAGEMENT TEAM IS RESPONSIBLE FOR PROVIDING NEAR REAL-TIME POLICY AND OVERALL MISSION DIRECTION WHENEVER OPERATIONS OUTSIDE THE SHUTTLE/PAYLOAD MISSION RULES OR OPERATING BASE ARE REQUIRED.

C. THE MANAGER, SPACE SHUTTLE PROGRAM (OR HIS DESIGNATED REPRESENTATIVE), AS CHAIRMAN OF THE MISSION MANAGEMENT TEAM, IS THE FINAL AUTHORITY FOR COMMITTING THE SPACE SHUTTLE SYSTEM TO ACCOMPLISH UNPLANNED TASKS FOR WHICH SPACE SHUTTLE SAFETY AND/OR OPERATIONAL RISK ARE GREATER THAN PLANNED PREMISSION.

D. THE FLIGHT MANAGER (OR HIS DESIGNATED REPRESENTATIVE) CHAIRS THE CMT. THE FLIGHT MANAGER PROVIDES THE CMT LAUNCH GO TO THE MMT UPON STATUSING THE PAYLOAD/EXPERIMENT ORGANIZATIONS FOR READINESS. THE FLIGHT MANAGER, AS CMT CHAIR, OVERSEES THE FLIGHT MANIFEST OPERATIONS FROM THE CUSTOMER SUPPORT ROOM (CSR), RESOLVING PRIORITY ISSUES, AND COORDINATING AND/OR OVERSEEING THE RESOLUTION OF ANY OTHER FLIGHT MANIFEST ISSUE. ®[DN 13]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-12 MISSION MANAGEMENT TEAM (MMT) (CONTINUED)

E. THE PAYLOAD MISSION MANAGER (OR HIS DESIGNATED REPRESENTATIVE), AS A MEMBER OF THE CARGO MANAGEMENT TEAM, IS THE FINAL AUTHORITY WITHIN HIS PAYLOAD COMPLEMENT ON PAYLOAD MISSION OBJECTIVES OR POLICY CHANGES AND FOR COMMITTING THE PAYLOAD TO ACCOMPLISH TASKS FOR WHICH THE OPERATIONAL RISK IS GREATER THAN PLANNED PREMISSION. ®[DN 13]

The Payload Mission Manager (or his representative) is a member of the CMT and makes the final decision regarding payload objectives within his payload complement to the Flight Manager. The Payload Mission Manager for Spacehab is the Spacehab Program Manager and the Payload Mission Manager for FREESTAR is the FREESTAR Mission Manager. Reference Rule {107_1A-14}, PAYLOAD OPERATIONS/MANAGEMENT AUTHORITY, for additional information. Payload Mission Manager for RAMBO is DOD REP. ®[DN 13] ®[CR 5895A]

107_1A-13 FLIGHT CONTROL TEAM (FCT)

A. THE FCT IS RESPONSIBLE FOR EXECUTING THE FLIGHT WITHIN THE GUIDELINES AND AUTHORITY ESTABLISHED WITHIN THE SPACE SHUTTLE OPERATIONAL FLIGHT RULES.

B. THE FLIGHT DIRECTOR AND VARIOUS PAYLOAD OPERATIONS DIRECTORS ARE THE PRIMARY POINTS OF CONTACT FOR OPERATIONS COORDINATION ALTHOUGH THE PRIMARY PAYLOAD OPERATIONS CONTROL CENTER (POCC) INTERFACE TO THE MISSION CONTROL CENTER (MCC) FCT IS NOMINALLY THROUGH THE MCC PAYLOAD OFFICER.

C. (FLIGHT SPECIFIC)

ORGANIZATION	LOCATION	CALL SIGN	TITLE
SPACE SHUTTLE	HOUSTON MCC	HOUSTON FLIGHT	NASA FLIGHT DIRECTOR
SPACE SHUTTLE	HOUSTON MCC	PAYLOADS	NASA PAYLOAD OFFICER
SPACEHAB	JSC POCC	SHOD	SPACEHAB OPS DIRECTOR
FREESTAR	GSFC POCC	HH OPS	HITCHHIKER OPERATIONS DIRECTOR
RAMBO	DOD POCC (JSC)	DOD REP	DOD REPRESENTATIVE

®[DN 89] ®[CR 5534] ®[CR 5895A]

107_1A-14 PAYLOAD OPERATIONS/MANAGEMENT AUTHORITY

A. SPACEHAB

1. SPACEHAB PROGRAM MANAGER (SHPM) AUTHORITY

   a. PRELAUNCH THE SHPM OR HIS DESIGNATED REPRESENTATIVE MAY REQUEST LAUNCH HOLDS VIA MCC-H FOR GROUND SUPPORT FACILITIES ANOMALIES THAT VIOLATE LAUNCH COMMIT CRITERIA. ®[DN 14]

   b. POST LAUNCH THE SHPM OR HIS DESIGNATED REPRESENTATIVE IS THE FINAL AUTHORITY FOR SPACEHAB MODULE SYSTEMS-RELATED DECISIONS. THE SHPM, AFTER ANALYSIS OF THE SPACEHAB SYSTEMS CONDITION, MAY CHOOSE TO TAKE ANY NECESSARY SYSTEMS ACTION REQUIRED TO PRESERVE SYSTEMS CAPABILITY.

2. SPACEHAB OPERATIONS DIRECTOR (SHOD) AUTHORITY

   THE SHOD IS RESPONSIBLE FOR DIRECTING THE TECHNICAL SPACEHAB FCT MEMBERS AND HAS THE PRIMARY AUTHORITY TO MAKE REAL-TIME OPERATIONS DECISIONS FOR THE SPACEHAB MODULE SYSTEMS.

   THE SHOD IS THE PRIMARY POINT OF CONTACT TO THE PAYLOAD OFFICER AND COORDINATES SPACEHAB SYSTEMS, RESPONSES TO SPACEHAB RELATED ANOMALIES, RESPONSES TO SPACE SHUTTLE PROGRAM (SSP) FCT INQUIRES, CHANGES TO EXPERIMENT OPERATIONS, AND REQUESTS FOR ORBITER INFORMATION AND SERVICES. ®[DN 14]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-14 PAYLOAD OPERATIONS/MANAGEMENT AUTHORITY (CONTINUED)

B. FREESTAR

1. THE HITCHHIKER OPERATIONS DIRECTOR (HH OPS), LOCATED AT THE GSFC POCC, ACTS AS THE PRINCIPAL OPERATIONS INTERFACE TO THE MCC PL OFFICER. THE HH OPS DIRECTOR REPRESENTS THE FREESTAR PAYLOAD.

2. THE FREESTAR MISSION MANAGER, LOCATED AT THE GSFC POCC, IS THE FINAL AUTHORITY FOR FREESTAR-RELATED DECISIONS.

3. THE HITCHHIKER REPRESENTATIVE (HH REP), LOCATED AT THE JSC CSR, IS THE FINAL AUTHORITY FOR FREESTAR RELATED DECISIONS IF THE FREESTAR MISSION MANAGER IS UNABLE TO BE REACHED.

C. RAMBO ®[CR 5534] ®[CR 5895A]

THE DEPARTMENT OF DEFENSE REPRESENTATIVE (DOD REP), LOCATED AT THE JSC DOD POCC, IS THE FINAL AUTHORITY FOR RAMBO-RELATED DECISIONS. ®[DN 14] ®[CR 5534] ®[CR 5895A]

SECTION 2 - FLIGHT OPERATIONS

PRELAUNCH

ASCENT/ENTRY/POST-LANDING

ORBIT

107_2A-2 LAUNCH COMMIT CRITERIA (CONTINUED)

4. PAYLOAD DATA INTERLEAVER WITH EITHER THE PRIMARY OR BACKUP DECOM LOCKED. ®[DN 74]

The Payload Data Interleaver (PDI) provides the only source of telemetry to the orbiter General Purpose Computer (GPC) or downlink for operation of the Spacehab system. With either the primary DECOM (DECOM 1) or backup DECOM (DECOM2) locked, the crew will be able to monitor safety critical parameters through the Backup Flight System (BFS). The ground has the capability to determine the state of the safety critical parameters through other means in the event of a failure of the primary DECOM.

DOCUMENTATION: LCC RDM-04, STS-107 MEL.

5. ORBITER BUS REQUIREMENTS:

   a. PRI PL

   b. PL AFT MNB

The primary payload bus and PL Aft Main Bus B (MNB), and PL cabin buses provide power to Spacehab equipment and experiments. The PL AC2 and AC3 buses are not active prelaunch, but the orbiter AC buses providing power to these PL AC buses are covered by the Generic Orbiter LCC. PL CAB 2 and PL CAB 3 are required by Spacehab, but the only insight into PL CAB 2 and PL CAB 3 is the switch position.

DOCUMENTATION: LCC EDPC-03, EDPC-04, RDM-05, RDM-06, STS-107 MEL.

6. TWO OF TWO FLOW PROPORTIONING MODULE (FPM)

Two Flow Proportioning Valves (FPV's) in Payload Heat Exchanger (PLHX) are required during Spacehab operations.

DOCUMENTATION: LCC ECL-40, STS-107 MEL.

B. COMMAND AND TELEMETRY PROCESSING CAPABILITY MUST BE OPERATIONAL OR HAVE AN ESTIMATED TIME TO RETURN TO OPERATIONS BY SPACEHAB ACTIVATION TO ENABLE GROUND COMMANDING AND MONITORING OF CRITICAL SUBSYSTEMS DURING ON-ORBIT OPERATIONS.

Ground commanding is required to configure Spacehab systems and to control experiment operations. The ability to throughput and process downlink data is required to monitor critical Spacehab systems and to collect experiment data.

C. FREESTAR AND RAMBO HAVE NO LAUNCH COMMIT CRITERIA. ®[DN 74] ®[CR 5895A]

107_2A-3 LAUNCH TURNAROUND

A. FOR A LAUNCH DELAY OF 24 HOURS FROM THE INITIAL LAUNCH ATTEMPT, THE MIDDECK MUST BE ACCESSED TO REPLACE SPACEHAB MIDDECK EXPERIMENTS. ®[DN 18]

B. FOR A LAUNCH DELAY OF 48 HOURS FROM THE INITIAL ATTEMPT (I.E., TWO CONSECUTIVE LAUNCH ATTEMPTS SCRUBBED), THE MIDDECK AND SPACEHAB MODULE MUST BE ACCESSED TO REMOVE, REFURBISH, AND REPLACE EXPERIMENTS.

Some middeck payloads can only sustain the initial planned launch attempt. For a 1 day delay after the payloads have been installed, they must be replaced to support a second launch attempt. If launch is delayed by 48 hours or more (two consecutive launch attempts scrubbed), there are middeck payloads which must be removed, refurbished, and reinstalled prior to a subsequent launch attempt. In addition, there are also payloads in the Spacehab module that must be removed, refurbished, and reinstalled. Reference the Spacehab CIP (NSTS 21426) for specific payloads which require refurbishment or replacement following two consecutive launch attempts.

C. FREESTAR HAS NO LAUNCH SCRUB TURNAROUND REQUIREMENTS. ®[DN 18]

107_2A-14 LOSS OF ET LOX LIQUID LEVEL CONTROL SENSORS (CONTINUED)

The ET project has determined that the PLOAD LOX loading estimate based on liquid level control using a 100 percent sensor which subsequently fails will remain valid after a switch to the second 100 percent ET LOX liquid level control sensor. Therefore, switching liquid level control from one 100 percent sensor to the second 100 percent sensor does not invalidate the original PLOAD loading estimate. ®[CR 5575A]

The ET project has determined that the PLOAD LOX loading estimate based on liquid level control using either 100 percent sensor is not accurate in the event of a later failure of both 100 percent LOX liquid level control sensors and subsequent fill to the 100.15 percent sensor per LCC ET-10. The ET Project has requested DOSS to rerun PLOAD or revert to 100.15 percent MPS inventory loading estimates. A rerun and QA of PLOAD loading updates, nominal mission performance margin, and launch window impacts requires approximately 40 minutes. KSC Ground Operations is unable to accept launch window updates after L-39 minutes. However, FDO and ARD support should reflect the best possible estimate of the true LOX loading. Therefore, these elements will reconfigure to reflect LOX loading to the 100.15 percent MPS inventory values, if the failover occurs after the latest time to rerun PLOAD (about L-1:20 hour) and prior to L-25 minutes, regardless of whether or not the KSC launch window is updated.

For any level sensor failure after L-25 minutes, no action is required by the MCC. A late sensor failure (either the first or the second) may result in an underload of approximately 1,100 pounds of LOX, which still meets LCC ET-10 launch requirements. This equates to approximately 15 fps of ascent performance margin. STS-107 Ascent Performance Margin is sufficient to ensure a guided nominal MECO for a launch in this condition. However, a launch with an underload of this magnitude will result in TAL and ATO abort boundary calls being made approximately 15 fps early. The program accepts this risk due to its low probability of occurrence.

In the event of a failure of both 100 percent sensors and failover to a fill to the 100.15 percent sensor failure, no additional drainback time will be added to the countdown. The requirement for the additional drainback to the 100 percent level has been waived through a mission-specific analysis.

Late failover to a LOX tank fill controlled by the 100.15 percent (after failure of both 100 percent level sensors) will require verification that the LOX loading is consistent with MPS inventory loading estimates. The MPS inventory is protected if the ullage pressure is less than 1.036 psi. Ullage pressure above this limit indicates an underload of a magnitude beyond that covered in the FPR. The value of 1.036 psi is derived by adding the ullage pressure used in deriving the inventory (.781 psi) to a tolerance that is protected by FPR (.255 psi). ®[CR 5575A]

107_2A-15 TAL RAINSHOWER EXCEPTIONS

FOR TAL, RAIN SHOWERS (EXCLUDING THUNDERSTORMS) WITHIN THE LIMITS LISTED IN RULE {A2-6}, LANDING SITE WEATHER CRITERIA [HC], PARAGRAPH C, MAY BE ACCEPTABLE IF CONTINUOUS RADAR AND AIRCRAFT SURVEILLANCE INDICATES ALL OF THE FOLLOWING CONDITIONS ARE MET. ®[CR 5898]

1. COVERAGE: SHOWERS COVER LESS THAN 10 PERCENT OF THE AREA WITHIN 20 NM OF THE TAL RUNWAY.

2. MOVEMENT/DEVELOPMENT: OBSERVED HORIZONTAL MOVEMENT IS CONSISTENT AND NO ADDITIONAL CONVECTIVE DEVELOPMENT IS FORECAST.

3. LIGHTNING POTENTIAL: TOPS OF CLOUDS CONTAINING PRECIPITATION DO NOT EXCEED THE +5 DEG C LEVEL AND HAVE NOT EXCEEDED THE -10 DEG C LEVEL WITHIN 2.5 HOURS PRIOR TO LAUNCH.

4. INTENSITY: PRECIPITATION IS LIGHT (LESS THAN 30 DBZ) AT ALL LEVELS WITHIN AND BELOW THE CLOUD.

5. FOR ANY SHOWER WITHIN 20 MILES OF THE TAL RUNWAY, IF THE SHOWER EXCEEDS PARAGRAPHS 3 OR 4, THEN A 2-NM VERTICAL CLEARANCE FROM THE TOP OF THAT SHOWER AND A 10-NM LATERAL CLEARANCE MUST BE MAINTAINED ALONG THE APPROACH CORRIDORS.

6. RUNWAY MEETS THE LANDING AND ROLLOUT CRITERIA AND NAVAID REQUIREMENTS SPECIFIED IN RULE {A2-1}, PRELAUNCH GO/NO-GO REQUIREMENTS.

7. THERE IS A HIGH LEVEL OF CONFIDENCE THAT AT LEAST ONE APPROACH (OVERHEAD OR STRAIGHT-IN) WILL BE ACCEPTABLE AT TAL LANDING TIME. TREND MONITORING UTILIZING RADAR AND AIRCRAFT SURVEILLANCE SHOULD INDICATE THAT A STABLE AND PREDICTABLE ENVIRONMENT EXISTS. ®[CR 5898]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-15 TAL RAINSHOWER EXCEPTIONS (CONTINUED)

DUE TO THE RELATIVELY RECENT ACQUISITION OF SPANISH RADAR DATA, A LACK OF EXPERIENCE EXISTS ASSESSING SPANISH RADAR DATA. ADDITIONALLY, THIS DATA HAS LOWER FREQUENCY AND POTENTIALLY LESS RELIABILITY OF RECEIPT THAN CONUS RADAR DATA. BASED ON THESE FACTORS, LAUNCH DAY CONDITIONS COULD BE SUCH THAT SUFFICIENT CONFIDENCE DOES NOT EXIST TO EXERCISE THIS RULE. THE ASCENT FLIGHT DIRECTOR WILL DETERMINE IF THIS RULE CAN BE SAFELY APPLIED ON LAUNCH DAY. ®[CR 5898]

TAL PRECIPITATION LIMITS

The TAL shower exception specifies conditions under which launch is acceptable when showers are within the area of the TAL runway on launch day. SMG originally developed the conditions specified in this rule to meet orbiter design requirements for RTLS. The availability of Spanish radar data makes it possible to give consideration to these same type exceptions for TAL runways in Spain. Similar to RTLS, the short forecast interval for TAL and availability of radar and weather aircraft may allow improved estimation of rain shower movement and characterization of the cloud type. Additional launch probability is gained by eliminating the avoidance criteria for showers that do not pose a threat due to lightning, hail, visibility, aerodynamic control, or MLS attenuation. Tile damage that occurs if precipitation is encountered is acceptable. Radial, lateral, and vertical avoidance criteria still apply for any storm that poses a threat to the orbiter.

Cloud Top Temperatures and Lightning Avoidance - *Clouds that exceed the conditions stated in paragraphs 3 and 4 above pose a threat of hail or lightning (natural and triggered). Clouds with < 30 DBZ and tops below the +5 deg C thermal layer do not pose a threat of stored electrical charge. Clouds that have previously extended above the -10 deg C thermal layer must be avoided for 2.5 hours to allow any accumulated charge to dissipate. A 2-nm vertical clearance and a 10-nm lateral clearance must be maintained along the approach paths of the overhead and straight-in HAC's for showers exceeding these limits. The Lightning Avoidance Criteria Peer Review Committee reviewed and concurred with these criteria at their KSC meeting in February 1994.*

If the orbiter encounters ice, window damage may occur resulting in reduced visibility (depending on ice population, mass, density, and relative velocity) and RCC coating damage may occur forcing RCC panel replacement. Clouds with tops below the +5 deg C thermal layer are warm enough to assure they do not contain hail. ®[CR 5898]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-15 TAL RAINSHOWER EXCEPTIONS (CONTINUED)

Light Precipitation - Testing of TPS tiles flown through moderate rainfall (35 to 40 dbz) indicates that significant tile damage will occur if the orbiter encounters ice-free precipitation at velocities below Mach 1 and above touchdown speed. The extent of damage depends on drop size and the angle of incidence between a drop and a tile. Conservative estimates of effects on approach and landing characteristics assuming a worst-case estimate of approximately 2000 damaged tiles (nose and canopy/windshield areas, vertical tail and OMS pod leading edges) show no significant effect on landing performance. A retrim to a slightly higher angle of attack would be the primary noticeable response to flight through rain during landing approach. No structure or control system damage would occur. Testing indicates that damage to RCC does not occur when flown through light rain at speeds below 0.7 Mach. RCC damage is not desirable due to replacement cost and lead time. RCC damage caused by precipitation impact would not affect aerodynamic performance. ®[CR 5898]

Tile damage could result in a loss of up to 1000 ft of touchdown distance. Typical touchdown distances carry adequate margin to protect this type of energy loss. A dispersed entry that is flown through a shower on a day that predicted touchdown conditions are at the limits specified in Rule {A4-110}, AIMPOINT, EVALUATION VELOCITY, AND SHORT FIELD SELECTION, could result in a vehicle touchdown on the underrun. Consideration should be given to not launching on a low energy day where the capability to avoid showers is low. Otherwise, adequate margin exists within the system to support loss of touchdown energy due to tile damage.

Water attenuates microwave signals at MLS frequencies; however, MLS performance is not severely affected. Analysis of MLS link performance with a transmitter power output of 1600 W (the minimum acceptable transmitter power output level) shows that MLS acquires at over 9 nm slant range when a rainfall rate of 10 mm/hr (0.4 in/hr) exists along the entire path between the orbiter and the ground MLS station. Since "light" rainfall is less than 0.4 in/hr, nominal MLS acquisition is protected.

Ceiling and visibility criteria specified in paragraph A of Rule {A2-6}, LANDING SITE WEATHER CRITERIA [HC], still apply and protect for adequate crew visibility of the PAPI's, aimpoint, and ball bar through clouds and precipitation. WX RECON has primary responsibility for assessing visibility through light precipitation from any showers of concern that do not fall within the field of view used by meteorological observers to evaluate visibility. Ground observers are limited to evaluations using fixed landmarks.

Area Coverage/Multiple HAC's - While it is acceptable to encounter showers that meet the criteria specified in this rule, it is still more desirable to avoid them if possible. Limiting the number of showers in the vicinity of the TAL runway minimizes the chances of encountering a shower. If more than 10 percent coverage exists or is forecast but both approaches are clear and will remain clear of showers, the intent of this constraint has been met. ®[CR 5898]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-15 TAL RAINSHOWER EXCEPTIONS (CONTINUED)

Movement and Convective Development - Consistent horizontal motion that is linear or near linear and can be tracked is required to accurately forecast future movement. Conditions must be thermodynamically stable. Observed and forecast conditions are the same and expected to remain unchanged throughout the TAL period. ®[CR 5898]

Paragraph 6 defines the clearance requirements of showers with lightning potential (tops greater than +5 deg C or returns greater than 30 dbz) which have not demonstrated air to ground lightning strikes. The clearance requirements for lightning potential are the same as those of actual thunderstorms. ®[CR 5898]

ORBIT

PRIORITIES AND MISSION DURATION

107_2A-21 HIGH PRIORITY FLIGHT OBJECTIVES/MINIMUM DURATION FLIGHT

A. MINIMUM DURATION FLIGHT (MDF) WILL LAST APPROXIMATELY 72 HOURS WITH LANDING ON THE MORNING OF FD4 PER RULE {A2-102}, MISSION DURATION REQUIREMENTS. ®[ED]

The MDF has a nominal minimum length of approximately 72 hours. The term "approximately 72 hours" is used to allow for utilization of primary landing site (PLS) and secondary landing site (SLS) landing opportunities which occur during a given flight day. The minimum duration is set at the number of days normally required to ensure a good probability of having a healthy crew for entry and landing and to provide the opportunity to accomplish activities that could enhance orbiter entry/landing conditions. The payload/experiments must be considered secondary to vehicle/crew safety and are not sufficient grounds for mission continuation. FD4 landing is the standard MDF duration. The MDF timeline must allow for Flight Control System (FCS) C/O, RCS hot fire, and cabin stow.

B. EXPERIMENT OPERATIONS MAY CONTINUE UP TO THE NOMINAL DEACTIVATION TIME DEFINED IN THE ENTRY DAY TIMELINE ON A NONINTERFERENCE BASIS WITH ORBITER OPERATIONS IN PREPARING FOR DEORBIT AND ENTRY.

Nominal experiment deactivation will be scheduled to preserve sufficient time for orbiter preparation for deorbit and entry. Experiments may be performed before and up to this time on a noninterference basis. Spacehab middeck experiments are considered part of Spacehab and would be deactivated at the same time the module is deactivated.

C. IF ON-ORBIT OPERATIONAL CONFLICTS EXIST WITHIN THE STRUCTURE OF AN MDF, THE CONFLICTS WILL BE RESOLVED ACCORDING TO THE PRIORITIES DEFINED IN RULE {107_2A-22}, ON-ORBIT GENERAL PRIORITIES. SECONDARY FLIGHT OBJECTIVES MAY BE ACCOMPLISHED WITHIN THE STRUCTURE OF AN MDF AS LONG AS THEY DO NOT INTERFERE WITH OR JEOPARDIZE THE HIGH PRIORITY FLIGHT OBJECTIVES.

107_2A-22 ON-ORBIT GENERAL PRIORITIES (CONTINUED)

7. ASTROCULTURE GLOVEBOX (AST-10/2)

8. COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF)

9. COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX) ®[DN 20]

10. ZEOLITE CRYSTAL GROWTH-1 (ZCG-1)

11. FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH-2 (FRESH-2)

12. GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA)

13. BIOLOGICAL RESEARCH IN CANISTERS (BRIC)

F. FREESTAR PAYLOADS

1. MEDITERRANEAN ISRAELI DUST EXPERIMENT (MEIDEX)

2. SOLAR CONSTANT EXPERIMENT-3 (SOLCON-3)

3. SHUTTLE OZONE LIMB SOUNDING EXPERIMENT-02 (SOLSE-02)

4. CRITICAL VISCOSITY OF XENON-2 (CVX-2)

5. LOW POWER TRANSCEIVER (LPT)

6. SPACE EXPERIMENT MODULE (SEM)

G. DTO 700-14 MAGR GPS ®[CR 5895A]

The TEHM is used by both the PHAB4 and VCD experiments, but is listed under the highest priority payload it supports. Detailed Supplementary Objectives (DSO's) manifested for this flight have no real-time requirements (i.e., only pre and post-flight requirements) and are, therefore, not listed in this rule. RAMBO has no real-time requirements except for state vectors. ®[CR 5622] ®[CR 5633]

DOCUMENTATION: STS-107 FRD (NSTS 17462-107), PRD for Spacehab Commercial Payloads (NSTS 21464), PRD for ESA Payloads (NSTS 21459), PRD for Code U Payloads (NSTS 21463).
®[DN 20]

107_2A-23 ON-ORBIT PROPELLANT PRIORITIES

PROPELLANT PRIORITIES FOR CONSUMABLES LIMITED SITUATIONS, HIGHEST PRIORITIES FIRST ARE:

TABLE 107_2A-23-I - PROPELLANT PRIORITIES

PRIORITY	FLIGHT ACTIVITY	NOTES
1	NOMINAL OMS/RCS REDLINES (PROTECTS 1-1 DEORBIT OPPORTUNITIES	REF RULE {A2-108}, CONSUMABLES MANAGEMENT
2	MINIMUM DURATION FLIGHT	
3	WEATHER WAVEOFF EXTENSION DAY (PROTECTS 2-1-1 DEORBIT OPPORTUNITIES)	THE WEATHER WAVEOFF EXTENSION DAY IS LOWER PRIORITY THAN THE MINIMUM ALTITUDE REQUIRED FOR PRIMARY PAYLOAD ACTIVITIES. REF RULE {A2-108C}, CONSUMABLES MANAGEMENT.
4	NOMINAL MISSION DURATION	EXTEND MISSION DURATION IN FLIGHT DAY INCREMENTS PAST MDF, UP TO NOMINAL. ADDITIONAL DAYS WILL INCLUDE NOMINALLY PLANNED ACTIVITIES (ATTITUDE MANEUVERS, ATTITUDE HOLD, ETC.). REF RULE {A2-108}, CONSUMABLES MANAGEMENT.
5	PROVIDE ADDITIONAL DEORBIT ATTEMPTS UP TO 2-2-2	PROVIDING 2-2-2 (TWO ATTEMPTS ON THREE CONSECUTIVE DAYS) REQUIRES AN ADDITIONAL TWO REVS OF WAVEOFF ABOVE 2-1-1 CAPABILITY.
6	RAISE AND/OR CIRCULARIZE ORBIT AS HIGH AS POSSIBLE UP TO NOMINAL ALTITUDE	ALL PROPELLANT MARGIN ABOVE FULL MISSION DURATION AND ACTIVITIES WILL BE ALLOCATED TO RAISING THE ORBIT AND/OR CIRCULARIZING THE ORBIT AS HIGH AS POSSIBLE UP TO THE NOMINAL MISSION ALTITUDE OF 150 NM.
7	ET PHOTOGRAPHY MANEUVERS	THE SSP STRONGLY DESIRES ET PHOTOGRAPHY.
8	OMS ENGINE FAIL	REF RULES {A6-303}, OMS REDLINES [CIL]; {A6-304}, FORWARD RCS REDLINES; AND {A6-305}, AFT RCS REDLINES. OMS ENGINE FAIL PROTECTION FOR THE DEORBIT WAVEOFF EXTENSION DAY MAY BE DELETED IN FAVOR OF HIGH PRIORITY FLIGHT OBJECTIVES.
9	ADJUST ORBIT FOR ADDITIONAL LANDING OPPORTUNITIES	PROPELLANT BEYOND WHAT IS REQUIRED FOR PRIMARY MISSION OBJECTIVES MAY BE USED TO PERFORM ORBIT ADJUST BURNS TO GAIN ADDITIONAL LANDING OPPORTUNITIES.

®[DN 11] ®[CR 5519] ®[ED] ®[CR 5895A]

107_2A-54 PGSC USAGE GUIDELINES

TABLE 107_2A-54-I - PGSC USAGE PLAN

PGSC	FUNCTION	ORBITER PROVIDED	SPACEHAB PROVIDED
STS1	OCA	X	
STS2	WINDECOM	X	
STS3	PROSHARE	X	
STS4	WORLDMAP	X	
PL1	MEIDEX	X	
PL2	SOLSE-2	X	
PL3	SH SUBSYSTEM, HLS PHAB-4 BAR CODE READER	X	
PL4	AST, MGM, BDS-05, & ZCG	X	
PL5	CM-2	X (WINDOWS 95 OS)	
PL6	VCD FE	X (WINDOWS 95 OS)	
HLS	HLS MPFE		X
ARMS	ARMS		X

®[DN 27]

NOTE: PGSC BACKUP OPTIONS WILL BE DOCUMENTED AS REFERENCE DATA IN THE PAYLOAD OPS CHECKLIST.

PROGRAMMATICALLY, THE TWO STOWED PGSC’S ARE DEDICATED TO MEIDEX AND SOLSE. OPERATIONALLY, THEY WILL BE USED AS REQUIRED TO SUPPORT FIRST AND SECOND PGSC FAILURES. SHOULD MEIDEX OR SOLSE PGSC’S REQUIRE BACKUP, THEY WILL BE GIVEN PRIORITY OVER OTHER USERS. ®[DN 27]

PAYLOAD CONSTRAINTS

107_2A-61 PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY

TABLE 107_2A-61-I – PAYLOAD CONTAMINATION MATRIX

CUSTOMERS WITH DUMP AND/OR PURGE CONTAMINATION CONCERNS SHOULD BE NOTIFIED OF CHANGES TO DUMP PLANS AT LEAST 90 MINUTES PRIOR TO THE EVENT, IF POSSIBLE. NOZZLE DUMP ATTITUDES MAY BE BIASED FROM THE RETROGRADE DIRECTION IF REQUIRED TO PROTECT THERMAL CONSTRAINTS. ®[DN 48]

PAYLOAD	TIMEFRAME	SUPPLY DUMPS, WASTE DUMPS, FES OPERATIONS	OMS BURN	PRCS	OMS/RCS PROPELLANT /JET LEAKS AND APU OPERATIONS	ORBITER LEAKS	FUEL CELL PURGES
SPACEHAB [4]	N/A	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
MEIDEX [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (DOOR OPEN)	NO NOZZLE DUMPS	PROHIBITED WHEN DOOR OPEN	PROHIBITED WHEN DOOR OPEN EXCEPT WHEN LANDTRACK MANEUVER REQUIRED [1]	CLOSE DOOR ASAP VIA SSP [2]	CLOSE DOOR ASAP VIA SSP [2]	INHIBITED
	NON-OPERATING (DOOR CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SOLSE [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (DOOR OPEN)	NO NOZZLE DUMPS, MINIMIZE FES OPS [3]	PROHIBITED WHEN DOOR OPEN	MINIMIZE PRCS FIRINGS WHEN DOOR OPEN [1]	CLOSE DOOR ASAP VIA PGSC [2]	CLOSE DOOR ASAP VIA PGSC [2]	INHIBITED
	NON-OPERATING (DOOR CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SOLCON [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (COVER AND SHUTTERS OPEN)	NO NOZZLE DUMPS	PROHIBITED WHEN COVER AND SHUTTERS OPEN	MINIMIZE PRCS FIRINGS WHEN COVER AND SHUTTERS OPEN [1]	CLOSE COVER OR SHUTTERS ASAP VIA GROUND COMMAND [2]	CLOSE COVER OR SHUTTERS ASAP VIA GROUND COMMAND [2]	INHIBITED
	NON-OPERATING (COVER OR SHUTTERS CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
LPT	DURING GPS NAV DATA TAKES	NO NOZZLE DUMPS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	INHIBITED
CVX	N/A	NO CONSTRAINTS	NO OMS BURNS DURING CRITICAL PERIODS	NO PRCS DURING CRITICAL PERIODS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS

®[DN 48] ®[DN 53] ®[CR 5846] ®[CR 5895A]

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107_2A-63 MICROGRAVITY CONSTRAINTS

PAYLOAD		TIMEFRAME	OMS BURN	PRCS [1]	VRCS	EXERCISE
ADVANCED PROTEIN CRYSTALLIZATION FACILITY (APCF)		ACTIVATION UNTIL DEACTIVATION	PROHIBITED WITHOUT PRIOR NOTIFICATION	PROHIBITED WITHOUT PRIOR NOTIFICATION	NO CONSTRAINT	NO CONSTRAINT
COMMERCIAL MACROMOLECULAR AND PROTEIN CRYSTAL GROWTH (CMPCG)		FIRST 10 DAYS FOLLOWING ACTIVATION	HIGHLY DESIRE PROHIBITED	HIGHLY DESIRE PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALIZATION FACILITY (CPCG-PCF)		FIRST 24 HOURS FOLLOWING INITIALIZATION	HIGHLY DESIRE PROHIBITED	HIGHLY DESIRE PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
MECHANICS OF GRANULAR MATERIALS (MGM)		ACTIVATION UNTIL DEACTIVATION FOR TEST POINTS 1-8	PROHIBITED	PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
COMBUSTION MODULE-2 (CM-2)	LAMINAR SOOT PROCESSES (LSP)	MICROGRAVITY PERIOD BEGINS 22-28 MINUTES AFTER THE START OF A RUN AND LASTS FOR 11 MINUTES	PROHIBITED	PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
	STRUCTURE OF FLAME BALLS AT LOW LEWIS NUMBERS (SOFBALL)	MICROGRAVITY PERIOD BEGINS 18 MINUTES INTO EACH RUN AND LASTS FOR VARIOUS DURATIONS (1.5 TO APPROXIMATELY 4 HRS) DEPENDING ON THE RUN.	PROHIBITED	PROHIBITED	PROHIBITED (GRAVITY GRADIENT ATTITUDE REQUIRED)	ARMS CREW EXERCISE/CYCLE ERGOMETER OPS AND ORBITER CYCLE ERGOMETER OPS PROHIBITED DURING MICROGRAVITY PERIOD.
	WATER MIST	MICROGRAVITY PERIOD BEGINS AT EXPERIMENT RUN START +23 OR 29 MINUTES (DEPENDING ON THE RUN) AND LASTS FOR 2-4 MINUTES	PROHIBITED	PROHIBITED	PROHIBITED	ARMS CREW EXERCISE/ERGOMETER OPS AND ORBITER ERGOMETER OPS PROHIBITED DURING THE MICROGRAVITY PERIOD [3]
ZEOLITE CRYSTAL GROWTH (ZCG)		FURNACE ACTIVATION UNTIL ZCG DEACTIVATION	PROHIBITED	PROHIBITED WITH ALLOWANCE FOR ALT DAP AS NEGOTIATED WITH ZCG	NO CONSTRAINT [1]	MINIMIZE CREW EXERCISE DURING FIRST 10 HOURS POST-FURNACE ACTIVATION.
CRITICAL VISCOSITY OF XENON-2 (CVX-2)		CRITICAL PERIODS [2]	PROHIBITED	PROHIBITED [1]	NO CONSTRAINT	AVOID SCHEDULING CONSECUTIVE EXERCISE PERIODS WHEN POSSIBLE DURING CRITICAL PHASES

®[DN 49] ®[CR 5623] ®[CR 5628A] ®[CR 5895A]

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107_2A-63 MICROGRAVITY CONSTRAINTS (CONTINUED)

NOTES:

[1] FOR LOSS OF VERNS, MGM, LSP, WATER MIST, ZCG AND CVX-2 WILL CONTINUE OPERATIONS USING ALT DAP. ®[DN 49]

[2] CRITICAL PERIODS OCCUR WHEN THE EXPERIMENT APPROACHES ITS CRITICAL TEMPERATURE AND WILL BE DEFINED BY THE CUSTOMER AND PROVIDED AS PART OF THE REPLAN CYCLE. THESE CRITICAL PERIODS ARE APPROXIMATELY DEFINED BY THE FOLLOWING PAYLOAD EVENT TIMES (REFERENCED FROM CVX-2 ACTIVATION): 26 TO 47 HOURS, 64 TO 115 HOURS, AND 130 TO 182 HOURS FOR A 200 HOUR TIMELINE; AND 20 TO 35 HOURS, 54 TO 73 HOURS, 129 TO 151 HOURS, 205 TO 227 HOURS, AND 281 TO 303 HOURS FOR A 308 HOUR TIMELINE.

[3] EXERCISE MAY BE SCHEDULED DURING WATER MIST RUNS, BUT THE CREWMEMBER MUST PAUSE FOR THE SHORT MICROGRAVITY PERIOD.

The gravity gradient attitude is required for SOFBALL to maintain predictable comm during the lengthy microgravity periods. Exercise in the Spacehab is prohibited during SOFBALL microgravity periods to achieve the best microgravity environment possible. Exercise in the middeck is also prohibited during SOFBALL Free Drift periods.

Most MIST tests require microgravity beginning 37 minutes into each run. However, MIST tests 12 and 22 are an exception to this rule with microgravity periods beginning 22 minutes into each run. No special attitude is required for MIST since the Free Drift period is short and comm should remain predictable. Exercise in the middeck and in Spacehab module prohibited during MIST Free Drift periods.

CVX-2 critical periods occur when the experiment approaches its critical temperature. The most critical part of CVX-2's timeline is the last 10 hours of the first pass through Tc (liquid-vapor critical point of Xenon, approx 16.7 degrees C). They will use this "fast" pass to locate Tc for the remainder of the mission. Each of the later "slow" passes through Tc requires about 80 hours, with the last 30 hours being most important. Based upon on-orbit performance, CVX will be able to more accurately define the most critical portions of the CVX timeline during flight. Actual critical period timeframes will be defined by the customer and provided as part of the replan cycle.

OMS burns and PRCS jet firings are not allowed during CVX-2 critical periods. Shuttle maneuvers using VRCS sometimes create DC accelerations that exceed the steady-state requirement of 0.24 milli-g, but they are too short-lived to cause a problem.

CVX-2 is very susceptible to impacts on the sample cell during exercise periods due to the AC accelerations reducing the measurement signal-to-noise ratio. To protect sample data against possible degradation due to crew exercise, CVX desires that during critical periods, exercise not be scheduled consecutively. This scheduling is desirable for the entire mission, yet extremely important during critical periods operations. Based upon on-orbit performance, CVX will be able to more accurately define the most critical portions of the CVX timeline during flight.

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107_2A-63 MICROGRAVITY CONSTRAINTS (CONTINUED)

CMPCG and CPCG-PCF are both sensitive to microgravity disturbances during crystal nucleation and crystal growth which can cause detrimental effects to crystal formation and the solution boundary layer as the crystals grow in solution. CMPCG consists of approximately 1008 samples that have a wide variance in the timing of nucleation and growth phases. CMPCG highly desires minimized disturbances during their entire crystal growth phase, but especially for the first 10 days of crystal growth. CPCG-PCF consists of only one sample and highly desires minimized disturbances during the first 24 hours of crystal growth which is the expected nucleation and early growth phase. ®[CR 5628A]

Reference Rule {107_2A-61} PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY, for OMS/RCS constraints driven by contamination concerns. ®[DN 49]

107_2A-64 RESERVED ®[CR 5895A]

107_2A-71 ATTITUDE/POINTING CONSTRAINTS

A. SPACEHAB

1. COMBINED TWO-PHASE LOOP EXPERIMENT (COM2PLEX)

a. COM2PLEX REQUIRES A -ZLV (NADIR) ATTITUDE FOR 48 HOURS PER EACH OF THE THREE LOOPS FOR A TOTAL OF 144 HOURS. ANY YAW IS ACCEPTABLE. COM2PLEX CAN WITHSTAND ATTITUDE BIASES UP TO 20 DEGREES WHICH LAST NO MORE THAN 20 MINUTES. THE TIME SPENT BIASED CAN TOTAL NO MORE THAN 40 MINUTES EVERY 24-HOUR PERIOD. ®[DN 79]

b. COM2PLEX DEEP SPACE POINTING IS LIMITED TO 90 MINUTES IF UNPOWERED. AFTER 90 MINUTES, COM2PLEX REQUIRES A -ZLV (NADIR) ATTITUDE FOR 1 HOUR BEFORE REAPPLYING POWER. COM2PLEX HAS NO DEEP POINTING CONSTRAINT WHILE POWERED.

c. COM2PLEX MUST BE IN A REDUCED POWER STATE FOR SOLAR POINTING.

The COM2PLEX payload requires maintaining a similar attitude for the duration of each of the three experiment runs to reduce thermal fluctuations and maintain comparability between the runs.

2. MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

a. MSTRS REQUIRES A -ZLV (NADIR) ATTITUDE FOR EACH OPERATIONAL CYCLE EXCEPT AS NOTED IN PARAGRAPH B BELOW.

Each operations cycle consists of a 1 hour warm up period and a minimum of four continuous orbits. The MSTRS payload requires no bias in the -ZLV (NADIR) attitude to accurately geo-locate radio frequency sources on Earth. ®[DN 79]

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ORBIT GENERAL

107_4A-11 ORBITAL MANEUVER CRITICALITY AND DEFINITIONS

A. ALL STS-107 ORBIT MANEUVERS ARE CLASSIFIED AS “CRITICAL” OR “NONCRITICAL” AS FOLLOWS:

MANEUVER	CLASSIFICATION	VGO TRIMS (FPS)
OMS-1	CRITICAL FOR CREW SAFETY (IF REQUIRED)	|EACH VGO| < 2
OMS-2	CRITICAL FOR CREW SAFETY	|EACH VGO| < 2
ORBIT ADJUST (OA)	NONCRITICAL	|EACH VGO| < 0.2
DEORBIT	CRITICAL FOR CREW SAFETY	|VGOX/Z| < 2; DO NOT TRIM VGOY

®[CR 5895A]

Maneuvers listed are not necessarily in time order of execution.

OMS-1 (if required), OMS-2 and deorbit are always considered critical to the crew’s safety because they may entail atmospheric reentry if TIG is delayed or an underburn is performed.

Orbit Adjust are considered noncritical in the sense that they may be slipped at least one orbit, or deleted, without impact to crew safety or mission success. ®[CR 5895A]

B. CHANGES TO THE PREFLIGHT PLANNED MANEUVER SEQUENCE WILL BE COORDINATED WITH THE PAYLOAD CUSTOMERS AS FOLLOWS:

THE SPACEHAB CUSTOMER, THE GSFC POCC, AND DOD REP WILL BE NOTIFIED DAILY OF CHANGES TO THE PREFLIGHT BURN PLAN WITH ESTIMATES OF THE MAGNITUDE OF EACH BURN. IN THE EVENT OF ANY UNSCHEDULED BURN, THEY WILL BE NOTIFIED AS SOON AS POSSIBLE.

The burn plan information is required to plan experiment operations which are affected by OMS/RCS contamination or accelerations environments. Some doors/covers may need to be closed for certain burns. In the event of any unscheduled burn, such as a collision avoidance burn, at least 15 minutes are required to compute and prepare the burn PAD. The payloads can use this time to perform commanding to minimize the impact to science.

107_4A-12 EOM ORBIT ADJUST BURNS

A. IF PROPELLANT IS AVAILABLE, ORBIT ADJUSTS MAY BE PERFORMED TO INCREASE THE NUMBER OF DEORBIT OPPORTUNITIES AVAILABLE. IF AN ELLIPTIC ORBIT IS TARGETED FOLLOWING THE ADJUST, STEEP DEORBIT CAPABILITY SHALL BE RETAINED TO SATISFY RULE {A4-103A}.3, OFF-NOMINAL ORBITAL ALTITUDE RECOVERY PRIORITIES. ®[ED]

B. THE ORBIT ADJUST PLAN WILL ATTEMPT TO ACHIEVE THE FOLLOWING COMBINATIONS OF LANDING OPPORTUNITIES STATED IN ORDER OF DECREASING PRIORITY. ONLY OPPORTUNITIES WHICH SATISFY THE CREW DAY CONSTRAINTS (REF RULE {A4-107A}.7, PLS/EOM LANDING OPPORTUNITY REQUIREMENTS), WILL BE CONSIDERED (7 HRS < AWAKE TIME BEFORE LANDING < 16 HRS). AN ORBIT ADJUST PLAN WHICH WOULD RESULT IN LOSS OF OPPORTUNITIES AT A HIGHER PRIORITY THAN THOSE GAINED WILL NOT BE PERFORMED EVEN IF DAYLIGHT OPPORTUNITIES ARE PROVIDED BY THE PLAN. ®[ED]

PRIORITY	SITE	EOM	EOM + 1	EOM + 2
1	KSC EDW	1 1	1 1	1 1
2	KSC	2		
3	KSC		2	
4	EDW		2	
5	EDW			2
6	KSC			2

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DO4/Lead RPE
DO5/D. D. Stapleton
DO5/ACO/Payload Officer (12)
DO5/Lead ISO
DT22/CDH Library (2)
DT26/Station Training Lead
DT34/Library
DT35/Section Library
DT37/Manager (2)
DT37/J. Zeh (2)
DV/GSFCRO
DX22/Group Lead (6)
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STS-107

FINAL, PCN-1, P&I #1

JANUARY 14, 2003

THIS DOCUMENT INCORPORATES CHANGES TO THE FOLLOWING RULES (SINCE THE FINAL, PCN-1, DATED DECEMBER 19, 2002) BY THE APPLICABLE DISCREPANCY NOTICES (DN'S) AND CHANGE REQUESTS (CR'S).

RULE NO.	CR NO.	RULE NO.	CR NO.
107_1A-12	CR 5895A		
107_1A-13	CR 5895A		
107_1A-14	CR 5895A		
107_2A-2	CR 5895A		
107_2A-15	CR 5898		
107_2A-22	CR 5895A		
107_2A-23	CR 5895A		
107_2A-61	CR 5895A		
107_2A-63	CR 5895A		
107_2A-64	CR 5895A		
		BOOK MGR	BAL 01/14/03
107_4A-11	CR 5895A	FINAL QA	ned 01/14/03

NSTS - 18308

Space Shuttle Operational Flight Rules Annex

Flight STS-107

Mission Operations Directorate

Final

June 20, 2002

PCN-1

December 19, 2002

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

Verify that this is the correct version before use.

JOINT SHUTTLE-ISS OPERATIONAL FLIGHT RULES ANNEX

STS-107

FINAL, PCN-1

DECEMBER 19, 2002

THIS DOCUMENT INCORPORATES CHANGES TO THE FOLLOWING RULES (SINCE THE FINAL DATED JUNE 20, 2002) BY THE APPLICABLE DISCREPANCY NOTICES (DN'S) AND CHANGE REQUESTS (CR'S).

RULE NO.	CR NO.
107_1A-2	ED
107_1A-22	CR 5844
107_2A-1	CR 5845
107_2A-1	CR 5868A
107_2A-1	CR 5871
107_2A-2	CR 5621
107_2A-12	ED
107_2A-14	CR 5575A
107_2A-21	ED
107_2A-22	CR 5622
107_2A-22	CR 5633
107_2A-23	ED
107_2A-24	ED
107_2A-25	CR 5872
107_2A-26	ED
107_2A-41	ED
107_2A-42	CR 5844
107_2A-42	ED
107_2A-51	ED
107_2A-52	ED
107_2A-53	CR 5844
107_2A-53	ED
107_2A-61	CR 5846
107_2A-63	CR 5623
107_2A-63	CR 5628A
107_2A-71	CR 5615
107_2A-71	CR 5844
107_2A-71	CR 5847
107_3A-3	ED
107_3A-6	ED
107_3A-6	CR 5635
107_4A-1	ED
107_4A-12	ED
107_7A-3	ED
107_8A-3	ED

RULE NO.	CR NO.
107_9A-1	CR 5844
107_9A-2	ED
107_9A-3	CR 5703
107_9A-3	CR 5848
107_10A-1	ED
107_10A-3	ED
107_10A-4	ED
107_11A-1	CR 5849
107_11A-1	ED
107_11A-2	CR 5850
107_11A-2	ED
107_11A-3	CR 5624
107_11A-4	CR 5625C
107_11A-6	ED
107_15A-2	ED
107_17A-1	ED
107_17A-2	ED
107_17A-3	ED
107_17A-4	ED
107_17A-5	ED
107_17A-6	ED
107_17A-8	ED
107_18A-1	ED
107_18A-2	CR 5617C
107_18A-3	ED
107_18A-4	ED
107_18A-5	ED
107_18A-6	ED
107_19A-1	CR 5627B
107_19A-262	CR 5700
107_20A-2	CR 5626A
107_20A-3	CR 5851
APPENDIX A	CR 5844

BOOK MGR BAL 12/19/02
FINAL QA ned 12/19/02

Verify that this is the correct version before use.

SPACE SHUTTLE OPERATIONAL FLIGHT RULES ANNEX

FLIGHT STS-107

FINAL, PCN-1

PREFACE

THIS DOCUMENT, DATED DECEMBER 19, 2002, CONTAINS THE FINAL, PCN-1 VERSION OF THE STS-107 FLIGHT-SPECIFIC FLIGHT RULES AND IS INTENDED TO BE USED IN CONJUNCTION WITH THE SPACE SHUTTLE OPERATIONAL FLIGHT RULES, NSTS-12820, VOLUME A, WHICH CONTAIN THE GENERIC FLIGHT RULES FOR ALL FLIGHTS.

THE FLIGHT RULE NUMBERING SYSTEM HAS BEEN UPDATED. THE NEW NUMBERS WILL MAKE RULES EASIER TO REFERENCE BOTH PRE-MISSION AND IN THE CONTROL CENTER. AN EXPLANATION OF THE UPDATED NUMBERING SYSTEM IS SHOWN ON PAGE VII.

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

ALL FLIGHT RULES ARE AVAILABLE ON THE INTERNET. THE URL IS: **HTTP://MOD.JSC.NASA.GOV/DA8**. NO ID OR PASSWORD WILL BE REQUIRED TO ACCESS ANY OF THE RULES PROVIDED THE USER IS ACCESSING FROM A TRUSTED SITE (ALL NASA CENTERS, CONTRACTORS, AND INTERNATIONAL PARTNERS). IF UNABLE TO ACCESS, USERS NEED TO SEND AN E-MAIL NOTE TO DA8/M. L. GRIFFITH (MARY.L.GRIFFITH1@JSC.NASA.GOV) WITH THEIR FULL NAME, COMPANY, IP ADDRESS, AND A JUSTIFICATION STATEMENT FOR ACCESS.

APPROVED BY:

J. MILTON HEFLIN
CHIEF, FLIGHT DIRECTOR OFFICE

KELLY B. BECK
STS-107 LEAD FLIGHT DIRECTOR

JON C. HARPOLD
DIRECTOR, MISSION OPERATIONS

RONALD D. DITTEMORE
MANAGER, SPACE SHUTTLE PROGRAM

SECTION 1 - GENERAL, AUTHORITY, AND DEFINITIONS

GENERAL

107_1A-1 FLIGHT RULE APPLICABILITY

THIS DOCUMENT CONTAINS THE STS-107 FLIGHT-SPECIFIC FLIGHT RULES AND IS INTENDED TO BE USED IN CONJUNCTION WITH THE SPACE SHUTTLE OPERATIONAL FLIGHT RULES, NSTS-12820, VOLUME A, WHICH CONTAIN THE GENERIC FLIGHT RULES FOR ALL FLIGHTS.

107_1A-2 VEHICLE CONFIGURATION

STS-107/OV-102 FLIGHT SPECIFIC VEHICLE CONFIGURATIONS AS RELATED TO THE GENERIC RULES ARE LISTED IN THE FOLLOWING TABLE:

TABLE 107_1A-2-I

VEHICLE CONFIG DEPENDENT RULES	COMPONENT/ SYSTEM	CONFIGURATION
SECTIONS A#.6.#, {A13-156}, {A17-202}, {A17-302}	SPACEHAB	RESEARCH DOUBLE MODULE
{A10-361}, {A10-362}, {A10-363}, {A10-364}, {A10-365}	VIEWPORT	YES
{A15-201}, {A15-202}, {A17-202}, {A17-302}, {A18-60}, {A18-61}, {A18-62}, {A18-306}	AIRLOCK	INTERNAL
{A17-202}, {A17-302}	TUNNEL ADAPTER	YES
{A10-341}, {A10-342}, {A10-343}, {A10-344}, {A10-345}, {A10-346}	ODS	NO
{A10-281}	PRLA	N/A
{A2-112}, SECTION 12	PDRS	NO
{A2-105}, {A2-1001}, {A7-102}, {A7-5}, {A7-109}, {A7-1001}, {A8-18}	DISPLAY SYSTEM	MEDS
{A15-26}	SSOR/SSER	YES
{A9-257}, {A9-262}	CRYO TANK SET	9
{A17-202}, {A17-302}	N_2 TANK SET	5 (OFF-LOADED TO THE EQUIVALENT OF 4)
{A2-1001}, {A13-152}, {A13-155}, {A17-53}, {A17-106}, {A17-155}, {A17-156}, {A17-1001}	CO_2 CONTROL	LIOH

®[ED]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-2 VEHICLE CONFIGURATION (CONTINUED)

TABLE 107_1A-2-I (CONTINUED)

VEHICLE CONFIG DEPENDENT RULES	COMPONENT/ SYSTEM	CONFIGURATION
{A10-73}	HYD ACCUMULATOR	BELLOWS (ALL)
{A13-30}, {A17-551}	IODINE REMOVAL	GIRA PRIME
{A2-1001}, {A9-154}, {A18-256}, {A18-1001}	RAD ISOLATION VALVE	YES
{A9-154}, {A17-3}, {A17-103}, {A17-151}, {A17-153}, {A17-154}, {A17-1001}	AV BAY 3A FAN	STD AVIONICS BAY FAN
{A2-265}	GPS	SINGLE STRING
{A9-154}	TACAN	GOULD (ALL 3 SLOTS)
{A5-2}, {A5-10}, {A5-11}, {A5-12}, {A5-153}	SSME	C - BLOCK II L - BLOCK II R - BLOCK II
{A6-2}, {A6-3}	OMS	L - 116 R - 114
{A2-105}	SPARE HUD	NO
{A2-105}	PAYLOAD RECORDER	YES
{A2-323}	SPARE PDI	YES

®[DN 84] ®[ED]

107_1A-3 PAYLOAD OPERATIONS ASSESSMENT

FOR PAYLOAD OPERATIONS GO/NO-GO DECISION PURPOSES, PAYLOAD AND SPACECRAFT SYSTEM CAPABILITY ASSESSMENTS WILL BE BASED ON THE BEST ESTIMATE OF THEIR CAPABILITY TO MEET THE MINIMUM FLIGHT REQUIREMENTS. SYSTEMS PERFORMANCE CAPABILITY IN EXCESS OF SPECIFICATION REQUIREMENTS WILL BE CONSIDERED USABLE.

Reference Rules {107_19A-1}, SPACEHAB MINIMUM MISSION OBJECTIVES and {107_20A-1}, FREESTAR MINIMUM MISSION OBJECTIVES. ®[DN 12]

107_1A-22 **SUPPORT EQUIPMENT FCR RESPONSIBILITY (CONTINUED)**

E. PGSC RESPONSIBILITIES: ®[DN 16]

1. ORBITER PROVIDED PGSC HARDWARE - FAO
2. SPACEHAB PROVIDED LAPTOP COMPUTERS - PAYLOADS
3. PCDECOM SOFTWARE – FAO
4. GPS DTO 700-14 SOFTWARE - GNC
5. MEIDEX AND SHUTTLE OZONE LIMB SOUNDING EXPERIMENT (SOLSE)-2 (HH-JR/BIA) SOFTWARE – PAYLOADS ®[CR 5844]
6. SPACEHAB AND EXPERIMENT SOFTWARE - PAYLOADS

The purpose of this Rule is to define the FCT points of contact for equipment used in support of payloads. Reference Rule {107_2A-54}, PGSC USAGE GUIDELINES, for additional information on PGSC and SH Laptop computer usage. ®[DN 16]

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SECTION 2 - FLIGHT OPERATIONS

PRELAUNCH

ASCENT/ENTRY/POST-LANDING

ORBIT

GENERAL

PAYLOAD CONSTRAINTS

ATTITUDE/POINTING CONSTRAINTS

SECTION 2 - FLIGHT OPERATIONS

PRELAUNCH

107_2A-1 **LAUNCH WINDOW**

A. ON JANUARY 16, 2003, THE LAUNCH WINDOW OPENS AT 15:39 GREENWICH MEAN TIME (GMT) AND CLOSES AT 18:09 GMT. ®[CR 5556A] ®[CR 5868A]

1. THE LAUNCH WINDOW OPENS ON 2-2-2 KSC AND EDW. ®[CR 5868A]

2. CLOSING OF THE WINDOW IS CONSTRAINED BY THE 2.5-HOUR CREW ON BACK TIME CONSTRAINT.

3. FOR SCHEDULING AND NOTIFICATION PURPOSES, THE LAUNCH CLEARANCE WINDOW (LAUNCH PERIOD) IS 4 HOURS IN DURATION. THE LAUNCH PERIOD IS 1500 TO 1900 GMT. ®[CR 5556A] ®[CR 5871]

B. MEDITERRANEAN ISRAELI DUST EXPERIMENT (MEIDEX) REQUIRES A LAUNCH WINDOW THAT WILL TAKE THE ORBITER THROUGH THE TWO PRIMARY MEIDEX ROIS DURING DAYLIGHT HOURS SUCH THAT THE SPECIFIED SOLAR ZENITH ANGLE OVER THE ROI IS SATISFIED FOR A COMBINED MINIMUM OBSERVATION TIME OF NO LESS THAN 140 MINUTES. A SOLAR ZENITH WITHIN 45 DEG IS REQUIRED IF THE LAUNCH DATES FALL BETWEEN MARCH 7TH THROUGH SEPTEMBER 23RD. OUTSIDE OF THIS TIMEFRAME, THE SOLAR ZENITH ANGLE IS REQUIRED TO BE WITHIN 70 DEG. ®[CR 5845]

Solar declination prohibits meeting the 45 deg constraint for the duration of the mission if the launch date falls outside of the March 7th to September 23rd timeframe. If the launch occurs outside of this timeframe, MEIDEX highly desires that operations are maximized when the solar zenith angle is within 60 deg or less over the ROI. MEIDEX solar zenith angle definition is the angle between the Sun and orbiter zenith, unless a specific ground location is chosen. In that case, the solar zenith angle definition is the angle between the Sun and the groundsite zenith. The Mediterranean ROI is defined by Latitude 31 N to 39 N and Longitude 0 (Greenwich) to 35E. The Atlantic ROI is defined by 15 N Latitude/35 W Longitude, 15 N Latitude/20 W Longitude, 5 N Latitude/10 W Longitude, 5 N Latitude/5 E Longitude, 5 S Latitude/5 E Longitude, and 5 S Latitude/35 W Longitude. MEIDEX desires to be flown between the months of September and June, as the standard atmospheric profile during July and August provide few opportunities for viable sampling. MEIDEX highly desires to be flown during the months of March-May or September-October due to enhanced probability for dust events in the Mediterranean ROI (where peak intensity and activity of desert aerosols occur during the spring and fall). If mission operations occur during the months of July or August, then the Atlantic ROI will be enlarged to 25 N (where dust plumes migrate during this period). ®[CR 5845]

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107_2A-1 LAUNCH WINDOW (CONTINUED)

C. THE PREDICTED USABLE MAIN PROPULSION SYSTEM (MPS) RESIDUALS AT NOMINAL MAIN ENGINE CUTOFF (MECO) MUST BE GREATER THAN OR EQUAL TO 2.93-SIGMA PLUS MEAN IN-FLIGHT PERFORMANCE RESERVE. ®[CR 5556A]

Ascent Performance Margin (APM) can be reduced from the standard 3-sigma value to 2.93-sigma. This reduction protects all Range Safety constraints and meets the payload altitude requirements defined in the CIP (150 circular). This reduction in APM is equivalent to a 3-feet/second underspeed and this can be made up with the existing Orbital Maneuvering System (OMS) and forward RCS propellant margin. This 3-fps underspeed reduces the MECO apogee from 153 to 151.5 nm which is the payload minimum altitude constraint. Thus, all performance margins and LOX drainback times on launch day will be computed using the 2.93-sigma level. ®[CR 5556A] ®[CR 5868A]

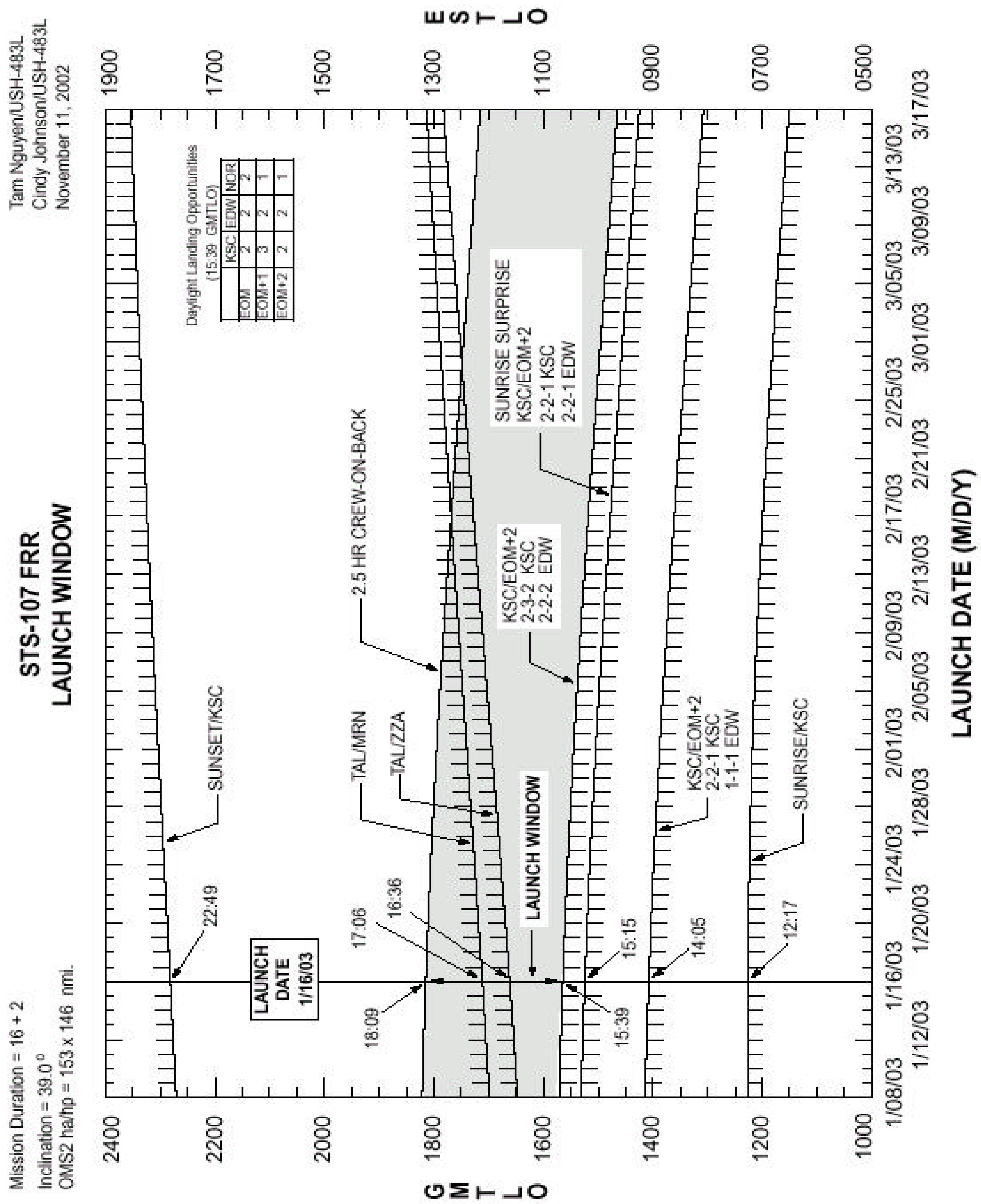
D. THE STANDARD LAUNCH WINDOW GRAPH IS SHOWN AS TABLE 107_2A-1-I.

E. THE LAUNCH WINDOW DIGITAL DATA IS SHOWN AS TABLE 107_2A-1-II.

THIS RULE CONTINUED ON NEXT PAGE

107_2A-1 LAUNCH WINDOW (CONTINUED)

TABLE 107_2A-1-I - COMPOSITE LAUNCH WINDOW GRAPH



®[CR 5556A] ®[CR 5868A]

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107_2A-1 LAUNCH WINDOW (CONTINUED)

TABLE 107_2A-1-II - LAUNCH WINDOW DIGITAL DATA

November 11, 2002

Tam Nguyen/USH-483L
Cindy Johnson/USH-483L

STS-107 FRR DIGITAL LAUNCH WINDOW

NOMINAL FLIGHT DURATION = 15:22:10 (D:H:M) MET

DATE at Greenwich (M/D/Y)	WINDOW OPENINGS: 1 KSC Sunrise SR-0 min GMT (H:M)	2 EOM+2/KSC 1-1-1 KSC&EDW SR-10 min GMT (H:M)	3 EOM+2/KSC SUNRISE SURPRISE SR+60 min GMT (H:M)	4 EOM+2/KSC 2-2-2 KSC&EDW SR-10 min GMT (H:M)	WINDOW CLOSINGS: 5 TAL/ZZA SS+15 min GMT (H:M)	6 TAL/MRN SS+15 min GMT (H:M)	7 2.5 HOUR CREW-ON-BACK GMT (H:M)	8 KSC Sunset SS+0 min GMT (H:M)
01/08/2003	12:17	14:09	15:19	15:43	16:28	16:59	18:13	22:42
01/09/2003	12:17	14:09	15:19	15:43	16:29	17:00	18:13	22:43
01/10/2003	12:17	14:08	15:18	15:43	16:30	17:00	18:13	22:44
01/11/2003	12:17	14:08	15:18	15:42	16:31	17:01	18:12	22:45
01/12/2003	12:17	14:07	15:17	15:42	16:32	17:02	18:12	22:45
01/13/2003	12:17	14:07	15:17	15:41	16:33	17:03	18:11	22:46
01/14/2003	12:17	14:06	15:16	15:41	16:34	17:04	18:11	22:47
01/15/2003	12:17	14:06	15:16	15:40	16:35	17:05	18:10	22:48
01/16/2003	**12:17**	**14:05**	**15:15**	**15:39**	**16:36**	**17:06**	**18:09**	**22:49**
01/17/2003	12:17	14:05	15:15	15:39	16:38	17:07	18:09	22:49
01/18/2003	12:17	14:04	15:14	15:38	16:39	17:08	18:08	22:50
01/19/2003	12:16	14:03	15:13	15:38	16:40	17:09	18:08	22:51
01/20/2003	12:16	14:03	15:13	15:37	16:41	17:11	18:07	22:52
01/21/2003	12:16	14:02	15:12	15:36	16:42	17:12	18:06	22:53
01/22/2003	12:16	14:01	15:11	15:36	16:44	17:13	18:06	22:54
01/23/2003	12:15	14:01	15:11	15:35	16:45	17:14	18:05	22:54
01/24/2003	12:15	14:00	15:10	15:34	16:46	17:15	18:04	22:55
01/25/2003	12:15	13:59	15:09	15:33	16:47	17:16	18:03	22:56
01/26/2003	12:14	13:58	15:08	15:33	16:49	17:17	18:03	22:57

The nominal launch window open and close times are shown in boxes.
Launch window duration is 2.5 hours

1 and 8 protect daylight launch
2 protects at least one daylight landing opportunity to KSC and EDW for EOM, EOM+1, and EOM+2
3 protects at least one daylight landing opportunity to KSC that is at least 60 minutes after sunrise for EOM, EOM+1, and EOM+2
4 protects at least two daylight landing opportunities to KSC and EDW for EOM, EOM+1, and EOM+2
5 and 6 protect daylight TALs
7 protects 2.5 hour crew-on-back constraint

®[CR 5556A] ®[CR 5868A]

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107_2A-1 LAUNCH WINDOW (CONTINUED)

TABLE 107_2A-1-II - LAUNCH WINDOW DIGITAL DATA (CONTINUED)

November 11, 2002

STS-107 FRR DIGITAL LAUNCH WINDOW

NOMINAL FLIGHT DURATION = 15:22:10 (D:H:M) MET

Tam Nguyen/USH-483L
Cindy Johnson/USH-483L

	WINDOW OPENINGS				WINDOW CLOSINGS			
DATE at Greenwich (M/D/Y)	1 KSC Sunrise SR-0 min GMT (H:M)	2 EOM+2/KSC 1-1-1 KSC&EDW SR-10 min GMT (H:M)	3 EOM+2/KSC SUNRISE SURPRISE SR+60 min GMT (H:M)	4 EOM+2/KSC 2-2-2 KSC&EDW SR-10 min GMT (H:M)	5 TAL/ZZA SS+15 min GMT (H:M)	6 TAL/MRN SS+15 min GMT (H:M)	7 2.5 HOUR CREW-ON-BACK GMT (H:M)	8 KSC Sunset SS+0 min GMT (H:M)
01/27/2003	12:14	13:58	15:08	15:32	16:50	17:18	18:02	22:58
01/28/2003	12:13	13:57	15:07	15:31	16:51	17:19	18:01	22:59
01/29/2003	12:13	13:56	15:06	15:30	16:52	17:20	18:00	22:59
01/30/2003	12:12	13:55	15:05	15:29	16:54	17:21	17:59	23:00
01/31/2003	12:12	13:54	15:04	15:28	16:55	17:22	17:58	23:01
02/01/2003	12:11	13:53	15:03	15:27	16:56	17:24	17:57	23:02
02/02/2003	12:11	13:52	15:02	15:27	16:57	17:25	17:57	23:03
02/03/2003	12:10	13:51	15:01	15:26	16:59	17:26	17:56	23:03
02/04/2003	12:10	13:51	15:01	15:25	17:00	17:27	17:55	23:04
02/05/2003	12:09	13:50	15:00	15:24	17:01	17:28	17:54	23:05
02/06/2003	12:08	13:49	14:59	15:23	17:02	17:29	17:53	23:06
02/07/2003	12:08	13:48	14:58	15:22	17:04	17:30	17:52	23:07
02/08/2003	12:07	13:47	14:57	15:21	17:05	17:31	17:51	23:07
02/09/2003	12:06	13:46	14:56	15:20	17:06	17:32	17:50	23:08
02/10/2003	12:06	13:45	14:55	15:19	17:07	17:33	17:49	23:09
02/11/2003	12:05	13:44	14:54	15:18	17:09	17:34	17:48	23:10
02/12/2003	12:04	13:43	14:53	15:17	17:10	17:35	17:47	23:10
02/13/2003	12:03	13:42	14:52	15:16	17:11	17:36	17:46	23:11
02/14/2003	12:03	13:41	14:51	15:15	17:12	17:37	17:45	23:12

The nominal launch window open and close times are shown in boxes.
Launch window duration is 2.5 hours

1 and 8 protect daylight launch
2 protects at least one daylight landing opportunity to KSC and EDW for EOM, EOM+1, and EOM+2
3 protects at least one daylight landing opportunity to KSC that is at least 60 minutes after sunrise for EOM, EOM+1, and EOM+2
4 protects at least two daylight landing opportunities to KSC and EDW for EOM, EOM+1, and EOM+2
5 and 6 protect daylight TALs
7 protects 2.5 hour crew-on-back constraint

®[CR 5556A] ®[CR 5868A]

107_2A-2 LAUNCH COMMIT CRITERIA

THE FOLLOWING PAYLOAD REQUIREMENTS ARE MANDATORY TO COMMIT THE ORBITER TO LAUNCH AND ARE EFFECTIVE UNTIL T-9 MINUTES AND COUNTING, OR AS DICTATED BY LCC EFFECTIVITY: ®[DN 74]

A. ORBITER LCC REQUIREMENTS DRIVEN BY PRIMARY PAYLOAD ACTIVITIES PER THE STS-107 MINIMUM EQUIPMENT LIST (MEL):

1. ONE OF TWO PAYLOAD (PL) COMMUNICATION STRINGS (PF MDM/PSP/MTU FREQUENCY DIVIDER)

Orbiter Generic LCC requires two of two PF MDM's for payload bay door closure but the Payload Signal Processor (PSP) requirement is mission dependent. For STS-107, Spacehab requires a payload communication string, which includes a PSP and its associated payload MDM. String 1 accepts serial commands from the orbiter GPC via payload MDM PF1, and string 2 accepts serial commands from the orbiter GPC via payload MDM PF2. There are three frequency dividers but only two provide clock signals for PSP command capability. Frequency divider 1 provides clock signals for PSP1 command capability and frequency divider 2 provides clock signals for PSP2 command capability.

DOCUMENTATION: LCC DPS-03, BFS-09, INS-03, STS-107 MEL.

2. PF1 MDM DISCRETE OUTPUT CARD 14 TO SPACEHAB ®[CR 5621]

Discrete Output High (DOH) card 14 channel 2 provides a single command interface to critical Spacehab subsystems and is required to support Spacehab operations. Failure of this card to a high state will cause an FSS Arm indication and subsequent Main Power Kill. Spacehab also utilizes PF1 MDM Discrete Output Low (DOL) card 0 channel 2 and PF2 MDM DOH card 2 channel 2. Critical system hardware is controlled by PF1 MDM Card 0, but all hardware can be recovered with on-orbit IFM's (FD1 IFM will be required in order to complete SH Activation) and an LCC was not deemed appropriate. The PF2 MDM card 2 cannot be detected for a failure to either a low or high state and therefore an LCC could not be written. The PF2 MDM card 2 failure to the high state will issue a FSS Discharge command, but the command will have no effect unless the FSS is armed at that time. ®[CR 5537]

DOCUMENTATION: LCC RDM-06. ®[CR 5537] ®[CR 5621]

3. MTU/GMT IRIG-B CONVERTER/PTB

The Master Timing Unit (MTU) supplies GMT and MET to various downstream users, including payloads via the Payload Timing Buffer. The Miniature Satellite Threat Reporting System (MSTRS) Spacehab payload is the driver for this LCC since it receives GMT directly from the Payload Timing Buffer from the GMT IRIG-B converter and cannot use MET. Therefore, if the GMT IRIG-B converter fails, MSTRS will not have timetag information and results in loss of nearly all MSTRS science objectives. Refer to Rule {107_7A-3}, LOSS OF ORBITER MASTER TIMING UNIT (MTU)/PAYLOAD TIMING BUFFER, for additional impacts that do not directly affect launch go/no-go decisions.

DOCUMENTATION: LCC INS-03, STS-107 MEL. ®[DN 74]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-2 **LAUNCH COMMIT CRITERIA (CONTINUED)**

4. PAYLOAD DATA INTERLEAVER WITH EITHER THE PRIMARY OR BACKUP DECOM LOCKED. ®[DN 74]

The Payload Data Interleaver (PDI) provides the only source of telemetry to the orbiter General Purpose Computer (GPC) or downlink for operation of the Spacehab system. With either the primary DECOM (DECOM 1) or backup DECOM (DECOM2) locked, the crew will be able to monitor safety critical parameters through the Backup Flight System (BFS). The ground has the capability to determine the state of the safety critical parameters through other means in the event of a failure of the primary DECOM.

DOCUMENTATION: LCC RDM-04, STS-107 MEL.

5. ORBITER BUS REQUIREMENTS:

   a. PRI PL

   b. PL AFT MNB

The primary payload bus and PL Aft Main Bus B (MNB), and PL cabin buses provide power to Spacehab equipment and experiments. The PL AC2 and AC3 buses are not active prelaunch, but the orbiter AC buses providing power to these PL AC buses are covered by the Generic Orbiter LCC. PL CAB 2 and PL CAB 3 are required by Spacehab, but the only insight into PL CAB 2 and PL CAB 3 is the switch position.

DOCUMENTATION: LCC EDPC-03, EDPC-04, RDM-05, RDM-06, STS-107 MEL.

6. TWO OF TWO FLOW PROPORTIONING MODULE (FPM)

Two Flow Proportioning Valves (FPV's) in Payload Heat Exchanger (PLHX) are required during Spacehab operations.

DOCUMENTATION: LCC ECL-40, STS-107 MEL.

B. COMMAND AND TELEMETRY PROCESSING CAPABILITY MUST BE OPERATIONAL OR HAVE AN ESTIMATED TIME TO RETURN TO OPERATIONS BY SPACEHAB ACTIVATION TO ENABLE GROUND COMMANDING AND MONITORING OF CRITICAL SUBSYSTEMS DURING ON-ORBIT OPERATIONS.

Ground commanding is required to configure Spacehab systems and to control experiment operations. The ability to throughput and process downlink data is required to monitor critical Spacehab systems and to collect experiment data.

C. FREESTAR, SIMPLEX, AND RAMBO HAVE NO LAUNCH COMMIT CRITERIA. ®[DN 74]

107_2A-3 LAUNCH TURNAROUND

A. FOR A LAUNCH DELAY OF 24 HOURS FROM THE INITIAL LAUNCH ATTEMPT, THE MIDDECK MUST BE ACCESSED TO REPLACE SPACEHAB MIDDECK EXPERIMENTS. ®[DN 18]

B. FOR A LAUNCH DELAY OF 48 HOURS FROM THE INITIAL ATTEMPT (I.E., TWO CONSECUTIVE LAUNCH ATTEMPTS SCRUBBED), THE MIDDECK AND SPACEHAB MODULE MUST BE ACCESSED TO REMOVE, REFURBISH, AND REPLACE EXPERIMENTS.

Some middeck payloads can only sustain the initial planned launch attempt. For a 1 day delay after the payloads have been installed, they must be replaced to support a second launch attempt. If launch is delayed by 48 hours or more (two consecutive launch attempts scrubbed), there are middeck payloads which must be removed, refurbished, and reinstalled prior to a subsequent launch attempt. In addition, there are also payloads in the Spacehab module that must be removed, refurbished, and reinstalled. Reference the Spacehab CIP (NSTS 21426) for specific payloads which require refurbishment or replacement following two consecutive launch attempts.

C. FREESTAR HAS NO LAUNCH SCRUB TURNAROUND REQUIREMENTS. ®[DN 18]

ASCENT/ENTRY/POST-LANDING

107_2A-11 RESERVED ®[DN 19]

107_2A-12 SUBSONIC PILOT FLIGHT CONTROL

AT THE DISCRETION OF THE COMMANDER (CDR), THE PILOT (PLT) MAY FLY CONTROL STICK STEERING (CSS) FROM THE BEGINNING OF SUBSONIC FLIGHT WITH THE FOLLOWING CONSTRAINTS: ®[CR 5478]

A. THE CDR WILL FLY THE ORBITER FROM 10 SECONDS PRIOR TO HAC INTERCEPT THROUGH THE INITIAL ROLL ONTO THE HAC.

B. THE CDR WILL FLY FROM A HAC TURN ANGLE OF 90 DEGREES THROUGH LANDING ROLLOUT.

C. WHEN CSS IS ENGAGED, ONBOARD GUIDANCE COMMANDS WILL BE FOLLOWED.

D. THE CDR WILL FLY (NO TRANSFER OF CONTROL) FOR THE FOLLOWING CASES:

1. IF THE MCC RECOMMENDS “DELAYED CSS PREFERRED” PER RULE {A4-156}, HAC SELECTION CRITERIA ®[ED]

2. SYSTEMS OR NAVIGATION PROBLEMS THAT REQUIRE CSS, PER RULES {A2-261}, ENTRY DTO/AUTO MODE/CROSSWIND DTO NO-GO, AND {A4-208}, ENTRY TAKEOVER RULES ®[ED]

3. VEHICLE ENERGY PROBLEMS REQUIRING A GROUND CONTROLLED APPROACH (GCA)

4. RTLS/TAL/ECAL/ELS ABORTS

5. BFS ENGAGED

6. ANY GUIDANCE, NAVIGATION, OR FLIGHT CONTROL SYSTEM(S) FAILURE (E.G., CDR HUD) THAT INCREASES THE PROBABILITY OF A TRAJECTORY TRANSIENT RESULTING FROM THE TRANSFER OF CONTROL (MCC CALL). LOSS OF A SINGLE STRING OF REDUNDANCY IN ANY SYSTEM (E.G., ONE AA, ONE FCS CHANNEL, ONE RHC CHANNEL, ETC.), WITH NO OTHER FAILURES, IS NOT CAUSE FOR PRECLUDING TRANSFER OF CONTROL. ®[CR 5478]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-12 SUBSONIC PILOT FLIGHT CONTROL (CONTINUED)

7. IF THE MCC RECOMMENDS NO-GO FOR PLT FLYING BASED ON HAC DYNAMICS (E.G., TAIL WINDS > 80 KNOTS AT HAC INTERCEPT) ®[CR 5478]

E. THE PLT IS THE BACKUP TO THE CDR FOR ANY FLIGHT PHASES REQUIRING CSS CONTROL. IF REQUIRED FOR VEHICLE SAFETY, THE CDR MAY TRANSFER CONTROL TO THE PLT AT ANY TIME.

Allowing the PLT to fly for a short period of time during entry enhances training and better prepares the pilot for future orbiter flying tasks. The intent of this rule is to allow the PLT to fly for approximately 20 seconds during a single period, either prior to HAC intercept or once established on the HAC prior to the 90. During a normal entry, there is sufficient time following the end of the transonic buffet to allow the PLT to control the orbiter and still allow the CDR sufficient time to complete the more critical maneuvers such as the initial roll onto the HAC and lining up on final. When CSS is engaged, onboard guidance will be followed, and no inputs will be made other than those required to fly to the glideslope and course centerline, or otherwise ensure a safe landing.

There are some cases in which it is not prudent to allow the PLT to have this training time, however. If the 6 degree of freedom entry simulation as explained in Rule {A4-156}, HAC SELECTION CRITERIA, indicates that delaying CSS until a HAC turn angle of 180 degrees is preferred, the CDR should fly from CSS initiation through rollout. For these HAC cases, energy stops diverging at the 180 degree point and begins to slowly recover. Handing control of the vehicle between the CDR and PLT in this timeframe is not prudent, since the vehicle energy is already lower than typical and the time to correct any energy problems is diminished. Likewise, a vehicle problem as outlined in Rules {A2-261}, ENTRY DTO/AUTO MODE/CROSSWIND DTO GO/NO-GO, or {A4-208}, ENTRY TAKEOVER RULES, requires significant concentration on the flying task, and a handover of control is inappropriate. Systems failures that would invoke this rule are two AA failures, no or single air data, no yaw jet flight control mode, or a navigation system anomaly that affects the vehicle energy state (GCA). In the event of an abort, flight control handovers between CDR and PLT should be avoided due to the increased risk inherently associated with the abort, and to eliminate the possibility of introducing any handover dispersions to an already challenging abort landing. The transfer of control is assumed to have an insignificant impact on the vehicle trajectory and energy state, although arguably that impact is non-zero. That is, in most cases it is nearly impossible to transfer vehicle control without introducing some very small transient, which for the nominal case is acceptable. However, the transfer of control is not warranted for any guidance, navigation, or flight control system(s) problem(s) that could cause a transfer of control to result in more than an insignificant impact on the trajectory. Additionally, for certain HAC dynamics (e.g., high tail winds at HAC intercept), the flying task requires more setup time prior to HAC intercept, and more time-critical inputs before, during, and after HAC intercept. In these cases, vehicle energy state can be less forgiving for delayed piloting response (at HAC intercept, and for the first 180 deg of HAC), and transfer of vehicle control is not warranted. ®[ED]

Flight crews are trained preflight to transfer control positively and verbally in a CRM environment. Any time that a situation occurs that detracts from the CDR's ability to fly the vehicle, it is acceptable for the CDR to hand control of the vehicle over to the PLT, regardless of the constraints imposed by this rule.
®[CR 5478]

107_2A-13 TAL/AOA OPS 3 TRANSITION

IF A GPC FAILS WHILE COMMANDING RCS JETS TO FIRE, THE AFFECTED STRING WILL EITHER BE NOT ASSIGNED DURING THE TAL/AOA OPS 3 TRANSITION OR THE AFFECTED MDM'S WILL BE POWER-CYCLED PRIOR TO THE TAL/AOA OPS 3 TRANSITION. ®[CR 5526]

Flight Software DR 110886 documents conditions that can cause uncommanded RCS jet firings in OPS 3 if a GPC fails while commanding RCS jets to fire in OPS 1. To avoid this condition, the affected string will not be assigned to the TAL/AOA OPS 3 transition. If the string is to be assigned to the OPS 3 transition, a power-cycle of the affected MDM is first required to clear the jet commands. ®[CR 5526]

107_2A-14 LOSS OF ET LOX LIQUID LEVEL CONTROL SENSORS

IN THE PRELAUNCH TIMEFRAME: ®[CR 5575A]

A. FOR THE LOSS OF THE FIRST 100 PERCENT ET LOX LIQUID LEVEL CONTROL SENSOR, NO MCC ACTION IS REQUIRED, REGARDLESS OF WHEN THE FIRST SENSOR FAILS.

B. LOSS OF A SECOND 100 PERCENT ET LOX LIQUID LEVEL CONTROL SENSOR WILL RESULT IN THE TRANSFER OF ET LOX LOADING CONTROL TO THE 100.15 PERCENT SENSOR.

1. FOR CONTROL TRANSFER TO 100.15 PERCENT SENSOR PRIOR TO L-25 MINUTES:

   a. ARD AND LAUNCH WINDOW DATA WILL BE BASED ON A 100.15 PERCENT LOX LOADING ESTIMATE (WITH ADJUSTMENT FOR ADDITIONAL DRAINBACK TIME, AS APPLICABLE).

   b. IF STABLE REPLENISH USING THE 100.15 PERCENT SENSOR IS REACHED PRIOR TO L-1:20 HOURS, THE LOX LOADING ESTIMATE WILL BE GENERATED USING PLOAD. OTHERWISE, “NO PLOAD” LOADING ESTIMATES WILL BE USED (PER RULE {A2-7C}, DAY-OF-LAUNCH ET LOAD DATA) DUE TO MCC OPERATIONAL PROCESSING TIMELINE CONSTRAINTS.

   c. ADDITIONAL DRAINBACK TIME SHALL BE INSERTED INTO THE TIMELINE AFTER THE START OF DRAINBACK AS SPECIFIED BY THE DOLILU OPERATIONS SUPPORT PLAN. FD WILL COORDINATE THE INSERTION OF THE ADDITIONAL DRAINBACK TIME, IF ANY, WITH NTD.

2. FOR CONTROL TRANSFER TO 100.15 PERCENT SENSOR AFTER L-25 MINUTES:

   a. ARD CALCULATIONS WILL NOT BE UPDATED.

   b. ADDITIONAL DRAINBACK TIME WILL NOT BE INSERTED INTO THE TIMELINE.

   c. MCC WILL BE NO-GO FOR LAUNCH UNTIL THE PSIG REPRESENTATIVE IN THE MER VALIDATES THAT THE MEASURED ULLAGE PRESSURE DOES NOT EXCEED 0.255 PSI ABOVE THE TDDP NOMINAL LOAD ULLAGE PRESSURE OF 0.781 PSIG. ®[CR 5575A]

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107_2A-14 LOSS OF ET LOX LIQUID LEVEL CONTROL SENSORS (CONTINUED)

The ET project has determined that the PLOAD LOX loading estimate based on liquid level control using a 100 percent sensor which subsequently fails will remain valid after a switch to the second 100 percent ET LOX liquid level control sensor. Therefore, switching liquid level control from one 100 percent sensor to the second 100 percent sensor does not invalidate the original PLOAD loading estimate. ®[CR 5575A]

The ET project has determined that the PLOAD LOX loading estimate based on liquid level control using either 100 percent sensor is not accurate in the event of a later failure of both 100 percent LOX liquid level control sensors and subsequent fill to the 100.15 percent sensor per LCC ET-10. The ET Project has requested DOSS to rerun PLOAD or revert to 100.15 percent MPS inventory loading estimates. A rerun and QA of PLOAD loading updates, nominal mission performance margin, and launch window impacts requires approximately 40 minutes. KSC Ground Operations is unable to accept launch window updates after L-39 minutes. However, FDO and ARD support should reflect the best possible estimate of the true LOX loading. Therefore, these elements will reconfigure to reflect LOX loading to the 100.15 percent MPS inventory values, if the failover occurs after the latest time to rerun PLOAD (about L-1:20 hour) and prior to L-25 minutes, regardless of whether or not the KSC launch window is updated.

For any level sensor failure after L-25 minutes, no action is required by the MCC. A late sensor failure (either the first or the second) may result in an underload of approximately 1,100 pounds of LOX, which still meets LCC ET-10 launch requirements. This equates to approximately 15 fps of ascent performance margin. STS-107 Ascent Performance Margin is sufficient to ensure a guided nominal MECO for a launch in this condition. However, a launch with an underload of this magnitude will result in TAL and ATO abort boundary calls being made approximately 15 fps early. The program accepts this risk due to its low probability of occurrence.

In the event of a failure of both 100 percent sensors and failover to a fill to the 100.15 percent sensor failure, no additional drainback time will be added to the countdown. The requirement for the additional drainback to the 100 percent level has been waived through a mission-specific analysis.

Late failover to a LOX tank fill controlled by the 100.15 percent (after failure of both 100 percent level sensors) will require verification that the LOX loading is consistent with MPS inventory loading estimates. The MPS inventory is protected if the ullage pressure is less than 1.036 psi. Ullage pressure above this limit indicates an underload of a magnitude beyond that covered in the FPR. The value of 1.036 psi is derived by adding the ullage pressure used in deriving the inventory (.781 psi) to a tolerance that is protected by FPR (.255 psi). ®[CR 5575A]

PRIORITIES AND MISSION DURATION

107_2A-21 HIGH PRIORITY FLIGHT OBJECTIVES/MINIMUM DURATION FLIGHT

A. MINIMUM DURATION FLIGHT (MDF) WILL LAST APPROXIMATELY 72 HOURS WITH LANDING ON THE MORNING OF FD4 PER RULE {A2-102}, MISSION DURATION REQUIREMENTS. ®[ED]

The MDF has a nominal minimum length of approximately 72 hours. The term "approximately 72 hours" is used to allow for utilization of primary landing site (PLS) and secondary landing site (SLS) landing opportunities which occur during a given flight day. The minimum duration is set at the number of days normally required to ensure a good probability of having a healthy crew for entry and landing and to provide the opportunity to accomplish activities that could enhance orbiter entry/landing conditions. The payload/experiments must be considered secondary to vehicle/crew safety and are not sufficient grounds for mission continuation. FD4 landing is the standard MDF duration. The MDF timeline must allow for Flight Control System (FCS) C/O, RCS hot fire, and cabin stow.

B. EXPERIMENT OPERATIONS MAY CONTINUE UP TO THE NOMINAL DEACTIVATION TIME DEFINED IN THE ENTRY DAY TIMELINE ON A NONINTERFERENCE BASIS WITH ORBITER OPERATIONS IN PREPARING FOR DEORBIT AND ENTRY.

Nominal experiment deactivation will be scheduled to preserve sufficient time for orbiter preparation for deorbit and entry. Experiments may be performed before and up to this time on a noninterference basis. Spacehab middeck experiments are considered part of Spacehab and would be deactivated at the same time the module is deactivated.

C. IF ON-ORBIT OPERATIONAL CONFLICTS EXIST WITHIN THE STRUCTURE OF AN MDF, THE CONFLICTS WILL BE RESOLVED ACCORDING TO THE PRIORITIES DEFINED IN RULE {107_2A-22}, ON-ORBIT GENERAL PRIORITIES. SECONDARY FLIGHT OBJECTIVES MAY BE ACCOMPLISHED WITHIN THE STRUCTURE OF AN MDF AS LONG AS THEY DO NOT INTERFERE WITH OR JEOPARDIZE THE HIGH PRIORITY FLIGHT OBJECTIVES.

107_2A-22 ON-ORBIT GENERAL PRIORITIES

IF ON-ORBIT OPERATIONAL CONFLICTS EXIST, THE CONFLICTS WILL BE RESOLVED ACCORDING TO THE FOLLOWING PRIORITIZATION. PRIORITY WILL BE GIVEN TO SATISFYING MINIMUM REQUIREMENTS FOR ALL PAYLOADS, AS DEFINED IN RULES {107_19A-1}, SPACEHAB MINIMUM MISSION OBJECTIVES, AND {107_20A-1}, FREESTAR MINIMUM MISSION OBJECTIVES, OVER HIGHLY DESIRED REQUIREMENTS FOR HIGHER PRIORITY PAYLOADS. ®[DN 20]

A. CREW SAFETY

B. SPACEHAB COMMERCIAL SPONSORED PAYLOADS

1. ADVANCED RESPIRATORY MONITORING SYSTEM (ARMS)

2. CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS)

3. MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

4. COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH (CMPCG)

5. COMBINED 2 PHASE LOOP EXPERIMENT (COM2PLEX)

6. SPACE TECHNOLOGY AND RESEARCH STUDENTS BOOTES (STARS BOOTES)

7. STAR NAVIGATION (STARNAV)

8. OSTEOPOROSIS EXPERIMENT IN ORBIT (OSTEO)

9. EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS (ERISTO)

10. PHYSIOLOGY AND BIOCHEMISTRY 4 (PHAB4)

    a. ENHANCED ORBITER REFRIGERATOR/FREEZER (EOR/F)

    b. THERMOELECTRIC HOLDING MODULE (TEHM)

    c. CENTRIFUGE ®[DN 20]

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107_2A-22 ON-ORBIT GENERAL PRIORITIES (CONTINUED)

C. ESA/NASA SPONSORED PAYLOADS

1. BIOPACK
2. FACILITY FOR ADSORPTION AND SURFACE TENSION (FAST)
3. ADVANCE PROTEIN CRYSTALLIZATION FACILITY (APCF)
4. BIOBOX

D. NASA/ISS SPONSORED PAYLOADS

VAPOR COMPRESSION DISTILLATION (VCD)

E. NASA/CODE U SPONSORED PAYLOADS

1. COMBUSTION MODULE-2 (CM-2)
   a. LAMINAR SOOT PROCESS (LSP)
   b. STRUCTURE OF FLAME BALLS AT LOW LEWIS-NUMBER (SOFBALL)
   c. WATER MIST
   d. SPACE ACCELERATION MEASUREMENT SYSTEM FREE FLYER (SAMS FF)
   e. ORBITAL ACCELERATION RESEARCH EQUIPMENT (OARE)
   ®[DN 20]
2. MECHANICS OF GRANULAR MATERIALS (MGM)
3. BIOREACTOR DEMONSTRATION SYSTEM-05 (BDS-05)
4. MICROBIAL PHYSIOLOGICAL FLIGHT EXPERIMENT (MPFE)
5. SLEEP-3
6. ASTROCULTURE PLANT GROWTH CHAMBER (AST-10/1)

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107_2A-22 **ON-ORBIT GENERAL PRIORITIES (CONTINUED)**

7. ASTROCULTURE GLOVEBOX (AST-10/2)

8. COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF)

9. COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX) ®[DN 20]

10. ZEOLITE CRYSTAL GROWTH-1 (ZCG-1)

11. FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH-2 (FRESH-2)

12. GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA)

13. BIOLOGICAL RESEARCH IN CANISTERS (BRIC)

F. FREESTAR PAYLOADS

1. MEDITERRANEAN ISRAELI DUST EXPERIMENT (MEIDEX)

2. SOLAR CONSTANT EXPERIMENT-3 (SOLCON-3)

3. SHUTTLE OZONE LIMB SOUNDING EXPERIMENT-02 (SOLSE-02)

4. CRITICAL VISCOSITY OF XENON-2 (CVX-2)

5. LOW POWER TRANSCEIVER (LPT)

6. SPACE EXPERIMENT MODULE (SEM)

G. SIMPLEX

H. DTO 700-14 MAGR GPS

The TEHM is used by both the PHAB4 and VCD experiments, but is listed under the highest priority payload it supports. Detailed Supplementary Objectives (DSO's) manifested for this flight have no real-time requirements (i.e., only pre and post-flight requirements) and are, therefore, not listed in this rule. RAMBO has no real-time requirements except for state vectors. ®[CR 5622] ®[CR 5633]

DOCUMENTATION: STS-107 FRD (NSTS 17462-107), PRD for Spacehab Commercial Payloads (NSTS 21464), PRD for ESA Payloads (NSTS 21459), PRD for Code U Payloads (NSTS 21463).
®[DN 20]

107_2A-23 ON-ORBIT PROPELLANT PRIORITIES

PROPELLANT PRIORITIES FOR CONSUMABLES LIMITED SITUATIONS, HIGHEST PRIORITIES FIRST ARE:

TABLE 107_2A-23-I - PROPELLANT PRIORITIES

PRIORITY	FLIGHT ACTIVITY	NOTES
1	NOMINAL OMS/RCS REDLINES (PROTECTS 1-1 DEORBIT OPPORTUNITIES	REF RULE {A2-108}, CONSUMABLES MANAGEMENT
2	MINIMUM DURATION FLIGHT	
3	WEATHER WAVEOFF EXTENSION DAY (PROTECTS 2-1-1 DEORBIT OPPORTUNITIES)	THE WEATHER WAVEOFF EXTENSION DAY IS LOWER PRIORITY THAN THE MINIMUM ALTITUDE REQUIRED FOR PRIMARY PAYLOAD ACTIVITIES. REF RULE {A2-108C}, CONSUMABLES MANAGEMENT.
4	NOMINAL MISSION DURATION	EXTEND MISSION DURATION IN FLIGHT DAY INCREMENTS PAST MDF, UP TO NOMINAL. ADDITIONAL DAYS WILL INCLUDE NOMINALLY PLANNED ACTIVITIES (ATTITUDE MANEUVERS, ATTITUDE HOLD, ETC.). REF RULE {A2-108}, CONSUMABLES MANAGEMENT.
5	PROVIDE ADDITIONAL DEORBIT ATTEMPTS UP TO 2-2-2	PROVIDING 2-2-2 (TWO ATTEMPTS ON THREE CONSECUTIVE DAYS) REQUIRES AN ADDITIONAL TWO REVS OF WAVEOFF ABOVE 2-1-1 CAPABILITY.
6	RAISE AND/OR CIRCULARIZE ORBIT AS HIGH AS POSSIBLE UP TO NOMINAL ALTITUDE	ALL PROPELLANT MARGIN ABOVE FULL MISSION DURATION AND ACTIVITIES WILL BE ALLOCATED TO RAISING THE ORBIT AND/OR CIRCULARIZING THE ORBIT AS HIGH AS POSSIBLE UP TO THE NOMINAL MISSION ALTITUDE OF 150 NM.
7	ET PHOTOGRAPHY MANEUVERS	THE SSP STRONGLY DESIRES ET PHOTOGRAPHY.
8	OMS ENGINE FAIL	REF RULES {A6-303}, OMS REDLINES [CIL]; {A6-304}, FORWARD RCS REDLINES; AND {A6-305}, AFT RCS REDLINES. OMS ENGINE FAIL PROTECTION FOR THE DEORBIT WAVEOFF EXTENSION DAY MAY BE DELETED IN FAVOR OF HIGH PRIORITY FLIGHT OBJECTIVES.
9	ADJUST ORBIT FOR ADDITIONAL LANDING OPPORTUNITIES	PROPELLANT BEYOND WHAT IS REQUIRED FOR PRIMARY MISSION OBJECTIVES MAY BE USED TO PERFORM ORBIT ADJUST BURNS TO GAIN ADDITIONAL LANDING OPPORTUNITIES.
10	SIMPLEX	

®[DN 11] ®[CR 5519] ®[ED]

107_2A-24 ON-ORBIT NON-PROP CONSUMABLES PRIORITIES

THE PRIORITIES FOR O_2, H_2, AND N_2 CONSUMABLE LIMITED SITUATIONS, HIGHEST FIRST, ARE:

A. CONTINGENCY RESERVES, MEASUREMENT ERROR, ETC., FROM THE APPROPRIATE SHUTTLE REDLINE RULES IN VOLUME A

Reference Rule {A9-257}, PRSD H2 AND O2 REDLINE DETERMINATION. These redlines include a 2-1-1 shuttle deorbit opportunity plus minimum power level requirements for a safe landing and other contingency reserves. Consumables for one contingency EVA for payload bay door closure would come out of these redlines and is not implicitly bookkept as a separate line item. ®[ED]

B. MINIMUM DURATION FLIGHT

Minimum duration flight has a nominal length of approximately 72 hours, including on-orbit time, ascent, post-insertion, deorbit prep, and entry.

C. NOMINAL MISSION DURATION AND PLANNED ACTIVITIES

Nominal mission duration of 16 days. Planned mission activities for STS-107 include consumables for 3.5 hours of post-landing power. Planned mission activities are documented in the Flight Plan (JSC-48000-107) and FRD (NSTS 17462-107). The post-landing power requirements are documented in the Spacehab Flight Planning Annex 2, Part 1 (NSTS21426). ®[DN 80]

D. ADDITIONAL SHUTTLE DEORBIT OPPORTUNITIES TO 2-2-2.

This requires approximately 4.5 lbm H2 and 27.5 lbm O_2.

E. ADDITIONAL DTV USE ABOVE THE MINIMUM MEIDEX REQUIREMENTS.

5.66 kWh of cryo have been budgeted for DTV operation in support of MEIDEX video requirements. Additional use of the DTV system may be possible if cryo margins and priorities allow. Worst case power levels for DTV operations are 39 W for recording (DTV multiplexer not powered) and 73 W for playback. Procedural treatment of DTV leaves the equipment deactivated except during periods of frequent use. DTV will nominally operate 15 days in support of MEIDEX with worst case 5-7 hours/day powered to support recording and another 1-2 hours/day to support video playback.
®[DN 80] ®[CR 5538]

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107_2A-24 ON-ORBIT NON-PROP CONSUMABLES PRIORITIES (CONTINUED)

F. ADDITIONAL OPERATION OF OARE BEYOND ITS MINIMUM SUPPORT REQUIREMENTS FOR CM-2 SOFBALL. ®[CR 5538]

OARE draws 120 W average power. 15.61 kWh of cryo have been budgeted for OARE required operations which include power for ascent, a 24 hour period prior to CM-2 SOFBALL operations, and during CM-2 SOFBALL operations. The Payload Recorder draws 17 W in standby, 56 W in record, and 84 W in playback. 6.7 kWh have been allotted for required recording of OARE data by the Payload Recorder and its associated playback which include a 4 hour period during the 24 hour period prior to CM-2 SOFBALL and from 30 minutes prior to until 30 minutes after each CM-2 SOFBALL microgravity period. SOFBALL operates for approximately 5 days and includes 15 microgravity periods ranging from 1.5 - 4 hours in duration. Additional highly desired operation of OARE includes the first 24 hours of the mission and during CM-2 WATER MSIT operations (approximately 2.52 kWh and 8.16 kWh additional, respectively). OARE highly desires recording and playback of all OARE data by the Payload Recorder. Power requirements for additional Payload Recorder operation will need to be calculated in real time. ®[CR 5538]

107_2A-25 REPLAN STRATEGY ®[DN 21]

A. GENERAL

1. PAYLOAD OBJECTIVES THAT ARE NOT COMPLETED AS PLANNED DUE TO A PROBLEM WITH THE PAYLOAD (E.G., HARDWARE, SOFTWARE, INSUFFICIENT TIME ESTIMATES, ETC.) WILL BE REPLANNED WITHIN THAT PAYLOAD'S RESOURCE ALLOCATION. THIS INCLUDES ANY TROUBLESHOOTING, IN-FLIGHT MAINTENANCE (IFM) PROCEDURES, REPEAT OF LOST RUNS, ETC. IF THE PAYLOAD'S MINIMUM REQUIREMENTS CANNOT BE MET WITHIN ITS OWN ALLOCATION, THE SPACEHAB PROGRAM MANAGER OR HITCHHIKER OPERATIONS MANAGER FOR FREESTAR MAY ELECT TO IMPACT EXPERIMENTS WITHIN THEIR PAYLOAD COMPLEMENT TO RECOVER LOST OBJECTIVES FOR A HIGHER PRIORITY PAYLOAD.

2. PAYLOAD OPERATIONS IN PROGRESS THAT ARE RUNNING LONGER THAN EXPECTED AND ARE DIFFICULT TO RESCHEDULE (E.G., ATTITUDE TIMELINE DEPENDENT, KU-COVERAGE, TIME-CRITICAL SCIENCE EVENT, ETC.) MAY BE ALLOWED TO COMPLETE AS LONG AS OTHER PAYLOAD ACTIVITIES IMPACTED BY THE DELAY CAN BE DELAYED OR RESCHEDULED.

3. IF AN ORBITER ANOMALY, ACTIVITY, OR OTHER EVENT RESULTS IN THE LOSS OF OBJECTIVES FOR MULTIPLE PAYLOADS, MISSED OBJECTIVES WILL BE RESCHEDULED IF REQUESTED BY THE CUSTOMER. RESCHEDULING OF MISSED OBJECTIVES WILL MINIMIZE CHANGES TO ORIGINALLY PLANNED ACTIVITIES. CONFLICTS WILL BE RESOLVED BASED ON THE PRIORITIES IDENTIFIED IN RULE {107_2A-22}, ON-ORBIT GENERAL PRIORITIES, TO ATTEMPT TO MEET THE MINIMUM REQUIREMENTS FOR ALL PAYLOADS. LOWER PRIORITY ACTIVITIES MAY BE SCHEDULED AT AN EARLIER TIME THAN HIGHER PRIORITY ACTIVITIES IF REQUIRED TO OPTIMIZE THE TIMELINE AND TOTAL SCIENCE FOR THE REMAINING MISSION DURATION AS LONG AS THE HIGHER PRIORITY ACTIVITIES BASED ON CUSTOMER INPUT CAN BE ACCOMMODATED. ®[DN 21] ®[CR 5872]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

Lost payload objectives due to experiment problems or underestimated task durations will be rescheduled within that payload's allocation, preferably at the experiment level since the STS-107 timeline has little flexibility due to attitude requirements/constraints, microgravity constraints, crew availability, etc. However, if rescheduling within the experiment's allocation is not possible, SPACEHAB or FREESTAR may elect to impact other experiments within their payload complement to recover lost objectives for a higher priority experiment assuming the appropriate resources are available (attitude timeline, Ku-band coverage, crew time, etc.). In some cases, if a payload activity is running longer than planned, it may be allowed to continue to completion if the overall impact to the timeline is less than if the activity were rescheduled at a later time as long as other payload activities impacted by the delay can be delayed or rescheduled. If an orbiter anomaly, activity, or other event that affects multiple payloads results in missed objectives, those objectives may be rescheduled based on customer input. In some cases, the payload customer may elect to forego missed objectives to maintain the originally planned timeline. Rule {107_2A-22}, ON-ORBIT GENERAL PRIORITIES, will be used to resolve conflicts, in an attempt to meet minimum mission objectives for all payloads before considering highly desirable objectives.
®[DN 21] ®[CR 5872]

B. LOSS OF KU-BAND

1. ACTIVATE ALL AVAILABLE NASA AND AIR FORCE GROUND STATIONS WITH S-BAND FM CAPABILITY

Nominally, only two NASA ground stations (MILA, FL and Dryden, CA) support the shuttle S-band FM downlink. The are eight additional ground stations that can be activated in contingency situations: two NASA (ESTL, Houston, TX and Wallops Island, VA) and six Air Force (COOK, Vandenberg AFB, CA; REEF, Diego Garcia, British Indian Ocean Territory; HULA, Kaena Point, HI; GUAM, Andersen AFB, Guam; PIKE, Colorado Tracking Station, Schriever AFB, CO; and LION, RAF Oakhanger, United Kingdom). Note that only MILA and Dryden are capable of supporting video downlink.

2. MAXIMIZE TDRS-Z SUPPORT

TDRS-Z support eliminates the shuttle TDRS Zone of Exclusion (ZOE). Eliminating the ZOE alleviates the need for the Operational Recorder to capture data during the ZOE for later S-band FM downlink.

3. AN IFM WILL BE CONSIDERED TO CONNECT THE SPACEHAB PL DIGITAL DATA STREAM TO THE S-BAND FM SYSTEM.

The Spacehab Experiment High Rate data stream is nominally routed as the PL Digital input to Ku-band Channel 2. In the event of a Ku-band failure, an IFM can be performed to reroute this input to be the PL Digital input to the S-band FM system. A similar IFM was performed for the Alpha Magnetic Spectrometer (AMS) payload on STS-91. ®[DN 21]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

4. S-BAND FM DOWNLINK WILL BE PRIORITIZED AMONG THE FOLLOWING USERS: ®[DN 21]

   a. OPS RECORDER DUMPS

   b. PL DIGITAL – SPACEHAB EXPERIMENT DATA (IF IFM PERFORMED)

   c. ANALOG VIDEO - SPACEHAB EXPERIMENT AND MEIDEX

   d. PL RECORDER DUMPS - OARE DATA

5. UPLINK/DOWNLINK OF PAYLOAD FILES WILL BE DISCONTINUED

File uplink/downlink is nominally accomplished using OCA and the KFX software application on the Ku-band system. The backup method for file uplink/downlink is via modem on an A/G channel utilizing the MFX software application. Since transfer rates for MFX are in the range of 1.5 kbps, a 1 Mb file would take over 11 minutes to transfer. In order to minimize the monopolization of one A/G, nominal MFX utilization will be limited to execute package uplink. Payload file transfers are nominally planned for MEIDEX, SOLSE, and Astroculture. MEIDEX data is also recorded on the MEIDEX PGSC and downlinked in FREESTAR's PDI data stream. Loss of the ability to downlink MEIDEX files simply eliminates the ability of the ground to verify that the PGSC is cataloging data correctly. SOLSE data is also recorded on an experiment hard drive and on the SOLSE PGSC. Loss of the ability to downlink SOLSE files eliminates the ability of the ground to verify that the PGSC is cataloging data correctly and also prevents the ground from optimizing experiment operations based on real-time observation. Loss of the ability to downlink Astroculture files impacts the integrity of ground control group following.

6. THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE DEALLOCATED FROM S-BAND COVERAGE:

   a. EOR/F

   b. TEHM

   c. MGM

EOR/F and TeHM S-band downlink is strictly housekeeping data and is not science related; MGM data is used to validate a future operational concept and is of secondary importance to primary science.
®[DN 21]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

7. THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE RETIMELINED BASED ON PRIORITIZED SHARING OF THE SPACEHAB PDI DOWNLINK: ®[DN 21]

   a. BIOBOX

   b. BIOPACK

   c. COM2PLEX

   d. FAST/VIDEO DIGITIZER SYSTEM (VDS)

   e. MSTRS

   f. VCD-FE

   g. CM-2

   h. STARS-BOOTES

The experiment allocation within Spacehab's 32 kbps PDI data stream is 25 kbps. Each of the above experiments can individually fit within that allocation, but not all of them can fit simultaneously.

8. THE FOLLOWING SPACEHAB EXPERIMENTS DO NOT FIT WITHIN THE SPACEHAB PDI DOWNLINK, BUT WILL BE ABLE TO SAFELY CONTINUE OPERATIONS AND SCIENCE GATHERING:

   a. ARMS

   b. MOD SAMS

   c. BIOTUBE

   d. ZCG

   e. ASTROCULTURE

   f. BDS-05

The data stream for each of these experiments exceeds the 25 kbps allocation for experiments with the Spacehab PDI window. They could, however, continue to operate and gather science with significant replanning. ®[DN 21]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

9. THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE DISCONTINUED: ®[DN 21]

   STARNAV

10. ALL NOMINALLY PLANNED FREESTAR OPERATIONS WILL CONTINUE. IN ADDITION, THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE UNAFFECTED:

    a. FRESH

    b. CIBX

    c. OSTEO

    d. ERISTO

    e. MPFE

    f. APCF

    g. BRIC

    h. CMPCG

    i. CPCG-PCF

    j. CEBAS

    k. SLEEP

    l. PHAB4

FREESTAR experiments can continue to operate with no science loss. All experiment video and/or data is recorded on-board. Loss of Ku downlink only diminishes the ability of the FREESTAR POCC to verify experiment operation and make changes to optimize science. ®[DN 21]

107_2A-26 EXTENSION DAY GUIDELINES

A. FOR EXTENSION DAYS, THE SPACEHAB MODULE, MODULE EXPERIMENTS, MIDDECK EXPERIMENTS, AND FREESTAR WILL NOMINALLY BE POWERED DOWN TO THE SURVIVAL POWER CONFIGURATION DEFINED IN RULE {107_9A-3}, SURVIVAL POWER CONFIGURATION. ®[DN 81]

B. NO EXPERIMENT ACTIVITIES WHICH REQUIRE ORBITER CONSUMABLES OTHER THAN CRYO AS DEFINED IN PART A. ABOVE WILL NORMALLY BE PLANNED. SPACEHAB ACTIVATION OR INGRESS IS NOT REQUIRED FOR EXTENSION DAYS.

C. FOR EXTENSION DAYS, THE ATTITUDE WILL NOMINALLY BE –ZLV, -XVV.

Extension days would generally be required only for weather, orbiter, and/or landing site problems that would benefit from extra time before landing. To prevent further complications, the Spacehab/experiments should be maintained in a safe, ascent/entry configuration. Excursions from -ZLV, -XVV will occur for water dumps, end-of-mission thermal conditioning, or other orbiter system related reason. No payload science will be done during extension days. If Spacehab is re-ingressed and if time permits, experiments status checks will be done. ®[DN 81]

Reference Rule {A2-330}, EXTENSION DAY GROUNDRULES. ®[ED]

107_2A-27 PAYLOAD GO/NO-GO CALLS

A. SPACEHAB

THE SPACEHAB OPERATIONS DIRECTOR (SHOD) WILL PROVIDE GO/NO-GO CALLS TO THE PAYLOAD OFFICER FOR THE FOLLOWING NOMINAL MISSION EVENTS:

1. SPACEHAB SYSTEMS ACTIVATION

2. SPACEHAB ENTRY PREP

B. FREESTAR

THE HH OPERATIONS DIRECTOR WILL PROVIDE GO/NO-GO CALLS TO THE PAYLOAD OFFICER FOR THE FOLLOWING NOMINAL MISSION EVENTS:

FREESTAR ACTIVATION/DEACTIVATION ®[DN 22]

SAFETY DEFINITION AND MANAGEMENT

107_2A-41 REAL-TIME SAFETY COORDINATION

SPACEHAB: EXCEPTIONS TO RULE {A2-312}, REAL-TIME SAFETY COORDINATION, INCLUDE: ®[ED]

NONE IDENTIFIED

107_2A-42 PAYLOAD RAPID SAFING

A. THE FOLLOWING ITEMS IN THE SPACEHAB ARE CONSIDERED PENETRATION HAZARDS AND MUST BE CREW TENDED WHILE UNSTOWED AND SAFED PRIOR TO CLOSING THE SPACEHAB HATCH: ®[DN 23] ®[CR 5539A] ®[CR 5555A]

1. CM-2 WATER MIST PROPANE BOTTLES, QUANTITY TWO, INSTALLED IN EMS OR STOWED IN MESS RACK LOCATION PF04 (EMS FOAM IN PLACE AND STRAPS 8, 10, 12, AND 13 SECURED)

2. CM-2 WATER MIST EMS STOWED IN MESS RACK LOCATION PF04 WITH STRAPS 12 AND 13 SECURED OR INSTALLED IN CM-2 CHAMBER WITH GUN BOLTS ENGAGED

3. BDS-05 BIOREACTOR ENCLOSURE (BE) INSTALLED IN AC14 WITH LOCKER DOOR LATCHED CLOSED

SPACEHAB emergency procedures ensure that all penetrators are safed before the module is egressed. If time permits, a more nominal egress will be performed. Reference Rule {A2-329}, SPACEHAB DEACTIVATION/ENTRY PREP. ®[CR 5539A] ®[ED]

B. COM2PLEX, MSTRS, AND STARNAV MUST BE UNPOWERED PRIOR TO ENTRY ®[CR 5555A] ®[CR 5558]

COM2PLEX, MSTRS, and STARNAV are SPACEHAB rooftop mounted payloads that present a potential ignition source for flammable atmosphere assumed to be present in the PLB during ascent and entry. These payloads are powered from EXCP2 DC3, EXCP1 DC7, and EXCP2 DC2. Individual power control of any of these three sources is available at the EXCP in SPACEHAB. These sources can be unpowered from outside of SPACEHAB by doing any one of the following: opening PDU relay K2 via crew MCDS command (SPEC 222 - ITEM 14, DC EXCP 1/2 OFF), turning OFF the PDU EXP DC BUS switch on panel L12, turning OFF the PL PRI switch on panel R1, or if a Main Power Kill is issued. Reference: Hazard Reports COM-HR-STD-01; Cause 11, STD-MSTRS-F1; Cause 11, and STD-STARNAV-1; Cause 11, respectively. ®[CR 5555A] ®[CR 5558]

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107_2A-42 PAYLOAD RAPID SAFING (CONTINUED)

C. SPACEHAB MIDDECK PAYLOADS WILL BE CONFIGURED FOR SAFE ENTRY ®[CR 5555A]

SPACEHAB middeck payloads include BDS-05, Biopack, BRIC, CEBAS, CMPCG, OSTEO, and ancillary hardware for ZCG and HLS. Hazard Report BPK-BE-HR-0001; Cause 3 requires that the Biopack Cooler/Freezer door be closed with the handle flush and secured by Velcro, that the Biopack Incubator Tray (BIT) be fully inserted within the Incubator with both handles in parallel position, and that the Incubator access door be fully closed with handle flush and secured by Velcro. Hazard Report STD PTCU 15; Cause 2 requires that the Biopack Passive Thermal Control Units (PTCU) be stowed when not in use and during launch and landing. Hazard Report PGBX-U1; Cause 2 requires that the Biopack Glovebox be stowed in a middeck locker for launch and landing. ®[CR 5558]

D. FREESTAR: ®[CR 5555A]

1. THE CREW WILL TAKE BOTH THE HH AV PWR AND HH EXP PWR SWITCHES ON PANEL L12U TO THE OFF POSITION.

Generic Hitchhiker hazard report F-3 requires HH payloads to be unpowered during ascent/entry based on flammable atmosphere and potential ignition source concerns. The HH POCC desires to command an orderly shutdown or safing of the experiments. However, if time does not permit an orderly shutdown, FREESTAR experiments are safe for entry in any configuration. Deactivation by the crew in a rapid safing scenario will not be delayed to allow time for an orderly shutdown.

2. MEIDEX AND SOLSE DOOR ARE SAFE FOR LANDING IN ANY CONFIGURATION.®[DN 23] ®[CR 5844]

The doors are normally closed for entry, but are safe in any configuration based on structural load capability. ®[CR 5844]

GENERAL

107_2A-51 EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE

ELECTRICAL EQUIPMENT OR EXPERIMENTS, SELF-POWERED OR FACILITY-POWERED, SHALL NOT BE TRANSFERRED BETWEEN THE ORBITER AND SPACEHAB UNLESS CERTIFIED FOR USE IN BOTH LOCATIONS. THE FOLLOWING LIST OF EQUIPMENT IS CERTIFIED FOR USE IN THE SPACEHAB MODULE (BEYOND THE EQUIPMENT IDENTIFIED IN RULE {A2 -326}, EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE): ®[ED]

ELECTRICAL EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE DOCUMENTED IN PUBLISHED PROCEDURES. ®[DN 24]

This rule in support of Rule {A2-326}, EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE. Equipment may only be used in areas where it has been approved from an electromagnetic compatibility standpoint. In addition, power budgeting/planning can only be accomplished effectively if equipment movement strategy is coordinated. If exchange of equipment is documented in approved orbiter or payload flight data file procedures, the compatibility and planning assessment has been performed and the equipment may be used in either location. If it is desired to exchange equipment not listed in Rule {A2-326}, EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE, and not included in approved procedures, an assessment must be performed prior to equipment exchange to verify electromagnetic compatibility, power budgeting/planning, heat load impacts, etc. ®[DN 24] ®[ED]

107_2A-52 CONSTRAINTS ON CABLES THROUGH THE SPACEHAB HATCH AND TUNNEL

THE BPSMU IS THE ONLY DRAG-THROUGH APPROVED FOR USE IN SPACEHAB. ®[DN 25]

In support of Rule {A2-331}, CONSTRAINTS ON CABLES THROUGH THE SPACEHAB HATCH AND TUNNEL. There are no cables except the BPSMU that might need to be run through the Spacehab hatch. ®[DN 25] ®[ED]

107_2A-53 PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES

A. IN SUPPORT OF RULE {A2-105}, IN-FLIGHT MAINTENANCE (IFM), THE FOLLOWING IS A LIST OF PAYLOAD UNSCHEDULED IFM PROCEDURES WHICH HAVE BEEN PRE-MISSION COORDINATED AND REQUIRE ONLY REAL-TIME APPROVAL PRIOR TO IMPLEMENTATION. ®[ED]

1. SPACEHAB IFM'S INCLUDED IN RULE {A2-324}, SPACEHAB IN-FLIGHT MAINTENANCE (IFM) PROCEDURES. ®[ED]

2. PDI IFM TO INSTALL SPARE PDI PER RULE {107_11A-11}, PDI FAILURE MANAGEMENT.

Failure of the PDI takes out payload monitoring and science data downlinks for both Spacehab and FREESTAR, as well as the ability to downlink video via SSV. Portions of the Spacehab PDI stream can be reconfigured to its Ku-band Ch 2 data stream, but lesser availability of the Ku downlink path due to orbiter blockage make recovery of the S-Band (PDI) capability for Spacehab mandatory.

3. STANDARD SWITCH PANEL (SSP) IFM TO REGAIN PRIMARY PAYLOAD FUNCTIONS WILL BE PERFORMED, IF REQUIRED.

Spacehab, FREESTAR, and OARE require activation from the SSP. Single switch failures could prevent these payloads from being activated, strand the MEIDEX door in the open position, or inhibit LPT power. The IFM will be performed to regain these critical functions. ®[DN 52] ®[CR 5844]

4. PSP IFM TO WIRE FREESTAR TO PSP-2 PER RULE {107_11A-12}, PSP FAILURE MANAGEMENT.

A generic Hitchhiker IFM is available to work around a failure of the Payload Signal Processor (PSP). The Hitchhiker avionics are wired to PSP-1, but can be connected to PSP-2 via IFM. The IFM will be scheduled as mission priorities permit.

5. FOR FAILURE OF PL1 MDM, AN MDM REPLACEMENT IFM WILL BE CONSIDERED TO REGAIN COMMANDING FOR FREESTAR AND OARE.

The only command interface to both FREESTAR and OARE via PL1 MDM, neither has a backup command path. For failure of PL1 MDM, FREESTAR commanding could be recovered with an IFM to either replace PL1 MDM or to connect to PSP-2. The only option for OARE requires MDM replacement.

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107_2A-53 PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES (CONTINUED)

6. FOR FAILURE OF THE DIGITAL TV MUX SUCH THAT IT CANNOT BE SWITCHED BACK TO SPACEHAB PL MAX KU CH 3 DOWNLINK, THEN THE SH PL MAX DATA RECOVERY IFM WILL BE PERFORMED TO ROUTE SPACEHAB KU CH 3 DATA DIRECTLY TO THE KUSP.

SPACEHAB will lose the ability to downlink Experiment LOS playback data. Twelve SPACEHAB payloads will lose science if this data is not available. ®[CR 5540]

7. CM-2 IFM'S ®[DN 26]

   a. IFM-01 DEPP CARD CHANGEOUT

   b. IFM-02 DPP CARD CHANGEOUT

   c. IFM-03 LSP IGNITER ARM/STEPPER MOTOR ASSEMBLY CHANGEOUT

   d. IFM-04 RECONFIGURE LASER DIODE DRIVER

   e. IFM-05 REPLACE LASER DIODE ASSEMBLY

   f. IFM-06 THERMOCOUPLE (TC) RAKE CHANGEOUT

   g. IFM-07 IGNITER ELECTRODE TIP CHANGEOUT

   h. IFM-08 PDP FUSE CHANGEOUT

   i. IFM-09 MIST IGNITION TROUBLESHOOT

   j. IFM-10 REPLACE 10 BASE-T TRANSCEIVER

   k. IFM-11 MANUAL IRIS SETTING

8. EOR/F IFM-01 EOR/F TEMP DISPLAY BATTERY CHANGEOUT

9. ERISTO IFM-01 EXCHANGE ERISTO PWR CABLE

10. OSTEO IFM-01 EXCHANGE OSTEO PWR CABLE ®[DN 26] ®[CR 5540]

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107_2A-53 PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES (CONTINUED)

11. FOR FAILURE OF THE KU-BAND SIGNAL PROCESSOR TO DOWNLINK CHANNEL 2 PAYLOAD DIGITAL DATA, AN IFM WILL BE PERFORMED TO ROUTE THE SPACEHAB 2 MB EXPERIMENT DATA STREAM TO THE S-BAND FM SIGNAL PROCESSOR. ®[CR 5540]

Eight SPACEHAB experiments use the Ku Channel 2 data stream for real-time science data. ®[CR 5540]

B. IN SUPPORT OF RULE {A2-105}, IN-FLIGHT MAINTENANCE (IFM), THE FOLLOWING IS A LIST OF SPACEHAB EXPERIMENT UNSCHEDULED IFM PROCEDURES WHICH DO NOT REQUIRE REAL-TIME APPROVAL OR COORDINATION PRIOR TO IMPLEMENTATION: ®[ED]

NONE IDENTIFIED ®[DN 26]

C. NO IFM PROCEDURES WILL BE INITIATED BY THE CREW ON AN EXPERIMENT KNOWN TO REPRESENT A TOXIC HAZARD UNTIL CONCURRENCE FOR THE REPAIR PROCEDURE IS OBTAINED FROM THE MCC FLIGHT DIRECTOR. SPACEHAB EVACUATION AND/OR PROTECTIVE EQUIPMENT MAY BE REQUIRED (SEE RULE {A13-156}, SPACEHAB HAZARDOUS SUBSTANCE SPILL RESPONSE). ALL PAYLOAD EXPERIMENTS/SAMPLES CONTAINING HAZARDOUS MATERIALS ARE DEFINED IN THE FLIGHT SPECIFIC ANNEX.

A real-time assessment of the possibility of repairing an experiment and the risk of exposing the crew to a toxic substance during the repair will need to be made. The IFM may require that the cleanup equipment specified in Rule {A13-156}, SPACEHAB HAZARDOUS SUBSTANCE SPILL RESPONSE, be used to minimize risk of crew exposure to toxic substances. ®[ED]

107_2A-54 PGSC USAGE GUIDELINES

TABLE 107_2A-54-I - PGSC USAGE PLAN

PGSC	FUNCTION	ORBITER PROVIDED	SPACEHAB PROVIDED
STS1	OCA	X	
STS2	WINDECOM	X	
STS3	PROSHARE	X	
STS4	WORLDMAP	X	
PL1	MEIDEX	X	
PL2	SOLSE-2	X	
PL3	SH SUBSYSTEM, HLS PHAB-4 BAR CODE READER	X	
PL4	AST, MGM, BDS-05, & ZCG	X	
PL5	CM-2	X (WINDOWS 95 OS)	
PL6	VCD FE	X (WINDOWS 95 OS)	
HLS	HLS MPFE		X
ARMS	ARMS		X

®[DN 27]

NOTE: PGSC BACKUP OPTIONS WILL BE DOCUMENTED AS REFERENCE DATA IN THE PAYLOAD OPS CHECKLIST.

PROGRAMMATICALLY, THE TWO STOWED PGSC’S ARE DEDICATED TO MEIDEX AND SOLSE. OPERATIONALLY, THEY WILL BE USED AS REQUIRED TO SUPPORT FIRST AND SECOND PGSC FAILURES. SHOULD MEIDEX OR SOLSE PGSC’S REQUIRE BACKUP, THEY WILL BE GIVEN PRIORITY OVER OTHER USERS. ®[DN 27]

PAYLOAD CONSTRAINTS

107_2A-61 PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY

TABLE 107_2A-61-I – PAYLOAD CONTAMINATION MATRIX

CUSTOMERS WITH DUMP AND/OR PURGE CONTAMINATION CONCERNS SHOULD BE NOTIFIED OF CHANGES TO DUMP PLANS AT LEAST 90 MINUTES PRIOR TO THE EVENT, IF POSSIBLE. NOZZLE DUMP ATTITUDES MAY BE BIASED FROM THE RETROGRADE DIRECTION IF REQUIRED TO PROTECT THERMAL CONSTRAINTS. ®[DN 48]

PAYLOAD	TIMEFRAME	SUPPLY DUMPS, WASTE DUMPS, FES OPERATIONS	OMS BURN	PRCS	OMS/RCS PROPELLANT /JET LEAKS AND APU OPERATIONS	ORBITER LEAKS	FUEL CELL PURGES
SPACEHAB [4]	N/A	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
MEIDEX [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (DOOR OPEN)	NO NOZZLE DUMPS	PROHIBITED WHEN DOOR OPEN	PROHIBITED WHEN DOOR OPEN EXCEPT WHEN LANDTRACK MANEUVER REQUIRED [1]	CLOSE DOOR ASAP VIA SSP [2]	CLOSE DOOR ASAP VIA SSP [2]	INHIBITED
	NON-OPERATING (DOOR CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SOLSE [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (DOOR OPEN)	NO NOZZLE DUMPS, MINIMIZE FES OPS [3]	PROHIBITED WHEN DOOR OPEN	MINIMIZE PRCS FIRINGS WHEN DOOR OPEN [1]	CLOSE DOOR ASAP VIA PGSC [2]	CLOSE DOOR ASAP VIA PGSC [2]	INHIBITED
	NON-OPERATING (DOOR CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SOLCON [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (COVER AND SHUTTERS OPEN)	NO NOZZLE DUMPS	PROHIBITED WHEN COVER AND SHUTTERS OPEN	MINIMIZE PRCS FIRINGS WHEN COVER AND SHUTTERS OPEN [1]	CLOSE COVER OR SHUTTERS ASAP VIA GROUND COMMAND [2]	CLOSE COVER OR SHUTTERS ASAP VIA GROUND COMMAND [2]	INHIBITED
	NON-OPERATING (COVER OR SHUTTERS CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
LPT	DURING GPS NAV DATA TAKES	NO NOZZLE DUMPS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	INHIBITED
CVX	N/A	NO CONSTRAINTS	NO OMS BURNS DURING CRITICAL PERIODS	NO PRCS DURING CRITICAL PERIODS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SIMPLEX	15 MIN PREBURN THROUGH 5 MIN POST BURN	DESIRE NO NOZZLE DUMPS AND FES	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	DESIRED INHIBITED

®[DN 48] ®[DN 53] ®[CR 5846]

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107_2A-61 PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY (CONTINUED)

NOTES: ®[DN 48]

[1] IF VERNS ARE LOST, OPERATIONS MAY CONTINUE USING PRCS JETS. PRCS IS REQUIRED FOR MEIDEX LANDTRACK MANEUVERS. ®[CR 5846]

[2] MAY BE LEFT OPEN AT THE DISCRETION OF THE GSFC POCC.

[3] SOLSE HIGHLY DESIRES FES DISABLED DURING CHECKOUT AND CALIBRATION ORBITS AND DESIRES IT OFF DURING SCIENCE OPERATIONS.

[4] REFER TO RULE {107_2A-71}, ATTITUDE AND POINTING CONSTRAINTS, FOR RAM CONSTRAINTS BASED ON CONTAMINATION CONCERNS.

Nozzle dumps and OMS/PRCS operations have the potential to put contaminants in the vicinity of the payload bay, causing potential contamination of the SOLCON instrument and the SOLSE, and MEIDEX windows and potential degradation of science. These payloads have no constraints against these types of activities when the experiment doors/shutters are closed. Although SOLSE highly desires the FES inhibited, thermal analysis indicates that inhibiting FES operations will probably not be possible. SOLCON will nominally leave their cover open for the duration of the flight, closing their shutters during contamination periods. The shutters should protect the instrument adequately from standard orbiter contamination events. In the case of jet or orbiter leaks, SOLCON may choose to close their cover via ground command as additional protection against contamination.

Alt DAP attitude control is required during Landmark Track Maneuvers. MEIDEX may request a Landmark Track of significant storms are present. If so, the request will likely come near the end of the mission, when the effects of potential contamination on the window will minimize the impact to the total science gained. ®[CR 5846]

Reference Rules {107_2A-62}, DAP CONSTRAINTS and {107_2A-63}, MICROGRAVITY REQUIREMENTS, for additional constraints on attitude control and OMS burns. ®[DN 48]

107_2A-62 DAP CONSTRAINTS

PAYLOAD	TIMEFRAME	CONTROL MODE	ATTITUDE DEADBAND [1]	RATE DEADBAND
SPACEHAB	DURING COM2PLEX, STARNAV, AND MSTRS OBSERVATIONS	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
MEIDEX	DURING STATIONARY SPRITE AND EARTH OBSERVATIONS	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
	DURING MOON CALIBRATIONS	VRCS	2 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
SOLSE	LIMB OBSERVATIONS	VRCS	0.1 DEG	.02 DEG/SEC
		ALT DAP	1.5 DEG (0.7 DEG DESIRED)	.07 DEG/SEC
	POLAR SWEEP MANEUVER	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	1.5 DEG	.07 DEG/SEC
	EARTH OBSERVATIONS	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
SOLCON	SOLAR OBSERVATIONS	VRCS	0.1 DEG	.02 DEG/SEC
		ALT DAP	1 DEG (0.3 DEG DESIRED)	.07 DEG/SEC

®[DN 28]

NOTES:

[1] FOR LOSS OF VERNS DURING FREESTAR DATA TAKES, ALT DAP WILL BE SELECTED FOR THE REMAINDER OF THAT DATA TAKE. THE FREESTAR MISSION MANAGER WILL REQUEST TIGHTER DEADBANDS TO MEET PRIORITIZED PAYLOAD SCIENCE REQUIREMENTS DEPENDING ON PROP AVAILABILITY.

All FREESTAR instruments except SOLCON can acquire limited science when operating at a 3 deg attitude deadband, expecting instrument targets to occasionally pass through the instrument FOV's. The FREESTAR Mission Manager will prioritize FREESTAR payload objectives in light of available prop and mission objectives met to date. For loss of VERNS, ALT DAP attitude control is required to acquire science. In this case, a degradation of science due to contamination by PRCS jets is acceptable.

The attitude deadband during the SOLSE polar sweep may be relaxed to 1 deg in order to facilitate reaching attitude within the desired time. Upon reaching the target attitude, the deadbands should be collapsed to 0.1 deg. ®[DN 28]

107_2A-63 MICROGRAVITY CONSTRAINTS

PAYLOAD		TIMEFRAME	OMS BURN	PRCS [1]	VRCS	EXERCISE
ADVANCED PROTEIN CRYSTALLIZATION FACILITY (APCF)		ACTIVATION UNTIL DEACTIVATION	PROHIBITED WITHOUT PRIOR NOTIFICATION	PROHIBITED WITHOUT PRIOR NOTIFICATION	NO CONSTRAINT	NO CONSTRAINT
COMMERCIAL MACROMOLECULAR AND PROTEIN CRYSTAL GROWTH (CMPCG)		FIRST 10 DAYS FOLLOWING ACTIVATION	HIGHLY DESIRE PROHIBITED	HIGHLY DESIRE PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALIZATION FACILITY (CPCG-PCF)		FIRST 24 HOURS FOLLOWING INITIALIZATION	HIGHLY DESIRE PROHIBITED	HIGHLY DESIRE PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
MECHANICS OF GRANULAR MATERIALS (MGM)		ACTIVATION UNTIL DEACTIVATION FOR TEST POINTS 1-8	PROHIBITED	PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
COMBUSTION MODULE-2 (CM-2)	LAMINAR SOOT PROCESSES (LSP)	MICROGRAVITY PERIOD BEGINS 22-28 MINUTES AFTER THE START OF A RUN AND LASTS FOR 11 MINUTES	PROHIBITED	PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
	STRUCTURE OF FLAME BALLS AT LOW LEWIS NUMBERS (SOFBALL)	MICROGRAVITY PERIOD BEGINS 18 MINUTES INTO EACH RUN AND LASTS FOR VARIOUS DURATIONS (1.5 TO APPROXIMATELY 4 HRS) DEPENDING ON THE RUN.	PROHIBITED	PROHIBITED	PROHIBITED (GRAVITY GRADIENT ATTITUDE REQUIRED)	ARMS CREW EXERCISE/CYCLE ERGOMETER OPS AND ORBITER CYCLE ERGOMETER OPS PROHIBITED DURING MICROGRAVITY PERIOD.
	WATER MIST	MICROGRAVITY PERIOD BEGINS AT EXPERIMENT RUN START +23 OR 29 MINUTES (DEPENDING ON THE RUN) AND LASTS FOR 2-4 MINUTES	PROHIBITED	PROHIBITED	PROHIBITED	ARMS CREW EXERCISE/ERGOMETER OPS AND ORBITER ERGOMETER OPS PROHIBITED DURING THE MICROGRAVITY PERIOD [3]
ZEOLITE CRYSTAL GROWTH (ZCG)		FURNACE ACTIVATION UNTIL ZCG DEACTIVATION	PROHIBITED WITH ALLOWANCE FOR SIMPLEX AS NEGOTIATED WITH ZCG	PROHIBITED WITH ALLOWANCE FOR ALT DAP AS NEGOTIATED WITH ZCG	NO CONSTRAINT [1]	MINIMIZE CREW EXERCISE DURING FIRST 10 HOURS POST-FURNACE ACTIVATION.
CRITICAL VISCOSITY OF XENON-2 (CVX-2)		CRITICAL PERIODS [2]	PROHIBITED	PROHIBITED [1]	NO CONSTRAINT	AVOID SCHEDULING CONSECUTIVE EXERCISE PERIODS WHEN POSSIBLE DURING CRITICAL PHASES

®[DN 49] ®[CR 5623] ®[CR 5628A]

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107_2A-63 MICROGRAVITY CONSTRAINTS (CONTINUED)

NOTES:

[1] FOR LOSS OF VERNS, MGM, LSP, WATER MIST, ZCG AND CVX-2 WILL CONTINUE OPERATIONS USING ALT DAP. ®[DN 49]

[2] CRITICAL PERIODS OCCUR WHEN THE EXPERIMENT APPROACHES ITS CRITICAL TEMPERATURE AND WILL BE DEFINED BY THE CUSTOMER AND PROVIDED AS PART OF THE REPLAN CYCLE. THESE CRITICAL PERIODS ARE APPROXIMATELY DEFINED BY THE FOLLOWING PAYLOAD EVENT TIMES (REFERENCED FROM CVX-2 ACTIVATION): 26 TO 47 HOURS, 64 TO 115 HOURS, AND 130 TO 182 HOURS FOR A 200 HOUR TIMELINE; AND 20 TO 35 HOURS, 54 TO 73 HOURS, 129 TO 151 HOURS, 205 TO 227 HOURS, AND 281 TO 303 HOURS FOR A 308 HOUR TIMELINE.

[3] EXERCISE MAY BE SCHEDULED DURING WATER MIST RUNS, BUT THE CREWMEMBER MUST PAUSE FOR THE SHORT MICROGRAVITY PERIOD.

The gravity gradient attitude is required for SOFBALL to maintain predictable comm during the lengthy microgravity periods. Exercise in the Spacehab is prohibited during SOFBALL microgravity periods to achieve the best microgravity environment possible. Exercise in the middeck is also prohibited during SOFBALL Free Drift periods.

Most MIST tests require microgravity beginning 37 minutes into each run. However, MIST tests 12 and 22 are an exception to this rule with microgravity periods beginning 22 minutes into each run. No special attitude is required for MIST since the Free Drift period is short and comm should remain predictable. Exercise in the middeck and in Spacehab module prohibited during MIST Free Drift periods.

CVX-2 critical periods occur when the experiment approaches its critical temperature. The most critical part of CVX-2's timeline is the last 10 hours of the first pass through Tc (liquid-vapor critical point of Xenon, approx 16.7 degrees C). They will use this "fast" pass to locate Tc for the remainder of the mission. Each of the later "slow" passes through Tc requires about 80 hours, with the last 30 hours being most important. Based upon on-orbit performance, CVX will be able to more accurately define the most critical portions of the CVX timeline during flight. Actual critical period timeframes will be defined by the customer and provided as part of the replan cycle.

OMS burns and PRCS jet firings are not allowed during CVX-2 critical periods. Shuttle maneuvers using VRCS sometimes create DC accelerations that exceed the steady-state requirement of 0.24 milli-g, but they are too short-lived to cause a problem.

CVX-2 is very susceptible to impacts on the sample cell during exercise periods due to the AC accelerations reducing the measurement signal-to-noise ratio. To protect sample data against possible degradation due to crew exercise, CVX desires that during critical periods, exercise not be scheduled consecutively. This scheduling is desirable for the entire mission, yet extremely important during critical periods operations. Based upon on-orbit performance, CVX will be able to more accurately define the most critical portions of the CVX timeline during flight.

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107_2A-63 MICROGRAVITY CONSTRAINTS (CONTINUED)

CMPCG and CPCG-PCF are both sensitive to microgravity disturbances during crystal nucleation and crystal growth which can cause detrimental effects to crystal formation and the solution boundary layer as the crystals grow in solution. CMPCG consists of approximately 1008 samples that have a wide variance in the timing of nucleation and growth phases. CMPCG highly desires minimized disturbances during their entire crystal growth phase, but especially for the first 10 days of crystal growth. CPCG-PCF consists of only one sample and highly desires minimized disturbances during the first 24 hours of crystal growth which is the expected nucleation and early growth phase. ®[CR 5628A]

Reference Rule {107_2A-61} PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY, for OMS/RCS constraints driven by contamination concerns. ®[DN 49]

107_2A-64 SIMPLEX BURN REQUIREMENTS

A. FOR THE SIMPLEX TEST BURN, IT IS DESIRED THAT THE ORBITER BE IN ATTITUDE AT LEAST 1 MINUTE PRIOR TO AND 1 MINUTE AFTER THE TEST BURN. ®[DN 88]

B. SIMPLEX TEST BURN ORIENTATION IS PRIORITIZED AS FOLLOWS (HIGHEST TO LOWEST): BURNS INTO RAM, BURNS INTO WAKE, BURNS NORMAL TO THE VELOCITY VECTOR.

C. FOR TEST BURNS OBSERVED BY THE VERY LARGE ARRAY (VLA), A DUAL ENGINE OMS BURN OF AT LEAST 10 SECOND DURATION IS REQUIRED. IT IS ALSO REQUIRED THAT THE BURN OCCUR ON AN ORBIT THAT COMES WITHIN 60 DEGREES OF VLA TELESCOPE ZENITH, ALTHOUGH THE BURN MAY BE INITIATED OR COMPLETED JUST PRIOR TO ENTERING THAT 60-DEGREE CONE.

There are 30 acceptable burns in support of SIMPLEX as documented in NSTS-21327, SIMPLEX Payload Integration Plan. The requirements for each burn vary in duration of burn, direction of burn, night or day, and position relative to the ground site. There has only been one viable opportunity identified preflight to fit within the integrated requirements of the STS-107 mission timeline. That burn will be observed by the VLA site. ®[DN 88]

107_2A-71 ATTITUDE/POINTING CONSTRAINTS

A. SPACEHAB

1. COMBINED TWO-PHASE LOOP EXPERIMENT (COM2PLEX)

a. COM2PLEX REQUIRES A -ZLV (NADIR) ATTITUDE FOR 48 HOURS PER EACH OF THE THREE LOOPS FOR A TOTAL OF 144 HOURS. ANY YAW IS ACCEPTABLE. COM2PLEX CAN WITHSTAND ATTITUDE BIASES UP TO 20 DEGREES WHICH LAST NO MORE THAN 20 MINUTES. THE TIME SPENT BIASED CAN TOTAL NO MORE THAN 40 MINUTES EVERY 24-HOUR PERIOD. ®[DN 79]

b. COM2PLEX DEEP SPACE POINTING IS LIMITED TO 90 MINUTES IF UNPOWERED. AFTER 90 MINUTES, COM2PLEX REQUIRES A -ZLV (NADIR) ATTITUDE FOR 1 HOUR BEFORE REAPPLYING POWER. COM2PLEX HAS NO DEEP POINTING CONSTRAINT WHILE POWERED.

c. COM2PLEX MUST BE IN A REDUCED POWER STATE FOR SOLAR POINTING.

The COM2PLEX payload requires maintaining a similar attitude for the duration of each of the three experiment runs to reduce thermal fluctuations and maintain comparability between the runs.

2. MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

a. MSTRS REQUIRES A -ZLV (NADIR) ATTITUDE FOR EACH OPERATIONAL CYCLE EXCEPT AS NOTED IN PARAGRAPH B BELOW.

Each operations cycle consists of a 1 hour warm up period and a minimum of four continuous orbits. The MSTRS payload requires no bias in the -ZLV (NADIR) attitude to accurately geo-locate radio frequency sources on Earth. ®[DN 79]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. DURING ONE ENTIRE PHASE 2 ORBIT SET (FOUR CONTINUOUS ORBITS), MSTRS REQUIRES A 15-DEGREE BIAS FROM –ZLV (NADIR) SUCH THAT THE SHUTTLE BAY IS POINTING IN A NORTHERLY DIRECTION. THE ATTITUDE FOR THE WARM-UP PERIOD PRIOR TO THIS ORBIT SET WILL NOT BE BIASED. ®[DN 79]

c. MSTRS DEEP SPACE POINTING IS LIMITED TO 2 HOURS. AFTER 2 HOURS, MSTRS REQUIRES A –ZLV (NADIR) ATTITUDE FOR 2 HOURS TO RECOVER. DUE TO TECHNICAL CONCERNS WITH ORBITER OFF GASSING, MSTRS REQUIRES THEIR FIRST OPERATIONAL CYCLE TO OCCUR LATER THAN 16 HOURS MET. MSTRS REQUIRES A MINIMUM OF 24 HOURS BETWEEN OPERATIONAL CYCLES.

3. STAR NAVIGATION (STARNAV)

a. STARNAV REQUIRES A MINIMUM OF TWENTY OBSERVATIONS WITH THE FOV OF THE INSTRUMENT POINTED 25 DEGREES FROM THE EARTH LIMB AND 30 DEGREES FROM THE SUN. STARNAV ALSO REQUIRES A NON-INERTIAL ATTITUDE FOR EACH 30 MINUTES OBSERVATION. BACK-TO-BACK OBSERVATIONS CANNOT BE SCHEDULED.

STARNAV's field of view is defined as a cone generated by a 5.5 degree half angle projection. The total conical field of view is an 11 degree sweep centered on the bore of STARNAV's camera. ®[DN 79]

b. STARNAV MUST BE POWERED OFF DURING PASSES THROUGH THE SOUTH ATLANTIC ANOMALY (SAA). STARNAV MUST BE POWERED ON DURING MANEUVERS CAUSING THE FOV TO SWEEP THROUGH THE SUN VECTOR

STARNAV is powered off during SAA passes and powered on during solar passes to protect electronics.

c. STARNAV REQUIRES DEEP SPACE POINTING TO BE LIMITED TO 5 HOURS. AFTER 5 HOURS, STARNAV POWER MUST BE RESTORED OR THE STARNAV PAYLOAD MUST RETURN TO A -ZLV (NADIR) ATTITUDE TO RECOVER. STARNAV'S RECOVERY TIME IS EQUAL TO THE TIME SPENT DEEP SPACE POINTING WITHOUT POWER. ®[DN 79]

The STARNAV recovery time in a warm attitude is equal to the duration of time in the deep space attitude. STARNAV will be powered off when not observing.

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

d. STARNAV REQUIRES BAY-TO-SUN POINTING BE LIMITED TO 36 MINUTES WHEN POWERED ON. STARNAV HAS NO –ZSI CONSTRAINT WHEN POWERED OFF. ®[DN 79]

e. STARNAV'S FIELD OF VIEW MAY NOT SWEEP THROUGH RAM AT ANY RATE.

Sweeping through RAM may damage STARNAV's lens. ®[DN 79]

4. COMBUSTION MODULE-2 (CM-2)

CM-2 REQUIRES FREE DRIFT FOR THE SOFBALL AND MIST TESTS. SOFBALL DESIRES A GRAVITY GRADIENT ATTITUDE DURING MICROGRAVITY PERIODS. MIST FREE DRIFT PERIODS HAVE NO ATTITUDE REQUIREMENT.

Free Drift periods required for SOFBALL are significantly longer in duration than MIST's, so a Gravity Gradient attitude is desired to maintain predictable comm during that time.

B. FREESTAR

1. MEIDEX

a. DURING MEIDEX EARTH VIEWING DATA TAKES, THE ORBITER -Z AXIS MUST BE POINTED AT THE EARTH, WITH A ROLL BIAS AS NECESSARY FOR TARGET ACQUISITION OVER THE REGION OF INTEREST.

During primary data collection periods, MEIDEX requires a bay-to-earth, tail/nose forward based orientation to ensure best possible ROI coverage in relation to the instrument FOV and to enable maximum data acquisition. Optimum opportunities and flexibility for MEIDEX observations will be acquired when the orbiter trajectory passes directly over the ROI. During these observations, slight attitude biases away from Nadir may be considered in order to ensure that the designated targets remain within the MEIDEX FOV. The MEIDEX instrument can assist in target tracking by tilting ?22.5 deg in the YZ plane (resulting in a north to south scan across the groundtrack). MEIDEX desires that dedicated operations not occur within the South Atlantic Anomaly (SAA) on more than three consecutive orbits. ®[CR 5847]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. IF REQUESTED, MEIDEX LANDMARK TRACK MANEUVERS CAN BE UTILIZED TO TRACK SIGNIFICANT DUST STORMS THROUGH AN ENTIRE OVERPASS. ®[DN 79]

LTM's would likely be requested no more than once or twice during the mission, and only if significant dust activity were present. As LTM maneuvers require PRCS attitude control (which could increase potential for contamination on the MEIDEX window), MEIDEX would request the scheduling of an LTM as late as possible in the mission.

c. DURING MEIDEX LUNAR CALIBRATIONS, A LUNAR INERTIAL ATTITUDE IS REQUIRED.

There is no requirement for a specific moon orientation in respect to the MEIDEX FOV.

d. DURING MEIDEX GROUND CALIBRATIONS, MEIDEX REQUIRES A BAY-TO-EARTH, NOSE/TAIL FORWARD ORIENTATION, WITH A MAXIMUM ATTITUDE BIAS OF ?30 DEGREES FROM LOCAL NADIR OVER THE PRE-SELECTED SITE, FOR A MINIMUM OF 20–30 SECONDS. MEIDEX HIGHLY DESIRES A LANDMARK TRACK FOR A MINIMUM OF 3 MINUTES. ®[CR 5615]

e. DURING SPRITE OBSERVATIONS, MEIDEX REQUIRES A NOSE/TAIL DOWN, BELLY FORWARD ATTITUDE WITH THE ORBITER VIEWING TOWARDS THE DUSK-TERMINATOR DURING ECLIPSE FOR A MINIMUM OF 20 MINUTES (> 30 MINUTES DESIRED).

In order to maximize limb coverage, the MEIDEX canister center axis is required to point 50 km above the earth's limb.

f. WITH THE DOOR IN THE OPEN POSITION, MEIDEX REQUIRES THAT THE SUN NOT ENTER WITHIN 5 DEGREES OF THE XYBION CAMERA FOV. ®[CR 5844] ®[CR 5847]

Meidex will request that the crew close the experiment door and temporarily terminate science activities if the sun constraints are predicted to be violated. The Xybion camera FOV is 10.76 deg x 14.04 deg with the long axis in the Y direction and is centered on the –Z orbiter body axis. ®[DN 79]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

g. WITH THE DOOR IN THE OPEN POSITION, MEIDEX SHOULD NOT VIEW RAM WITHIN A ± 70 DEGREE FOV IN THE –Z AXIS. IF THE RAM PASSES THROUGH THE INSTRUMENT CENTRAL POSITION ± 70 DEGREES, THE ANGULAR RATE IS REQUIRED TO BE AT LEAST 0.2 DEGREE/SECOND. ®[CR 5844] ®[CR 5847]

Exposure to extended RAM could damage the instrument window thus degrading the optical properties necessary for valid science. MEIDEX will request that the crew close the door via SSP and temporarily terminate science if the RAM constraint is predicted to be violated. ®[DN 55] ®[CR 5844]

2. SOLSE

a. SOLSE REQUIRES A BIASED PORT WING TO EARTH, BELLY-TO-RAM ATTITUDE DURING LIMB VIEWS. ®[DN 79]

(1) DURING VISIBLE FILTER OBSERVATIONS, THE -Z AXIS IS REQUIRED TO BE POINTED AT 25 KM ABOVE THE EARTH’S SURFACE.

(2) DURING UV FILTER OBSERVATIONS, THE -Z AXIS IS REQUIRED TO BE POINTED AT 32 KM ABOVE THE EARTH’S SURFACE.

(3) SOLSE REQUIRES THAT THE OBLATENESS OF THE EARTH BE FACTORED INTO THE ORBITER POINTING AS NECESSARY.

(4) SOLSE REQUIRES THAT ORBITER POINTING BE ADJUSTED AS REQUIRED TO KEEP THE –Z AXIS WITHIN ±5 KM OF THE TARGETED ALTITUDE.

Small attitude adjustment maneuvers may be required during SOLSE limb views in order to keep the SOLSE FOV within 5 km of the Earth altitude under observation. Depending on the orbital altitude, a slight tilt of the XY plane will be required to maintain vertical resolution at the limb. SOLSE may request to change a limb view to a polar view depending upon match-up availability with ground truth sites. Although polar views are considered superior to alternative viewing options, SOLSE may request that a polar sweep maneuver be performed during a SOLSE limb view. ®[DN 79] ®[CR 5847]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. SOLSE REQUIRES A BAY-TO-EARTH, TAIL/NOSE FORWARD ATTITUDE DURING EARTH VIEWING OBSERVATIONS. ®[CR 5847]

This orientation ensures that the long axis of the SOLSE field of view is perpendicular to the ground track.

c. SOLSE REQUIRES A BIAS -YLV +XVV ATTITUDE (NORTHERN VIEWS) OR BIAS -YLV -XVV ATTITUDE (SOUTHERN VIEWS) DURING POLAR VIEWING OBSERVATIONS.

SOLSE highly desires three orbits of hbar polar view observations, two north and one south. The polar views will allow SOLSE-2 to extend the coverage for SOLSE observations to higher latitudes (simulating science that could be achieved on a higher inclination flight). All polar view operations are desired to be performed in attitude for the entire daylit portion of the orbit.

d. SOLSE REQUIRES THAT THE ORBITER –Z AXIS NOT BE POINTED WITHIN ?70 DEG OF THE RAM WHEN THE SOLSE DOOR IS OPEN. ®[CR 5844]

Viewing RAM could cause atomic oxygen contamination on the window, resulting in severely degraded data.

e. SOLSE REQUIRES THAT THE SUN REMAIN OUTSIDE OF A ?7.5 FIELD OF VIEW (FOV) FROM THE –Z AXIS WHEN THE DOOR IS OPEN. ®[DN 79] ®[CR 5844] ®[CR 5847]

Viewing the Sun may solarize contaminants on the window and degrade the optical qualities of the window.

3. SOLCON

a. DURING SOLAR VIEWING DATA TAKES, THE ORBITER -Z AXIS MUST BE POINTED AT THE SUN FOR 40 MINUTES. THE SUN MUST BE GREATER THAN 10 DEGREES ABOVE THE EARTH HORIZON FOR THE DURATION OF THE EXPERIMENT. OBSERVATIONS MAY BE SCHEDULED AS TWO CONSECUTIVE SOLAR VIEWING PAIRS.

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. SOLCON REQUIRES DEEP-SPACE VIEWING (ORBITER -Z AXIS > 15 DEGREES AWAY FROM EARTH AND > 25 DEGREES AWAY FROM THE SUN) OF AT LEAST 10 MIN IN DURATION PRIOR TO AND FOLLOWING EACH SOLAR VIEWING ORBIT.

Deep space attitude required for instrument calibration prior to and after each SOLCON data take. The deep space viewing need not occur in a fixed attitude as long as the FOV constraints are met. ®[DN 56]

c. SOLCON REQUIRES THAT THE RAM REMAIN ±10 DEGREES OUTSIDE THE INSTRUMENT CENTRAL POSITION (ORBITER –Z AXIS) WHEN THE EXPERIMENT SHUTTERS ARE OPEN. TEMPORARY VIOLATIONS ARE ACCEPTABLE IF THE RAM PASSES THROUGH THE INSTRUMENT CENTRAL POSITION AT AN ANGULAR RATE OF AT LEAST 0.2 DEGREE/SECOND.

Extended RAM exposure could damage SOLCON optics. SOLCON will close shutters and temporarily terminate science collection for predicted RAM violations.

4. CVX HAS NO ATTITUDE POINTING REQUIREMENTS FOR SCIENCE COLLECTION.

a. DURING NON-CRITICAL PERIODS, CVX SHALL NOT BE EXPOSED TO MORE THAN 60 MINUTES OF SOLAR VIEWING DURING ANY 4 HOUR PERIOD, WITH THE EXCEPTION OF SOLCON SOLAR PAIRS AS OUTLINED IN RULE {107_2A-71B}.4.B, ATTITUDE/POINTING CONSTRAINTS. ®[DN 57]

The CVX experiment must be limited to less than 60 minutes of solar viewing during any 4-hour period. If more than 60 minutes of solar viewing were to occur, CVX would potentially lose valuable experiment data. This limitation is for reasons of successful operations and is not a safety requirement. Solar viewing is defined as sustained solar flux within 60 degrees of the -Z axis. During critical periods, CVX should be able to tolerate the Sun sweeping through the payload bay (as in an LVLH attitude hold like bay to wake). CVX should also be able to tolerate sustained off-normal solar flux during critical periods as long as the Sun is greater than 60 degrees off normal (-Z axis). Flight-specific attitudes will be analyzed to ensure that thermal limits are not exceeded during critical periods.

b. DURING NON-CRITICAL PERIODS, SOLCON SOLAR PAIRS (45 MINUTES ON CONSECUTIVE ORBITS) CAN BE SCHEDULED WITH THE FOLLOWING CONSTRAINTS:

THIS RULE CONTINUED ON NEXT PAGE

107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

(1) CVX-2 REQUIRES AN ATTITUDE COLDER THAN BAY TO EARTH IN BETWEEN OBSERVATIONS.

(2) CVX-2 REQUIRES 6 HOURS OF RECOVERY TIME IN A BAY TO EARTH OR COLDER ATTITUDE FOLLOWING A SOLCON PAIR PRIOR TO ADDITIONAL SOLAR VIEWING.

c. DURING CRITICAL PERIODS, CVX SHALL NOT BE EXPOSED TO ANY -ZSI ATTITUDES.

Five critical periods occur during the 304 hours of desired CVX operations while CVX is establishing the critical temperature of Xenon. Reference the rationale in Rule {107_2A-63}, MICROGRAVITY CONSTRAINTS, for approximate timeframe of critical periods. -ZSI excursions during these periods will cause critical temperature determination excursions that exceed the experiment's ability to perform the science run. ®[DN 57]

d. EITHER OPERATING OR NON-OPERATING, CVX SHALL NOT BE EXPOSED TO –ZSI ATTITUDES THAT EXCEED 70 MINUTES IN DURATION. ®[DN 79]

CVX is impacted by more than 30 minutes of solar viewing and cannot recover from greater than 70 minutes of continuous solar viewing. ®[DN 57]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

5. LPT

   a. LPT REQUIRES SPACE VIEWING (-Z AXIS > 90 DEG FROM NADIR) DURING GPS OPERATIONS.

The GPS Navigation test requires two observations of two consecutive orbits of bay-to-space attitude.
®[DN 79]

   b. LPT REQUIRES GROUND STATION VIEWING FOR 5 MINUTES (-Z AXIS TO MILA, WLPS, OR DFRC, WITH MINIMUM LOS ELEVATION ANGLE OF 5 DEGREES FROM THE GROUND STATION) DURING GN OPERATIONS, WITH TARGET TRACKING FOR A MINIMUM OF THREE OF THE EIGHT TESTS. ®[CR 5847]

   c. LPT REQUIRES A TRACKING AND DATA RELAY SATELLITE (TDRS) TRACK ATTITUDE DURING TDRS COMMUNICATIONS TESTS FOR A TOTAL OF 6 HOURS. THE PASS MINIMUM IS 15 MINUTES.

   d. LPT REQUIRES THE ORBITER -Z AXIS TO A TDRS AND DFRC, WITH MINIMUM LOS ELEVATION ANGLE OF 5 DEGREES, DURING RANGE SAFETY OPERATIONS WHICH LAST A MINIMUM OF 2.5 MINUTES.

LPT desires acquisition of two TDRS's simultaneously during the Range Safety Tests; however, maximization of pass over DFRC is prioritized over two TDRS's. Two Range Safety tests are required.
®[CR 5847]

   e. LPT REQUIRES A TDRS TRACK ATTITUDE DURING ON-ORBIT RECONFIG TESTS. EACH OF THE TWO TESTS ARE 20 MINUTES. ®[DN 79]

107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

c. AOA/PLS: DUAL TRACKING CAPABILITY ABOVE 100K FEET IS HIGHLY DESIRABLE BUT IS NOT SCHEDULED FOR AOA AND PLS DEORBIT. ®[CR 5501]

In the event that a delta state is uplinked, it allows proper onboard verification to be performed through 100K feet (tracking not required below 100K feet).

d. FD1 PLS ONLY: AT LEAST ONE TDRS OR TWO C-BAND RADAR PASSES ARE REQUIRED TO SUPPORT PRE-DEORBIT STATE VECTOR ACCURACY.

For AOA and PLS deorbits, best effort call up of high speed tracking resources is accepted (ref. Rule {A3-102}, STDN FAILURE DECISION MATRIX). The time between launch and landing for an AOA deorbit is short enough to consider onboard navigation autonomous, and although best effort tracking call up will be requested, it is not mandatory. There is a high probability of obtaining PLS tracking support from KSC or EDW area radars on a best effort basis if the ranges are given more than 3 hours advance notice. There is little chance of obtaining such support for a Northrup Lakebed Landing Site (NOR) PLS deorbit unless the request is made during duty hours. Tracking support is virtually assured at all three CONUS sites, given 24 hours notice (ref. AEFTP #82 minutes). ®[ED]

Post MECO tracking is required for flight day 1 deorbit cases in order to ensure the onboard state vector meets deorbit burn accuracy requirements. For high inclination launches (57 deg. and 51.6 deg.), at least one TDRS is required for orbit 3 cases, because the ground tracks for orbits 1 through 3 do not permit adequate C-Band coverage (ref. Rules {A4-101}, ONBOARD NAVIGATION MAINTENANCE, and {A3-102}, STDN FAILURE DECISION MATRIX - Note [2]). ®[ED]

e. FOR COMMIT TO LAUNCH AND SCHEDULING PURPOSES, END OF MISSION (EOM) DUAL TRACKING CAPABILITY (TWO C-BANDS OR ONE S-BAND AND ONE C-BAND) FROM ABOVE 100K FT TO THE GROUND IS NOT REQUIRED. IF ANY OF THE CAPABILITIES LISTED IN PARAGRAPH B3 BELOW ARE NOT EXPECTED TO BE AVAILABLE PRIOR TO DEORBIT TIG, SCHEDULING EOM DUAL TRACKING BECOMES MANDATORY. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

5. REDUNDANCY FOR ASCENT INCLUDING INTACT ABORTS: ®[CR 5501]

    a. REDUNDANCY IN EQUIPMENT AND NETWORK SCHEDULING FOR AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING SHALL BE PLANNED AND SCHEDULED FOR LAUNCH THROUGH GO FOR ORBIT OPS OR INTACT ABORT LANDING. NOTE: FOR TDRS SCHEDULING, REDUNDANCY IS NOT REQUIRED.

    b. CONSIDERATION WILL BE GIVEN TO ATTEMPTING TO REGAIN FAILED REDUNDANT EQUIPMENT IF THE RECOVERY WILL NOT AFFECT THE REMAINING MANDATORY EQUIPMENT AND RECOVERY PROCEDURES ESTIMATED TIME OF RETURN TO OPERATION (ETRO) IS PRIOR TO THE NOMINAL PLANNED TIME FOR COMING OUT OF THE T-9 MINUTE HOLD.

    c. RECOVERY EFFORTS FOR FAILED REDUNDANT EQUIPMENT IN THE MCC AND INTEGRATED NETWORK WILL NOT BE PERFORMED BETWEEN T-9 MINUTES AND COUNTING AND MET 15 MINUTES OR LANDING FOR RTLS OR TAL.

B. DEORBIT/ENTRY

1. PRE-DEORBIT. IT IS HIGHLY DESIRABLE TO HAVE THE MAXIMUM DURATION OF COVERAGE POSSIBLE FOR AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING FROM TIG -4 HR TO DEORBIT DECISION. REDUNDANCY IS DESIRABLE BUT NOT REQUIRED.

Preparing the orbiter for entry includes a number of complex and critical steps such as moding flight software to OPS 3, closing the payload bay doors, activating Flash Evaporator System (FES) cooling. Having MCC connectivity to troubleshoot any anomalies that may occur is very useful. Additionally, MCC is prime to provide deorbit maneuver targets and to assess landing site readiness including weather. Deorbit decision time is normally TIG -23 minutes. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

2. DEORBIT DECISION. GROUND AND INTEGRATED NETWORK EQUIPMENT FUNCTIONALITY AND SCHEDULING MUST PROVIDE AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING FROM THE MCC GO FOR DEORBIT TO POST LANDING. REDUNDANCY FOR MANDATORY FUNCTIONS IS HIGHLY DESIRABLE BUT NOT REQUIRED. ®[CR 5501]

   UHF TWO-WAY VOICE IS HIGHLY DESIRABLE DURING ENTRY TO KSC OR DFRC WHEN IN RANGE OF THE GROUND STATION AS A BACKUP TO S-BAND VOICE. S-BAND VOICE IS MANDATORY AS DESCRIBED ABOVE.

Monitoring vehicle systems, energy management, anomaly resolution, and landing site evaluation from touchdown parameters to weather conditions is the primary job of the MCC during shuttle entry.

3. TRAJECTORY PROCESSING SUPPORT FOR ENTRY:

   IF ALL OF THE CAPABILITIES LISTED BELOW ARE EXPECTED TO BE AVAILABLE PRIOR TO DEORBIT TIG, C-BAND TRACKING IS NOT MANDATORY. S-BAND TRACKING IS HIGHLY DESIRABLE IN THE ABSENCE OF C-BAND TRACKING. IF DURING THE MISSION ANY OF THE FOLLOWING CAPABILITIES ARE LOST, EOM DUAL TRACKING CAPABILITY BECOMES MANDATORY FOR COMMIT TO DEORBIT:

   a. IMU’S: FULL REDUNDANCY (THREE LINE REPLACEABLE UNITS (LRU’S) AND ASSOCIATED DATA PROCESSING SYSTEM (DPS) AND ELECTRICAL POWER SYSTEM (EPS) FUNCTIONALITY).

   b. ONBOARD TACAN: FULL REDUNDANCY (THREE LRU’S AND ASSOCIATED DPS AND EPS FUNCTIONALITY). ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

c. ONBOARD MICROWAVE LANDING SYSTEM (MLS): FULL REDUNDANCY (THREE LRU'S AND ASSOCIATED DPS AND EPS FUNCTIONALITY) REQUIRED IF MLS IS REQUIRED FOR LANDING (REF RULE {A3-202}, MLS). ®[CR 5501] ®[ED]

d. GROUND TACAN STATIONS: TWO STATIONS AVAILABLE AND CONFIRMED OPERATIONAL WITHIN SPECIFICATIONS (REF RULE {A8-52B}.2, SENSOR FAILURES). FEDERAL AVIATION AGENCY (FAA)/USAF SPECIFICATIONS ARE NOT ADEQUATE (REF NSTS 07700, VOL X, BOOK 3, PARAGRAPH 1.3.1.1.1).

In order to maximize launch probability by alleviating C-Band tracking data scheduling conflicts with the Eastern Range Operations Control Center (ROCC), the mandatory requirement for scheduling dual source high speed tracking for EOM is eliminated, provided that sufficient redundancy is available (TACAN and IMU) to correct the navigation state prior to violation of entry guidance limits. If sufficient redundancy is lost during the mission, dual source high-speed tracking becomes mandatory for commit to deorbit. The TSU trajectory processor Kalman filter cannot meet ground accuracy requirements with only one source of tracking data. The filter requires at least two sources. The 100K-feet altitude constraint was chosen to allow sufficient time to assess the vehicle energy conditions and to update onboard navigation state (after nominal TACAN acquisition) in order to correct a violation of delta state limits. This requirement also allows time to GCA to within guidance limits prior to TAEM.

With three functioning IMU's and the associated DPS/EPS equipment, the first failure is fully protected by redundancy management. When two IMU's are available, 95 percent of the cases involving the second failure are properly resolved by the IMU RM which uses the IMU BITE logic.

With three functioning onboard TACAN transceivers and their associated DPS equipment, the first failure is fully protected by redundancy management. When two TACAN's are available, 90 percent of the cases involving the second failure are covered with TACAN self-test.

With three functioning onboard MLS transceivers and their associated DPS equipment, the first failure is fully protected by redundancy management. When two MLS's are available, a dilemma between the LRU's will remain unresolved unless a BITE had been previously set against one of the LRU's. If the dilemma is unresolved, MLS may not process at all (for range/azimuth dilemmas) or only partially process (for elevation dilemmas). For days when MLS is required as defined in Rule {A3-202}, MLS, ground tracking is required to resolve dilemmas in order to make the MLS usable. Reference Rule {A8-18A}, LANDING SYSTEMS REQUIREMENTS. ®[CR 5501] ®[ED]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

To ensure that valid TACAN data are available, both primary and secondary ground stations must be confirmed to be within programmatically required limits (NASA operational requirements of 1 degree and 0.3 mile per Rule {A8-52B}.2, SENSOR FAILURES, rather than FAA/Department of Defense (DOD) certification (2.5 degrees and 0.5 mile per NSTS 07700, Vol X specification). With the pre-deorbit ground station checks, full single fault tolerance exists. If both the primary and the secondary ground stations were to fail after deorbit, the MCC can uplink another TACAN station. ®[CR 5501] ®[ED]

Any failure in either the onboard IMU's, TACAN's, MLS's, or TACAN ground stations which results in loss of single fault tolerance for entry will require that high speed tracking be provided for EOM.

S-band data is highly desired because it may provide insight in the case of a TACAN bias, although it cannot by itself be used as a source of "ground truth."

In relaxing the tracking data requirement from mandatory to highly desirable, it is understood and acknowledged to be an acceptable risk to rely totally on TACAN as required to achieve a safe landing. If the normal ceiling limit exists, and TACAN data is not processed by navigation, and no independent valid tracking data are present, the vehicle is unlikely to achieve the runway.

4. POST LANDING. GROUND EQUIPMENT WILL PROVIDE FOR AIR-TO-GROUND VOICE, COMMAND, AND TELEMETRY FROM LANDING UNTIL VEHICLE HANDOVER TO GROUND OPERATIONS MANAGER (GOM). REDUNDANCY IS NOT REQUIRED. ®[CR 5501]

107_3A-4 INTEGRATED NETWORK FAILURE DECISION MATRIX

ASCENT AND INTACT ABORT LANDINGS AT KSC							
SITE	STATION ID	TYPE	RQMNT	ASCENT/RTLS		TAL	KSC AOA & 1ST DAY PLS
				28.5 INC	HIGHER INC		
JONATHAN DICKINSON MISSILE TRACKING ANNEX (JDMTA)	JDIS	S-BD	TLM D/L VOICE	1 OF 2 M	1 OF 2 M		
PONCE DE LEON	PDL	S-BD 14	CMD U/L VOICE	1 OF 2 HD [1]	1 OF 2 M [2]		
	FIXED DIPOLE	UHF	VOICE				
MILA	MILS	S-BD 30-1	CMD TLM VOICE	1 OF 2 M	1 OF 2 M		1 OF 2 HD
	MLXS	S-BD 30-2					
	TELTRAC	UHF	VOICE	1 OF 2 M	1 OF 2 M		1 OF 2 HD
	QUAD HELIX						
TDRSS	WSC	S-BD	CMD TLM VOICE	M [3]	M [3]	M	M [5], [6]
			TRK	HD	HD		M [5]
WALLOPS	WLPS	S-BD 30	CMD TLM VOICE		HD		
	QUAD HELIX	UHF	VOICE		1 OF 1 HD		
MERRITT ISLAND	MLAC MLMC	FPQ-14 MCB-17	RADAR TRK	2 OF 6 HD	2 OF 6 HD		NOT SCHEDULED ACCEPT BEST EFFORT CALLUP
PATRICK	PATC	FPQ-14	RADAR TRK				
CANAVERAL	CNVC CMTC	FPS-16 MOTR	RADAR TRK				
MILA	MILS OR MLXS	S-BD	RANGING TRK				
WALLOPS	WLPC WLRC WLIC	FPQ-6 FPS-16 FPS-16	RADAR TRK		2 OF 3 HD [4]		

®[CR 5501]

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107_3A-6 TRAJECTORY SERVER FAILURES

A. A TRAJECTORY SERVER IS CONSIDERED FAILED FOR ANY OF THE FOLLOWING CONDITIONS: ®[CR 5545]

1. ERRORS IN ONE OR BOTH COMPUTERS THAT AFFECT REQUIRED PROCESSING LISTED IN RULE {A3-51}, TRAJECTORY PROCESSING REQUIREMENTS ®[ED]

2. ERRORS WITH SECONDARY INDICATIONS OF COMPUTER PROBLEMS (SUCH AS ERRORS OF DIFFERENT TYPES, EXCESSIVE CPU USAGE, CORRUPTED TELEMETRY OR TRAJECTORY PROCESSING, ETC.)

Errors can occur in the prime and backup trajectory server with no impact to processing. If one or more errors occur, and do not affect required processing, the computer is not considered failed.

B. IF THE PRIME TRAJECTORY SERVER IS CONSIDERED FAILED, AND A BACKUP TRAJECTORY SERVER IS AVAILABLE, A SELECTOVER WILL BE PERFORMED. ®[CR 5635]

Two redundant trajectory servers will be maintained at all times during this flight to assure availability of trajectory processing.

The third trajectory server will also be configured to the mission activity for all critical phases as a "static standby" and during all other mission phases where not required by another activity.

C. TRAJECTORY SERVER COMMIT TO LAUNCH AND REDUNDANCY REQUIREMENTS ARE DEFINED IN RULE {107_3A-3}, GROUND AND NETWORK DETAILED REQUIREMENTS AND RULE {107_3A-5}, CRITICAL LAUNCH SYSTEMS RECOVERY TIMES. ®[CR 5545]

Three Trajectory Servers will be supporting launch. If the prime and backup Trajectory Servers suffer unrecoverable failures, only the third Trajectory Server remains available for flight use. However, this system will not be a "hot backup," and thus some level of configuration of the third Trajectory Server to flight-ready status is required. ®[CR 5545]

Per Rule {A3-51}, TRAJECTORY PROCESSING REQUIREMENTS, launch will be No-Go until an ARD is reconfigured for launch since required processing would otherwise be unavailable. ®[ED] ®[CR 5635]

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SECTION 4 - TRAJECTORY AND GUIDANCE

PRELAUNCH/ASCENT/ENTRY

107_4A-1 TRAJECTORY AND GUIDANCE PARAMETERS

FLIGHT SPECIFIC TRAJECTORY AND GUIDANCE PARAMETERS AS THEY RELATE TO THE ALL FLIGHTS RULES ARE LISTED IN THE FOLLOWING TABLE:

RULE REFERENCE	PARAMETER	VALUE
ALL	NOMINAL THROTTLE	104%
ALL	ABORT THROTTLE	104%
ALL	MAX THROTTLE	109%
ALL	THRUST BUCKET	104/72%
{A4-55}	DELTA V ABOVE AFT PRESS QTY	100.9 FPS
{A4-1A}	2 SIGMA + MEAN INFLT FPR	2058 LBS
{A4-1B}	3 SIGMA + MEAN INFLT FPR	3047 LBS
{A2-52}, {A4-55}	MINIMUM HP	85 NM
{A4-55}	DESIGN MECO UNDERSPEED	240 FPS
{A4-55}	CRITICAL MECO UNDERSPEED	1EO 474 FPS 2EO 450 FPS
{A4-57A}	NOMINAL	40 FPS
{A2-205B}	UNDISPERSED CROSSRANGE: ASCENDING/LEFT ASCENDING/RIGHT DESCENDING/LEFT DESCENDING/RIGHT	 835 NM N/A 840 NM N/A
{A4-107A}	DISPERSED CROSSRANGE: ASCENDING/LEFT ASCENDING/RIGHT DESCENDING/LEFT DESCENDING/RIGHT	 770 NM N/A 781 NM N/A NM
{A4-159}	CONT PAYLOAD RETURN AFTER ORBIT 3	N/A

®[CR 5535] ®[ED]

* ALL RIGHT TURN APPROACHES TO CONUS SITES ARE WITHIN CROSSRANGE CAPABILITY.

107_4A-2 PAYLOAD ALTITUDE REQUIREMENTS ®[CR 5541]

A. SPACEHAB HAS NO UNIQUE ALTITUDE REQUIREMENTS. SPACEHAB EXPERIMENT MSTRS DESIRES AS CLOSE AS POSSIBLE TO THE NOMINALLY PLANNED ALTITUDE OF 150 NM.

MSTRS preplanning has involved coordination and scheduling of numerous cooperative ground sites. Altitudes lower that 150 nm translate to smaller antenna fields of view and thereby decrease time available for signal acquisition and processing. In addition, some ground sites will not be available at a lower altitude. A lower altitude will result in a need to reschedule cooperative ground sites, and could possibly result in loss of availability of some sites, with resultant science losses. ®[DN 91]

B. FREESTAR HAS NO UNIQUE ALTITUDE REQUIREMENTS. FREESTAR ORBITAL REQUIREMENTS ARE AS FOLLOWS:

1. IN AN ABORT TO ORBIT SCENARIO, FREESTAR PREFERS INCREASED INCLINATION OVER INCREASED ALTITUDE.

2. SOLSE-2 REQUIRES A NEAR CIRCULAR ORBIT ®[CR 5541]

SOLSE-2 highly desires to be operated at the highest inclination possible to increase in-flight correlation opportunities with ground-truth measurements.

ORBIT GENERAL

107_4A-11 ORBITAL MANEUVER CRITICALITY AND DEFINITIONS

A. ALL STS-107 ORBIT MANEUVERS ARE CLASSIFIED AS “CRITICAL” OR “NONCRITICAL” AS FOLLOWS:

<table>
<tr><th>MANEUVER</th><th>CLASSIFICATION</th><th>VGO TRIMS (FPS)</th></tr>
<tr><td>OMS-1</td><td>CRITICAL FOR CREW SAFETY (IF REQUIRED)</td><td>|EACH VGO| < 2</td></tr>
<tr><td>OMS-2</td><td>CRITICAL FOR CREW SAFETY</td><td>|EACH VGO| < 2</td></tr>
<tr><td>SIMPLEX</td><td>NONCRITICAL</td><td>|EACH VGO| < 2</td></tr>
<tr><td>ORBIT ADJUST (OA)</td><td>NONCRITICAL</td><td>|EACH VGO| < 0.2</td></tr>
<tr><td>DEORBIT</td><td>CRITICAL FOR CREW SAFETY</td><td>|VGOX/Z| < 2; DO NOT TRIM VGOY</td></tr>
</table>

Maneuvers listed are not necessarily in time order of execution.

OMS-1 (if required), OMS-2 and deorbit are always considered critical to the crew’s safety because they may entail atmospheric reentry if TIG is delayed or an underburn is performed.

Simplex and Orbit Adjust are considered noncritical in the sense that they may be slipped at least one orbit, or deleted, without impact to crew safety or mission success.

B. CHANGES TO THE PREFLIGHT PLANNED MANEUVER SEQUENCE WILL BE COORDINATED WITH THE PAYLOAD CUSTOMERS AS FOLLOWS:

THE SPACEHAB CUSTOMER, THE GSFC POCC, AND DOD REP WILL BE NOTIFIED DAILY OF CHANGES TO THE PREFLIGHT BURN PLAN WITH ESTIMATES OF THE MAGNITUDE OF EACH BURN. IN THE EVENT OF ANY UNSCHEDULED BURN, THEY WILL BE NOTIFIED AS SOON AS POSSIBLE.

The burn plan information is required to plan experiment operations which are affected by OMS/RCS contamination or accelerations environments. Some doors/covers may need to be closed for certain burns. In the event of any unscheduled burn, such as a collision avoidance burn, at least 15 minutes are required to compute and prepare the burn PAD. The payloads can use this time to perform commanding to minimize the impact to science.

107_4A-12 EOM ORBIT ADJUST BURNS

A. IF PROPELLANT IS AVAILABLE, ORBIT ADJUSTS MAY BE PERFORMED TO INCREASE THE NUMBER OF DEORBIT OPPORTUNITIES AVAILABLE. IF AN ELLIPTIC ORBIT IS TARGETED FOLLOWING THE ADJUST, STEEP DEORBIT CAPABILITY SHALL BE RETAINED TO SATISFY RULE {A4-103A}.3, OFF-NOMINAL ORBITAL ALTITUDE RECOVERY PRIORITIES. ®[ED]

B. THE ORBIT ADJUST PLAN WILL ATTEMPT TO ACHIEVE THE FOLLOWING COMBINATIONS OF LANDING OPPORTUNITIES STATED IN ORDER OF DECREASING PRIORITY. ONLY OPPORTUNITIES WHICH SATISFY THE CREW DAY CONSTRAINTS (REF RULE {A4-107A}.7, PLS/EOM LANDING OPPORTUNITY REQUIREMENTS), WILL BE CONSIDERED (7 HRS < AWAKE TIME BEFORE LANDING < 16 HRS). AN ORBIT ADJUST PLAN WHICH WOULD RESULT IN LOSS OF OPPORTUNITIES AT A HIGHER PRIORITY THAN THOSE GAINED WILL NOT BE PERFORMED EVEN IF DAYLIGHT OPPORTUNITIES ARE PROVIDED BY THE PLAN. ®[ED]

PRIORITY	SITE	EOM	EOM + 1	EOM + 2
1	KSC EDW	1 1	1 1	1 1
2	KSC	2		
3	KSC		2	
4	EDW		2	
5	EDW			2
6	KSC			2

SECTION 7 - DATA SYSTEMS

GENERAL

107_7A-1 CONSTRAINTS ON PORT MODING OR I/O RESETS

THERE ARE NO PAYLOAD CONSTRAINTS ON PAYLOAD MDM PORT MODING OR SM I/O RESETS.

Both port moding and I/O resets are transparent to the STS-107 payload complement.

107_7A-2 ORBITER DATA PROCESSING SYSTEM

FOR FAILURE OF THE SM GPC INTERFACE TO EITHER PAYLOAD DATA BUS RESULTING IN SELECTION OF ONLY A SINGLE PF MDM AT A TIME, SELECTION OF PF1 IS PREFERRED OVER PF2 FOR ALL PAYLOAD OPERATIONS.

The PF1 MDM provides GPC control over the Ku-band antenna, as well as communications with FREESTAR via PSP 1. FREESTAR utilizes PSP 1 only for command throughput and is not wired to PSP 2. Ku-band operations provide command path to Spacehab, downlink of Spacehab high rate data, and video and OCA files downlink for both Spacehab and FREESTAR..

107_7A-3 LOSS OF ORBITER MASTER TIMING UNIT (MTU)/PAYLOAD TIMING BUFFER

A. SHOULD THE MTU FAIL, ALL PSP COMMANDING WOULD BE LOST, IN ADDITION TO TIME SIGNALS PROVIDED TO THE PAYLOADS VIA THE PAYLOAD TIMING BUFFER (PTB).

All PSP commanding is lost when the MTU fails. Reference Rule {107_11A-1}, PAYLOAD GROUND COMMANDING, for impacts and workarounds for the loss of PSP commanding. ®[DN 75]

B. THE FOLLOWING EXPERIMENTS ARE IMPACTED BY LOSS OF TIMING SIGNAL:

1. SPACEHAB – LOSS OF GREENWICH MEAN TIME (GMT) IMPACTS MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS). LOSS OF BOTH GMT AND MISSION ELAPSED TIME (MET) IMPACTS STAR NAVIGATION (STARNAV).

The MTU supplies GMT and MET to various downstream users, including payloads via the PTB. The MSTRS Spacehab payload receives GMT directly from the PTB from the GMT IRIG-B converter and cannot use MET. Therefore, if the GMT IRIG-B converter fails, MSTRS will not have timetag information and results in loss of nearly all science objectives. The Spacehab Experiment Data System (EDS) uses GMT or MET from the PTB to generate and provide NTP for Spacehab experiments, including Space Accelerometer System (SAMS)-FF, CM-2, STARS BOOTES, and STARNAV. If both GMT and MET signals are lost, then the EDS uses its internal time, which may drift. This could result in science loss for STARNAV since accurate timing signals are required for its attitude determination algorithm. As long as GMT or MET is available from the PTB, STARNAV will not suffer any science loss. SAMS-FF, CM-2, and STARS-BOOTES science will not be impacted by loss of both GMT and MET, but post-flight analysis may be more difficult.

2. FREESTAR – LOSS OF MASTER TIMING UNIT (MTU) RESULTS IN LOSS OF TIME TAG INFORMATION TO FREESTAR SUBSYSTEM PDI DATA

Orbiter MET supplied by the MTU to the PTB is provided to FREESTAR.

3. OARE

This rule is in support of Rule {A2-335}, LOSS OF ORBITER MASTER TIMING UNIT (MTU)/PAYLOAD TIMING BUFFER. ®[DN 75] ®[ED]

SECTION 8 - GUIDANCE, NAVIGATION, CONTROL (GNC)

GENERAL

107_8A-1 GPS DTO 700-14 OPERATIONS GUIDELINES

THE FOLLOWING OPERATIONAL TEST OBJECTIVES SPECIFIED IN DTO 700-14 (SINGLE STRING GLOBAL POSITIONING SYSTEM) WILL BE PERFORMED IN THE SPECIFIED MAJOR MODES:

A. GPS SELF-TEST (GNC OPS 801)

B. GPS SHORT AND LONG POWER CYCLES (GNC OPS 201)

C. GPS POWER CYCLE (GNC OPS 201, GNC OPS 301)

D. GPS FILTER RESTART (GNC OPS 201, GNC OPS 301)

107_8A-2 RESERVED ®[DN 46]

107_8A-3 DEU EQUIVALENT MANEUVER COMMANDING DURING CREW SLEEP

(REFERENCE RULES {A2-111}, DPS COMMAND CRITERIA AND {A7-108}, DEU EQUIVALENT CRITERIA.) ®[ED]

A. IF A CRITICAL MANEUVER IS REQUIRED, IT IS DESIRABLE TO LOAD AS A FUTURE MANEUVER. WHEN THIS IS NOT POSSIBLE, CREW ALERT SPC’S WILL BE USED AS REQUIRED TO ENSURE CREW WAKEUP TO PROTECT FOR AN UNEXPECTED LOSS OF COMM.

A “critical maneuver” is defined as any maneuver that is required to prevent the orbiter, payload or crew constraint from being violated. In these circumstances, a future maneuver may be used to help ensure that the violation does not occur. If it is not possible to load the future maneuver because of other intermediate maneuvers, a stored programmed command (SPC) may be used to wake the crew if an unexpected loss of communications occurs. Potential violations include such things as orbiter thermal constraints, excessive propellant usage, uncomfortable cabin temperature changes, and payload experiment objective/constraint violations. When this situation exists, “safe” bailout attitudes and DAP’s will be provided to the crew prior to crew sleep.

B. ALL NON-STANDARD MANEUVER STARTS AND STOPS WILL BE SCHEDULED DURING AOS.

In order to provide MCC monitoring, all non-standard maneuvers will be scheduled to start and stop during AOS. This will allow the MCC to monitor for any unusual and unexpected behavior such as DAP shelf pulsing and vernier jet on-time violations. Non-standard maneuvers are those that have required a flight-specific analysis (i.e., unusual attitude or rate deadbands and rotation rates, orbiter/HST attached ops, loaded RMS ops, orbiter/Mir docked ops, etc.).

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SECTION 9 - ELECTRICAL

GENERAL

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SECTION 9 - ELECTRICAL

GENERAL

107_9A-1 ORBITER PAYLOAD BAY FLOODLIGHT CONSTRAINTS

A. FREESTAR

1. ALL PAYLOAD BAY FLOODLIGHTS AND EXTERNAL LIGHT SOURCES ARE REQUIRED TO BE OFF DURING DEDICATED OBSERVATIONS AND CALIBRATIONS FOR MEIDEX.

2. ALL PAYLOAD BAY FLOODLIGHTS AND EXTERNAL LIGHT SOURCES ARE REQUIRED TO BE OFF DURING SCIENCE OBSERVATIONS FOR SOLSE

Camera D with illuminator ring will be utilized during SOLSE door opening/closing over orbit eclipse in order to view the functioning of the door. Illuminator ring will be turned off following door opening.
®[CR 5844]

3. ALL PAYLOAD BAY FLOODLIGHTS AND EXTERNAL LIGHT SOURCES WITHIN 45 DEGREES OF THE CENTRAL VIEWING AXIS OF SOLCON (PARALLEL TO –Z AXIS OUT OF THE PLB) ARE REQUIRED TO BE OFF DURING EXPERIMENT OPERATIONS.

B. SPACEHAB HAS NO PAYLOAD BAY FLOODLIGHT CONSTRAINTS.

C. ATTITUDE DEPENDENT OPERATION OF THE PAYLOAD BAY LIGHTS IS LIMITED TO THE FOLLOWING CONSTRAINTS:

ORBITER ATTITUDE	FWD PORT AND STBD LIGHTS 1 AND 2	MID PORT AND STBD LIGHTS 3 AND 4	AFT PORT LIGHT 5 AFT STBD LIGHT 6
BAY TO EARTH/ TAIL TO EARTH/ BOTTOM TO EARTH	NO CONSTRAINT	OFF AT ALL TIMES	NO CONSTRAINT
BAY TO SUN/ SOLAR INERTIAL	ON 75 MINS FOLLOWED BY AT LEAST 45 MINS OFF	OFF AT ALL TIMES	ON 150 MINS FOLLOWED BY AT LEAST 45 MINS OFF

The attitude dependent payload bay flood light (PBFL) operational constraints are based on PLBFL system thermal limitations.

107_9A-2 ON-ORBIT PAYLOAD BUS POWER LEVEL MANAGEMENT

THE PRIMARY PAYLOAD POWER SOURCES TO THE ORBITER PLB FOR STS-107 WILL BE MANAGED AS FOLLOWS:

A. PRIMARY PAYLOAD MNC AND FC3 – NOMINAL POWER LEVELS ABOVE 8 KW CONTINUOUS ARE PERMISSIBLE PROVIDED INDIVIDUAL FUEL CELL POWER CONSTRAINTS ARE NOT VIOLATED AND ADEQUATE BUS VOLTAGES ARE MAINTAINED.

B. PRIMARY PAYLOAD MNB - 7 KW CONTINUOUS, AND PEAK

For STS-107 the nominal on orbit power configuration for the primary payload bus is the MNC bus feed. During nominal on-orbit operation main B will be tied to MNC so that fuel cells 2 and 3 will share the load on the primary PL bus. The MNC and FC3 feeder constraints are based upon FC power limitations. It has always been the philosophy to feed the payloads from orbiter buses rather than directly from the FC, when possible. If it becomes necessary the FC3 feed can be used and has the same power constraints as the orbiter MNC bus feed.

The maximum continuous payload bus power level planned for STS-107 is slightly over 8 kW. For STS-107 a power analysis was done. Results showed that adequate bus voltages will be maintained for the planned maximum continuous payload power level provided the fuel cells are performing at curve 16 or better. The Fuel Cell performance requirement is documented in the Flight Requirements Document. The power exceedance is documented in ICD-2-19001.

Per Rule {A9-51}, FC POWER LEVEL CONSTRAINTS, the fuel cells may be nominally operated from 2 to 10 kW continuously and between 10 and 12 kW for not more than 15 minutes every 3 hours. In the nominal bus tied configuration the planned loads should not violate the individual fuel cell power constraints. If, however, it becomes necessary, the Payload power would be managed to maintain the individual fuel cells within their power level constraints. ®[ED]

Per Rule {A9-109}, PRIMARY PAYLOAD BUS MANAGEMENT, the MNB feeder is constrained to 7 kW continuous and peak. This constraint is based on bus configuration not on a fuel cell power limitation. Therefore, if the MNC or FC3 to primary PL bus connections become unavailable then primary payload bus power thru the MNB connection must be managed to maintain the power level less than 7 kW continuous and peak.

Reference: Rules {A9-109}, PRIMARY PAYLOAD BUS MANAGEMENT, {A9-51}, FC POWER LEVEL CONSTRAINTS, and {A9-352}, SPACEHAB MAIN BUS MANAGEMENT, ICD –2-19001, STS 107 FRD.
®[ED]

107_9A-3 SURVIVAL POWER CONFIGURATION

A. SPACEHAB

1. FOR THE SPACEHAB MODULE, THE MINIMUM POWER LEVEL REQUIRED IS 1699 WATTS (W) AVERAGE POWER, 1837 W (MAXIMUM CONTINUOUS POWER) AND 1921 W (PEAK POWER). ®[DN 77] ®[CR 5703]

2. FOR THE SPACEHAB MIDDECK EXPERIMENTS, THE MINIMUM POWER LEVEL REQUIRED IS 384 W (AVERAGE AND MAXIMUM CONTINUOUS POWER) AND 388 W (PEAK POWER).

The survival power level is the minimum power level required to preserve science and is used for the entry configuration. Power requirements for all Spacehab experiments nominally powered for entry are included in this minimum power level since these experiments require continuous power. This minimum power level may also be used for an orbiter problem, requiring reduced total power levels. The following Spacehab module experiments are powered during entry: CIBX, STARS-BOOTES, EOR/F, TEHM, APCF, Biobox, BDS-05, AST-10/1, CPCG-PCF, and FRESH-2. The following Spacehab middeck payloads are powered during entry: CEBAS, CMPCG, and Biopack.

B. FOR FREESTAR, THE MINIMUM POWER CONFIGURATION REQUIRES 480 W (MAXIMUM CONTINUOUS POWER). ®[CR 5848]

This value corresponds with 11.5 kwhr for 24 hours of operations and assumes power for the FREESTAR avionics and heaters. The applicable heater duty cycle from table 4-1 should be applied for deviations from a bay-to-earth attitude when determining extension day power requirements. If additional power is available for science, the maximum power required is 17.86 kwhr. ®[DN 77] ®[CR 5848]

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SECTION 10 – MECHANICAL

GENERAL

107_10A-1 AUXILIARY POWER UNIT (APU) LEAKS

IF AN APU MUST BE STARTED DUE TO AN ACTUAL OR SUSPECTED FUEL LEAK, FREESTAR PAYLOADS (MEIDEX, SOLSE AND SOLCON) WILL CLOSE THEIR EXTERNAL COVERS PER {107_2A-61}, CONTAMINATION CONSTRAINTS SUMMARY. APU START WILL NOT BE DELAYED TO PERFORM THIS ACTION.

An APU that develops an actual or suspected leak on orbit will be started and run to depletion per Rule {A10-27B}, APU FUEL LEAKS [CIL]. Payload contamination due to APU exhaust is a concern. However, delaying APU start in order to close covers will increase the amount of Hydrazine in the aft compartment, increasing the risk of fire during entry. ®[ED]

107_10A-2 HYDRAULIC CIRCULATION PUMP OPERATION CONSTRAINTS

THERE ARE NO CONSTRAINTS TO HYDRAULIC CIRC PUMP STARTUPS ON A MAIN BUS THAT POWERS THE PRIMARY PAYLOAD BUS DURING ORBIT OPERATIONS. PLANNED OPERATION OF THE PUMPS WILL BE COORDINATED WITH THE SPACEHAB SHOD.

The voltage ripple caused by the startup of a hydraulic circ pump is not a concern for the payloads on this flight. Pump operation causes a substantial disturbance to the microgravity environment needed for Spacehab science. Coordination ensures postflight data reduction can identify disturbances attributed to circ pump operations. Prior approval to run a circ pump is not required.

107_10A-3 KU-BAND ANTENNA STOW REQUIREMENTS

A. FOR LOSS OF REDUNDANT KU-BAND ANTENNA STOW CAPABILITY, THE DEPLOYED ASSEMBLY WILL BE STOWED AS SOON AS PRACTICAL AFTER SPACEHAB AND FREESTAR PAYLOAD OPERATIONS ARE COMPLETE BUT NO LATER THAN THE BEGINNING OF THE DAY PRIOR TO ENTRY.

This rule is a flight specific scenario allowed by Rule {A10-301}, ANTENNA STOW REQUIREMENT [CIL]. The Ku-band subsystem is mandatory for Spacehab and FREESTAR payloads. Therefore, stowing the deployed assembly (consisting of the antenna dish, gimbal motors, and deployed electronics) immediately after deployment actuator stow redundancy has been lost would be costly in terms of mission success. However, in order to minimize the potential of a second failure that would require a deployed assembly jettison, and in order to allow sufficient time to respond to any contingency that may arise during the stow operation (including the need for an EVA), the deployed assembly shall be stowed at least 1 day prior to deorbit. The antenna dish can be positioned manually during an EVA if a gimbal motor or gimbal motor drive fails, in order to permit locking the gimbals for entry. However, the deployed assembly cannot be manually repositioned to within the GO FOR PLBD CLOSURE envelope in the event of a dual motor deployment actuator failure. ®[ED]

B. FOR LOSS OF TEMPERATURE CONTROL OR TEMPERATURE MONITORING CAPABILITY, THE KU-BAND ANTENNA WILL BE STOWED AS SOON AS PRACTICAL AFTER SPACEHAB AND FREESTAR PAYLOAD OPERATIONS ARE COMPLETE BUT NO LATER THAN THE BEGINNING OF THE DAY PRIOR TO ENTRY.

This rule is a flight specific scenario allowed by Rule {A10-301}, ANTENNA STOW REQUIREMENT [CIL]. Precise antenna positioning capability is required to lock the gimbals and properly stow the Ku-band antenna. When the temperature of the antenna gyro mechanism, signal feed, or the alpha or beta gimbal angle cannot be maintained within SODB limits, the capability to obtain correct stow angles may be lost. The Ku-band antenna deployed assembly gimbals must be locked for entry, or jettison is inevitable. Therefore, when the Ku-band antenna temperature control or monitoring capability is lost, the Ku-band systems should be deactivated and the antenna stowed as a precaution following Spacehab and FREESTAR operations. ®[ED]

107_10A-4 FILLED CWC STOWAGE MANAGEMENT

A. THE NUMBER OF FILLED CONTINGENCY WATER CONTAINERS (CWC'S) IN THE ORBITER WILL NOT EXCEED THE NUMBER OF CERTIFIED STOWAGE LOCATIONS AVAILABLE FOR LANDING. THE MAXIMUM NUMBER OF FILLED CWC'S THAT MAY BE RETURNED IN THE ORBITER IS FOUR.

Preflight planned stowage has been reviewed and the number of certified stowage locations is limited to this amount. The available CWC stowage locations are two in Volume F, and one each in volumes G and H.

B. REFERENCE RULE {A18-606}, RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT, FOR CONSTRAINTS ON CWC STOWAGE IN THE SPACEHAB. ®[ED]

CWC's may be stowed in Spacehab per Rule {A18-606}, RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT, if orbiter certified stowage locations are not available. ®[ED]

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SECTION 11 - COMMUNICATIONS

GENERAL

FAILURE MANAGEMENT

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SECTION 11 - COMMUNICATIONS

GENERAL

107_11A-1 PAYLOAD GROUND COMMANDING

A. ALL PAYLOAD COMMANDING WILL BE COORDINATED WITH HOUSTON FLIGHT THROUGH HOUSTON PAYLOADS OR INCO PER RULE {A2-313}, GROUND COMMANDING. ®[DN 76] ®[ED]

B. NOMINALLY, POCC COMMANDING IS SINGLE STAGE, PAYLOAD THROUGHPUT COMMANDING TO THE PAYLOAD THROUGHPUT COMMAND (PTC) BUFFER AND WILL BE MANAGED SO THAT MULTIPLE POCC'S ARE ENABLED SIMULTANEOUSLY. IF THE NEED FOR POCC TWO-STAGE COMMANDING ARISES, POCC AND MCC COMMANDING TO THE SM GENERAL PURPOSE COMPUTER (GPC) TWO-STAGE BUFFER WILL BE MANAGED SO THAT BOTH ARE ENABLED SIMULTANEOUSLY. SIMULTANEOUS (SIMO) COMMANDING THROUGHOUT EACH TDRS PASS IS APPROVED UNDER THE FOLLOWING CONDITIONS: ®[DN 70]

1. ALL POCC HAZARDOUS COMMANDING WILL BE COORDINATED WITH HOUSTON PAYLOADS PRIOR TO COMMAND INITIATION. THERE ARE NO POCC HAZARDOUS COMMANDS DEFINED FOR STS-107.

2. THE COMMANDING PARTY IS RESPONSIBLE FOR DETECTING AND RETRANSMITTING ANY LOST COMMANDS.

3. POCC COMMANDING WILL NOT BE PLANNED TO OCCUR DURING CRITICAL ORBITER COMMANDING.

4. LARGE COMMAND BLOCKS (MCC OR POCC), WILL BE COORDINATED.

SIMO commanding is possible, with the risk that contention over the PTC buffer by POCC commanding or the two-stage buffer by POCC or MCC or two-stage commands. The ground command server will normally reject commands that do not have adequate spacing, but sometimes command spacing may result in the systems management (SM) GPC rejecting one of the commands. Either the POCC or the MCC INCO can detect lost commands and retransmit them. This method of commanding is less desirable than a more structured method where contention over the PTC buffer or two-stage buffer is procedurally avoided. Due to safety considerations, hazardous commands must always be coordinated. To avoid loss of critical orbiter commands, POCC commanding will be planned around these critical commands. Since large blocks of commands require more command system time, more care must be used to avoid contention and loss of these types of commands; therefore, large command blocks will still require coordination. ®[DN 70]

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107_11A-1 PAYLOAD GROUND COMMANDING (CONTINUED)

C. REMOTE POCC LOCATIONS

1. SPACEHAB COMMANDING VIA THE MCC REMOTE POCC INTERFACE SHALL ORIGINATE FROM THE JSC POCC.

2. FREESTAR COMMANDING VIA THE MCC REMOTE POCC INTERFACE SHALL ORIGINATE FROM THE GSFC POCC. LPT COMMANDING VIA GN STATIONS INTERFACE SHALL ORIGINATE FROM THE GSFC POCC OR LPT BACKUP POCC AT GSFC. ®[CR 5849]

SOLCON and CVX will also command via Remote POCC's in Belgium and at Glenn Research Center, respectively. SOLCON and CVX commands originating from the Remote POCC's will be transmitted to the GSFC POCC and forwarded to JSC via standard HH command lines. In case of GSFC POCC evacuation, FREESTAR will relocate to a backup POCC. The backup POCC is operationally similar in architecture to the SOLCON and CVX remote POCC's. Commands from the backup POCC will be transmitted to the primary GSFC POCC and forwarded to JSC via standard HH command lines. The backup FREESTAR POCC relies upon the front-end processor in the primary POCC remaining configured and functional at time of evacuation. In the case of a POCC evacuation, LPT will command to the GN stations from a separate backup facility located at GSFC. ®[DN 59] ®[CR 5849]

D. SPACEHAB COMMAND REQUIREMENTS

1. SPACEHAB REQUIRES PAYLOAD SIGNAL PROCESSOR (PSP) COMMANDING FOR SPACEHAB ACTIVATION/DEACTIVATION AND FOR THE FOLLOWING PAYLOADS: ®[DN 76]

   a. BIOBOX

   b. BIOPACK

   c. COM2PLEX

   d. MGM

   e. MSTRS

2. FOR THE LOSS OF PSP COMMANDING, KU CHANNEL 1 FORWARD LINK COMMANDING MAY BE USED AS A BACKUP FOR EXPERIMENT COMMANDING DEPENDING ON AVAILABILITY.

Spacehab commanding via the PSP is the only command path for several SH subsystems and is the primary command path for the Biobox, Biopack, COM2PLEX, MGM, and MSTRS experiments. The backup command path for these experiments is via the Ku-band system. ®[DN 76]

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107_11A-1 PAYLOAD GROUND COMMANDING (CONTINUED)

E. FREESTAR COMMAND REQUIREMENTS

1. GROUND COMMANDS FROM THE FREESTAR POCC WILL BE USED TO CONDUCT THE MAJORITY OF FREESTAR EXPERIMENT OPERATIONS. IN ADDITION, CREWMEMBERS COMMAND THE MEIDEX AND SOLSE INSTRUMENTS.

Most FREESTAR experiment operations are controlled by ground command. Onboard activation and deactivation, MEIDEX door operations, MEIDEX commanding (primary mode), LPT power enable and SOLSE activation, deactivation, command and control are performed by the crew. All SOLSE commanding will be performed via PGSC command.

2. FREESTAR REQUIRES PAYLOAD COMMANDING DURING THE FOLLOWING PERIODS:

   a. FOR 30 MINUTES IMMEDIATELY FOLLOWING ACTIVATION

   b. FOR AT LEAST 10 MINUTES IN APPROXIMATELY EACH 90 MINUTE INTERVAL THROUGHOUT THE MISSION, AND FOR AT LEAST 15 MINUTES IN APPROXIMATELY EACH 3 HOUR INTERVAL DURING ORBITER SAFETY-CRITICAL OPERATIONS.

   c. MAXIMUM AVAILABLE COMMANDING DURING ALL DEDICATED MEIDEX, CVX, SOLCON, AND LPT OPERATING PERIODS

   d. FOR 15 MINUTES NO SOONER THAN 30 MINUTES BEFORE EACH EXPERIMENT OBSERVATION.

   e. SIXTY MINUTES FOR MEIDEX EXPERIMENT CHECKOUT AS SOON AS POSSIBLE FOLLOWING HITCHHIKER ACTIVATION

The primary means for MEIDEX commanding during dedicated observations is via PGSC command (commanding can alternately be performed from the ground if crew support is unavailable).

   f. 60 MINUTES FOR CVX OPERATIONS IMMEDIATELY FOLLOWING HITCHHIKER ACTIVATION AND IMMEDIATELY PRIOR TO HH DEACTIVATION

   g. 10 MINUTES FOR SOLCON CHECKOUTS PRIOR TO AND FOLLOWING EACH OBSERVATION (WITHIN 60 MINUTES OF OBSERVATION)

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107_11A-1 PAYLOAD GROUND COMMANDING (CONTINUED)

h. NEAR-CONTINUOUS PSP BEGINNING FIFTEEN MINUTES PRIOR TO DEDICATED LPT OPERATIONS AND CONTINUING THROUGHOUT OPERATIONS

LPT highly desires maximum available PSP throughout the mission in order to accomplish supplemental flight objectives. Payload commanding and telemetry during GN and TDRS tests will be primarily performed via direct communications between LPT and Ground Stations (MILA, WLPS or DFRC) through TDRSS. Primary command during GPS tests and backup command and telemetry capability during GN and TDRS tests will be provided via the HH avionics (use of direct to ground communications is required to achieve full experiment success).

i. FOR 20 MINUTES PRIOR TO DEACTIVATION

FREESTAR may request additional periodic commanding to maintain experiment health and to support measurements of opportunity on a non-interference basis.

3. FOR LOSS OF COMMAND CAPABILITY TO THE HH PAYLOAD, THE HH PAYLOAD WILL REMAIN ACTIVATED, THE MEIDEX AND SOLSE OPERATIONS WILL BE COMMANDED BY THE CREW VIA THE PGSC, AND THE LPT OPERATIONS WILL BE COMMANDED VIA GROUND STATIONS.

The HH heaters and payload instruments must remain powered on in order to prevent hardware damage. Payload survival heaters and HH avionics/heaters are sensor controlled. In the event that the thermal environment is not compatible with the HH configuration, the POCC may request that the HH payload be powered down prior to the nominal powerdown. There are no safety concerns with leaving the HH payload powered up. HH telemetry maybe monitored at the HH POCC to ensure that the HH payload instruments will not be damaged. Note that PSP-1 is the only ground command path to the HH avionics. ®[DN 76]

LPT can accomplish a limited set of its nominal operations via direct commanding from ground stations or via the TDRS network. With loss of PSP, MEIDEX can accomplish their flight objectives via PGSC command/control. SOLSE is controlled entirely through the PGSC interface and does not utilize PSP commanding. SOLSE, MEIDEX, and LPT operations can continue as long as their power relays have been activated via HH carrier PSP command prior to MTU failure. For loss of command, CVX-2 operations will continue. CVX-2 is programmed with a default timeline which requires approximately 200 hours to complete. The optimum CVX mission plan requires extension of this timeline to 304 hours. Alteration of the default timeline will require commanding during the first 4 days of the mission. Should CVX lose the ability to command during this period, the instrument will perform the initial part of the 304-hour timeline and then revert back to the default timeline, with probable loss of all remaining science. Should CVX lose commanding after the first 4 days of the mission, the instrument will execute the programmed 304-hour timeline. ®[DN 76] ®[CR 5849]

107_11A-2 PAYLOAD TELEMETRY

A. SPACEHAB TFL REQUIREMENTS – A TFL SUPPORTING 32 KBPS TELEMETRY IS REQUIRED FROM SPACEHAB ACTIVATION TO DEACTIVATION EXCEPT WHEN ORBITER HDR GNC IS REQUIRED. ®[DN 4]

PDI data is nominally used for SPACEHAB systems, Biobox, Biopack, CM-2, COM2PLEX, EOR/F, HLS TEHM, MGM, and MSTRS. ®[CR 5554]

B. FREESTAR TFL REQUIREMENTS

1. A TFL SUPPORTING FREESTAR 8 KBPS TELEMETRY IS REQUIRED FROM FREESTAR ACTIVATION TO DEACTIVATION.

The 8 kbps data stream is required to monitor FREESTAR health and status. ®[CR 5542]

2. IF A TFL IS REQUIRED THAT DOES NOT SUPPORT FREESTAR TELEMETRY DUE TO ORBITER SAFETY CRITICAL OPERATIONS OR HIGHER PRIORITY PAYLOAD OPERATIONS, PDI DATA IS REQUIRED AT LEAST 15 MINUTES IN EACH 3-HOUR INTERVAL.

FREESTAR will negotiate waiving the telemetry requirement during brief periods of other high-priority payload operations.

3. FOR UNPLANNED LOSS OF ALL EIGHT KBPS DATA, FREESTAR WILL REMAIN ACTIVATED AND SCIENCE OPERATIONS MAY CONTINUE AT THE DISCRETION OF THE FREESTAR POCC.

FREESTAR needs to keep the HH avionics heaters and the FREESTAR experiment heaters on to prevent hardware damage. FREESTAR and HH avionics heaters are sensor controlled and affixed to the hardware mounting plates. There are no safety concerns with leaving FREESTAR powered without insight into payload health and status. Based on the discretion of the FREESTAR POCC, science operations may continue as long as the last available housekeeping telemetry indicated FREESTAR was functioning nominally. With total loss of eight kbps data, MEIDEX, SOLSE, SOLCON, and LPT will be able to continue operations through crew PGSC interaction (MEIDEX and SOLSE), on-board recording (SOLCON and CVX), and ground station interfaces (LPT). SOLCON will be able to continue operations as data will be recorded within the instrument Mass Memory Unit (MMU). CVX has the internal capability to record all data. Insight to viscometry data and unique phenomena will be lost. ®[DN 4] ®[DN 60] ®[CR 5850]

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107_11A-2 PAYLOAD TELEMETRY (CONTINUED)

C. ORBITER TFL REQUIREMENTS BEYOND THOSE COVERED IN RULE {A2-129}, ORBITER ON-ORBIT HIGH DATA RATE REQUIREMENTS.
®[DN 87] ®[ED]

1. TFL 161 IS PREFERRED FOR FCS CHECKOUT

Rule {A2-129}, ORBITER ON-ORBIT HIGH DATA RATE REQUIREMENTS, documents the mandatory requirement for high rate OI data in support of FCS checkout. Several STS-107 telemetry configurations supply high rate OI data, but do not supply the full set of desired parameters for evaluation of the APU hydraulic systems. ®[ED]

2. HIGH RATE GNC DATA IS REQUIRED DURING THE RCS HOTFIRE TEST.

3. HIGH RATE GNC DATA IS REQUIRED IN SUPPORT OF GPS ON-ORBIT OPERATIONS.

Reference section 3.7 of NSTS-16725 FTSOD.

4. HIGH RATE GNC DATA IS HIGHLY DESIRED JUST PRIOR TO EACH IMU ALIGN.

High rate GNC data is highly desired to capture star data used for the IMU align.

5. HIGH RATE OI DATA IS DESIRED AT ALL TIMES FOR INCREASED ABILITY TO DIAGNOSE ELECTRICAL SHORTS.

Orbiter bus current sensor data is downlinked at a higher sample rate in high rate OI data. The higher rate increases the statistical probability of capturing bus shorts when they occur. ®[DN 87]

107_11A-3 KU-BAND REQUIREMENTS AND CONSTRAINTS

A. KU-BAND CONSTRAINTS

1. ALL PAYLOADS WILL BE PROTECTED BY THE STANDARD BETA 21+ MASK MODE OF OPERATIONS

2. NEITHER SPACEHAB NOR FREESTAR HAVE ANY OTHER CONSTRAINTS AGAINST OPERATIONS OF THE KU-BAND SYSTEM.

The KU-band comm system will be managed to preclude the direct radiation of LPT at greater than 70 volts/meter. The standard beta 21 + mask mode does not violate LPT constraints.

B. PAYLOAD REQUIREMENTS FOR KU COMMUNICATIONS

1. SPACEHAB:

a. KU 128 KBPS FORWARD LINK COMMANDING TO THE RDM EXPERIMENT DATA SYSTEM AND EXPERIMENTS. ®[CR 5554]

Ku 128 kbps forward link commanding is the primary command path for the Experiment Data System, the Video Digitizer System (VDS) and CM-2, FAST, MSTRS, SAMS FF, STARS-Bootes, STARNAV, and ZCG. The backup command path for these experiments is via PSP commanding. ®[CR 5624]

b. CHANNEL 1 FOR DOWNLINK VOICE, ORBITER SYSTEMS DATA AND SPACEHAB SYSTEMS DATA VIA THE PDI.

c. CHANNEL 2 FOR SPACEHAB SYSTEMS DATA, SPACEHAB EXPERIMENT DATA, AND PAYLOAD RECORDER DUMPS OF OARE DATA

Channel 2 data is utilized by the SH VDS and by ARMS, CM-2, FAST, SAMS FF, STARNAV, STARS-Bootes, VCD, and ZCG. The VDS has no unique data requirements, but is used in support of experiments. ®[CR 5624]

d. CHANNEL 3 FOR VIDEO DOWNLINK AND SPACEHAB LOS RECORDER DUMPS

e. CHANNEL 2 OR 3 FOR OCA DOWNLINK OF ASTROCULTURE FILES ®[CR 5554]

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107_11A-3 <u>KU-BAND REQUIREMENTS AND CONSTRAINTS (CONTINUED)</u>

2. FREESTAR:

   a. CHANNEL 3 FOR VIDEO DOWNLINK OF MEIDEX OBSERVATIONS AND INITIAL DOOR OPENINGS FOR MEIDEX AND SOLSE.

   b. CHANNEL 2 OR 3 FOR OCA DOWNLINK OF MEIDEX AND SOLSE DATA FILES

MEIDEX requires the downlink of payload provided video in real-time or near real-time during dedicated operations and desires maximized opportunities for payload video downlink during all secondary operations. Both MEIDEX and SOLSE require downlink of data files via the OCA interface.

There are also standard orbiter requirements for the Ku-band. (e.g., Execute Package, mail syncs, videoconferencing, file transfers, etc.). OCA is nominally planned to occur on Channel 3. To the extent possible, Ops Recorder dumps will occur on either Ku Channel 2 via TDRS-Z or S-band FM via ground stations, so as to be non-interference with payload utilization of the Ku assets. ®[CR 5554]

107_11A-4 CCTV REQUIREMENTS

A. MCC-H WILL REQUEST PERMISSION FROM THE CREW BEFORE DOWNLINK OF ANY VIDEO WHICH MAY INCLUDE IMAGES OF THE CREW. ®[DN 3]

MCC-H is responsible for ensuring that the downlinked video of crewmembers is controlled and maintains a level of privacy for the crew.

B. DOWNLINK OF VIDEO WITH SUPERFICIAL IMAGES OF THE CREW IS PERMITTED WITHOUT SPECIFIC CREW AUTHORIZATION.

Downlinks involving a superficial view of a small portion of a crewmember, such as the view of a crewmember's hands inside a glove box or other experimental apparatus, are not expected to require any crew permission.

C. SPACEHAB EXPERIMENT OPERATIONS REQUIRE USE OF THE ORBITER CCTV SYSTEM AS FOLLOWS:

Refer to Annex 2 Part II for specific scheduling requirements. ®[CR 5554]

1. BDS-05 DESIRES REAL-TIME VIDEO DOWNLINK OF TISSUES IN THEIR BIOREACTOR. IF VIDEO DOWNLINK OF BDS-05 IS NOT POSSIBLE, VIDEO PLAYBACK WITHIN 24 HOURS IS ACCEPTABLE.

BDS-05 uses the shared camcorder.

2. BIOTUBE REQUIRES REAL-TIME VIDEO DOWNLINK BEGINNING 20 HOURS AFTER BIOTUBE ACTIVATION. A 3-MINUTE VIDEO DOWNLINK IS REQUIRED EVERY 2 HOURS UNTIL BIOTUBE TERMINATION.

Biotube uses an internal camera.

3. CM-2

   a. LSP REQUIRES VIDEO FOR EACH PRE-TEST VERIFICATION AND EACH TEST SEQUENCE. ®[CR 5625C]

   b. SOFBALL REQUIRES VIDEO FOR THE FIRST TEST RUN.

   c. MIST REQUIRES VIDEO FOR EACH RUN.

CM-2 uses an internal camera. Since CM-2 SOFBALL operations have been nominally scheduled to be crew tended, real-time video downlink is not required other than on the first run. ®[CR 5554] ®[CR 5625C]

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107_11A-4 CCTV REQUIREMENTS (CONTINUED)

4. FAST REQUIRES REAL-TIME VIDEO DOWNLINK FOR ACTIVATION, DEACTIVATION, EXPERIMENT SEQUENCES, AND INJECTIONS. ®[CR 5554]

FAST uses an internal camera.

5. MGM REQUIRES REAL-TIME VIDEO DOWNLINK COVERAGE OF EXPERIMENT ACTIVATION. DOWNLINK OF VIDEO OR PHOTO TAKEN DURING DEACTIVATION IS DESIRED PRIOR TO THE NEXT MGM RUN.

MGM uses the shared camcorder. A video or still image during deactivation is desired to eliminate the need for a reform. However, if an image is not available, there is no impact to science since a reform is already scheduled as a part of each deactivation.

6. STARS-BOOTES REQUIRES REAL-TIME VIDEO DOWNLINK TWICE DAILY, TWO 2-HOUR SESSIONS OF VIDEO DOWNLINK OF THE CRYSTAL GROWTH EXPERIMENT, AND TWO 2-HOUR SESSIONS OF VIDEO DOWNLINK OF THE SILKWORM EXPERIMENT.

STAR-BOOTES uses an internal camera.

7. ZCG REQUIRES REAL-TIME VIDEO DOWNLINK DURING ZCG CLEAR AUTOCLAVE OPS WHILE THE CREWMEMBER IS MIXING THE CLEAR AUTOCLAVES. ®[DN 31]

ZCG uses the Shared Camcorder. ®[CR 5554]

D. FREESTAR EXPERIMENT OPERATIONS REQUIRE USE OF THE ORBITER CCTV SYSTEM AS FOLLOWS: ®[DN 3]

1. ORBITER CCTV MONITORING IS REQUIRED FOR THE FIRST CANISTER DOOR OPENINGS FOR MEIDEX AND SOLSE. VIDEO VERIFICATION IS ALSO REQUIRED OF DOOR POSITIONS AFTER FINAL CLOSINGS BUT PRIOR TO FREESTAR DEACTIVATION. ®[CR 5625C]

Video of each experiment will be an additional confirmation that the instruments are intact and functioning properly.

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107_11A-4 CCTV REQUIREMENTS (CONTINUED)

2. IF GROUND INSIGHT INTO DOOR POSITION IS LOST, MEIDEX REQUIRES CCTV OR CREW VERIFICATION OF DOOR POSITION PRIOR TO AND IMMEDIATELY FOLLOWING ALL OBSERVATIONS.

Position of the MEIDEX door is nominally indicated through ground and PGSC. If ground insight into door position is lost, MEIDEX requires confirmation of door position. If the door is not full open prior to a data take, data may not be obtained during the observation. If door is not full closed after an observation, MEIDEX contamination constraints may be inadvertently violated, resulting in instrument damage. This requirement is to ensure mission success, maximum science acquisition, and reflight hardware integrity.

3. MEIDEX CCTV REQUIREMENTS

OBSERVATION	REAL-TIME DOWNLINK [1]	PLAYBACK DOWNLINK [2]	DSR-20 RECORDING (XYBION)	V10 RECORDING (SEKAI)
STARTUP/CHECKOUT	N/A	N/A	DESIRED	DESIRED
PRIMARY DATA TAKES (FIRST 140 MIN OF ROI), CALIBRATION, AND COORDINATED SCIENCE	REQUIRED	REQUIRED [3]	REQUIRED	HIGHLY DESIRED
SECONDARY DATA TAKES (ADDITIONAL ROI)	REQUIRED	DESIRED [3]	HIGHLY DESIRED	HIGHLY DESIRED
SPRITE VIEWS	REQUIRED	DESIRED [3]	REQUIRED	REQUIRED
SLANT VISIBILITY	N/A	N/A	N/A	N/A

®[CR 5625C]

NOTES:

[1] MEIDEX REQUIRES MAXIMUM AVAILABLE REAL-TIME DOWNLINK. MEIDEX VIDEO DOWNLINKED IN REAL TIME CAN BE EITHER ANALOG SEKAI, ANALOG XYBION, OR DIGITAL XYBION. SSV IS REQUIRED FOR ALL MEIDEX OBSERVATION FOR WHICH REAL-TIME DOWNLINK IS NOT ALLOCATED.

[2] PLAYBACK DOWNLINKS ARE ALWAYS DIGITAL XYBION. PLAYBACKS ARE ONLY CONSIDERED FOR VIDEO FOR WHICH NO REAL-TIME DOWNLINK WAS SCHEDULED.

[3] WITHIN 6 HOURS OF DATA COLLECTION OR PRIOR TO COMPLETION OF THE NEXT REPLANNING CYCLE, WHICHEVER COMES FIRST.

Real-time downlink during MEIDEX operations will allow the PI to verify the configuration of the two cameras during data collection and optimize settings for the best possible science. The playback of the images from the Xybion cameras will allow the POCC to adjust the systems for the next planned operation.

MEIDEX Xybion video is recorded on internal video tape recorders but this video is not available during the flight. In cabin recording serves as a backup data set. The Sekai camera is not recorded internally. Its recording is highly desired in order to provide additional post-flight reference. The Sekai video will not nominally be played back during flight. Minimum acceptable SSV downlink rate is 17.6 kbps. ®[CR 5625C]

107_11A-5 LPT AND S-BAND PM MANAGEMENT

A. THE ORBITER S-BAND PM SYSTEM SHALL NOMINALLY BE OPERATED USING LOW FREQUENCY TO PREVENT INTERFERENCE WITH LPT SCIENCE OBJECTIVES. ®[CR 5512A]

The LPT payload operates with ground stations and TDRSS on the same frequency pair as the orbiter S-Band PM system high frequency pair (2106.4 MHz receive and 2287.5 MHz transmit). If the orbiter was operated at the same frequency as LPT, it might interfere with LPT data collection. Although the orbiter uses right hand polar circularization and LPT uses left hand polar circularization, there is the possibility that S-band PM transmissions from the orbiter may cause interference. It is not expected that the orbiter forward link will interfere with LPT since the signal strength from TDRS is much lower than the signal transmitted from the orbiter.

B. FOR A FAILURE OF THE ORBITER S-BAND PM SYSTEM LOW FREQUENCY, THE ORBITER S-BAND PM SYSTEM WILL BE MANAGED TO PREVENT INTERFERENCE WITH LPT DURING SCIENCE DATA TAKES WHEN ORBITER AND PAYLOAD PRIORITIES PERMIT. THE LPT CUSTOMER MAY ELECT TO PERFORM SCIENCE DATA TAKES EVEN IF THE ORBITER S-BAND SYSTEM IS NOT CONFIGURED TO PREVENT INTERFERENCE.

If the orbiter cannot use low frequency and the orbiter S-band return link can be given up temporarily based on orbiter and payload priorities and Ku-band availability, the S-band power amplifier will be turned off as required during LPT science data takes to preclude interference. If the MCC has the capability to command communications equipment, the MCC will command the S-Band PM power amp to off if it is predicted that the orbiter upper S-Band PM antennas will be active during LPT operations. For a GCIL failure such that the MCC can no longer configure orbiter communications equipment, the crew can power off the S-band power amplifier via switch. The orbiter Ku-Band may serve as the downlink path for the orbiter operational data, if it is in view of TDRS. If it is predicted that the orbiter lower S-band PM antennas will be active during LPT operations, no orbiter S-band PM system configuration is required since interference is not expected.

If the full-up orbiter S-band PM system is required due to higher priority orbiter or payload requirements, the power amp will not be turned off. In this case, the LPT customer may elect to perform science data takes and accept the possibility of interference rather than lose a science collection opportunity. ®[CR 5512A]

C. LPT SHALL BE INHIBITED VIA THE SSP DURING EVA'S AND ORBITER SAFETY CRITICAL OPERATIONS.

The majority of LPT operations are controlled from the POCC directly through the ground stations or TDRS to LPT. The inhibit switch on the Standard Switch Panel will be used to ensure that the LPT does not interfere with EVA operations or orbiter safety critical operations

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107_11A-5 LPT AND S-BAND PM MANAGEMENT (CONTINUED)

D. LPT SHALL BE INHIBITED FROM TRANSMITTING VIA GROUND COMMAND DURING MSTRS OPERATIONS AND DURING PERIODS WHEN LPT SCIENCE DATA IS NOT REQUIRED AND THE ORBITER S-BAND PM SYSTEM HIGH FREQUENCY IS REQUIRED.

The inhibit switch on the Standard Switch Panel removes power from the LPT experiment and prevents both transmitting and receiving. The POCC has the capability to inhibit LPT transmissions alone via ground command. During MSTRS operations and during periods when LPT science data is not required and the orbiter S-Band PM system low frequency is failed, LPT will be inhibited from transmitting via ground command in order to continue receiving data. This configuration will allow LPT to continue GPS operations and validation in a receive only mode.

107_11A-6 AIR TO GROUND (A/G) COMM MANAGEMENT

ALL SPACEHAB A/G COMMUNICATIONS WILL BE CONDUCTED WITHIN THE GUIDELINES OF RULE {A-321}, SPACEHAB AIR-TO-GROUND (A/G) USAGE, WITH THE FOLLOWING FLIGHT SPECIFIC EXCEPTION: ®[ED]

NONE IDENTIFIED

FAILURE MANAGEMENT

107_11A-11 PDI FAILURE MANAGEMENT

FOR A LOSS OF THE PDI, A PDI IFM WILL BE REQUIRED TO INSTALL THE SPARE PDI.

Spacehab and FREESTAR have requirements for PDI telemetry to their respective POCC's. Without the PDI telemetry, primary mission science objectives will be compromised. Some data recording/storage capability exists for certain experiments; however, the overall science complement would be severely impacted without PDI telemetry.

Spacehab systems use the PDI as their only data source with the exception of MDM parameters. The Spacehab Biobox, Biopack, CM-2, COM2PLEX, EOR/F, TEHM, MGM, and MSTRS payloads use the PDI as their primary data source but can also use Ku channel 2 as backup. ®[DN 78]

FREESTAR primary data source is via the PDI stream. CVX and SOLCON downlink data is lost without PDI service. Real-time insight into MEIDEX operations is lost without PDI service, although MEIDEX data can be downlinked from the MEIDEX PGSC following observations. Although LPT data via the HH interface will be lost without PDI, LPT operations can continue when SN and/or GN resources are available for data downlink. ®[DN 61]

Reference Rule {107_2A-53}, PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES.

107_11A-12 PSP FAILURE MANAGEMENT

IN CASE OF A PSP-1 FAILURE, AN IFM WILL BE PERFORMED TO WIRE FREESTAR TO PSP-2 AS SOON AS PRACTICAL.

FREESTAR is wired only to PSP-1. If system failures cause a swap to PSP-2 (PSP-1 failed or otherwise unusable), FREESTAR payloads would be severely impacted with no way to command to the experiment from the HH POCC.

A preflight approved IFM has been developed to wire FREESTAR to PSP-2 by accessing the patch cabling at the Payload Station Distribution Panel (PSDP) and routing PSP-2 command output ports to the HH command input. Limited commanding is available to the payload via the PGSC if PSP functionality is not recovered.

Reference Rule {107_2A-53C}, PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES).

107_11A-13 RESERVED ®[DN 5]

SECTION 15 - EXTRAVEHICULAR ACTIVITY (EVA)

GENERAL

107_15A-1 EVA HAZARD MANAGEMENT

THE FOLLOWING TABLE DOCUMENTS KNOWN HAZARDS TO EVA CREW PRESENTED BY STS-107 PAYLOADS. THE CONTROLS FOR EACH OF THESE HAZARDS MUST BE IN PLACE PRIOR TO AND THROUGHOUT ANY STS-107 EVA.

PAYLOAD	HAZARD TYPE	DETAILS/CONTROLS
FREESTAR	CREW CONTACT	A KEEPOUT ZONE WILL BE IMPLEMENTED TO PREVENT INADVERTENT CONTACT WITH THE FREESTAR PAYLOAD [1]
MEIDEX	CREW CONTACT	THE MEIDEX DOOR WILL BE CLOSED AND POWER REMOVED DURING EVA'S TO AVOID INADVERTENT DOOR MOTION AND CREW CONTACT.
SOLSE	CREW CONTACT	THE SOLSE DOOR WILL BE CLOSED AND POWER REMOVED DURING EVA'S TO AVOID INADVERTENT DOOR MOTION AND CREW CONTACT.
SOLCON	CREW CONTACT	THE SOLCON COVER WILL BE CLOSED DURING EVA TO AVOID INADVERTENT COVER MOTION AND CREW CONTACT.
LPT	RF/EMI	THE LPT POWER AND TRANSMITTER IS DISABLED WITH THREE INHIBITS (2 SSP INHIBITS, 1 GROUND COMMAND).
COM2PLEX	MOLTEN METAL	PAYLOAD POWER WILL BE REMOVED PRIOR TO EVA TO ELIMINATE THE POTENTIAL OF MOLTEN METAL RESULTING FROM CREW KICK LOADS APPLIED TO POWERED CABLES (REF. SH HR I-11).
MSTRS	MOLTEN METAL	PAYLOAD POWER WILL BE REMOVED PRIOR TO EVA TO ELIMINATE THE POTENTIAL OF MOLTEN METAL RESULTING FROM CREW KICK LOADS APPLIED TO POWERED CABLES (REF. SH HR I-11).
STARNAV	MOLTEN METAL	PAYLOAD POWER WILL BE REMOVED PRIOR TO EVA TO ELIMINATE THE POTENTIAL OF MOLTEN METAL RESULTING FROM CREW KICK LOADS APPLIED TO POWERED CABLES (REF. SH HR I-11).

®[DN 62]

[1] ALL FREESTAR PAYLOAD HARDWARE WITHIN 24 INCHES OF THE SILL EVA TRANSLATION PATH IS SAFE FOR CONTACT BY THE CREW. THE ONLY PORTION OF FREESTAR WHICH IS WITHIN 24 INCHES OF THE ORBITER SILL TRANSLATION PATH IS THE OUTER PORTION OF THE MPESS AND ITS MOUNTING HARDWARE. NONE OF THE EXPERIMENTS ON FREESTAR ARE WITHIN 24 INCHES OF THE ORBITER SILL TRANSLATION PATH. THE FOLLOWING AREAS ON FREESTAR ARE IDENTIFIED AS SUSCEPTIBLE TO EVA KICKLOADS FOR MISSION SUCCESS REASONS: ELECTRICAL WIRING AND CONNECTORS, ELECTRICAL HARNESS BRACKETS AND THE LPT 18-INCH TRANSMIT ANTENNA AND PEDESTAL. IN ORDER TO PROTECT THESE COMPONENTS, THE FREESTAR KEEPOUT ZONE IS ANYWHERE ON THE PAYLOAD OUTSIDE OF THE EVA TRANSLATION ZONE. ®[DN 62]

This information in this table is derived from a variety of sources including but not limited to: Payload safety assessments, hazard reports, sharp edge inspections, payload walkdowns, and EMU certification limits. Proper management of each of these hazards is required to ensure EVA crew safety and/or proper EMU operation.

107_15A-2 SPACEHAB EVA CONSTRAINTS

A. THE FOLLOWING EXPERIMENTS ARE NOT CERTIFIED TO OPERATE AT 10.2 PSI:

1. ARMS ®[DN 33]

2. CM-2

3. MGM

4. ZCG

ARMS, CM-2, MGM, and ZCG are not certified to operate in the 10.2 environment. Operation of the SH Module at 10.2 would require these payloads to be deactivated. Although ARMS materials are certified for a 30 percent O_2 environment, it will not be allowed to operate in this case due to higher 0_2 concentrations within the payload (per PSRP agreement). ®[DN 33]

B. IN THE EVENT OF AN EVA, SPACEHAB WILL BE CONFIGURED FOR SAFE ENTRY AND THE HAB WILL REMAIN AT 14.7 PSI.

This rule is in support of Rule {A2-317}, EVA CONSTRAINTS, and defines the strategy for Spacehab management for an EVA. There are no scheduled or unscheduled EVA's planned for STS-107. Possible contingency EVA's include Ku-band antenna stow and Payload Bay Door closure. These contingency EVA's do not require a 10.2 psi pre-breathe protocol such that the orbiter will remain at 14.7 psi. In preparation for airlock depress, the Spacehab will be configured for safe entry and the hatch closed. If experiment operations were originally planned during the time of the contingency EVA, experiment operations that do not require crew interaction may continue. ®[ED]

SECTION 17 - LIFE SUPPORT

GENERAL

107_17A-1 SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS

A. DURING OPERATIONS OF SPACEHAB ACTIVELY COOLED EXPERIMENTS, THE ORBITER CABIN ATMOSPHERE MUST BE MAINTAINED WITHIN THESE SPECIFIED LIMITS:

THERE ARE NO SPACEHAB EXPERIMENTS THAT REQUIRE THAT THE ORBITER CABIN ATMOSPHERE BE MAINTAINED OUTSIDE THE NOMINAL RANGE FOR STS-107.

B. THE FOLLOWING PAYLOADS REQUIRE SPECIFIC ENVIRONMENTAL CONTROLS IN EXCESS OF NORMAL SUBSYSTEM REQUIREMENTS. TEMPORARY INCREASES ABOVE THE LIMIT DURING PREPLANNED FES INHIBITS WHENEVER NEITHER CM-2 NOR VCD ARE ACTIVE ARE ACCEPTABLE. SPACEHAB POCC CONCURRENCE IS REQUIRED FOR FES INHIBITS NOT IN THE ORIGINAL FLIGHT PLAN. ®[DN 50]

CONDITION	REQUIREMENT
NEITHER VCD NOR CM-2 ACTIVE	EVAP OUT T ? 50 DEGREES WITH BOTH FPVS IN THE PL HX POSITION
BOTH VCD AND CM-2 ACTIVE	EVAP OUT T ? 41 DEGREES WITH BOTH FPVS IN THE PL HX POSITION
VCD ACTIVE, CM-2 NOT ACTIVE	EVAP OUT T ? 45 DEGREES WITH BOTH FPVS IN THE PL HX POSITION
VCD NOT ACTIVE, CM-2 ACTIVE	EVAP OUT T ? 50 DEGREES WITH BOTH FPVS IN THE PL HX POSITION

Thermal Analysis shows that to maintain SPACEHAB within the limits required to satisfy payload thermal requirements, both FPV's are required to be in "PLHX" when Spacehab and Spacehab payloads are in their on-orbit configuration (reference Rule {107_18A-2}, ORBITER FREON FLOW PROPORTIONING VALVE (FPV) USAGE). Analysis results show, to meet the predicted Spacehab thermal loads with only one FPV in the PL position, the EVAP OUT temperature would have to be 35 deg F or less, which is outside the system capabilities. The normal orbiter evaporator outlet temperature with the Flash Evaporator System (FES) activated is 38 to 40 deg F. However, with the FES deactivated, the temperature could range between 38 and 65 deg F. ®[DN 50]

THIS RULE CONTINUED ON NEXT PAGE

107_17A-1 SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS (CONTINUED)

CM-2 and VCD are the only payloads that will be directly affected by temporary fluctuations in the EVAP Out FREON temperature range. All requirements listed in the table above were developed assuming an average SH experiment surface air load of approx 1500 Watts and are imposed to ensure the successful operation of CM-2 and VCD. FES inhibits which would cause increases in the EVAP Out temp in excess of these requirements should be excluded during the operation of CM-2 and VCD.

Outside the operation of CM-2 and VCD, the EVAP Out temperature should be maintained below 50 deg F to maintain control of the SH cabin environment (i.e., below 80 deg F). Temporary increases in the EVAP Out temperature in excess of 50 deg F are acceptable however sustained increases of the EVAP Out temperature in excess of 50 deg F can adversely impact the ability of the SH ECS to maintain the SH module environment below 80 deg F. As noted previously, this limit on the EVAP Out temperature assumes approximately approx 1500 W of experiment surface air load. Actual surface air heat loads can approach approx 2300 W for STS-107 and may require that the EVAP Out temperature be maintained below 41 deg F (i.e., nominal range as described in ICD-A-21426-RDM).

C. THE FOLLOWING EXPERIMENTS NOMINALLY RELEASE GASES INTO THE CABIN:

ARMS, FRESH-2 AND VCD ®[DN 50]

In support of Rule {A17-651}, SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS. Detailed information on the amount and type of gases is contained in the Hazardous Material Summary Table, STS-107 PGSC software application. ®[DN 50] ®[ED]

107_17A-2 MODULE ATMOSPHERIC CONTROL

THE ORBITER ENVIRONMENT WILL BE MANAGED TO ALLOW THE MODULE TO OPERATE WITHIN THE FOLLOWING GUIDELINES:

NONE IDENTIFIED

In support of Rule {A17-652}, SPACEHAB SUBSYSTEM FAN/AIR LOOP. This rule identifies any deviations from the generic rule atmospheric requirements. ®[ED]

107_17A-3 USE OF SPACEHAB VOLUME AIR TO SUPPORT A SHUTTLE CABIN LEAK

IN THE EVENT OF AN UNISOLATABLE SHUTTLE CABIN LEAK, ANY AVAILABLE SPACEHAB AIR MAY BE USED TO EXTEND THE TIME ON-ORBIT TO AVOID A BAILOUT SITUATION OR TO ALLOW LANDING AT A MORE DESIRABLE LANDING SITE (REF RULE {A2-205C}, EMERGENCY DEORBIT). ®[ED]

Landing at a CONUS site (KSC, EDW, NOR) is more desirable than at an emergency landing site or bailout. Other factors such as lighting, landing aids, shuttle energy state, weather, etc. will also affect the landing decision.

DOCUMENTATION: Engineering judgment

107_17A-4 EXPERIMENT VENT VALVE

THE EXPERIMENT VENT VALVE WILL ALWAYS BE CLOSED WHEN ALL THE CREW IS ASLEEP UNLESS REQUIRED FOR THE FOLLOWING EXPERIMENT OPERATIONS:

NONE IDENTIFIED

In support of Rule {A17-754}, EXPERIMENT VENT VALVE. Since this mission is dual shift ops, there will be no periods when the crew will be asleep while the Experiment Vent Valve is in use. ®[DN 35] ®[ED]

107_17A-5 RDM LIOH CANISTER

THE FOLLOWING EXPERIMENTS WILL REQUIRE A LIOH CANISTER TO BE INSTALLED IN THE CO_2 REMOVAL ASSEMBLY PRIOR TO ANY NOMINAL HATCH CLOSURE IN ORDER TO PRESERVE SCIENCE:

FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH (FRESH)

In support of Rule {A17-758}, RDM LIOH CANISTER. Rule is to define experiments that require LiOH changeouts before nominal hatch closure. ®[ED]

107_17A-6 CABIN TEMPERATURE MANAGEMENT

A. ON-ORBIT POWERDOWNS:

1. CHECK SPACEHAB CABIN TEMPERATURE SETTING PRIOR TO IMPLEMENTING EITHER ORBITER OR SPACEHAB POWERDOWN STEPS.
®[DN 47]

2. IF ADDITIONAL EQUIPMENT POWERDOWN IS REQUIRED TO MAINTAIN ORBITER CREW CABIN TEMPERATURE, THE FOLLOWING TABLE WILL BE USED (DEPENDENT ON MISSION ACTIVITIES). EQUIPMENT POWERED ON BUT NOT IN USE WILL BE POWERED DOWN IN ORDER OF PRIORITY BEFORE POWERING DOWN EQUIPMENT BEING USED FOR EXPERIMENT OR ORBITER OPERATIONS. THIS LIST IS TO BE CONSIDERED AS SUPPLEMENTAL TO THAT CONTAINED IN RULE {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT.
®[ED]

EQUIPMENT	ELECTRICAL LOAD (WATTS)	COMMENT
ERGOMETER	20	CAN BE USED IN NON-POWERED MODE
STS1 PGSC	60-65	OCA ROUTER - 760XD ON SINGLE SLOT AC EXPANSION UNIT. REQUIRED FOR OCA OPERATIONS.
STS2 PGSC	60-65	WINDECOM – 760XD ON SINGLE SLOT AC EXPANSION UNIT. NO STS-107 PAYLOADS REQUIRE PCMMU DATA VIA WINDECOM.
STS3 PGSC	60-65	PROSHARE – 760XD ON SINGLE SLOT AC EXPANSION UNIT. REQUIRED FOR KFX OCA OPERATIONS.
STS4 PGSC	40	WORLDMAP – 760XD W/O EXPANSION UNIT, DC POWER. CREW SITUATIONAL AWARENESS.
PL1 PGSC	40	MEIDEX – 760XD W/O EXPANSION UNIT, DC POWER. REQUIRED DURING MEIDEX OPERATIONS.
PL2 PGSC	40	SOLSE-2 – 760XD W/O EXPANSION UNIT, DC POWER. REQUIRED DURING SOLSE-2 OPERATIONS.
TV MONITOR COLOR	56 (NOM) 86 (MAX)	USED FOR MEIDEX OPS
MUX (DTV)	73	NEEDED FOR DOWNLINK DTV. DTV POWER IS CONFIGURATION DEPENDANT. 73 WATTS REPRESENTS THE WORST-CASE CONFIGURATION.
DSR-20	50	CAN BE USED FOR RECORDING MEIDEX
CAMCORDER	10	PAO OPS, MEIDEX, LIMITED PAYLOAD OPS
V10	18	PAO OPS, MEIDEX, LIMITED PAYLOAD OPS
SPACEHAB-POWERED MIDDECK PAYLOADS	492	IMPACTS SCIENCE. SPACEHAB MIDDECK PAYLOADS INCLUDE BIOPACK AND BIOPACK GLOVEBOX, CMPCG, CEBAS, OSTEO, AND BRIC.

®[DN 36] ®[DN 47] ®[DN 82] ®[CR 5549]

THIS RULE CONTINUED ON NEXT PAGE

107_17A-6 CABIN TEMPERATURE MANAGEMENT (CONTINUED)

Spacehab cabin temperature adjustments can influence both Hab and orbiter cabin temperature conditions. A crew adjustment of the Hab cabin temp setting may be the cause of higher temps in either volume, and an adjustment may be all that is required to deal with higher temperature conditions. With the exception of the color monitor (due to its use for MEIDEX ops), all items listed above are not mentioned in Rule {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT. The items in this flight-specific rule should then be considered for powerdown in addition to those listed in the Rule. The priority given to each item to be considered for potential powerdown is dependent on ongoing operations at the time. ®[DN 47] ®[ED]

3. IF EQUIPMENT POWERDOWN IS REQUIRED TO MAINTAIN THE SPACEHAB MODULE TEMPERATURE, THE FOLLOWING TABLE WILL BE USED (DEPENDENT ON MISSION ACTIVITIES). EQUIPMENT POWERED ON BUT NOT IN USE WILL BE POWERED DOWN IN ORDER OF PRIORITY BEFORE POWERING DOWN EQUIPMENT BEING USED FOR EXPERIMENT OR SPACEHAB OPERATIONS.

EQUIPMENT	ELECTRICAL LOAD (WATTS)	COMMENT
AUX LIGHT	105	AC POWERED AUX LIGHT AVAILABLE FOR USE IN SH MODULE. HIGHLY DESIRABLE DURING HLS BLOOD DRAWS.
PL3 PGSC (SH)	70-80	SH SUBSYSTEM – 760XD ON SINGLE SLOT AC EXPANSION UNIT. NO REQUIRED OPERATIONS.
SH AFT MODULE LIGHT	20	LIGHTS IN AFT MODULE OF SH CAN BE SWITCHED OFF INDIVIDUALLY.
PAO CAMCORDER	20	LOSS OF PAO VIDEO IN SH MODULE
SH MOD MODULE PAYLOADS	EXPERIMENT DEPENDENT	IMPACTS SCIENCE.

®[DN 36]

B. ENTRY:

CABIN TEMPERATURE WILL BE MANAGED AS FOLLOWS TO ENSURE ADEQUATE ENTRY TEMPERATURES IN ACCORDANCE TO RULE {A13-31}, CREW CABIN TEMPERATURE LIMITS: ®[ED]

1. PRIOR TO THE LAST PRE-SLEEP PERIOD OF EOM-1, THE CABIN TEMP CONTROLLER WILL BE AUTOMATICALLY DRIVEN TO A POSITION TO ACHIEVE A CABIN TEMP OF 70 DEG F AT CREW WAKE ON ENTRY DAY.

THIS RULE CONTINUED ON NEXT PAGE

107_17A-6 CABIN TEMPERATURE MANAGEMENT (CONTINUED)

2. PRIOR TO THE LAST PRE-SLEEP PERIOD OF EOM-1, IF SLEEP TEMPERATURES WILL BE UNACCEPTABLY COLD, PER CDR AND SURGEON AGREEMENT, THE CABIN TEMP CONTROLLER POSITION CAN BE CONFIGURED TO PROVIDE A COMFORTABLE SLEEP ENVIRONMENT WHILE STILL STRIVING TO ACHIEVE THE OPTIMAL COLDSOAK.

3. THE CABIN TEMPERATURE CONTROLLER BYPASS VLV WILL BE AUTOMATICALLY DRIVEN TO THE "FULL COOL" POSITION, POST SLEEP OF ENTRY DAY.

4. ACTION WILL NOT BE TAKEN TO REDUCE CABIN TEMPERATURE IF THE D/O PREP TIMELINE HAS BEEN ENTERED.

5. FOR WAVEOFF DAYS, PREFLIGHT ANALYSIS WILL DICTATE THE LEVEL OF ACCEPTABLE POWER (EITHER GROUP B OR C POWERDOWN) TO OBVIATE CABIN TEMPERATURE CONCERNS.

Due to STS-107 being a dual-shift flight, a flight-specific modification of Rule {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT, was necessary, since that rule only deals with single-shift flights. Pre-flight thermal analysis indicates that positioning the cabin temp controller in the manner described above will achieve the desired post-landing crew cabin temperatures. ®[ED]

107_17A-7 WCS CONSTRAINTS

NO DUMPING OF URINE SAMPLES INTO THE WASTE COLLECTION SYSTEM (WCS) IS PERMITTED WITHOUT COMPLETION OF ANALYSIS DETERMINING THAT THIS IS ACCEPTABLE. ®[CR 5494A]

PhAB4 Urine Collection Bags (UCB's) contain a Lithium Chloride (LiCl) volume marker. The effect of interaction of LiCl in any amount with the main constituent (Oxone?) of the Shuttle Urine Pretreat Assembly (SUPA) is unknown at this time, pending completion of chemical analysis. Results thus far show no real chance for poisonous species formation (upon combination of LiCl and Oxone?), as well as no increased corrosion risk from LiCl in combination with Oxone? . The risk is thought to be primarily from increased solids formation, which could severely hamper WCS operations or even negate them completely. Until that risk is shown to be reasonably low or even non-existent, no urine samples containing LiCl should be dumped into the WCS. This most likely cannot be done prior to the flight of STS-107. However, if the analysis is completed and results received post STS-107 launch, and should those results show little to no increased risk of solids formation, consideration will then be given to dumping urine samples into the WCS, if required.

DOCUMENTATION: Engineering judgment, K. Chhipwadia STS-107 January 2002 IPT presentation
®[CR 5494A]

107_17A-8 RDM FAN START-UP OPERATIONS

ALLOW AT LEAST 6 SECONDS AFTER ANY FAN IS POWERED UP PRIOR TO POWERING ON ANY ADDITIONAL RDM FAN. ®[CR 5550]

PDU and APDU circuit design provides over current protection for ARS and HFA(2) fan start-up, respectively. The circuit design inhibits full current draw for approximately 5.5 seconds after the ON command is initiated. Prior to the end of this current limiting period, the fan being powered up may not achieve full operational status. Additional fan start-ups during this time may hinder the optimal flow of the air in the system. Additional SPACEHAB RDM fan startup constraints are listed in Rules {A17-704}, CABIN/HFA FAN and {A17-705}, ATMOSPHERE REVITALIZATION SYSTEM (ARS) FAN. ®[ED]

DOCUMENTATION: Memo 2H-SPACEHAB-02063. ®[CR 5550]

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SECTION 18 - THERMAL

GENERAL

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SECTION 18 - THERMAL

GENERAL

107_18A-1 BONDLINE ENTRY INTERFACE (EI) TEMPERATURES

MAXIMUM ALLOWABLE BONDLINE ENTRY INTERFACE (EI) TEMPERATURES ARE BASED ON STRUCTURAL CONSTRAINTS AND FLIGHT-SPECIFIC PARAMETERS FOR VEHICLE LOADING. THE LIMITS LISTED BELOW ARE THE LANDING OPPORTUNITY-INDEPENDENT LIMITS FOR STS-107:

DESCRIPTION	TEMPERATURE MEASUREMENT NO'S	MAX LIMIT, DEG F
PLBD	V37T1000	66.0
	V37T1006	66.0
	V37T1002	81.0
	V37T1004	81.0
PORT (STBD)	V09T1012(14)	100.3
	V09T1724(20)	119.6
	V09T1030(28)	61.4
	V34T1106(08)	118.9
	V34T1102(04)	69.9
TOP	V09T1524	67.0
	V09T1004	92.3
	V09T1024	92.3
BOTTOM	V09T1624	122.2
	V09T1702	97.5
	V09T1000	92.2
	V09T1002	92.2
	V09T1016	100.3
	V09T1022	99.3
	V34T1110	89.3
	V34T1112	89.3

These are the STS-107 flight-specific limits, as referenced in Rule {A18-401B}, THERMAL PROTECTION SYSTEM (TPS) BONDLINE TEMPERATURES. The term "Opportunity-Independent" refers to the representative set of deorbit opportunity cases from which these limits are derived. The limits listed represent the most restrictive for each MSID from all of the cases including a weight change of up to 3000 lbs and a cg shift of up to 3 inches. ®[ED]

DOCUMENTATION: STS-107 Flight Design Product DSCT-29, January 11, 2002.

107_18A-2 ORBITER FREON FLOW PROPORTIONING VALVE (FPV) USAGE

THE TWO ORBITER FREON FPV'S WILL NOMINALLY BE USED ACCORDING TO THE FOLLOWING PLAN:

A. PRELAUNCH (POWERED ASCENT): ONE FPV IN THE INTERCHANGER (ICH) POSITION AND ONE FPV IN THE PAYLOAD HEAT EXCHANGER (PLHX) POSITION UNTIL LAUNCH MINUS 2 HRS. AT THAT POINT, BOTH FPV'S ARE PLACED IN ICH FOR ASCENT. ®[CR 5617C]

Both FPV's must be in ICH for ascent. However, cold soaking the Spacehab module prelaunch via one FPV in PLHX keeps the predicted module temperatures acceptable until post insertion. It is desired to keep the SH Module temperature below 85 deg F during ascent for the FRESH-2 payload. Moving the FPV back to the ICH position still guarantees a nominal crew cabin temperature at ingress and during ascent.

B. ON-ORBIT 14.7 PSI OPS:

1. AFTER SUCCESSFULLY REACHING ORBIT (POST INSERTION), ONE FPV WILL BE PLACED IN "PLHX" POSITION UNTIL DEORBIT PREP.

2. THE SECOND FPV WILL BE TAKEN TO "PLHX" NO EARLIER THAN THE END OF SPACEHAB ACTIVATION BUT BEFORE ACTIVATION OF WATER COOLED EXPERIMENTS. EXACT TIMING OF SECOND FPV MOVEMENT WILL DEPEND ON AN ASSESSMENT OF ORBITER AND SPACEHAB CABIN TEMPERATURES.

C. DEORBIT PREP/ENTRY: AT THE END OF SPACEHAB ENTRY PREP ONE FPV WILL BE RETURNED TO "ICH". THE OTHER FPV WILL BE RETURNED TO "ICH" AT THE BEGINNING OF DEORBIT PREP FOR ENTRY AND LANDING. FOR EXTENSION DAYS, AN FPV IN "PLHX" IS REQUIRED TO MAINTAIN SPACEHAB WITHIN THERMAL REQUIREMENTS. ®[DN 68] ®[CR 5617C]

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107_18A-2 ORBITER FREON FLOW PROPORTIONING VALVE (FPV) USAGE (CONTINUED)

Thermal Analysis shows that to maintain Spacehab within the limits required to satisfy payload thermal requirements both FPV's are required to be in "PLHX" when Spacehab and Spacehab payloads are in their on-orbit configuration (reference Rule {107_17A-1}, SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS). However, real-time assessment of the actual orbiter cabin temperature following the ascent phase may result in delaying the second valve movement to payload until such time that this temperature decreases to more desirable levels (less than 80 deg F; reference Rule {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT). Flight data shows that orbiter cabin temperatures typically range from 79 to 84 deg F following ascent. Delaying the second FPV movement to PLHX will aid in decreasing orbiter cabin temperatures at a significantly higher rate than if both FPV's were to be in PLHX. The delay will not be so long as to compromise SPACEHAB thermal constraints and conditions, and will be done before activation of SPACEHAB water-cooled experiments. A single FPV is required to be in "PLHX" with Spacehab in the entry configuration until the start of deorbit prep to assure that the Spacehab thermal limits are not violated during entry and post-landing. It is desired to keep the SH Module temperature below 85 deg F during entry and post-landing for the FRESH-2 payload. ®[DN 68] ®[CR 5617C]

D. POSTLANDING: BOTH FPV'S WILL BE IN THE "ICH" POSITION UNTIL REQUESTED FOR PAYLOAD COOLING NO LATER THAN ONE HOUR AFTER LANDING BUT NO EARLIER THAN CREW EGRESS. THEN ONE FPV IS PLACED INTO THE "PLHX" POSITION FOR THE DURATION OF EARLY EXPERIMENT RETRIEVAL OPERATIONS. IF CREW EGRESS IS DELAYED PAST LANDING PLUS ONE HOUR, POSITIONING THE FPV'S TO "PLHX" WILL BE DELAYED UNTIL AFTER CREW EGRESS. ®[CR 5617C]

Moving one FPV to PLHX allows Spacehab to maintain module temperature during early experiment sample retrieval operations. Waiting until crew egress to move one FPV to PLHX maximizes orbiter cabin cooling for crew comfort until ground ventilation can be connected. Thermal analysis shows that the Spacehab module air temperature will reach approximately 85 deg F after 3.5 hours and 90 deg F after 6 hours of operation with both FPV's in "ICH" while in the descent/post-landing configuration. It is desired to keep the SH Module temperature below 85 deg F during post-landing for the FRESH-2 payload. ®[DN 68]

107_18A-3 END-OF-MISSION THERMAL CONDITIONING

THE ATTITUDES FOR THE LAST 15 HOURS PRIOR TO THE START OF THE DEORBIT PREP WILL BE RESERVED FOR THERMAL CONDITIONING. THIS WILL CONSIST OF 5 HOURS OF BOTTOM SUN AND 10 HOURS OF –ZLV –YVV. PRECEDING THIS 15-HOUR PERIOD, SOME SECTIONS OF THE ATTITUDE TIMELINE ARE BEING FLOWN –ZLV –YVV IN ORDER TO MINIMIZE NEED FOR FUTURE BELLY SUN. NOMINALLY, THE THERMAL CONDITIONING PROTECTS FOR NEOM + 2 REVS; HOWEVER, FOR THIS FLIGHT, NEOM + 1 REV IS BEING PROTECTED. ®[CR 5505]

Thermal conditioning will be required for the BET and main landing gear tires prior to the deorbit prep. It will consist of biased belly Sun to warm the tires and bay Earth, nose north toward the Sun (-ZLV -YVV) to decrease the BET. The duration of the belly Sun attitude may be readdressed in real time to meet the actual conditions at the end of mission (launch delay, actual temperatures differing from predictions, etc). The EOM conditions specified in Rule {A2-110}, STRUCTURES THERMAL CONDITIONING, are not sufficient due to the extremely high mission-specific NEOM tire limit of 12 degrees. ®[ED]

Rationale: Engineering judgment ®[CR 5505]

107_18A-4 WATER LINE HEATER MANAGEMENT

EXCEPTIONS TO WATERLINE HEATER MANAGEMENT RULE:

NONE IDENTIFIED

In support of Rule {A18-555}, WATER LINE HEATER MANAGEMENT. Need to list any exceptions to the generic rule on management of the water line heaters, in particular, in attitude management deltas for loss of water line heaters. ®[ED]

107_18A-5 RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT

A. CWC STOWAGE CONSTRAINTS

1. A SPACEHAB CWC TO BE NOMINALLY STOWED IN SPACEHAB FOR ENTRY IS LIMITED TO 32 LBS OF WATER.

If the final Spacehab CWC is to be stowed inside the Spacehab module, the designated CWC stowage location for STS-107 (on the module ceiling) can structurally accommodate 32 lbs of water.

2. A SPACEHAB CWC TO BE NOMINALLY STOWED IN THE ORBITER FOR ENTRY IS LIMITED TO 95 LBS OF WATER.

If the Final Spacehab CWC is to be stowed in the orbiter, the designated orbiter stowage locations (per Rule {107_10A-4}, FILLED CWC STOWAGE MANAGEMENT, can accommodate 95 lbs.

B. CWC REFILL AND DUMP CONSTRAINTS

1. CWC’S MAY BE FILLED A MAXIMUM OF TWO CYCLES (ONE INITIAL FILL PLUS A REFILL).

2. CWC’S MAY BE DUMPED OVERBOARD A MAXIMUM OF TWO CYCLES (ONE INITIAL DUMP PLUS ONE ADDITIONAL DUMP).

3. FOR PURPOSES OF COUNTING FILLS AND DUMPS, A PARTIAL DUMP OF A CWC COUNTS AS ONE CYCLE. ®[DN 37]

For life-cycle considerations, each CWC is certified for a maximum of two fills or dumps. Once the CWC is dumped, a cycle is complete. Partial fills and dumps only count as one cycle if that dump has emptied the bag fully, or the dump has gone on long enough such that a significant fraction of the water has gone overboard. For example, full CWC’s from STS-108 (approx 75-91 lbm avg) took around 45 min to an hour to dump. Therefore, a dump of around 30 min would be considered a “significant fraction”. However, if a dump only lasted 3 min and had to stop, that would likely not be considered “significant” (and therefore, that CWC could still be used again without it counting as one full cycle). In either case, real-time consultation with MER Engineering personnel would then occur, and the dump signature examined to determine if a significant fracture was dumped.

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107_18A-5 RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT (CONTINUED)

C. THE LAST CST TO CWC TRANSFER TO BE INCLUDED IN A CWC DUMP SHALL OCCUR SUCH THAT SUBSEQUENT CST TO CWC TRANSFERS DO NOT EXCEED THE NUMBER OF AVAILABLE CWC STOWAGE LOCATIONS. TO PROTECT FOR SPACEHAB REINGRESS ON WAVE-OFF DAYS, THE ADDITIONAL CONDENSATE PREDICTED FOR OPEN HATCH OPERATIONS MUST BE ACCOMMODATED WITHOUT REQUIRING AN OVERBOARD DUMP ON WAVE-OFF DAYS.

The time of the last CST transfer to a CWC to be dumped overboard is driven by the collection rate following this transfer and the available stowage locations to accommodate CWC's used for subsequent CST to CWC transfers performed after the last overboard dump. Although this rule does not imply a requirement to re-ingress the Spacehab on wave-off days, if the Spacehab is re-ingressed, the additional condensate collected while the crew is in the Spacehab must be accounted for without requiring an overboard dump. The additional condensate collected must either be accounted for by extra ullage in the CST, ullage in a partially filled CWC, or another available stowage location for an additional CWC.

D. THE CST WILL BE MANAGED SUCH THAT A TRANSFER OF THE CST TO A CWC WILL NOT BE REQUIRED FOR EXTENSION DAYS.

Since the Spacehab CWC is disconnected and stowed for entry (nominally 7.5 hrs before TIG), condensate is collected in the CST and cannot be transferred to a CWC after this point. Per Rule {A18-606}, RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT, the CST must not exceed a pressure of 15 psi. The CST will be managed such that the final CST to CWC transfer before hatch closure will allow the CST to accommodate any condensate that will be produced from the final transfer through two extension days including 52.5 hrs from the nominal end of mission TIG to the last EOM +2 deorbit opportunity, 1 hr for entry, and 7 hours for R+7 retrieval. If Spacehab is re-entered on waveoff days, the CST may have to be transferred to a CWC since more condensate will be collected when the crew is in the module.
®[ED]

107_18A-6 SPACEHAB SUBSYSTEM WATER LOOP MANAGEMENT

THE SUBSYSTEM WATER LOOP OR WATER LINE HEATERS MUST BE ACTIVE PRIOR TO PAYLOAD BAY DOOR OPENING AND MUST REMAIN ACTIVE THRU EI-10 MINUTES, UNLESS ATTITUDE MANAGEMENT IS INVOKED. ®[CR 5551]

This rule is intended to supersede paragraph C of Rule {A18-552}, SPACEHAB SUBSYSTEM WATER LOOP MANAGEMENT. Boeing thermal analysis (MDC 93W5633) indicates at least 2 hours exists before damage to the PLHX is possible due to freezing for stagnant water lines without heaters with the PLB doors closed. Between EI-10 and postlanding wheelstop (approximately 1 hour), the crew is in their seats and are considered to be unavailable to initiate Orbiter Water Line Heaters via L12 panel switch action. The SPACEHAB half of the water line heaters can be initiated by crew action on panel C3. Attitude Management in place of either loop flow or line heaters is addressed in Rule {A18-555}, WATER LINE HEATER MANAGEMENT. ®[CR 5551] ®[ED]

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SECTION 19 - SPACEHAB

GENERAL

107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES

THE FOLLOWING PAYLOAD MISSION OBJECTIVES ARE DEFINED AS MINIMUM MISSION REQUIREMENTS FOR A NOMINAL DURATION MISSION. ®[CR 5544B]

REFERENCE RULES {107_11A-4}, CCTV REQUIREMENTS, {107_19A-3}, EXPERIMENT POWER INTERRUPT CONSTRAINTS, {107_2A-63}, MICROGRAVITY CONSTRAINTS, AND {107_2A-71}, ATTITUDE/POINTING CONSTRAINTS, FOR REQUIREMENTS IN SUPPORT OF MISSION OBJECTIVES.

A. ADVANCED PROTEIN CRYSTALLIZATION FACILITY (APCF) REQUIRES CONTINUOUS POWER THROUGH DEACTIVATION.

APCF is autonomous, and operates independently of crew intervention. APCF activation and deactivation are required in support of mission objectives.

B. ADVANCED RESPIRATORY MONITORING SYSTEM (ARMS) REQUIRES COMPLETION OF THE FOLLOWING 27 ACTIVITY SETS:

2 REBREATHE 1A RUNS AND 1 REBREATHE 1B RUN

1 MUSCULAR 1A RUN, 5 MUSCULAR 1B RUNS, AND 2 MUSCULAR 1C RUNS

4 PULMONARY 1 RUNS, 4 PULMONARY 2 RUNS, AND 4 PULMONARY 3 RUNS

4 MUSCULAR 2 RUNS

For maximum mission success, ARMS desires that these runs be executed on time and in the documented sequence as shown in the Flight Plan. Overall ARMS activities must be preceded by successful setup of the ARMS hardware and ergometer unit.

C. ASTROCULTURE 10/1 (AST) REQUIRES CONTINUOUS POWER, 4 SAMPLINGS (2 WITH VIDEO AND 2 WITHOUT), AND OCA FILE DOWNLINKS. AST 10/2 REQUIRES FLUID TRANSFER ACTIVITIES AND TWO INSTANCES OF 35 MM STILL PHOTOS. ®[CR 5627B]

AST activities must be preceded by activation. AST 10/2 is unpowered. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

D. BIOBOX REQUIRES CONTINUOUS POWER. ®[CR 5544B] ®[CR 5627B]

BIOBOX operations are ground commanded with no crew interaction or insight. Experiment monitoring and commanding are done from the ground.

E. BIOPACK REQUIRES CONTINUOUS POWER BEGINNING WITH ACTIVATION AND PERFORMANCE OF THE LEUKIN, BONES, REPAIR, CONNECT, STROMA, BACTER, YSTRES, AND BIOKIN EXPERIMENTS.

F. GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA) REQUIRES CONTINUOUS POWER FROM ACTIVATION LATE IN THE MISSION TO DEACTIVATION FOR APPROXIMATELY 48 HOURS OF OPERATION PRIOR TO MODULE CLOSEOUT.

The payload software autonomously controls all operations following power-up. Activation and deactivation are required in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

G. BIOLOGICAL RESEARCH IN CANISTERS (BRIC) REQUIRES CONTINUOUS POWER UNTIL POWERDOWN AND COMPLETION OF LED OPERATIONS FOR FOUR CANISTERS, INHIBITION FOR THREE CANISTERS, AND FIXATION FOR ALL CANISTERS.

H. BIOREACTOR DEMONSTRATION SYSTEM (BDS-05) REQUIRES 18 INSTANCES OF MEDIA SAMPLE AND PCBA ANALYSIS, 7 INSTANCES OF CELL SAMPLE AND FIXATION, 11 INSTANCES OF MEDIA TRAY EXAMINE, AND 6 INSTANCES OF TISSUE SAMPLE 35 MM STILL PHOTOS.

BDS-05 activities must be preceded by successful activation, setup, and media tray configuration. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

I. CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS) REQUIRES INITIAL TAPE INSTALLATION AS EARLY AS POSSIBLE, DAILY TAPE CHANGEOUT, AND CONTINUOUS POWER.

J. COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX) REQUIRES ACTIVATION PRIOR TO CREW SLEEP ON FLIGHT DAY (FD) 1, FOUR MID-MISSION ADJUSTMENTS, AND CONTINUOUS POWER. ®[CR 5627B]

Activation and deactivation are required in support of mission objectives. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

K. COMBUSTION MODULE – 2 (CM-2) REQUIRES COMPLETION OF THE FOLLOWING ACTIVITIES: ®[CR 5544B]

Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements and Rule {107_2A-63}, MICROGRAVITY CONSTRAINTS. ®[CR 5627B]

1. LSP – 15 TESTS

LSP tests require successful setup, checkout, LSP integration, VCR checkout, and pre-test verifications. In support of LSP operations, two CM-2 chamber accesses to changeout equipment, VCR tape changeouts, startups, shutdown evacuations, chamber fills, and powerdowns are required. At the end of each test, file downlink is required. LSP deintegration is required to remove the LSP EMS.

2. SOFBALL – 15 TESTS

SOFBALL tests require successful EMS integration, checkout, pre-test two-bottle fill, and on-orbit leak integrity check. In support of SOFBALL operations, SOFBALL power ups, tape changeouts pre-test, GC flushes and calibrations, TARGA/DDR changeouts, powerdowns and GC bakeout are required. At the end of each test and after last GC calibration, file downlink is required. SOFBALL shutdown is required to remove the SOFBALL EMS.

3. MIST – 33 TESTS INCLUDING 3 DRY TESTS

MIST tests require successful EMS integration, startup, and color camera setting adjustment. In support of MIST operations, chamber accesses to changeout equipment, powerups, chamber bleeds, powerdowns, and MIST shutdowns are required. At the end of each test, file downlink is required. MIST deintegration is required to remove the MIST EMS. ®[CR 5627B]

L. COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH (CMPCG) REQUIRES CONTINUOUS POWER.

Activation and deactivation are required in support of mission objectives.

M. COMBINED TWO-PHASE LOOP EXPERIMENT (COM2PLEX) REQUIRES COMPLETION OF A LOOP HEALTH CHECK PRIOR TO INITIAL OPERATIONS, 3 NON-CONTIGUOUS, 48 HOUR SESSIONS OF ATTITUDE DEPENDENT GROUND COMMANDED OPERATIONS, AND ATTITUDE INDEPENDENT GROUND OPERATIONS.

Activation and deactivation are required in support of mission objectives. Reference Rule {107_2A-71}, ATTITUDE/POINTING REQUIREMENTS, for attitude requirements and constraints. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

N. COMMERCIAL PROTEIN CRYSTAL GROWTH PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF) REQUIRES CONTINUOUS POWER. ®[CR 5544B]

Activation and deactivation (once temperature ramp from 4-22 deg C is complete) are required in support of mission objectives.

O. EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS (ERISTO) REQUIRES 10 CELL FEEDINGS AND CONTINUOUS POWER THROUGH DEACTIVATION. ®[CR 5627B]

Deactivation is required in support of mission objectives. The specific intervals at which ERISTO cell feedings occur are defined in NSTS-21426 Spacehab-GRLM CIP Annex 2, part II.

P. FACILITY FOR ADSORPTION AND SURFACE TENSION (FAST) REQUIRES ACTIVATION NO EARLIER THAN SH MODULE ACTIVATION PLUS 4 HOURS AND CONTINUOUS POWER FROM ACTIVATION THROUGH DEACTIVATION. FAST REQUIRES 9 GROUND COMMANDED EXPERIMENT RUNS. EACH EXPERIMENT RUN CONSISTS OF 3 EXPERIMENT SEQUENCES, 3 THERMOREGULATIONS, AND ONE INJECTION.

Activation and deactivation are required in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

Q. FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH (FRESH) REQUIRES CONTINUOUS POWER AND WATER REFILLS AS REQUIRED.

Reference Rule {107_19A-262}, FRESH STATUS CHECKS, for status check requirements.

R. HLS - ENHANCED ORBITER REFRIGERATOR/FREEZER (EOR/F) REQUIRES CONTINUOUS POWER FROM ACTIVATION ON-ORBIT THROUGH POSTLANDING RETRIEVAL.

EOR/F is a support item for HLS and has no science objectives.

S. HLS - THERMOELECTRIC HOLDING MODULE (TEHM) REQUIRES CONTINUOUS POWER. ®[CR 5627B]

TEHM is a support item for HLS and has no science objectives. The TEHM will also be used for cold storage of the Vapor Compression Distillation Flight Experiment (VCD FE) sample box. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

T. HLS - MICROBIAL PHYSIOLOGY FLIGHT EXPERIMENTS (MPFE) REQUIRES TRAY #1 ANALYSIS AS EARLY AS POSSIBLE, 7 INSTANCES OF TEST CARD ANALYSIS, GROWTH CONTROL SETUP, AND GROWTH CONTROL TERMINATION. ®[CR 5544B] ®[CR 5627B]

Activation and deactivation are required in support of mission objectives. The quality of science return from analysis of card tray 1 quickly diminishes beyond 48 hours after preflight inoculation.

U. HLS - SLEEP REQUIRES THE CREW TO UNSTOW/DON ACTILIGHT WATCHES AS SOON AS POSSIBLE AFTER ORBIT IS ACHIEVED AND COMPLETE A SLEEP LOG AS SOON AS POSSIBLE AFTER WAKEUP EACH DAY. ACTILIGHT WATCHES ARE DOFFED AND STOWED PRIOR TO D/O PREP.

V. HLS - PHYSIOLOGY AND BIOCHEMISTRY EXPERIMENT SET (PHAB4) REQUIRES DESIGNATED CREWMEMBERS TO PERFORM THE FOLLOWING:

1. ON A DAILY BASIS, INGEST POTASSIUM CITRATE TABLETS WITH EVENING MEAL, COLLECT AND FREEZE SALIVA SAMPLES, COLLECT AND STORE SALIVA SAMPLES AT AMBIENT TEMPERATURE.

2. COLLECT AND FREEZE ADDITIONAL SALIVA SAMPLES ON FLIGHT DAYS 3 AND 12.

3. PCBA ANALYSIS OF BLOOD DRAWN ON FLIGHT DAYS 3-6 AND 12-15.

In support of PCBA analysis, a functional test and control analysis will be performed on the PCBA every day on which blood draws will be performed.

4. COLLECT URINE SAMPLES ON FLIGHT DAYS 3-6 AND 12-15.

5. ON FLIGHT DAYS 3 AND 12, PHAB-4 CREWMEMBERS BEGIN A TIMED SEQUENCE OF ACTIVITIES INCLUDING FASTING BLOOD DRAWS, ORAL TRACER INGESTION, AND CALCIUM TRACER INFUSION (FD3 ONLY). ADDITIONAL BLOOD DRAWS ARE REQUIRED 24, 48, AND 72 HOURS AFTER ORAL TRACER INGESTION. ®[CR 5544B] ®[CR 5627B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

6. INFUSE DESIGNATED CREWMEMBERS WITH HISTIDINE TRACER ON FLIGHT DAY 3 AND 12 AT 10-12 HOURS AFTER ORAL CALCIUM AND ALANINE TRACER INGESTION AND COLLECT BLOOD SAMPLES 10 MINUTES AFTER HISTIDINE TRACER INFUSION. ®[CR 5544B] ®[CR 5627B]

In support of PHAB-4 blood collection, blood samples should stand for 15 minutes prior to centrifuging, then be centrifuged for 15 minutes, and placed in the EORF within 1 hour 15 minutes of collection.

7. ALL CREWMEMBERS RECORD ALL FOOD, FLUIDS, MEDICATIONS AND EXERCISE ON DESIGNATED FLIGHT DAYS.

The Bar Code Readers are used to facilitate recording crew intake and will be downloaded to the shared or subsystem PGSC on Flight Days 4, 6, 13, 14, and 15. The Bar Code Reader batteries will be replaced on Flight Days 4, 11, and 14.

W. MECHANICS OF GRANULAR MATERIALS (MGM) REQUIRES COMPLETION OF THREE RUNS ON EACH OF THREE TEST CELLS, PERFORMED IN SEQUENCE.

Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

X. MINIATURE SATELLITE THREAT REPORTING SYSTEMS (MSTRS) REQUIRES SYSTEM POWER ON PRIOR TO BEGINNING OPERATIONS, (OPERATIONS MUST NOT BEGIN EARLIER THAN 00/16:00) GROUND COMMANDED OPS FOR 4 SETS OF 4 CONTINUOUS ORBITS EACH, AND A 1 HOUR WARM-UP PRIOR TO EACH SET OF OBSERVATIONS. EACH OPERATIONS SET MUST BE SEPARATED BY 24 HOURS. ®[CR 5627B]

Reference Rule {107_2A-71}, ATTITUDE/POINTING REQUIREMENTS, for attitude requirements and constraints.

Y. OSTEOPOROSIS EXPERIMENT (OSTEO) REQUIRES 11 CELL FEEDINGS APPROXIMATELY 24 HOURS APART AND CONTINUOUS POWER THROUGH DEACTIVATION.

Deactivation is required in support of mission objectives. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

Z. SPACE ACCELERATION MEASUREMENT SYSTEM – FREE FLYER (SAMS-FF) REQUIRES POWER DURING OPERATIONS. ®[CR 5544B]

Activation and Deactivation is required in support of mission objectives. SAMS is primarily flown to provide time correlated microgravity environment data to CM2 and MGM.

AA. STAR NAVIGATION (STARNAV) REQUIRES 20, 30-MINUTE GROUND COMMANDED DATATAKES. IMMEDIATELY FOLLOWING EACH OBSERVATION, 5 MINUTES FOR IMAGE DOWNLOAD AND DEACTIVATION IS REQUIRED BEFORE NEXT DATATAKE BEGINS. STARNAV REQUIRES THEIR OPERATIONS BE CONDUCTED OVER A MINIMUM FOUR DAY INTERVAL BETWEEN THE FIRST AND LAST OPERATIONS.

Activation and deactivation is required in support of mission objectives. Reference Rule {107_2A-71}, ATTITUDE/POINTING REQUIREMENTS, for attitude requirements and constraints.

AB. STARS-BOOTES REQUIRES VIDEO PER RULE {107_11A-4}, CCTV REQUIREMENTS.

Experiment activation is required twice in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS for video requirements.

AC. VAPOR COMPRESSION DISTILLATION (VCD) REQUIRES 6 DAYS OF EXPERIMENT OPERATIONS (WATER SAMPLES FOR ALL RUNS EXCEPT THE FIRST DAY AND AIA VALVE POSITIONING FOR 3 OUT OF 6 RUNS). ®[CR 5627B]

Setup, activation, deactivation, and shutdown are required in support of mission objectives.

AD. ZEOLITE CRYSTAL GROWTH (ZCG) REQUIRES MIXING OF 12 CLEAR AUTOCLAVE UNITS AND MIXING OF 19 METAL AUTOCLAVE ASSEMBLIES WITH SUBSEQUENT FURNACE PROCESSING OF THESE UNITS. ®[CR 5627B]

Activation, deactivation of the furnace, and stowage of the processed autoclave units are required in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements. ®[CR 5544B]

107_19A-2 SPACEHAB ACTIVATION CONSTRAINTS

IT IS HIGHLY DESIRABLE TO PERFORM SPACEHAB EXPERIMENT DATA SYSTEM ACTIVATION WHILE AOS.

SPACEHAB POCC highly desires monitoring of the activation steps in order to detect and recover from any off nominal conditions. If LOS, the crew can continue with the rest of Spacehab activation and then return to Experiment Data System Activation once AOS. ®[DN 38]

107_19A-3 EXPERIMENT POWER INTERRUPT CONSTRAINTS

FOR LOSS OF POWER, THE MAXIMUM TIME THE FOLLOWING EXPERIMENTS CAN SURVIVE WITHOUT POWER IS DEFINED BELOW:

A. SPACEHAB MIDDECK EXPERIMENTS

1. OSTEO – 20 MINUTES
2. CEBAS – 15 MINUTES
3. BRIC - 15 MINUTES
4. CMPCG - 15 MINUTES
5. BIOPACK - 15 MINUTES ®[DN 69]

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ZEOLITE CRYSTAL GROWTH-1 (ZCG-1)

107_19A-251 ZCG TOUCH TEMPERATURE

CREW UNLOADING OF ZCG AUTOCLAVES WILL NOT OCCUR UNTIL ADEQUATE COOL DOWN TIME HAS BEEN ALLOTTED AND THEIR TEMPERATURE HAS BEEN VERIFIED LESS THEN 45 DEG C. ®[CR 5555A]

The ZCG furnace processes the autoclaves at temperatures as high as 175 deg C. The furnace temperature can be monitored via the Zeolite Experiment Control System (ZECS) data display and by temperature strips placed on the surface of the furnace. Reference: Hazard Report ZCG-1; Cause 2.

107_19A-252 ZCG AUTOCLAVE LEAKAGE

TO PROTECT AGAINST ZCG CLEAR AUTOCLAVE LEAKAGE, THREE LEVELS OF CONTAINMENT WILL BE MAINTAINED AT ALL TIMES, EXCEPT WHEN BEING TRANSFERRED INTO AND OUT OF THE GLOVEBAG.

ZCG metal autoclaves have three levels of containment by design and require no special considerations. ZCG clear autoclaves only provide two levels of containment, and therefore are dependent on sealed storage bags, a storage transportation box, and a Glovebag to provide the third level of containment. The Zeolite solution stored in the autoclaves is very caustic with pH between 10-12. The fluid in the autoclave is not under pressure in ambient conditions. Reference: Hazard Report GBXE-15; Causes 2, 3a, 3b.

107_19A-253 THROUGH 107_19A-260 ARE RESERVED ®[CR 5555A]

FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH-2 (FRESH-2)

107_19A-261 IMAGERY DOWNLINK CONSTRAINTS ®[CR 5562]

THERE WILL BE NO DOWNLINKED PHOTOS OR VIDEO OF THE ANIMAL SUBJECTS UNLESS REQUESTED BY THE NASA CHIEF VETERINARY OFFICER OR DUTY VETERINARIAN TO ASSESS THE HEALTH OR WELFARE OF THE ANIMALS. ROUTINE DOWNLINK OF PHOTOS OR VIDEO IMAGERY WILL NOT BE PERFORMED. ®[DN 41] ®[ED]

Animal health checks will be routinely performed throughout the mission and the results recorded by the crew. If the animals appear stressed, their status will be communicated by the crew to the Chief Veterinary Officer or Duty Veterinarian either by voice call or operational OCA file transfer. Downlinking of photos or video images may then occur if required by the NASA Chief Veterinary Officer or Duty Veterinarian for determination of animal health or welfare. Routine downlink of photos or video imagery of animals is not required for animal welfare or scientific reasons, and is therefore not authorized. Reference NASA Memo, "On-orbit Imagery of Animal Subjects," from M-7/Acting Deputy Associate Administrator for Space Shuttle, dated June 7, 2002. ®[DN 41] ®[CR 5562]

107_19A-262 FRESH STATUS CHECKS

DURING ORBIT OPERATIONS, FRESH-2 RODENTS AND HARDWARE REQUIRE A STATUS CHECK EVERY 24 HOURS WHILE ON ORBIT AS LONG AS THE SPACEHAB MODULE IS ACCESSIBLE TO THE CREW. ®[DN 42] ®[CR 5700]

Daily health and hardware checks are required to assure the well being of the animals. Reference page 59 of the National Research Council Guide for the Care and Use of Laboratory Animals. The SH hatch is nominally closed during final deorbit preparation and is not planned to be re-opened in the event of a deorbit waveoff. If Spacehab is re-ingressed and if time permits, experiment status checks will be performed.

Reference Rule {107_2A-26}, EXTENSION DAY GUIDELINES. ®[CR 5700]

107_19A-263 THROUGH 107_19A-270 ARE RESERVED

SECTION 20 - FREESTAR

GENERAL

107_20A-1 FREESTAR MINIMUM MISSION OBJECTIVES

THE FOLLOWING PAYLOAD MISSION OBJECTIVES ARE DEFINED AS MINIMUM MISSION REQUIREMENTS FOR A NOMINAL DURATION MISSION:

A. MEIDEX REQUIRES A MINIMUM OF 140 MINUTES OF DESERT AEROSOL PRIMARY DATA COLLECTION SCHEDULED BETWEEN THE TWO ROI'S AND A MINIMUM OF ONE LUNAR OR GROUND CALIBRATION EVERY SEVEN DAYS

For maximum mission success, MEIDEX highly desires to perform observations during every overpass of the ROI's in which the minimal lighting conditions are met within ± 45 degrees from zenith. As a secondary observation set, MEIDEX highly desires a minimum of 2 hours of Sprite observations.

B. SOLSE REQUIRES A MINIMUM OF SIX OBSERVATIONS OF LIMB VIEWING AND TWO OBSERVATIONS OF EARTH VIEWING (EACH SINGLE OBSERVATION IS APPROXIMATELY 120 MINUTES LONG, INCORPORATING AN ILLUMINATED ORBIT FLANKED BY TWO ECLIPSES).

SOLSE highly desires a minimum of four additional limb views and one additional earth view. After desired observations of 13 orbits are met, SOLSE has the capability to record data for 19 additional orbits (i.e., a total capacity of 32 orbits). ®[DN 63]

C. CVX REQUIRES A MINIMUM OF 200 HOURS OF CONTINUOUS OPERATIONS.

A total minimum of 304 hours of continuous operation is highly desired.

D. SOLCON REQUIRES A MINIMUM OF TEN, 40-MINUTE SOLAR VIEWING OBSERVATIONS, EACH PRECEDED AND FOLLOWED BY SPACE VIEWING CALIBRATIONS.

E. LPT REQUIRES THE ON-ORBIT DEMONSTRATION OF FIVE PAYLOAD OBJECTIVES: GPS NAVIGATION (4 ORBITS REQUIRED); GN COMMUNICATIONS (EIGHT 5 MINUTE TESTS REQUIRED); TRDSS COMMUNICATIONS (6 HOURS REQUIRED); ON-ORBIT RECONFIGURATION (TWO 20 MINUTE TESTS REQUIRED); AND DEMONSTRATION OF RANGE SAFETY (TWO 2.5 MINUTE TESTS REQUIRED).

Through each demonstration, LPT will also be validating their IP in Space capabilities. As a supplemental objective, LPT highly desires to operate the receivers as much as possible throughout the flight.

107_20A-2 HH ACTIVATION/DEACTIVATION

A. FREESTAR MUST BE ACTIVATED WITHIN 3 HOURS AFTER PLBD OPENING OR PRIOR TO LEAVING A -ZLV ATTITUDE, WHICHEVER COMES FIRST. HH MUST BE DEACTIVATED WITHIN 3 HOURS OF PLBD CLOSURE.

Activation (comprised of crew performed activation plus ground commanded application of power to thermostatically controlled experiment heaters) is required to prevent the HH electronics from violating the operational limits of 0 deg C to 40 deg C at powerup. Deactivation is required no earlier than 3 hours prior to PLBD closure to prevent violation of the -10 deg C thermal limit on the unpowered HH electronics. This limit is for reasons of certification of reflight hardware and is not a safety requirement. Note: This assumes an initial temperature of 20 deg C when the PLBD's are opened and a PLBD opening attitude of -ZLV. The time to exceed thermal limits may be updated if the bay sill temperatures vary significantly from 20 deg C, or if actual maneuver times do not occur as scheduled. ®[DN 64] ®[CR 5626A]

B. SOLSE MUST BE ACTIVATED WITHIN 6 HOURS AFTER PLBD OPENING. SOLSE MUST BE DEACTIVATED WITHIN 6 HOURS OF PLBD CLOSURE.

The SOLSE constraint is based upon the assumption that a -ZLV (payload bay to Earth) attitude is flown. This requirement is reduced to 4.5 hours if the initial Orbiter attitude is not payload bay to Earth.

107_20A-3 HH THERMAL CONSTRAINTS

A. HH EXPOSURE LIMITS

1. WITH THE HH PAYLOAD ACTIVATED AND HEATERS ENABLED IN THE ABSENCE OF THERMAL ANALYSIS, THE LIMITS ARE TABULATED AS FOLLOWS:

ATTITUDE	COMPONENT	TEMP LIMIT (°C)	EXPOSURE TIME (HRS)
-ZLV	AVIONICS EXPERIMENT	N/A N/A	NO CONSTRAINTS
-ZSI	AVIONICS EXPERIMENT	40 13	8 1
-ZDS	AVIONICS EXPERIMENT	0 12	6.5 6.75

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107_20A-3 HH THERMAL CONSTRAINTS (CONTINUED)

E. IF FREESTAR HAS BEEN DEACTIVATED DUE TO VIOLATIONS AND/OR PREDICTED VIOLATIONS OF LOWER THERMAL LIMITS OF THE HH AVIONICS, THE PAYLOAD MAY ONLY BE DEACTIVATED FOR PERIODS OF LESS THAN 3 HOURS ASSUMING THAT BENIGN ATTITUDES, SUCH AS -ZLV, WILL BE FLOWN. ON A BEST EFFORT BASIS, THE SHUTTLE SHALL ASSUME A THERMAL RECOVERY ATTITUDE BEFORE REACTIVATION IS ATTEMPTED. THE PERIOD REQUIRED FOR PAYLOAD RECOVERY WILL BE DETERMINED IN REAL TIME THROUGH THERMAL ANALYSIS AT THE HH POCC.

Assuming a nominal operating temperature of 12 deg C, the HH avionics could fall below its operational temperature limit of 0 deg C within 4 hours if powered off. This limit is for mission success and is not a safety requirement. If the HH avionics has violated its operational lower limit of 0 deg C, the payload must be warmed before activation is attempted. As no telemetry is available to monitor the temperature of the payload when the HH avionics is deactivated, specifications of the warming required will be based on real-time analysis. Activating the avionics when the temperature is too low could result in potentially serious damage to flight hardware. If the HH avionics is predicted to have fallen below its lower hardware qualification limit of -10 deg C, a real-time assessment will be made, as the performance of the HH avionics may not be reliable even after warming to within operational limits.

F. SOLSE REQUIRES THAT THE HH-JR AVIONICS AND BIA REMAIN ENABLED FROM PAYLOAD ACTIVATION THROUGH DEACTIVATION. ®[CR 5851]

Heater power is not maintained if the BIA and/or HH-JR avionics are disabled. ®[CR 5851]

G. CVX – REFERENCE RULE {107_2A-71}, ATTITUDE/POINTING CONSTRAINTS. ®[DN 67]

H. FREESTAR SHALL NOT BE EXPOSED TO MORE THAN 12 HOURS CONTINUOUS SOLAR VIEWING. ®[DN 66]

Thermal analysis predicts that the MEIDEX battery could exceed its safety temperature limits if the MEIDEX power is failed ON with the MEIDEX door closed in a bay to sun attitude that exceeds 12 hours. ®[DN 66]

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APPENDIX A

ACRONYMS AND ABBREVIATIONS

A	ANALYSIS
A/G	AIR-TO-GROUND
ABE	ARMED BASED ELECTRONICS
ABT	ABORT
AC	ALTERNATING CURRENT
ACS	ATTITUDE CONTROL SYSTEM
ACVS	AUTOMATIC TARGETING AND REFLECTIVE ALIGNMENT CONCEPT COMPUTER VISION SYSTEM
ADSEP	ADVANCED SEPARATION
AGHF	ADVANCED GRADIENT HEATING FACILITY
ALT	ALTERNATE
	ALTITUDE
AOA	ABORT ONCE AROUND
AOS	ACQUISITION OF SIGNAL
APCF	ADVANCE PROTEIN CRYSTALLIZATION FACILITY
APDU	ALT POWER DISTRIBUTION UNIT
AP08	ALTERNATE PROCEDURE #8
APU	AUXILIARY POWER UNIT
ARMS	ADVANCED RESPIRATORY MONITORING SYSTEM
ASAP	AS SOON AS POSSIBLE
AST	ASTROCULTURE
AST-10/1	ASTROCULTURE PLANT GROWTH CHAMBER
AST-10/2	ASTROCULTURE GLOVEBOX
ATO	ABORT TO ORBIT
ATR	AMBIENT TEMPERATURE RECORDER
ATT	ATTITUDE
AUG	AUGMENTED
AUTO	AUTOMATIC
AV	AVIONICS
AZ	AZIMUTH
BDS	BIOREACTOR DEMONSTRATION SYSTEM
BET	BENDING EFFECT TEMPERATURE
	BEST ESTIMATE TRAJECTORY
BFS	BACKUP FLIGHT SYSTEM
BIA	BUS INTERFACE ADAPTER
BIOS	BASIC INPUT/OUTPUT SYSTEM
BIOTUBE/MFA	GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS
BITE	BINARY INTERNAL TIME ELECTRONICS
	BUILT IN TEST EQUIPMENT
BRIC	BIOLOGICAL RESEARCH IN CANISTERS
BRSS	BOEING REUSABLE SPACE SYSTEMS
B/U	BACKUP

BVD	BAY VENT DOOR
C	CELSIUS
C/O	CHECKOUT
CAB	CABIN
CAPCOM	CAPSULE COMMUNICATOR
CAPT	CAPTURE
CCM	CORRECTIVE COMBINATION MANEUVER
CCTV	CLOSED CIRCUIT TELEVISION
CCW	COUNTER CLOCKWISE
CDU	CENTRAL DATA UNIT
CDR	COMMANDER
CE	CARGO ELEMENT
CEBAS	CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM
CEWL	CENTRALIZED EXPERIMENT WATER LOOP
CG	CENTER OF GRAVITY
CIBX	COMMERCIAL ITA BIOMEDICAL EXPERIMENT
CIC	CREW INTERFACE COORDINATOR
CIL	CRITICAL ITEMS LIST
CIRC	CIRCULATION
CIS	CELLS IN SPACE
CM-2	COMBUSTION MODULE-2
CMD	COMMANDED
CMOS	COMPLEMENTARY METAL OXIDE SEMICONDUCTOR
CMPCG	COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH
CMT	CARGO MANAGEMENT TEAM
CNTCS	CONTACTS
CNTL	CONTROL
COAS	CREW OPTICAL ALIGNMENT SITE
COM2PLEX	COMBINED 2 PHASE LOOP EXPERIMENT
COMM	COMMUNICATION
COMP	COMPUTED
CONT	CONTINUE
CONUS	CONTINENTAL UNITED STATES
COOK	(NASA CONTINGENCY GROUND STATION LOCATED AT VANDENBERG AFB, CA)
CPA	COMBUSTION PRODUCTS ANALYZER
CPCG	COMMERCIAL PROTEIN CRYSTAL GROWTH
CPCG-PCF	COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY
CPM	CELL PERFORMANCE MONITOR
CR	CHANGE REQUEST
CSCS	CENTRALIZED SUCTION COOLING SYSTEM
CSR	CUSTOMER SUPPORT ROOM
CSS	CONTROL STICK STEERING
CVX	CRITICAL VISCOSITY OF XENON
CW	CLOCKWISE

D	DERIGIDIZATION
DAP	DIGITAL AUTO PILOT
DB	DEAD BAND
DEC	DECLINATION
DEG	DEGREES
DEU	DISPLAY ELECTRONICS UNIT
DFRC	DRYDEN FLIGHT RESEARCH CENTER
DLY	DELAY
DM	SPACEHAB DOUBLE MODULE
DN	DISCREPANCY NOTICE
DOD	DEPARTMENT OF DEFENSE
DOH	DISCRETE OUTPUT HIGH
DOL	DISCRETE OUTPUT LOW
DPLY	DEPLOY
DPS	DATA PROCESSING SYSTEM(S)
DS	DEEP SPACE
DSO	DETAILED SUPPLEMENTARY OBJECTIVE
DTO	DEVELOPMENT TEST OBJECTIVE
DTV	DIGITAL TELEVISION
DV	DELTA VELOCITY

EAFB	EDWARDS AIR FORCE BASE
ECLS	ENVIRONMENTAL CONTROL AND LIFE SUPPORT
ECS	ENERGY CONVERSION SUBSYSTEM
EDO	EXTENDED DURATION ORBITER
EDS	EXPERIMENT DATA SYSTEM
EDW	EDWARDS AIR FORCE BASE
EE	END EFFECTOR
EECOM	EMERGENCY, ENVIRONMENTAL AND CONSUMABLES MANAGEMENT
EGIL	ELECTRICAL GENERATION AND INTEGRATED LOADING
EI	ENTRY INTERFACE
EL	ELEVATION
EMU	EXTRAVEHICULAR MOBILITY UNIT
E-NOSE	ELECTRONIC NOSE
EOM	END OF MISSION
EOR/F	ENHANCED ORBITER REFRIGERATOR/FREEZER
EPS	ELECTRICAL POWER SYSTEM
ESC	ELECTRONIC STILL CAMERA
ESM	ELECTRONIC SUPPORT MODULE
ESTL	(NASA CONTINGENCY GROUND STATIONS LOCATED IN HOUSTON, TX AND IN WALLOPS ISLAND, VA)
ERISTO	EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS
ET	EXTERNAL TANK
ETRO	ESTIMATED TIME OF RETURN TO OPERATION
EVA	EXTRAVEHICULAR ACTIVITIES

EVP	EXHAUST/VENT PACKAGE
EXP	EXPERIMENT
F	FAHRENHEIT
F/C	FLIGHT CONTROL
FAA	FEDERAL AVIATION AGENCY
F/C	FLIGHT CONTROL
FAO	FLIGHT ACTIVITIES OFFICER
FAST	FACILITY FOR ADSORPTION AND SURFACE TENSION STUDIES
FC	FUEL CELL
FCMS	FUEL CELL MONITORING SYSTEM
FCR	FLIGHT CONTROL ROOM
FCS	FLIGHT CONTROL SYSTEM
FCT	FLIGHT CONTROL TEAM
FD	FLIGHT DIRECTOR
FD	FLIGHT DAY
FDF	FLIGHT DYNAMICS FACILITY
FDO	FLIGHT DYNAMICS OFFICER
FES	FLASH EVAPORATOR SYSTEM
FM	FREQUENCY MODULATED
FMDM	FLEX MULTIPLEXER/DEMULTIPLEXER
FOFE	FIBER OPTICS FLIGHT EXPERIMENT
FOR	FLIGHT OPERATIONS REVIEW
FOV	FIELD OF VIEW
FPM	FLOW PROPORTIONING MODULE
FPR	FLIGHT PERFORMANCE RESERVE
FPS	FEET PER SEC
FPV	FLOW PROPORTIONING VALVE
FRCB	FLIGHT RULES CONTROL BOARD
FRCS	FORWARD REACTION CONTROL SYSTEM
FRESH	FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH
FSCU INT	FIRE SUPPRESSION AND CONTROL UNIT INTERNAL
FWD	FORWARD
GAS	GET AWAY SPECIAL
GBA	GAS BRIDGE ASSEMBLY
GCA	GROUND CONTROLLED APPROACH
GF	GRAPPLE FIXTURE
GIRA	GALLEY IODINE REMOVAL ASSEMBLY
GMT	GREENWICH MEAN TIME
GNC	GUIDANCE NAVIGATION AND CONTROL
GOM	GROUND OPERATIONS MANAGER
GPO	GUIDANCE & PROCEDURES OFFICER
GPC	GENERAL PURPOSE COMPUTER
GPS	GLOBAL POSITIONING SYSTEM
GSE	GROUND SUPPORT EQUIPMENT
GSFC	GODDARD SPACE FLIGHT CENTER

GUAM	(NASA CONTINGENCY GROUND STATION LOCATED AT ANDERSON AFB, GUAM)
HAINS	HIGH-ACCURACY INERTIAL NAVIGATION SYSTEM
HAZ	HAZARDOUS
HBIA	HITCHHIKER BUS INTERFACE ASSEMBLY
HDR	HIGH DATA RATE
HE	HELIUM
HEDS	HUMAN EXPLORATION AND DEVELOPMENT OF SPACE
HES	HITCHHIKER EJECTION SYSTEM
HESE	HITCHHIKER EJECTION SYSTEM ELECTRONICS
HH	HITCHHIKER
HHL	HAND HELD LASER
HH OPS	HITCHHIKER OPERATIONS DIRECTOR
HLS	HUMAN LIFE SCIENCES
HN	HIGH NOON ®[CR 5844]
HP	HEIGHT OF PERIGEE
HST	HUBBLE SPACE TELESCOPE
HTD	HEDS TECHNOLOGY DEMONSTRATION
HULA	(NASA CONTINGENCY GROUND STATION LOCATED AT KAENA POINT, HI)
HVIU	HITCHHIKER VIDEO INTERFACE UNIT
I	INHIBIT
IC	INSTRUMENT CARRIER
IEH-3	INTERNATIONAL EXTREME ULTRAVIOLET HITCHHIKER
IFM	IN-FLIGHT MAINTENANCE
IMU	INERTIAL MEASUREMENT UNIT
IP	IMPACT POINT
IPS	INERTIAL POINTING SYSTEM
INCO	INSTRUMENTATION AND COMMUNICATIONS OFFICER
INFLT	IN-FLIGHT
I/O	INPUT/OUTPUT
ITA	SPACEHAB INTEGRATED TUNNEL ASSEMBLY
JDI	JONATHAN DICKINSON
JDMTA	JOHNATHAN DICKINSON MISSILE TEST ANNEX
JOIP	JOINT OPERATIONS INTERFACE PROCEDURES
JSC	LYNDON B. JOHNSON SPACE CENTER
KBPS	KILO BITS PER SEC
KOH	POTASSIUM HYDROXIDE
KSC	JOHN F. KENNEDY SPACE CENTER
KW	KILOWATTS

L	LEFT
LBS	POUNDS
LCC	LAUNCH COMMIT CRITERIA
LCG	LAMBERT CYCLIC GUIDANCE
LDR	LOW DATA RATE
LED	LIGHT EMITTING DIODE
LION	(NASA CONTINGENCY GROUND STATION LOCATED AT RAF OAKHANGER, UNITED KINGDOM)
LIRS	THE LOW IODINE RESIDUAL SYSTEM
LOS	LINE OF SIGHT
LPT	LOW POWER TRANSCEIVER
LRU	LINE REPLACEABLE UNIT
LSP	LAMINAR SOOT PROCESS
LTM	LANDMARK TRACK MANEUVER
LV	LOCAL VERTICAL
LVLH	LOCAL VERTICAL LOCAL HORIZONTAL

M	METER
	MEASURED
	MIDDECK
MAGR	MINIATURE AIRBORNE GPS RECEIVER
MAN	MANUAL
MASS	MINIATURE ACQUISITION SUN SENSOR
MAT	MATERIAL
MAX	MAXIMUM
MBPS	MEGA BITS PER SECOND
MCC	MISSION CONTROL CENTER
MCC-H	MISSION CONTROL CENTER - HOUSTON
MCC-M	MISSION CONTROL CENTER - MOSCOW
MCS	MAGNETIC CONTROL SYSTEM
MCIU	MANIPULATOR CONTROL INTERFACE UNIT
MCV	MICROBIAL CHECK VALVE
MDF	MINIMUM DURATION FLIGHT
MDM	MULTIPLEXER/DEMULTIPLEXER
MECO	MAIN ENGINE CUTOFF
MEIDEX	MEDITERRANEAN ISRAELI DUST EXPERIMENT
MEL	MINIMUM EQUIPMENT LIST
MESS	MAXIMUM ENVELOPE STORAGE SYSTEM
MET	MISSION ELAPSED TIME
MGBX	MIDDECK GLOVEBOX
MGM	MECHANICS OF GRANULAR MATERIALS
MILA	MERRITT ISLAND LAUNCH AREA
MIN	MINIMUM
MIST	WATER MIST EXPERIMENT
MLS	MICROWAVE LANDING SYSTEM
MM	MISSION MANAGER
MMACS	MECHANICAL, MAINTENANCE, ARM AND CREW SYSTEMS

MMT	MISSION MANAGEMENT TEAM
MMU	MASS MEMORY UNIT
MN	MAIN
MNB	MAIN BUS B
MOSA	MISSION OPS SUPPORT AREA
MPCC	MULTI-PROGRAM CONTROL CENTER
MPE	MISSION PECULIAR EQUIPMENT
MPFE	MICROBIAL PHYSIOLOGICAL FLIGHT EXPERIMENT
MPM	MANIPULATOR POSITIONING MECHANISM
MPS	MAIN PROPULSION SYSTEM
MRL	MANIPULATOR RETENTION LATCH
MSID	MEASUREMENT STIMULATION IDENTIFICATION
MSTRS	MINIATURE SATELLITE THREAT REPORTING SYSTEM
MTBF	MEAN TIME BETWEEN FAILURES
MTU	MASTER TIMING UNIT
MUX	MULTIPLEXER
N/A	NOT APPLICABLE
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NC	PHASE ANGLE ADJUSTMENT MANEUVER
NCC	NETWORK CONTROL CENTER
NOR	NORTHRUP LAKEBED LANDING SITE
NORM	NORMAL
NPLS	NEXT PRIMARY LANDING SITE
NSTS	NATIONAL SPACE TRANSPORTATION SYSTEM
NM	NAUTICAL MILES
O	OVERHEAD
OARE	ORBITAL ACCELERATION RESEARCH EXPERIMENT
	ORBITAL ACCELERATION RESEARCH EQUIPMENT
OCA	ORBITER COMMUNICATIONS ADAPTER
ODRC	ORBITAL DATA REDUCTION COMPLEX
ODS	ORBITER DOCKING SYSTEM
OI	OPERATIONAL INSTRUMENTATION
OIS	OPERATIONAL AND INTERCOM SYSTEM
OLIC	ON-ORBIT LEAK INTEGRITY CHECK
OME	ORBITAL MANEUVERING ENGINE
OMI	OPERATIONS AND MAINTENANCE INSTRUCTION
OMS	ORBITAL MANEUVERING SYSTEM
OPR	OPERATOR
OPS	OPERATIONS
OPT	OPTION
OSTEO	OSTEOPOROSIS EXPERIMENT IN ORBIT
OSVS	ORBITER SPACE VISION SYSTEM FLIGHT TESTING

PAO	PUBLIC AFFAIRS OFFICER
PCBA	PORTABLE CLINICAL BLOOD ANALYZER
PCF	PROTEIN CRYSTALLIZATION FACILITY
PCM	PULSE CODE MODULATOR
PCMMU	PULSE CODE MODULATION MASTER UNIT
PCUEP	PHASE CHANGE UPPER END PLATE
PDI	PAYLOAD DATA INTERLEAVER
PDIP	PAYLOAD DATA INTERFACE PANEL
PDL	PONCE DE LEON STATION
PDRS	PAYLOAD DEPLOY AND RETRIEVAL SYSTEMS
PDSU	POWER DISTRIBUTION AND SUPPLY UNIT
PF	PAYLOAD FORWARD
PF1	PAYLOAD FORWARD #1
PGSC	PAYLOAD AND GENERAL SUPPORT COMPUTER
PHA	PULSE HEIGHT ANALYSIS
PHAB4	PHYSIOLOGY AND BIOCHEMISTRY 4
PI	PAYLOAD INTERROGATOR
PIKE	(NASA CONTINGENCY GROUND STATION FOR S-BAND FM DOWNLINK LOCATED AT COLORADO TRACKING STATION, SCHRIEVER AFB, CO)
PIP	PAYLOAD INTEGRATION PLAN
PL	PAYLOAD
P/L	PAYLOAD
PLB	PAYLOAD BAY
PLBD	PAYLOAD BAY DOORS
PLHX	PAYLOAD HEAT EXCHANGER
PLS	PRIMARY LANDING SITE
PLT	PILOT
POCC	PAYLOAD OPERATIONS CONTROL CENTER
POL	PAYLOAD OPERATIONS LEAN
POSN	POSITION
PPRV	POSITIVE PRESSURE RELIEF VALVE
PRCB	PROGRAM REQUIREMENTS CONTROL BOARD
PRCS	PRIMARY REACTION CONTROL SYSTEM
PRE	PRELIMINARY
PRI	PRIMARY
PROP	PROPULSION
PROX	PROXIMITY
PSP	PAYLOAD SIGNAL PROCESSOR
PSRP	PAYLOAD SAFETY REVIEW PANEL
PTB	PAYLOAD TIMING BUFFER
QDM	QUICK DON MASK
R	RIGHT
RA	RIGHT ACENSION
RAM	RANDOM ACCESS MEMORY

RBAR	RADIUS VECTOR
RCS	REACTION CONTROL SYSTEM
RDM	SPACEHABE RESEARCH DOUBLE MODULE
REF	REFERENCE
REEF	(NASA CONTINGENCY GROUND STATION LOCATED AT DIEG O GARCIA, BRITISH INDIAN OCEAN TERRITORY)
REGRPL	REGRAPPLE
REP	REPRESENTATIVE
REL	RELEASE
REM	RELEASE ENGAGE MECHANISM
RF	RADIO FREQUENCY
R/F	REFRIGERATOR/FREEZER
RHC	ROTATIONAL HAND CONTROLLER
RHS	REHYDRATION STATION
RM	REDUNDANCY MANAGEMENT
RME	RISK MITIGATION EXPERIMENT
RMS	REMOTE MANIPULATOR SYSTEM
RNDZ	RENDEZVOUS
ROCC	RANGE OPERATIONS CONTROL CENTER
ROI	RADIUS OF INFLUENCE
ROT	ROTATION
RPOP	RENDEZVOUS PROX OPS PROGRAM
RR	RENDEZVOUS RADAR
RS	REDUNDANT SET
RSAD	RMS SITUATIONAL AWARENESS DISPLAY
RSCS	RACK SUCTION COOLING SYSTEM
RSGF	RIGIDIZE SENSING GRAPPLE FIXTURE
RSS	RACK SUPPORT STRUCTURE
RTLS	RETURN TO LAUNCH SITE
RTS	REMOTE TRACKING STATION

SAA	SOUTH ATLANTIC ANOMALY
SAMS	SPACE ACCELEROMETER SYSTEM
SAMS-FF	SPACE ACCELEROMETER SYSTEM FREE FLYER
SAREX	SHUTTLE AMATEUR RADIO EXPERIMENT
SEC	SECOND
SEH	SOLAR EXTREME ULTRAVIOLET HITCHHIKER
SEM	SPACE EXPERIMENT MODULE
SEP	SEPARATION
SF_6	SULFUR HEXAFLUORIDE
SH	SPACEHAB
SHPM	SPACEHAB PROGRAM MANAGER
SHO	SATELLITE HANDOVER
SHOD	SPACEHAB OPERATIONS DIRECTOR
SHPM	SPACEHAB PROGRAM MANAGER
SI	SOLAR INERTIAL
SIGI	SPACE INTEGRATED GLOBAL POSITIONING SYSTEM/INTERNAL NAVIGATION SYSTEM
SIMO	SIMULTANEOUS

SJ	SINGLE JOINT
SLS	SECONDARY LANDING SITE
SLWT	SUPER LIGHT-WEIGHT TANK
SM	SYSTEMS MANAGEMENT
SMAC	SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATION
SODB	SHUTTLE OPERATIONAL DATA BOOK
SOFBALL	STRUCTURE OF FLAME BALLS AT LOW LEWIS-NUMBER
SOLCON	SOLAR CONSTANT EXPERIMENT
SOLSE	SHUTTLE OZONE LIMB SOUNDING EXPERIMENT
SPC	STORED PROGRAM COMMAND
SQ	SQUARE
SR	SUNRISE
SRB	SOLID ROCKET BOOSTER
SS	SUNSET
SSP	SPACE SHUTTLE PROGRAM
	STANDARD SWITCH PANEL
SSR	SOLID STATE RECORDER
ST	STAR TRACKER
STARNAV	STAR NAVIGATION
STARS BOOTES	SPACE TECHNOLOGY AND RESEARCH STUDENTS BOOTES
STBD	STARBOARD
STDN	SPACECRAFT TRACKING AND DATA NETWORK
STS	SUNRISE THROUGH SUNSET
SUPA	SHUTTLE URINE PRETREAT ASSEMBLY
SYS	SYSTEM
T	TAKEOFF
TACAN	TACTICAL AIR NAVIGATION
TAEM	TERMINAL AREA ENERGY MANAGEMENT
TAL	TRANSATLANTIC ABORT LANDING
TB	TALK BACK
TBD	TO BE DETERMINED
TDRS	TRACKING AND DATA RELAY SATELLITE
TDRSS	TRACKING AND DATA RELAY SATELLITE SYSTEM
TEHM	THERMOELECTRIC HOLDING MODULE
TFL	TELEMETRY FORMAT LOAD
THC	TRANSLATIONAL HAND CONTROLLER
TI	TERMINAL PHASE INITIATION
TIG	TIME OF IGNITION
TK	TANK
TPS	THERMAL PROTECTION SYSTEM
TRANS	TRANSLATION
TSU	TRAJECTORY SERVER UPGRADE
TVIP	TELEVISION INTERFACE PANEL
UCB	URINE COLLECTION BAG

V	VELOCITY
VBAR	VELOCITY VECTOR
VCD	VAPOR COMPRESSION DISTILLATION
VCD FE	VAPOR COMPRESSION DISTILLATION FLIGHT EXPERIMENT
VERN	VERNIER
VFEU	VESTIBIULAR FUNCTION EXPERIMENT UNIT
VGS	VIDEO GUIDANCE SENSOR
VIP	VACUUM ION PUMP
VLA	VERY LARGE ARRAY
VRCS	VERNIER REACTION CONTROL SYSTEM
VV	VELOCITY VECTOR
W	WATTS
WCS	WASTE COLLECTION SYSTEM
WDC	WATCH DOG CIRCUIT
WLPS	WALLOPS ISLAND
W/S	WHEEL STOP
WSC	WHITE SANDS COMPLEX
WT	WEIGHT
ZCG	ZEOLITE CRYSTAL GROWTH
ZOE	ZONE OF EXCLUSION

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NASA JSC
AC5/J. W. Young
AP4/R. Navias (2)
AG/J. H. Greene
GP23/STI Center (2)
CB/Chief
DA/J. C. Harpold
DA8/Book Manager (35)
DA82/Action Center (8)
DA83/MOD Library (2)
DA83/MOD Lib Update Task (6)
DF22/DPS Flt Rules Rep (3)
DF23/C&T (5)
DF24/Comm Sys (4)
DF25/C&DH (5)
DF52/R. C. Doremus (4)
DF53/Flight Rule Lead
DF53/OSO Library Mgr (3)
DF53/Flight Lead (2)
DF62/Group Lead (4)
DF63/Group Lead (7)
DF64Group Lead (8)
DF7/R. E. Armstrong (5)
DF74/Library (5)
DF76/Group Lead (3)
DF82/Acting Group Lead (12)
DF83/C. Tyrell (5)
DF84/Flight Lead (5)
DM21/Lead FDM
DM32/Group Lead (8)
DM32/F. B. Lowes
DM33/Group Lead (2)
DM34/Group Lead (2)
DM4/Library (2)
DM43/G. E. Pogue (2)
DM46/W. E. Powers (3)
DO12/Safety Office
DO13/HSG-H Library (3)
DO13/HSG-M Library (3)
DO13/MSR Library
DO13/TTI Library (2)
DO4/FDF Library (3)
DO4/Lead FAO (4)
DO4/Lead Pointer
DO4/Lead Timeline
DO4/Lead Ops Planner (3)
DO4/Lead RPE
DO5/D. D. Stapleton
DO5/ACO/Payload Officer (12)
DO5/Lead ISO
DT22/CDH Library (2)
DT26/Station Training Lead
DT34/Library
DT35/Section Library
DT37/Manager (2)
DT37/J. Zeh (2)
DV/GSFCRO
DX22/Group Lead (6)
DX25/RMS Library
DX32/S. B. Person (5)
DX32/EVA Flt Lead
EC5/S. Peterson
EC6/H. A. Rotter
ES/G. F. Galbreath
ES3/H. Chang
EV/16-Library
EV16/R. I. Macias (2)
MA/R. D. Dittemore
MA2/L. J. Ham
MS2/R. O. Wallace
MT3/A. E. Sweet
MV1/D. L. McCormack
NC62/S. Moran
NE2/P. J. Bennett
NE2/C. A. Crawford
NE42/B. Dick (2)
NQ113/D. W. Pate
NT52/M. Caro
OA/W. H. Gerstenmaier
OB/ISS MER Manager
OC/S. L. Creasy
OC/Console Support (2)
OD/P. J. Cerna
OE/L. Gana
OR/W. A. Mackey (2)
SA/J. R. Davis
SD2/P. Stepaniak
SD24/T. Gaston (4)
SD26/J. Clark (3)
SF6/K. M. Krumrey
SM2/B. A. Bahr
XA/G. A. Flynt
XA/C. H. Seaman
ZR1/AF Tech Library (3)
ZS8/Lead Forecaster
B30S/MER Library (3)

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C42/S. P. Hennigan

PATRICK AFB DOD
45RANS/DOUF (2)
45SPW/SEO
CSR-3200
CSR 3202

Boeing – Huntington Beach, CA
H017-D307/R. Rose
H017-D307/J. Ward
H017-D416/S. Copenhaver
N45-E135/B. J. McMillan
AA05/D. L. Woolhouse

BOEING-HOUSTON
HB2-10/ISS MER Manager
HB2-10/M. Baggerley
HB2-20/S. H. Stephen
HB5-10/D. Schuaab
HB5-10/L. K. Railsback
HS2-10/S. J. Sheffield
HS2-20/R. Gatica
HS-21/T. E. Goetz
HS-22/Flight Manager
HS3-30/S. L. Phillips
HS-43/Operations Lead
JHOU/ZC01/S. Arrieta
JHOU/ZC01/C. S. Asuncion
JHOU/ZC01/F. N. Humphry
JHOU/ZC01/L. W. Jenkins
JHOU/ZC01/D. W. Camp
JHOU/ZC01/H. N. Vu
JHOU/2620/L. Ramon
HZ1-10/D. J. Coronado
HZ1-10/R. A. Kagawa
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SPACE SHUTTLE OPERATIONAL FLIGHT RULES ANNEX

FLIGHT STS-107

FINAL

PREFACE

THIS DOCUMENT, DATED JUNE 20,2002, CONTAINS THE FINAL VERSION OF THE STS-107 FLIGHT-SPECIFIC FLIGHT RULES AND IS INTENDED TO BE USED IN CONJUNCTION WITH THE SPACE SHUTTLE OPERATIONAL FLIGHT RULES, NSTS-12820, VOLUME A, WHICH CONTAIN THE GENERIC FLIGHT RULES FOR ALL FLIGHTS.

THE FLIGHT RULE NUMBERING SYSTEM HAS BEEN UPDATED. THE NEW NUMBERS WILL MAKE RULES EASIER TO REFERENCE BOTH PRE-MISSION AND IN THE CONTROL CENTER. AN EXPLANATION OF THE UPDATED NUMBERING SYSTEM IS SHOWN ON PAGE VII.

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

ALL FLIGHT RULES ARE AVAILABLE ON THE INTERNET. THE URL IS: **HTTP://MOD.JSC.NASA.GOV/DA8**. NO ID OR PASSWORD WILL BE REQUIRED TO ACCESS ANY OF THE RULES PROVIDED THE USER IS ACCESSING FROM A TRUSTED SITE (ALL NASA CENTERS, CONTRACTORS, AND INTERNATIONAL PARTNERS). IF UNABLE TO ACCESS, USERS NEED TO SEND AN E-MAIL NOTE TO DA8/M. L. GRIFFITH (MARY.L.GRIFFITH1@JSC.NASA.GOV) WITH THEIR FULL NAME, COMPANY, IP ADDRESS, AND A JUSTIFICATION STATEMENT FOR ACCESS.

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

APPROVED BY:

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MANAGER, SPACE SHUTTLE PROGRAM

SECTION 1 - GENERAL, AUTHORITY, AND DEFINITIONS

GENERAL

AUTHORITY

FCR RESPONSIBILITIES

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SECTION 1 - GENERAL, AUTHORITY, AND DEFINITIONS

GENERAL

107_1A-1 FLIGHT RULE APPLICABILITY

THIS DOCUMENT CONTAINS THE STS-107 FLIGHT-SPECIFIC FLIGHT RULES AND IS INTENDED TO BE USED IN CONJUNCTION WITH THE SPACE SHUTTLE OPERATIONAL FLIGHT RULES, NSTS-12820, VOLUME A, WHICH CONTAIN THE GENERIC FLIGHT RULES FOR ALL FLIGHTS.

107_1A-2 VEHICLE CONFIGURATION

STS-107/OV-102 FLIGHT SPECIFIC VEHICLE CONFIGURATIONS AS RELATED TO THE GENERIC RULES ARE LISTED IN THE FOLLOWING TABLE:

TABLE 107_1A-2-I

VEHICLE CONFIG DEPENDENT RULES	COMPONENT/ SYSTEM	CONFIGURATION
SECTIONS A#.6.#, {A13-156}, {A17-202}, {A17-302}	SPACEHAB	RESEARCH DOUBLE MODULE
{A10-361}, {A10-362}, {A10-363}, {A10-364}, {A10-365}	VIEWPORT	YES
{A15-201}, {A15-202}, {A17-202}, {A17-302}, {A18-60}, {A18-61}, {A18-62}, {A18-306}	AIRLOCK	INTERNAL
{A17-202}, {A17-302}	TUNNEL ADAPTER	YES
{A10-341}, {A10-342}, {A10-343}, {A10-344}, {A10-345}, {A10-346}	ODS	NO
{A10-281}	PRLA	N/A
{A2-112}, SECTION 12	PDRS	NO
{A2-105}, {A2-1001}, {A7-102}, {A7-5}, {A7-109}, {A7-1001}, {A8-18}	DISPLAY SYSTEM	MEDS
{A15-26}	SSOR/SSER	YES
{A9-257}, {A9-262}	CRYO TANK SET	9
{A17-202}, {A17-302}	N_2 TANK SET	5 (OFF-LOADED TO THE EQUIVALENT OF 4)
{A2-1001}, {A13-152}, {A13-155}, {A17-53}, {A17-106}, {A17-155}, {A17-156}, {A17-1001}	CO_2 CONTROL	LIOH

®[ED]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-2 VEHICLE CONFIGURATION (CONTINUED)

TABLE 107_1A-2-I (CONTINUED)

VEHICLE CONFIG DEPENDENT RULES	COMPONENT/ SYSTEM	CONFIGURATION
{A10-73}	HYD ACCUMULATOR	BELLOWS (ALL)
{A13-30}, {A17-551}	IODINE REMOVAL	GIRA PRIME
{A2-1001}, {A9-154}, {A18-256}, {A18-1001}	RAD ISOLATION VALVE	YES
{A9-154}, {A17-3}, {A17-103}, {A17-151}, {A17-153}, {A17-154}, {A17-1001}	AV BAY 3A FAN	STD AVIONICS BAY FAN
{A2-265}	GPS	SINGLE STRING
{A9-154}	TACAN	GOULD (ALL 3 SLOTS)
{A5-2}, {A5-10}, {A5-11}, {A5-12}, {A5-153}	SSME	C - BLOCK II L - BLOCK II R - BLOCK II
{A6-2}, {A6-3}	OMS	L - 116 R - 114
{A2-105}	SPARE HUD	NO
{A2-105}	PAYLOAD RECORDER	YES
{A2-323}	SPARE PDI	YES

®[DN 84] ®[ED]

107_1A-3 PAYLOAD OPERATIONS ASSESSMENT

FOR PAYLOAD OPERATIONS GO/NO-GO DECISION PURPOSES, PAYLOAD AND SPACECRAFT SYSTEM CAPABILITY ASSESSMENTS WILL BE BASED ON THE BEST ESTIMATE OF THEIR CAPABILITY TO MEET THE MINIMUM FLIGHT REQUIREMENTS. SYSTEMS PERFORMANCE CAPABILITY IN EXCESS OF SPECIFICATION REQUIREMENTS WILL BE CONSIDERED USABLE.

Reference Rules {107_19A-1}, SPACEHAB MINIMUM MISSION OBJECTIVES and {107_20A-1}, FREESTAR MINIMUM MISSION OBJECTIVES. ®[DN 12]

107_1A-4 ORBITER COORDINATE SYSTEM

THE ORBITER BODY AXIS COORDINATE SYSTEM WILL BE USED WITHIN THE FLIGHT RULES CONTEXT. THIS AXIS SYSTEM IS DEFINED AS A RIGHT-HANDED, ORTHOGONAL COORDINATE SYSTEM WITH THE +X AXIS EXTENDING FORWARD (THROUGH THE ORBITER NOSE), AND THE +Y AXIS EXTENDING TO STARBOARD. THE +Z AXIS COMPLETES THE RIGHT-HAND SYSTEM AND EXTENDS DOWNWARD (THROUGH THE ORBITER BELLY).

This coordinate system is used onboard the orbiter by the orbiter flight software. It is different than the orbiter structural axis system used in the Payload Integration Plan (PIP) which has the +X axis extending aft through the orbiter tail, and the +Z axis extending upwards out of the payload bay. The +Y axis in both systems is the same (extends to orbiter starboard).

AUTHORITY

107_1A-11 FLIGHT DIRECTOR AUTHORITY

A. THE NASA FLIGHT DIRECTOR (FD) IS THE FINAL AUTHORITY IN CONTINUING THE SPACE SHUTTLE INTERFACE TO THE PAYLOAD.

Self-explanatory.

B. THE FLIGHT DIRECTOR, AFTER ANALYSIS OF THE FLIGHT CONDITION, MAY CHOOSE TO TAKE ANY NECESSARY ACTION REQUIRED FOR THE SUCCESSFUL COMPLETION OF THE FLIGHT CONSISTENT WITH CREW SAFETY.

Self-explanatory.

C. THE FLIGHT DIRECTOR IS RESPONSIBLE FOR OVERALL FLIGHT OPERATIONS INTEGRATION AND EXECUTION FROM SOLID ROCKET BOOSTER (SRB) IGNITION UNTIL CREW EGRESS OR GROUND SUPPORT EQUIPMENT (GSE) COOLING ACTIVATION, WHICHEVER OCCURS LATER. AT THIS TIME, THE FLIGHT DIRECTOR WILL TRANSFER OVERALL RESPONSIBILITY TO THE GROUND OPERATIONS MANAGER (GOM).

These rule statements are intended to more specifically define this authority within the context of mission operations. JSC Mission Operations is not responsible for control of Spacehab subsystem operations.

107_1A-12 MISSION MANAGEMENT TEAM (MMT)

A. THE MMT CONSISTS OF:

1. MANAGER, SPACE SHUTTLE PROGRAM

2. SPACE SHUTTLE ELEMENTS (AS SPECIFIED BY SPACE SHUTTLE PROGRAM OFFICE)

3. MISSION OPERATIONS DIRECTOR

4. CARGO MANAGEMENT TEAM (CMT) ®[DN 13]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-12 MISSION MANAGEMENT TEAM (MMT) (CONTINUED)

Every attempt will be made preflight to predict potential anomaly and contingency situations and establish the best course of action. However, for those contingencies not covered in the preflight documentation, a structure exists to provide customer inputs and decisions to the mission management and the Flight Control Teams (FCT's). This structure is the Mission Management Team (MMT).

The MMT at JSC consists of NASA mission management and payload management representatives. The NASA mission management includes the Manager, Space Shuttle Program, or his designated representative, the Director of Mission Operations, the Cargo Management Team, and other appropriate NASA management. The Cargo Management Team is physically located at JSC and is chaired by the Space Shuttle Flight Manager (Space Shuttle Program Integration Office). The payload management representative includes the Payload Mission Manager(s), or his designated representative. ®[DN 13]

The purpose of the MMT is to provide management direction and decisions when mission events fall outside the scope of predefined real-time operations roles and responsibilities. If mission circumstances require an unanticipated change in the major mission objective or operations policy, the operations team will recommend a course of action and identify options to the MMT. The MMT evaluates the operations team's recommendation and provides direction to implement the agreed course of action.

B. THE MISSION MANAGEMENT TEAM IS RESPONSIBLE FOR PROVIDING NEAR REAL-TIME POLICY AND OVERALL MISSION DIRECTION WHENEVER OPERATIONS OUTSIDE THE SHUTTLE/PAYLOAD MISSION RULES OR OPERATING BASE ARE REQUIRED.

C. THE MANAGER, SPACE SHUTTLE PROGRAM (OR HIS DESIGNATED REPRESENTATIVE), AS CHAIRMAN OF THE MISSION MANAGEMENT TEAM, IS THE FINAL AUTHORITY FOR COMMITTING THE SPACE SHUTTLE SYSTEM TO ACCOMPLISH UNPLANNED TASKS FOR WHICH SPACE SHUTTLE SAFETY AND/OR OPERATIONAL RISK ARE GREATER THAN PLANNED PREMISSION.

D. THE FLIGHT MANAGER (OR HIS DESIGNATED REPRESENTATIVE) CHAIRS THE CMT. THE FLIGHT MANAGER PROVIDES THE CMT LAUNCH GO TO THE MMT UPON STATUSING THE PAYLOAD/EXPERIMENT ORGANIZATIONS FOR READINESS. THE FLIGHT MANAGER, AS CMT CHAIR, OVERSEES THE FLIGHT MANIFEST OPERATIONS FROM THE CUSTOMER SUPPORT ROOM (CSR), RESOLVING PRIORITY ISSUES, AND COORDINATING AND/OR OVERSEEING THE RESOLUTION OF ANY OTHER FLIGHT MANIFEST ISSUE. ®[DN 13]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-12 MISSION MANAGEMENT TEAM (MMT) (CONTINUED)

E. THE PAYLOAD MISSION MANAGER (OR HIS DESIGNATED REPRESENTATIVE), AS A MEMBER OF THE CARGO MANAGEMENT TEAM, IS THE FINAL AUTHORITY WITHIN HIS PAYLOAD COMPLEMENT ON PAYLOAD MISSION OBJECTIVES OR POLICY CHANGES AND FOR COMMITTING THE PAYLOAD TO ACCOMPLISH TASKS FOR WHICH THE OPERATIONAL RISK IS GREATER THAN PLANNED PREMISSION. ®[DN 13]

The Payload Mission Manager (or his representative) is a member of the CMT and makes the final decision regarding payload objectives within his payload complement to the Flight Manager. The Payload Mission Manager for Spacehab is the Spacehab Program Manager and the Payload Mission Manager for FREESTAR is the FREESTAR Mission Manager. Reference Rule {107_1A-14}, PAYLOAD OPERATIONS/MANAGEMENT AUTHORITY, for additional information. Payload Mission Manager for RAMBO is DOD REP. ®[DN 13] ®[CR 5895A]

107_1A-13 FLIGHT CONTROL TEAM (FCT)

A. THE FCT IS RESPONSIBLE FOR EXECUTING THE FLIGHT WITHIN THE GUIDELINES AND AUTHORITY ESTABLISHED WITHIN THE SPACE SHUTTLE OPERATIONAL FLIGHT RULES.

B. THE FLIGHT DIRECTOR AND VARIOUS PAYLOAD OPERATIONS DIRECTORS ARE THE PRIMARY POINTS OF CONTACT FOR OPERATIONS COORDINATION ALTHOUGH THE PRIMARY PAYLOAD OPERATIONS CONTROL CENTER (POCC) INTERFACE TO THE MISSION CONTROL CENTER (MCC) FCT IS NOMINALLY THROUGH THE MCC PAYLOAD OFFICER.

C. (FLIGHT SPECIFIC)

ORGANIZATION	LOCATION	CALL SIGN	TITLE
SPACE SHUTTLE	HOUSTON MCC	HOUSTON FLIGHT	NASA FLIGHT DIRECTOR
SPACE SHUTTLE	HOUSTON MCC	PAYLOADS	NASA PAYLOAD OFFICER
SPACEHAB	JSC POCC	SHOD	SPACEHAB OPS DIRECTOR
FREESTAR	GSFC POCC	HH OPS	HITCHHIKER OPERATIONS DIRECTOR
RAMBO	DOD POCC (JSC)	DOD REP	DOD REPRESENTATIVE

®[DN 89] ®[CR 5534] ®[CR 5895A]

107_1A-14 PAYLOAD OPERATIONS/MANAGEMENT AUTHORITY

A. SPACEHAB

1. SPACEHAB PROGRAM MANAGER (SHPM) AUTHORITY

a. PRELAUNCH THE SHPM OR HIS DESIGNATED REPRESENTATIVE MAY REQUEST LAUNCH HOLDS VIA MCC-H FOR GROUND SUPPORT FACILITIES ANOMALIES THAT VIOLATE LAUNCH COMMIT CRITERIA. ®[DN 14]

b. POST LAUNCH THE SHPM OR HIS DESIGNATED REPRESENTATIVE IS THE FINAL AUTHORITY FOR SPACEHAB MODULE SYSTEMS-RELATED DECISIONS. THE SHPM, AFTER ANALYSIS OF THE SPACEHAB SYSTEMS CONDITION, MAY CHOOSE TO TAKE ANY NECESSARY SYSTEMS ACTION REQUIRED TO PRESERVE SYSTEMS CAPABILITY.

2. SPACEHAB OPERATIONS DIRECTOR (SHOD) AUTHORITY

THE SHOD IS RESPONSIBLE FOR DIRECTING THE TECHNICAL SPACEHAB FCT MEMBERS AND HAS THE PRIMARY AUTHORITY TO MAKE REAL-TIME OPERATIONS DECISIONS FOR THE SPACEHAB MODULE SYSTEMS.

THE SHOD IS THE PRIMARY POINT OF CONTACT TO THE PAYLOAD OFFICER AND COORDINATES SPACEHAB SYSTEMS, RESPONSES TO SPACEHAB RELATED ANOMALIES, RESPONSES TO SPACE SHUTTLE PROGRAM (SSP) FCT INQUIRES, CHANGES TO EXPERIMENT OPERATIONS, AND REQUESTS FOR ORBITER INFORMATION AND SERVICES. ®[DN 14]

THIS RULE CONTINUED ON NEXT PAGE

107_1A-14 PAYLOAD OPERATIONS/MANAGEMENT AUTHORITY (CONTINUED)

B. FREESTAR

1. THE HITCHHIKER OPERATIONS DIRECTOR (HH OPS), LOCATED AT THE GSFC POCC, ACTS AS THE PRINCIPAL OPERATIONS INTERFACE TO THE MCC PL OFFICER. THE HH OPS DIRECTOR REPRESENTS THE FREESTAR PAYLOAD.

2. THE FREESTAR MISSION MANAGER, LOCATED AT THE GSFC POCC, IS THE FINAL AUTHORITY FOR FREESTAR-RELATED DECISIONS.

3. THE HITCHHIKER REPRESENTATIVE (HH REP), LOCATED AT THE JSC CSR, IS THE FINAL AUTHORITY FOR FREESTAR RELATED DECISIONS IF THE FREESTAR MISSION MANAGER IS UNABLE TO BE REACHED.

C. RAMBO ®[CR 5534] ®[CR 5895A]

THE DEPARTMENT OF DEFENSE REPRESENTATIVE (DOD REP), LOCATED AT THE JSC DOD POCC, IS THE FINAL AUTHORITY FOR RAMBO-RELATED DECISIONS. ®[DN 14] ®[CR 5534] ®[CR 5895A]

FCR RESPONSIBILITIES

107_1A-21 DEVELOPMENT TEST OBJECTIVE (DTO)/DETAILED SUPPLEMENTARY OBJECTIVE (DSO)/RISK MITIGATION EXPERIMENT (RME)/HUMAN EXPLORATION AND DEVELOPMENT OF SPACE TECHNOLOGY DEMONSTRATION (HTD) FCR RESPONSIBILITIES

THE FOLLOWING FCR POSITIONS ARE RESPONSIBLE FOR THE LISTED DTO'S, DSO'S, RME'S, AND HTD'S.

A. GUIDANCE, NAVIGATION, AND CONTROL (GNC):

1. DTO 805 CROSSWIND LANDING PERFORMANCE (DTO OF OPPORTUNITY)

2. DTO 700-14 SINGLE STRING GLOBAL POSITIONING SYSTEM – NO PAYLOAD AND GENERAL SUPPORT COMPUTER (PGSC) OPTION

B. SURGEON:

1. DSO 632 PHARMACOKINETICS & CONTRIBUTING PHYSIOLOGIC CHANGES DURING SPACE FLIGHT-PROTOCOL B (PRE/POST FLIGHT) ®[CR 5489]

2. DSO 635 SPATIAL REORIENTATION FOLLOWING SPACE FLIGHT (PRE/POST FLIGHT)

3. DSO 498 SPACE FLIGHT AND IMMUNE FUNCTION (NO IN-FLIGHT CREW TIME OR STOWAGE IS REQUIRED) ®[DN 15] ®[CR 5489]

107_1A-22 SUPPORT EQUIPMENT FCR RESPONSIBILITY ®[DN 16]

THE FOLLOWING EQUIPMENT USED IN SUPPORT OF THE PAYLOADS IS THE RESPONSIBILITY OF THE FCR DISCIPLINES AS INDICATED:

A. PAYLOAD DATA INTERFACE PANEL (PDIP):

1. ELECTRICAL OUTLETS - EGIL

2. PAYLOAD DATA INTERFACE PANEL (PDIP) COMM PORTS - PAYLOADS (J101,J103,J105), (INCO) (J107)

3. KU-BAND RATE SWITCH - INCO

4. KU-BAND DATA I/O PORT AND JUMPER PLUG - FAO ®[DN 2] ®[DN 16]

Comm port J101 is used by Mediterranean Israeli Dust Experiment (MEIDEX) to route experiment video to the orbiter. J103 is used by MEIDEX for PGSC interface. J105 is used to establish a command and data interface between BIOPACK and Spacehab. J107 is used by SSV for VSU & PDI interface. The Ku-Band rate switch is the responsibility of INCO due to its interface to the Ku Signal Processor and potential for interrupting Spacehab Ku Channel 2 and 3 data. FAO provides expertise on the Ku-Band Data I/O connector used to route data via the Orbiter Communications Adapter (OCA). A Jumper Plug installed on the Ku-Band Data I/O port is necessary to complete the Ku-band Forward Link command path to Spacehab. This plug will be installed prelaunch. There is also a stowed backup plug. ®[DN 2] ®[CR 5536]

B. DIGITAL TELEVISION (DTV) – INCO

DTV is flown in support of the MEIDEX payload. The full DTV system has been integrated into the vehicle such that the MUX controls the source of PL MAX data (Spacehab or DTV video) to Channel 3 of the Ku-band Signal Processor (KuSP).

C. STANDARD SWITCH PANELS (SSP) - PAYLOADS

For STS-107, there are two SSP's being flown at the L12 location. SSP-1 supports FREESTAR and OARE and SSP-2 supports Spacehab and the PDIP.

D. OCA - FAO

THIS RULE CONTINUED ON NEXT PAGE

107_1A-22 SUPPORT EQUIPMENT FCR RESPONSIBILITY (CONTINUED)

E. PGSC RESPONSIBILITIES: ®[DN 16]

1. ORBITER PROVIDED PGSC HARDWARE - FAO
2. SPACEHAB PROVIDED LAPTOP COMPUTERS - PAYLOADS
3. PCDECOM SOFTWARE – FAO
4. GPS DTO 700-14 SOFTWARE - GNC
5. MEIDEX AND SHUTTLE OZONE LIMB SOUNDING EXPERIMENT (SOLSE)-2 (HH-JR/BIA) SOFTWARE – PAYLOADS ®[CR 5844]
6. SPACEHAB AND EXPERIMENT SOFTWARE - PAYLOADS

The purpose of this Rule is to define the FCT points of contact for equipment used in support of payloads. Reference Rule {107_2A-54}, PGSC USAGE GUIDELINES, for additional information on PGSC and SH Laptop computer usage. ®[DN 16]

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SECTION 2 - FLIGHT OPERATIONS

PRELAUNCH

ASCENT/ENTRY/POST-LANDING

ORBIT

GENERAL

PAYLOAD CONSTRAINTS

ATTITUDE/POINTING CONSTRAINTS

SECTION 2 - FLIGHT OPERATIONS

PRELAUNCH

107_2A-1 LAUNCH WINDOW

A. ON JANUARY 16, 2003, THE LAUNCH WINDOW OPENS AT 15:39 GREENWICH MEAN TIME (GMT) AND CLOSES AT 18:09 GMT. ®[CR 5556A] ®[CR 5868A]

1. THE LAUNCH WINDOW OPENS ON 2-2-2 KSC AND EDW. ®[CR 5868A]

2. CLOSING OF THE WINDOW IS CONSTRAINED BY THE 2.5-HOUR CREW ON BACK TIME CONSTRAINT.

3. FOR SCHEDULING AND NOTIFICATION PURPOSES, THE LAUNCH CLEARANCE WINDOW (LAUNCH PERIOD) IS 4 HOURS IN DURATION. THE LAUNCH PERIOD IS 1500 TO 1900 GMT. ®[CR 5556A] ®[CR 5871]

B. MEDITERRANEAN ISRAELI DUST EXPERIMENT (MEIDEX) REQUIRES A LAUNCH WINDOW THAT WILL TAKE THE ORBITER THROUGH THE TWO PRIMARY MEIDEX ROIS DURING DAYLIGHT HOURS SUCH THAT THE SPECIFIED SOLAR ZENITH ANGLE OVER THE ROI IS SATISFIED FOR A COMBINED MINIMUM OBSERVATION TIME OF NO LESS THAN 140 MINUTES. A SOLAR ZENITH WITHIN 45 DEG IS REQUIRED IF THE LAUNCH DATES FALL BETWEEN MARCH 7TH THROUGH SEPTEMBER 23RD. OUTSIDE OF THIS TIMEFRAME, THE SOLAR ZENITH ANGLE IS REQUIRED TO BE WITHIN 70 DEG. ®[CR 5845]

Solar declination prohibits meeting the 45 deg constraint for the duration of the mission if the launch date falls outside of the March 7th to September 23rd timeframe. If the launch occurs outside of this timeframe, MEIDEX highly desires that operations are maximized when the solar zenith angle is within 60 deg or less over the ROI. MEIDEX solar zenith angle definition is the angle between the Sun and orbiter zenith, unless a specific ground location is chosen. In that case, the solar zenith angle definition is the angle between the Sun and the groundsite zenith. The Mediterranean ROI is defined by Latitude 31 N to 39 N and Longitude 0 (Greenwich) to 35E. The Atlantic ROI is defined by 15 N Latitude/35 W Longitude, 15 N Latitude/20 W Longitude, 5 N Latitude/10 W Longitude, 5 N Latitude/5 E Longitude, 5 S Latitude/5 E Longitude, and 5 S Latitude/35 W Longitude. MEIDEX desires to be flown between the months of September and June, as the standard atmospheric profile during July and August provide few opportunities for viable sampling. MEIDEX highly desires to be flown during the months of March-May or September-October due to enhanced probability for dust events in the Mediterranean ROI (where peak intensity and activity of desert aerosols occur during the spring and fall). If mission operations occur during the months of July or August, then the Atlantic ROI will be enlarged to 25 N (where dust plumes migrate during this period). ®[CR 5845]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-1 LAUNCH WINDOW (CONTINUED)

C. THE PREDICTED USABLE MAIN PROPULSION SYSTEM (MPS) RESIDUALS AT NOMINAL MAIN ENGINE CUTOFF (MECO) MUST BE GREATER THAN OR EQUAL TO 2.93-SIGMA PLUS MEAN IN-FLIGHT PERFORMANCE RESERVE. ®[CR 5556A]

Ascent Performance Margin (APM) can be reduced from the standard 3-sigma value to 2.93-sigma. This reduction protects all Range Safety constraints and meets the payload altitude requirements defined in the CIP (150 circular). This reduction in APM is equivalent to a 3-feet/second underspeed and this can be made up with the existing Orbital Maneuvering System (OMS) and forward RCS propellant margin. This 3-fps underspeed reduces the MECO apogee from 153 to 151.5 nm which is the payload minimum altitude constraint. Thus, all performance margins and LOX drainback times on launch day will be computed using the 2.93-sigma level. ®[CR 5556A] ®[CR 5868A]

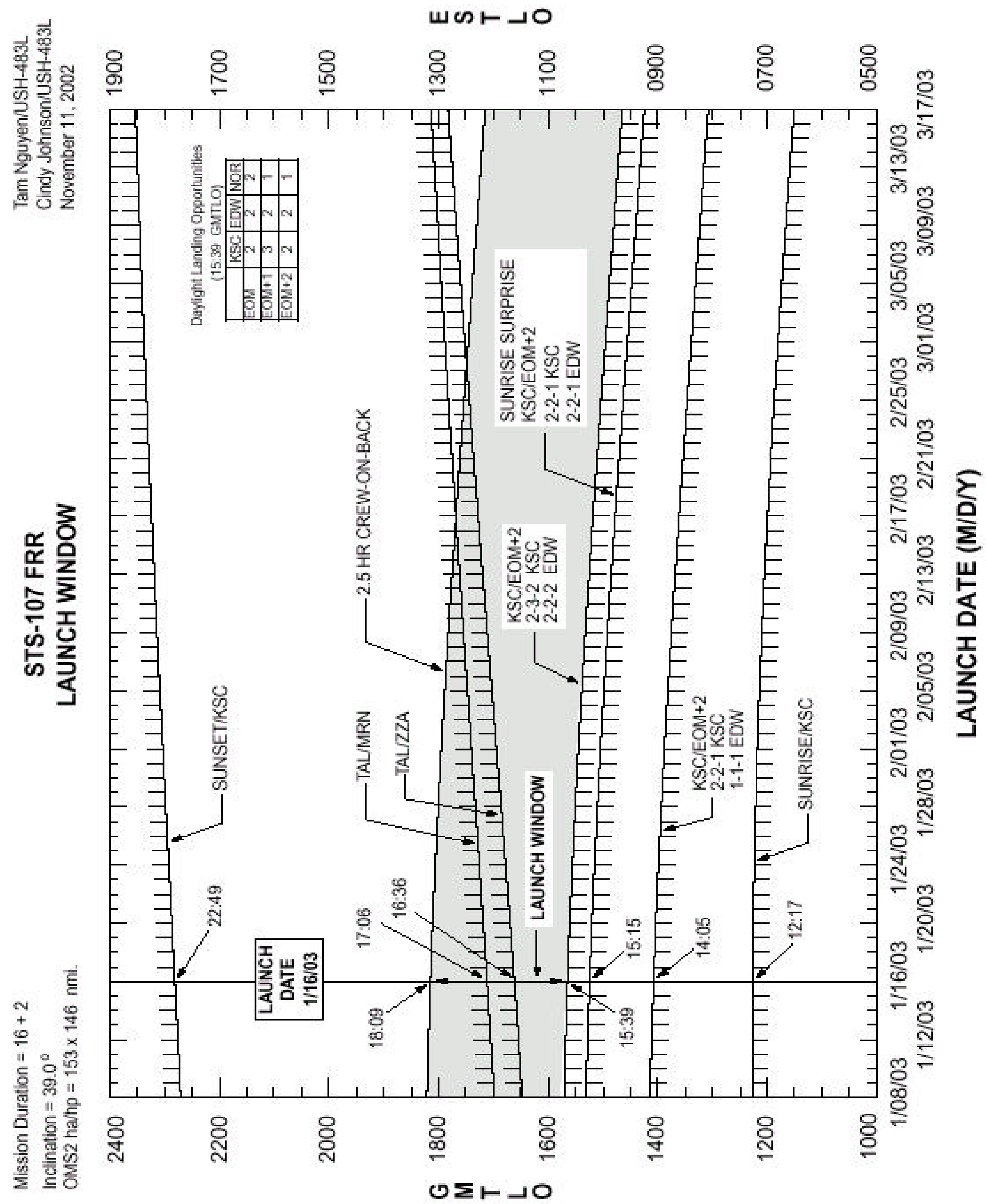
D. THE STANDARD LAUNCH WINDOW GRAPH IS SHOWN AS TABLE 107_2A-1-I.

E. THE LAUNCH WINDOW DIGITAL DATA IS SHOWN AS TABLE 107_2A-1-II.

THIS RULE CONTINUED ON NEXT PAGE

107_2A-1 LAUNCH WINDOW (CONTINUED)

TABLE 107_2A-1-I - COMPOSITE LAUNCH WINDOW GRAPH



®[CR 5556A] ®[CR 5868A]

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107_2A-1 LAUNCH WINDOW (CONTINUED)

TABLE 107_2A-1-II - LAUNCH WINDOW DIGITAL DATA

November 11, 2002

Tam Nguyen/USH-483L
Cindy Johnson/USH-483L

STS-107 FRR DIGITAL LAUNCH WINDOW

NOMINAL FLIGHT DURATION = 15:22:10 (D:H:M) MET

	WINDOW OPENINGS				WINDOW CLOSINGS			
DATE at Greenwich (M/D/Y)	1 KSC Sunrise SR-0 min GMT (H:M)	2 EOM+2/KSC 1-1-1 KSC&EDW SR-10 min GMT (H:M)	3 EOM+2/KSC SUNRISE SURPRISE SR+60 min GMT (H:M)	4 EOM+2/KSC 2-2-2 KSC&EDW SR-10 min GMT (H:M)	5 TAL/ZZA SS+15 min GMT (H:M)	6 TAL/MRN SS+15 min GMT (H:M)	7 2.5 HOUR CREW-ON-BACK GMT (H:M)	8 KSC Sunset SS+0 min GMT (H:M)
01/08/2003	12:17	14:09	15:19	15:43	16:28	16:59	18:13	22:42
01/09/2003	12:17	14:09	15:19	15:43	16:29	17:00	18:13	22:43
01/10/2003	12:17	14:08	15:18	15:43	16:30	17:00	18:13	22:44
01/11/2003	12:17	14:08	15:18	15:42	16:31	17:01	18:12	22:45
01/12/2003	12:17	14:07	15:17	15:42	16:32	17:02	18:12	22:45
01/13/2003	12:17	14:07	15:17	15:41	16:33	17:03	18:11	22:46
01/14/2003	12:17	14:06	15:16	15:41	16:34	17:04	18:11	22:47
01/15/2003	12:17	14:06	15:16	15:40	16:35	17:05	18:10	22:48
01/16/2003	12:17	14:05	15:15	15:39	16:36	17:06	18:09	22:49
01/17/2003	12:17	14:05	15:15	15:39	16:38	17:07	18:09	22:49
01/18/2003	12:17	14:04	15:14	15:38	16:39	17:08	18:08	22:50
01/19/2003	12:16	14:03	15:13	15:38	16:40	17:09	18:08	22:51
01/20/2003	12:16	14:03	15:13	15:37	16:41	17:11	18:07	22:52
01/21/2003	12:16	14:02	15:12	15:36	16:42	17:12	18:06	22:53
01/22/2003	12:16	14:01	15:11	15:36	16:44	17:13	18:06	22:54
01/23/2003	12:15	14:01	15:11	15:35	16:45	17:14	18:05	22:54
01/24/2003	12:15	14:00	15:10	15:34	16:46	17:15	18:04	22:55
01/25/2003	12:15	13:59	15:09	15:33	16:47	17:16	18:03	22:56
01/26/2003	12:14	13:58	15:08	15:33	16:49	17:17	18:03	22:57

The nominal launch window open and close times are shown in boxes.
Launch window duration is 2.5 hours

1 and 8 protect daylight launch
2 protects at least one daylight landing opportunity to KSC and EDW for EOM, EOM+1, and EOM+2
3 protects at least one daylight landing opportunity to KSC that is at least 60 minutes after sunrise for EOM, EOM+1, and EOM+2
4 protects at least two daylight landing opportunities to KSC and EDW for EOM, EOM+1, and EOM+2
5 and 6 protect daylight TALs
7 protects 2.5 hour crew-on-back constraint

®[CR 5556A] ®[CR 5868A]

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107_2A-1 LAUNCH WINDOW (CONTINUED)

TABLE 107_2A-1-II - LAUNCH WINDOW DIGITAL DATA (CONTINUED)

November 11, 2002

STS-107 FRR DIGITAL LAUNCH WINDOW

NOMINAL FLIGHT DURATION = 15:22:10 (D:H:M) MET

Tam Nguyen/USH-483L
Cindy Johnson/USH-483L

DATE at Greenwich (M/D/Y)	WINDOW OPENINGS: 1 KSC Sunrise SR-0 min GMT (H:M)	2 EOM+2/KSC 1-1-1 KSC&EDW SR-10 min GMT (H:M)	3 EOM+2/KSC SUNRISE SURPRISE SR+60 min GMT (H:M)	4 EOM+2/KSC 2-2-2 KSC&EDW SR-10 min GMT (H:M)	WINDOW CLOSINGS: 5 TAL/ZZA SS+15 min GMT (H:M)	6 TAL/MRN SS+15 min GMT (H:M)	7 2.5 HOUR CREW-ON-BACK GMT (H:M)	8 KSC Sunset SS+0 min GMT (H:M)
01/27/2003	12:14	13:58	15:08	15:32	16:50	17:18	18:02	22:58
01/28/2003	12:13	13:57	15:07	15:31	16:51	17:19	18:01	22:59
01/29/2003	12:13	13:56	15:06	15:30	16:52	17:20	18:00	22:59
01/30/2003	12:12	13:55	15:05	15:29	16:54	17:21	17:59	23:00
01/31/2003	12:12	13:54	15:04	15:28	16:55	17:22	17:58	23:01
02/01/2003	12:11	13:53	15:03	15:27	16:56	17:24	17:57	23:02
02/02/2003	12:11	13:52	15:02	15:27	16:57	17:25	17:57	23:03
02/03/2003	12:10	13:51	15:01	15:26	16:59	17:26	17:56	23:03
02/04/2003	12:10	13:51	15:01	15:25	17:00	17:27	17:55	23:04
02/05/2003	12:09	13:50	15:00	15:24	17:01	17:28	17:54	23:05
02/06/2003	12:08	13:49	14:59	15:23	17:02	17:29	17:53	23:06
02/07/2003	12:08	13:48	14:58	15:22	17:04	17:30	17:52	23:07
02/08/2003	12:07	13:47	14:57	15:21	17:05	17:31	17:51	23:07
02/09/2003	12:06	13:46	14:56	15:20	17:06	17:32	17:50	23:08
02/10/2003	12:06	13:45	14:55	15:19	17:07	17:33	17:49	23:09
02/11/2003	12:05	13:44	14:54	15:18	17:09	17:34	17:48	23:10
02/12/2003	12:04	13:43	14:53	15:17	17:10	17:35	17:47	23:10
02/13/2003	12:03	13:42	14:52	15:16	17:11	17:36	17:46	23:11
02/14/2003	12:03	13:41	14:51	15:15	17:12	17:37	17:45	23:12

The nominal launch window open and close times are shown in boxes.
Launch window duration is 2.5 hours

1 and 8 protect daylight launch
2 protects at least one daylight landing opportunity to KSC and EDW for EOM, EOM+1, and EOM+2
3 protects at least one daylight landing opportunity to KSC that is at least 60 minutes after sunrise for EOM, EOM+1, and EOM+2
4 protects at least two daylight landing opportunities to KSC and EDW for EOM, EOM+1, and EOM+2
5 and 6 protect daylight TALs
7 protects 2.5 hour crew-on-back constraint

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107_2A-2 LAUNCH COMMIT CRITERIA

THE FOLLOWING PAYLOAD REQUIREMENTS ARE MANDATORY TO COMMIT THE ORBITER TO LAUNCH AND ARE EFFECTIVE UNTIL T-9 MINUTES AND COUNTING, OR AS DICTATED BY LCC EFFECTIVITY: ®[DN 74]

A. ORBITER LCC REQUIREMENTS DRIVEN BY PRIMARY PAYLOAD ACTIVITIES PER THE STS-107 MINIMUM EQUIPMENT LIST (MEL):

1. ONE OF TWO PAYLOAD (PL) COMMUNICATION STRINGS (PF MDM/PSP/MTU FREQUENCY DIVIDER)

Orbiter Generic LCC requires two of two PF MDM's for payload bay door closure but the Payload Signal Processor (PSP) requirement is mission dependent. For STS-107, Spacehab requires a payload communication string, which includes a PSP and its associated payload MDM. String 1 accepts serial commands from the orbiter GPC via payload MDM PF1, and string 2 accepts serial commands from the orbiter GPC via payload MDM PF2. There are three frequency dividers but only two provide clock signals for PSP command capability. Frequency divider 1 provides clock signals for PSP1 command capability and frequency divider 2 provides clock signals for PSP2 command capability.

DOCUMENTATION: LCC DPS-03, BFS-09, INS-03, STS-107 MEL.

2. PF1 MDM DISCRETE OUTPUT CARD 14 TO SPACEHAB ®[CR 5621]

Discrete Output High (DOH) card 14 channel 2 provides a single command interface to critical Spacehab subsystems and is required to support Spacehab operations. Failure of this card to a high state will cause an FSS Arm indication and subsequent Main Power Kill. Spacehab also utilizes PF1 MDM Discrete Output Low (DOL) card 0 channel 2 and PF2 MDM DOH card 2 channel 2. Critical system hardware is controlled by PF1 MDM Card 0, but all hardware can be recovered with on-orbit IFM's (FD1 IFM will be required in order to complete SH Activation) and an LCC was not deemed appropriate. The PF2 MDM card 2 cannot be detected for a failure to either a low or high state and therefore an LCC could not be written. The PF2 MDM card 2 failure to the high state will issue a FSS Discharge command, but the command will have no effect unless the FSS is armed at that time. ®[CR 5537]

DOCUMENTATION: LCC RDM-06. ®[CR 5537] ®[CR 5621]

3. MTU/GMT IRIG-B CONVERTER/PTB

The Master Timing Unit (MTU) supplies GMT and MET to various downstream users, including payloads via the Payload Timing Buffer. The Miniature Satellite Threat Reporting System (MSTRS) Spacehab payload is the driver for this LCC since it receives GMT directly from the Payload Timing Buffer from the GMT IRIG-B converter and cannot use MET. Therefore, if the GMT IRIG-B converter fails, MSTRS will not have timetag information and results in loss of nearly all MSTRS science objectives. Refer to Rule {107_7A-3}, LOSS OF ORBITER MASTER TIMING UNIT (MTU)/PAYLOAD TIMING BUFFER, for additional impacts that do not directly affect launch go/no-go decisions.

DOCUMENTATION: LCC INS-03, STS-107 MEL. ®[DN 74]

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107_2A-2 LAUNCH COMMIT CRITERIA (CONTINUED)

4. PAYLOAD DATA INTERLEAVER WITH EITHER THE PRIMARY OR BACKUP DECOM LOCKED. ®[DN 74]

The Payload Data Interleaver (PDI) provides the only source of telemetry to the orbiter General Purpose Computer (GPC) or downlink for operation of the Spacehab system. With either the primary DECOM (DECOM 1) or backup DECOM (DECOM2) locked, the crew will be able to monitor safety critical parameters through the Backup Flight System (BFS). The ground has the capability to determine the state of the safety critical parameters through other means in the event of a failure of the primary DECOM.

DOCUMENTATION: LCC RDM-04, STS-107 MEL.

5. ORBITER BUS REQUIREMENTS:

   a. PRI PL

   b. PL AFT MNB

The primary payload bus and PL Aft Main Bus B (MNB), and PL cabin buses provide power to Spacehab equipment and experiments. The PL AC2 and AC3 buses are not active prelaunch, but the orbiter AC buses providing power to these PL AC buses are covered by the Generic Orbiter LCC. PL CAB 2 and PL CAB 3 are required by Spacehab, but the only insight into PL CAB 2 and PL CAB 3 is the switch position.

DOCUMENTATION: LCC EDPC-03, EDPC-04, RDM-05, RDM-06, STS-107 MEL.

6. TWO OF TWO FLOW PROPORTIONING MODULE (FPM)

Two Flow Proportioning Valves (FPV's) in Payload Heat Exchanger (PLHX) are required during Spacehab operations.

DOCUMENTATION: LCC ECL-40, STS-107 MEL.

B. COMMAND AND TELEMETRY PROCESSING CAPABILITY MUST BE OPERATIONAL OR HAVE AN ESTIMATED TIME TO RETURN TO OPERATIONS BY SPACEHAB ACTIVATION TO ENABLE GROUND COMMANDING AND MONITORING OF CRITICAL SUBSYSTEMS DURING ON-ORBIT OPERATIONS.

Ground commanding is required to configure Spacehab systems and to control experiment operations. The ability to throughput and process downlink data is required to monitor critical Spacehab systems and to collect experiment data.

C. FREESTAR AND RAMBO HAVE NO LAUNCH COMMIT CRITERIA. ®[DN 74] ®[CR 5895A]

107_2A-3 LAUNCH TURNAROUND

A. FOR A LAUNCH DELAY OF 24 HOURS FROM THE INITIAL LAUNCH ATTEMPT, THE MIDDECK MUST BE ACCESSED TO REPLACE SPACEHAB MIDDECK EXPERIMENTS. ®[DN 18]

B. FOR A LAUNCH DELAY OF 48 HOURS FROM THE INITIAL ATTEMPT (I.E., TWO CONSECUTIVE LAUNCH ATTEMPTS SCRUBBED), THE MIDDECK AND SPACEHAB MODULE MUST BE ACCESSED TO REMOVE, REFURBISH, AND REPLACE EXPERIMENTS.

Some middeck payloads can only sustain the initial planned launch attempt. For a 1 day delay after the payloads have been installed, they must be replaced to support a second launch attempt. If launch is delayed by 48 hours or more (two consecutive launch attempts scrubbed), there are middeck payloads which must be removed, refurbished, and reinstalled prior to a subsequent launch attempt. In addition, there are also payloads in the Spacehab module that must be removed, refurbished, and reinstalled. Reference the Spacehab CIP (NSTS 21426) for specific payloads which require refurbishment or replacement following two consecutive launch attempts.

C. FREESTAR HAS NO LAUNCH SCRUB TURNAROUND REQUIREMENTS. ®[DN 18]

ASCENT/ENTRY/POST-LANDING

107_2A-11 **RESERVED** ®[DN 19]

107_2A-12 **SUBSONIC PILOT FLIGHT CONTROL**

AT THE DISCRETION OF THE COMMANDER (CDR), THE PILOT (PLT) MAY FLY CONTROL STICK STEERING (CSS) FROM THE BEGINNING OF SUBSONIC FLIGHT WITH THE FOLLOWING CONSTRAINTS: ®[CR 5478]

A. THE CDR WILL FLY THE ORBITER FROM 10 SECONDS PRIOR TO HAC INTERCEPT THROUGH THE INITIAL ROLL ONTO THE HAC.

B. THE CDR WILL FLY FROM A HAC TURN ANGLE OF 90 DEGREES THROUGH LANDING ROLLOUT.

C. WHEN CSS IS ENGAGED, ONBOARD GUIDANCE COMMANDS WILL BE FOLLOWED.

D. THE CDR WILL FLY (NO TRANSFER OF CONTROL) FOR THE FOLLOWING CASES:

1. IF THE MCC RECOMMENDS “DELAYED CSS PREFERRED” PER RULE {A4-156}, HAC SELECTION CRITERIA ®[ED]

2. SYSTEMS OR NAVIGATION PROBLEMS THAT REQUIRE CSS, PER RULES {A2-261}, ENTRY DTO/AUTO MODE/CROSSWIND DTO NO-GO, AND {A4-208}, ENTRY TAKEOVER RULES ®[ED]

3. VEHICLE ENERGY PROBLEMS REQUIRING A GROUND CONTROLLED APPROACH (GCA)

4. RTLS/TAL/ECAL/ELS ABORTS

5. BFS ENGAGED

6. ANY GUIDANCE, NAVIGATION, OR FLIGHT CONTROL SYSTEM(S) FAILURE (E.G., CDR HUD) THAT INCREASES THE PROBABILITY OF A TRAJECTORY TRANSIENT RESULTING FROM THE TRANSFER OF CONTROL (MCC CALL). LOSS OF A SINGLE STRING OF REDUNDANCY IN ANY SYSTEM (E.G., ONE AA, ONE FCS CHANNEL, ONE RHC CHANNEL, ETC.), WITH NO OTHER FAILURES, IS NOT CAUSE FOR PRECLUDING TRANSFER OF CONTROL. ®[CR 5478]

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107_2A-12 SUBSONIC PILOT FLIGHT CONTROL (CONTINUED)

7. IF THE MCC RECOMMENDS NO-GO FOR PLT FLYING BASED ON HAC DYNAMICS (E.G., TAIL WINDS > 80 KNOTS AT HAC INTERCEPT) ®[CR 5478]

E. THE PLT IS THE BACKUP TO THE CDR FOR ANY FLIGHT PHASES REQUIRING CSS CONTROL. IF REQUIRED FOR VEHICLE SAFETY, THE CDR MAY TRANSFER CONTROL TO THE PLT AT ANY TIME.

Allowing the PLT to fly for a short period of time during entry enhances training and better prepares the pilot for future orbiter flying tasks. The intent of this rule is to allow the PLT to fly for approximately 20 seconds during a single period, either prior to HAC intercept or once established on the HAC prior to the 90. During a normal entry, there is sufficient time following the end of the transonic buffet to allow the PLT to control the orbiter and still allow the CDR sufficient time to complete the more critical maneuvers such as the initial roll onto the HAC and lining up on final. When CSS is engaged, onboard guidance will be followed, and no inputs will be made other than those required to fly to the glideslope and course centerline, or otherwise ensure a safe landing.

There are some cases in which it is not prudent to allow the PLT to have this training time, however. If the 6 degree of freedom entry simulation as explained in Rule {A4-156}, HAC SELECTION CRITERIA, indicates that delaying CSS until a HAC turn angle of 180 degrees is preferred, the CDR should fly from CSS initiation through rollout. For these HAC cases, energy stops diverging at the 180 degree point and begins to slowly recover. Handing control of the vehicle between the CDR and PLT in this timeframe is not prudent, since the vehicle energy is already lower than typical and the time to correct any energy problems is diminished. Likewise, a vehicle problem as outlined in Rules {A2-261}, ENTRY DTO/AUTO MODE/CROSSWIND DTO GO/NO-GO, or {A4-208}, ENTRY TAKEOVER RULES, requires significant concentration on the flying task, and a handover of control is inappropriate. Systems failures that would invoke this rule are two AA failures, no or single air data, no yaw jet flight control mode, or a navigation system anomaly that affects the vehicle energy state (GCA). In the event of an abort, flight control handovers between CDR and PLT should be avoided due to the increased risk inherently associated with the abort, and to eliminate the possibility of introducing any handover dispersions to an already challenging abort landing. The transfer of control is assumed to have an insignificant impact on the vehicle trajectory and energy state, although arguably that impact is non-zero. That is, in most cases it is nearly impossible to transfer vehicle control without introducing some very small transient, which for the nominal case is acceptable. However, the transfer of control is not warranted for any guidance, navigation, or flight control system(s) problem(s) that could cause a transfer of control to result in more than an insignificant impact on the trajectory. Additionally, for certain HAC dynamics (e.g., high tail winds at HAC intercept), the flying task requires more setup time prior to HAC intercept, and more time-critical inputs before, during, and after HAC intercept. In these cases, vehicle energy state can be less forgiving for delayed piloting response (at HAC intercept, and for the first 180 deg of HAC), and transfer of vehicle control is not warranted. ®[ED]

Flight crews are trained preflight to transfer control positively and verbally in a CRM environment. Any time that a situation occurs that detracts from the CDR's ability to fly the vehicle, it is acceptable for the CDR to hand control of the vehicle over to the PLT, regardless of the constraints imposed by this rule.
®[CR 5478]

107_2A-13 TAL/AOA OPS 3 TRANSITION

IF A GPC FAILS WHILE COMMANDING RCS JETS TO FIRE, THE AFFECTED STRING WILL EITHER BE NOT ASSIGNED DURING THE TAL/AOA OPS 3 TRANSITION OR THE AFFECTED MDM'S WILL BE POWER-CYCLED PRIOR TO THE TAL/AOA OPS 3 TRANSITION. ®[CR 5526]

Flight Software DR 110886 documents conditions that can cause uncommanded RCS jet firings in OPS 3 if a GPC fails while commanding RCS jets to fire in OPS 1. To avoid this condition, the affected string will not be assigned to the TAL/AOA OPS 3 transition. If the string is to be assigned to the OPS 3 transition, a power-cycle of the affected MDM is first required to clear the jet commands. ®[CR 5526]

107_2A-14 LOSS OF ET LOX LIQUID LEVEL CONTROL SENSORS

IN THE PRELAUNCH TIMEFRAME: ®[CR 5575A]

A. FOR THE LOSS OF THE FIRST 100 PERCENT ET LOX LIQUID LEVEL CONTROL SENSOR, NO MCC ACTION IS REQUIRED, REGARDLESS OF WHEN THE FIRST SENSOR FAILS.

B. LOSS OF A SECOND 100 PERCENT ET LOX LIQUID LEVEL CONTROL SENSOR WILL RESULT IN THE TRANSFER OF ET LOX LOADING CONTROL TO THE 100.15 PERCENT SENSOR.

1. FOR CONTROL TRANSFER TO 100.15 PERCENT SENSOR PRIOR TO L-25 MINUTES:

a. ARD AND LAUNCH WINDOW DATA WILL BE BASED ON A 100.15 PERCENT LOX LOADING ESTIMATE (WITH ADJUSTMENT FOR ADDITIONAL DRAINBACK TIME, AS APPLICABLE).

b. IF STABLE REPLENISH USING THE 100.15 PERCENT SENSOR IS REACHED PRIOR TO L-1:20 HOURS, THE LOX LOADING ESTIMATE WILL BE GENERATED USING PLOAD. OTHERWISE, “NO PLOAD” LOADING ESTIMATES WILL BE USED (PER RULE {A2-7C}, DAY-OF-LAUNCH ET LOAD DATA) DUE TO MCC OPERATIONAL PROCESSING TIMELINE CONSTRAINTS.

c. ADDITIONAL DRAINBACK TIME SHALL BE INSERTED INTO THE TIMELINE AFTER THE START OF DRAINBACK AS SPECIFIED BY THE DOLILU OPERATIONS SUPPORT PLAN. FD WILL COORDINATE THE INSERTION OF THE ADDITIONAL DRAINBACK TIME, IF ANY, WITH NTD.

2. FOR CONTROL TRANSFER TO 100.15 PERCENT SENSOR AFTER L-25 MINUTES:

a. ARD CALCULATIONS WILL NOT BE UPDATED.

b. ADDITIONAL DRAINBACK TIME WILL NOT BE INSERTED INTO THE TIMELINE.

c. MCC WILL BE NO-GO FOR LAUNCH UNTIL THE PSIG REPRESENTATIVE IN THE MER VALIDATES THAT THE MEASURED ULLAGE PRESSURE DOES NOT EXCEED 0.255 PSI ABOVE THE TDDP NOMINAL LOAD ULLAGE PRESSURE OF 0.781 PSIG. ®[CR 5575A]

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107_2A-14 LOSS OF ET LOX LIQUID LEVEL CONTROL SENSORS (CONTINUED)

The ET project has determined that the PLOAD LOX loading estimate based on liquid level control using a 100 percent sensor which subsequently fails will remain valid after a switch to the second 100 percent ET LOX liquid level control sensor. Therefore, switching liquid level control from one 100 percent sensor to the second 100 percent sensor does not invalidate the original PLOAD loading estimate. ®[CR 5575A]

The ET project has determined that the PLOAD LOX loading estimate based on liquid level control using either 100 percent sensor is not accurate in the event of a later failure of both 100 percent LOX liquid level control sensors and subsequent fill to the 100.15 percent sensor per LCC ET-10. The ET Project has requested DOSS to rerun PLOAD or revert to 100.15 percent MPS inventory loading estimates. A rerun and QA of PLOAD loading updates, nominal mission performance margin, and launch window impacts requires approximately 40 minutes. KSC Ground Operations is unable to accept launch window updates after L-39 minutes. However, FDO and ARD support should reflect the best possible estimate of the true LOX loading. Therefore, these elements will reconfigure to reflect LOX loading to the 100.15 percent MPS inventory values, if the failover occurs after the latest time to rerun PLOAD (about L-1:20 hour) and prior to L-25 minutes, regardless of whether or not the KSC launch window is updated.

For any level sensor failure after L-25 minutes, no action is required by the MCC. A late sensor failure (either the first or the second) may result in an underload of approximately 1,100 pounds of LOX, which still meets LCC ET-10 launch requirements. This equates to approximately 15 fps of ascent performance margin. STS-107 Ascent Performance Margin is sufficient to ensure a guided nominal MECO for a launch in this condition. However, a launch with an underload of this magnitude will result in TAL and ATO abort boundary calls being made approximately 15 fps early. The program accepts this risk due to its low probability of occurrence.

In the event of a failure of both 100 percent sensors and failover to a fill to the 100.15 percent sensor failure, no additional drainback time will be added to the countdown. The requirement for the additional drainback to the 100 percent level has been waived through a mission-specific analysis.

Late failover to a LOX tank fill controlled by the 100.15 percent (after failure of both 100 percent level sensors) will require verification that the LOX loading is consistent with MPS inventory loading estimates. The MPS inventory is protected if the ullage pressure is less than 1.036 psi. Ullage pressure above this limit indicates an underload of a magnitude beyond that covered in the FPR. The value of 1.036 psi is derived by adding the ullage pressure used in deriving the inventory (.781 psi) to a tolerance that is protected by FPR (.255 psi). ®[CR 5575A]

107_2A-15 TAL RAINSHOWER EXCEPTIONS

FOR TAL, RAIN SHOWERS (EXCLUDING THUNDERSTORMS) WITHIN THE LIMITS LISTED IN RULE {A2-6}, LANDING SITE WEATHER CRITERIA [HC], PARAGRAPH C, MAY BE ACCEPTABLE IF CONTINUOUS RADAR AND AIRCRAFT SURVEILLANCE INDICATES ALL OF THE FOLLOWING CONDITIONS ARE MET. ®[CR 5898]

1. COVERAGE: SHOWERS COVER LESS THAN 10 PERCENT OF THE AREA WITHIN 20 NM OF THE TAL RUNWAY.

2. MOVEMENT/DEVELOPMENT: OBSERVED HORIZONTAL MOVEMENT IS CONSISTENT AND NO ADDITIONAL CONVECTIVE DEVELOPMENT IS FORECAST.

3. LIGHTNING POTENTIAL: TOPS OF CLOUDS CONTAINING PRECIPITATION DO NOT EXCEED THE +5 DEG C LEVEL AND HAVE NOT EXCEEDED THE -10 DEG C LEVEL WITHIN 2.5 HOURS PRIOR TO LAUNCH.

4. INTENSITY: PRECIPITATION IS LIGHT (LESS THAN 30 DBZ) AT ALL LEVELS WITHIN AND BELOW THE CLOUD.

5. FOR ANY SHOWER WITHIN 20 MILES OF THE TAL RUNWAY, IF THE SHOWER EXCEEDS PARAGRAPHS 3 OR 4, THEN A 2-NM VERTICAL CLEARANCE FROM THE TOP OF THAT SHOWER AND A 10-NM LATERAL CLEARANCE MUST BE MAINTAINED ALONG THE APPROACH CORRIDORS.

6. RUNWAY MEETS THE LANDING AND ROLLOUT CRITERIA AND NAVAID REQUIREMENTS SPECIFIED IN RULE {A2-1}, PRELAUNCH GO/NO-GO REQUIREMENTS.

7. THERE IS A HIGH LEVEL OF CONFIDENCE THAT AT LEAST ONE APPROACH (OVERHEAD OR STRAIGHT-IN) WILL BE ACCEPTABLE AT TAL LANDING TIME. TREND MONITORING UTILIZING RADAR AND AIRCRAFT SURVEILLANCE SHOULD INDICATE THAT A STABLE AND PREDICTABLE ENVIRONMENT EXISTS. ®[CR 5898]

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107_2A-15 TAL RAINSHOWER EXCEPTIONS (CONTINUED)

DUE TO THE RELATIVELY RECENT ACQUISITION OF SPANISH RADAR DATA, A LACK OF EXPERIENCE EXISTS ASSESSING SPANISH RADAR DATA. ADDITIONALLY, THIS DATA HAS LOWER FREQUENCY AND POTENTIALLY LESS RELIABILITY OF RECEIPT THAN CONUS RADAR DATA. BASED ON THESE FACTORS, LAUNCH DAY CONDITIONS COULD BE SUCH THAT SUFFICIENT CONFIDENCE DOES NOT EXIST TO EXERCISE THIS RULE. THE ASCENT FLIGHT DIRECTOR WILL DETERMINE IF THIS RULE CAN BE SAFELY APPLIED ON LAUNCH DAY. ®[CR 5898]

TAL PRECIPITATION LIMITS

The TAL shower exception specifies conditions under which launch is acceptable when showers are within the area of the TAL runway on launch day. SMG originally developed the conditions specified in this rule to meet orbiter design requirements for RTLS. The availability of Spanish radar data makes it possible to give consideration to these same type exceptions for TAL runways in Spain. Similar to RTLS, the short forecast interval for TAL and availability of radar and weather aircraft may allow improved estimation of rain shower movement and characterization of the cloud type. Additional launch probability is gained by eliminating the avoidance criteria for showers that do not pose a threat due to lightning, hail, visibility, aerodynamic control, or MLS attenuation. Tile damage that occurs if precipitation is encountered is acceptable. Radial, lateral, and vertical avoidance criteria still apply for any storm that poses a threat to the orbiter.

Cloud Top Temperatures and Lightning Avoidance - *Clouds that exceed the conditions stated in paragraphs 3 and 4 above pose a threat of hail or lightning (natural and triggered). Clouds with < 30 DBZ and tops below the +5 deg C thermal layer do not pose a threat of stored electrical charge. Clouds that have previously extended above the -10 deg C thermal layer must be avoided for 2.5 hours to allow any accumulated charge to dissipate. A 2-nm vertical clearance and a 10-nm lateral clearance must be maintained along the approach paths of the overhead and straight-in HAC's for showers exceeding these limits. The Lightning Avoidance Criteria Peer Review Committee reviewed and concurred with these criteria at their KSC meeting in February 1994.*

If the orbiter encounters ice, window damage may occur resulting in reduced visibility (depending on ice population, mass, density, and relative velocity) and RCC coating damage may occur forcing RCC panel replacement. Clouds with tops below the +5 deg C thermal layer are warm enough to assure they do not contain hail. ®[CR 5898]

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107_2A-15 TAL RAINSHOWER EXCEPTIONS (CONTINUED)

Light Precipitation - Testing of TPS tiles flown through moderate rainfall (35 to 40 dbz) indicates that significant tile damage will occur if the orbiter encounters ice-free precipitation at velocities below Mach 1 and above touchdown speed. The extent of damage depends on drop size and the angle of incidence between a drop and a tile. Conservative estimates of effects on approach and landing characteristics assuming a worst-case estimate of approximately 2000 damaged tiles (nose and canopy/windshield areas, vertical tail and OMS pod leading edges) show no significant effect on landing performance. A retrim to a slightly higher angle of attack would be the primary noticeable response to flight through rain during landing approach. No structure or control system damage would occur. Testing indicates that damage to RCC does not occur when flown through light rain at speeds below 0.7 Mach. RCC damage is not desirable due to replacement cost and lead time. RCC damage caused by precipitation impact would not affect aerodynamic performance. ®[CR 5898]

Tile damage could result in a loss of up to 1000 ft of touchdown distance. Typical touchdown distances carry adequate margin to protect this type of energy loss. A dispersed entry that is flown through a shower on a day that predicted touchdown conditions are at the limits specified in Rule {A4-110}, AIMPOINT, EVALUATION VELOCITY, AND SHORT FIELD SELECTION, could result in a vehicle touchdown on the underrun. Consideration should be given to not launching on a low energy day where the capability to avoid showers is low. Otherwise, adequate margin exists within the system to support loss of touchdown energy due to tile damage.

Water attenuates microwave signals at MLS frequencies; however, MLS performance is not severely affected. Analysis of MLS link performance with a transmitter power output of 1600 W (the minimum acceptable transmitter power output level) shows that MLS acquires at over 9 nm slant range when a rainfall rate of 10 mm/hr (0.4 in/hr) exists along the entire path between the orbiter and the ground MLS station. Since "light" rainfall is less than 0.4 in/hr, nominal MLS acquisition is protected.

Ceiling and visibility criteria specified in paragraph A of Rule {A2-6}, LANDING SITE WEATHER CRITERIA [HC], still apply and protect for adequate crew visibility of the PAPI's, aimpoint, and ball bar through clouds and precipitation. WX RECON has primary responsibility for assessing visibility through light precipitation from any showers of concern that do not fall within the field of view used by meteorological observers to evaluate visibility. Ground observers are limited to evaluations using fixed landmarks.

Area Coverage/Multiple HAC's - While it is acceptable to encounter showers that meet the criteria specified in this rule, it is still more desirable to avoid them if possible. Limiting the number of showers in the vicinity of the TAL runway minimizes the chances of encountering a shower. If more than 10 percent coverage exists or is forecast but both approaches are clear and will remain clear of showers, the intent of this constraint has been met. ®[CR 5898]

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107_2A-15 TAL RAINSHOWER EXCEPTIONS (CONTINUED)

Movement and Convective Development - Consistent horizontal motion that is linear or near linear and can be tracked is required to accurately forecast future movement. Conditions must be thermodynamically stable. Observed and forecast conditions are the same and expected to remain unchanged throughout the TAL period. ®[CR 5898]

Paragraph 6 defines the clearance requirements of showers with lightning potential (tops greater than +5 deg C or returns greater than 30 dbz) which have not demonstrated air to ground lightning strikes. The clearance requirements for lightning potential are the same as those of actual thunderstorms. ®[CR 5898]

ORBIT

PRIORITIES AND MISSION DURATION

107_2A-21 HIGH PRIORITY FLIGHT OBJECTIVES/MINIMUM DURATION FLIGHT

A. MINIMUM DURATION FLIGHT (MDF) WILL LAST APPROXIMATELY 72 HOURS WITH LANDING ON THE MORNING OF FD4 PER RULE {A2-102}, MISSION DURATION REQUIREMENTS. ®[ED]

The MDF has a nominal minimum length of approximately 72 hours. The term "approximately 72 hours" is used to allow for utilization of primary landing site (PLS) and secondary landing site (SLS) landing opportunities which occur during a given flight day. The minimum duration is set at the number of days normally required to ensure a good probability of having a healthy crew for entry and landing and to provide the opportunity to accomplish activities that could enhance orbiter entry/landing conditions. The payload/experiments must be considered secondary to vehicle/crew safety and are not sufficient grounds for mission continuation. FD4 landing is the standard MDF duration. The MDF timeline must allow for Flight Control System (FCS) C/O, RCS hot fire, and cabin stow.

B. EXPERIMENT OPERATIONS MAY CONTINUE UP TO THE NOMINAL DEACTIVATION TIME DEFINED IN THE ENTRY DAY TIMELINE ON A NONINTERFERENCE BASIS WITH ORBITER OPERATIONS IN PREPARING FOR DEORBIT AND ENTRY.

Nominal experiment deactivation will be scheduled to preserve sufficient time for orbiter preparation for deorbit and entry. Experiments may be performed before and up to this time on a noninterference basis. Spacehab middeck experiments are considered part of Spacehab and would be deactivated at the same time the module is deactivated.

C. IF ON-ORBIT OPERATIONAL CONFLICTS EXIST WITHIN THE STRUCTURE OF AN MDF, THE CONFLICTS WILL BE RESOLVED ACCORDING TO THE PRIORITIES DEFINED IN RULE {107_2A-22}, ON-ORBIT GENERAL PRIORITIES. SECONDARY FLIGHT OBJECTIVES MAY BE ACCOMPLISHED WITHIN THE STRUCTURE OF AN MDF AS LONG AS THEY DO NOT INTERFERE WITH OR JEOPARDIZE THE HIGH PRIORITY FLIGHT OBJECTIVES.

107_2A-22 ON-ORBIT GENERAL PRIORITIES

IF ON-ORBIT OPERATIONAL CONFLICTS EXIST, THE CONFLICTS WILL BE RESOLVED ACCORDING TO THE FOLLOWING PRIORITIZATION. PRIORITY WILL BE GIVEN TO SATISFYING MINIMUM REQUIREMENTS FOR ALL PAYLOADS, AS DEFINED IN RULES {107_19A-1}, SPACEHAB MINIMUM MISSION OBJECTIVES, AND {107_20A-1}, FREESTAR MINIMUM MISSION OBJECTIVES, OVER HIGHLY DESIRED REQUIREMENTS FOR HIGHER PRIORITY PAYLOADS. ®[DN 20]

A. CREW SAFETY

B. SPACEHAB COMMERCIAL SPONSORED PAYLOADS

1. ADVANCED RESPIRATORY MONITORING SYSTEM (ARMS)

2. CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS)

3. MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

4. COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH (CMPCG)

5. COMBINED 2 PHASE LOOP EXPERIMENT (COM2PLEX)

6. SPACE TECHNOLOGY AND RESEARCH STUDENTS BOOTES (STARS BOOTES)

7. STAR NAVIGATION (STARNAV)

8. OSTEOPOROSIS EXPERIMENT IN ORBIT (OSTEO)

9. EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS (ERISTO)

10. PHYSIOLOGY AND BIOCHEMISTRY 4 (PHAB4)

    a. ENHANCED ORBITER REFRIGERATOR/FREEZER (EOR/F)

    b. THERMOELECTRIC HOLDING MODULE (TEHM)

    c. CENTRIFUGE ®[DN 20]

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107_2A-22 ON-ORBIT GENERAL PRIORITIES (CONTINUED)

C. ESA/NASA SPONSORED PAYLOADS

1. BIOPACK

2. FACILITY FOR ADSORPTION AND SURFACE TENSION (FAST)

3. ADVANCE PROTEIN CRYSTALLIZATION FACILITY (APCF)

4. BIOBOX

D. NASA/ISS SPONSORED PAYLOADS

VAPOR COMPRESSION DISTILLATION (VCD)

E. NASA/CODE U SPONSORED PAYLOADS

1. COMBUSTION MODULE-2 (CM-2)

   a. LAMINAR SOOT PROCESS (LSP)

   b. STRUCTURE OF FLAME BALLS AT LOW LEWIS-NUMBER (SOFBALL)

   c. WATER MIST

   d. SPACE ACCELERATION MEASUREMENT SYSTEM FREE FLYER (SAMS FF)

   e. ORBITAL ACCELERATION RESEARCH EQUIPMENT (OARE)
   ®[DN 20]

2. MECHANICS OF GRANULAR MATERIALS (MGM)

3. BIOREACTOR DEMONSTRATION SYSTEM-05 (BDS-05)

4. MICROBIAL PHYSIOLOGICAL FLIGHT EXPERIMENT (MPFE)

5. SLEEP-3

6. ASTROCULTURE PLANT GROWTH CHAMBER (AST-10/1)

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107_2A-22 ON-ORBIT GENERAL PRIORITIES (CONTINUED)

7. ASTROCULTURE GLOVEBOX (AST-10/2)

8. COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF)

9. COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX) ®[DN 20]

10. ZEOLITE CRYSTAL GROWTH-1 (ZCG-1)

11. FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH-2 (FRESH-2)

12. GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA)

13. BIOLOGICAL RESEARCH IN CANISTERS (BRIC)

F. FREESTAR PAYLOADS

1. MEDITERRANEAN ISRAELI DUST EXPERIMENT (MEIDEX)

2. SOLAR CONSTANT EXPERIMENT-3 (SOLCON-3)

3. SHUTTLE OZONE LIMB SOUNDING EXPERIMENT-02 (SOLSE-02)

4. CRITICAL VISCOSITY OF XENON-2 (CVX-2)

5. LOW POWER TRANSCEIVER (LPT)

6. SPACE EXPERIMENT MODULE (SEM)

G. DTO 700-14 MAGR GPS ®[CR 5895A]

The TEHM is used by both the PHAB4 and VCD experiments, but is listed under the highest priority payload it supports. Detailed Supplementary Objectives (DSO's) manifested for this flight have no real-time requirements (i.e., only pre and post-flight requirements) and are, therefore, not listed in this rule. RAMBO has no real-time requirements except for state vectors. ®[CR 5622] ®[CR 5633]

DOCUMENTATION: STS-107 FRD (NSTS 17462-107), PRD for Spacehab Commercial Payloads (NSTS 21464), PRD for ESA Payloads (NSTS 21459), PRD for Code U Payloads (NSTS 21463). ®[DN 20]

107_2A-23 ON-ORBIT PROPELLANT PRIORITIES

PROPELLANT PRIORITIES FOR CONSUMABLES LIMITED SITUATIONS, HIGHEST PRIORITIES FIRST ARE:

TABLE 107_2A-23-I - PROPELLANT PRIORITIES

PRIORITY	FLIGHT ACTIVITY	NOTES
1	NOMINAL OMS/RCS REDLINES (PROTECTS 1-1 DEORBIT OPPORTUNITIES	REF RULE {A2-108}, CONSUMABLES MANAGEMENT
2	MINIMUM DURATION FLIGHT	
3	WEATHER WAVEOFF EXTENSION DAY (PROTECTS 2-1-1 DEORBIT OPPORTUNITIES)	THE WEATHER WAVEOFF EXTENSION DAY IS LOWER PRIORITY THAN THE MINIMUM ALTITUDE REQUIRED FOR PRIMARY PAYLOAD ACTIVITIES. REF RULE {A2-108C}, CONSUMABLES MANAGEMENT.
4	NOMINAL MISSION DURATION	EXTEND MISSION DURATION IN FLIGHT DAY INCREMENTS PAST MDF, UP TO NOMINAL. ADDITIONAL DAYS WILL INCLUDE NOMINALLY PLANNED ACTIVITIES (ATTITUDE MANEUVERS, ATTITUDE HOLD, ETC.). REF RULE {A2-108}, CONSUMABLES MANAGEMENT.
5	PROVIDE ADDITIONAL DEORBIT ATTEMPTS UP TO 2-2-2	PROVIDING 2-2-2 (TWO ATTEMPTS ON THREE CONSECUTIVE DAYS) REQUIRES AN ADDITIONAL TWO REVS OF WAVEOFF ABOVE 2-1-1 CAPABILITY.
6	RAISE AND/OR CIRCULARIZE ORBIT AS HIGH AS POSSIBLE UP TO NOMINAL ALTITUDE	ALL PROPELLANT MARGIN ABOVE FULL MISSION DURATION AND ACTIVITIES WILL BE ALLOCATED TO RAISING THE ORBIT AND/OR CIRCULARIZING THE ORBIT AS HIGH AS POSSIBLE UP TO THE NOMINAL MISSION ALTITUDE OF 150 NM.
7	ET PHOTOGRAPHY MANEUVERS	THE SSP STRONGLY DESIRES ET PHOTOGRAPHY.
8	OMS ENGINE FAIL	REF RULES {A6-303}, OMS REDLINES [CIL]; {A6-304}, FORWARD RCS REDLINES; AND {A6-305}, AFT RCS REDLINES. OMS ENGINE FAIL PROTECTION FOR THE DEORBIT WAVEOFF EXTENSION DAY MAY BE DELETED IN FAVOR OF HIGH PRIORITY FLIGHT OBJECTIVES.
9	ADJUST ORBIT FOR ADDITIONAL LANDING OPPORTUNITIES	PROPELLANT BEYOND WHAT IS REQUIRED FOR PRIMARY MISSION OBJECTIVES MAY BE USED TO PERFORM ORBIT ADJUST BURNS TO GAIN ADDITIONAL LANDING OPPORTUNITIES.

®[DN 11] ®[CR 5519] ®[ED] ®[CR 5895A]

107_2A-24 ON-ORBIT NON-PROP CONSUMABLES PRIORITIES

THE PRIORITIES FOR O_2, H_2, AND N_2 CONSUMABLE LIMITED SITUATIONS, HIGHEST FIRST, ARE:

A. CONTINGENCY RESERVES, MEASUREMENT ERROR, ETC., FROM THE APPROPRIATE SHUTTLE REDLINE RULES IN VOLUME A

Reference Rule {A9-257}, PRSD H2 AND O2 REDLINE DETERMINATION. These redlines include a 2-1-1 shuttle deorbit opportunity plus minimum power level requirements for a safe landing and other contingency reserves. Consumables for one contingency EVA for payload bay door closure would come out of these redlines and is not implicitly bookkept as a separate line item. ®[ED]

B. MINIMUM DURATION FLIGHT

Minimum duration flight has a nominal length of approximately 72 hours, including on-orbit time, ascent, post-insertion, deorbit prep, and entry.

C. NOMINAL MISSION DURATION AND PLANNED ACTIVITIES

Nominal mission duration of 16 days. Planned mission activities for STS-107 include consumables for 3.5 hours of post-landing power. Planned mission activities are documented in the Flight Plan (JSC-48000-107) and FRD (NSTS 17462-107). The post-landing power requirements are documented in the Spacehab Flight Planning Annex 2, Part 1 (NSTS21426). ®[DN 80]

D. ADDITIONAL SHUTTLE DEORBIT OPPORTUNITIES TO 2-2-2.

This requires approximately 4.5 lbm H2 and 27.5 lbm O_2.

E. ADDITIONAL DTV USE ABOVE THE MINIMUM MEIDEX REQUIREMENTS.

5.66 kWh of cryo have been budgeted for DTV operation in support of MEIDEX video requirements. Additional use of the DTV system may be possible if cryo margins and priorities allow. Worst case power levels for DTV operations are 39 W for recording (DTV multiplexer not powered) and 73 W for playback. Procedural treatment of DTV leaves the equipment deactivated except during periods of frequent use. DTV will nominally operate 15 days in support of MEIDEX with worst case 5-7 hours/day powered to support recording and another 1-2 hours/day to support video playback.
®[DN 80] ®[CR 5538]

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107_2A-24 ON-ORBIT NON-PROP CONSUMABLES PRIORITIES (CONTINUED)

F. ADDITIONAL OPERATION OF OARE BEYOND ITS MINIMUM SUPPORT REQUIREMENTS FOR CM-2 SOFBALL. ®[CR 5538]

OARE draws 120 W average power. 15.61 kWh of cryo have been budgeted for OARE required operations which include power for ascent, a 24 hour period prior to CM-2 SOFBALL operations, and during CM-2 SOFBALL operations. The Payload Recorder draws 17 W in standby, 56 W in record, and 84 W in playback. 6.7 kWh have been allotted for required recording of OARE data by the Payload Recorder and its associated playback which include a 4 hour period during the 24 hour period prior to CM-2 SOFBALL and from 30 minutes prior to until 30 minutes after each CM-2 SOFBALL microgravity period. SOFBALL operates for approximately 5 days and includes 15 microgravity periods ranging from 1.5 - 4 hours in duration. Additional highly desired operation of OARE includes the first 24 hours of the mission and during CM-2 WATER MSIT operations (approximately 2.52 kWh and 8.16 kWh additional, respectively). OARE highly desires recording and playback of all OARE data by the Payload Recorder. Power requirements for additional Payload Recorder operation will need to be calculated in real time. ®[CR 5538]

107_2A-25 REPLAN STRATEGY ®[DN 21]

A. GENERAL

1. PAYLOAD OBJECTIVES THAT ARE NOT COMPLETED AS PLANNED DUE TO A PROBLEM WITH THE PAYLOAD (E.G., HARDWARE, SOFTWARE, INSUFFICIENT TIME ESTIMATES, ETC.) WILL BE REPLANNED WITHIN THAT PAYLOAD'S RESOURCE ALLOCATION. THIS INCLUDES ANY TROUBLESHOOTING, IN-FLIGHT MAINTENANCE (IFM) PROCEDURES, REPEAT OF LOST RUNS, ETC. IF THE PAYLOAD'S MINIMUM REQUIREMENTS CANNOT BE MET WITHIN ITS OWN ALLOCATION, THE SPACEHAB PROGRAM MANAGER OR HITCHHIKER OPERATIONS MANAGER FOR FREESTAR MAY ELECT TO IMPACT EXPERIMENTS WITHIN THEIR PAYLOAD COMPLEMENT TO RECOVER LOST OBJECTIVES FOR A HIGHER PRIORITY PAYLOAD.

2. PAYLOAD OPERATIONS IN PROGRESS THAT ARE RUNNING LONGER THAN EXPECTED AND ARE DIFFICULT TO RESCHEDULE (E.G., ATTITUDE TIMELINE DEPENDENT, KU-COVERAGE, TIME-CRITICAL SCIENCE EVENT, ETC.) MAY BE ALLOWED TO COMPLETE AS LONG AS OTHER PAYLOAD ACTIVITIES IMPACTED BY THE DELAY CAN BE DELAYED OR RESCHEDULED.

3. IF AN ORBITER ANOMALY, ACTIVITY, OR OTHER EVENT RESULTS IN THE LOSS OF OBJECTIVES FOR MULTIPLE PAYLOADS, MISSED OBJECTIVES WILL BE RESCHEDULED IF REQUESTED BY THE CUSTOMER. RESCHEDULING OF MISSED OBJECTIVES WILL MINIMIZE CHANGES TO ORIGINALLY PLANNED ACTIVITIES. CONFLICTS WILL BE RESOLVED BASED ON THE PRIORITIES IDENTIFIED IN RULE {107_2A-22}, ON-ORBIT GENERAL PRIORITIES, TO ATTEMPT TO MEET THE MINIMUM REQUIREMENTS FOR ALL PAYLOADS. LOWER PRIORITY ACTIVITIES MAY BE SCHEDULED AT AN EARLIER TIME THAN HIGHER PRIORITY ACTIVITIES IF REQUIRED TO OPTIMIZE THE TIMELINE AND TOTAL SCIENCE FOR THE REMAINING MISSION DURATION AS LONG AS THE HIGHER PRIORITY ACTIVITIES BASED ON CUSTOMER INPUT CAN BE ACCOMMODATED. ®[DN 21] ®[CR 5872]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

Lost payload objectives due to experiment problems or underestimated task durations will be rescheduled within that payload's allocation, preferably at the experiment level since the STS-107 timeline has little flexibility due to attitude requirements/constraints, microgravity constraints, crew availability, etc. However, if rescheduling within the experiment's allocation is not possible, SPACEHAB or FREESTAR may elect to impact other experiments within their payload complement to recover lost objectives for a higher priority experiment assuming the appropriate resources are available (attitude timeline, Ku-band coverage, crew time, etc.). In some cases, if a payload activity is running longer than planned, it may be allowed to continue to completion if the overall impact to the timeline is less than if the activity were rescheduled at a later time as long as other payload activities impacted by the delay can be delayed or rescheduled. If an orbiter anomaly, activity, or other event that affects multiple payloads results in missed objectives, those objectives may be rescheduled based on customer input. In some cases, the payload customer may elect to forego missed objectives to maintain the originally planned timeline. Rule {107_2A-22}, ON-ORBIT GENERAL PRIORITIES, will be used to resolve conflicts, in an attempt to meet minimum mission objectives for all payloads before considering highly desirable objectives.
®[DN 21] ®[CR 5872]

B. LOSS OF KU-BAND

1. ACTIVATE ALL AVAILABLE NASA AND AIR FORCE GROUND STATIONS WITH S-BAND FM CAPABILITY

Nominally, only two NASA ground stations (MILA, FL and Dryden, CA) support the shuttle S-band FM downlink. The are eight additional ground stations that can be activated in contingency situations: two NASA (ESTL, Houston, TX and Wallops Island, VA) and six Air Force (COOK, Vandenberg AFB, CA; REEF, Diego Garcia, British Indian Ocean Territory; HULA, Kaena Point, HI; GUAM, Andersen AFB, Guam; PIKE, Colorado Tracking Station, Schriever AFB, CO; and LION, RAF Oakhanger, United Kingdom). Note that only MILA and Dryden are capable of supporting video downlink.

2. MAXIMIZE TDRS-Z SUPPORT

TDRS-Z support eliminates the shuttle TDRS Zone of Exclusion (ZOE). Eliminating the ZOE alleviates the need for the Operational Recorder to capture data during the ZOE for later S-band FM downlink.

3. AN IFM WILL BE CONSIDERED TO CONNECT THE SPACEHAB PL DIGITAL DATA STREAM TO THE S-BAND FM SYSTEM.

The Spacehab Experiment High Rate data stream is nominally routed as the PL Digital input to Ku-band Channel 2. In the event of a Ku-band failure, an IFM can be performed to reroute this input to be the PL Digital input to the S-band FM system. A similar IFM was performed for the Alpha Magnetic Spectrometer (AMS) payload on STS-91. ®[DN 21]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

4. S-BAND FM DOWNLINK WILL BE PRIORITIZED AMONG THE FOLLOWING USERS: ®[DN 21]

   a. OPS RECORDER DUMPS

   b. PL DIGITAL – SPACEHAB EXPERIMENT DATA (IF IFM PERFORMED)

   c. ANALOG VIDEO - SPACEHAB EXPERIMENT AND MEIDEX

   d. PL RECORDER DUMPS - OARE DATA

5. UPLINK/DOWNLINK OF PAYLOAD FILES WILL BE DISCONTINUED

File uplink/downlink is nominally accomplished using OCA and the KFX software application on the Ku-band system. The backup method for file uplink/downlink is via modem on an A/G channel utilizing the MFX software application. Since transfer rates for MFX are in the range of 1.5 kbps, a 1 Mb file would take over 11 minutes to transfer. In order to minimize the monopolization of one A/G, nominal MFX utilization will be limited to execute package uplink. Payload file transfers are nominally planned for MEIDEX, SOLSE, and Astroculture. MEIDEX data is also recorded on the MEIDEX PGSC and downlinked in FREESTAR's PDI data stream. Loss of the ability to downlink MEIDEX files simply eliminates the ability of the ground to verify that the PGSC is cataloging data correctly. SOLSE data is also recorded on an experiment hard drive and on the SOLSE PGSC. Loss of the ability to downlink SOLSE files eliminates the ability of the ground to verify that the PGSC is cataloging data correctly and also prevents the ground from optimizing experiment operations based on real-time observation. Loss of the ability to downlink Astroculture files impacts the integrity of ground control group following.

6. THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE DEALLOCATED FROM S-BAND COVERAGE:

   a. EOR/F

   b. TEHM

   c. MGM

EOR/F and TeHM S-band downlink is strictly housekeeping data and is not science related; MGM data is used to validate a future operational concept and is of secondary importance to primary science.
®[DN 21]

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107_2A-25 **REPLAN STRATEGY (CONTINUED)**

7. THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE RETIMELINED BASED ON PRIORITIZED SHARING OF THE SPACEHAB PDI DOWNLINK: ®[DN 21]

    a. BIOBOX

    b. BIOPACK

    c. COM2PLEX

    d. FAST/VIDEO DIGITIZER SYSTEM (VDS)

    e. MSTRS

    f. VCD-FE

    g. CM-2

    h. STARS-BOOTES

The experiment allocation within Spacehab's 32 kbps PDI data stream is 25 kbps. Each of the above experiments can individually fit within that allocation, but not all of them can fit simultaneously.

8. THE FOLLOWING SPACEHAB EXPERIMENTS DO NOT FIT WITHIN THE SPACEHAB PDI DOWNLINK, BUT WILL BE ABLE TO SAFELY CONTINUE OPERATIONS AND SCIENCE GATHERING:

    a. ARMS

    b. MOD SAMS

    c. BIOTUBE

    d. ZCG

    e. ASTROCULTURE

    f. BDS-05

The data stream for each of these experiments exceeds the 25 kbps allocation for experiments with the Spacehab PDI window. They could, however, continue to operate and gather science with significant replanning. ®[DN 21]

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107_2A-25 REPLAN STRATEGY (CONTINUED)

9. THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE DISCONTINUED: ®[DN 21]

   STARNAV

10. ALL NOMINALLY PLANNED FREESTAR OPERATIONS WILL CONTINUE. IN ADDITION, THE FOLLOWING SPACEHAB EXPERIMENTS WILL BE UNAFFECTED:

    a. FRESH

    b. CIBX

    c. OSTEO

    d. ERISTO

    e. MPFE

    f. APCF

    g. BRIC

    h. CMPCG

    i. CPCG-PCF

    j. CEBAS

    k. SLEEP

    l. PHAB4

FREESTAR experiments can continue to operate with no science loss. All experiment video and/or data is recorded on-board. Loss of Ku downlink only diminishes the ability of the FREESTAR POCC to verify experiment operation and make changes to optimize science. ®[DN 21]

107_2A-26 EXTENSION DAY GUIDELINES

A. FOR EXTENSION DAYS, THE SPACEHAB MODULE, MODULE EXPERIMENTS, MIDDECK EXPERIMENTS, AND FREESTAR WILL NOMINALLY BE POWERED DOWN TO THE SURVIVAL POWER CONFIGURATION DEFINED IN RULE {107_9A-3}, SURVIVAL POWER CONFIGURATION. ®[DN 81]

B. NO EXPERIMENT ACTIVITIES WHICH REQUIRE ORBITER CONSUMABLES OTHER THAN CRYO AS DEFINED IN PART A. ABOVE WILL NORMALLY BE PLANNED. SPACEHAB ACTIVATION OR INGRESS IS NOT REQUIRED FOR EXTENSION DAYS.

C. FOR EXTENSION DAYS, THE ATTITUDE WILL NOMINALLY BE –ZLV, -XVV.

Extension days would generally be required only for weather, orbiter, and/or landing site problems that would benefit from extra time before landing. To prevent further complications, the Spacehab/experiments should be maintained in a safe, ascent/entry configuration. Excursions from -ZLV, -XVV will occur for water dumps, end-of-mission thermal conditioning, or other orbiter system related reason. No payload science will be done during extension days. If Spacehab is re-ingressed and if time permits, experiments status checks will be done. ®[DN 81]

Reference Rule {A2-330}, EXTENSION DAY GROUNDRULES. ®[ED]

107_2A-27 PAYLOAD GO/NO-GO CALLS

A. SPACEHAB

THE SPACEHAB OPERATIONS DIRECTOR (SHOD) WILL PROVIDE GO/NO-GO CALLS TO THE PAYLOAD OFFICER FOR THE FOLLOWING NOMINAL MISSION EVENTS:

1. SPACEHAB SYSTEMS ACTIVATION

2. SPACEHAB ENTRY PREP

B. FREESTAR

THE HH OPERATIONS DIRECTOR WILL PROVIDE GO/NO-GO CALLS TO THE PAYLOAD OFFICER FOR THE FOLLOWING NOMINAL MISSION EVENTS:

FREESTAR ACTIVATION/DEACTIVATION ®[DN 22]

107_2A-41 REAL-TIME SAFETY COORDINATION

SPACEHAB: EXCEPTIONS TO RULE {A2-312}, REAL-TIME SAFETY COORDINATION, INCLUDE: ®[ED]

NONE IDENTIFIED

107_2A-42 PAYLOAD RAPID SAFING

A. THE FOLLOWING ITEMS IN THE SPACEHAB ARE CONSIDERED PENETRATION HAZARDS AND MUST BE CREW TENDED WHILE UNSTOWED AND SAFED PRIOR TO CLOSING THE SPACEHAB HATCH: ®[DN 23] ®[CR 5539A] ®[CR 5555A]

1. CM-2 WATER MIST PROPANE BOTTLES, QUANTITY TWO, INSTALLED IN EMS OR STOWED IN MESS RACK LOCATION PF04 (EMS FOAM IN PLACE AND STRAPS 8, 10, 12, AND 13 SECURED)

2. CM-2 WATER MIST EMS STOWED IN MESS RACK LOCATION PF04 WITH STRAPS 12 AND 13 SECURED OR INSTALLED IN CM-2 CHAMBER WITH GUN BOLTS ENGAGED

3. BDS-05 BIOREACTOR ENCLOSURE (BE) INSTALLED IN AC14 WITH LOCKER DOOR LATCHED CLOSED

SPACEHAB emergency procedures ensure that all penetrators are safed before the module is egressed. If time permits, a more nominal egress will be performed. Reference Rule {A2-329}, SPACEHAB DEACTIVATION/ENTRY PREP. ®[CR 5539A] ®[ED]

B. COM2PLEX, MSTRS, AND STARNAV MUST BE UNPOWERED PRIOR TO ENTRY ®[CR 5555A] ®[CR 5558]

COM2PLEX, MSTRS, and STARNAV are SPACEHAB rooftop mounted payloads that present a potential ignition source for flammable atmosphere assumed to be present in the PLB during ascent and entry. These payloads are powered from EXCP2 DC3, EXCP1 DC7, and EXCP2 DC2. Individual power control of any of these three sources is available at the EXCP in SPACEHAB. These sources can be unpowered from outside of SPACEHAB by doing any one of the following: opening PDU relay K2 via crew MCDS command (SPEC 222 - ITEM 14, DC EXCP 1/2 OFF), turning OFF the PDU EXP DC BUS switch on panel L12, turning OFF the PL PRI switch on panel R1, or if a Main Power Kill is issued. Reference: Hazard Reports COM-HR-STD-01; Cause 11, STD-MSTRS-F1; Cause 11, and STD-STARNAV-1; Cause 11, respectively. ®[CR 5555A] ®[CR 5558]

THIS RULE CONTINUED ON NEXT PAGE

107_2A-42 PAYLOAD RAPID SAFING (CONTINUED)

C. SPACEHAB MIDDECK PAYLOADS WILL BE CONFIGURED FOR SAFE ENTRY ®[CR 5555A]

SPACEHAB middeck payloads include BDS-05, Biopack, BRIC, CEBAS, CMPCG, OSTEO, and ancillary hardware for ZCG and HLS. Hazard Report BPK-BE-HR-0001; Cause 3 requires that the Biopack Cooler/Freezer door be closed with the handle flush and secured by Velcro, that the Biopack Incubator Tray (BIT) be fully inserted within the Incubator with both handles in parallel position, and that the Incubator access door be fully closed with handle flush and secured by Velcro. Hazard Report STD PTCU 15; Cause 2 requires that the Biopack Passive Thermal Control Units (PTCU) be stowed when not in use and during launch and landing. Hazard Report PGBX-U1; Cause 2 requires that the Biopack Glovebox be stowed in a middeck locker for launch and landing. ®[CR 5558]

D. FREESTAR: ®[CR 5555A]

1. THE CREW WILL TAKE BOTH THE HH AV PWR AND HH EXP PWR SWITCHES ON PANEL L12U TO THE OFF POSITION.

Generic Hitchhiker hazard report F-3 requires HH payloads to be unpowered during ascent/entry based on flammable atmosphere and potential ignition source concerns. The HH POCC desires to command an orderly shutdown or safing of the experiments. However, if time does not permit an orderly shutdown, FREESTAR experiments are safe for entry in any configuration. Deactivation by the crew in a rapid safing scenario will not be delayed to allow time for an orderly shutdown.

2. MEIDEX AND SOLSE DOOR ARE SAFE FOR LANDING IN ANY CONFIGURATION. ®[DN 23] ®[CR 5844]

The doors are normally closed for entry, but are safe in any configuration based on structural load capability. ®[CR 5844]

GENERAL

107_2A-51 EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE

ELECTRICAL EQUIPMENT OR EXPERIMENTS, SELF-POWERED OR FACILITY-POWERED, SHALL NOT BE TRANSFERRED BETWEEN THE ORBITER AND SPACEHAB UNLESS CERTIFIED FOR USE IN BOTH LOCATIONS. THE FOLLOWING LIST OF EQUIPMENT IS CERTIFIED FOR USE IN THE SPACEHAB MODULE (BEYOND THE EQUIPMENT IDENTIFIED IN RULE {A2 -326}, EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE): ®[ED]

ELECTRICAL EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE DOCUMENTED IN PUBLISHED PROCEDURES. ®[DN 24]

This rule in support of Rule {A2-326}, EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE. Equipment may only be used in areas where it has been approved from an electromagnetic compatibility standpoint. In addition, power budgeting/planning can only be accomplished effectively if equipment movement strategy is coordinated. If exchange of equipment is documented in approved orbiter or payload flight data file procedures, the compatibility and planning assessment has been performed and the equipment may be used in either location. If it is desired to exchange equipment not listed in Rule {A2-326}, EQUIPMENT EXCHANGE BETWEEN ORBITER CABIN AND SPACEHAB MODULE, and not included in approved procedures, an assessment must be performed prior to equipment exchange to verify electromagnetic compatibility, power budgeting/planning, heat load impacts, etc. ®[DN 24] ®[ED]

107_2A-52 CONSTRAINTS ON CABLES THROUGH THE SPACEHAB HATCH AND TUNNEL

THE BPSMU IS THE ONLY DRAG-THROUGH APPROVED FOR USE IN SPACEHAB. ®[DN 25]

In support of Rule {A2-331}, CONSTRAINTS ON CABLES THROUGH THE SPACEHAB HATCH AND TUNNEL. There are no cables except the BPSMU that might need to be run through the Spacehab hatch. ®[DN 25] ®[ED]

107_2A-53 PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES

A. IN SUPPORT OF RULE {A2-105}, IN-FLIGHT MAINTENANCE (IFM), THE FOLLOWING IS A LIST OF PAYLOAD UNSCHEDULED IFM PROCEDURES WHICH HAVE BEEN PRE-MISSION COORDINATED AND REQUIRE ONLY REAL-TIME APPROVAL PRIOR TO IMPLEMENTATION. ®[ED]

1. SPACEHAB IFM'S INCLUDED IN RULE {A2-324}, SPACEHAB IN-FLIGHT MAINTENANCE (IFM) PROCEDURES. ®[ED]

2. PDI IFM TO INSTALL SPARE PDI PER RULE {107_11A-11}, PDI FAILURE MANAGEMENT.

Failure of the PDI takes out payload monitoring and science data downlinks for both Spacehab and FREESTAR, as well as the ability to downlink video via SSV. Portions of the Spacehab PDI stream can be reconfigured to its Ku-band Ch 2 data stream, but lesser availability of the Ku downlink path due to orbiter blockage make recovery of the S-Band (PDI) capability for Spacehab mandatory.

3. STANDARD SWITCH PANEL (SSP) IFM TO REGAIN PRIMARY PAYLOAD FUNCTIONS WILL BE PERFORMED, IF REQUIRED.

Spacehab, FREESTAR, and OARE require activation from the SSP. Single switch failures could prevent these payloads from being activated, strand the MEIDEX door in the open position, or inhibit LPT power. The IFM will be performed to regain these critical functions. ®[DN 52] ®[CR 5844]

4. PSP IFM TO WIRE FREESTAR TO PSP-2 PER RULE {107_11A-12}, PSP FAILURE MANAGEMENT.

A generic Hitchhiker IFM is available to work around a failure of the Payload Signal Processor (PSP). The Hitchhiker avionics are wired to PSP-1, but can be connected to PSP-2 via IFM. The IFM will be scheduled as mission priorities permit.

5. FOR FAILURE OF PL1 MDM, AN MDM REPLACEMENT IFM WILL BE CONSIDERED TO REGAIN COMMANDING FOR FREESTAR AND OARE.

The only command interface to both FREESTAR and OARE via PL1 MDM, neither has a backup command path. For failure of PL1 MDM, FREESTAR commanding could be recovered with an IFM to either replace PL1 MDM or to connect to PSP-2. The only option for OARE requires MDM replacement.

THIS RULE CONTINUED ON NEXT PAGE

107_2A-53 PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES (CONTINUED)

6. FOR FAILURE OF THE DIGITAL TV MUX SUCH THAT IT CANNOT BE SWITCHED BACK TO SPACEHAB PL MAX KU CH 3 DOWNLINK, THEN THE SH PL MAX DATA RECOVERY IFM WILL BE PERFORMED TO ROUTE SPACEHAB KU CH 3 DATA DIRECTLY TO THE KUSP.

SPACEHAB will lose the ability to downlink Experiment LOS playback data. Twelve SPACEHAB payloads will lose science if this data is not available. ®[CR 5540]

7. CM-2 IFM'S ®[DN 26]

   a. IFM-01 DEPP CARD CHANGEOUT

   b. IFM-02 DPP CARD CHANGEOUT

   c. IFM-03 LSP IGNITER ARM/STEPPER MOTOR ASSEMBLY CHANGEOUT

   d. IFM-04 RECONFIGURE LASER DIODE DRIVER

   e. IFM-05 REPLACE LASER DIODE ASSEMBLY

   f. IFM-06 THERMOCOUPLE (TC) RAKE CHANGEOUT

   g. IFM-07 IGNITER ELECTRODE TIP CHANGEOUT

   h. IFM-08 PDP FUSE CHANGEOUT

   i. IFM-09 MIST IGNITION TROUBLESHOOT

   j. IFM-10 REPLACE 10 BASE-T TRANSCEIVER

   k. IFM-11 MANUAL IRIS SETTING

8. EOR/F IFM-01 EOR/F TEMP DISPLAY BATTERY CHANGEOUT

9. ERISTO IFM-01 EXCHANGE ERISTO PWR CABLE

10. OSTEO IFM-01 EXCHANGE OSTEO PWR CABLE ®[DN 26] ®[CR 5540]

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107_2A-53 PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES (CONTINUED)

11. FOR FAILURE OF THE KU-BAND SIGNAL PROCESSOR TO DOWNLINK CHANNEL 2 PAYLOAD DIGITAL DATA, AN IFM WILL BE PERFORMED TO ROUTE THE SPACEHAB 2 MB EXPERIMENT DATA STREAM TO THE S-BAND FM SIGNAL PROCESSOR. ®[CR 5540]

Eight SPACEHAB experiments use the Ku Channel 2 data stream for real-time science data. ®[CR 5540]

B. IN SUPPORT OF RULE {A2-105}, IN-FLIGHT MAINTENANCE (IFM), THE FOLLOWING IS A LIST OF SPACEHAB EXPERIMENT UNSCHEDULED IFM PROCEDURES WHICH DO NOT REQUIRE REAL-TIME APPROVAL OR COORDINATION PRIOR TO IMPLEMENTATION: ®[ED]

   NONE IDENTIFIED ®[DN 26]

C. NO IFM PROCEDURES WILL BE INITIATED BY THE CREW ON AN EXPERIMENT KNOWN TO REPRESENT A TOXIC HAZARD UNTIL CONCURRENCE FOR THE REPAIR PROCEDURE IS OBTAINED FROM THE MCC FLIGHT DIRECTOR. SPACEHAB EVACUATION AND/OR PROTECTIVE EQUIPMENT MAY BE REQUIRED (SEE RULE {A13-156}, SPACEHAB HAZARDOUS SUBSTANCE SPILL RESPONSE). ALL PAYLOAD EXPERIMENTS/SAMPLES CONTAINING HAZARDOUS MATERIALS ARE DEFINED IN THE FLIGHT SPECIFIC ANNEX.

A real-time assessment of the possibility of repairing an experiment and the risk of exposing the crew to a toxic substance during the repair will need to be made. The IFM may require that the cleanup equipment specified in Rule {A13-156}, SPACEHAB HAZARDOUS SUBSTANCE SPILL RESPONSE, be used to minimize risk of crew exposure to toxic substances. ®[ED]

107_2A-54 PGSC USAGE GUIDELINES

TABLE 107_2A-54-I - PGSC USAGE PLAN

PGSC	FUNCTION	ORBITER PROVIDED	SPACEHAB PROVIDED
STS1	OCA	X	
STS2	WINDECOM	X	
STS3	PROSHARE	X	
STS4	WORLDMAP	X	
PL1	MEIDEX	X	
PL2	SOLSE-2	X	
PL3	SH SUBSYSTEM, HLS PHAB-4 BAR CODE READER	X	
PL4	AST, MGM, BDS-05, & ZCG	X	
PL5	CM-2	X (WINDOWS 95 OS)	
PL6	VCD FE	X (WINDOWS 95 OS)	
HLS	HLS MPFE		X
ARMS	ARMS		X

®[DN 27]

NOTE: PGSC BACKUP OPTIONS WILL BE DOCUMENTED AS REFERENCE DATA IN THE PAYLOAD OPS CHECKLIST.

PROGRAMMATICALLY, THE TWO STOWED PGSC’S ARE DEDICATED TO MEIDEX AND SOLSE. OPERATIONALLY, THEY WILL BE USED AS REQUIRED TO SUPPORT FIRST AND SECOND PGSC FAILURES. SHOULD MEIDEX OR SOLSE PGSC’S REQUIRE BACKUP, THEY WILL BE GIVEN PRIORITY OVER OTHER USERS. ®[DN 27]

PAYLOAD CONSTRAINTS

107_2A-61 PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY

TABLE 107_2A-61-I – PAYLOAD CONTAMINATION MATRIX

CUSTOMERS WITH DUMP AND/OR PURGE CONTAMINATION CONCERNS SHOULD BE NOTIFIED OF CHANGES TO DUMP PLANS AT LEAST 90 MINUTES PRIOR TO THE EVENT, IF POSSIBLE. NOZZLE DUMP ATTITUDES MAY BE BIASED FROM THE RETROGRADE DIRECTION IF REQUIRED TO PROTECT THERMAL CONSTRAINTS. ®[DN 48]

PAYLOAD	TIMEFRAME	SUPPLY DUMPS, WASTE DUMPS, FES OPERATIONS	OMS BURN	PRCS	OMS/RCS PROPELLANT /JET LEAKS AND APU OPERATIONS	ORBITER LEAKS	FUEL CELL PURGES
SPACEHAB [4]	N/A	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
MEIDEX [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (DOOR OPEN)	NO NOZZLE DUMPS	PROHIBITED WHEN DOOR OPEN	PROHIBITED WHEN DOOR OPEN EXCEPT WHEN LANDTRACK MANEUVER REQUIRED [1]	CLOSE DOOR ASAP VIA SSP [2]	CLOSE DOOR ASAP VIA SSP [2]	INHIBITED
	NON-OPERATING (DOOR CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SOLSE [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (DOOR OPEN)	NO NOZZLE DUMPS, MINIMIZE FES OPS [3]	PROHIBITED WHEN DOOR OPEN	MINIMIZE PRCS FIRINGS WHEN DOOR OPEN [1]	CLOSE DOOR ASAP VIA PGSC [2]	CLOSE DOOR ASAP VIA PGSC [2]	INHIBITED
	NON-OPERATING (DOOR CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
SOLCON [4]	20 MIN PRIOR TO AND DURING EXPERIMENT OBSERVATIONS (COVER AND SHUTTERS OPEN)	NO NOZZLE DUMPS	PROHIBITED WHEN COVER AND SHUTTERS OPEN	MINIMIZE PRCS FIRINGS WHEN COVER AND SHUTTERS OPEN [1]	CLOSE COVER OR SHUTTERS ASAP VIA GROUND COMMAND [2]	CLOSE COVER OR SHUTTERS ASAP VIA GROUND COMMAND [2]	INHIBITED
	NON-OPERATING (COVER OR SHUTTERS CLOSED)	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS
LPT	DURING GPS NAV DATA TAKES	NO NOZZLE DUMPS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS	INHIBITED
CVX	N/A	NO CONSTRAINTS	NO OMS BURNS DURING CRITICAL PERIODS	NO PRCS DURING CRITICAL PERIODS	NO CONSTRAINTS	NO CONSTRAINTS	NO CONSTRAINTS

®[DN 48] ®[DN 53] ®[CR 5846] ®[CR 5895A]

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107_2A-61 PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY (CONTINUED)

NOTES: ®[DN 48]

[1] IF VERNS ARE LOST, OPERATIONS MAY CONTINUE USING PRCS JETS. PRCS IS REQUIRED FOR MEIDEX LANDTRACK MANEUVERS. ®[CR 5846]

[2] MAY BE LEFT OPEN AT THE DISCRETION OF THE GSFC POCC.

[3] SOLSE HIGHLY DESIRES FES DISABLED DURING CHECKOUT AND CALIBRATION ORBITS AND DESIRES IT OFF DURING SCIENCE OPERATIONS.

[4] REFER TO RULE {107_2A-71}, ATTITUDE AND POINTING CONSTRAINTS, FOR RAM CONSTRAINTS BASED ON CONTAMINATION CONCERNS.

Nozzle dumps and OMS/PRCS operations have the potential to put contaminants in the vicinity of the payload bay, causing potential contamination of the SOLCON instrument and the SOLSE, and MEIDEX windows and potential degradation of science. These payloads have no constraints against these types of activities when the experiment doors/shutters are closed. Although SOLSE highly desires the FES inhibited, thermal analysis indicates that inhibiting FES operations will probably not be possible. SOLCON will nominally leave their cover open for the duration of the flight, closing their shutters during contamination periods. The shutters should protect the instrument adequately from standard orbiter contamination events. In the case of jet or orbiter leaks, SOLCON may choose to close their cover via ground command as additional protection against contamination.

Alt DAP attitude control is required during Landmark Track Maneuvers. MEIDEX may request a Landmark Track of significant storms are present. If so, the request will likely come near the end of the mission, when the effects of potential contamination on the window will minimize the impact to the total science gained. ®[CR 5846]

Reference Rules {107_2A-62}, DAP CONSTRAINTS and {107_2A-63}, MICROGRAVITY REQUIREMENTS, for additional constraints on attitude control and OMS burns. ®[DN 48]

107_2A-62 DAP CONSTRAINTS

PAYLOAD	TIMEFRAME	CONTROL MODE	ATTITUDE DEADBAND [1]	RATE DEADBAND
SPACEHAB	DURING COM2PLEX, STARNAV, AND MSTRS OBSERVATIONS	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
MEIDEX	DURING STATIONARY SPRITE AND EARTH OBSERVATIONS	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
	DURING MOON CALIBRATIONS	VRCS	2 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
SOLSE	LIMB OBSERVATIONS	VRCS	0.1 DEG	.02 DEG/SEC
		ALT DAP	1.5 DEG (0.7 DEG DESIRED)	.07 DEG/SEC
	POLAR SWEEP MANEUVER	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	1.5 DEG	.07 DEG/SEC
	EARTH OBSERVATIONS	VRCS	1 DEG	.02 DEG/SEC
		ALT DAP	3 DEG	.07 DEG/SEC
SOLCON	SOLAR OBSERVATIONS	VRCS	0.1 DEG	.02 DEG/SEC
		ALT DAP	1 DEG (0.3 DEG DESIRED)	.07 DEG/SEC

®[DN 28]

NOTES:

[1] FOR LOSS OF VERNS DURING FREESTAR DATA TAKES, ALT DAP WILL BE SELECTED FOR THE REMAINDER OF THAT DATA TAKE. THE FREESTAR MISSION MANAGER WILL REQUEST TIGHTER DEADBANDS TO MEET PRIORITIZED PAYLOAD SCIENCE REQUIREMENTS DEPENDING ON PROP AVAILABILITY.

All FREESTAR instruments except SOLCON can acquire limited science when operating at a 3 deg attitude deadband, expecting instrument targets to occasionally pass through the instrument FOV's. The FREESTAR Mission Manager will prioritize FREESTAR payload objectives in light of available prop and mission objectives met to date. For loss of VERNS, ALT DAP attitude control is required to acquire science. In this case, a degradation of science due to contamination by PRCS jets is acceptable.

The attitude deadband during the SOLSE polar sweep may be relaxed to 1 deg in order to facilitate reaching attitude within the desired time. Upon reaching the target attitude, the deadbands should be collapsed to 0.1 deg. ®[DN 28]

107_2A-63 MICROGRAVITY CONSTRAINTS

PAYLOAD		TIMEFRAME	OMS BURN	PRCS [1]	VRCS	EXERCISE
ADVANCED PROTEIN CRYSTALLIZATION FACILITY (APCF)		ACTIVATION UNTIL DEACTIVATION	PROHIBITED WITHOUT PRIOR NOTIFICATION	PROHIBITED WITHOUT PRIOR NOTIFICATION	NO CONSTRAINT	NO CONSTRAINT
COMMERCIAL MACROMOLECULAR AND PROTEIN CRYSTAL GROWTH (CMPCG)		FIRST 10 DAYS FOLLOWING ACTIVATION	HIGHLY DESIRE PROHIBITED	HIGHLY DESIRE PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALIZATION FACILITY (CPCG-PCF)		FIRST 24 HOURS FOLLOWING INITIALIZATION	HIGHLY DESIRE PROHIBITED	HIGHLY DESIRE PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
MECHANICS OF GRANULAR MATERIALS (MGM)		ACTIVATION UNTIL DEACTIVATION FOR TEST POINTS 1-8	PROHIBITED	PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
COMBUSTION MODULE-2 (CM-2)	LAMINAR SOOT PROCESSES (LSP)	MICROGRAVITY PERIOD BEGINS 22-28 MINUTES AFTER THE START OF A RUN AND LASTS FOR 11 MINUTES	PROHIBITED	PROHIBITED	NO CONSTRAINT	NO CONSTRAINT
	STRUCTURE OF FLAME BALLS AT LOW LEWIS NUMBERS (SOFBALL)	MICROGRAVITY PERIOD BEGINS 18 MINUTES INTO EACH RUN AND LASTS FOR VARIOUS DURATIONS (1.5 TO APPROXIMATELY 4 HRS) DEPENDING ON THE RUN.	PROHIBITED	PROHIBITED	PROHIBITED (GRAVITY GRADIENT ATTITUDE REQUIRED)	ARMS CREW EXERCISE/CYCLE ERGOMETER OPS AND ORBITER CYCLE ERGOMETER OPS PROHIBITED DURING MICROGRAVITY PERIOD.
	WATER MIST	MICROGRAVITY PERIOD BEGINS AT EXPERIMENT RUN START +23 OR 29 MINUTES (DEPENDING ON THE RUN) AND LASTS FOR 2-4 MINUTES	PROHIBITED	PROHIBITED	PROHIBITED	ARMS CREW EXERCISE/ERGOMETER OPS AND ORBITER ERGOMETER OPS PROHIBITED DURING THE MICROGRAVITY PERIOD [3]
ZEOLITE CRYSTAL GROWTH (ZCG)		FURNACE ACTIVATION UNTIL ZCG DEACTIVATION	PROHIBITED	PROHIBITED WITH ALLOWANCE FOR ALT DAP AS NEGOTIATED WITH ZCG	NO CONSTRAINT [1]	MINIMIZE CREW EXERCISE DURING FIRST 10 HOURS POST-FURNACE ACTIVATION.
CRITICAL VISCOSITY OF XENON-2 (CVX-2)		CRITICAL PERIODS [2]	PROHIBITED	PROHIBITED [1]	NO CONSTRAINT	AVOID SCHEDULING CONSECUTIVE EXERCISE PERIODS WHEN POSSIBLE DURING CRITICAL PHASES

®[DN 49] ®[CR 5623] ®[CR 5628A] ®[CR 5895A]

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107_2A-63 MICROGRAVITY CONSTRAINTS (CONTINUED)

NOTES:

[1] FOR LOSS OF VERNS, MGM, LSP, WATER MIST, ZCG AND CVX-2 WILL CONTINUE OPERATIONS USING ALT DAP. ®[DN 49]

[2] CRITICAL PERIODS OCCUR WHEN THE EXPERIMENT APPROACHES ITS CRITICAL TEMPERATURE AND WILL BE DEFINED BY THE CUSTOMER AND PROVIDED AS PART OF THE REPLAN CYCLE. THESE CRITICAL PERIODS ARE APPROXIMATELY DEFINED BY THE FOLLOWING PAYLOAD EVENT TIMES (REFERENCED FROM CVX-2 ACTIVATION): 26 TO 47 HOURS, 64 TO 115 HOURS, AND 130 TO 182 HOURS FOR A 200 HOUR TIMELINE; AND 20 TO 35 HOURS, 54 TO 73 HOURS, 129 TO 151 HOURS, 205 TO 227 HOURS, AND 281 TO 303 HOURS FOR A 308 HOUR TIMELINE.

[3] EXERCISE MAY BE SCHEDULED DURING WATER MIST RUNS, BUT THE CREWMEMBER MUST PAUSE FOR THE SHORT MICROGRAVITY PERIOD.

The gravity gradient attitude is required for SOFBALL to maintain predictable comm during the lengthy microgravity periods. Exercise in the Spacehab is prohibited during SOFBALL microgravity periods to achieve the best microgravity environment possible. Exercise in the middeck is also prohibited during SOFBALL Free Drift periods.

Most MIST tests require microgravity beginning 37 minutes into each run. However, MIST tests 12 and 22 are an exception to this rule with microgravity periods beginning 22 minutes into each run. No special attitude is required for MIST since the Free Drift period is short and comm should remain predictable. Exercise in the middeck and in Spacehab module prohibited during MIST Free Drift periods.

CVX-2 critical periods occur when the experiment approaches its critical temperature. The most critical part of CVX-2's timeline is the last 10 hours of the first pass through Tc (liquid-vapor critical point of Xenon, approx 16.7 degrees C). They will use this "fast" pass to locate Tc for the remainder of the mission. Each of the later "slow" passes through Tc requires about 80 hours, with the last 30 hours being most important. Based upon on-orbit performance, CVX will be able to more accurately define the most critical portions of the CVX timeline during flight. Actual critical period timeframes will be defined by the customer and provided as part of the replan cycle.

OMS burns and PRCS jet firings are not allowed during CVX-2 critical periods. Shuttle maneuvers using VRCS sometimes create DC accelerations that exceed the steady-state requirement of 0.24 milli-g, but they are too short-lived to cause a problem.

CVX-2 is very susceptible to impacts on the sample cell during exercise periods due to the AC accelerations reducing the measurement signal-to-noise ratio. To protect sample data against possible degradation due to crew exercise, CVX desires that during critical periods, exercise not be scheduled consecutively. This scheduling is desirable for the entire mission, yet extremely important during critical periods operations. Based upon on-orbit performance, CVX will be able to more accurately define the most critical portions of the CVX timeline during flight.

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107_2A-63 MICROGRAVITY CONSTRAINTS (CONTINUED)

CMPCG and CPCG-PCF are both sensitive to microgravity disturbances during crystal nucleation and crystal growth which can cause detrimental effects to crystal formation and the solution boundary layer as the crystals grow in solution. CMPCG consists of approximately 1008 samples that have a wide variance in the timing of nucleation and growth phases. CMPCG highly desires minimized disturbances during their entire crystal growth phase, but especially for the first 10 days of crystal growth. CPCG-PCF consists of only one sample and highly desires minimized disturbances during the first 24 hours of crystal growth which is the expected nucleation and early growth phase. ®[CR 5628A]

Reference Rule {107_2A-61} PAYLOAD CONTAMINATION CONSTRAINTS SUMMARY, for OMS/RCS constraints driven by contamination concerns. ®[DN 49]

107_2A-64 RESERVED ®[CR 5895A]

107_2A-71 ATTITUDE/POINTING CONSTRAINTS

A. SPACEHAB

1. COMBINED TWO-PHASE LOOP EXPERIMENT (COM2PLEX)

a. COM2PLEX REQUIRES A -ZLV (NADIR) ATTITUDE FOR 48 HOURS PER EACH OF THE THREE LOOPS FOR A TOTAL OF 144 HOURS. ANY YAW IS ACCEPTABLE. COM2PLEX CAN WITHSTAND ATTITUDE BIASES UP TO 20 DEGREES WHICH LAST NO MORE THAN 20 MINUTES. THE TIME SPENT BIASED CAN TOTAL NO MORE THAN 40 MINUTES EVERY 24-HOUR PERIOD. ®[DN 79]

b. COM2PLEX DEEP SPACE POINTING IS LIMITED TO 90 MINUTES IF UNPOWERED. AFTER 90 MINUTES, COM2PLEX REQUIRES A -ZLV (NADIR) ATTITUDE FOR 1 HOUR BEFORE REAPPLYING POWER. COM2PLEX HAS NO DEEP POINTING CONSTRAINT WHILE POWERED.

c. COM2PLEX MUST BE IN A REDUCED POWER STATE FOR SOLAR POINTING.

The COM2PLEX payload requires maintaining a similar attitude for the duration of each of the three experiment runs to reduce thermal fluctuations and maintain comparability between the runs.

2. MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

a. MSTRS REQUIRES A -ZLV (NADIR) ATTITUDE FOR EACH OPERATIONAL CYCLE EXCEPT AS NOTED IN PARAGRAPH B BELOW.

Each operations cycle consists of a 1 hour warm up period and a minimum of four continuous orbits. The MSTRS payload requires no bias in the -ZLV (NADIR) attitude to accurately geo-locate radio frequency sources on Earth. ®[DN 79]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. DURING ONE ENTIRE PHASE 2 ORBIT SET (FOUR CONTINUOUS ORBITS), MSTRS REQUIRES A 15-DEGREE BIAS FROM –ZLV (NADIR) SUCH THAT THE SHUTTLE BAY IS POINTING IN A NORTHERLY DIRECTION. THE ATTITUDE FOR THE WARM-UP PERIOD PRIOR TO THIS ORBIT SET WILL NOT BE BIASED. ®[DN 79]

c. MSTRS DEEP SPACE POINTING IS LIMITED TO 2 HOURS. AFTER 2 HOURS, MSTRS REQUIRES A –ZLV (NADIR) ATTITUDE FOR 2 HOURS TO RECOVER. DUE TO TECHNICAL CONCERNS WITH ORBITER OFF GASSING, MSTRS REQUIRES THEIR FIRST OPERATIONAL CYCLE TO OCCUR LATER THAN 16 HOURS MET. MSTRS REQUIRES A MINIMUM OF 24 HOURS BETWEEN OPERATIONAL CYCLES.

3. STAR NAVIGATION (STARNAV)

a. STARNAV REQUIRES A MINIMUM OF TWENTY OBSERVATIONS WITH THE FOV OF THE INSTRUMENT POINTED 25 DEGREES FROM THE EARTH LIMB AND 30 DEGREES FROM THE SUN. STARNAV ALSO REQUIRES A NON-INERTIAL ATTITUDE FOR EACH 30 MINUTES OBSERVATION. BACK-TO-BACK OBSERVATIONS CANNOT BE SCHEDULED.

STARNAV's field of view is defined as a cone generated by a 5.5 degree half angle projection. The total conical field of view is an 11 degree sweep centered on the bore of STARNAV's camera. ®[DN 79]

b. STARNAV MUST BE POWERED OFF DURING PASSES THROUGH THE SOUTH ATLANTIC ANOMALY (SAA). STARNAV MUST BE POWERED ON DURING MANEUVERS CAUSING THE FOV TO SWEEP THROUGH THE SUN VECTOR

STARNAV is powered off during SAA passes and powered on during solar passes to protect electronics.

c. STARNAV REQUIRES DEEP SPACE POINTING TO BE LIMITED TO 5 HOURS. AFTER 5 HOURS, STARNAV POWER MUST BE RESTORED OR THE STARNAV PAYLOAD MUST RETURN TO A -ZLV (NADIR) ATTITUDE TO RECOVER. STARNAV'S RECOVERY TIME IS EQUAL TO THE TIME SPENT DEEP SPACE POINTING WITHOUT POWER. ®[DN 79]

The STARNAV recovery time in a warm attitude is equal to the duration of time in the deep space attitude. STARNAV will be powered off when not observing.

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

d. STARNAV REQUIRES BAY-TO-SUN POINTING BE LIMITED TO 36 MINUTES WHEN POWERED ON. STARNAV HAS NO –ZSI CONSTRAINT WHEN POWERED OFF. ®[DN 79]

e. STARNAV'S FIELD OF VIEW MAY NOT SWEEP THROUGH RAM AT ANY RATE.

Sweeping through RAM may damage STARNAV's lens. ®[DN 79]

4. COMBUSTION MODULE-2 (CM-2)

CM-2 REQUIRES FREE DRIFT FOR THE SOFBALL AND MIST TESTS. SOFBALL DESIRES A GRAVITY GRADIENT ATTITUDE DURING MICROGRAVITY PERIODS. MIST FREE DRIFT PERIODS HAVE NO ATTITUDE REQUIREMENT.

Free Drift periods required for SOFBALL are significantly longer in duration than MIST's, so a Gravity Gradient attitude is desired to maintain predictable comm during that time.

B. FREESTAR

1. MEIDEX

a. DURING MEIDEX EARTH VIEWING DATA TAKES, THE ORBITER -Z AXIS MUST BE POINTED AT THE EARTH, WITH A ROLL BIAS AS NECESSARY FOR TARGET ACQUISITION OVER THE REGION OF INTEREST.

During primary data collection periods, MEIDEX requires a bay-to-earth, tail/nose forward based orientation to ensure best possible ROI coverage in relation to the instrument FOV and to enable maximum data acquisition. Optimum opportunities and flexibility for MEIDEX observations will be acquired when the orbiter trajectory passes directly over the ROI. During these observations, slight attitude biases away from Nadir may be considered in order to ensure that the designated targets remain within the MEIDEX FOV. The MEIDEX instrument can assist in target tracking by tilting ?22.5 deg in the YZ plane (resulting in a north to south scan across the groundtrack). MEIDEX desires that dedicated operations not occur within the South Atlantic Anomaly (SAA) on more than three consecutive orbits. ®[CR 5847]

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107_2A-71 **ATTITUDE/POINTING CONSTRAINTS (CONTINUED)**

b. IF REQUESTED, MEIDEX LANDMARK TRACK MANEUVERS CAN BE UTILIZED TO TRACK SIGNIFICANT DUST STORMS THROUGH AN ENTIRE OVERPASS. ®[DN 79]

LTM's would likely be requested no more than once or twice during the mission, and only if significant dust activity were present. As LTM maneuvers require PRCS attitude control (which could increase potential for contamination on the MEIDEX window), MEIDEX would request the scheduling of an LTM as late as possible in the mission.

c. DURING MEIDEX LUNAR CALIBRATIONS, A LUNAR INERTIAL ATTITUDE IS REQUIRED.

There is no requirement for a specific moon orientation in respect to the MEIDEX FOV.

d. DURING MEIDEX GROUND CALIBRATIONS, MEIDEX REQUIRES A BAY-TO-EARTH, NOSE/TAIL FORWARD ORIENTATION, WITH A MAXIMUM ATTITUDE BIAS OF ?30 DEGREES FROM LOCAL NADIR OVER THE PRE-SELECTED SITE, FOR A MINIMUM OF 20–30 SECONDS. MEIDEX HIGHLY DESIRES A LANDMARK TRACK FOR A MINIMUM OF 3 MINUTES. ®[CR 5615]

e. DURING SPRITE OBSERVATIONS, MEIDEX REQUIRES A NOSE/TAIL DOWN, BELLY FORWARD ATTITUDE WITH THE ORBITER VIEWING TOWARDS THE DUSK-TERMINATOR DURING ECLIPSE FOR A MINIMUM OF 20 MINUTES (> 30 MINUTES DESIRED).

In order to maximize limb coverage, the MEIDEX canister center axis is required to point 50 km above the earth's limb.

f. WITH THE DOOR IN THE OPEN POSITION, MEIDEX REQUIRES THAT THE SUN NOT ENTER WITHIN 5 DEGREES OF THE XYBION CAMERA FOV. ®[CR 5844] ®[CR 5847]

Meidex will request that the crew close the experiment door and temporarily terminate science activities if the sun constraints are predicted to be violated. The Xybion camera FOV is 10.76 deg x 14.04 deg with the long axis in the Y direction and is centered on the –Z orbiter body axis. ®[DN 79]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

g. WITH THE DOOR IN THE OPEN POSITION, MEIDEX SHOULD NOT VIEW RAM WITHIN A ± 70 DEGREE FOV IN THE –Z AXIS. IF THE RAM PASSES THROUGH THE INSTRUMENT CENTRAL POSITION ± 70 DEGREES, THE ANGULAR RATE IS REQUIRED TO BE AT LEAST 0.2 DEGREE/SECOND. ®[CR 5844] ®[CR 5847]

Exposure to extended RAM could damage the instrument window thus degrading the optical properties necessary for valid science. MEIDEX will request that the crew close the door via SSP and temporarily terminate science if the RAM constraint is predicted to be violated. ®[DN 55] ®[CR 5844]

2. SOLSE

a. SOLSE REQUIRES A BIASED PORT WING TO EARTH, BELLY-TO-RAM ATTITUDE DURING LIMB VIEWS. ®[DN 79]

(1) DURING VISIBLE FILTER OBSERVATIONS, THE -Z AXIS IS REQUIRED TO BE POINTED AT 25 KM ABOVE THE EARTH’S SURFACE.

(2) DURING UV FILTER OBSERVATIONS, THE -Z AXIS IS REQUIRED TO BE POINTED AT 32 KM ABOVE THE EARTH’S SURFACE.

(3) SOLSE REQUIRES THAT THE OBLATENESS OF THE EARTH BE FACTORED INTO THE ORBITER POINTING AS NECESSARY.

(4) SOLSE REQUIRES THAT ORBITER POINTING BE ADJUSTED AS REQUIRED TO KEEP THE –Z AXIS WITHIN ±5 KM OF THE TARGETED ALTITUDE.

Small attitude adjustment maneuvers may be required during SOLSE limb views in order to keep the SOLSE FOV within 5 km of the Earth altitude under observation. Depending on the orbital altitude, a slight tilt of the XY plane will be required to maintain vertical resolution at the limb. SOLSE may request to change a limb view to a polar view depending upon match-up availability with ground truth sites. Although polar views are considered superior to alternative viewing options, SOLSE may request that a polar sweep maneuver be performed during a SOLSE limb view. ®[DN 79] ®[CR 5847]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. SOLSE REQUIRES A BAY-TO-EARTH, TAIL/NOSE FORWARD ATTITUDE DURING EARTH VIEWING OBSERVATIONS. ®[CR 5847]

This orientation ensures that the long axis of the SOLSE field of view is perpendicular to the ground track.

c. SOLSE REQUIRES A BIAS -YLV +XVV ATTITUDE (NORTHERN VIEWS) OR BIAS -YLV -XVV ATTITUDE (SOUTHERN VIEWS) DURING POLAR VIEWING OBSERVATIONS.

SOLSE highly desires three orbits of hbar polar view observations, two north and one south. The polar views will allow SOLSE-2 to extend the coverage for SOLSE observations to higher latitudes (simulating science that could be achieved on a higher inclination flight). All polar view operations are desired to be performed in attitude for the entire daylit portion of the orbit.

d. SOLSE REQUIRES THAT THE ORBITER –Z AXIS NOT BE POINTED WITHIN ?70 DEG OF THE RAM WHEN THE SOLSE DOOR IS OPEN. ®[CR 5844]

Viewing RAM could cause atomic oxygen contamination on the window, resulting in severely degraded data.

e. SOLSE REQUIRES THAT THE SUN REMAIN OUTSIDE OF A ?7.5 FIELD OF VIEW (FOV) FROM THE –Z AXIS WHEN THE DOOR IS OPEN. ®[DN 79] ®[CR 5844] ®[CR 5847]

Viewing the Sun may solarize contaminants on the window and degrade the optical qualities of the window.

3. SOLCON

a. DURING SOLAR VIEWING DATA TAKES, THE ORBITER -Z AXIS MUST BE POINTED AT THE SUN FOR 40 MINUTES. THE SUN MUST BE GREATER THAN 10 DEGREES ABOVE THE EARTH HORIZON FOR THE DURATION OF THE EXPERIMENT. OBSERVATIONS MAY BE SCHEDULED AS TWO CONSECUTIVE SOLAR VIEWING PAIRS.

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

b. SOLCON REQUIRES DEEP-SPACE VIEWING (ORBITER -Z AXIS > 15 DEGREES AWAY FROM EARTH AND > 25 DEGREES AWAY FROM THE SUN) OF AT LEAST 10 MIN IN DURATION PRIOR TO AND FOLLOWING EACH SOLAR VIEWING ORBIT.

Deep space attitude required for instrument calibration prior to and after each SOLCON data take. The deep space viewing need not occur in a fixed attitude as long as the FOV constraints are met. ®[DN 56]

c. SOLCON REQUIRES THAT THE RAM REMAIN ±10 DEGREES OUTSIDE THE INSTRUMENT CENTRAL POSITION (ORBITER –Z AXIS) WHEN THE EXPERIMENT SHUTTERS ARE OPEN. TEMPORARY VIOLATIONS ARE ACCEPTABLE IF THE RAM PASSES THROUGH THE INSTRUMENT CENTRAL POSITION AT AN ANGULAR RATE OF AT LEAST 0.2 DEGREE/SECOND.

Extended RAM exposure could damage SOLCON optics. SOLCON will close shutters and temporarily terminate science collection for predicted RAM violations.

4. CVX HAS NO ATTITUDE POINTING REQUIREMENTS FOR SCIENCE COLLECTION.

a. DURING NON-CRITICAL PERIODS, CVX SHALL NOT BE EXPOSED TO MORE THAN 60 MINUTES OF SOLAR VIEWING DURING ANY 4 HOUR PERIOD, WITH THE EXCEPTION OF SOLCON SOLAR PAIRS AS OUTLINED IN RULE {107_2A-71B}.4.B, ATTITUDE/POINTING CONSTRAINTS. ®[DN 57]

The CVX experiment must be limited to less than 60 minutes of solar viewing during any 4-hour period. If more than 60 minutes of solar viewing were to occur, CVX would potentially lose valuable experiment data. This limitation is for reasons of successful operations and is not a safety requirement. Solar viewing is defined as sustained solar flux within 60 degrees of the -Z axis. During critical periods, CVX should be able to tolerate the Sun sweeping through the payload bay (as in an LVLH attitude hold like bay to wake). CVX should also be able to tolerate sustained off-normal solar flux during critical periods as long as the Sun is greater than 60 degrees off normal (-Z axis). Flight-specific attitudes will be analyzed to ensure that thermal limits are not exceeded during critical periods.

b. DURING NON-CRITICAL PERIODS, SOLCON SOLAR PAIRS (45 MINUTES ON CONSECUTIVE ORBITS) CAN BE SCHEDULED WITH THE FOLLOWING CONSTRAINTS:

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107_2A-71 **ATTITUDE/POINTING CONSTRAINTS (CONTINUED)**

(1) CVX-2 REQUIRES AN ATTITUDE COLDER THAN BAY TO EARTH IN BETWEEN OBSERVATIONS.

(2) CVX-2 REQUIRES 6 HOURS OF RECOVERY TIME IN A BAY TO EARTH OR COLDER ATTITUDE FOLLOWING A SOLCON PAIR PRIOR TO ADDITIONAL SOLAR VIEWING.

c. DURING CRITICAL PERIODS, CVX SHALL NOT BE EXPOSED TO ANY -ZSI ATTITUDES.

Five critical periods occur during the 304 hours of desired CVX operations while CVX is establishing the critical temperature of Xenon. Reference the rationale in Rule {107_2A-63}, MICROGRAVITY CONSTRAINTS, for approximate timeframe of critical periods. -ZSI excursions during these periods will cause critical temperature determination excursions that exceed the experiment's ability to perform the science run. ®[DN 57]

d. EITHER OPERATING OR NON-OPERATING, CVX SHALL NOT BE EXPOSED TO –ZSI ATTITUDES THAT EXCEED 70 MINUTES IN DURATION. ®[DN 79]

CVX is impacted by more than 30 minutes of solar viewing and cannot recover from greater than 70 minutes of continuous solar viewing. ®[DN 57]

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107_2A-71 ATTITUDE/POINTING CONSTRAINTS (CONTINUED)

5. LPT

   a. LPT REQUIRES SPACE VIEWING (-Z AXIS > 90 DEG FROM NADIR) DURING GPS OPERATIONS.

The GPS Navigation test requires two observations of two consecutive orbits of bay-to-space attitude.
®[DN 79]

   b. LPT REQUIRES GROUND STATION VIEWING FOR 5 MINUTES (-Z AXIS TO MILA, WLPS, OR DFRC, WITH MINIMUM LOS ELEVATION ANGLE OF 5 DEGREES FROM THE GROUND STATION) DURING GN OPERATIONS, WITH TARGET TRACKING FOR A MINIMUM OF THREE OF THE EIGHT TESTS. ®[CR 5847]

   c. LPT REQUIRES A TRACKING AND DATA RELAY SATELLITE (TDRS) TRACK ATTITUDE DURING TDRS COMMUNICATIONS TESTS FOR A TOTAL OF 6 HOURS. THE PASS MINIMUM IS 15 MINUTES.

   d. LPT REQUIRES THE ORBITER -Z AXIS TO A TDRS AND DFRC, WITH MINIMUM LOS ELEVATION ANGLE OF 5 DEGREES, DURING RANGE SAFETY OPERATIONS WHICH LAST A MINIMUM OF 2.5 MINUTES.

LPT desires acquisition of two TDRS's simultaneously during the Range Safety Tests; however, maximization of pass over DFRC is prioritized over two TDRS's. Two Range Safety tests are required.
®[CR 5847]

   e. LPT REQUIRES A TDRS TRACK ATTITUDE DURING ON-ORBIT RECONFIG TESTS. EACH OF THE TWO TESTS ARE 20 MINUTES. ®[DN 79]

SECTION 3 - GROUND INSTRUMENTATION

GENERAL

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SECTION 3 - GROUND INSTRUMENTATION

GENERAL

107_3A-1 GROUND AND NETWORK DEFINITIONS

A. MCC IS DEFINED AS THE EQUIPMENT AND FUNCTIONALITY PROVIDED BY THE JSC BUILDING 30 COMPLEX AND ASSOCIATED INFRASTRUCTURE AT JSC WHICH PROVIDE POWER, COOLING, AND COMMUNICATIONS TO BUILDING 30. ®[CR 5501]

B. INTEGRATED NETWORK INCLUDES THE FOLLOWING:

1. THE NASA GROUND TRACKING AND DATA STATIONS AT MERRITT ISLAND LAUNCH AREA (MILA), DRYDEN FLIGHT RESEARCH CENTER (DFRC), WALLOPS ISLAND (WLPS), PONCE DE LEON STATION (PDL), AND INCLUDING JONATHAN DICKINSON (JDI)

Even though JDI is part of the Eastern Range operated by the USAF 45th Space Wing at the Jonathan Dickinson Missile Test Annex (JDMTA), for the purposes of this rule it is considered part of the NASA network.

2. THE SPACE NETWORK INCLUDING THE WHITE SANDS COMPLEX (WSC) FACILITY AND FUNCTIONALITY AS WELL AS THE TRACKING AND DATA RELAY SATELLITE (TDRS)

3. GSFC FACILITIES THAT PROVIDE COMMUNICATIONS RELAY AND SCHEDULING: THE MISSION OPS SUPPORT AREA (MOSA), FLIGHT DYNAMICS FACILITY (FDF), AND THE NETWORK CONTROL CENTER (NCC), AND ASSOCIATED INFRASTRUCTURE AT GSFC WHICH PROVIDE POWER, COOLING, AND COMMUNICATIONS TO THOSE FACILITIES.

4. NASA AND USAF RADAR TRACKING SITES AS SHOWN IN RULE {107_3A-4}, INTEGRATED NETWORK FAILURE DECISION MATRIX

5. COMMERCIAL LINKS CONNECTING JSC, GSFC, WSC, KSC, DFRC, ETC.

6. INTERCONNECTIVITY TO USAF REMOTE TRACKING STATION (RTS) SITES ®[CR 5501]

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107_3A-1 GROUND AND NETWORK DEFINITIONS (CONTINUED)

C. CRITICAL SHUTTLE FLIGHT PHASES ARE DEFINED AS LAUNCH THROUGH GO FOR ORBIT OPS OR INTACT ABORT LANDING AND GO FOR DEORBIT BURN THROUGH WHEELSTOP. ®[CR 5501]

D. TRAJECTORY PROCESSING IS DEFINED AS THE CAPABILITY OF THE MCC TO TAKE TRAJECTORY DATA FROM VARIOUS SOURCES (RADAR TRACKING, S-BAND DOPPLER, ONBOARD INERTIAL NAVIGATION, ONBOARD GLOBAL POSITIONING SATELLITE (GPS)) AND IN REAL TIME COMPUTE CURRENT STATE AND PERFORMANCE CAPABILITY THAT ARE USED TO DETERMINE ABORT MODE CAPABILITY, MANEUVER TARGETS, AND MAKE OTHER MISSION CRITICAL DECISIONS. ®[CR 5501]

107_3A-2 GROUND AND NETWORK OVERALL PHILOSOPHY

A. MANDATORY REQUIREMENTS: AIR-TO-GROUND (A/G) VOICE, COMMAND, HDR TELEMETRY, AND TRAJECTORY PROCESSING DURING CRITICAL PHASES OF FLIGHT IS MANDATORY. THE MCC AND INTEGRATED NETWORK EQUIPMENT AND ASSOCIATED SOFTWARE TO PROVIDE THESE MANDATORY FUNCTIONS MUST BE AVAILABLE AND SCHEDULED TO INITIATE A CRITICAL ACTIVITY. ®[CR 5501]

The MCC and network provide the ability to collect, process, and display the information needed to invoke mission rule decision, analyze subsystem performance to prevent failures, and to relieve the flight crew of the need to monitor subsystems in detail. Command provides the means to configure onboard systems for nominal operations as well as for anomaly resolution. Command is required to provide uplink remedies to systems problems which require off-nominal systems configurations that can be most effectively accomplished or, in some cases, only accomplished from the ground. A/G voice provides the means to communicate between the flight crew and the flight control team for mission activities, abort region definition, anomaly resolutions, and many other activities.

This rule states a general principle which must be understood in the light of what is technically feasible. For example, the mandatory requirement is not meant to imply that there can be no short gaps since site handovers, etc. will lead to momentary outages. Additionally, the next rule gives greater detail to parts of critical periods when longer outages can be allowed. ®[CR 5501]

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107_3A-2 GROUND AND NETWORK OVERALL PHILOSOPHY (CONTINUED)

B. REDUNDANCY: ®[CR 5501]

1. SCHEDULING: REDUNDANCY IN MANDATORY MCC AND INTEGRATED NETWORK FUNCTIONS SHALL BE SCHEDULED AND PLANNED TO BE AVAILABLE AT THE INITIATION OF A CRITICAL ACTIVITY.

NOTE: REDUNDANCY IS NOT REQUIRED WHEN SCHEDULING FOR THE TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS) NETWORK.

TDRSS network redundancy is well demonstrated and tying up resources by scheduling redundant services is not required. Loss of TDRSS service has been demonstrated in practice to be very remote and emergency rescheduling using alternate equipment is very rapid. TDRSS network redundancy is based on having multiple satellites in both eastern and western locations, two independent ground stations, multiple communication paths between WSC and MCC, and full redundancy in scheduling and other supporting equipment. The TDRSS network has more users than can be scheduled, so it is prudent to not explicitly schedule redundant TDRSS coverage.

2. LOSS OF REDUNDANCY: REDUNDANCY IS NOT REQUIRED TO INITIATE A CRITICAL ACTIVITY. FOLLOWING A FAILURE THAT CAUSES LOSS OF REDUNDANCY, IF FEASIBLE, THE REMAINING SINGLE STRING SHOULD BE DEMONSTRATED TO BE FUNCTIONAL PRIOR TO THE INITIATION OF A CRITICAL ACTIVITY.

It is prudent to support mission critical operations with redundancy. MCC and Network functions are by design very reliable. Operational history has demonstrated that MCC and Network functional reliability is very high. When operating on a single string of equipment that is demonstrated to be functioning, which is not annunciating an alarm or operating in an anomalous manner, there is a very low probability of failure in the short time duration of a shuttle-critical phase. Unless there is direct evidence to conclude a failure is imminent on operating equipment, there is no reason to delay a critical scheduled event for failure of a redundant string. Conversely, if analysis of a failed system clearly indicates a threat to the remaining equipment, it is prudent not to initiate a critical activity if possible.

3. RECOVERY OF LOST REDUNDANCY: RECOVERY OF REDUNDANT EQUIPMENT SHOULD NOT BE ATTEMPTED IF THERE IS RISK TO THE PLANNED T=0 OR DEORBIT TIME OF IGNITION (TIG).

Recovery of redundant equipment or function generally has a non-zero risk of operator error or other reason causing loss of the functioning, mandatory equipment string. At pre-defined times for launch or deorbit, this risk should not be incurred. ®[CR 5501]

107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS

A. ASCENT ®[CR 5501]

1. NOMINAL ASCENT: **AIR**-TO-**GROUND** VOICE, (**TEST2)** COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING ARE MANDATORY FROM LIFTOFF THROUGH MET 15 MINUTES. FROM MET 15 MINUTES THROUGH GO FOR ORBIT OPS, IT IS HIGHLY DESIRABLE TO HAVE THE MAXIMUM DURATION OF COVERAGE POSSIBLE FOR AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING.

   IN ADDITION TO MANDATORY S-BAND TWO-WAY VOICE, UHF TWO-WAY VOICE IS REQUIRED AS A BACKUP DURING LAUNCH FROM LIFTOFF THROUGH NOMINAL HANDUP TO TDRS AND IS HIGHLY DESIRABLE THROUGH MILA LOS OR UNTIL RETURN TO LAUNCH SITE (RTLS) LANDING.

Redundant A/G voice is necessary for abort request and abort region calls and to rapidly convey verbal responses to observed subsystem anomalies and rule violations. The availability of both S-band and UHF ensures that Solid Rocket Booster (SRB) plume, station handovers, and most onboard and ground subsystem failures will not result in disruption of A/G voice capability causing critical calls to be missed. Early in ascent, TDRS is not thought to be acceptable due to antenna look angles, structural blockage, etc. Therefore, MILA, PDL, and JDI provide communications link capability.

The latter stages of ascent, after TDRS handup between 7 and 8 minutes MET, are supported by TDRS. The TDRS network has more user requirements than can be accommodated thus requiring priority scheduling. TDRS schedule should include uninterrupted communications through the latest underspeed MECO that occurs no later than MET 13 minutes. An additional 2 minutes to assess the situation and provide maneuver direction to the crew can be accomplished by a well-practiced MCC team. This means that TDRS scheduling should support through MET 15 minutes at a minimum.

To ensure mission success for rendezvous missions and to resolve any anomalies that may have occurred during ascent, it is prudent and highly desirable to have the maximum available communications capability through OMS-2 cutoff. Following that, to ensure timely anomaly resolution and to provide the maximum efficiency and mission success through the complex tasks of early post insertion (OPS 2 transition, opening payload bay doors, initiating radiator cooling, etc.), communications is vital. GO for Orbit Ops normally occurs at about 1 hr 30 min MET.

From the TDRS perspective, command, telemetry, and voice are either both available simultaneously or not; they are not independent. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

2. RTLS, TRANSATLANTIC ABORT LANDING (TAL): CONTINUOUS AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING ARE MANDATORY FOR RTLS OR TAL FOLLOWING ABORT DECLARATION THOUGH INTACT ABORT LANDING INCLUDING POST-LANDING. ®[CR 5501]

This requirement for TAL may be met by the use of an emergency Satellite Handover (SHO) for the TDRS network since landing occurs at approximately MET 37 minutes. RTLS requirements may be covered by scheduling MILA alone. The declaration of an RTLS or TAL abort results in procedures that involve additional risk. MCC support is required and will normally be available throughout the RTLS or TAL. This increased insight into systems performance and additional expertise significantly increases the probability of a successful landing with a vehicle that has already had a major systems failure. A/G voice is required to coordinate any recommendations to the crew and to relay to the crew final weather, runway, landing aid, and major systems status.

3. ABORT TO ORBIT (ATO), ABORT ONCE AROUND (AOA): FOR THE PERIOD FROM MET 15 MINUTES THROUGH LANDING FOR AOA OR LANDING FOR FIRST DAY PRIMARY LANDING SITE (PLS) OR THROUGH GO FOR ORBIT OPS FOR ATO, IT IS HIGHLY DESIRABLE TO HAVE THE MAXIMUM DURATION OF COVERAGE POSSIBLE FOR AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING.

4. ASCENT TRAJECTORY PROCESSING SUPPORT

   a. ASCENT RADAR TRACKING: DUAL TRACKING IS HIGHLY DESIRABLE FROM EITHER ONE S-BAND AND ONE C-BAND, OR TWO C-BANDS FROM LIFTOFF THROUGH MECO PLUS 1 MINUTE.

Dual source tracking is desired to allow monitoring of the health of onboard navigation during powered flight, to provide delta state uplink capability to correct extreme onboard navigation errors which could result in unsafe or mission-limiting MECO conditions for an ascent to orbit or an RTLS, and to provide an independent ground navigation source for ascent performance boundary calls. To obtain an accurate post-MECO ground filter vector, a minimum of 1 minute of tracking post-MECO is required for processor convergence. An accurate post-MECO ground filter vector may be used to update onboard navigation before OMS-2 if required to significantly decrease delta-V cost due to planar error for ground-up rendezvous flights, or before OMS-1 or OMS-2 if the gain in delta-V capability would prevent ascent capability downmoding. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

Ground tracking through MECO+1 is highly desirable rather than mandatory because flight history and Mean Time Between Failures (MTBF) data show that the probability of either software or hardware failures corrupting onboard navigation during ascent are extremely small. MTBF studies for the high accuracy inertial navigation system (HAINS) inertial measurement units (IMU's), general purpose computers (GPC's), and multiplexer/demultiplexers (MDM's) indicate a probability of loss of two IMU's to be on the order of 10^{-10}. Although recovery of corrupted onboard navigation by means of a powered flight delta state is theoretically possible, and would be attempted if required, success at all times during the ascent is not a certainty. With regard to onboard navigation errors which are not large enough to pose a safety concern, but which could affect the mission, the history of post-MECO state vector updates shows that although there are worthwhile paybacks in propellant margin, their absence would not adversely impact propellant budgets. For these reasons, ground-tracking requirements through MECO for due east launches was abandoned by the shuttle program as a cost savings measure. Ground tracking through MECO +1 is only available for high inclination launches. ®[CR 5501]

Upon removal of the Range Safety destruct package from the external tank, the flight crew/MCC assumed responsibility for public safety during second stage. The tracking navigation state precludes limit line violation due to severe onboard navigation problems (state vector update or manual MECO) and prevents loss of External Tank Impact Point (ET IP) prediction due to telemetry loss/data dropouts. At the existing limits of ground tracking, ET IP no longer endangers North American landmasses or islands.

Ground radar tracking is only highly desirable for NASA purposes during the early phases of ascent as shown by the tables in Rule {107_3A-4}, INTEGRATED NETWORK FAILURE DECISION MATRIX. Note that the Eastern Range has a more constraining requirement. If all east coast radars are functioning, for high inclination launches radar tracking can be extended to nominal MECO plus 1 minute. For low inclination launches, radar tracking is lost prior to 8 minutes MET. It is desirable to have ground radar verification of the MECO state.

b. RTLS ENTRY RADAR TRACKING: TRACKING IS HIGHLY DESIRABLE FROM EITHER ONE S-BAND AND ONE C-BAND, OR TWO C-BANDS FROM RTLS MECO TO 100K FEET.

The trajectory server upgrade (TSU) trajectory processor Kalman filter cannot meet ground accuracy requirements with only one source of tracking data; the filter requires at least two sources. The 100K-feet altitude constraint was chosen to allow sufficient time to assess the vehicle energy conditions and to update onboard navigation state (after nominal TACAN acquisition) in order to correct a violation of delta state limits. Dual tracking capability also allows time to GCA to within guidance limits prior toTAEM. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

c. AOA/PLS: DUAL TRACKING CAPABILITY ABOVE 100K FEET IS HIGHLY DESIRABLE BUT IS NOT SCHEDULED FOR AOA AND PLS DEORBIT. ®[CR 5501]

In the event that a delta state is uplinked, it allows proper onboard verification to be performed through 100K feet (tracking not required below 100K feet).

d. FD1 PLS ONLY: AT LEAST ONE TDRS OR TWO C-BAND RADAR PASSES ARE REQUIRED TO SUPPORT PRE-DEORBIT STATE VECTOR ACCURACY.

For AOA and PLS deorbits, best effort call up of high speed tracking resources is accepted (ref. Rule {A3-102}, STDN FAILURE DECISION MATRIX). The time between launch and landing for an AOA deorbit is short enough to consider onboard navigation autonomous, and although best effort tracking call up will be requested, it is not mandatory. There is a high probability of obtaining PLS tracking support from KSC or EDW area radars on a best effort basis if the ranges are given more than 3 hours advance notice. There is little chance of obtaining such support for a Northrup Lakebed Landing Site (NOR) PLS deorbit unless the request is made during duty hours. Tracking support is virtually assured at all three CONUS sites, given 24 hours notice (ref. AEFTP #82 minutes). ®[ED]

Post MECO tracking is required for flight day 1 deorbit cases in order to ensure the onboard state vector meets deorbit burn accuracy requirements. For high inclination launches (57 deg. and 51.6 deg.), at least one TDRS is required for orbit 3 cases, because the ground tracks for orbits 1 through 3 do not permit adequate C-Band coverage (ref. Rules {A4-101}, ONBOARD NAVIGATION MAINTENANCE, and {A3-102}, STDN FAILURE DECISION MATRIX - Note [2]). ®[ED]

e. FOR COMMIT TO LAUNCH AND SCHEDULING PURPOSES, END OF MISSION (EOM) DUAL TRACKING CAPABILITY (TWO C-BANDS OR ONE S-BAND AND ONE C-BAND) FROM ABOVE 100K FT TO THE GROUND IS NOT REQUIRED. IF ANY OF THE CAPABILITIES LISTED IN PARAGRAPH B3 BELOW ARE NOT EXPECTED TO BE AVAILABLE PRIOR TO DEORBIT TIG, SCHEDULING EOM DUAL TRACKING BECOMES MANDATORY. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

5. REDUNDANCY FOR ASCENT INCLUDING INTACT ABORTS: ®[CR 5501]

   a. REDUNDANCY IN EQUIPMENT AND NETWORK SCHEDULING FOR AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING SHALL BE PLANNED AND SCHEDULED FOR LAUNCH THROUGH GO FOR ORBIT OPS OR INTACT ABORT LANDING. NOTE: FOR TDRS SCHEDULING, REDUNDANCY IS NOT REQUIRED.

   b. CONSIDERATION WILL BE GIVEN TO ATTEMPTING TO REGAIN FAILED REDUNDANT EQUIPMENT IF THE RECOVERY WILL NOT AFFECT THE REMAINING MANDATORY EQUIPMENT AND RECOVERY PROCEDURES ESTIMATED TIME OF RETURN TO OPERATION (ETRO) IS PRIOR TO THE NOMINAL PLANNED TIME FOR COMING OUT OF THE T-9 MINUTE HOLD.

   c. RECOVERY EFFORTS FOR FAILED REDUNDANT EQUIPMENT IN THE MCC AND INTEGRATED NETWORK WILL NOT BE PERFORMED BETWEEN T-9 MINUTES AND COUNTING AND MET 15 MINUTES OR LANDING FOR RTLS OR TAL.

B. DEORBIT/ENTRY

1. PRE-DEORBIT. IT IS HIGHLY DESIRABLE TO HAVE THE MAXIMUM DURATION OF COVERAGE POSSIBLE FOR AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING FROM TIG -4 HR TO DEORBIT DECISION. REDUNDANCY IS DESIRABLE BUT NOT REQUIRED.

Preparing the orbiter for entry includes a number of complex and critical steps such as moding flight software to OPS 3, closing the payload bay doors, activating Flash Evaporator System (FES) cooling. Having MCC connectivity to troubleshoot any anomalies that may occur is very useful. Additionally, MCC is prime to provide deorbit maneuver targets and to assess landing site readiness including weather. Deorbit decision time is normally TIG -23 minutes. ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

2. DEORBIT DECISION. GROUND AND INTEGRATED NETWORK EQUIPMENT FUNCTIONALITY AND SCHEDULING MUST PROVIDE AIR-TO-GROUND VOICE, COMMAND, TELEMETRY, AND TRAJECTORY PROCESSING FROM THE MCC GO FOR DEORBIT TO POST LANDING. REDUNDANCY FOR MANDATORY FUNCTIONS IS HIGHLY DESIRABLE BUT NOT REQUIRED. ®[CR 5501]

   UHF TWO-WAY VOICE IS HIGHLY DESIRABLE DURING ENTRY TO KSC OR DFRC WHEN IN RANGE OF THE GROUND STATION AS A BACKUP TO S-BAND VOICE. S-BAND VOICE IS MANDATORY AS DESCRIBED ABOVE.

Monitoring vehicle systems, energy management, anomaly resolution, and landing site evaluation from touchdown parameters to weather conditions is the primary job of the MCC during shuttle entry.

3. TRAJECTORY PROCESSING SUPPORT FOR ENTRY:

   IF ALL OF THE CAPABILITIES LISTED BELOW ARE EXPECTED TO BE AVAILABLE PRIOR TO DEORBIT TIG, C-BAND TRACKING IS NOT MANDATORY. S-BAND TRACKING IS HIGHLY DESIRABLE IN THE ABSENCE OF C-BAND TRACKING. IF DURING THE MISSION ANY OF THE FOLLOWING CAPABILITIES ARE LOST, EOM DUAL TRACKING CAPABILITY BECOMES MANDATORY FOR COMMIT TO DEORBIT:

   a. IMU’S: FULL REDUNDANCY (THREE LINE REPLACEABLE UNITS (LRU’S) AND ASSOCIATED DATA PROCESSING SYSTEM (DPS) AND ELECTRICAL POWER SYSTEM (EPS) FUNCTIONALITY).

   b. ONBOARD TACAN: FULL REDUNDANCY (THREE LRU’S AND ASSOCIATED DPS AND EPS FUNCTIONALITY). ®[CR 5501]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

c. ONBOARD MICROWAVE LANDING SYSTEM (MLS): FULL REDUNDANCY (THREE LRU'S AND ASSOCIATED DPS AND EPS FUNCTIONALITY) REQUIRED IF MLS IS REQUIRED FOR LANDING (REF RULE {A3-202}, MLS). ®[CR 5501] ®[ED]

d. GROUND TACAN STATIONS: TWO STATIONS AVAILABLE AND CONFIRMED OPERATIONAL WITHIN SPECIFICATIONS (REF RULE {A8-52B}.2, SENSOR FAILURES). FEDERAL AVIATION AGENCY (FAA)/USAF SPECIFICATIONS ARE NOT ADEQUATE (REF NSTS 07700, VOL X, BOOK 3, PARAGRAPH 1.3.1.1.1).

In order to maximize launch probability by alleviating C-Band tracking data scheduling conflicts with the Eastern Range Operations Control Center (ROCC), the mandatory requirement for scheduling dual source high speed tracking for EOM is eliminated, provided that sufficient redundancy is available (TACAN and IMU) to correct the navigation state prior to violation of entry guidance limits. If sufficient redundancy is lost during the mission, dual source high-speed tracking becomes mandatory for commit to deorbit. The TSU trajectory processor Kalman filter cannot meet ground accuracy requirements with only one source of tracking data. The filter requires at least two sources. The 100K-feet altitude constraint was chosen to allow sufficient time to assess the vehicle energy conditions and to update onboard navigation state (after nominal TACAN acquisition) in order to correct a violation of delta state limits. This requirement also allows time to GCA to within guidance limits prior to TAEM.

With three functioning IMU's and the associated DPS/EPS equipment, the first failure is fully protected by redundancy management. When two IMU's are available, 95 percent of the cases involving the second failure are properly resolved by the IMU RM which uses the IMU BITE logic.

With three functioning onboard TACAN transceivers and their associated DPS equipment, the first failure is fully protected by redundancy management. When two TACAN's are available, 90 percent of the cases involving the second failure are covered with TACAN self-test.

With three functioning onboard MLS transceivers and their associated DPS equipment, the first failure is fully protected by redundancy management. When two MLS's are available, a dilemma between the LRU's will remain unresolved unless a BITE had been previously set against one of the LRU's. If the dilemma is unresolved, MLS may not process at all (for range/azimuth dilemmas) or only partially process (for elevation dilemmas). For days when MLS is required as defined in Rule {A3-202}, MLS, ground tracking is required to resolve dilemmas in order to make the MLS usable. Reference Rule {A8-18A}, LANDING SYSTEMS REQUIREMENTS. ®[CR 5501] ®[ED]

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107_3A-3 GROUND AND NETWORK DETAILED REQUIREMENTS (CONTINUED)

To ensure that valid TACAN data are available, both primary and secondary ground stations must be confirmed to be within programmatically required limits (NASA operational requirements of 1 degree and 0.3 mile per Rule {A8-52B}.2, SENSOR FAILURES, rather than FAA/Department of Defense (DOD) certification (2.5 degrees and 0.5 mile per NSTS 07700, Vol X specification). With the pre-deorbit ground station checks, full single fault tolerance exists. If both the primary and the secondary ground stations were to fail after deorbit, the MCC can uplink another TACAN station. ®[CR 5501] ®[ED]

Any failure in either the onboard IMU's, TACAN's, MLS's, or TACAN ground stations which results in loss of single fault tolerance for entry will require that high speed tracking be provided for EOM.

S-band data is highly desired because it may provide insight in the case of a TACAN bias, although it cannot by itself be used as a source of "ground truth."

In relaxing the tracking data requirement from mandatory to highly desirable, it is understood and acknowledged to be an acceptable risk to rely totally on TACAN as required to achieve a safe landing. If the normal ceiling limit exists, and TACAN data is not processed by navigation, and no independent valid tracking data are present, the vehicle is unlikely to achieve the runway.

4. POST LANDING. GROUND EQUIPMENT WILL PROVIDE FOR AIR-TO-GROUND VOICE, COMMAND, AND TELEMETRY FROM LANDING UNTIL VEHICLE HANDOVER TO GROUND OPERATIONS MANAGER (GOM). REDUNDANCY IS NOT REQUIRED. ®[CR 5501]

107_3A-4 INTEGRATED NETWORK FAILURE DECISION MATRIX

ASCENT AND INTACT ABORT LANDINGS AT KSC							
SITE	STATION ID	TYPE	RQMNT	ASCENT/RTLS		TAL	KSC AOA & 1ST DAY PLS
				28.5 INC	HIGHER INC		
JONATHAN DICKINSON MISSILE TRACKING ANNEX (JDMTA)	JDIS	S-BD	TLM D/L VOICE	1 OF 2 M	1 OF 2 M		
PONCE DE LEON	PDL	S-BD 14					
			CMD U/L VOICE	1 OF 2 HD [1]	1 OF 2 M [2]		
	FIXED DIPOLE	UHF	VOICE				
MILA	MILS	S-BD 30-1	CMD TLM VOICE	1 OF 2 M	1 OF 2 M		1 OF 2 HD
	MLXS	S-BD 30-2					
	TELTRAC	UHF	VOICE	1 OF 2 M	1 OF 2 M		1 OF 2 HD
	QUAD HELIX						
TDRSS	WSC	S-BD	CMD TLM VOICE	M [3]	M [3]	M	M [5], [6]
			TRK	HD	HD		M [5]
WALLOPS	WLPS	S-BD 30	CMD TLM VOICE		HD		
	QUAD HELIX	UHF	VOICE		1 OF 1 HD		
MERRITT ISLAND	MLAC MLMC	FPQ-14 MCB-17	RADAR TRK	2 OF 6 HD	2 OF 6 HD		NOT SCHEDULED ACCEPT BEST EFFORT CALLUP
PATRICK	PATC	FPQ-14	RADAR TRK				
CANAVERAL	CNVC CMTC	FPS-16 MOTR	RADAR TRK				
MILA	MILS OR MLXS	S-BD	RANGING TRK				
WALLOPS	WLPC WLRC WLIC	FPQ-6 FPS-16 FPS-16	RADAR TRK		2 OF 3 HD [4]		

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107_3A-4 INTEGRATED NETWORK FAILURE DECISION MATRIX (CONTINUED)

INTACT ABORT LANDINGS AT EDWARDS OR NORTHRUP STRIP					
SITE	STATION ID	TYPE	RQMNT	EDW AOA & 1ST DAY PLS	NOR AOA & 1ST DAY PLS
DRYDEN	ATF1	S-BD-21	TLM CMD VOICE	1 OF 2 HD	
	ATF2				
	PARABOLIC DISH	UHF	VOICE	1 OF 3 HD	
TDRSS	WSC	S-BD	CMD TLM VOICE	M [6]	M [6]
NORTHRUP STRIP	SAL	UHF OMNI	VOICE		2 OF 2 HD
	NORTHRUP STRIP	UHF OMNI			
PT. PILLAR	PPMC	MPS-36	RADAR TRK	NOT SCHEDULED ACCEPT BEST EFFORT CALLUP	
	PTPC	FPQ-6			
VANDENBURG	VDHC	FPQ-14	RADAR TRK		NOT SCHEDULED ACCEPT BEST EFFORT CALLUP
	VDBC	TPQ-18			
	VDSC	FPS-16			
	VDMC	MOTR			
EDWARDS/ DRYDEN	FRCC	RIR-716	RADAR TRK		
	FDRC	RIR-716			
	EFFC	FPS-16			
WHITE SANDS MISSILE RANGE	HOLC	FPS-16	RADAR TRK		
	WHSC	FPS-16			
	WSSC	FPS-16			
	WSMC	MOTR			

®[CR 5501]

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107_3A-4 INTEGRATED NETWORK FAILURE DECISION MATRIX (CONTINUED)

END OF MISSION – 2ND DAY PLS THROUGH NOMINAL EOM						
SITE	STATION ID	TYPE	RQMT	KSC	EDWARDS	NORTHRUP STRIP
TDRSS	WEST	S-BD	TLM CMD VOICE	M	M	M
	EAST			M		
	ANY		TRK	M	M	M
MILA		RANGING	TRK	HD		
	MILS	S-BD 30-1	TLM CMD VOICE	1 OF 2 HD [7]		
	MLXS	S-BD 30-2				
	TELTRAC	UHF	VOICE	1 OF 2 HD		
	QUAD HELIX					
MERRITT ISLAND	MLAC	FPQ-14	RADAR TRK	2 OF 5 HD		
	MLMC	MCB-17				
PATRICK	PATC	FPQ-14				
CANAVERAL	CNVC	FPS-16				
	CMTC	MOTR				
DRYDEN	ATF1	S-BD 12	TLM CMD VOICE		1 OF 2 HD [8]	
	ATF2					
	PARABOLIC DISH	UHF	VOICE		1 OF 3 HD	
PT. PILLAR	PPMC	MPS-36	RADAR TRK		ANY 2 RADARS FROM PT. PILLAR VANDENBURG EDWARDS OR DRYDEN HD	
	PTPC	FPQ-6				
VANDENBURG	VDHC	FPQ-14	RADAR TRK			
	VDBC	TPQ-18				
	VDSC	FPS-16				
	VDMC	MOTR				
EDWARDS/ DRYDEN	FRCC	RIR-716	RADAR TRK			
	FDRC	RIR-716				
	EFFC	FPS-16				
NORTHRUP STRIP	SAL	UHF	VOICE			2 OF 2 HD
	NORTHRUP STRIP	UHF OMNI				
WHITE SANDS MISSILE RANGE	HOLC	FPS-16	RADAR TRK			2 OF 4 HD
	WHSC	FPS-16				
	WSSC	FPS-16				
	WSMC	MOTR				

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107_3A-4 INTEGRATED NETWORK FAILURE DECISION MATRIX (CONTINUED)

NOTES: ®[CR 5501]

[1] FOR MISSIONS WITH AN INCLINATION OF 28.5 DEGREES, PDL S-BAND AND UHF UPLINK IS HIGHLY DESIRABLE.

[2] FOR MISSIONS WITH AN INCLINATION GREATER THAN 28.5 DEGREES, PDL CMD OR UHF UPLINK IS REQUIRED DUE TO MIL UHF BEING BLOCKED BY THE SRB PLUME.

[3] ANY TDRS EAST IS MANDATORY.

[4] FOR 57-DEGREE MISSIONS ALL THREE RADARS ARE SCHEDULED. ONLY WLPC AND WLRC ARE SCHEDULED FOR OTHER MISSIONS GREATER THAN 28.5 DEGREES.

[5] ONE TDRS REQUIRED TO ENSURE PRE-BURN STATE VECTOR ACCURACY FOR FIRST DAY PLS DEORBIT IF ONBOARD GPS IS FAILED.

[6] ANY TDRS WEST IS MANDATORY FOR AOA AND FIRST DAY PLS.

[7] ANY TDRS EAST OR MILA IS MANDATORY TO COVER THE LAST PHASE OF KSC LANDING AND POST LANDING SUPPORT UNTIL VEHICLE IS HANDED OVER TO GOM.

[8] ANY TDRS WEST OR DFRC IS MANDATORY TO COVER THE LAST PHASE OF EDW LANDING AND POST LANDING SUPPORT UNTIL VEHICLE IS HANDED OVER TO GOM. ®[CR 5501]

107_3A-5 CRITICAL LAUNCH SYSTEMS RECOVERY TIMES

SYSTEM	SERVICE	DESCRIPTION OF EQUIPMENT	QUANTITY OF EQUIPMENT REQUIRED/ SCHEDULED /TOTAL	AVERAGE SELECTOVER TIME (AUTO OR MAN)	AVERAGE TIME TO RESTORE REDUNDANCY FOLLOWING REPAIR	
CCF CONSOLIDATED COMMUNICATION FACILITY	CMD & A/G VOICE TLM & A/G VOICE TRK DATA	FEP - UPLINK FEP- DOWNLINK/REAL TIME FEP-GROUND-TO-GROUND	1 OF 2/3 1 OF 2/3 1 OF 2/2	30 SECONDS (M) 30 SECONDS (M) 20 SECONDS (M)	10 MINUTES 10 MINUTES 10 MINUTES	FEP RE REBOO CONSIS
PROCESSES AND ROUTES ALL DATA COMING IN AND OUT OF THE MCC	ALL	CDSS	BUILT IN REDUNDANCY	N/A	BUILT IN REDUNDANCY	CDSS C ROUTIN
	ALL	NASCOM IP EQUIP.	1 OF 2/2	30 SECONDS (M)	15 MIN.	LAUNCH
	ALL	NASCOM IP CIRCUITS	MULTIPLE	1 SECOND (A)	SEE NOTE 1	NOTE 1 REPAIR
	UPLINK & DOWNLINK	MDM	1 OF 2/2	30 SECONDS (M)	10 MINUTES	SERVIC
	TLM & CMD LAN I/F	GIGASWITCH	1 OF 2/2	30 SECONDS (A)	REBOOT 1 MINUTE	
		CEM (CCF ELEMENT MANAGER)	1 OF 2/2	4 MINUTES (M)	REBOOT 6 MINUTES	FAILUR AND CC CONFIG
VOICE ALL VOICE COMMUNICATIONS IN/OUT OF MCC	S-BAND A/G VOICE	AGVE	1 OF 2/3	5 SECONDS (M)	HARDWARE REPAIR	ASSUM
	UHF A/G VOICE	UHF	1 OF 2	1 MINUTE (M)	HARDWARE REPAIR	
	ALL VOICE	DVIS	BUILT IN REDUNDANCY	BUILT IN REDUNDANCY	BUILT IN REDUNDANCY	DVIS CF AND RE LAUNCH

®[CR 5501]

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107_3A-5 CRITICAL LAUNCH SYSTEMS RECOVERY TIMES (CONTINUED)

SYSTEM	SERVICE	DESCRIPTION OF EQUIPMENT	QUANTITY OF EQUIPMENT REQUIRED/ SCHEDULED /TOTAL	AVERAGE SELECTOVER TIME (AUTO OR MAN)	AVERAGE TIME TO RESTORE REDUNDANCY FOLLOWING REPAIR	
LANS DATA COMMUNICATION TRANSFER FOR W/S'S		BRIDGES	1 OF 2/2	30 SECONDS (A)	REBOOT: 1 MINUTE	BRIDGE SECONI
		CONCENTRATORS	1 OF 2/2	1 SECOND (A)	REBOOT: 1 MINUTE	WS'S F/ IMMEDI/ FAILURI SEGMEI TO DAT
TSUP (TRAJECTORY SUBSYSTEM UPGRADE PROJECT) - PROVIDES TRAJECTORY PROCESSING	TRAJECTORY PROCESSING	TSUP SERVERS - HARDWARE/OS TRAJECTORY SOFTWARE APPLICATION - SOFTWARE	1 OF 2/3	1 SECOND (M)	REBOOT: 5 MINUTES	TSUP R REBOO FAILED
PLATFORM SERVERS	MCC NETWORK USER SERVICES	CM SERVERS -PLATFORM SERVICES	1 OF 2/2	45 SECONDS (A)	REBOOT: 25 MINUTES	CM SER SECONI
	CMD, TRAJECTORY & TLM PROCESSING DELAYS	HA SERVERS (READ/WRITE)	1 OF 1/2	50 MINUTES (A)	REBOOT: 15 MINUTES	SERVEF SERVIC FOR FU
	NETWORK REGISTRATION	NAME SERVERS (NETWORK SERVICES)	1 OF 2/2	1 MINUTE (A)	REBOOT: 5 MINUTES	
	CLOCK & GROUP DISPLAYS	VTS SERVER	1 OF 2/4	30 SECONDS (A)	REBOOT: 5 MINUTES	
COMMAND	COMMAND PROCESSING	COMMAND SERVERS	1 OF 1/5	1 MINUTE (A)	REBOOT: 5 MINUTES	FOLLOV COMMA 5-15 MIN

®[CR 5501]

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107_3A-5 CRITICAL LAUNCH SYSTEMS RECOVERY TIMES (CONTINUED)

SYSTEM	SERVICE	DESCRIPTION OF EQUIPMENT	QUANTITY OF EQUIPMENT REQUIRED/ SCHEDULED /TOTAL	AVERAGE SELECTOVER TIME (AUTO OR MAN)	AVERAGE TIME TO RESTORE REDUNDANCY FOLLOWING REPAIR	
W/S'S USER I/F DEVICE	USER WORKSTATION	DEC ALPHA STATIONS	MULTIPLE	GO TO B/U POSITION (M)	REBOOT: 15 MIN RIS DL: 30 MIN REPLACE UNIT	USER ACTIVI OPERA REBOO W/S HA REQUI
DOLILU DAY OF LAUNCH ILOAD UPDATE	DOLILU PROCESSING	IPS W/S'S & FILE SERVERS, COMM MUX, FSH & MOC, NASCOM 2000	1 OF 2/2	6 MINUTES (M)	6 MINUTES	ILOAD
EQUIPMENT AIR HANDLERS	BUILDING 30S DVIS UNDER FLOOR DVIS OVERHEAD	CRITICAL EQUIPMENT DVIS UNDER FLOOR DVIS OVERHEAD	4 OF 6/6 1 OF 2/2 1 OR 2/2	AUTOMATIC AUTOMATIC AUTOMATIC	AIR HANDLERS HARDWARE REPAIR HOURS	WITHO DOWN WITHO SHUT SHUT PERMA
EQUIPMENT POWER	CRITICAL EQUIPMENT CRITICAL EQUIPMENT HIGHLY DESIRABLE HIGHLY DESIRABLE	BUILDING 30S AX BUS BUILDING 30S A BUS BUILDING 30S BX BUS BUILDING 30S B BUS	1 OF 2/2 1 OF 2/2 1 OF 2/2 1 OF 2/2	AUTOMATIC AUTOMATIC MANUAL MANUAL	AUTOMATIC AUTOMATIC 30 MIN 30 MIN	AUTOM BACKU START LOST. MANUA TRANS LOST.

®[CR 5501]

NOTE: RECOVERY TIMES DO NOT INCLUDE FAULT ISOLATION, HARDWARE, AND SOFTWARE REPAIR TIME ®[CR 5501]

107_3A-6 TRAJECTORY SERVER FAILURES

A. A TRAJECTORY SERVER IS CONSIDERED FAILED FOR ANY OF THE FOLLOWING CONDITIONS: ®[CR 5545]

1. ERRORS IN ONE OR BOTH COMPUTERS THAT AFFECT REQUIRED PROCESSING LISTED IN RULE {A3-51}, TRAJECTORY PROCESSING REQUIREMENTS ®[ED]

2. ERRORS WITH SECONDARY INDICATIONS OF COMPUTER PROBLEMS (SUCH AS ERRORS OF DIFFERENT TYPES, EXCESSIVE CPU USAGE, CORRUPTED TELEMETRY OR TRAJECTORY PROCESSING, ETC.)

Errors can occur in the prime and backup trajectory server with no impact to processing. If one or more errors occur, and do not affect required processing, the computer is not considered failed.

B. IF THE PRIME TRAJECTORY SERVER IS CONSIDERED FAILED, AND A BACKUP TRAJECTORY SERVER IS AVAILABLE, A SELECTOVER WILL BE PERFORMED. ®[CR 5635]

Two redundant trajectory servers will be maintained at all times during this flight to assure availability of trajectory processing.

The third trajectory server will also be configured to the mission activity for all critical phases as a "static standby" and during all other mission phases where not required by another activity.

C. TRAJECTORY SERVER COMMIT TO LAUNCH AND REDUNDANCY REQUIREMENTS ARE DEFINED IN RULE {107_3A-3}, GROUND AND NETWORK DETAILED REQUIREMENTS AND RULE {107_3A-5}, CRITICAL LAUNCH SYSTEMS RECOVERY TIMES. ®[CR 5545]

Three Trajectory Servers will be supporting launch. If the prime and backup Trajectory Servers suffer unrecoverable failures, only the third Trajectory Server remains available for flight use. However, this system will not be a "hot backup," and thus some level of configuration of the third Trajectory Server to flight-ready status is required. ®[CR 5545]

Per Rule {A3-51}, TRAJECTORY PROCESSING REQUIREMENTS, launch will be No-Go until an ARD is reconfigured for launch since required processing would otherwise be unavailable. ®[ED] ®[CR 5635]

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SECTION 4 - TRAJECTORY AND GUIDANCE

PRELAUNCH/ASCENT/ENTRY

ORBIT GENERAL

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SECTION 4 - TRAJECTORY AND GUIDANCE

PRELAUNCH/ASCENT/ENTRY

107_4A-1 TRAJECTORY AND GUIDANCE PARAMETERS

FLIGHT SPECIFIC TRAJECTORY AND GUIDANCE PARAMETERS AS THEY RELATE TO THE ALL FLIGHTS RULES ARE LISTED IN THE FOLLOWING TABLE:

RULE REFERENCE	PARAMETER	VALUE
ALL	NOMINAL THROTTLE	104%
ALL	ABORT THROTTLE	104%
ALL	MAX THROTTLE	109%
ALL	THRUST BUCKET	104/72%
{A4-55}	DELTA V ABOVE AFT PRESS QTY	100.9 FPS
{A4-1A}	2 SIGMA + MEAN INFLT FPR	2058 LBS
{A4-1B}	3 SIGMA + MEAN INFLT FPR	3047 LBS
{A2-52}, {A4-55}	MINIMUM HP	85 NM
{A4-55}	DESIGN MECO UNDERSPEED	240 FPS
{A4-55}	CRITICAL MECO UNDERSPEED	1EO 474 FPS 2EO 450 FPS
{A4-57A}	NOMINAL	40 FPS
{A2-205B}	UNDISPERSED CROSSRANGE: ASCENDING/LEFT ASCENDING/RIGHT DESCENDING/LEFT DESCENDING/RIGHT	 835 NM N/A 840 NM N/A
{A4-107A}	DISPERSED CROSSRANGE: ASCENDING/LEFT ASCENDING/RIGHT DESCENDING/LEFT DESCENDING/RIGHT	 770 NM N/A 781 NM N/A NM
{A4-159}	CONT PAYLOAD RETURN AFTER ORBIT 3	N/A

®[CR 5535] ®[ED]

* ALL RIGHT TURN APPROACHES TO CONUS SITES ARE WITHIN CROSSRANGE CAPABILITY.

107_4A-2 PAYLOAD ALTITUDE REQUIREMENTS ®[CR 5541]

A. SPACEHAB HAS NO UNIQUE ALTITUDE REQUIREMENTS. SPACEHAB EXPERIMENT MSTRS DESIRES AS CLOSE AS POSSIBLE TO THE NOMINALLY PLANNED ALTITUDE OF 150 NM.

MSTRS preplanning has involved coordination and scheduling of numerous cooperative ground sites. Altitudes lower that 150 nm translate to smaller antenna fields of view and thereby decrease time available for signal acquisition and processing. In addition, some ground sites will not be available at a lower altitude. A lower altitude will result in a need to reschedule cooperative ground sites, and could possibly result in loss of availability of some sites, with resultant science losses. ®[DN 91]

B. FREESTAR HAS NO UNIQUE ALTITUDE REQUIREMENTS. FREESTAR ORBITAL REQUIREMENTS ARE AS FOLLOWS:

1. IN AN ABORT TO ORBIT SCENARIO, FREESTAR PREFERS INCREASED INCLINATION OVER INCREASED ALTITUDE.

2. SOLSE-2 REQUIRES A NEAR CIRCULAR ORBIT ®[CR 5541]

SOLSE-2 highly desires to be operated at the highest inclination possible to increase in-flight correlation opportunities with ground-truth measurements.

ORBIT GENERAL

107_4A-11 ORBITAL MANEUVER CRITICALITY AND DEFINITIONS

A. ALL STS-107 ORBIT MANEUVERS ARE CLASSIFIED AS “CRITICAL” OR “NONCRITICAL” AS FOLLOWS:

MANEUVER	CLASSIFICATION	VGO TRIMS (FPS)
OMS-1	CRITICAL FOR CREW SAFETY (IF REQUIRED)	|EACH VGO| < 2
OMS-2	CRITICAL FOR CREW SAFETY	|EACH VGO| < 2
ORBIT ADJUST (OA)	NONCRITICAL	|EACH VGO| < 0.2
DEORBIT	CRITICAL FOR CREW SAFETY	|VGOX/Z| < 2; DO NOT TRIM VGOY

®[CR 5895A]

Maneuvers listed are not necessarily in time order of execution.

OMS-1 (if required), OMS-2 and deorbit are always considered critical to the crew’s safety because they may entail atmospheric reentry if TIG is delayed or an underburn is performed.

Orbit Adjust are considered noncritical in the sense that they may be slipped at least one orbit, or deleted, without impact to crew safety or mission success. ®[CR 5895A]

B. CHANGES TO THE PREFLIGHT PLANNED MANEUVER SEQUENCE WILL BE COORDINATED WITH THE PAYLOAD CUSTOMERS AS FOLLOWS:

THE SPACEHAB CUSTOMER, THE GSFC POCC, AND DOD REP WILL BE NOTIFIED DAILY OF CHANGES TO THE PREFLIGHT BURN PLAN WITH ESTIMATES OF THE MAGNITUDE OF EACH BURN. IN THE EVENT OF ANY UNSCHEDULED BURN, THEY WILL BE NOTIFIED AS SOON AS POSSIBLE.

The burn plan information is required to plan experiment operations which are affected by OMS/RCS contamination or accelerations environments. Some doors/covers may need to be closed for certain burns. In the event of any unscheduled burn, such as a collision avoidance burn, at least 15 minutes are required to compute and prepare the burn PAD. The payloads can use this time to perform commanding to minimize the impact to science.

107_4A-12 EOM ORBIT ADJUST BURNS

A. IF PROPELLANT IS AVAILABLE, ORBIT ADJUSTS MAY BE PERFORMED TO INCREASE THE NUMBER OF DEORBIT OPPORTUNITIES AVAILABLE. IF AN ELLIPTIC ORBIT IS TARGETED FOLLOWING THE ADJUST, STEEP DEORBIT CAPABILITY SHALL BE RETAINED TO SATISFY RULE {A4-103A}.3, OFF-NOMINAL ORBITAL ALTITUDE RECOVERY PRIORITIES. ®[ED]

B. THE ORBIT ADJUST PLAN WILL ATTEMPT TO ACHIEVE THE FOLLOWING COMBINATIONS OF LANDING OPPORTUNITIES STATED IN ORDER OF DECREASING PRIORITY. ONLY OPPORTUNITIES WHICH SATISFY THE CREW DAY CONSTRAINTS (REF RULE {A4-107A}.7, PLS/EOM LANDING OPPORTUNITY REQUIREMENTS), WILL BE CONSIDERED (7 HRS < AWAKE TIME BEFORE LANDING < 16 HRS). AN ORBIT ADJUST PLAN WHICH WOULD RESULT IN LOSS OF OPPORTUNITIES AT A HIGHER PRIORITY THAN THOSE GAINED WILL NOT BE PERFORMED EVEN IF DAYLIGHT OPPORTUNITIES ARE PROVIDED BY THE PLAN. ®[ED]

PRIORITY	SITE	EOM	EOM + 1	EOM + 2
1	KSC EDW	1 1	1 1	1 1
2	KSC	2		
3	KSC		2	
4	EDW		2	
5	EDW			2
6	KSC			2

SECTION 8 - GUIDANCE, NAVIGATION, CONTROL (GNC)

GENERAL

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SECTION 8 - GUIDANCE, NAVIGATION, CONTROL (GNC)

GENERAL

107_8A-1 GPS DTO 700-14 OPERATIONS GUIDELINES

THE FOLLOWING OPERATIONAL TEST OBJECTIVES SPECIFIED IN DTO 700-14 (SINGLE STRING GLOBAL POSITIONING SYSTEM) WILL BE PERFORMED IN THE SPECIFIED MAJOR MODES:

A. GPS SELF-TEST (GNC OPS 801)

B. GPS SHORT AND LONG POWER CYCLES (GNC OPS 201)

C. GPS POWER CYCLE (GNC OPS 201, GNC OPS 301)

D. GPS FILTER RESTART (GNC OPS 201, GNC OPS 301)

107_8A-2 RESERVED ®[DN 46]

107_8A-3 DEU EQUIVALENT MANEUVER COMMANDING DURING CREW SLEEP

(REFERENCE RULES {A2-111}, DPS COMMAND CRITERIA AND {A7-108}, DEU EQUIVALENT CRITERIA.) ®[ED]

A. IF A CRITICAL MANEUVER IS REQUIRED, IT IS DESIRABLE TO LOAD AS A FUTURE MANEUVER. WHEN THIS IS NOT POSSIBLE, CREW ALERT SPC’S WILL BE USED AS REQUIRED TO ENSURE CREW WAKEUP TO PROTECT FOR AN UNEXPECTED LOSS OF COMM.

A “critical maneuver” is defined as any maneuver that is required to prevent the orbiter, payload or crew constraint from being violated. In these circumstances, a future maneuver may be used to help ensure that the violation does not occur. If it is not possible to load the future maneuver because of other intermediate maneuvers, a stored programmed command (SPC) may be used to wake the crew if an unexpected loss of communications occurs. Potential violations include such things as orbiter thermal constraints, excessive propellant usage, uncomfortable cabin temperature changes, and payload experiment objective/constraint violations. When this situation exists, “safe” bailout attitudes and DAP’s will be provided to the crew prior to crew sleep.

B. ALL NON-STANDARD MANEUVER STARTS AND STOPS WILL BE SCHEDULED DURING AOS.

In order to provide MCC monitoring, all non-standard maneuvers will be scheduled to start and stop during AOS. This will allow the MCC to monitor for any unusual and unexpected behavior such as DAP shelf pulsing and vernier jet on-time violations. Non-standard maneuvers are those that have required a flight-specific analysis (i.e., unusual attitude or rate deadbands and rotation rates, orbiter/HST attached ops, loaded RMS ops, orbiter/Mir docked ops, etc.).

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107_8A-3 DEU EQUIVALENT MANEUVER COMMANDING DURING CREW SLEEP (CONTINUED)

C. MANEUVERS DURING CREW SLEEP WILL NOT BE PERFORMED IF THE MCC CANNOT CONFIRM DAP AND UNIVERSAL POINTING PARAMETERS ARE CORRECT.

Due to TFL and/or low data rate telemetry requirements, there are times when the MCC does not have insight into any of the DAP parameters or the universal pointing maneuver parameters. If either of these conditions exists, no uplinks will be performed. Insight is not required during the maneuver as long as it is not a non-standard maneuver as described in paragraph B above.

D. IT IS PREFERRED THAT ALL DAP LOADS WILL BE CONFIGURED BY THE CREW PRIOR TO THE START OF THE SLEEP SHIFT.

DAP's required during the sleep shift can be loaded by the crew prior to sleep to minimize the number of commands needing to be sent. The MCC will then only have to command a change in the DAP number (A1 to A15 for example). Since the MCC does not have the capability to change from DAP A to B, all operations will be done within a specific DAP (either A or B).

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SECTION 7 - DATA SYSTEMS

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SECTION 7 - DATA SYSTEMS

GENERAL

107_7A-1 CONSTRAINTS ON PORT MODING OR I/O RESETS

THERE ARE NO PAYLOAD CONSTRAINTS ON PAYLOAD MDM PORT MODING OR SM I/O RESETS.

Both port moding and I/O resets are transparent to the STS-107 payload complement.

107_7A-2 ORBITER DATA PROCESSING SYSTEM

FOR FAILURE OF THE SM GPC INTERFACE TO EITHER PAYLOAD DATA BUS RESULTING IN SELECTION OF ONLY A SINGLE PF MDM AT A TIME, SELECTION OF PF1 IS PREFERRED OVER PF2 FOR ALL PAYLOAD OPERATIONS.

The PF1 MDM provides GPC control over the Ku-band antenna, as well as communications with FREESTAR via PSP 1. FREESTAR utilizes PSP 1 only for command throughput and is not wired to PSP 2. Ku-band operations provide command path to Spacehab, downlink of Spacehab high rate data, and video and OCA files downlink for both Spacehab and FREESTAR..

107_7A-3 LOSS OF ORBITER MASTER TIMING UNIT (MTU)/PAYLOAD TIMING BUFFER

A. SHOULD THE MTU FAIL, ALL PSP COMMANDING WOULD BE LOST, IN ADDITION TO TIME SIGNALS PROVIDED TO THE PAYLOADS VIA THE PAYLOAD TIMING BUFFER (PTB).

All PSP commanding is lost when the MTU fails. Reference Rule {107_11A-1}, PAYLOAD GROUND COMMANDING, for impacts and workarounds for the loss of PSP commanding. ®[DN 75]

B. THE FOLLOWING EXPERIMENTS ARE IMPACTED BY LOSS OF TIMING SIGNAL:

1. SPACEHAB – LOSS OF GREENWICH MEAN TIME (GMT) IMPACTS MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS). LOSS OF BOTH GMT AND MISSION ELAPSED TIME (MET) IMPACTS STAR NAVIGATION (STARNAV).

The MTU supplies GMT and MET to various downstream users, including payloads via the PTB. The MSTRS Spacehab payload receives GMT directly from the PTB from the GMT IRIG-B converter and cannot use MET. Therefore, if the GMT IRIG-B converter fails, MSTRS will not have timetag information and results in loss of nearly all science objectives. The Spacehab Experiment Data System (EDS) uses GMT or MET from the PTB to generate and provide NTP for Spacehab experiments, including Space Accelerometer System (SAMS)-FF, CM-2, STARS BOOTES, and STARNAV. If both GMT and MET signals are lost, then the EDS uses its internal time, which may drift. This could result in science loss for STARNAV since accurate timing signals are required for its attitude determination algorithm. As long as GMT or MET is available from the PTB, STARNAV will not suffer any science loss. SAMS-FF, CM-2, and STARS-BOOTES science will not be impacted by loss of both GMT and MET, but post-flight analysis may be more difficult.

2. FREESTAR – LOSS OF MASTER TIMING UNIT (MTU) RESULTS IN LOSS OF TIME TAG INFORMATION TO FREESTAR SUBSYSTEM PDI DATA

Orbiter MET supplied by the MTU to the PTB is provided to FREESTAR.

3. OARE

This rule is in support of Rule {A2-335}, LOSS OF ORBITER MASTER TIMING UNIT (MTU)/PAYLOAD TIMING BUFFER. ®[DN 75] ®[ED]

SECTION 6 - PROPULSION

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SECTION 6 - PROPULSION

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107_6A-1 VRCS MAXIMUM JET ON-TIME CONSTRAINT

A SINGLE STEADY STATE VERNIER FIRING OF UP TO 500 SECONDS IN DURATION IS ALLOWED. ®[CR 5520]

WSTF testing in support of the ISS reboost was used to validate a Boeing Thermal Math Model (TMM) of the VRCS thrusters. Analyses by Boeing-Thermal using the TMM have demonstrated that 500-second VRCS firings do not violate any vernier jet thermal constraints (ref. SODB, volume I, paragraph 3.4.3.2). There is no minimum cooldown period required between 500-second VRCS firings. ®[CR 5520]

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SECTION 5 - BOOSTER

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SECTION 9 - ELECTRICAL

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SECTION 9 - ELECTRICAL

GENERAL

107_9A-1 ORBITER PAYLOAD BAY FLOODLIGHT CONSTRAINTS

A. FREESTAR

1. ALL PAYLOAD BAY FLOODLIGHTS AND EXTERNAL LIGHT SOURCES ARE REQUIRED TO BE OFF DURING DEDICATED OBSERVATIONS AND CALIBRATIONS FOR MEIDEX.

2. ALL PAYLOAD BAY FLOODLIGHTS AND EXTERNAL LIGHT SOURCES ARE REQUIRED TO BE OFF DURING SCIENCE OBSERVATIONS FOR SOLSE

Camera D with illuminator ring will be utilized during SOLSE door opening/closing over orbit eclipse in order to view the functioning of the door. Illuminator ring will be turned off following door opening.
®[CR 5844]

3. ALL PAYLOAD BAY FLOODLIGHTS AND EXTERNAL LIGHT SOURCES WITHIN 45 DEGREES OF THE CENTRAL VIEWING AXIS OF SOLCON (PARALLEL TO –Z AXIS OUT OF THE PLB) ARE REQUIRED TO BE OFF DURING EXPERIMENT OPERATIONS.

B. SPACEHAB HAS NO PAYLOAD BAY FLOODLIGHT CONSTRAINTS.

C. ATTITUDE DEPENDENT OPERATION OF THE PAYLOAD BAY LIGHTS IS LIMITED TO THE FOLLOWING CONSTRAINTS:

ORBITER ATTITUDE	FWD PORT AND STBD LIGHTS 1 AND 2	MID PORT AND STBD LIGHTS 3 AND 4	AFT PORT LIGHT 5 AFT STBD LIGHT 6
BAY TO EARTH/ TAIL TO EARTH/ BOTTOM TO EARTH	NO CONSTRAINT	OFF AT ALL TIMES	NO CONSTRAINT
BAY TO SUN/ SOLAR INERTIAL	ON 75 MINS FOLLOWED BY AT LEAST 45 MINS OFF	OFF AT ALL TIMES	ON 150 MINS FOLLOWED BY AT LEAST 45 MINS OFF

The attitude dependent payload bay flood light (PBFL) operational constraints are based on PLBFL system thermal limitations.

107_9A-2 ON-ORBIT PAYLOAD BUS POWER LEVEL MANAGEMENT

THE PRIMARY PAYLOAD POWER SOURCES TO THE ORBITER PLB FOR STS-107 WILL BE MANAGED AS FOLLOWS:

A. PRIMARY PAYLOAD MNC AND FC3 – NOMINAL POWER LEVELS ABOVE 8 KW CONTINUOUS ARE PERMISSIBLE PROVIDED INDIVIDUAL FUEL CELL POWER CONSTRAINTS ARE NOT VIOLATED AND ADEQUATE BUS VOLTAGES ARE MAINTAINED.

B. PRIMARY PAYLOAD MNB - 7 KW CONTINUOUS, AND PEAK

For STS-107 the nominal on orbit power configuration for the primary payload bus is the MNC bus feed. During nominal on-orbit operation main B will be tied to MNC so that fuel cells 2 and 3 will share the load on the primary PL bus. The MNC and FC3 feeder constraints are based upon FC power limitations. It has always been the philosophy to feed the payloads from orbiter buses rather than directly from the FC, when possible. If it becomes necessary the FC3 feed can be used and has the same power constraints as the orbiter MNC bus feed.

The maximum continuous payload bus power level planned for STS-107 is slightly over 8 kW. For STS-107 a power analysis was done. Results showed that adequate bus voltages will be maintained for the planned maximum continuous payload power level provided the fuel cells are performing at curve 16 or better. The Fuel Cell performance requirement is documented in the Flight Requirements Document. The power exceedance is documented in ICD-2-19001.

Per Rule {A9-51}, FC POWER LEVEL CONSTRAINTS, the fuel cells may be nominally operated from 2 to 10 kW continuously and between 10 and 12 kW for not more than 15 minutes every 3 hours. In the nominal bus tied configuration the planned loads should not violate the individual fuel cell power constraints. If, however, it becomes necessary, the Payload power would be managed to maintain the individual fuel cells within their power level constraints. ®[ED]

Per Rule {A9-109}, PRIMARY PAYLOAD BUS MANAGEMENT, the MNB feeder is constrained to 7 kW continuous and peak. This constraint is based on bus configuration not on a fuel cell power limitation. Therefore, if the MNC or FC3 to primary PL bus connections become unavailable then primary payload bus power thru the MNB connection must be managed to maintain the power level less than 7 kW continuous and peak.

Reference: Rules {A9-109}, PRIMARY PAYLOAD BUS MANAGEMENT, {A9-51}, FC POWER LEVEL CONSTRAINTS, and {A9-352}, SPACEHAB MAIN BUS MANAGEMENT, ICD –2-19001, STS 107 FRD.
®[ED]

107_9A-3 SURVIVAL POWER CONFIGURATION

A. SPACEHAB

1. FOR THE SPACEHAB MODULE, THE MINIMUM POWER LEVEL REQUIRED IS 1699 WATTS (W) AVERAGE POWER, 1837 W (MAXIMUM CONTINUOUS POWER) AND 1921 W (PEAK POWER). ®[DN 77] ®[CR 5703]

2. FOR THE SPACEHAB MIDDECK EXPERIMENTS, THE MINIMUM POWER LEVEL REQUIRED IS 384 W (AVERAGE AND MAXIMUM CONTINUOUS POWER) AND 388 W (PEAK POWER).

The survival power level is the minimum power level required to preserve science and is used for the entry configuration. Power requirements for all Spacehab experiments nominally powered for entry are included in this minimum power level since these experiments require continuous power. This minimum power level may also be used for an orbiter problem, requiring reduced total power levels. The following Spacehab module experiments are powered during entry: CIBX, STARS-BOOTES, EOR/F, TEHM, APCF, Biobox, BDS-05, AST-10/1, CPCG-PCF, and FRESH-2. The following Spacehab middeck payloads are powered during entry: CEBAS, CMPCG, and Biopack.

B. FOR FREESTAR, THE MINIMUM POWER CONFIGURATION REQUIRES 480 W (MAXIMUM CONTINUOUS POWER). ®[CR 5848]

This value corresponds with 11.5 kwhr for 24 hours of operations and assumes power for the FREESTAR avionics and heaters. The applicable heater duty cycle from table 4-1 should be applied for deviations from a bay-to-earth attitude when determining extension day power requirements. If additional power is available for science, the maximum power required is 17.86 kwhr. ®[DN 77] ®[CR 5848]

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SECTION 10 – MECHANICAL

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SECTION 10 – MECHANICAL

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107_10A-1 AUXILIARY POWER UNIT (APU) LEAKS

IF AN APU MUST BE STARTED DUE TO AN ACTUAL OR SUSPECTED FUEL LEAK, FREESTAR PAYLOADS (MEIDEX, SOLSE AND SOLCON) WILL CLOSE THEIR EXTERNAL COVERS PER {107_2A-61}, CONTAMINATION CONSTRAINTS SUMMARY. APU START WILL NOT BE DELAYED TO PERFORM THIS ACTION.

An APU that develops an actual or suspected leak on orbit will be started and run to depletion per Rule {A10-27B}, APU FUEL LEAKS [CIL]. Payload contamination due to APU exhaust is a concern. However, delaying APU start in order to close covers will increase the amount of Hydrazine in the aft compartment, increasing the risk of fire during entry. ®[ED]

107_10A-2 HYDRAULIC CIRCULATION PUMP OPERATION CONSTRAINTS

THERE ARE NO CONSTRAINTS TO HYDRAULIC CIRC PUMP STARTUPS ON A MAIN BUS THAT POWERS THE PRIMARY PAYLOAD BUS DURING ORBIT OPERATIONS. PLANNED OPERATION OF THE PUMPS WILL BE COORDINATED WITH THE SPACEHAB SHOD.

The voltage ripple caused by the startup of a hydraulic circ pump is not a concern for the payloads on this flight. Pump operation causes a substantial disturbance to the microgravity environment needed for Spacehab science. Coordination ensures postflight data reduction can identify disturbances attributed to circ pump operations. Prior approval to run a circ pump is not required.

107_10A-3 KU-BAND ANTENNA STOW REQUIREMENTS

A. FOR LOSS OF REDUNDANT KU-BAND ANTENNA STOW CAPABILITY, THE DEPLOYED ASSEMBLY WILL BE STOWED AS SOON AS PRACTICAL AFTER SPACEHAB AND FREESTAR PAYLOAD OPERATIONS ARE COMPLETE BUT NO LATER THAN THE BEGINNING OF THE DAY PRIOR TO ENTRY.

This rule is a flight specific scenario allowed by Rule {A10-301}, ANTENNA STOW REQUIREMENT [CIL]. The Ku-band subsystem is mandatory for Spacehab and FREESTAR payloads. Therefore, stowing the deployed assembly (consisting of the antenna dish, gimbal motors, and deployed electronics) immediately after deployment actuator stow redundancy has been lost would be costly in terms of mission success. However, in order to minimize the potential of a second failure that would require a deployed assembly jettison, and in order to allow sufficient time to respond to any contingency that may arise during the stow operation (including the need for an EVA), the deployed assembly shall be stowed at least 1 day prior to deorbit. The antenna dish can be positioned manually during an EVA if a gimbal motor or gimbal motor drive fails, in order to permit locking the gimbals for entry. However, the deployed assembly cannot be manually repositioned to within the GO FOR PLBD CLOSURE envelope in the event of a dual motor deployment actuator failure. ®[ED]

B. FOR LOSS OF TEMPERATURE CONTROL OR TEMPERATURE MONITORING CAPABILITY, THE KU-BAND ANTENNA WILL BE STOWED AS SOON AS PRACTICAL AFTER SPACEHAB AND FREESTAR PAYLOAD OPERATIONS ARE COMPLETE BUT NO LATER THAN THE BEGINNING OF THE DAY PRIOR TO ENTRY.

This rule is a flight specific scenario allowed by Rule {A10-301}, ANTENNA STOW REQUIREMENT [CIL]. Precise antenna positioning capability is required to lock the gimbals and properly stow the Ku-band antenna. When the temperature of the antenna gyro mechanism, signal feed, or the alpha or beta gimbal angle cannot be maintained within SODB limits, the capability to obtain correct stow angles may be lost. The Ku-band antenna deployed assembly gimbals must be locked for entry, or jettison is inevitable. Therefore, when the Ku-band antenna temperature control or monitoring capability is lost, the Ku-band systems should be deactivated and the antenna stowed as a precaution following Spacehab and FREESTAR operations. ®[ED]

107_10A-4 FILLED CWC STOWAGE MANAGEMENT

A. THE NUMBER OF FILLED CONTINGENCY WATER CONTAINERS (CWC'S) IN THE ORBITER WILL NOT EXCEED THE NUMBER OF CERTIFIED STOWAGE LOCATIONS AVAILABLE FOR LANDING. THE MAXIMUM NUMBER OF FILLED CWC'S THAT MAY BE RETURNED IN THE ORBITER IS FOUR.

Preflight planned stowage has been reviewed and the number of certified stowage locations is limited to this amount. The available CWC stowage locations are two in Volume F, and one each in volumes G and H.

B. REFERENCE RULE {A18-606}, RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT, FOR CONSTRAINTS ON CWC STOWAGE IN THE SPACEHAB. ®[ED]

CWC's may be stowed in Spacehab per Rule {A18-606}, RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT, if orbiter certified stowage locations are not available. ®[ED]

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SECTION 13 - AEROMEDICAL

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SECTION 13 - AEROMEDICAL

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107_13A-1 PAYLOAD HAZARDOUS MATERIALS

THE STS-107 SECONDARY PAYLOADS INCLUDE THE HAZARDOUS MATERIALS LISTED BELOW:

A. LEVEL 4 HAZARDOUS MATERIALS (A MINIMUM OF THREE LEVELS OF CONTAINMENT REQUIRED):

1. TEHM – TEHM FACILITY INSULATION

2. HLS – LITHIUM THIONYL CHLORIDE BATTERIES.

The Thermoelectric Holding Module (TEHM) facility contains level 4 insulation. This insulation is inside the walls and door of the TEHM. The Human Life Sciences (HLS) Portable Clinical Blood Analyzers (PCBA's) and Ambient Temperature Recorders (ATR's) use lithium thionyl chloride batteries. TEHM meets the containment criteria for level 4 hazardous materials. The ATR batteries are certified for JSC 20793 compliance and the PCBA is certified as GFE. ®[DN 32]

B. LEVEL 3 HAZARDOUS MATERIALS (A MINIMUM OF THREE LEVELS OF CONTAINMENT REQUIRED):

NONE IDENTIFIED

C. LEVEL 2 HAZARDOUS MATERIALS (A MINIMUM OF THREE LEVELS OF CONTAINMENT REQUIRED):

1. ARMS

2. BIOBOX

3. BIOPACK

4. BIOTUBE

5. BDS-05

6. BRIC

7. CIBX

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107_13A-1 **PAYLOAD HAZARDOUS MATERIALS (CONTINUED)**

8. CM-2

9. HLS

10. ZCG

D. LEVEL 1 HAZARDOUS MATERIALS (A MINIMUM OF TWO LEVELS OF CONTAINMENT REQUIRED):

1. APCF
2. BDS-05
3. BIOBOX
4. BIOPACK
5. CEBAS
6. CIBX
7. CM-2
8. CMPCG
9. CPCG-PCF
10. ERISTO
11. FAST
12. HLS
13. OSTEO
14. STARS
15. ZCG

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107_13A-1 PAYLOAD HAZARDOUS MATERIALS (CONTINUED)

E. LEVEL 0 HAZARDOUS MATERIALS (A MINIMUM OF ONE LEVEL OF CONTAINMENT REQUIRED):

1. APCF
2. ARMS
3. ASTROCULTURE
4. BDS-05
5. BIOBOX
6. BIOPACK
7. BIOTUBE
8. CEBAS
9. CIBX
10. CM-2
11. CMPCG
12. FAST
13. FRESH-02
14. HLS
15. MGM
16. MPFE
17. OSTEO
18. STARS
19. VCD

This list is based on a candidate list and the toxicity of each experiment will be no greater than as listed. More detailed information on each hazard level and associated substances is contained in the Hazardous Materials Look-Up Table (Haz Mat), STS-107 PGSC software application. ®[DN 32]

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SECTION 12 - ROBOTICS

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SECTION 11 - COMMUNICATIONS

GENERAL

FAILURE MANAGEMENT

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SECTION 11 - COMMUNICATIONS

GENERAL

107_11A-1 PAYLOAD GROUND COMMANDING

A. ALL PAYLOAD COMMANDING WILL BE COORDINATED WITH HOUSTON FLIGHT THROUGH HOUSTON PAYLOADS OR INCO PER RULE {A2-313}, GROUND COMMANDING. ®[DN 76] ®[ED]

B. NOMINALLY, POCC COMMANDING IS SINGLE STAGE, PAYLOAD THROUGHPUT COMMANDING TO THE PAYLOAD THROUGHPUT COMMAND (PTC) BUFFER AND WILL BE MANAGED SO THAT MULTIPLE POCC'S ARE ENABLED SIMULTANEOUSLY. IF THE NEED FOR POCC TWO-STAGE COMMANDING ARISES, POCC AND MCC COMMANDING TO THE SM GENERAL PURPOSE COMPUTER (GPC) TWO-STAGE BUFFER WILL BE MANAGED SO THAT BOTH ARE ENABLED SIMULTANEOUSLY. SIMULTANEOUS (SIMO) COMMANDING THROUGHOUT EACH TDRS PASS IS APPROVED UNDER THE FOLLOWING CONDITIONS: ®[DN 70]

1. ALL POCC HAZARDOUS COMMANDING WILL BE COORDINATED WITH HOUSTON PAYLOADS PRIOR TO COMMAND INITIATION. THERE ARE NO POCC HAZARDOUS COMMANDS DEFINED FOR STS-107.

2. THE COMMANDING PARTY IS RESPONSIBLE FOR DETECTING AND RETRANSMITTING ANY LOST COMMANDS.

3. POCC COMMANDING WILL NOT BE PLANNED TO OCCUR DURING CRITICAL ORBITER COMMANDING.

4. LARGE COMMAND BLOCKS (MCC OR POCC), WILL BE COORDINATED.

SIMO commanding is possible, with the risk that contention over the PTC buffer by POCC commanding or the two-stage buffer by POCC or MCC or two-stage commands. The ground command server will normally reject commands that do not have adequate spacing, but sometimes command spacing may result in the systems management (SM) GPC rejecting one of the commands. Either the POCC or the MCC INCO can detect lost commands and retransmit them. This method of commanding is less desirable than a more structured method where contention over the PTC buffer or two-stage buffer is procedurally avoided. Due to safety considerations, hazardous commands must always be coordinated. To avoid loss of critical orbiter commands, POCC commanding will be planned around these critical commands. Since large blocks of commands require more command system time, more care must be used to avoid contention and loss of these types of commands; therefore, large command blocks will still require coordination. ®[DN 70]

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107_11A-1 PAYLOAD GROUND COMMANDING (CONTINUED)

C. REMOTE POCC LOCATIONS

1. SPACEHAB COMMANDING VIA THE MCC REMOTE POCC INTERFACE SHALL ORIGINATE FROM THE JSC POCC.

2. FREESTAR COMMANDING VIA THE MCC REMOTE POCC INTERFACE SHALL ORIGINATE FROM THE GSFC POCC. LPT COMMANDING VIA GN STATIONS INTERFACE SHALL ORIGINATE FROM THE GSFC POCC OR LPT BACKUP POCC AT GSFC. ®[CR 5849]

SOLCON and CVX will also command via Remote POCC's in Belgium and at Glenn Research Center, respectively. SOLCON and CVX commands originating from the Remote POCC's will be transmitted to the GSFC POCC and forwarded to JSC via standard HH command lines. In case of GSFC POCC evacuation, FREESTAR will relocate to a backup POCC. The backup POCC is operationally similar in architecture to the SOLCON and CVX remote POCC's. Commands from the backup POCC will be transmitted to the primary GSFC POCC and forwarded to JSC via standard HH command lines. The backup FREESTAR POCC relies upon the front-end processor in the primary POCC remaining configured and functional at time of evacuation. In the case of a POCC evacuation, LPT will command to the GN stations from a separate backup facility located at GSFC. ®[DN 59] ®[CR 5849]

D. SPACEHAB COMMAND REQUIREMENTS

1. SPACEHAB REQUIRES PAYLOAD SIGNAL PROCESSOR (PSP) COMMANDING FOR SPACEHAB ACTIVATION/DEACTIVATION AND FOR THE FOLLOWING PAYLOADS: ®[DN 76]

   a. BIOBOX

   b. BIOPACK

   c. COM2PLEX

   d. MGM

   e. MSTRS

2. FOR THE LOSS OF PSP COMMANDING, KU CHANNEL 1 FORWARD LINK COMMANDING MAY BE USED AS A BACKUP FOR EXPERIMENT COMMANDING DEPENDING ON AVAILABILITY.

Spacehab commanding via the PSP is the only command path for several SH subsystems and is the primary command path for the Biobox, Biopack, COM2PLEX, MGM, and MSTRS experiments. The backup command path for these experiments is via the Ku-band system. ®[DN 76]

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107_11A-1 PAYLOAD GROUND COMMANDING (CONTINUED)

E. FREESTAR COMMAND REQUIREMENTS

1. GROUND COMMANDS FROM THE FREESTAR POCC WILL BE USED TO CONDUCT THE MAJORITY OF FREESTAR EXPERIMENT OPERATIONS. IN ADDITION, CREWMEMBERS COMMAND THE MEIDEX AND SOLSE INSTRUMENTS.

Most FREESTAR experiment operations are controlled by ground command. Onboard activation and deactivation, MEIDEX door operations, MEIDEX commanding (primary mode), LPT power enable and SOLSE activation, deactivation, command and control are performed by the crew. All SOLSE commanding will be performed via PGSC command.

2. FREESTAR REQUIRES PAYLOAD COMMANDING DURING THE FOLLOWING PERIODS:

   a. FOR 30 MINUTES IMMEDIATELY FOLLOWING ACTIVATION

   b. FOR AT LEAST 10 MINUTES IN APPROXIMATELY EACH 90 MINUTE INTERVAL THROUGHOUT THE MISSION, AND FOR AT LEAST 15 MINUTES IN APPROXIMATELY EACH 3 HOUR INTERVAL DURING ORBITER SAFETY-CRITICAL OPERATIONS.

   c. MAXIMUM AVAILABLE COMMANDING DURING ALL DEDICATED MEIDEX, CVX, SOLCON, AND LPT OPERATING PERIODS

   d. FOR 15 MINUTES NO SOONER THAN 30 MINUTES BEFORE EACH EXPERIMENT OBSERVATION.

   e. SIXTY MINUTES FOR MEIDEX EXPERIMENT CHECKOUT AS SOON AS POSSIBLE FOLLOWING HITCHHIKER ACTIVATION

The primary means for MEIDEX commanding during dedicated observations is via PGSC command (commanding can alternately be performed from the ground if crew support is unavailable).

   f. 60 MINUTES FOR CVX OPERATIONS IMMEDIATELY FOLLOWING HITCHHIKER ACTIVATION AND IMMEDIATELY PRIOR TO HH DEACTIVATION

   g. 10 MINUTES FOR SOLCON CHECKOUTS PRIOR TO AND FOLLOWING EACH OBSERVATION (WITHIN 60 MINUTES OF OBSERVATION)

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107_11A-1 PAYLOAD GROUND COMMANDING (CONTINUED)

h. NEAR-CONTINUOUS PSP BEGINNING FIFTEEN MINUTES PRIOR TO DEDICATED LPT OPERATIONS AND CONTINUING THROUGHOUT OPERATIONS

LPT highly desires maximum available PSP throughout the mission in order to accomplish supplemental flight objectives. Payload commanding and telemetry during GN and TDRS tests will be primarily performed via direct communications between LPT and Ground Stations (MILA, WLPS or DFRC) through TDRSS. Primary command during GPS tests and backup command and telemetry capability during GN and TDRS tests will be provided via the HH avionics (use of direct to ground communications is required to achieve full experiment success).

i. FOR 20 MINUTES PRIOR TO DEACTIVATION

FREESTAR may request additional periodic commanding to maintain experiment health and to support measurements of opportunity on a non-interference basis.

3. FOR LOSS OF COMMAND CAPABILITY TO THE HH PAYLOAD, THE HH PAYLOAD WILL REMAIN ACTIVATED, THE MEIDEX AND SOLSE OPERATIONS WILL BE COMMANDED BY THE CREW VIA THE PGSC, AND THE LPT OPERATIONS WILL BE COMMANDED VIA GROUND STATIONS.

The HH heaters and payload instruments must remain powered on in order to prevent hardware damage. Payload survival heaters and HH avionics/heaters are sensor controlled. In the event that the thermal environment is not compatible with the HH configuration, the POCC may request that the HH payload be powered down prior to the nominal powerdown. There are no safety concerns with leaving the HH payload powered up. HH telemetry maybe monitored at the HH POCC to ensure that the HH payload instruments will not be damaged. Note that PSP-1 is the only ground command path to the HH avionics. ®[DN 76]

LPT can accomplish a limited set of its nominal operations via direct commanding from ground stations or via the TDRS network. With loss of PSP, MEIDEX can accomplish their flight objectives via PGSC command/control. SOLSE is controlled entirely through the PGSC interface and does not utilize PSP commanding. SOLSE, MEIDEX, and LPT operations can continue as long as their power relays have been activated via HH carrier PSP command prior to MTU failure. For loss of command, CVX-2 operations will continue. CVX-2 is programmed with a default timeline which requires approximately 200 hours to complete. The optimum CVX mission plan requires extension of this timeline to 304 hours. Alteration of the default timeline will require commanding during the first 4 days of the mission. Should CVX lose the ability to command during this period, the instrument will perform the initial part of the 304-hour timeline and then revert back to the default timeline, with probable loss of all remaining science. Should CVX lose commanding after the first 4 days of the mission, the instrument will execute the programmed 304-hour timeline. ®[DN 76] ®[CR 5849]

107_11A-2 PAYLOAD TELEMETRY

A. SPACEHAB TFL REQUIREMENTS – A TFL SUPPORTING 32 KBPS TELEMETRY IS REQUIRED FROM SPACEHAB ACTIVATION TO DEACTIVATION EXCEPT WHEN ORBITER HDR GNC IS REQUIRED. ®[DN 4]

PDI data is nominally used for SPACEHAB systems, Biobox, Biopack, CM-2, COM2PLEX, EOR/F, HLS TEHM, MGM, and MSTRS. ®[CR 5554]

B. FREESTAR TFL REQUIREMENTS

1. A TFL SUPPORTING FREESTAR 8 KBPS TELEMETRY IS REQUIRED FROM FREESTAR ACTIVATION TO DEACTIVATION.

The 8 kbps data stream is required to monitor FREESTAR health and status. ®[CR 5542]

2. IF A TFL IS REQUIRED THAT DOES NOT SUPPORT FREESTAR TELEMETRY DUE TO ORBITER SAFETY CRITICAL OPERATIONS OR HIGHER PRIORITY PAYLOAD OPERATIONS, PDI DATA IS REQUIRED AT LEAST 15 MINUTES IN EACH 3-HOUR INTERVAL.

FREESTAR will negotiate waiving the telemetry requirement during brief periods of other high-priority payload operations.

3. FOR UNPLANNED LOSS OF ALL EIGHT KBPS DATA, FREESTAR WILL REMAIN ACTIVATED AND SCIENCE OPERATIONS MAY CONTINUE AT THE DISCRETION OF THE FREESTAR POCC.

FREESTAR needs to keep the HH avionics heaters and the FREESTAR experiment heaters on to prevent hardware damage. FREESTAR and HH avionics heaters are sensor controlled and affixed to the hardware mounting plates. There are no safety concerns with leaving FREESTAR powered without insight into payload health and status. Based on the discretion of the FREESTAR POCC, science operations may continue as long as the last available housekeeping telemetry indicated FREESTAR was functioning nominally. With total loss of eight kbps data, MEIDEX, SOLSE, SOLCON, and LPT will be able to continue operations through crew PGSC interaction (MEIDEX and SOLSE), on-board recording (SOLCON and CVX), and ground station interfaces (LPT). SOLCON will be able to continue operations as data will be recorded within the instrument Mass Memory Unit (MMU). CVX has the internal capability to record all data. Insight to viscometry data and unique phenomena will be lost. ®[DN 4] ®[DN 60] ®[CR 5850]

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107_11A-2 PAYLOAD TELEMETRY (CONTINUED)

C. ORBITER TFL REQUIREMENTS BEYOND THOSE COVERED IN RULE {A2-129}, ORBITER ON-ORBIT HIGH DATA RATE REQUIREMENTS. ®[DN 87] ®[ED]

1. TFL 161 IS PREFERRED FOR FCS CHECKOUT

Rule {A2-129}, ORBITER ON-ORBIT HIGH DATA RATE REQUIREMENTS, documents the mandatory requirement for high rate OI data in support of FCS checkout. Several STS-107 telemetry configurations supply high rate OI data, but do not supply the full set of desired parameters for evaluation of the APU hydraulic systems. ®[ED]

2. HIGH RATE GNC DATA IS REQUIRED DURING THE RCS HOTFIRE TEST.

3. HIGH RATE GNC DATA IS REQUIRED IN SUPPORT OF GPS ON-ORBIT OPERATIONS.

Reference section 3.7 of NSTS-16725 FTSOD.

4. HIGH RATE GNC DATA IS HIGHLY DESIRED JUST PRIOR TO EACH IMU ALIGN.

High rate GNC data is highly desired to capture star data used for the IMU align.

5. HIGH RATE OI DATA IS DESIRED AT ALL TIMES FOR INCREASED ABILITY TO DIAGNOSE ELECTRICAL SHORTS.

Orbiter bus current sensor data is downlinked at a higher sample rate in high rate OI data. The higher rate increases the statistical probability of capturing bus shorts when they occur. ®[DN 87]

107_11A-3 KU-BAND REQUIREMENTS AND CONSTRAINTS

A. KU-BAND CONSTRAINTS

1. ALL PAYLOADS WILL BE PROTECTED BY THE STANDARD BETA 21+ MASK MODE OF OPERATIONS

2. NEITHER SPACEHAB NOR FREESTAR HAVE ANY OTHER CONSTRAINTS AGAINST OPERATIONS OF THE KU-BAND SYSTEM.

The KU-band comm system will be managed to preclude the direct radiation of LPT at greater than 70 volts/meter. The standard beta 21 + mask mode does not violate LPT constraints.

B. PAYLOAD REQUIREMENTS FOR KU COMMUNICATIONS

1. SPACEHAB:

a. KU 128 KBPS FORWARD LINK COMMANDING TO THE RDM EXPERIMENT DATA SYSTEM AND EXPERIMENTS. ®[CR 5554]

Ku 128 kbps forward link commanding is the primary command path for the Experiment Data System, the Video Digitizer System (VDS) and CM-2, FAST, MSTRS, SAMS FF, STARS-Bootes, STARNAV, and ZCG. The backup command path for these experiments is via PSP commanding. ®[CR 5624]

b. CHANNEL 1 FOR DOWNLINK VOICE, ORBITER SYSTEMS DATA AND SPACEHAB SYSTEMS DATA VIA THE PDI.

c. CHANNEL 2 FOR SPACEHAB SYSTEMS DATA, SPACEHAB EXPERIMENT DATA, AND PAYLOAD RECORDER DUMPS OF OARE DATA

Channel 2 data is utilized by the SH VDS and by ARMS, CM-2, FAST, SAMS FF, STARNAV, STARS-Bootes, VCD, and ZCG. The VDS has no unique data requirements, but is used in support of experiments. ®[CR 5624]

d. CHANNEL 3 FOR VIDEO DOWNLINK AND SPACEHAB LOS RECORDER DUMPS

e. CHANNEL 2 OR 3 FOR OCA DOWNLINK OF ASTROCULTURE FILES ®[CR 5554]

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107_11A-3 KU-BAND REQUIREMENTS AND CONSTRAINTS (CONTINUED)

2. FREESTAR:

   a. CHANNEL 3 FOR VIDEO DOWNLINK OF MEIDEX OBSERVATIONS AND INITIAL DOOR OPENINGS FOR MEIDEX AND SOLSE.

   b. CHANNEL 2 OR 3 FOR OCA DOWNLINK OF MEIDEX AND SOLSE DATA FILES

MEIDEX requires the downlink of payload provided video in real-time or near real-time during dedicated operations and desires maximized opportunities for payload video downlink during all secondary operations. Both MEIDEX and SOLSE require downlink of data files via the OCA interface.

There are also standard orbiter requirements for the Ku-band. (e.g., Execute Package, mail syncs, videoconferencing, file transfers, etc.). OCA is nominally planned to occur on Channel 3. To the extent possible, Ops Recorder dumps will occur on either Ku Channel 2 via TDRS-Z or S-band FM via ground stations, so as to be non-interference with payload utilization of the Ku assets. ®[CR 5554]

107_11A-4 CCTV REQUIREMENTS

A. MCC-H WILL REQUEST PERMISSION FROM THE CREW BEFORE DOWNLINK OF ANY VIDEO WHICH MAY INCLUDE IMAGES OF THE CREW. ®[DN 3]

MCC-H is responsible for ensuring that the downlinked video of crewmembers is controlled and maintains a level of privacy for the crew.

B. DOWNLINK OF VIDEO WITH SUPERFICIAL IMAGES OF THE CREW IS PERMITTED WITHOUT SPECIFIC CREW AUTHORIZATION.

Downlinks involving a superficial view of a small portion of a crewmember, such as the view of a crewmember's hands inside a glove box or other experimental apparatus, are not expected to require any crew permission.

C. SPACEHAB EXPERIMENT OPERATIONS REQUIRE USE OF THE ORBITER CCTV SYSTEM AS FOLLOWS:

Refer to Annex 2 Part II for specific scheduling requirements. ®[CR 5554]

1. BDS-05 DESIRES REAL-TIME VIDEO DOWNLINK OF TISSUES IN THEIR BIOREACTOR. IF VIDEO DOWNLINK OF BDS-05 IS NOT POSSIBLE, VIDEO PLAYBACK WITHIN 24 HOURS IS ACCEPTABLE.

BDS-05 uses the shared camcorder.

2. BIOTUBE REQUIRES REAL-TIME VIDEO DOWNLINK BEGINNING 20 HOURS AFTER BIOTUBE ACTIVATION. A 3-MINUTE VIDEO DOWNLINK IS REQUIRED EVERY 2 HOURS UNTIL BIOTUBE TERMINATION.

Biotube uses an internal camera.

3. CM-2

   a. LSP REQUIRES VIDEO FOR EACH PRE-TEST VERIFICATION AND EACH TEST SEQUENCE. ®[CR 5625C]

   b. SOFBALL REQUIRES VIDEO FOR THE FIRST TEST RUN.

   c. MIST REQUIRES VIDEO FOR EACH RUN.

CM-2 uses an internal camera. Since CM-2 SOFBALL operations have been nominally scheduled to be crew tended, real-time video downlink is not required other than on the first run. ®[CR 5554] ®[CR 5625C]

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107_11A-4 CCTV REQUIREMENTS (CONTINUED)

4. FAST REQUIRES REAL-TIME VIDEO DOWNLINK FOR ACTIVATION, DEACTIVATION, EXPERIMENT SEQUENCES, AND INJECTIONS. ®[CR 5554]

FAST uses an internal camera.

5. MGM REQUIRES REAL-TIME VIDEO DOWNLINK COVERAGE OF EXPERIMENT ACTIVATION. DOWNLINK OF VIDEO OR PHOTO TAKEN DURING DEACTIVATION IS DESIRED PRIOR TO THE NEXT MGM RUN.

MGM uses the shared camcorder. A video or still image during deactivation is desired to eliminate the need for a reform. However, if an image is not available, there is no impact to science since a reform is already scheduled as a part of each deactivation.

6. STARS-BOOTES REQUIRES REAL-TIME VIDEO DOWNLINK TWICE DAILY, TWO 2-HOUR SESSIONS OF VIDEO DOWNLINK OF THE CRYSTAL GROWTH EXPERIMENT, AND TWO 2-HOUR SESSIONS OF VIDEO DOWNLINK OF THE SILKWORM EXPERIMENT.

STAR-BOOTES uses an internal camera.

7. ZCG REQUIRES REAL-TIME VIDEO DOWNLINK DURING ZCG CLEAR AUTOCLAVE OPS WHILE THE CREWMEMBER IS MIXING THE CLEAR AUTOCLAVES. ®[DN 31]

ZCG uses the Shared Camcorder. ®[CR 5554]

D. FREESTAR EXPERIMENT OPERATIONS REQUIRE USE OF THE ORBITER CCTV SYSTEM AS FOLLOWS: ®[DN 3]

1. ORBITER CCTV MONITORING IS REQUIRED FOR THE FIRST CANISTER DOOR OPENINGS FOR MEIDEX AND SOLSE. VIDEO VERIFICATION IS ALSO REQUIRED OF DOOR POSITIONS AFTER FINAL CLOSINGS BUT PRIOR TO FREESTAR DEACTIVATION. ®[CR 5625C]

Video of each experiment will be an additional confirmation that the instruments are intact and functioning properly.

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107_11A-4 CCTV REQUIREMENTS (CONTINUED)

2. IF GROUND INSIGHT INTO DOOR POSITION IS LOST, MEIDEX REQUIRES CCTV OR CREW VERIFICATION OF DOOR POSITION PRIOR TO AND IMMEDIATELY FOLLOWING ALL OBSERVATIONS.

Position of the MEIDEX door is nominally indicated through ground and PGSC. If ground insight into door position is lost, MEIDEX requires confirmation of door position. If the door is not full open prior to a data take, data may not be obtained during the observation. If door is not full closed after an observation, MEIDEX contamination constraints may be inadvertently violated, resulting in instrument damage. This requirement is to ensure mission success, maximum science acquisition, and reflight hardware integrity.

3. MEIDEX CCTV REQUIREMENTS

OBSERVATION	REAL-TIME DOWNLINK [1]	PLAYBACK DOWNLINK [2]	DSR-20 RECORDING (XYBION)	V10 RECORDING (SEKAI)
STARTUP/CHECKOUT	N/A	N/A	DESIRED	DESIRED
PRIMARY DATA TAKES (FIRST 140 MIN OF ROI), CALIBRATION, AND COORDINATED SCIENCE	REQUIRED	REQUIRED [3]	REQUIRED	HIGHLY DESIRED
SECONDARY DATA TAKES (ADDITIONAL ROI)	REQUIRED	DESIRED [3]	HIGHLY DESIRED	HIGHLY DESIRED
SPRITE VIEWS	REQUIRED	DESIRED [3]	REQUIRED	REQUIRED
SLANT VISIBILITY	N/A	N/A	N/A	N/A

®[CR 5625C]

NOTES:

[1] MEIDEX REQUIRES MAXIMUM AVAILABLE REAL-TIME DOWNLINK. MEIDEX VIDEO DOWNLINKED IN REAL TIME CAN BE EITHER ANALOG SEKAI, ANALOG XYBION, OR DIGITAL XYBION. SSV IS REQUIRED FOR ALL MEIDEX OBSERVATION FOR WHICH REAL-TIME DOWNLINK IS NOT ALLOCATED.

[2] PLAYBACK DOWNLINKS ARE ALWAYS DIGITAL XYBION. PLAYBACKS ARE ONLY CONSIDERED FOR VIDEO FOR WHICH NO REAL-TIME DOWNLINK WAS SCHEDULED.

[3] WITHIN 6 HOURS OF DATA COLLECTION OR PRIOR TO COMPLETION OF THE NEXT REPLANNING CYCLE, WHICHEVER COMES FIRST.

Real-time downlink during MEIDEX operations will allow the PI to verify the configuration of the two cameras during data collection and optimize settings for the best possible science. The playback of the images from the Xybion cameras will allow the POCC to adjust the systems for the next planned operation.

MEIDEX Xybion video is recorded on internal video tape recorders but this video is not available during the flight. In cabin recording serves as a backup data set. The Sekai camera is not recorded internally. Its recording is highly desired in order to provide additional post-flight reference. The Sekai video will not nominally be played back during flight. Minimum acceptable SSV downlink rate is 17.6 kbps. ®[CR 5625C]

107_11A-5 LPT AND S-BAND PM MANAGEMENT

A. THE ORBITER S-BAND PM SYSTEM SHALL NOMINALLY BE OPERATED USING LOW FREQUENCY TO PREVENT INTERFERENCE WITH LPT SCIENCE OBJECTIVES. ®[CR 5512A]

The LPT payload operates with ground stations and TDRSS on the same frequency pair as the orbiter S-Band PM system high frequency pair (2106.4 MHz receive and 2287.5 MHz transmit). If the orbiter was operated at the same frequency as LPT, it might interfere with LPT data collection. Although the orbiter uses right hand polar circularization and LPT uses left hand polar circularization, there is the possibility that S-band PM transmissions from the orbiter may cause interference. It is not expected that the orbiter forward link will interfere with LPT since the signal strength from TDRS is much lower than the signal transmitted from the orbiter.

B. FOR A FAILURE OF THE ORBITER S-BAND PM SYSTEM LOW FREQUENCY, THE ORBITER S-BAND PM SYSTEM WILL BE MANAGED TO PREVENT INTERFERENCE WITH LPT DURING SCIENCE DATA TAKES WHEN ORBITER AND PAYLOAD PRIORITIES PERMIT. THE LPT CUSTOMER MAY ELECT TO PERFORM SCIENCE DATA TAKES EVEN IF THE ORBITER S-BAND SYSTEM IS NOT CONFIGURED TO PREVENT INTERFERENCE.

If the orbiter cannot use low frequency and the orbiter S-band return link can be given up temporarily based on orbiter and payload priorities and Ku-band availability, the S-band power amplifier will be turned off as required during LPT science data takes to preclude interference. If the MCC has the capability to command communications equipment, the MCC will command the S-Band PM power amp to off if it is predicted that the orbiter upper S-Band PM antennas will be active during LPT operations. For a GCIL failure such that the MCC can no longer configure orbiter communications equipment, the crew can power off the S-band power amplifier via switch. The orbiter Ku-Band may serve as the downlink path for the orbiter operational data, if it is in view of TDRS. If it is predicted that the orbiter lower S-band PM antennas will be active during LPT operations, no orbiter S-band PM system configuration is required since interference is not expected.

If the full-up orbiter S-band PM system is required due to higher priority orbiter or payload requirements, the power amp will not be turned off. In this case, the LPT customer may elect to perform science data takes and accept the possibility of interference rather than lose a science collection opportunity. ®[CR 5512A]

C. LPT SHALL BE INHIBITED VIA THE SSP DURING EVA’S AND ORBITER SAFETY CRITICAL OPERATIONS.

The majority of LPT operations are controlled from the POCC directly through the ground stations or TDRS to LPT. The inhibit switch on the Standard Switch Panel will be used to ensure that the LPT does not interfere with EVA operations or orbiter safety critical operations

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107_11A-5 LPT AND S-BAND PM MANAGEMENT (CONTINUED)

D. LPT SHALL BE INHIBITED FROM TRANSMITTING VIA GROUND COMMAND DURING MSTRS OPERATIONS AND DURING PERIODS WHEN LPT SCIENCE DATA IS NOT REQUIRED AND THE ORBITER S-BAND PM SYSTEM HIGH FREQUENCY IS REQUIRED.

The inhibit switch on the Standard Switch Panel removes power from the LPT experiment and prevents both transmitting and receiving. The POCC has the capability to inhibit LPT transmissions alone via ground command. During MSTRS operations and during periods when LPT science data is not required and the orbiter S-Band PM system low frequency is failed, LPT will be inhibited from transmitting via ground command in order to continue receiving data. This configuration will allow LPT to continue GPS operations and validation in a receive only mode.

107_11A-6 AIR TO GROUND (A/G) COMM MANAGEMENT

ALL SPACEHAB A/G COMMUNICATIONS WILL BE CONDUCTED WITHIN THE GUIDELINES OF RULE {A-321}, SPACEHAB AIR-TO-GROUND (A/G) USAGE, WITH THE FOLLOWING FLIGHT SPECIFIC EXCEPTION: ®[ED]

NONE IDENTIFIED

FAILURE MANAGEMENT

107_11A-11 PDI FAILURE MANAGEMENT

FOR A LOSS OF THE PDI, A PDI IFM WILL BE REQUIRED TO INSTALL THE SPARE PDI.

Spacehab and FREESTAR have requirements for PDI telemetry to their respective POCC's. Without the PDI telemetry, primary mission science objectives will be compromised. Some data recording/storage capability exists for certain experiments; however, the overall science complement would be severely impacted without PDI telemetry.

Spacehab systems use the PDI as their only data source with the exception of MDM parameters. The Spacehab Biobox, Biopack, CM-2, COM2PLEX, EOR/F, TEHM, MGM, and MSTRS payloads use the PDI as their primary data source but can also use Ku channel 2 as backup. ®[DN 78]

FREESTAR primary data source is via the PDI stream. CVX and SOLCON downlink data is lost without PDI service. Real-time insight into MEIDEX operations is lost without PDI service, although MEIDEX data can be downlinked from the MEIDEX PGSC following observations. Although LPT data via the HH interface will be lost without PDI, LPT operations can continue when SN and/or GN resources are available for data downlink. ®[DN 61]

Reference Rule {107_2A-53}, PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES.

107_11A-12 PSP FAILURE MANAGEMENT

IN CASE OF A PSP-1 FAILURE, AN IFM WILL BE PERFORMED TO WIRE FREESTAR TO PSP-2 AS SOON AS PRACTICAL.

FREESTAR is wired only to PSP-1. If system failures cause a swap to PSP-2 (PSP-1 failed or otherwise unusable), FREESTAR payloads would be severely impacted with no way to command to the experiment from the HH POCC.

A preflight approved IFM has been developed to wire FREESTAR to PSP-2 by accessing the patch cabling at the Payload Station Distribution Panel (PSDP) and routing PSP-2 command output ports to the HH command input. Limited commanding is available to the payload via the PGSC if PSP functionality is not recovered.

Reference Rule {107_2A-53C}, PAYLOAD IN-FLIGHT MAINTENANCE (IFM) PROCEDURES).

107_11A-13 RESERVED ®[DN 5]

SECTION 14 - SPACE ENVIRONMENT

THERE ARE NO STS-107 RULES FOR THIS SECTION

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SECTION 15 - EXTRAVEHICULAR ACTIVITY (EVA)

GENERAL

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SECTION 15 - EXTRAVEHICULAR ACTIVITY (EVA)

GENERAL

107_15A-1 EVA HAZARD MANAGEMENT

THE FOLLOWING TABLE DOCUMENTS KNOWN HAZARDS TO EVA CREW PRESENTED BY STS-107 PAYLOADS. THE CONTROLS FOR EACH OF THESE HAZARDS MUST BE IN PLACE PRIOR TO AND THROUGHOUT ANY STS-107 EVA.

PAYLOAD	HAZARD TYPE	DETAILS/CONTROLS
FREESTAR	CREW CONTACT	A KEEPOUT ZONE WILL BE IMPLEMENTED TO PREVENT INADVERTENT CONTACT WITH THE FREESTAR PAYLOAD [1]
MEIDEX	CREW CONTACT	THE MEIDEX DOOR WILL BE CLOSED AND POWER REMOVED DURING EVA'S TO AVOID INADVERTENT DOOR MOTION AND CREW CONTACT.
SOLSE	CREW CONTACT	THE SOLSE DOOR WILL BE CLOSED AND POWER REMOVED DURING EVA'S TO AVOID INADVERTENT DOOR MOTION AND CREW CONTACT.
SOLCON	CREW CONTACT	THE SOLCON COVER WILL BE CLOSED DURING EVA TO AVOID INADVERTENT COVER MOTION AND CREW CONTACT.
LPT	RF/EMI	THE LPT POWER AND TRANSMITTER IS DISABLED WITH THREE INHIBITS (2 SSP INHIBITS, 1 GROUND COMMAND).
COM2PLEX	MOLTEN METAL	PAYLOAD POWER WILL BE REMOVED PRIOR TO EVA TO ELIMINATE THE POTENTIAL OF MOLTEN METAL RESULTING FROM CREW KICK LOADS APPLIED TO POWERED CABLES (REF. SH HR I-11).
MSTRS	MOLTEN METAL	PAYLOAD POWER WILL BE REMOVED PRIOR TO EVA TO ELIMINATE THE POTENTIAL OF MOLTEN METAL RESULTING FROM CREW KICK LOADS APPLIED TO POWERED CABLES (REF. SH HR I-11).
STARNAV	MOLTEN METAL	PAYLOAD POWER WILL BE REMOVED PRIOR TO EVA TO ELIMINATE THE POTENTIAL OF MOLTEN METAL RESULTING FROM CREW KICK LOADS APPLIED TO POWERED CABLES (REF. SH HR I-11).

®[DN 62]

[1] ALL FREESTAR PAYLOAD HARDWARE WITHIN 24 INCHES OF THE SILL EVA TRANSLATION PATH IS SAFE FOR CONTACT BY THE CREW. THE ONLY PORTION OF FREESTAR WHICH IS WITHIN 24 INCHES OF THE ORBITER SILL TRANSLATION PATH IS THE OUTER PORTION OF THE MPESS AND ITS MOUNTING HARDWARE. NONE OF THE EXPERIMENTS ON FREESTAR ARE WITHIN 24 INCHES OF THE ORBITER SILL TRANSLATION PATH. THE FOLLOWING AREAS ON FREESTAR ARE IDENTIFIED AS SUSCEPTIBLE TO EVA KICKLOADS FOR MISSION SUCCESS REASONS: ELECTRICAL WIRING AND CONNECTORS, ELECTRICAL HARNESS BRACKETS AND THE LPT 18-INCH TRANSMIT ANTENNA AND PEDESTAL. IN ORDER TO PROTECT THESE COMPONENTS, THE FREESTAR KEEPOUT ZONE IS ANYWHERE ON THE PAYLOAD OUTSIDE OF THE EVA TRANSLATION ZONE. ®[DN 62]

This information in this table is derived from a variety of sources including but not limited to: Payload safety assessments, hazard reports, sharp edge inspections, payload walkdowns, and EMU certification limits. Proper management of each of these hazards is required to ensure EVA crew safety and/or proper EMU operation.

107_15A-2 SPACEHAB EVA CONSTRAINTS

A. THE FOLLOWING EXPERIMENTS ARE NOT CERTIFIED TO OPERATE AT 10.2 PSI:

1. ARMS ®[DN 33]

2. CM-2

3. MGM

4. ZCG

ARMS, CM-2, MGM, and ZCG are not certified to operate in the 10.2 environment. Operation of the SH Module at 10.2 would require these payloads to be deactivated. Although ARMS materials are certified for a 30 percent O_2 environment, it will not be allowed to operate in this case due to higher 0_2 concentrations within the payload (per PSRP agreement). ®[DN 33]

B. IN THE EVENT OF AN EVA, SPACEHAB WILL BE CONFIGURED FOR SAFE ENTRY AND THE HAB WILL REMAIN AT 14.7 PSI.

This rule is in support of Rule {A2-317}, EVA CONSTRAINTS, and defines the strategy for Spacehab management for an EVA. There are no scheduled or unscheduled EVA's planned for STS-107. Possible contingency EVA's include Ku-band antenna stow and Payload Bay Door closure. These contingency EVA's do not require a 10.2 psi pre-breathe protocol such that the orbiter will remain at 14.7 psi. In preparation for airlock depress, the Spacehab will be configured for safe entry and the hatch closed. If experiment operations were originally planned during the time of the contingency EVA, experiment operations that do not require crew interaction may continue. ®[ED]

SECTION 18 - THERMAL

GENERAL

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SECTION 18 - THERMAL

GENERAL

107_18A-1 BONDLINE ENTRY INTERFACE (EI) TEMPERATURES

MAXIMUM ALLOWABLE BONDLINE ENTRY INTERFACE (EI) TEMPERATURES ARE BASED ON STRUCTURAL CONSTRAINTS AND FLIGHT-SPECIFIC PARAMETERS FOR VEHICLE LOADING. THE LIMITS LISTED BELOW ARE THE LANDING OPPORTUNITY-INDEPENDENT LIMITS FOR STS-107:

DESCRIPTION	TEMPERATURE MEASUREMENT NO'S	MAX LIMIT, DEG F
PLBD	V37T1000	66.0
	V37T1006	66.0
	V37T1002	81.0
	V37T1004	81.0
PORT (STBD)	V09T1012(14)	100.3
	V09T1724(20)	119.6
	V09T1030(28)	61.4
	V34T1106(08)	118.9
	V34T1102(04)	69.9
TOP	V09T1524	67.0
	V09T1004	92.3
	V09T1024	92.3
BOTTOM	V09T1624	122.2
	V09T1702	97.5
	V09T1000	92.2
	V09T1002	92.2
	V09T1016	100.3
	V09T1022	99.3
	V34T1110	89.3
	V34T1112	89.3

These are the STS-107 flight-specific limits, as referenced in Rule {A18-401B}, THERMAL PROTECTION SYSTEM (TPS) BONDLINE TEMPERATURES. The term "Opportunity-Independent" refers to the representative set of deorbit opportunity cases from which these limits are derived. The limits listed represent the most restrictive for each MSID from all of the cases including a weight change of up to 3000 lbs and a cg shift of up to 3 inches. ®[ED]

DOCUMENTATION: STS-107 Flight Design Product DSCT-29, January 11, 2002.

107_18A-2 ORBITER FREON FLOW PROPORTIONING VALVE (FPV) USAGE

THE TWO ORBITER FREON FPV'S WILL NOMINALLY BE USED ACCORDING TO THE FOLLOWING PLAN:

A. PRELAUNCH (POWERED ASCENT): ONE FPV IN THE INTERCHANGER (ICH) POSITION AND ONE FPV IN THE PAYLOAD HEAT EXCHANGER (PLHX) POSITION UNTIL LAUNCH MINUS 2 HRS. AT THAT POINT, BOTH FPV'S ARE PLACED IN ICH FOR ASCENT. ®[CR 5617C]

Both FPV's must be in ICH for ascent. However, cold soaking the Spacehab module prelaunch via one FPV in PLHX keeps the predicted module temperatures acceptable until post insertion. It is desired to keep the SH Module temperature below 85 deg F during ascent for the FRESH-2 payload. Moving the FPV back to the ICH position still guarantees a nominal crew cabin temperature at ingress and during ascent.

B. ON-ORBIT 14.7 PSI OPS:

   1. AFTER SUCCESSFULLY REACHING ORBIT (POST INSERTION), ONE FPV WILL BE PLACED IN "PLHX" POSITION UNTIL DEORBIT PREP.

   2. THE SECOND FPV WILL BE TAKEN TO "PLHX" NO EARLIER THAN THE END OF SPACEHAB ACTIVATION BUT BEFORE ACTIVATION OF WATER COOLED EXPERIMENTS. EXACT TIMING OF SECOND FPV MOVEMENT WILL DEPEND ON AN ASSESSMENT OF ORBITER AND SPACEHAB CABIN TEMPERATURES.

C. DEORBIT PREP/ENTRY: AT THE END OF SPACEHAB ENTRY PREP ONE FPV WILL BE RETURNED TO "ICH". THE OTHER FPV WILL BE RETURNED TO "ICH" AT THE BEGINNING OF DEORBIT PREP FOR ENTRY AND LANDING. FOR EXTENSION DAYS, AN FPV IN "PLHX" IS REQUIRED TO MAINTAIN SPACEHAB WITHIN THERMAL REQUIREMENTS. ®[DN 68] ®[CR 5617C]

THIS RULE CONTINUED ON NEXT PAGE

107_18A-2 ORBITER FREON FLOW PROPORTIONING VALVE (FPV) USAGE (CONTINUED)

Thermal Analysis shows that to maintain Spacehab within the limits required to satisfy payload thermal requirements both FPV's are required to be in "PLHX" when Spacehab and Spacehab payloads are in their on-orbit configuration (reference Rule {107_17A-1}, SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS). However, real-time assessment of the actual orbiter cabin temperature following the ascent phase may result in delaying the second valve movement to payload until such time that this temperature decreases to more desirable levels (less than 80 deg F; reference Rule {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT). Flight data shows that orbiter cabin temperatures typically range from 79 to 84 deg F following ascent. Delaying the second FPV movement to PLHX will aid in decreasing orbiter cabin temperatures at a significantly higher rate than if both FPV's were to be in PLHX. The delay will not be so long as to compromise SPACEHAB thermal constraints and conditions, and will be done before activation of SPACEHAB water-cooled experiments. A single FPV is required to be in "PLHX" with Spacehab in the entry configuration until the start of deorbit prep to assure that the Spacehab thermal limits are not violated during entry and post-landing. It is desired to keep the SH Module temperature below 85 deg F during entry and post-landing for the FRESH-2 payload. ®[DN 68] ®[CR 5617C]

D. POSTLANDING: BOTH FPV'S WILL BE IN THE "ICH" POSITION UNTIL REQUESTED FOR PAYLOAD COOLING NO LATER THAN ONE HOUR AFTER LANDING BUT NO EARLIER THAN CREW EGRESS. THEN ONE FPV IS PLACED INTO THE "PLHX" POSITION FOR THE DURATION OF EARLY EXPERIMENT RETRIEVAL OPERATIONS. IF CREW EGRESS IS DELAYED PAST LANDING PLUS ONE HOUR, POSITIONING THE FPV'S TO "PLHX" WILL BE DELAYED UNTIL AFTER CREW EGRESS. ®[CR 5617C]

Moving one FPV to PLHX allows Spacehab to maintain module temperature during early experiment sample retrieval operations. Waiting until crew egress to move one FPV to PLHX maximizes orbiter cabin cooling for crew comfort until ground ventilation can be connected. Thermal analysis shows that the Spacehab module air temperature will reach approximately 85 deg F after 3.5 hours and 90 deg F after 6 hours of operation with both FPV's in "ICH" while in the descent/post-landing configuration. It is desired to keep the SH Module temperature below 85 deg F during post-landing for the FRESH-2 payload. ®[DN 68]

107_18A-3 END-OF-MISSION THERMAL CONDITIONING

THE ATTITUDES FOR THE LAST 15 HOURS PRIOR TO THE START OF THE DEORBIT PREP WILL BE RESERVED FOR THERMAL CONDITIONING. THIS WILL CONSIST OF 5 HOURS OF BOTTOM SUN AND 10 HOURS OF –ZLV –YVV. PRECEDING THIS 15-HOUR PERIOD, SOME SECTIONS OF THE ATTITUDE TIMELINE ARE BEING FLOWN –ZLV –YVV IN ORDER TO MINIMIZE NEED FOR FUTURE BELLY SUN. NOMINALLY, THE THERMAL CONDITIONING PROTECTS FOR NEOM + 2 REVS; HOWEVER, FOR THIS FLIGHT, NEOM + 1 REV IS BEING PROTECTED. ®[CR 5505]

Thermal conditioning will be required for the BET and main landing gear tires prior to the deorbit prep. It will consist of biased belly Sun to warm the tires and bay Earth, nose north toward the Sun (-ZLV -YVV) to decrease the BET. The duration of the belly Sun attitude may be readdressed in real time to meet the actual conditions at the end of mission (launch delay, actual temperatures differing from predictions, etc). The EOM conditions specified in Rule {A2-110}, STRUCTURES THERMAL CONDITIONING, are not sufficient due to the extremely high mission-specific NEOM tire limit of 12 degrees. ®[ED]

Rationale: Engineering judgment ®[CR 5505]

107_18A-4 WATER LINE HEATER MANAGEMENT

EXCEPTIONS TO WATERLINE HEATER MANAGEMENT RULE:

NONE IDENTIFIED

In support of Rule {A18-555}, WATER LINE HEATER MANAGEMENT. Need to list any exceptions to the generic rule on management of the water line heaters, in particular, in attitude management deltas for loss of water line heaters. ®[ED]

107_18A-5 RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT

A. CWC STOWAGE CONSTRAINTS

1. A SPACEHAB CWC TO BE NOMINALLY STOWED IN SPACEHAB FOR ENTRY IS LIMITED TO 32 LBS OF WATER.

If the final Spacehab CWC is to be stowed inside the Spacehab module, the designated CWC stowage location for STS-107 (on the module ceiling) can structurally accommodate 32 lbs of water.

2. A SPACEHAB CWC TO BE NOMINALLY STOWED IN THE ORBITER FOR ENTRY IS LIMITED TO 95 LBS OF WATER.

If the Final Spacehab CWC is to be stowed in the orbiter, the designated orbiter stowage locations (per Rule {107_10A-4}, FILLED CWC STOWAGE MANAGEMENT, can accommodate 95 lbs.

B. CWC REFILL AND DUMP CONSTRAINTS

1. CWC’S MAY BE FILLED A MAXIMUM OF TWO CYCLES (ONE INITIAL FILL PLUS A REFILL).

2. CWC’S MAY BE DUMPED OVERBOARD A MAXIMUM OF TWO CYCLES (ONE INITIAL DUMP PLUS ONE ADDITIONAL DUMP).

3. FOR PURPOSES OF COUNTING FILLS AND DUMPS, A PARTIAL DUMP OF A CWC COUNTS AS ONE CYCLE. ®[DN 37]

For life-cycle considerations, each CWC is certified for a maximum of two fills or dumps. Once the CWC is dumped, a cycle is complete. Partial fills and dumps only count as one cycle if that dump has emptied the bag fully, or the dump has gone on long enough such that a significant fraction of the water has gone overboard. For example, full CWC’s from STS-108 (approx 75-91 lbm avg) took around 45 min to an hour to dump. Therefore, a dump of around 30 min would be considered a “significant fraction”. However, if a dump only lasted 3 min and had to stop, that would likely not be considered “significant” (and therefore, that CWC could still be used again without it counting as one full cycle). In either case, real-time consultation with MER Engineering personnel would then occur, and the dump signature examined to determine if a significant fracture was dumped.

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107_18A-5 RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT (CONTINUED)

C. THE LAST CST TO CWC TRANSFER TO BE INCLUDED IN A CWC DUMP SHALL OCCUR SUCH THAT SUBSEQUENT CST TO CWC TRANSFERS DO NOT EXCEED THE NUMBER OF AVAILABLE CWC STOWAGE LOCATIONS. TO PROTECT FOR SPACEHAB REINGRESS ON WAVE-OFF DAYS, THE ADDITIONAL CONDENSATE PREDICTED FOR OPEN HATCH OPERATIONS MUST BE ACCOMMODATED WITHOUT REQUIRING AN OVERBOARD DUMP ON WAVE-OFF DAYS.

The time of the last CST transfer to a CWC to be dumped overboard is driven by the collection rate following this transfer and the available stowage locations to accommodate CWC's used for subsequent CST to CWC transfers performed after the last overboard dump. Although this rule does not imply a requirement to re-ingress the Spacehab on wave-off days, if the Spacehab is re-ingressed, the additional condensate collected while the crew is in the Spacehab must be accounted for without requiring an overboard dump. The additional condensate collected must either be accounted for by extra ullage in the CST, ullage in a partially filled CWC, or another available stowage location for an additional CWC.

D. THE CST WILL BE MANAGED SUCH THAT A TRANSFER OF THE CST TO A CWC WILL NOT BE REQUIRED FOR EXTENSION DAYS.

Since the Spacehab CWC is disconnected and stowed for entry (nominally 7.5 hrs before TIG), condensate is collected in the CST and cannot be transferred to a CWC after this point. Per Rule {A18-606}, RDM CONDENSATE STORAGE TANK (CST)/CONTINGENCY WATER CONTAINER (CWC) MANAGEMENT, the CST must not exceed a pressure of 15 psi. The CST will be managed such that the final CST to CWC transfer before hatch closure will allow the CST to accommodate any condensate that will be produced from the final transfer through two extension days including 52.5 hrs from the nominal end of mission TIG to the last EOM +2 deorbit opportunity, 1 hr for entry, and 7 hours for R+7 retrieval. If Spacehab is re-entered on waveoff days, the CST may have to be transferred to a CWC since more condensate will be collected when the crew is in the module.
®[ED]

107_18A-6 SPACEHAB SUBSYSTEM WATER LOOP MANAGEMENT

THE SUBSYSTEM WATER LOOP OR WATER LINE HEATERS MUST BE ACTIVE PRIOR TO PAYLOAD BAY DOOR OPENING AND MUST REMAIN ACTIVE THRU EI-10 MINUTES, UNLESS ATTITUDE MANAGEMENT IS INVOKED. ®[CR 5551]

This rule is intended to supersede paragraph C of Rule {A18-552}, SPACEHAB SUBSYSTEM WATER LOOP MANAGEMENT. Boeing thermal analysis (MDC 93W5633) indicates at least 2 hours exists before damage to the PLHX is possible due to freezing for stagnant water lines without heaters with the PLB doors closed. Between EI-10 and postlanding wheelstop (approximately 1 hour), the crew is in their seats and are considered to be unavailable to initiate Orbiter Water Line Heaters via L12 panel switch action. The SPACEHAB half of the water line heaters can be initiated by crew action on panel C3. Attitude Management in place of either loop flow or line heaters is addressed in Rule {A18-555}, WATER LINE HEATER MANAGEMENT. ®[CR 5551] ®[ED]

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SECTION 17 - LIFE SUPPORT

GENERAL

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SECTION 17 - LIFE SUPPORT

GENERAL

107_17A-1 SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS

A. DURING OPERATIONS OF SPACEHAB ACTIVELY COOLED EXPERIMENTS, THE ORBITER CABIN ATMOSPHERE MUST BE MAINTAINED WITHIN THESE SPECIFIED LIMITS:

THERE ARE NO SPACEHAB EXPERIMENTS THAT REQUIRE THAT THE ORBITER CABIN ATMOSPHERE BE MAINTAINED OUTSIDE THE NOMINAL RANGE FOR STS-107.

B. THE FOLLOWING PAYLOADS REQUIRE SPECIFIC ENVIRONMENTAL CONTROLS IN EXCESS OF NORMAL SUBSYSTEM REQUIREMENTS. TEMPORARY INCREASES ABOVE THE LIMIT DURING PREPLANNED FES INHIBITS WHENEVER NEITHER CM-2 NOR VCD ARE ACTIVE ARE ACCEPTABLE. SPACEHAB POCC CONCURRENCE IS REQUIRED FOR FES INHIBITS NOT IN THE ORIGINAL FLIGHT PLAN. ®[DN 50]

CONDITION	REQUIREMENT
NEITHER VCD NOR CM-2 ACTIVE	EVAP OUT T ? 50 DEGREES WITH BOTH FPVS IN THE PL HX POSITION
BOTH VCD AND CM-2 ACTIVE	EVAP OUT T ? 41 DEGREES WITH BOTH FPVS IN THE PL HX POSITION
VCD ACTIVE, CM-2 NOT ACTIVE	EVAP OUT T ? 45 DEGREES WITH BOTH FPVS IN THE PL HX POSITION
VCD NOT ACTIVE, CM-2 ACTIVE	EVAP OUT T ? 50 DEGREES WITH BOTH FPVS IN THE PL HX POSITION

Thermal Analysis shows that to maintain SPACEHAB within the limits required to satisfy payload thermal requirements, both FPV's are required to be in "PLHX" when Spacehab and Spacehab payloads are in their on-orbit configuration (reference Rule {107_18A-2}, ORBITER FREON FLOW PROPORTIONING VALVE (FPV) USAGE). Analysis results show, to meet the predicted Spacehab thermal loads with only one FPV in the PL position, the EVAP OUT temperature would have to be 35 deg F or less, which is outside the system capabilities. The normal orbiter evaporator outlet temperature with the Flash Evaporator System (FES) activated is 38 to 40 deg F. However, with the FES deactivated, the temperature could range between 38 and 65 deg F. ®[DN 50]

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107_17A-1 SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS (CONTINUED)

CM-2 and VCD are the only payloads that will be directly affected by temporary fluctuations in the EVAP Out FREON temperature range. All requirements listed in the table above were developed assuming an average SH experiment surface air load of approx 1500 Watts and are imposed to ensure the successful operation of CM-2 and VCD. FES inhibits which would cause increases in the EVAP Out temp in excess of these requirements should be excluded during the operation of CM-2 and VCD.

Outside the operation of CM-2 and VCD, the EVAP Out temperature should be maintained below 50 deg F to maintain control of the SH cabin environment (i.e., below 80 deg F). Temporary increases in the EVAP Out temperature in excess of 50 deg F are acceptable however sustained increases of the EVAP Out temperature in excess of 50 deg F can adversely impact the ability of the SH ECS to maintain the SH module environment below 80 deg F. As noted previously, this limit on the EVAP Out temperature assumes approximately approx 1500 W of experiment surface air load. Actual surface air heat loads can approach approx 2300 W for STS-107 and may require that the EVAP Out temperature be maintained below 41 deg F (i.e., nominal range as described in ICD-A-21426-RDM).

C. THE FOLLOWING EXPERIMENTS NOMINALLY RELEASE GASES INTO THE CABIN:

ARMS, FRESH-2 AND VCD ®[DN 50]

In support of Rule {A17-651}, SPACEHAB ENVIRONMENTAL CONTROL AND LIFE SUPPORT (ECLS) REQUIREMENTS. Detailed information on the amount and type of gases is contained in the Hazardous Material Summary Table, STS-107 PGSC software application. ®[DN 50] ®[ED]

107_17A-2 MODULE ATMOSPHERIC CONTROL

THE ORBITER ENVIRONMENT WILL BE MANAGED TO ALLOW THE MODULE TO OPERATE WITHIN THE FOLLOWING GUIDELINES:

NONE IDENTIFIED

In support of Rule {A17-652}, SPACEHAB SUBSYSTEM FAN/AIR LOOP. This rule identifies any deviations from the generic rule atmospheric requirements. ®[ED]

107_17A-3 USE OF SPACEHAB VOLUME AIR TO SUPPORT A SHUTTLE CABIN LEAK

IN THE EVENT OF AN UNISOLATABLE SHUTTLE CABIN LEAK, ANY AVAILABLE SPACEHAB AIR MAY BE USED TO EXTEND THE TIME ON-ORBIT TO AVOID A BAILOUT SITUATION OR TO ALLOW LANDING AT A MORE DESIRABLE LANDING SITE (REF RULE {A2-205C}, EMERGENCY DEORBIT). ®[ED]

Landing at a CONUS site (KSC, EDW, NOR) is more desirable than at an emergency landing site or bailout. Other factors such as lighting, landing aids, shuttle energy state, weather, etc. will also affect the landing decision.

DOCUMENTATION: Engineering judgment

107_17A-4 EXPERIMENT VENT VALVE

THE EXPERIMENT VENT VALVE WILL ALWAYS BE CLOSED WHEN ALL THE CREW IS ASLEEP UNLESS REQUIRED FOR THE FOLLOWING EXPERIMENT OPERATIONS:

NONE IDENTIFIED

In support of Rule {A17-754},EXPERIMENT VENT VALVE. Since this mission is dual shift ops, there will be no periods when the crew will be asleep while the Experiment Vent Valve is in use. ®[DN 35] ®[ED]

107_17A-5 RDM LIOH CANISTER

THE FOLLOWING EXPERIMENTS WILL REQUIRE A LIOH CANISTER TO BE INSTALLED IN THE CO_2 REMOVAL ASSEMBLY PRIOR TO ANY NOMINAL HATCH CLOSURE IN ORDER TO PRESERVE SCIENCE:

FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH (FRESH)

In support of Rule {A17-758}, RDM LIOH CANISTERS. Rule is to define experiments that require LiOH changeouts before nominal hatch closure. ®[ED]

107_17A-6 CABIN TEMPERATURE MANAGEMENT

A. ON-ORBIT POWERDOWNS:

1. CHECK SPACEHAB CABIN TEMPERATURE SETTING PRIOR TO IMPLEMENTING EITHER ORBITER OR SPACEHAB POWERDOWN STEPS.
®[DN 47]

2. IF ADDITIONAL EQUIPMENT POWERDOWN IS REQUIRED TO MAINTAIN ORBITER CREW CABIN TEMPERATURE, THE FOLLOWING TABLE WILL BE USED (DEPENDENT ON MISSION ACTIVITIES). EQUIPMENT POWERED ON BUT NOT IN USE WILL BE POWERED DOWN IN ORDER OF PRIORITY BEFORE POWERING DOWN EQUIPMENT BEING USED FOR EXPERIMENT OR ORBITER OPERATIONS. THIS LIST IS TO BE CONSIDERED AS SUPPLEMENTAL TO THAT CONTAINED IN RULE {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT.
®[ED]

EQUIPMENT	ELECTRICAL LOAD (WATTS)	COMMENT
ERGOMETER	20	CAN BE USED IN NON-POWERED MODE
STS1 PGSC	60-65	OCA ROUTER - 760XD ON SINGLE SLOT AC EXPANSION UNIT. REQUIRED FOR OCA OPERATIONS.
STS2 PGSC	60-65	WINDECOM – 760XD ON SINGLE SLOT AC EXPANSION UNIT. NO STS-107 PAYLOADS REQUIRE PCMMU DATA VIA WINDECOM.
STS3 PGSC	60-65	PROSHARE – 760XD ON SINGLE SLOT AC EXPANSION UNIT. REQUIRED FOR KFX OCA OPERATIONS.
STS4 PGSC	40	WORLDMAP – 760XD W/O EXPANSION UNIT, DC POWER. CREW SITUATIONAL AWARENESS.
PL1 PGSC	40	MEIDEX – 760XD W/O EXPANSION UNIT, DC POWER. REQUIRED DURING MEIDEX OPERATIONS.
PL2 PGSC	40	SOLSE-2 – 760XD W/O EXPANSION UNIT, DC POWER. REQUIRED DURING SOLSE-2 OPERATIONS.
TV MONITOR COLOR	56 (NOM) 86 (MAX)	USED FOR MEIDEX OPS
MUX (DTV)	73	NEEDED FOR DOWNLINK DTV. DTV POWER IS CONFIGURATION DEPENDANT. 73 WATTS REPRESENTS THE WORST-CASE CONFIGURATION.
DSR-20	50	CAN BE USED FOR RECORDING MEIDEX
CAMCORDER	10	PAO OPS, MEIDEX, LIMITED PAYLOAD OPS
V10	18	PAO OPS, MEIDEX, LIMITED PAYLOAD OPS
SPACEHAB-POWERED MIDDECK PAYLOADS	492	IMPACTS SCIENCE. SPACEHAB MIDDECK PAYLOADS INCLUDE BIOPACK AND BIOPACK GLOVEBOX, CMPCG, CEBAS, OSTEO, AND BRIC.

®[DN 36] ®[DN 47] ®[DN 82] ®[CR 5549]

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107_17A-6 CABIN TEMPERATURE MANAGEMENT (CONTINUED)

Spacehab cabin temperature adjustments can influence both Hab and orbiter cabin temperature conditions. A crew adjustment of the Hab cabin temp setting may be the cause of higher temps in either volume, and an adjustment may be all that is required to deal with higher temperature conditions. With the exception of the color monitor (due to its use for MEIDEX ops), all items listed above are not mentioned in Rule {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT. The items in this flight-specific rule should then be considered for powerdown in addition to those listed in the Rule. The priority given to each item to be considered for potential powerdown is dependent on ongoing operations at the time. ®[DN 47] ®[ED]

3. IF EQUIPMENT POWERDOWN IS REQUIRED TO MAINTAIN THE SPACEHAB MODULE TEMPERATURE, THE FOLLOWING TABLE WILL BE USED (DEPENDENT ON MISSION ACTIVITIES). EQUIPMENT POWERED ON BUT NOT IN USE WILL BE POWERED DOWN IN ORDER OF PRIORITY BEFORE POWERING DOWN EQUIPMENT BEING USED FOR EXPERIMENT OR SPACEHAB OPERATIONS.

EQUIPMENT	ELECTRICAL LOAD (WATTS)	COMMENT
AUX LIGHT	105	AC POWERED AUX LIGHT AVAILABLE FOR USE IN SH MODULE. HIGHLY DESIRABLE DURING HLS BLOOD DRAWS.
PL3 PGSC (SH)	70-80	SH SUBSYSTEM – 760XD ON SINGLE SLOT AC EXPANSION UNIT. NO REQUIRED OPERATIONS.
SH AFT MODULE LIGHT	20	LIGHTS IN AFT MODULE OF SH CAN BE SWITCHED OFF INDIVIDUALLY.
PAO CAMCORDER	20	LOSS OF PAO VIDEO IN SH MODULE
SH MOD MODULE PAYLOADS	EXPERIMENT DEPENDENT	IMPACTS SCIENCE.

®[DN 36]

B. ENTRY:

CABIN TEMPERATURE WILL BE MANAGED AS FOLLOWS TO ENSURE ADEQUATE ENTRY TEMPERATURES IN ACCORDANCE TO RULE {A13-31}, CREW CABIN TEMPERATURE LIMITS: ®[ED]

1. PRIOR TO THE LAST PRE-SLEEP PERIOD OF EOM-1, THE CABIN TEMP CONTROLLER WILL BE AUTOMATICALLY DRIVEN TO A POSITION TO ACHIEVE A CABIN TEMP OF 70 DEG F AT CREW WAKE ON ENTRY DAY.

THIS RULE CONTINUED ON NEXT PAGE

107_17A-6 CABIN TEMPERATURE MANAGEMENT (CONTINUED)

2. PRIOR TO THE LAST PRE-SLEEP PERIOD OF EOM-1, IF SLEEP TEMPERATURES WILL BE UNACCEPTABLY COLD, PER CDR AND SURGEON AGREEMENT, THE CABIN TEMP CONTROLLER POSITION CAN BE CONFIGURED TO PROVIDE A COMFORTABLE SLEEP ENVIRONMENT WHILE STILL STRIVING TO ACHIEVE THE OPTIMAL COLDSOAK.

3. THE CABIN TEMPERATURE CONTROLLER BYPASS VLV WILL BE AUTOMATICALLY DRIVEN TO THE “FULL COOL” POSITION, POST SLEEP OF ENTRY DAY.

4. ACTION WILL NOT BE TAKEN TO REDUCE CABIN TEMPERATURE IF THE D/O PREP TIMELINE HAS BEEN ENTERED.

5. FOR WAVEOFF DAYS, PREFLIGHT ANALYSIS WILL DICTATE THE LEVEL OF ACCEPTABLE POWER (EITHER GROUP B OR C POWERDOWN) TO OBVIATE CABIN TEMPERATURE CONCERNS.

Due to STS-107 being a dual-shift flight, a flight-specific modification of Rule {A17-152}, CABIN TEMPERATURE CONTROL AND MANAGEMENT, was necessary, since that rule only deals with single-shift flights. Pre-flight thermal analysis indicates that positioning the cabin temp controller in the manner described above will achieve the desired post-landing crew cabin temperatures. ®[ED]

107_17A-7 WCS CONSTRAINTS

NO DUMPING OF URINE SAMPLES INTO THE WASTE COLLECTION SYSTEM (WCS) IS PERMITTED WITHOUT COMPLETION OF ANALYSIS DETERMINING THAT THIS IS ACCEPTABLE. ®[CR 5494A]

PhAB4 Urine Collection Bags (UCB’s) contain a Lithium Chloride (LiCl) volume marker. The effect of interaction of LiCl in any amount with the main constituent (Oxone?) of the Shuttle Urine Pretreat Assembly (SUPA) is unknown at this time, pending completion of chemical analysis. Results thus far show no real chance for poisonous species formation (upon combination of LiCl and Oxone?), as well as no increased corrosion risk from LiCl in combination with Oxone? . The risk is thought to be primarily from increased solids formation, which could severely hamper WCS operations or even negate them completely. Until that risk is shown to be reasonably low or even non-existent, no urine samples containing LiCl should be dumped into the WCS. This most likely cannot be done prior to the flight of STS-107. However, if the analysis is completed and results received post STS-107 launch, and should those results show little to no increased risk of solids formation, consideration will then be given to dumping urine samples into the WCS, if required.

DOCUMENTATION: Engineering judgment, K. Chhipwadia STS-107 January 2002 IPT presentation
®[CR 5494A]

107_17A-8 RDM FAN START-UP OPERATIONS

ALLOW AT LEAST 6 SECONDS AFTER ANY FAN IS POWERED UP PRIOR TO POWERING ON ANY ADDITIONAL RDM FAN. ®[CR 5550]

PDU and APDU circuit design provides over current protection for ARS and HFA(2) fan start-up, respectively. The circuit design inhibits full current draw for approximately 5.5 seconds after the ON command is initiated. Prior to the end of this current limiting period, the fan being powered up may not achieve full operational status. Additional fan start-ups during this time may hinder the optimal flow of the air in the system. Additional SPACEHAB RDM fan startup constraints are listed in Rules {A17-704}, CABIN/HFA FAN and {A17-705}, ATMOSPHERE REVITALIZATION SYSTEM (ARS) FAN. ®[ED]

DOCUMENTATION: Memo 2H-SPACEHAB-02063. ®[CR 5550]

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SECTION 16 - POSTLANDING

THERE ARE NO STS-107 RULES FOR THIS SECTION

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SECTION 19 - SPACEHAB

GENERAL

ADVANCED RESPIRATORY MONITORING SYSTEM

CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS)

MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH (CMPCG)

COMBINED 2 PHASE LOOP EXPERIMENT (COM2PLEX)

SPACE TECHNOLOGY AND RESEARCH STUDENTS BOOTES (STARS BOOTES)

STAR NAVIGATION (STARNAV)

OSTEOPOROSIS EXPERIMENT IN ORBIT (OSTEO)

EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS (ERISTO)

PHYSIOLOGY AND BIOCHEMISTRY 4 (PHAB4)

BIOPACK

FACILITY FOR ADSORPTION AND SURFACE TENSION (FAST)

ADVANCE PROTEIN CRYSTALLIZATION FACILITY (APCF)

BIOBOX

VAPOR COMPRESSION DISTILLATION FLIGHT EXPERIMENT (VCD FE)

COMBUSTION MODULE (CM-2)

MECHANICS OF GRANULAR MATERIALS (MGM)

BIOREACTOR DEMONSTRATION SYSTEM-05 (BDS-05)

MICROBIAL PHYSIOLOGICAL FLIGHT EXPERIMENT (MPFE)

SLEEP-3

ASTROCULTURE

COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF)

COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX)

ZEOLITE CRYSTAL GROWTH-1 (ZCG-1)

FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH-2 (FRESH-2)

GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA)

REFRIGERATOR/FREEZER

SECTION 19 - SPACEHAB

GENERAL

107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES

THE FOLLOWING PAYLOAD MISSION OBJECTIVES ARE DEFINED AS MINIMUM MISSION REQUIREMENTS FOR A NOMINAL DURATION MISSION. ®[CR 5544B]

REFERENCE RULES {107_11A-4}, CCTV REQUIREMENTS, {107_19A-3}, EXPERIMENT POWER INTERRUPT CONSTRAINTS, {107_2A-63}, MICROGRAVITY CONSTRAINTS, AND {107_2A-71}, ATTITUDE/POINTING CONSTRAINTS, FOR REQUIREMENTS IN SUPPORT OF MISSION OBJECTIVES.

A. ADVANCED PROTEIN CRYSTALLIZATION FACILITY (APCF) REQUIRES CONTINUOUS POWER THROUGH DEACTIVATION.

APCF is autonomous, and operates independently of crew intervention. APCF activation and deactivation are required in support of mission objectives.

B. ADVANCED RESPIRATORY MONITORING SYSTEM (ARMS) REQUIRES COMPLETION OF THE FOLLOWING 27 ACTIVITY SETS:

2 REBREATHE 1A RUNS AND 1 REBREATHE 1B RUN

1 MUSCULAR 1A RUN, 5 MUSCULAR 1B RUNS, AND 2 MUSCULAR 1C RUNS

4 PULMONARY 1 RUNS, 4 PULMONARY 2 RUNS, AND 4 PULMONARY 3 RUNS

4 MUSCULAR 2 RUNS

For maximum mission success, ARMS desires that these runs be executed on time and in the documented sequence as shown in the Flight Plan. Overall ARMS activities must be preceded by successful setup of the ARMS hardware and ergometer unit.

C. ASTROCULTURE 10/1 (AST) REQUIRES CONTINUOUS POWER, 4 SAMPLINGS (2 WITH VIDEO AND 2 WITHOUT), AND OCA FILE DOWNLINKS. AST 10/2 REQUIRES FLUID TRANSFER ACTIVITIES AND TWO INSTANCES OF 35 MM STILL PHOTOS. ®[CR 5627B]

AST activities must be preceded by activation. AST 10/2 is unpowered. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

D. BIOBOX REQUIRES CONTINUOUS POWER. ®[CR 5544B] ®[CR 5627B]

BIOBOX operations are ground commanded with no crew interaction or insight. Experiment monitoring and commanding are done from the ground.

E. BIOPACK REQUIRES CONTINUOUS POWER BEGINNING WITH ACTIVATION AND PERFORMANCE OF THE LEUKIN, BONES, REPAIR, CONNECT, STROMA, BACTER, YSTRES, AND BIOKIN EXPERIMENTS.

F. GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA) REQUIRES CONTINUOUS POWER FROM ACTIVATION LATE IN THE MISSION TO DEACTIVATION FOR APPROXIMATELY 48 HOURS OF OPERATION PRIOR TO MODULE CLOSEOUT.

The payload software autonomously controls all operations following power-up. Activation and deactivation are required in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

G. BIOLOGICAL RESEARCH IN CANISTERS (BRIC) REQUIRES CONTINUOUS POWER UNTIL POWERDOWN AND COMPLETION OF LED OPERATIONS FOR FOUR CANISTERS, INHIBITION FOR THREE CANISTERS, AND FIXATION FOR ALL CANISTERS.

H. BIOREACTOR DEMONSTRATION SYSTEM (BDS-05) REQUIRES 18 INSTANCES OF MEDIA SAMPLE AND PCBA ANALYSIS, 7 INSTANCES OF CELL SAMPLE AND FIXATION, 11 INSTANCES OF MEDIA TRAY EXAMINE, AND 6 INSTANCES OF TISSUE SAMPLE 35 MM STILL PHOTOS.

BDS-05 activities must be preceded by successful activation, setup, and media tray configuration. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

I. CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS) REQUIRES INITIAL TAPE INSTALLATION AS EARLY AS POSSIBLE, DAILY TAPE CHANGEOUT, AND CONTINUOUS POWER.

J. COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX) REQUIRES ACTIVATION PRIOR TO CREW SLEEP ON FLIGHT DAY (FD) 1, FOUR MID-MISSION ADJUSTMENTS, AND CONTINUOUS POWER. ®[CR 5627B]

Activation and deactivation are required in support of mission objectives. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

K. COMBUSTION MODULE – 2 (CM-2) REQUIRES COMPLETION OF THE FOLLOWING ACTIVITIES: ®[CR 5544B]

Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements and Rule {107_2A-63}, MICROGRAVITY CONSTRAINTS. ®[CR 5627B]

1. LSP – 15 TESTS

LSP tests require successful setup, checkout, LSP integration, VCR checkout, and pre-test verifications. In support of LSP operations, two CM-2 chamber accesses to changeout equipment, VCR tape changeouts, startups, shutdown evacuations, chamber fills, and powerdowns are required. At the end of each test, file downlink is required. LSP deintegration is required to remove the LSP EMS.

2. SOFBALL – 15 TESTS

SOFBALL tests require successful EMS integration, checkout, pre-test two-bottle fill, and on-orbit leak integrity check. In support of SOFBALL operations, SOFBALL power ups, tape changeouts pre-test, GC flushes and calibrations, TARGA/DDR changeouts, powerdowns and GC bakeout are required. At the end of each test and after last GC calibration, file downlink is required. SOFBALL shutdown is required to remove the SOFBALL EMS.

3. MIST – 33 TESTS INCLUDING 3 DRY TESTS

MIST tests require successful EMS integration, startup, and color camera setting adjustment. In support of MIST operations, chamber accesses to changeout equipment, powerups, chamber bleeds, powerdowns, and MIST shutdowns are required. At the end of each test, file downlink is required. MIST deintegration is required to remove the MIST EMS. ®[CR 5627B]

L. COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH (CMPCG) REQUIRES CONTINUOUS POWER.

Activation and deactivation are required in support of mission objectives.

M. COMBINED TWO-PHASE LOOP EXPERIMENT (COM2PLEX) REQUIRES COMPLETION OF A LOOP HEALTH CHECK PRIOR TO INITIAL OPERATIONS, 3 NON-CONTIGUOUS, 48 HOUR SESSIONS OF ATTITUDE DEPENDENT GROUND COMMANDED OPERATIONS, AND ATTITUDE INDEPENDENT GROUND OPERATIONS.

Activation and deactivation are required in support of mission objectives. Reference Rule {107_2A-71}, ATTITUDE/POINTING REQUIREMENTS, for attitude requirements and constraints. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

N. COMMERCIAL PROTEIN CRYSTAL GROWTH PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF) REQUIRES CONTINUOUS POWER. ®[CR 5544B]

Activation and deactivation (once temperature ramp from 4-22 deg C is complete) are required in support of mission objectives.

O. EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS (ERISTO) REQUIRES 10 CELL FEEDINGS AND CONTINUOUS POWER THROUGH DEACTIVATION. ®[CR 5627B]

Deactivation is required in support of mission objectives. The specific intervals at which ERISTO cell feedings occur are defined in NSTS-21426 Spacehab-GRLM CIP Annex 2, part II.

P. FACILITY FOR ADSORPTION AND SURFACE TENSION (FAST) REQUIRES ACTIVATION NO EARLIER THAN SH MODULE ACTIVATION PLUS 4 HOURS AND CONTINUOUS POWER FROM ACTIVATION THROUGH DEACTIVATION. FAST REQUIRES 9 GROUND COMMANDED EXPERIMENT RUNS. EACH EXPERIMENT RUN CONSISTS OF 3 EXPERIMENT SEQUENCES, 3 THERMOREGULATIONS, AND ONE INJECTION.

Activation and deactivation are required in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

Q. FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH (FRESH) REQUIRES CONTINUOUS POWER AND WATER REFILLS AS REQUIRED.

Reference Rule {107_19A-262}, FRESH STATUS CHECKS, for status check requirements.

R. HLS - ENHANCED ORBITER REFRIGERATOR/FREEZER (EOR/F) REQUIRES CONTINUOUS POWER FROM ACTIVATION ON-ORBIT THROUGH POSTLANDING RETRIEVAL.

EOR/F is a support item for HLS and has no science objectives.

S. HLS - THERMOELECTRIC HOLDING MODULE (TEHM) REQUIRES CONTINUOUS POWER. ®[CR 5627B]

TEHM is a support item for HLS and has no science objectives. The TEHM will also be used for cold storage of the Vapor Compression Distillation Flight Experiment (VCD FE) sample box. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

T. HLS - MICROBIAL PHYSIOLOGY FLIGHT EXPERIMENTS (MPFE) REQUIRES TRAY #1 ANALYSIS AS EARLY AS POSSIBLE, 7 INSTANCES OF TEST CARD ANALYSIS, GROWTH CONTROL SETUP, AND GROWTH CONTROL TERMINATION. ®[CR 5544B] ®[CR 5627B]

Activation and deactivation are required in support of mission objectives. The quality of science return from analysis of card tray 1 quickly diminishes beyond 48 hours after preflight inoculation.

U. HLS - SLEEP REQUIRES THE CREW TO UNSTOW/DON ACTILIGHT WATCHES AS SOON AS POSSIBLE AFTER ORBIT IS ACHIEVED AND COMPLETE A SLEEP LOG AS SOON AS POSSIBLE AFTER WAKEUP EACH DAY. ACTILIGHT WATCHES ARE DOFFED AND STOWED PRIOR TO D/O PREP.

V. HLS - PHYSIOLOGY AND BIOCHEMISTRY EXPERIMENT SET (PHAB4) REQUIRES DESIGNATED CREWMEMBERS TO PERFORM THE FOLLOWING:

1. ON A DAILY BASIS, INGEST POTASSIUM CITRATE TABLETS WITH EVENING MEAL, COLLECT AND FREEZE SALIVA SAMPLES, COLLECT AND STORE SALIVA SAMPLES AT AMBIENT TEMPERATURE.

2. COLLECT AND FREEZE ADDITIONAL SALIVA SAMPLES ON FLIGHT DAYS 3 AND 12.

3. PCBA ANALYSIS OF BLOOD DRAWN ON FLIGHT DAYS 3-6 AND 12-15.

In support of PCBA analysis, a functional test and control analysis will be performed on the PCBA every day on which blood draws will be performed.

4. COLLECT URINE SAMPLES ON FLIGHT DAYS 3-6 AND 12-15.

5. ON FLIGHT DAYS 3 AND 12, PHAB-4 CREWMEMBERS BEGIN A TIMED SEQUENCE OF ACTIVITIES INCLUDING FASTING BLOOD DRAWS, ORAL TRACER INGESTION, AND CALCIUM TRACER INFUSION (FD3 ONLY). ADDITIONAL BLOOD DRAWS ARE REQUIRED 24, 48, AND 72 HOURS AFTER ORAL TRACER INGESTION. ®[CR 5544B] ®[CR 5627B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

6. INFUSE DESIGNATED CREWMEMBERS WITH HISTIDINE TRACER ON FLIGHT DAY 3 AND 12 AT 10-12 HOURS AFTER ORAL CALCIUM AND ALANINE TRACER INGESTION AND COLLECT BLOOD SAMPLES 10 MINUTES AFTER HISTIDINE TRACER INFUSION. ®[CR 5544B] ®[CR 5627B]

In support of PHAB-4 blood collection, blood samples should stand for 15 minutes prior to centrifuging, then be centrifuged for 15 minutes, and placed in the EORF within 1 hour 15 minutes of collection.

7. ALL CREWMEMBERS RECORD ALL FOOD, FLUIDS, MEDICATIONS AND EXERCISE ON DESIGNATED FLIGHT DAYS.

The Bar Code Readers are used to facilitate recording crew intake and will be downloaded to the shared or subsystem PGSC on Flight Days 4, 6, 13, 14, and 15. The Bar Code Reader batteries will be replaced on Flight Days 4, 11, and 14.

W. MECHANICS OF GRANULAR MATERIALS (MGM) REQUIRES COMPLETION OF THREE RUNS ON EACH OF THREE TEST CELLS, PERFORMED IN SEQUENCE.

Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements.

X. MINIATURE SATELLITE THREAT REPORTING SYSTEMS (MSTRS) REQUIRES SYSTEM POWER ON PRIOR TO BEGINNING OPERATIONS, (OPERATIONS MUST NOT BEGIN EARLIER THAN 00/16:00) GROUND COMMANDED OPS FOR 4 SETS OF 4 CONTINUOUS ORBITS EACH, AND A 1 HOUR WARM-UP PRIOR TO EACH SET OF OBSERVATIONS. EACH OPERATIONS SET MUST BE SEPARATED BY 24 HOURS. ®[CR 5627B]

Reference Rule {107_2A-71}, ATTITUDE/POINTING REQUIREMENTS, for attitude requirements and constraints.

Y. OSTEOPOROSIS EXPERIMENT (OSTEO) REQUIRES 11 CELL FEEDINGS APPROXIMATELY 24 HOURS APART AND CONTINUOUS POWER THROUGH DEACTIVATION.

Deactivation is required in support of mission objectives. ®[CR 5544B]

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107_19A-1 SPACEHAB MINIMUM MISSION OBJECTIVES (CONTINUED)

Z. SPACE ACCELERATION MEASUREMENT SYSTEM – FREE FLYER (SAMS-FF) REQUIRES POWER DURING OPERATIONS. ®[CR 5544B]

Activation and Deactivation is required in support of mission objectives. SAMS is primarily flown to provide time correlated microgravity environment data to CM2 and MGM.

AA. STAR NAVIGATION (STARNAV) REQUIRES 20, 30-MINUTE GROUND COMMANDED DATATAKES. IMMEDIATELY FOLLOWING EACH OBSERVATION, 5 MINUTES FOR IMAGE DOWNLOAD AND DEACTIVATION IS REQUIRED BEFORE NEXT DATATAKE BEGINS. STARNAV REQUIRES THEIR OPERATIONS BE CONDUCTED OVER A MINIMUM FOUR DAY INTERVAL BETWEEN THE FIRST AND LAST OPERATIONS.

Activation and deactivation is required in support of mission objectives. Reference Rule {107_2A-71}, ATTITUDE/POINTING REQUIREMENTS, for attitude requirements and constraints.

AB. STARS-BOOTES REQUIRES VIDEO PER RULE {107_11A-4}, CCTV REQUIREMENTS.

Experiment activation is required twice in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS for video requirements.

AC. VAPOR COMPRESSION DISTILLATION (VCD) REQUIRES 6 DAYS OF EXPERIMENT OPERATIONS (WATER SAMPLES FOR ALL RUNS EXCEPT THE FIRST DAY AND AIA VALVE POSITIONING FOR 3 OUT OF 6 RUNS). ®[CR 5627B]

Setup, activation, deactivation, and shutdown are required in support of mission objectives.

AD. ZEOLITE CRYSTAL GROWTH (ZCG) REQUIRES MIXING OF 12 CLEAR AUTOCLAVE UNITS AND MIXING OF 19 METAL AUTOCLAVE ASSEMBLIES WITH SUBSEQUENT FURNACE PROCESSING OF THESE UNITS. ®[CR 5627B]

Activation, deactivation of the furnace, and stowage of the processed autoclave units are required in support of mission objectives. Reference Rule {107_11A-4}, CCTV REQUIREMENTS, for video requirements. ®[CR 5544B]

107_19A-2 SPACEHAB ACTIVATION CONSTRAINTS

IT IS HIGHLY DESIRABLE TO PERFORM SPACEHAB EXPERIMENT DATA SYSTEM ACTIVATION WHILE AOS.

SPACEHAB POCC highly desires monitoring of the activation steps in order to detect and recover from any off nominal conditions. If LOS, the crew can continue with the rest of Spacehab activation and then return to Experiment Data System Activation once AOS. ®[DN 38]

107_19A-3 EXPERIMENT POWER INTERRUPT CONSTRAINTS

FOR LOSS OF POWER, THE MAXIMUM TIME THE FOLLOWING EXPERIMENTS CAN SURVIVE WITHOUT POWER IS DEFINED BELOW:

A. SPACEHAB MIDDECK EXPERIMENTS

1. OSTEO – 20 MINUTES
2. CEBAS – 15 MINUTES
3. BRIC - 15 MINUTES
4. CMPCG - 15 MINUTES
5. BIOPACK - 15 MINUTES ®[DN 69]

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107_19A-3 EXPERIMENT POWER INTERRUPT CONSTRAINTS (CONTINUED)

B. SPACEHAB MODULE EXPERIMENTS

1. S*T*A*R*S BOOTES - 15 MINUTES
2. ERISTO - 20 MINUTES
3. FAST - IMPACTS SCIENCE RUN IN PROGRESS ®[DN 69]
4. APCF -15 MINUTES
5. BIOBOX - 15 MINUTES
6. MGM – IMPACTS SCIENCE RUN IN PROGRESS
7. BDS-05 - 30 MINUTES
8. TEHM - 15 MINUTES
9. EOR/F – 30 MINUTES
10. AST - 15 MINUTES
11. CPCG-PCF - 15 MINUTES
12. FRESH-2 - 15 MINUTES
13. BIOTUBE - 15 MINUTES
14. CIBX - 15 MINUTES
15. MSTRS – NONE (IF ATTITUDE CONSTRAINTS OBSERVED) IMPACTS SCIENCE RUN IN PROGRESS
16. STARNAV – NONE (IF ATTITUDE CONSTRAINTS OBSERVED) IMPACTS SCIENCE RUN IN PROGRESS
17. COM2PLEX – 90 MINUTES (IF EXPOSED TO DEEP SPACE) IMPACTS SCIENCE RUN IN PROGRESS
18. ZCG – IMPACTS SCIENCE RUN IN PROGRESS ®[DN 69]
19. SAMS-FF – 15 MINUTES

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107_19A-3 EXPERIMENT POWER INTERRUPT CONSTRAINTS (CONTINUED)

20. CM-2 – IMPACTS SCIENCE RUN IN PROGRESS
21. VCD – IMPACTS SCIENCE RUN IN PROGRESS ®[DN 69]
22. ARMS – IMPACTS SCIENCE RUN IN PROGRESS
23. HLS MPFE (AMS AND LECS) – 15 MINUTES ®[DN 69]

Continuous power is necessary for preservation of science.

107_19A-4 MIDDECK ACTIVITIES

SHOULD THE SPACEHAB MODULE BE CLOSED OUT PRIOR TO THE NOMINAL END OF MISSION, CONSIDERATION WILL BE GIVEN TO PERFORMING THE NOMINALLY PLANNED MIDDECK ACTIVITIES: ®[DN 39]

107_19A-5 SPACEHAB STATUS CHECKS

A. THE FOLLOWING PAYLOADS NOMINALLY REQUIRE DAILY STATUS CHECKS: ®[CR 5544B]

1. BIOBOX
2. BRIC
3. CEBAS
4. CIBX
5. ERISTO
6. MSTRS
7. OSTEO

B. THE FOLLOWING PAYLOADS NOMINALLY REQUIRE TWICE DAILY STATUS CHECKS:

1. APCF
2. CMPCG
3. CPCG-PCF
4. EOR/F
5. FAST
6. STARS-BOOTES
7. TEHM

107_19A-6 THROUGH 107_19A-10 ARE RESERVED ®[CR 5544B]

ADVANCED RESPIRATORY MONITORING SYSTEM

107_19A-11 THROUGH 107_19A-20 ARE RESERVED

CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS)

107_19A-21 THROUGH 107_19A-30 ARE RESERVED

MINIATURE SATELLITE THREAT REPORTING SYSTEM (MSTRS)

107_19A-31 THROUGH 107_19A-40 ARE RESERVED

COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH (CMPCG)

107_19A-41 THROUGH 107_19A-50 ARE RESERVED

COMBINED 2 PHASE LOOP EXPERIMENT (COM2PLEX)

107_19A-51 THROUGH 107_19A-60 ARE RESERVED

SPACE TECHNOLOGY AND RESEARCH STUDENTS BOOTES (STARS BOOTES)

107_19A-61 ELECTRICAL SHOCK (S*T*A*R*S-BOOTES)

S*T*A*R*S-BOOTES WILL BE UNPOWERED PRIOR TO ANY CREW ACCESS TO THE EXPERIMENT TO PREVENT INJURY OF THE CREW DUE TO ELECTRIC SHOCK. ®[CR 5555A]

*S*T*A*R*S-Bootes contains fluorescent lamps and inverter ballasts that produce high AC voltages. The crew will nominally access STARS-Bootes to initialize the ant habitat, sample spider webs, and configure the chemical garden for video. Reference: Hazard Report STARS-02; Cause 3.*

107_19A-62 THROUGH 107_19A-70 ARE RESERVED ®[CR 5555A]

STAR NAVIGATION (STARNAV)

107_19A-71 THROUGH 107_19A-80 ARE RESERVED

OSTEOPOROSIS EXPERIMENT IN ORBIT (OSTEO)

107_19A-81 THROUGH 107_19A-90 ARE RESERVED

EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS (ERISTO)

107_19A-91 THROUGH 107_19A-100 ARE RESERVED

PHYSIOLOGY AND BIOCHEMISTRY 4 (PHAB4)

107_19A-101 THROUGH 107_19A-110 ARE RESERVED

BIOPACK

107_19A-111 BIOPACK FREEZER AND PTCU TOUCH TEMPERATURE

DURING ALL BIOPACK FREEZER, COOLER, AND PTCU OPERATIONS, THE CREW MUST WEAR GLOVES. ®[CR 5555A]

The BIOPACK freezer and cooler temperatures are set to 4 deg C. The PTCU maintains a temperature of 5 deg C. The allowed touch temperature lower limit is 4 deg C. Prudence dictates that the crew wear gloves when accessing these elements to prevent a hazardous situation. Reference: Hazard Report STD-BPK; Cause 9.

107_19A-112 TOXIC MATERIAL CONTAINMENT (BIOPACK)

THE SPACEHAB POCC WILL TRACK ALL CREW REPORTED SPILLS WITHIN GLOVEBOX AND INSTRUCT THE CREW WHEN GLOVEBOX FILTER CHANGEOUT BECOMES NECESSARY TO ENSURE THAT GLOVEBOX MAINTAINS ITS ABILITY TO PROVIDE ADEQUATE CONTAINMENT.

If the Glovebox filter becomes saturated, it can no longer ensure adequate containment. Glovebox operating procedures instruct the crew to report all spill quantities to the ground. Reference: Hazard Report PGBX-U1, Cause 7.

107_19A-113 THROUGH 107_19A-120 ARE RESERVED ®[CR 5555A]

FACILITY FOR ADSORPTION AND SURFACE TENSION (FAST)

107_19A-121 THROUGH 107_19A-130 ARE RESERVED

ADVANCE PROTEIN CRYSTALLIZATION FACILITY (APCF)

107_19A-131 THROUGH 107_19A-140 ARE RESERVED

BIOBOX

107_19A-141 **RESERVED** ®[CR 5555A]

107_19A-142 THROUGH 107_19A-150 ARE RESERVED

VAPOR COMPRESSION DISTILLATION FLIGHT EXPERIMENT (VCD FE)

107_19A-151 VCD HAZARDOUS FLUID CONTAINMENT ®[CR 5555A]

THE FOLLOWING ARE REQUIRED TO PREVENT LEAKAGE OF HAZARDOUS FLUID FROM VCD FE:

A. VCD FE 100 ML FLUID SAMPLES BAGS WILL NOT BE FILLED BEYOND 40 ML.

B. THE VCD FE AIR INJECTION ASSEMBLY (AIA) MUST BE CLOSED WITHIN 4.5 HOURS OF OPENING. ®[DN 71]

C. THE AIA CANISTER VALVE AND AIA SHUTOFF VALVE MUST BE CLOSED PRIOR DISCONNECTING THE AIA.

Samples are taken from a sample valve on VCD FE and transferred to 100 mL sample bags. The sample bags are marked with 40 mL and 60 mL lines to help the crew gauge volume. Sample size is limited to 40 mL to ensure that the sample volume does not exceed the capacity of the storage bag. To prevent inadvertent release of fluid while disengaging the AIA bottle, it must be disconnected before the bottle is empty to preclude the potential for the bottle to pull fluid from VCD should the check valve fail. When changing out the AIA, both the canister valve on the AIA and the AIA Shutoff valve on VCD must be closed to preclude leakage of fluid when demating QD's in the event of a check valve failure. Requirement source is Hazard Report VCD FE-F03; Causes 7 and 8. ®[DN 71] ®[CR 5555A] ®[CR 5558]

107_19A-152 THROUGH 107_19A-160 ARE RESERVED

COMBUSTION MODULE (CM-2)

107_19A-161 FRANGIBLE MATERIAL CONTAINMENT

PRIOR TO THE FIRST CM-2 CHAMBER ACCESS, IF A VACUUM CANNOT BE DRAWN/HELD, THE CHAMBER WILL NOT BE OPENED.

Prior to the first CM-2 chamber access, the chamber will be evacuated and backfilled with air. The inability to draw/hold a vacuum indicates a possible loss of window integrity (i.e., window fragment in chamber). Exposure of the crew to glass fragments is considered a catastrophic hazard (reference MSL-1 HR CM-1;2). Inflight inspection for glass fragments prior to first chamber access is not nominally performed.

107_19A-162 ELECTRICAL SHOCK/SHORTING

THE FOLLOWING EXPERIMENTS HAVE PLANNED ACTIVITIES WHICH COULD RESULT IN ELECTRICAL SHOCK TO CREW OR HARDWARE DAMAGE IF POWER IS NOT REMOVED. THESE COMPONENT/CABLE MATE/DEMATES WILL NOT BE PERFORMED UNLESS POWER HAS BEEN REMOVED.

CM-2

The cables to the CM-2 Experiment Mounting Structure (EMS) are nominally mated/demated when any EMS is installed/removed from the combustion chamber (reference MSL-1 HR CM-1; 13). ®[DN 90]

107_19A-163 CHAMBER/RACK ACCESS RESTRICTIONS (CM-2)

A. IF AT LEAST TWO INHIBITS TO POWERING THE CM-2 LASER DIODE CANNOT BE PUT IN PLACE, THE CHAMBER WILL NOT BE OPENED AND THE RACK WILL NOT BE ACCESSED.

Laser diodes are used to provide an illumination source for the diagnostic system during LSP experiment operations. Prior to accessing the chamber or rack two of the following three inhibits must be in place: 1) the DEPP is commanded to open the solid state relay, 2) the laser diode switch is placed in the "off" position, 3) the PDP cb No. 4 is opened, and the PDP switch 4 is placed in the off position. Exposure of the crewmembers to the laser diode beam is considered a catastrophic hazard (reference MSL-1 HR CM-1;1, Cause 2). No direct optical path exists during normal operations. Chamber access is a nominal operation required to install/remove the EMS's. Rack access is an off-nominal operation required to install the spare laser diode assembly. ®[CR 5555A]

B. WHEN THE SOFBALL EMS IS INSTALLED IN THE CM-2, THE CHAMBER LID WILL NOT BE REMOVED IF THE FOLLOWING CONDITIONS OCCUR:

1. LESS THAN 45 MINUTES HAS PASSED SINCE POWER WAS REMOVED FROM THE CM-2 SPARK IGNITER.

2. AT LEAST TWO INHIBITS TO POWER APPLICATION TO THE CM-2 SPARK IGNITER ARE NOT IN PLACE. ®[DN 90]

A spark igniter is used during SOFBALL experiment operations. Prior to accessing the chamber, the DEPP is commanded to open the solid state relay (which provides power to the spark circuit), the igniter latching switch is manually disabled, the PDP cb No. 3 is opened, and the PDP switch 3 is placed in the off position. The 45-minute wait allows the capacitor to discharge. These steps are performed to ensure that the crew are not shocked by the spark igniter during chamber access operations (reference MSL-1 HR CM-1; 8, Cause 1). ®[CR 5555A]

107_19A-164 TOXIC MATERIAL CONTAINMENT (CM-2)

A. IF THE CM-2 CHAMBER FAILS TO PASS ITS ON-ORBIT LEAK INTEGRITY CHECK (OLIC), SOFBALL TEST POINTS USING SF_6 WILL NOT BE PERFORMED.

After the SOFBALL EMS is installed in the CM-2 chamber, a leak integrity check will be performed. The chamber will be pressurized to 51.5 psia (3.5 atm) and leak tested for the next 30 minutes. A pressure drop greater than 0.39 psia will result in the termination of SOFBALL tests using sulfur hexafluoride (SF_6) (reference MSL-1 HR CM-1; 5, Cause 1). Exposure of the crew to the combustion products from SF_6 tests is a critical hazard. ®[DN 83] ®[CR 5555A]

B. IF ACCESS TO THE CM-2 CHAMBER IS REQUIRED AFTER THE ON-ORBIT LEAK INTEGRITY CHECK HAS BEEN PERFORMED, THE LEAK TEST WILL BE REPEATED PRIOR TO PERFORMING A SOFBALL TEST POINT USING SF_6.

If an off-nominal case arises where the CM-2 chamber must be opened after the on-orbit leak integrity check has been performed, a second 30-minute leak check is required prior to performing any SOFBALL test using SF_6 (reference MSL-1 HR CM-1; 5, Cause 1). ®[DN 83]

C. FOLLOWING A SOFBALL TEST POINT USING SF_6, THE CM-2 CHAMBER WILL NOT BE OPENED UNTIL THE COMPLETION OF THE CLEANUP CYCLE AND DUMP OF THE CONTENTS INTO THE SPACEHAB VENT SYSTEM.

The DEPP controls the duration of the cleanup cycle via operation of the blower. Procedures require the crew to verify that the cleanup cycle is complete via the PGSC display which indicates the cleanup time and the blower delta P vs time (reference MSL-1 HR CM-1; 5, Cause 2). ®[CR 5555A]

D. IF THE CM-2 CLEANUP LOOP FAILS, A SINGLE DUMP OF COMBUSTION BYPRODUCTS FROM A SOFBALL TEST USING SF_6 WILL BE ALLOWED. ALL REMAINING TESTS USING SF_6 WILL BE DELETED.

The combustion byproduct gases that are formed by SOFBALL test points using SF_6 as the diluents are both toxic and corrosive. The CM-2 cleanup loop removes the corrosive constituents (H_2S, HF, SO_2, SOF_2) from these gases. Only gases that are compatible with the Spacehab vacuum vent system are nominally allowed to be vented (reference MSL-1 HR CM-1; 5).

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107_19A-164 TOXIC MATERIAL CONTAINMENT (CM-2) (CONTINUED)

E. IF COMBUSTION PRODUCTS FROM A TEST USING SF_6 LEAK INTO THE CABIN, THE FOLLOWING ACTIONS WILL BE TAKEN:

STANDARD ARS SCRUBBING ®[DN 83]

Combustion products leaked from a test using SF_6 are considered tox level 0 due to the low concentration after dilution into the module volume. Therefore, no special scrubbing actions are required. These products will be efficiently removed by LiOH and, to some extent, by activated charcoal filters. ®[DN 83]

F. IF EVP PRESSURE CHANGES BY MORE THAN ?1 PSI BETWEEN THE START AND THE END OF CHAMBER VENTING, THE CM-2 CHAMBER WILL NOT BE ACCESSED UNTIL A NOMINAL VENT HAS BEEN PERFORMED AND CONFIRMED.

A change in the Exhaust/Vent Package (EVP) pressure between the start and end of venting indicates a reverse flow has occurred through the cleanup loop filter. This could result in LiOH particles being forced into the CM-2 chamber. Exposure of the crew to LiOH is a level 2 (catastrophic) hazard. If subsequent venting with no backflow can be confirmed, nominal operations can be continued (reference HR CM-1; 16, cause 2). ®[CR 5555A]

107_19A-165 PRE-IGNITION CONSTRAINTS (CM-2)

IF ANY OF THE FOLLOWING CONDITIONS EXIST, THE GASES IN THE CM-2 CHAMBER WILL NOT BE IGNITED:

A. THE FLOW TIME LOADED INTO THE MASS FLOW CONTROLLER EXCEEDS THE MAXIMUM FLOW TIME ALLOWED.

B. THE PRESSURE IN THE CHAMBER EXCEEDS THAT EXPECTED FROM THE LOADING OF A SINGLE BOTTLE.

The DEPP nominally provides timing control to the mass flow controller to limit the amount of fuel that is allowed in the chamber for each LSP test. In addition, two redundant timer relays shut off fuel flow into the chamber if a time limit of 6.5 minutes is exceeded. The loaded time must be verified to ensure the DEPP inhibit has not been bypassed (reference MSL-1 HR CM-1;7, POCC POH #SOP 2.13).

The ignition of the contents of more than one bottle could result in the overpressurization of the chamber. Opening more than one manual valve and subsequent failure of the DEPP could release contents of more than one bottle into the chamber. A higher than expected pressure would indicate an error had occurred during loading and the test sequence would be terminated (reference MSL-1 HR CM-1; 7). ®[CR 5555A] ®[CR 5558]

107_19A-166 DOOR CLOSURE VERIFICATION (CM-2)

EACH TIME THE CM-2 CHAMBER DOOR IS OPENED, THE FOLLOWING ACTION MUST BE TAKEN TO VERIFY THAT THE DOOR IS SECURELY CLOSED:

UPON CLOSURE, THE TWO T-BOLTS ON THE CHAMBER DOOR MARMON CLAMP MUST BE VERIFIED AT A TORQUE LEVEL OF 360 IN-LBS.

*Verifying the door is properly secured prevents an inadvertent release of the door at high pressure which could be a collision hazard to the crew (**reference MSL-1 HR CM-1;10**).*

107_19A-167 CHAMBER ISOLATION VALVE ENTRY POSITION (CM-2)

THE CM-2 CHAMBER ISOLATION VALVE WILL BE VERIFIED IN THE VENT POSITION PRIOR TO NOMINAL ENTRY.

If the FM514 solenoid valve and the FM402 regulator were to fail during entry, calibration gas will be released through a 25 psia relief valve into the vacuum vent line. To prevent the rated pressure of the Spacehab vacuum vent valve from being exceeded, the chamber isolation valve is opened to the Spacehab vent line prior to entry to allow the chamber to serve as a pressure sink if required (reference MSL-1 HR CM-1;3). ®[DN 40]

107_19A-168 CHAMBER FILL RESTRICTIONS

A. IF ANY OF THE FOLLOWING CANNOT BE VERIFIED IN THE CLOSED POSITION, THE CM-2 CHAMBER WILL NOT BE FILLED USING THE FM 150 AIR BOTTLE.

1. VALVE AC013

2. VALVE AC014

3. REGULATOR ACO15

B. IF THE OLIC SWITCH (SW004) CANNOT BE VERIFIED IN THE DISABLE POSITION, THE CM-2 CHAMBER WILL NOT BE FILLED USING THE AC010 AIR BOTTLE.

Filling the chamber with air from both the AC010 bottle and the FM150 bottle could result in a rupture of CM-2 pressure system hardware causing injury to the crew or to Spacehab (a catastrophic hazard). To prevent this, the inhibits listed above are required. ***Reference Hazard Report MSL-1 CM-1;3****.*

107_19A-169 THROUGH 107_19A-180 ARE RESERVED

MECHANICS OF GRANULAR MATERIALS (MGM)

107_19A-181 THROUGH 107_19A-190 ARE RESERVED

BIOREACTOR DEMONSTRATION SYSTEM-05 (BDS-05)

107_19A-191 THROUGH 107_19A-200 ARE RESERVED

MICROBIAL PHYSIOLOGICAL FLIGHT EXPERIMENT (MPFE)

107_19A-201 THROUGH 107_19A-210 ARE RESERVED

SLEEP-3

107_19A-211 THROUGH 107_19A-220 ARE RESERVED

ASTROCULTURE

107_19A-221 THROUGH 107_19A-230 ARE RESERVED

COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY (CPCG-PCF)

107_19A-231 THROUGH 107_19A-240 ARE RESERVED

COMMERCIAL ITA BIOMEDICAL EXPERIMENT (CIBX)

107_19A-241 THROUGH 107_19A-250 ARE RESERVED

ZEOLITE CRYSTAL GROWTH-1 (ZCG-1)

107_19A-251 ZCG TOUCH TEMPERATURE

CREW UNLOADING OF ZCG AUTOCLAVES WILL NOT OCCUR UNTIL ADEQUATE COOL DOWN TIME HAS BEEN ALLOTTED AND THEIR TEMPERATURE HAS BEEN VERIFIED LESS THEN 45 DEG C. ®[CR 5555A]

The ZCG furnace processes the autoclaves at temperatures as high as 175 deg C. The furnace temperature can be monitored via the Zeolite Experiment Control System (ZECS) data display and by temperature strips placed on the surface of the furnace. Reference: Hazard Report ZCG-1; Cause 2.

107_19A-252 ZCG AUTOCLAVE LEAKAGE

TO PROTECT AGAINST ZCG CLEAR AUTOCLAVE LEAKAGE, THREE LEVELS OF CONTAINMENT WILL BE MAINTAINED AT ALL TIMES, EXCEPT WHEN BEING TRANSFERRED INTO AND OUT OF THE GLOVEBAG.

ZCG metal autoclaves have three levels of containment by design and require no special considerations. ZCG clear autoclaves only provide two levels of containment, and therefore are dependent on sealed storage bags, a storage transportation box, and a Glovebag to provide the third level of containment. The Zeolite solution stored in the autoclaves is very caustic with pH between 10-12. The fluid in the autoclave is not under pressure in ambient conditions. Reference: Hazard Report GBXE-15; Causes 2, 3a, 3b.

107_19A-253 THROUGH 107_19A-260 ARE RESERVED ®[CR 5555A]

FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH-2 (FRESH-2)

107_19A-261 IMAGERY DOWNLINK CONSTRAINTS ®[CR 5562]

THERE WILL BE NO DOWNLINKED PHOTOS OR VIDEO OF THE ANIMAL SUBJECTS UNLESS REQUESTED BY THE NASA CHIEF VETERINARY OFFICER OR DUTY VETERINARIAN TO ASSESS THE HEALTH OR WELFARE OF THE ANIMALS. ROUTINE DOWNLINK OF PHOTOS OR VIDEO IMAGERY WILL NOT BE PERFORMED. ®[DN 41] ®[ED]

Animal health checks will be routinely performed throughout the mission and the results recorded by the crew. If the animals appear stressed, their status will be communicated by the crew to the Chief Veterinary Officer or Duty Veterinarian either by voice call or operational OCA file transfer. Downlinking of photos or video images may then occur if required by the NASA Chief Veterinary Officer or Duty Veterinarian for determination of animal health or welfare. Routine downlink of photos or video imagery of animals is not required for animal welfare or scientific reasons, and is therefore not authorized. Reference NASA Memo, "On-orbit Imagery of Animal Subjects," from M-7/Acting Deputy Associate Administrator for Space Shuttle, dated June 7, 2002. ®[DN 41] ®[CR 5562]

107_19A-262 FRESH STATUS CHECKS

DURING ORBIT OPERATIONS, FRESH-2 RODENTS AND HARDWARE REQUIRE A STATUS CHECK EVERY 24 HOURS WHILE ON ORBIT AS LONG AS THE SPACEHAB MODULE IS ACCESSIBLE TO THE CREW. ®[DN 42] ®[CR 5700]

Daily health and hardware checks are required to assure the well being of the animals. Reference page 59 of the National Research Council Guide for the Care and Use of Laboratory Animals. The SH hatch is nominally closed during final deorbit preparation and is not planned to be re-opened in the event of a deorbit waveoff. If Spacehab is re-ingressed and if time permits, experiment status checks will be performed.

Reference Rule {107_2A-26}, EXTENSION DAY GUIDELINES. ®[CR 5700]

107_19A-263 THROUGH 107_19A-270 ARE RESERVED

GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS (BIOTUBE/MFA)

107_19A-271 THROUGH 107_19A-280 ARE RESERVED

REFRIGERATOR/FREEZER

107_19A-281 REFRIGERATOR/FREEZER (R/F) FREON LEAK

A FREON LEAK FROM THE EOR/F UNIT DOES NOT CONSTITUTE A SAFETY OR HEALTH HAZARD TO THE CREW.

The only Freon based R/F on board STS-107 is the Enhanced Orbiter Refrigerator/Freezer (EOR/F), located in the module. A Freon leak from the primary to the secondary containment system would be indicated by a housing pressure greater than 17 psi, the cold box temperature rising, and the compressor running continuously. A Freon leak into the cabin would be indicated by a housing pressure of about 14.7 psi, the cold box temperature rising, and the compressor running continuously.

Instantaneous release of 36g of Freon 502 from the EOR/F would produce an average orbiter/Spacehab concentration well below the 30-day spacecraft maximum allowable concentration (SMAC) of 4960 mg/m^3. This poses no health hazard to the crew. ®[DN 43]

Reference: NASA SD2 Memo 123, Permissible Levels of Freon 502, dated February 27, 1996.

107_19A-282 EOR/F FAILURE

THE CONTENTS OF THE EOR/F FREEZER TAKE PRIORITY OVER THE CONTENTS OF THE TEHM REFRIGERATOR. THEREFORE, FOR A FAILURE OF THE EOR/F TO OPERATE IN FREEZER MODE, THE TEHM WILL BE RECONFIGURED TO A FREEZER AND THE CONTENTS OF THE TWO UNITS WILL BE EXCHANGED. THE GROUND WILL DIRECT THE CREW TO SET THE EOR/F TO REFRIGERATOR MODE, IF POSSIBLE, AND THE TEHM TO FREEZER MODE. THE GROUND WILL PROVIDE DETAILED INSTRUCTIONS TO THE CREW FOR MANAGEMENT OF THE TEHM AND EOR/F CONTENTS EXCHANGE PER THE HLS COLD STOWAGE CONTINGENCY PLAN. ®[DN 6]

107_19A-283 TEHM AND EOR/F TOUCH TEMPERATURE

DURING ALL FREEZER OPERATIONS, THE CREW MUST WEAR GLOVES.

The freezer set temperature is -22 deg C. The allowed touch temperature lower limit is 4 deg C. Therefore, the crew must wear gloves when accessing the freezer to prevent a hazardous situation.

107_19A-284 CONFIGURATION FOR ENTRY (TEHM)

THE PIP PIN WILL BE INSTALLED ON THE TEHM DOOR HANDLE FOR LAUNCH/LANDING. ®[CR 5555A]

Failure to ensure nominal entry configuration could result in unrestrained hardware with potential for collision with SPACEHAB hardware and other payloads. Since TEHM is flown in the SPACEHAB module for STS-107, it presents no hazard to the orbiter or crew when the SPACEHAB hatch is closed. None of TEHM contents present a penetration hazard. Reference Hazard Report TEHM-8; Cause 1.
®[CR 5555A]

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SECTION 20 - FREESTAR

GENERAL

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SECTION 20 - FREESTAR

GENERAL

107_20A-1 FREESTAR MINIMUM MISSION OBJECTIVES

THE FOLLOWING PAYLOAD MISSION OBJECTIVES ARE DEFINED AS MINIMUM MISSION REQUIREMENTS FOR A NOMINAL DURATION MISSION:

A. MEIDEX REQUIRES A MINIMUM OF 140 MINUTES OF DESERT AEROSOL PRIMARY DATA COLLECTION SCHEDULED BETWEEN THE TWO ROI'S AND A MINIMUM OF ONE LUNAR OR GROUND CALIBRATION EVERY SEVEN DAYS

For maximum mission success, MEIDEX highly desires to perform observations during every overpass of the ROI's in which the minimal lighting conditions are met within ± 45 degrees from zenith. As a secondary observation set, MEIDEX highly desires a minimum of 2 hours of Sprite observations.

B. SOLSE REQUIRES A MINIMUM OF SIX OBSERVATIONS OF LIMB VIEWING AND TWO OBSERVATIONS OF EARTH VIEWING (EACH SINGLE OBSERVATION IS APPROXIMATELY 120 MINUTES LONG, INCORPORATING AN ILLUMINATED ORBIT FLANKED BY TWO ECLIPSES).

SOLSE highly desires a minimum of four additional limb views and one additional earth view. After desired observations of 13 orbits are met, SOLSE has the capability to record data for 19 additional orbits (i.e., a total capacity of 32 orbits). ®[DN 63]

C. CVX REQUIRES A MINIMUM OF 200 HOURS OF CONTINUOUS OPERATIONS.

A total minimum of 304 hours of continuous operation is highly desired.

D. SOLCON REQUIRES A MINIMUM OF TEN, 40-MINUTE SOLAR VIEWING OBSERVATIONS, EACH PRECEDED AND FOLLOWED BY SPACE VIEWING CALIBRATIONS.

E. LPT REQUIRES THE ON-ORBIT DEMONSTRATION OF FIVE PAYLOAD OBJECTIVES: GPS NAVIGATION (4 ORBITS REQUIRED); GN COMMUNICATIONS (EIGHT 5 MINUTE TESTS REQUIRED); TRDSS COMMUNICATIONS (6 HOURS REQUIRED); ON-ORBIT RECONFIGURATION (TWO 20 MINUTE TESTS REQUIRED); AND DEMONSTRATION OF RANGE SAFETY (TWO 2.5 MINUTE TESTS REQUIRED).

Through each demonstration, LPT will also be validating their IP in Space capabilities. As a supplemental objective, LPT highly desires to operate the receivers as much as possible throughout the flight.

107_20A-2 HH ACTIVATION/DEACTIVATION

A. FREESTAR MUST BE ACTIVATED WITHIN 3 HOURS AFTER PLBD OPENING OR PRIOR TO LEAVING A -ZLV ATTITUDE, WHICHEVER COMES FIRST. HH MUST BE DEACTIVATED WITHIN 3 HOURS OF PLBD CLOSURE.

Activation (comprised of crew performed activation plus ground commanded application of power to thermostatically controlled experiment heaters) is required to prevent the HH electronics from violating the operational limits of 0 deg C to 40 deg C at powerup. Deactivation is required no earlier than 3 hours prior to PLBD closure to prevent violation of the -10 deg C thermal limit on the unpowered HH electronics. This limit is for reasons of certification of reflight hardware and is not a safety requirement. Note: This assumes an initial temperature of 20 deg C when the PLBD's are opened and a PLBD opening attitude of -ZLV. The time to exceed thermal limits may be updated if the bay sill temperatures vary significantly from 20 deg C, or if actual maneuver times do not occur as scheduled. ®[DN 64] ®[CR 5626A]

B. SOLSE MUST BE ACTIVATED WITHIN 6 HOURS AFTER PLBD OPENING. SOLSE MUST BE DEACTIVATED WITHIN 6 HOURS OF PLBD CLOSURE.

The SOLSE constraint is based upon the assumption that a -ZLV (payload bay to Earth) attitude is flown. This requirement is reduced to 4.5 hours if the initial Orbiter attitude is not payload bay to Earth.

107_20A-3 HH THERMAL CONSTRAINTS

A. HH EXPOSURE LIMITS

1. WITH THE HH PAYLOAD ACTIVATED AND HEATERS ENABLED IN THE ABSENCE OF THERMAL ANALYSIS, THE LIMITS ARE TABULATED AS FOLLOWS:

ATTITUDE	COMPONENT	TEMP LIMIT (°C)	EXPOSURE TIME (HRS)
-ZLV	AVIONICS EXPERIMENT	N/A N/A	NO CONSTRAINTS
-ZSI	AVIONICS EXPERIMENT	40 13	8 1
-ZDS	AVIONICS EXPERIMENT	0 12	6.5 6.75

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107_20A-3 **HH THERMAL CONSTRAINTS (CONTINUED)**

2. WITH THE HH PAYLOAD DEACTIVATED IN THE ABSENCE OF THERMAL ANALYSIS, THE HH LIMITS ARE TABULATED AS FOLLOWS:

ATTITUDE	COMPONENT	TEMP LIMIT (°C)	EXPOSURE TIME (HRS)
-ZLV	AVIONICS EXPERIMENT	0 0	4 7.5
-ZSI	AVIONICS EXPERIMENT	N/A N/A	NO CONSTRAINTS
-ZDS	AVIONICS EXPERIMENT	0 0	1.5 2.5

Both cases assume an initial start from steady state -ZLV temperatures. The operating temperature limits were used for the non-operating case so the avionics could be turned on at any time.

B. IF THE HH AVIONICS IS POWERED ON BUT THE HEATERS ARE FAILED OFF, THE HH AVIONICS WILL REACH ITS LOWER OPERATIONAL TEMPERATURE LIMIT 2 HOURS AFTER THE ORBITER MANEUVERS OUT OF -ZLV TO DEEP SPACE ATTITUDES. ®[DN 65]

Heat generated by the HH avionics, when powered on, is sufficient to maintain cyclic steady-state temperatures as long as the orbiter maintains a nominal -ZLV attitude.

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107_20A-3 HH THERMAL CONSTRAINTS (CONTINUED)

C. DURING ON-ORBIT OPERATIONS, FREESTAR DESIRES THAT THE HH AVIONICS TEMPERATURE BE MAINTAINED WITHIN ITS OPERATIONAL LIMITS OF 0 DEG C TO 40 DEG C. IF THE OPERATIONAL LIMITS CANNOT BE MAINTAINED, THE PAYLOAD WILL BE DEACTIVATED AND THE HARDWARE QUALIFICATION LIMITS OF -10 DEG C TO 50 DEG C MAY BE USED. ON A BEST EFFORT BASIS, THE SHUTTLE WILL MANAGE ATTITUDE TO MAINTAIN THESE LIMITS.

As stated in the General Environment Verification Specifications (GEVS), it is GSFC policy that when thermal vacuum testing is performed, the thermal criteria is established to both provide margins that compensate for uncertainties in the thermal parameters and to induce stress conditions to detect unsatisfactory performance that would not otherwise be uncovered before flight. The HH avionics has been tested and qualified from -10 deg C to 50 deg C; therefore, design operational limits of 0 deg C to 40 deg C were established using the required 10 deg margin. It is normal engineering practice to maintain electrical components within the design operational limits to allow for contingency situations. Although qualification limits may be approached, it is required to maintain avionics within these limits at all times because the reliability of the hardware cannot be guaranteed outside these limits. Thermal stresses which can be induced in conditions above and below these limits are unknown since testing has never been performed outside the -10 deg C to 50 deg C range. These limits are for mission success and are not safety requirements. FREESTAR has a primarily passive design with thermostatically controlled heaters to maintain lower operational temperatures in colder attitudes.

D. IF TELEMETRY IS NOT AVAILABLE AND HH AVIONICS COLD LIMITS ARE PREDICTED TO BE VIOLATED, FREESTAR WILL BE POWERED OFF UNTIL TEMPERATURES ARE PREDICTED TO BE WITHIN LIMITS. RECOVERY FROM OFF-NOMINAL CONDITIONS WILL BE BASED ON REAL-TIME ANALYSIS.

Non-operating cold temperature (qualification) limits for the avionics are 10 deg C lower than the operating (acceptance) limits; therefore, FREESTAR will be powered OFF if predictions suggest that the operating limits may be violated. Recovery actions are scenario-dependent and will generally consist of -ZSI maneuvers to warm the payload.

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107_20A-3 HH THERMAL CONSTRAINTS (CONTINUED)

E. IF FREESTAR HAS BEEN DEACTIVATED DUE TO VIOLATIONS AND/OR PREDICTED VIOLATIONS OF LOWER THERMAL LIMITS OF THE HH AVIONICS, THE PAYLOAD MAY ONLY BE DEACTIVATED FOR PERIODS OF LESS THAN 3 HOURS ASSUMING THAT BENIGN ATTITUDES, SUCH AS -ZLV, WILL BE FLOWN. ON A BEST EFFORT BASIS, THE SHUTTLE SHALL ASSUME A THERMAL RECOVERY ATTITUDE BEFORE REACTIVATION IS ATTEMPTED. THE PERIOD REQUIRED FOR PAYLOAD RECOVERY WILL BE DETERMINED IN REAL TIME THROUGH THERMAL ANALYSIS AT THE HH POCC.

Assuming a nominal operating temperature of 12 deg C, the HH avionics could fall below its operational temperature limit of 0 deg C within 4 hours if powered off. This limit is for mission success and is not a safety requirement. If the HH avionics has violated its operational lower limit of 0 deg C, the payload must be warmed before activation is attempted. As no telemetry is available to monitor the temperature of the payload when the HH avionics is deactivated, specifications of the warming required will be based on real-time analysis. Activating the avionics when the temperature is too low could result in potentially serious damage to flight hardware. If the HH avionics is predicted to have fallen below its lower hardware qualification limit of -10 deg C, a real-time assessment will be made, as the performance of the HH avionics may not be reliable even after warming to within operational limits.

F. SOLSE REQUIRES THAT THE HH-JR AVIONICS AND BIA REMAIN ENABLED FROM PAYLOAD ACTIVATION THROUGH DEACTIVATION.
®[CR 5851]

Heater power is not maintained if the BIA and/or HH-JR avionics are disabled. ®[CR 5851]

G. CVX – REFERENCE RULE {107_2A-71}, ATTITUDE/POINTING CONSTRAINTS. ®[DN 67]

H. FREESTAR SHALL NOT BE EXPOSED TO MORE THAN 12 HOURS CONTINUOUS SOLAR VIEWING. ®[DN 66]

Thermal analysis predicts that the MEIDEX battery could exceed its safety temperature limits if the MEIDEX power is failed ON with the MEIDEX door closed in a bay to sun attitude that exceeds 12 hours. ®[DN 66]

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APPENDIX A

ACRONYMS AND ABBREVIATIONS

A	ANALYSIS
A/G	AIR-TO-GROUND
ABE	ARMED BASED ELECTRONICS
ABT	ABORT
AC	ALTERNATING CURRENT
ACS	ATTITUDE CONTROL SYSTEM
ACVS	AUTOMATIC TARGETING AND REFLECTIVE ALIGNMENT CONCEPT COMPUTER VISION SYSTEM
ADSEP	ADVANCED SEPARATION
AGHF	ADVANCED GRADIENT HEATING FACILITY
ALT	ALTERNATE
	ALTITUDE
AOA	ABORT ONCE AROUND
AOS	ACQUISITION OF SIGNAL
APCF	ADVANCE PROTEIN CRYSTALLIZATION FACILITY
APDU	ALT POWER DISTRIBUTION UNIT
AP08	ALTERNATE PROCEDURE #8
APU	AUXILIARY POWER UNIT
ARMS	ADVANCED RESPIRATORY MONITORING SYSTEM
ASAP	AS SOON AS POSSIBLE
AST	ASTROCULTURE
AST-10/1	ASTROCULTURE PLANT GROWTH CHAMBER
AST-10/2	ASTROCULTURE GLOVEBOX
ATO	ABORT TO ORBIT
ATR	AMBIENT TEMPERATURE RECORDER
ATT	ATTITUDE
AUG	AUGMENTED
AUTO	AUTOMATIC
AV	AVIONICS
AZ	AZIMUTH
BDS	BIOREACTOR DEMONSTRATION SYSTEM
BET	BENDING EFFECT TEMPERATURE
	BEST ESTIMATE TRAJECTORY
BFS	BACKUP FLIGHT SYSTEM
BIA	BUS INTERFACE ADAPTER
BIOS	BASIC INPUT/OUTPUT SYSTEM
BIOTUBE/MFA	GRAVISENSING AND RESPONSE SYSTEMS OF PLANTS
BITE	BINARY INTERNAL TIME ELECTRONICS
	BUILT IN TEST EQUIPMENT
BRIC	BIOLOGICAL RESEARCH IN CANISTERS
BRSS	BOEING REUSABLE SPACE SYSTEMS
B/U	BACKUP
BVD	BAY VENT DOOR

C	CELSIUS
C/O	CHECKOUT
CAB	CABIN
CAPCOM	CAPSULE COMMUNICATOR
CAPT	CAPTURE
CCM	CORRECTIVE COMBINATION MANEUVER
CCTV	CLOSED CIRCUIT TELEVISION
CCW	COUNTER CLOCKWISE
CDU	CENTRAL DATA UNIT
CDR	COMMANDER
CE	CARGO ELEMENT
CEBAS	CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM
CEWL	CENTRALIZED EXPERIMENT WATER LOOP
CG	CENTER OF GRAVITY
CIBX	COMMERCIAL ITA BIOMEDICAL EXPERIMENT
CIC	CREW INTERFACE COORDINATOR
CIL	CRITICAL ITEMS LIST
CIRC	CIRCULATION
CIS	CELLS IN SPACE
CM-2	COMBUSTION MODULE-2
CMD	COMMANDED
CMOS	COMPLEMENTARY METAL OXIDE SEMICONDUCTOR
CMPCG	COMMERCIAL MACROMOLECULAR PROTEIN CRYSTAL GROWTH
CMT	CARGO MANAGEMENT TEAM
CNTCS	CONTACTS
CNTL	CONTROL
COAS	CREW OPTICAL ALIGNMENT SITE
COM2PLEX	COMBINED 2 PHASE LOOP EXPERIMENT
COMM	COMMUNICATION
COMP	COMPUTED
CONT	CONTINUE
CONUS	CONTINENTAL UNITED STATES
COOK	(NASA CONTINGENCY GROUND STATION LOCATED AT VANDENBERG AFB, CA)
CPA	COMBUSTION PRODUCTS ANALYZER
CPCG	COMMERCIAL PROTEIN CRYSTAL GROWTH
CPCG-PCF	COMMERCIAL PROTEIN CRYSTAL GROWTH - PROTEIN CRYSTALLIZATION FACILITY
CPM	CELL PERFORMANCE MONITOR
CR	CHANGE REQUEST
CSCS	CENTRALIZED SUCTION COOLING SYSTEM
CSR	CUSTOMER SUPPORT ROOM
CSS	CONTROL STICK STEERING
CVX	CRITICAL VISCOSITY OF XENON
CW	CLOCKWISE

D	DERIGIDIZATION
DAP	DIGITAL AUTO PILOT
DB	DEAD BAND
DEC	DECLINATION
DEG	DEGREES
DEU	DISPLAY ELECTRONICS UNIT
DFRC	DRYDEN FLIGHT RESEARCH CENTER
DLY	DELAY
DM	SPACEHAB DOUBLE MODULE
DN	DISCREPANCY NOTICE
DOD	DEPARTMENT OF DEFENSE
DOH	DISCRETE OUTPUT HIGH
DOL	DISCRETE OUTPUT LOW
DPLY	DEPLOY
DPS	DATA PROCESSING SYSTEM(S)
DS	DEEP SPACE
DSO	DETAILED SUPPLEMENTARY OBJECTIVE
DTO	DEVELOPMENT TEST OBJECTIVE
DTV	DIGITAL TELEVISION
DV	DELTA VELOCITY

EAFB	EDWARDS AIR FORCE BASE
ECLS	ENVIRONMENTAL CONTROL AND LIFE SUPPORT
ECS	ENERGY CONVERSION SUBSYSTEM
EDO	EXTENDED DURATION ORBITER
EDS	EXPERIMENT DATA SYSTEM
EDW	EDWARDS AIR FORCE BASE
EE	END EFFECTOR
EECOM	EMERGENCY, ENVIRONMENTAL AND CONSUMABLES MANAGEMENT
EGIL	ELECTRICAL GENERATION AND INTEGRATED LOADING
EI	ENTRY INTERFACE
EL	ELEVATION
EMU	EXTRAVEHICULAR MOBILITY UNIT
E-NOSE	ELECTRONIC NOSE
EOM	END OF MISSION
EOR/F	ENHANCED ORBITER REFRIGERATOR/FREEZER
EPS	ELECTRICAL POWER SYSTEM
ESC	ELECTRONIC STILL CAMERA
ESM	ELECTRONIC SUPPORT MODULE
ESTL	(NASA CONTINGENCY GROUND STATIONS LOCATED IN HOUSTON, TX AND IN WALLOPS ISLAND, VA)
ERISTO	EUROPEAN RESEARCH IN SPACE AND TERRESTRIAL OSTEOPOROSIS
ET	EXTERNAL TANK
ETRO	ESTIMATED TIME OF RETURN TO OPERATION
EVA	EXTRAVEHICULAR ACTIVITIES
EVP	EXHAUST/VENT PACKAGE
EXP	EXPERIMENT

F	FAHRENHEIT
F/C	FLIGHT CONTROL
FAA	FEDERAL AVIATION AGENCY
F/C	FLIGHT CONTROL
FAO	FLIGHT ACTIVITIES OFFICER
FAST	FACILITY FOR ADSORPTION AND SURFACE TENSION STUDIES
FC	FUEL CELL
FCMS	FUEL CELL MONITORING SYSTEM
FCR	FLIGHT CONTROL ROOM
FCS	FLIGHT CONTROL SYSTEM
FCT	FLIGHT CONTROL TEAM
FD	FLIGHT DIRECTOR
FD	FLIGHT DAY
FDF	FLIGHT DYNAMICS FACILITY
FDO	FLIGHT DYNAMICS OFFICER
FES	FLASH EVAPORATOR SYSTEM
FM	FREQUENCY MODULATED
FMDM	FLEX MULTIPLEXER/DEMULTIPLEXER
FOFE	FIBER OPTICS FLIGHT EXPERIMENT
FOR	FLIGHT OPERATIONS REVIEW
FOV	FIELD OF VIEW
FPM	FLOW PROPORTIONING MODULE
FPR	FLIGHT PERFORMANCE RESERVE
FPS	FEET PER SEC
FPV	FLOW PROPORTIONING VALVE
FRCB	FLIGHT RULES CONTROL BOARD
FRCS	FORWARD REACTION CONTROL SYSTEM
FRESH	FUNDAMENTAL RODENT EXPERIMENTS SUPPORTING HEALTH
FSCU INT	FIRE SUPPRESSION AND CONTROL UNIT INTERNAL
FWD	FORWARD

GAS	GET AWAY SPECIAL
GBA	GAS BRIDGE ASSEMBLY
GCA	GROUND CONTROLLED APPROACH
GF	GRAPPLE FIXTURE
GIRA	GALLEY IODINE REMOVAL ASSEMBLY
GMT	GREENWICH MEAN TIME
GNC	GUIDANCE NAVIGATION AND CONTROL
GOM	GROUND OPERATIONS MANAGER
GPO	GUIDANCE & PROCEDURES OFFICER
GPC	GENERAL PURPOSE COMPUTER
GPS	GLOBAL POSITIONING SYSTEM
GSE	GROUND SUPPORT EQUIPMENT
GSFC	GODDARD SPACE FLIGHT CENTER
GUAM	(NASA CONTINGENCY GROUND STATION LOCATED AT ANDERSON AFB, GUAM)

HAINS	HIGH-ACCURACY INERTIAL NAVIGATION SYSTEM
HAZ	HAZARDOUS
HBIA	HITCHHIKER BUS INTERFACE ASSEMBLY
HDR	HIGH DATA RATE
HE	HELIUM
HEDS	HUMAN EXPLORATION AND DEVELOPMENT OF SPACE
HES	HITCHHIKER EJECTION SYSTEM
HESE	HITCHHIKER EJECTION SYSTEM ELECTRONICS
HH	HITCHHIKER
HHL	HAND HELD LASER
HH OPS	HITCHHIKER OPERATIONS DIRECTOR
HLS	HUMAN LIFE SCIENCES
HN	HIGH NOON ®[CR 5844]
HP	HEIGHT OF PERIGEE
HST	HUBBLE SPACE TELESCOPE
HTD	HEDS TECHNOLOGY DEMONSTRATION
HULA	(NASA CONTINGENCY GROUND STATION LOCATED AT KAENA POINT, HI)
HVIU	HITCHHIKER VIDEO INTERFACE UNIT
I	INHIBIT
IC	INSTRUMENT CARRIER
IEH-3	INTERNATIONAL EXTREME ULTRAVIOLET HITCHHIKER
IFM	IN-FLIGHT MAINTENANCE
IMU	INERTIAL MEASUREMENT UNIT
IP	IMPACT POINT
IPS	INERTIAL POINTING SYSTEM
INCO	INSTRUMENTATION AND COMMUNICATIONS OFFICER
INFLT	IN-FLIGHT
I/O	INPUT/OUTPUT
ITA	SPACEHAB INTEGRATED TUNNEL ASSEMBLY
JDI	JONATHAN DICKINSON
JDMTA	JOHNATHAN DICKINSON MISSILE TEST ANNEX
JOIP	JOINT OPERATIONS INTERFACE PROCEDURES
JSC	LYNDON B. JOHNSON SPACE CENTER
KBPS	KILO BITS PER SEC
KOH	POTASSIUM HYDROXIDE
KSC	JOHN F. KENNEDY SPACE CENTER
KW	KILOWATTS
L	LEFT

LBS	POUNDS
LCC	LAUNCH COMMIT CRITERIA
LCG	LAMBERT CYCLIC GUIDANCE
LDR	LOW DATA RATE
LED	LIGHT EMITTING DIODE
LION	(NASA CONTINGENCY GROUND STATION LOCATED AT RAF OAKHANGER, UNITED KINGDOM)
LIRS	THE LOW IODINE RESIDUAL SYSTEM
LOS	LINE OF SIGHT
LPT	LOW POWER TRANSCEIVER
LRU	LINE REPLACEABLE UNIT
LSP	LAMINAR SOOT PROCESS
LTM	LANDMARK TRACK MANEUVER
LV	LOCAL VERTICAL
LVLH	LOCAL VERTICAL LOCAL HORIZONTAL
M	METER
	MEASURED
	MIDDECK
MAGR	MINIATURE AIRBORNE GPS RECEIVER
MAN	MANUAL
MASS	MINIATURE ACQUISITION SUN SENSOR
MAT	MATERIAL
MAX	MAXIMUM
MBPS	MEGA BITS PER SECOND
MCC	MISSION CONTROL CENTER
MCC-H	MISSION CONTROL CENTER - HOUSTON
MCC-M	MISSION CONTROL CENTER - MOSCOW
MCS	MAGNETIC CONTROL SYSTEM
MCIU	MANIPULATOR CONTROL INTERFACE UNIT
MCV	MICROBIAL CHECK VALVE
MDF	MINIMUM DURATION FLIGHT
MDM	MULTIPLEXER/DEMULTIPLEXER
MECO	MAIN ENGINE CUTOFF
MEIDEX	MEDITERRANEAN ISRAELI DUST EXPERIMENT
MEL	MINIMUM EQUIPMENT LIST
MESS	MAXIMUM ENVELOPE STORAGE SYSTEM
MET	MISSION ELAPSED TIME
MGBX	MIDDECK GLOVEBOX
MGM	MECHANICS OF GRANULAR MATERIALS
MILA	MERRITT ISLAND LAUNCH AREA
MIN	MINIMUM
MIST	WATER MIST EXPERIMENT
MLS	MICROWAVE LANDING SYSTEM
MM	MISSION MANAGER
MMACS	MECHANICAL, MAINTENANCE, ARM AND CREW SYSTEMS
MMT	MISSION MANAGEMENT TEAM
MMU	MASS MEMORY UNIT

MN	MAIN
MNB	MAIN BUS B
MOSA	MISSION OPS SUPPORT AREA
MPCC	MULTI-PROGRAM CONTROL CENTER
MPE	MISSION PECULIAR EQUIPMENT
MPFE	MICROBIAL PHYSIOLOGICAL FLIGHT EXPERIMENT
MPM	MANIPULATOR POSITIONING MECHANISM
MPS	MAIN PROPULSION SYSTEM
MRL	MANIPULATOR RETENTION LATCH
MSID	MEASUREMENT STIMULATION IDENTIFICATION
MSTRS	MINIATURE SATELLITE THREAT REPORTING SYSTEM
MTBF	MEAN TIME BETWEEN FAILURES
MTU	MASTER TIMING UNIT
MUX	MULTIPLEXER
N/A	NOT APPLICABLE
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NC	PHASE ANGLE ADJUSTMENT MANEUVER
NCC	NETWORK CONTROL CENTER
NOR	NORTHRUP LAKEBED LANDING SITE
NORM	NORMAL
NPLS	NEXT PRIMARY LANDING SITE
NSTS	NATIONAL SPACE TRANSPORTATION SYSTEM
NM	NAUTICAL MILES
O	OVERHEAD
OARE	ORBITAL ACCELERATION RESEARCH EXPERIMENT
	ORBITAL ACCELERATION RESEARCH EQUIPMENT
OCA	ORBITER COMMUNICATIONS ADAPTER
ODRC	ORBITAL DATA REDUCTION COMPLEX
ODS	ORBITER DOCKING SYSTEM
OI	OPERATIONAL INSTRUMENTATION
OIS	OPERATIONAL AND INTERCOM SYSTEM
OLIC	ON-ORBIT LEAK INTEGRITY CHECK
OME	ORBITAL MANEUVERING ENGINE
OMI	OPERATIONS AND MAINTENANCE INSTRUCTION
OMS	ORBITAL MANEUVERING SYSTEM
OPR	OPERATOR
OPS	OPERATIONS
OPT	OPTION
OSTEO	OSTEOPOROSIS EXPERIMENT IN ORBIT
OSVS	ORBITER SPACE VISION SYSTEM FLIGHT TESTING
PAO	PUBLIC AFFAIRS OFFICER
PCBA	PORTABLE CLINICAL BLOOD ANALYZER

PCF	PROTEIN CRYSTALLIZATION FACILITY
PCM	PULSE CODE MODULATOR
PCMMU	PULSE CODE MODULATION MASTER UNIT
PCUEP	PHASE CHANGE UPPER END PLATE
PDI	PAYLOAD DATA INTERLEAVER
PDIP	PAYLOAD DATA INTERFACE PANEL
PDL	PONCE DE LEON STATION
PDRS	PAYLOAD DEPLOY AND RETRIEVAL SYSTEMS
PDSU	POWER DISTRIBUTION AND SUPPLY UNIT
PF	PAYLOAD FORWARD
PF1	PAYLOAD FORWARD #1
PGSC	PAYLOAD AND GENERAL SUPPORT COMPUTER
PHA	PULSE HEIGHT ANALYSIS
PHAB4	PHYSIOLOGY AND BIOCHEMISTRY 4
PI	PAYLOAD INTERROGATOR
PIKE	(NASA CONTINGENCY GROUND STATION FOR S-BAND FM DOWNLINK LOCATED AT COLORADO TRACKING STATION, SCHRIEVER AFB, CO)
PIP	PAYLOAD INTEGRATION PLAN
PL	PAYLOAD
P/L	PAYLOAD
PLB	PAYLOAD BAY
PLBD	PAYLOAD BAY DOORS
PLHX	PAYLOAD HEAT EXCHANGER
PLS	PRIMARY LANDING SITE
PLT	PILOT
POCC	PAYLOAD OPERATIONS CONTROL CENTER
POL	PAYLOAD OPERATIONS LEAN
POSN	POSITION
PPRV	POSITIVE PRESSURE RELIEF VALVE
PRCB	PROGRAM REQUIREMENTS CONTROL BOARD
PRCS	PRIMARY REACTION CONTROL SYSTEM
PRE	PRELIMINARY
PRI	PRIMARY
PROP	PROPULSION
PROX	PROXIMITY
PSP	PAYLOAD SIGNAL PROCESSOR
PSRP	PAYLOAD SAFETY REVIEW PANEL
PTB	PAYLOAD TIMING BUFFER
QDM	QUICK DON MASK
R	RIGHT
RA	RIGHT ACENSION
RAM	RANDOM ACCESS MEMORY
RBAR	RADIUS VECTOR
RCS	REACTION CONTROL SYSTEM

RDM	SPACEHABE RESEARCH DOUBLE MODULE
REF	REFERENCE
REEF	(NASA CONTINGENCY GROUND STATION LOCATED AT DIEGO GARCIA, BRITISH INDIAN OCEAN TERRITORY)
REGRPL	REGRAPPLE
REP	REPRESENTATIVE
REL	RELEASE
REM	RELEASE ENGAGE MECHANISM
RF	RADIO FREQUENCY
R/F	REFRIGERATOR/FREEZER
RHC	ROTATIONAL HAND CONTROLLER
RHS	REHYDRATION STATION
RM	REDUNDANCY MANAGEMENT
RME	RISK MITIGATION EXPERIMENT
RMS	REMOTE MANIPULATOR SYSTEM
RNDZ	RENDEZVOUS
ROCC	RANGE OPERATIONS CONTROL CENTER
ROI	RADIUS OF INFLUENCE
ROT	ROTATION
RPOP	RENDEZVOUS PROX OPS PROGRAM
RR	RENDEZVOUS RADAR
RS	REDUNDANT SET
RSAD	RMS SITUATIONAL AWARENESS DISPLAY
RSCS	RACK SUCTION COOLING SYSTEM
RSGF	RIGIDIZE SENSING GRAPPLE FIXTURE
RSS	RACK SUPPORT STRUCTURE
RTLS	RETURN TO LAUNCH SITE
RTS	REMOTE TRACKING STATION
SAA	SOUTH ATLANTIC ANOMALY
SAMS	SPACE ACCELEROMETER SYSTEM
SAMS-FF	SPACE ACCELEROMETER SYSTEM FREE FLYER
SAREX	SHUTTLE AMATEUR RADIO EXPERIMENT
SEC	SECOND
SEH	SOLAR EXTREME ULTRAVIOLET HITCHHIKER
SEM	SPACE EXPERIMENT MODULE
SEP	SEPARATION
SF_6	SULFUR HEXAFLUORIDE
SH	SPACEHAB
SHPM	SPACEHAB PROGRAM MANAGER
SHO	SATELLITE HANDOVER
SHOD	SPACEHAB OPERATIONS DIRECTOR
SHPM	SPACEHAB PROGRAM MANAGER
SI	SOLAR INERTIAL
SIGI	SPACE INTEGRATED GLOBAL POSITIONING SYSTEM/INTERNAL NAVIGATION SYSTEM
SIMO	SIMULTANEOUS
SJ	SINGLE JOINT
SLS	SECONDARY LANDING SITE

SLWT	SUPER LIGHT-WEIGHT TANK
SM	SYSTEMS MANAGEMENT
SMAC	SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATION
SODB	SHUTTLE OPERATIONAL DATA BOOK
SOFBALL	STRUCTURE OF FLAME BALLS AT LOW LEWIS-NUMBER
SOLCON	SOLAR CONSTANT EXPERIMENT
SOLSE	SHUTTLE OZONE LIMB SOUNDING EXPERIMENT
SPC	STORED PROGRAM COMMAND
SQ	SQUARE
SR	SUNRISE
SRB	SOLID ROCKET BOOSTER
SS	SUNSET
SSP	SPACE SHUTTLE PROGRAM
	STANDARD SWITCH PANEL
SSR	SOLID STATE RECORDER
ST	STAR TRACKER
STARNAV	STAR NAVIGATION
STARS BOOTES	SPACE TECHNOLOGY AND RESEARCH STUDENTS BOOTES
STBD	STARBOARD
STDN	SPACECRAFT TRACKING AND DATA NETWORK
STS	SUNRISE THROUGH SUNSET
SUPA	SHUTTLE URINE PRETREAT ASSEMBLY
SYS	SYSTEM
T	TAKEOFF
TACAN	TACTICAL AIR NAVIGATION
TAEM	TERMINAL AREA ENERGY MANAGEMENT
TAL	TRANSATLANTIC ABORT LANDING
TB	TALK BACK
TBD	TO BE DETERMINED
TDRS	TRACKING AND DATA RELAY SATELLITE
TDRSS	TRACKING AND DATA RELAY SATELLITE SYSTEM
TEHM	THERMOELECTRIC HOLDING MODULE
TFL	TELEMETRY FORMAT LOAD
THC	TRANSLATIONAL HAND CONTROLLER
TI	TERMINAL PHASE INITIATION
TIG	TIME OF IGNITION
TK	TANK
TPS	THERMAL PROTECTION SYSTEM
TRANS	TRANSLATION
TSU	TRAJECTORY SERVER UPGRADE
TVIP	TELEVISION INTERFACE PANEL
UCB	URINE COLLECTION BAG
V	VELOCITY

VBAR	VELOCITY VECTOR
VCD	VAPOR COMPRESSION DISTILLATION
VCD FE	VAPOR COMPRESSION DISTILLATION FLIGHT EXPERIMENT
VERN	VERNIER
VFEU	VESTIBIULAR FUNCTION EXPERIMENT UNIT
VGS	VIDEO GUIDANCE SENSOR
VIP	VACUUM ION PUMP
VLA	VERY LARGE ARRAY
VRCS	VERNIER REACTION CONTROL SYSTEM
VV	VELOCITY VECTOR
W	WATTS
WCS	WASTE COLLECTION SYSTEM
WDC	WATCH DOG CIRCUIT
WLPS	WALLOPS ISLAND
W/S	WHEEL STOP
WSC	WHITE SANDS COMPLEX
WT	WEIGHT
ZCG	ZEOLITE CRYSTAL GROWTH
ZOE	ZONE OF EXCLUSION

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APPENDIX B - CHANGE CONTROL

CONTENTS

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APPENDIX B

CHANGE CONTROL

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this appendix is to delineate change control procedures for Volumes A, B, C, D, and flight-specific/increment-specific Flight Rules Annexes. This will ensure the proper coordination of changes and provide a record of the proposed changes including the rule rationale and the reason for making the change. The web-based database, Workflow, is now being used to generate CR's for Volumes A, B, C, D, and Flight Rules Annexes and is the preferred method for initiating CR's. Refer to paragraph 2.1.1 for Workflow enrollment instructions. The change request (CR) form on page B-10 is designed to assist this change control process only when it is not possible to use Workflow. Workflow is available at URL: **http://mod.jsc.nasa.gov/da8**. Under the **Workflow Link** title, click on the **Flight Rule CR System** link.

1.2 GENERAL

All Flights critical items list (CIL)-related rules and generic rules with a recurring potential for mission-specific options or exceptions will be flagged so that they are readily identifiable in the All Flights generic documents. Hazard control (HC)-related rules are monitored by NA/Safety Division, and impact to an HC rule requiring PRCB/JPRCB/SSPCB is reported to the FRCB/JFRCB. When a change to a CIL-related specific flight rule, or an HC-related rule, is approved and CIL retention rationale is affected by the change, the change will not be incorporated until a corresponding change to the retention rationale is approved by the Shuttle or Station Programs. The same general philosophy applies to the changes that modify existing payload or orbiter hazard controls. These flight rule changes will not be incorporated until the appropriate safety organization approves a corresponding change to the related hazard control documentation. A [CIL] tag, in brackets, will be added to the title for CIL-related rules. Some Volume A rules not identified as CIL are identified as hazard control and an [HC] tag, in brackets, will be added to the title of those rules. Volume B rules primarily have been identified for hazard control and will be tagged [HC] in the title. Examples of All Flights rules that have the recurring potential for flight-specific options or exceptions are some of the remote manipulator system rules. For those type flight rules, the options or exceptions can be exercised as part of the flight-specific Flight Rules Annex development process. Flight-specific exceptions to any other All Flights generic rules must be approved by the appropriate Flight Rules Control Board (FRCB) or Joint Flight Rules Control Board (JFRCB).

It is suggested that those organizations with flight rules which affect CIL retention rationale or hazard controls implement an independent internal CR handling procedure that identifies CIL or HC flight rules and protects against inappropriate changes to these types of rules.

The FRCB/JFRCB is responsible for review and approval of CR's written against the Volume A, B, C, and D generic rules documents. The FRCB/JFRCB is chaired by the Director, Mission Operations or his designee.

1.3 EFFECTIVITY

January 21, 2002.

2.0 CHANGE PROCEDURES

2.1 SUBMISSION OF CHANGES

The flight rules change control process starts when someone in the technical community identifies a valid need to delete or modify an existing flight rule or to add a new rule. The web-based database, Workflow, is now being used to generate CR's for Volumes A, B, C, D, and Flight Rules Annexes. Refer to the paragraphs below for Workflow user and enrollment instructions. That individual fills out the Workflow CR form. (If access to the Workflow form is not available to the user, a paper form is provided on page B-10.) In developing the Workflow change file, the CR author should cut and paste appropriate pages from the Flight Rules document and SAVE AS a user file in the user's directory. Changes may be made to the appropriate rules of the author's file. When working this file, please accept any revisions on the copied page then turn the REVISION MODE **ON** so the change inputs are highlighted. Extracted rule pages or blank pages free of the graphics frame are encouraged.

All of the current Flight Rules documents are available on the internet. The URL is: **http://mod.jsc.nasa.gov/da8**. No ID or password will be required to access any of the rules provided the user is accessing from a trusted site (all NASA centers, contractors, and International Partners). If unable to access, users need to send an e-mail note to DA8/M. L. Griffith (mary.l.griffith1@jsc.nasa.gov) with their full name, company, IP address, and a justification statement for access.

The completed CR is then submitted to a division FRCB/JFRCB representative for approval. That representative should ensure that all CR's are coordinated within the originating division before submitting them to the DA8/Flight Director Office, Lyndon B. Johnson Space Center, Houston, Texas 77058. Each division should establish its own process to handle this internal coordination. DF/System Division is an exception to this protocol. CR's from DF are not processed through the DF FRCB representative, but submitted to the Flight Director Office by DF Branch Offices. When internal coordination has been completed, the division FRCB/JFRCB representative signs the form and forwards it to the Flight Director Office. For Workflow CR's, facsimile signature is recognized by the DA8/Flight Director Office when the CR is routed electronically from the appropriate Group Lead, Branch Manager, or the Division FRCB/JFRCB representative within MOD to DA8/J. M. Bryant (to the appropriate DA8/Book Manager for Annexes) for generic rule CR's and cc to DA8/W. P. Dill for Space Shuttle Operational Flight Rules, Volume A; DA8/J. M. Bryant for ISS Generic Operational Flight Rules, Volume B; and DA8/W. P. Dill for Joint Shuttle/ISS Generic Operational Flight Rules, Volume C, or Soyuz/Progress/ISS Joint Flight Rules, Volume D. **Examples of the electronic addresses are: SMPT: william.p.dill1@jsc.nasa.gov or smpt: wdill@ems.jsc.nasa.gov.** Organizations outside MOD may submit CR's through the appropriate MOD division to facilitate presubmittal review and coordination or may submit completed CR's directly to the Flight Director Office. Workflow CR's submitted from outside MOD require a tailored setup for the author as the CR will not be processed without one additional review/approval inside the author's Branch, Group, etc. When practicable, coordination should include the Flight Director. Workflow CR's are encouraged from outside MOD.

2.1.1 Enrollment

“Workflow” is a web-based database which uses e-mail to route and announce CR’s for review or approval. The approval process is discussed in paragraph 2.2. Workflow requires the user to be enrolled in the database.

Anyone with a need who resides in the JSC Domain or certain trusted domains may be enrolled in Workflow by providing their full name, 4-digit mail code, domain user ID, telephone number, and e-mail address. The request and information should be provided to Division database editors, trusted domain database editors, or to the Book Manager listed on the Preface page of the flight rules documents.

Enrollment for users outside the JSC Domain/trusted domains is available if the user has a need to change or review flight rules. At URL: **http://mod.jsc.nasa.gov/da8**), under the title **Workflow Link**, click the **Process for obtaining access to Workflow** link. Fill out the form and follow the submitting instructions. The DA8/Flight Director Office will sponsor each request. The requester will be informed when the application is approved and enrollment completed.

The Workflow URL is: **https://jsc-mod-wrkflow.jsc.nasa.gov**. Refer to the Help and Frequently Asked Questions and the Complete Users Guide links for further information. There is also a Workflow Trainer CBT which is at URL: **http://mod.jsc.nasa.gov/da8**.

2.1.2 Format

Individuals desiring to submit a flight rule change will complete the Workflow CR form. For new flight rule submittals, the rule and its associated rationale should be phrased as it is intended to appear in the flight rules document. Supporting data for the rationale may be attached. For changes to existing rules, the proposed changes must be made obvious when making the Workflow file attachment by accepting any revisions on the Flight Rule page to be modified, then turn the revision mode **ON** so that changes may be clearly identified.

2.1.3 CR Input Nonconformance

If an error is discovered while reviewing an incorporated Flight Rule CR, please notify the Book Manager of the nonconformance using the EZ CR form provided on the next page of this appendix. (Be aware that this is not the Flight Rule CR form and should only be used to report nonconformances.) Verification of the nonconformance initiates a metric input, correction, possible corrective action, nonconformance disposition/approval, and closure. Closure of “Control of Nonconforming Product” nonconformance EZ CR’s are approved by the Flight Director Office USA supervisor or his designee. Closure of “Corrective and Preventive Action” nonconformance EZ CR’s are approved by the Chief of the Flight Director Office or his designee.

FLIGHT RULES EZ CR

DATE	INITIATED BY: ORG/NAME/PHONE	RULE NUMBER	CONTROL NUMBER

CR FLIGHT EFFECTIVITY	OTHER AFFECTED FLIGHT RULES	DOCUMENT w/Date | REV Date		ALL FLTS VOL
				ANNEX

Rule Element	Rule Section

SHORT DESCRIPTIVE TITLE OF CHANGE		RULE
		RATIONALE

Nonconformance Description - Attached (If required)

Special instructions (if required):

Approval

Date

NONCONFORMANCE TECHNICAL ERROR ☐ EDITORIAL ERROR ☐		
	RECEIVED: INCORPORATED: EZ CR STATUS: OPEN	(DA8 Use Only)
SUBMIT CR TO: Annex Book Manager or DA8/W. P. DILL, NASA/JSC, PHONE 713-483-5418 SMPT: william.p.dill1@jsc.nasa.gov		

INSTRUCTIONS

1. DATE - Enter FLIGHT RULES EZ CR initiation date.
2. INITIATED BY: ORG/NAME/PHONE - Enter the originator's organization, name, and phone number (including area code if other than JSC).
3. RULE NUMBER - Enter the nonconformance rule number.
4. CONTROL NUMBER - Leave blank; will be assigned and entered by the document manager.
5. FLIGHT EFFECTIVITY - Enter whether Generic or Flight Specific Number.
6. OTHER AFFECTED RULES - Enter other rules affected.
7. DOCUMENT DATE w/Date/ REV Date - Enter the "affective document" document date and the PCN/Rev (if applicable) that contains the rule to be modified.
8. Enter All Flights Volume A, B, or C, or check the appropriate box for the annex
9. RULE ELEMENT - Enter the rule element number.
10. RULE SECTION - Enter the rule section number
11. SHORT DESCRIPTIVE TITLE OF CHANGE - Enter a short descriptive title of the change.
12. ✍ RULE, ✍ RATIONALE - Check appropriate box for whether the nonconformance is in rule and/or rationale.
13. NONCONFORMANCE DESCRIPTION - Enter a description of the nonconformance.
14. SPECIAL INSTRUCTIONS (IF REQUIRED) - Enter any special instruction here.

15 NONCONFORMANCE - Leave blank; will be assigned and entered by the document manager.

2.2 CR APPROVAL

2.2.1 Coordination

Pre-coordination between the author and affected disciplines is assumed. In Workflow, when the Flight Director Office receives a generic flight rule CR for disposition, it will automatically be assigned a contol number, and it will be assigned to a coordinating flight director. The coordinating flight director works with the initiator on any desired changes to the wording for the rule or rationale. The coordinating flight director conducts the Flight Director Office review and assists in the identification of any additional data or coordination that may be required. When this initial coordination has been completed and external coordination is required, a mandatory review sheet is readied by the coordinating flight director and distributed for formal review and comment with an appropriate suspense date provided. When required, all FRCB/JFRCB members plus others identified by the coordinating flight director will receive review copies via Workflow. To allow adequate review time, the suspense date is established to support the next scheduled FRCB/JFRCB (or specific launch date). CR’s are required to be delivered to the Flight Director Office for review no later than 3 weeks prior to the FRCB/JFRCB. CR’s submitted after the 3-week deadline may be scheduled on the FRCB/JFRCB agendas at the discretion of the Board Chair.

This review includes an assessment of impact to retention rationale for CIL-related rules and a review of related orbiter or payload hazard reports. For all proposed changes to CIL/HC-related flight rules, the rationale must be approved by the respective Program before the CR may be placed on the Board agenda.

2.2.2 Approved/Disapproved/Deferred CR's

2.2.2.1 Generic CR's

For minor changes to generic rules/rationale, format only changes to flight rules, and when no mandatory review assignments have been made by the reviewing Flight Director, the FRCB/JFRCB Chairman may approve the CR without formal presentation to the board, provided no changes were recommended by the board members. These are the CR's identified on the FRCB/JFRCB agenda with an asterisk. Occasionally, the FRCB/JFRCB Chairman will approve and sign a CR out of board to expedite a CR through the process, and usually that CR will be presented at the next FRCB/JFRCB. All other CR's will be considered by the FRCB/JFRCB with a formal presentation. The FRCB/JFRCB considers each CR based on the impact on operations, the impact on documented hazard controls or CIL retention rationale, and the technical justification. Each CR will then be approved, disapproved, or deferred. Approved changes will be incorporated into the next page change notice (PCN) or revision to the generic document. Disapproved CR changes will be returned to the initiator along with the reason for disapproval. Disapprovals may be appealed to the Level II Program Office, if desired. The last possible FRCB/JFRCB action is deferral. CR's will be deferred for only two reasons: all mandatory concurrences have not been received, or additional data or analysis is needed. CR deferrals will be rescheduled for a subsequent FRCB/JFRCB meeting.

FRCB/JFRCB minutes document the status of each CR dispositioned (approved, deferred, approved with modification, actions given, and status of past actions). Workflow databased CR's may be processed by the Book Manager acting for the FRCB/JFRCB Chair in accordance with the FRCB/JFRCB CR status documented in the minutes.

2.2.2.2 Annex CR's

The Lead Flight Director has approval authority of CR's for Flight Specific Increment Annexes or for Flight Specific Annexes.

3.0 DOCUMENT REVISIONS/DEVELOPMENT

3.1 DEVELOPMENT

The Flight Director Office will compile for the generic documents the effective changes and corrections of minor typographical errors into complete Revisions or PCN's to the basic document.

The Flight Director Office prepares annexes on a per flight basis according to schedule template at approximately launch minus 7 months in most cases.

Editorial changes may be used to correct typographical errors if there are no other changes on the page concerned.

3.2 DOCUMENT APPROVAL

3.2.1 Generic Rules Documents

Revisions/PCN's to the Volume A document will be approved by the Chief, Flight Director Office; Director, Mission Operations; and Manager, Space Shuttle Program. Pen and Ink (P&I) changes will be approved by the Chief, Flight Director Office under DA8 memorandum with concurrence by the Director, Mission Operations. Real-time CR's are approved by the Flight Director and the Mission Operations Director and are statused to the Mission Management Team.

Revisions/PCN's to the Volume B and D documents will be approved by the Chief, Flight Director Office; Director, Mission Operations; and Manager, Space Station Program. P&I changes will be approved by the Chief, Flight Director Office under DA8 memorandum with concurrence by the Director, Mission Operations. Real-time CR's are approved by the Flight Director and the Mission Operations Director and are statused to the Mission Management Team.

Revisions/PCN's to the Volume C document will be approved by the Chief, Flight Director Office; Director, Mission Operations; Manager, Space Shuttle Program; and Manager, Space Station Program. P&I changes will be approved by the Chief, Flight Director Office under DA8 memorandum with concurrence by the Director, Mission Operations. Real-time CR's are approved by the Flight Director and the Mission Operations Director and are statused to the Mission Management Team.

Documents are updated with approved CR's and statused at program review boards. If all signatures are not obtained in time to meet publication schedules, signatures pages will be posted by eratta when they are received.

3.2.2 Annex Documents

A "Headsup" review copy of the "Final" document is provided for program review 5 working days prior to "Final" presentation to the affected Program Requirements Control Board (PRCB) or SSCB or Joint Board. After the 5-day review, the Flight Director is scheduled on the appropriate board agenda via a Control Board CR to brief any flight specific issues potentially affecting Program policies. Also, any additional significant changes received during the 5-day review period will be briefed.

Pre-Final documents are approved by the Lead Flight Director or his designee.

The Annex Final and Revisions/PCN's to the Final document will be approved by the Chief, Flight Director Office; Director, Mission Operations; and Manager, Space Shuttle Program. Pen and Ink (P&I) changes will be approved by the Lead Flight Director under DA8 memorandum with concurrence by the Chief, Flight Director Office and Director, Mission Operations. Real-time CR's are approved by the Flight Director and the Mission Operations Director and are statused to the Mission Management Team.

The Increment Annex Final and Revisions/PCN's to the Final will be approved by the Chief, Flight Director Office; Director, Mission Operations; Manager, Space Shuttle Program; and Manager, Space Station Program. Pen and Ink changes will be approved by the Lead Flight Director under DA8 memorandum with concurrence from the Chief, Flight Director Office and the Director, Mission Operations. Real-time CR's are approved by the Flight Director and the Mission Operations Director and are statused to the Mission Management Team.

3.3 PUBLICATION

3.3.1 <u>Schedule</u>

3.3.1.1 <u>Generic Rules</u>

All Flights documents (Volumes A, B, C, and D) originating as initial documents would approximately follow the schedule described for annexes except the FRCB/JFRCB would exercise individual rules approval prior to obtaining respective PRCB/JPRCB/SSPCB approvals. After initial release of Volumes A, B, C, etc., in "Final" form, subsequent revisions will be in the form of PCN's or Pen and Inks (P&I's), depending on CR traffic and mission requirements.

3.3.1.2 <u>Annex/Increment Rules</u>

Initial publication of annexes will be in "Basic" form and provided for the Flight Operations Review (FOR) data pack distribution at approximately launch minus 4 months for Space Shuttle only missions and L-5 months for Joint Shuttle/ISS missions (schedule provided by Payload FOR memorandum.) Post-FOR, the flight rules will be published in "Basic, Revision" form and distributed in time to support the flight simulation schedule. The "Final" approval process takes place at approximately liftoff minus 1 month. The logistics required for the formal approval process precludes initiating a PCN within 2 weeks of launch. Within 2 weeks of the launch, the Pen and Ink (P&I) process is invoked with P&I changes processed "on console" at launch minus 1 day, and produced on an "as required" basis. After liftoff, changes will be processed real time per JSC-26843, Flight Control Operations Handbook (FCOH) Shuttle Operations, SOP 1.2.1, Real-Time Flight Rules Changes, or JSC-29279, FCOH Station Operations, SOP 2.6, Real-Time Flight Rules Changes.

3.3.2 <u>Distribution</u>

Hard copy publications will be printed and distributed through normal administrative channels. Use of electronic copies off the website is encouraged. All of the current Flight Rules documents are available on the internet at URL: **http://mod.jsc.nasa.gov/da8**.

CHANGE REQUEST

(TO BE USED ONLY WHEN WORKFLOW DATABASE IS UNAVAILABLE.)

DATE	INITIATED BY: ORG/NAME/PHONE	CONTROL NUMBER	RULE NUMBER

CR FLIGHT EFFECTIVITY & Term Terminate after:	OTHER AFFECTED FLIGHT RULES	DOCUMENT w/Date | REV Date Rev:	☐ ALL FLTS VOL ☐ ANNEX ☐

Rule Element	Rule Section

SHORT DESCRIPTIVE TITLE OF CHANGE	☐ RULE ☐ RATIONALE

<u>Rule Change - Attached</u>

Special instructions (if required):

REASON FOR CHANGE (required input - each paragraph is limited to 255 characters)

Para 1:

Para 2:

Pre-Coord: (org/name)

APPROVED: Signed By: SUBMITTING ORGANIZATION FRCB/JFRCB MEMBER DATE:	CIL HAZARD CONSTRAINTS TO OPERATIONS? YES ☐ NO ☐ DOES THIS CHANGE MODIFY EXISTING CIL RETENTION RATIONALE? YES ☐ NO ☐	**APPROVED:** Signed By: FRCB/JFRCB CHAIRMAN DATE:
CHANGE IS A RESULT OF: NEW CAPABILITY ☐ H/W ☐ PROCEDURE CHG ☐ S/W ☐ EDITORIAL ☐ OTHER ☐	DOES THIS CHANGE AFFECT CREW PROCEDURES? YES ☐ NO ☐ DOES THIS CHANGE MODIFY FOR A CONTROLLED HAZARD? YES ☐ NO ☐	**APPROVED:** (ANNEX ONLY) Signed By: LEAD FLIGHT DIRECTOR DATE:

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MAND (X)	Evaluator	DATE	A	A/M	D	Comments

<u>SUBMIT CR TO: Annex Book Manager or</u> <u>DA8/W. P. DILL, NASA/JSC, PHONE 713-483-5418</u> <u>E-MAIL:</u> william.p.dill1@.jsc.nasa.gov	RECEIVED: INCORPORATED: CR STATUS:	(DA8 Use Only)

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19. CIL HAZARD CONSTRAINTS TO OPERATIONS: YES ✍ NO ✍ - Optional, the originator may attempt to answer this question; however, the responsibility lies with DF to determine if the CR affects JSC 23227, "CIL/Hazard Constraints to Operations." This is the MOD ops retention rationale document.
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24. APPROVED: LEAD FLIGHT DIRECTOR - This block is to be used only for Lead Flight Director concurrence for changes to the flight-specific annexes.
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