

Flight Procedures Handbook

Deorbit Prep

Mission Operations Directorate
Operations Division

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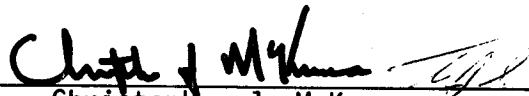
MISSION OPERATIONS DIRECTORATE

DEORBIT PREP
FLIGHT PROCEDURES HANDBOOK

FINAL, REVISION A

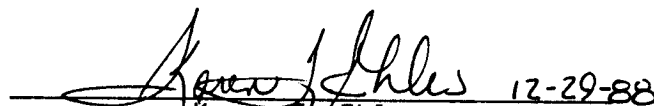
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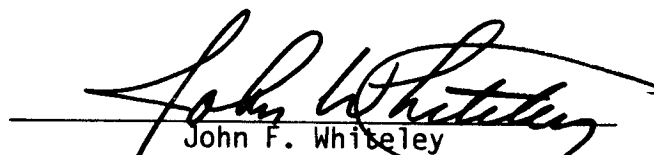


Christopher J. McKenna
Book Manager

APPROVED BY



Karen F. Ehlers 12-29-88
Rockwell Shuttle Operations Company



John F. Whiteley
Chief, Flight Activities Branch

Comments concerning this document may be addressed to DH4/Christopher J. McKenna, building T-585, room 114, 713-483-4362 or DH4/Timothy J. Stockdale, building T-585, room 114, 713-483-4499.

PURPOSE

The purpose of this document is to present the user with sufficient rationale and supporting information to give him/her a good understanding of the crew task for this mission phase. This handbook is intended primarily for use by flight crew members and flight controllers as follow-on to Shuttle systems training. This document is written such that it is as generic as possible.

SCOPE

The Deorbit Prep Procedures Handbook covers the following procedures:

- Nominal Deorbit Prep
- Deorbit Prep Backout
- BFS Deorbit Prep Notes
- Contingency PLBD Closure
- Contingency Deltas to Nominal D/O Prep

NOTE: This handbook is based on procedures in the STS-26 Deorbit Prep Flight Supplement (Final, Rev A, PCN-1) and the All Vehicle Deorbit Prep Book (Rev A, PCN-3). It is recommended that these procedures and timelines be used in conjunction with this handbook.

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SECTION 1
NOMINAL DEORBIT PREPARATIONS

1.1 OVERVIEW

The deorbit preparation (D/O Prep) procedures apply to the last four hours of the on-orbit period during a mission. The timeline provides a transition from the Flight Plan (FLT PLN) to the Entry Checklist. The D/O Prep procedures are scheduled on a timeline that is referenced to the time of ignition (TIG) of the deorbit burn. Deorbit prep begins at TIG -04:00 and ends at TIG -00:50. The sequence and timing of the procedures have been structured so that they will not change significantly from flight to flight. All procedures have been designed to be as generic as possible. Small procedural changes will be required for each flight to reflect flight-specific trajectory data and payload requirements.

During D/O Prep, the various Orbiter systems are put in the proper configuration for entry. The data processing system (DPS) is reconfigured in order to provide a multiple-redundant set of guidance software. The radiators are coldsoaked and the coolant loops are reconfigured in order to provide the proper thermal environment during entry. Attached payloads, as well as any support equipment for deployed payloads, are deactivated, and the payload bay doors (PLBD's) are closed. The inertial measurement units (IMU's) are aligned so that attitude data is accurate for the critical entry phase. Navigation and flight control hardware to be used after entry interface (EI) are activated. The crew escape system is set up and partial pressure suits are donned for additional crew safety. Finally, as an overall check of Orbiter configuration, the crew verifies the correct positions of all the switches. Towards the end of D/O Prep, the crew is allotted some time to review procedures for entry. At TIG -00:50, the crew transitions from D/O Prep to the Entry Checklist.

1.2 DETAILED PROCEDURES

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NOTES PRECEDING TIMELINE

The contingency ("starred") procedure on page 1-5 of the Deorbit Prep book addresses the scenario in which the time to TIG is between 2 hours 40 minutes and 4 hours. This will be used if the crew and Mission Control Center (MCC) personnel opt to take a deorbit opportunity within 4 hours for next primary landing site (PLS) failures. Since there may not be enough time to uplink and update the mission plan, all activities required prior to D/O Prep that are usually scheduled in the FLT PLN are listed here. The contingency procedure leads directly into the D/O Prep timeline. The D/O Prep procedures are then performed as rapidly as possible, i.e., procedures are performed one immediately after another. Shuttle Mission Simulator (SMS) runs have indicated that 2 hours 40 minutes is the shortest amount of time in which the nominal D/O Prep can be performed. Any failure requiring a deorbit in less than 2 hours 40 minutes that is not covered by another deorbit prep procedure should utilize the emergency D/O Prep procedure in the Contingency D/O Prep book.

The list located underneath the contingency procedure applies to nominal end-of-mission. It contains typical entry related activities that are scheduled prior to D/O Prep. This list ensures that the Orbiter is in the proper configuration for D/O Prep and that the D/O Prep timeline will remain clean and unobstructed.

CRT TIMER SETUP

TIG -04:00

As previously stated, D/O Prep procedures are referenced to the TIG of the deorbit burn. Consequently, timers must be set to count down to TIG. Timers are set in both guidance, navigation, and control (GNC) and systems management (SM) major functions since each is provided with a separate cathode ray tube (CRT) timer. The deorbit TIG is updated in the FLT PLN just prior to D/O Prep, and the crew enters that time into items 17-19 on specialist function display (SPEC) 2. The software will calculate the time remaining until TIG and display the count down in the upper right corner of the CRT's.

DAP CONFIG

TIG -03:59

The digital auto pilot (DAP) is configured to "A1/VERN" at the beginning of D/O prep timeline. Verniers are preferable because for their lower propellant usage. The A1 DAP is set up to protect a vernier reaction control system (VRCS) failure case. In such an event, "A1/NORM" is preferable to "B1/NORM" because the wider A1 deadband (5° vs 3°) results in less propellant usage. Nominally, the DAP will remain in the "A1/VERN" configuration until the radiator bypass and high load flash evaporator system (FES) activation are performed.

COLDSOAK INITIATE

TIG -03:56

The radiators are coldsoaked so they may be used as heatsinks during entry. The coldsoak initiate procedure places the radiators in a partially bypassed configuration which reduces the flow through the radiators and in turn results in colder panel temperatures.

To create the bypass, the radiator controller temperature is raised to 57° ("RAD CNTLR OUT TEMP- HI"). It is verified by observing the indicated increase in Freon temperature on the Evaporator Out Temp gage (panel 01). After the temperature has reached approximately 50°, the FES is activated to cool the Freon back down to 39°. FES testing and flight experience has demonstrated that a FES overtemp shutdown occurs if activation is attempted with inlet temperatures in the 41° to 47° range. The activation point of 50 ± 2 was chosen as to ensure that the temperature is well out of the range of concern.

Maintaining some flow through the panels (i.e., partial bypass) provides a coldsoak that is just as effective as a full bypass, but also permits the coldsoak to be performed while using only the topping FES. Since the topping FES vent is nonpropulsive, VRCS jets may be used for attitude control. A full radiator bypass would require activation of the high load FES which has propulsive venting and therefore requires the less propellant efficient primary RCS (PRCS) jets for attitude control. The propellant saved by using the VRCS jets results in attitude control for another two revs.

The high load duct heater is turned on at this time to allow sufficient warm up before high load FES activation during the "RAD BYPASS/FES C/O" procedure (TIG -02:50).

RAD STOW

TIG -03:45

The radiators are deployed on flights experiencing higher than normal heat loads (e.g., Spacelab) in order to increase their cooling capability. The radiators are stowed here in preparation for PLBD closing. Performing radiator stow at this time allows adequate time for trouble shooting should a stow related failure occur.

PAYLOAD DEACT

TIG -03:30 TO TIG -02:30 timeframe

Depending on flight specific requirements, D/O Prep actions may be required to place a payload in the proper configuration for entry. Since payload procedures and the timing of those procedures vary from flight to flight, a payload deactivation callout was placed at the top of certain detailed timeline pages. If a payload deactivation is required in the timeframe of a given page, the TIG time is pen-and-inked onto the appropriate blank as part of the Errata Package. The associated procedural steps will be located on the aft deck mission specialist (MS) page in the Flight Supplement. If a payload deactivation is not required, "N/A" is pen-and-inked onto the blanks

as part of the Errata Package to indicate that the callout is not applicable.

DPS CONFIG FOR D/O PREP

TIG -03:27

The redundant GNC operational sequence (OPS) 2 general purpose computer (GPC) is powered off on orbit for power-critical flights (e.g., Spacelab). If such is the case, that GPC is powered on at this time and is brought into the GNC OPS 2 set. This places the GPC's in the proper configuration for the "DPS ENTRY CONFIG" procedure (TIG -02:05) and allows time for troubleshooting should a GPC failure occur.

The backup flight system (BFS) GPC is also powered on at this time to ensure that it interfaces properly with a CRT.

CONFIG FOR PLBD CLOSING

TIG -03:15

Preparations for PLBD closing include the activation of the floodlights, which will provide optimal lighting for observation of the PLBD's. The number of floodlights activated is dependent on payload constraints as specified in the Flight Requirements Document. Also, the television/video tape recorder (TV/VTR) system is activated for viewing and, when desired, recording PLBD closure.

If the remote manipulator system (RMS) is flown, then the RMS heaters and RMS power are deactivated at this time. There is no longer a requirement to monitor temperatures once the doors are closed.

KU-BD ANT STOW

TIG -03:05

Depending on communications requirements and antenna failure status, the Ku-band antenna may or may not be stowed the day before entry. If it is still deployed when D/O Prep is entered, it is stowed at this time in preparation for PLBD closing. The timing of this procedure will become increasingly important as the text and graphics system (TAGS) replaces the teleprinter as the tool for message uplink since TAGS operations require use of the Ku-band antenna. Typically, some entry related messages are uplinked in the D/O Prep timeframe.

AUTO MNVR TO IMU ATT (OMIT IF BFS)

TIG -02:58

This maneuver places predesignated navigation stars in both the -Y and -Z star trackers for the IMU alignment (discussion on page 1-6). Flight specific star and attitude data are located on the summary timelines in the Flight Supplement.

If the BFS is engaged, this action will be omitted since the BFS does not have star tracker operations.

RAD BYPASS/FES C/O

TIG -02:49

The radiators are completely bypassed at this time in preparation for PLBD closing. Once the doors are closed and the radiators are no longer exposed to deep space, continued flow through the radiators would increase the radiator temperature, thereby reducing the effectiveness of the coldsoak. By stopping freon flow through the radiator and preserving the coldsoak, the radiators may be used as a heat sink later on during entry in place of the ammonia boiler system.

Alternate FES controllers are also checked out at this point. This is a noncritical redundant component checkout that is performed to reduce Shuttle turnaround time on the ground.

ENT STOWAGE

TIG -02:46

The entry stowage activity consists of stowing and reconfiguring various articles/equipment for crew safety during entry. Detailed descriptions of the equipment are contained in the Shuttle Flight Operations Manual (SFOM) Volume 12.

Preparation of the waste collection system (WCS) for full deactivation, scheduled approximately 2 hours later, is performed. Loose articles no longer needed, such as the FLT PLN, backup Shuttle portable onboard computer (SPOC), cameras, and personal hygiene kits are stowed. Also, the escape pole is set up in case an emergency situation requires a bailout. The "CAB TEMP CNTLR" switch is turned off, actuator linkage is stowed, and the cabin temp controller valve is placed in the full cool position to provide maximum cooling for entry.

IMU ALIGNMENT

TIG -02:44

An IMU alignment is performed in order to ensure acceptable accuracy of the IMU's for entry. Since this alignment is considered critical, a verification is required to ensure that the misalignment errors are less than 0.1°. The drift errors at EI are minimized by performing the alignment as closely as operationally reasonable to TIG.

The procedure is entered in an attitude that was previously established ("AUTO MNVR IMU ATT") so that selected stars are in the star trackers. SPEC 21, "IMU ALIGN", and SPEC 22, "S TRKR/COAS", are called up separately for monitor and control of IMU moding, and of star tracker operating and moding, respectively. The tracker shutters are then verified open. If the shutters are closed, the crew performs an off-nominal procedure that reduces the risk of inadvertent exposure of the star tracker(s) to possible damage from a bright object.

The star ID's, angle errors, and IMU delta angles, help the crew determine whether or not the star data is acceptable. The criterion for maximum allowable angular error (ANG ERR) is 0.08. ANG ERR is computed by the star tracker subsystem operating program (SOP) and is based on a 3-sigma star tracker and 1-sigma selected IMU performance. If no data or bad data appears in the table within 3 minutes of star tracker enabling, a contingency procedure directs the crew to verify attitude, stars, and mission elapsed time (MET). If all of these are reasonably correct, the tracker self tests are performed. Based on the results the crew will repeat dual star tracker alignment, perform single star tracker alignment, or troubleshoot per MCC direction.

The single star tracker alignment involves the acquisition of one star from the dual tracker attitude and then maneuvering to the single star attitude for the good tracker and taking data on a second star.

After acquiring good star data, an "ITEM 16" initiates torquing of the IMU platforms. However, if the check of the misalignment angles (sometimes referred to as torquing angles or angle deltas) finds them to be 0.8 or greater, the platforms will not be torqued until the ground has time to determine possible cause and consequence. The maximum misalignment error of 0.8 was determined based on 3-sigma star trackers with a 3 sigma IMU drift (.06 deg/hr) over, the longest expected time since the last alignment.

As stated earlier, the alignment is critical and therefore requires a verification. The Orbiter is maneuvered with norm jets until the IMU verification stars are present in the trackers (norm jets are used to counteract propulsive venting of the high load FES which was activated during the "RAD BYPASS/FES C/O" procedure). The same procedures are performed for the new star pair, except that the angle deltas are verified to be less than 0.1. If they are, the alignment was good and these delta angles are not torqued. If the angles are greater than 0.1, they will be torqued out and the crew will inform the MCC and maneuver to another star pair for a new verification.

Records of alignment data are kept in the IMU STAR LOG for future IMU performance analysis.

CLOSE PLBD

TIG -02:40

The PLBD activities and procedures required in the D/O Prep timeframe will nominally consist of an automatic PLBD closing on a SM GPC. However, if the SM GPC fails, the BFS can be substituted with no loss of capability as far as door operations are concerned. There is also a "CONTINGENCY PLBD CLOSURE" procedure available should the doors not close due to thermal bending (discussion on page 4-1).

Nominal PLBD closing is performed using the "PL BAY DOOR" display on CRT 4 and the controls on panel R13L. The selection of OPS 2 or 4 is dependent on the payload SM requirements at the time of door closing. Regardless of the SM OPS selection, PLBD operations are identical.

Before the actual closing begins, configuration checks and command enabling are performed. The "PL BAY DR SYS" switches are enabled to provide power to the door and latch open/close relays in the motor control assemblies (MCA's), which will allow the GPC's PLBD commands to be enacted. These PLBD enable switches are designed to prevent erroneous commands from reaching the motors and causing an alternating current (ac) phase short or premature operations of the doors.

Door motion begins as soon as the PLBD dedicated control switch on panel R13L is placed in the close position ("PL BAY DR - CL"). A timer is used to monitor door and latch drive times while the "PL BAY DOOR" display on CRT 4 is used to monitor door and latch positions. The port door and latches close first with the remaining closing sequence as follows: starboard (STBD) door, STBD forward and aft latches, centerline latches (outer sets then inner sets). During the closing it may be necessary to stop the auto sequence on two occasions: one, to review the closing indications, and two, to visually check the door clearances and determine the starboard door's ability to close. The PLBD GO/NO GO diagram located on the flip side of this procedure gives a schematic for the crew to gauge the door's clearance.

After all the closed indications are given, the door control switch is returned to the stop position, ac power is removed from the MCA's, and the PLBD enable switches are disabled. Since only three CRT's may be assigned at a time, CRT 4 is released from the SM GPC's control ("GPC/CRT 04 EXEC") to allow the third forward CRT to be used for the rest of deorbit and entry. CRT 4 is then powered off.

The manual PLBD closing procedure allows manual selection of door/latch operations for individual step by step closing of the payload bay doors. It is used when microswitch failures prevent the use of the auto sequence or anomalies require a more cautious door closing.

POST CLOSING CONFIG

TIG -02:35

Equipment associated with PLBD closing is deactivated and stowed at this time. Since CRT 4 was powered off at the end of the PLBD closing procedure, CRT 3 is powered on to obtain the nominal entry configuration. Also, foot loops located in the emergency egress routes are taped down to prevent crewmembers from tripping over them during postlanding egress (emergency or nominal).

GALLEY OR WATER DISPENSER ACTIVATION

TIG -02:31

On any given flight, either the galley or the water dispenser will be onboard. Whichever one is flown will be deactivated at this time because there is no requirement to keep the system activated once fluid loading preparation (scheduled prior to D/O Prep in the FLT PLN) is complete. The galley fan circuit breakers (cb's) are opened to minimize the risk of a short on the ac buses, and all other associated circuit breakers are pulled

in keeping with the philosophy of removing power from systems not required for entry.

PREL DEORB UPDATE/UPLINK

TIG -02:30

At this time the MCC updates (voices up) the preliminary orbital maneuvering system (OMS) propellant, deorbit, entry, and landing (DEL), and deorbit maneuver pads located in the Entry Checklist. The MCC also uplinks the current state vector and deorbit targets to the primary avionics software system (PASS) and BFS GPCs. If the MCC cannot provide (update or uplink) the deorbit targets, the SPOC can be used to generate the targets. The "PREL DEORB UPDATE/UPLINK" procedure occurs here since target and deorbit maneuver pad data are used for the maneuver to deorbit burn attitude at TIG -02:15. The "FINAL DEORB UPDATE/UPLINK" procedure occurs at TIG -00:46.

ENTRY SWITCH LIST/VER (Airlock)

TIG -02:28

The airlock and airlock hatch switch positions are verified for entry. This must be performed here since the airlock is not accessible once the middeck MS seats are installed.

HYD THERM COND - TERM

TIG -02:27

On orbit, the GPC's circulate hydraulic fluid as needed to prevent the landing gear from getting too cold for entry. This procedure terminates the thermal conditioning since it is no longer needed.

SPECIALIST SEAT INSTALLATION

TIG -02:25

The specialists' seats are removed from their orbit stowage locations, unfolded and installed in the same locations that were used for launch. After the seats have been installed, flight data file (FDF) containers may be attached to the sides of the seats. The commander and pilot seats are permanently fixed and do not need to be configured for entry.

APU STEAM VENT HTR ACT

TIG -02:24

Heaters associated with the water boiler steam vent are required to be turned on 2 hours before the auxiliary power units (APU's) are activated. This action allows the heaters to warm up to at least 130° F. The water boiler will then give a ready signal, which is one of the inputs to the APU ready-to-start talkback.

DED DISP ENT CONFIG

TIG -02:20

The flight control system and dedicated displays used for atmospheric flight must be powered on for entry. This procedure must be performed prior to the OPS 3 transition because of rate gyro assembly (RGA) and aerosurface servo amplifier (ASA) data requirements during and after the transition. The orbit DAP (OPS 2) uses only IMU data for attitude control, while the transition DAP (OPS 3) uses IMU's and RGA's. If the RGA's are not powered in OPS 3, the vehicle will spin out of control unless the DAP is configured for free drift. ASA switches in the "OFF" position at the time of the transition will result in inaccurate aerosurface position feedback to the GPC's, and thus incorrect position commands from the GPC's to the aerosurfaces at the time of APU start. This could damage actuators when full hydraulic pressure is reached.

WATER LOOP RECONFIG

TIG -02:17

The "WATER PUMP LOOP 1" switch is reconfigured from the "GPC" position to the "OFF" position. During on-orbit operations, the "GPC" position results in cyclic operation of the pump (once every fifty hours). In OPS 3, the "GPC" position results in continuous water pump "ON" commands, which is not desired except in contingency situations.

AUTO MNVR TO D/O BURN ATT

TIG -02:15

The crew will nominally maneuver the Orbiter from the IMU verification attitude directly to the deorbit burn attitude and remain there, inertially, until the burn. In general, at the time of the burn the tail is forward, the payload bay is towards the earth, and the Orbiter has some out-of-plane yaw (for propellant wasting). Maneuvering at this time allows an adequate tracking arc prior to the attitude adjustments made during the final maneuver to burn attitude at TIG -0:15.

CLOTHING CONFIG

TIG -02:10 MS,PS

TIG -01:50 CDR,PLT

The clothing configuration is performed as part of crew safety preparations for entry. Each crew member dons a launch and entry suit (LES), harness, and boots. Parachutes are strapped on upon seat ingress and act as seat-back cushions (the parachutes are Velcroed to the seat-backs for convenient storage).

The LES is a partial pressure suit that will create an artificial air pressure on a crew member in the event of a cabin leak or bail out where the ambient pressure is below 2.8 psia. The suit contains a cooling fan, G-suit, and numerous survival articles which are described in detail in the SFOM Volume 12.

The clothing configuration is split up to allow more room per crew member when performing the cumbersome task. It is performed as late as possible for crew comfort since the suits hinder movement and can become warm.

SSME HYD REPRESS PREP

TIG -02:08

This procedure configures the ascent thrust vector control (ATVC) switches in preparation for the "SSME HYD REPRESS" procedure at EI-12. The ATVC's are powered on to position the main engines in their stowed position. Improper positioning could result in bell thermal damage during entry. During the repressurization procedure itself, the hydraulic lines to the engine control valves and to the actuators are pressurized with hydraulic fluid. This ensures the valves are closed and the engines are seated securely in the stowed position for entry. The repress prep is scheduled here so that the ground can verify the ATVC's are powered on prior to the repress. The flight control system (FCS) channels are verified in "AUTO" since they control power to the ATVC's.

N2 QUANTITY COMPUTE

TIG -02:05

The nitrogen (N2) quantity is computed just prior to the OPS 3 transition and is then annotated on the cabin pressure leak nomograph in the Entry Pocket checklist. This must be performed in OPS 2 since SPEC 66 is not available in OPS 3. The purpose of the procedure is to give the crew the data necessary to determine the maximum amount of time available for deorbit in the event of a cabin leak while in OPS 3.

DPS ENTRY CONFIG

TIG -02:03

This procedure transitions the GPCs from an on-orbit configuration (GNC OPS 2 and SM OPS) to an entry configuration (GNC OPS 3 and BFS), as shown below.

Configuration	GPC				
	1	2	3	4	5
Onorbit configuration					
Major function (OPS)	GNC 2	GNC 2	GNC 3 ^a	SM	BFS, OPS 0
Mode switch	RUN	RUN	HALT	RUN	STBY
Output switch	Normal	Normal	Normal	Terminate	Normal
String assignment	1, 3	2, 4	--	--	--
CRT assignment	1	2, 4	--	--	--
Entry configuration					
Major function (OPS)	GNC 3	GNC 3	GNC 3	GNC 3	BFS, GNC 3
Mode switch	RUN	RUN	RUN	RUN	RUN
Output switch	Normal	Normal	Normal	Normal	Backup
String assignment	1	2	3	4	--
CRT assignment	1	2	3	--	--

^aFreeze-dried.

The transition to OPS 3 is performed in three main parts. First, a two-GPC redundant set is transitioned to OPS 3 using a mass memory unit (MMU) as a software source. The freeze-dried GPC remains in STBY, and GPC 4 retains SM OPS. Second, GPC 5 containing BFS software is transitioned to OPS 3 and becomes the BFS for entry. Third, GPCs 3 and 4 are added to the GPC OPS 3 redundant set. By accomplishing the reconfiguration in three steps, one GPC with OPS 3 software intact is guaranteed.

Additional procedures are integrated into those three main parts. Prior to the transition, the correct pulse code modulation master unit (PCMMU) formats, or telemetry format loads (TFL's), are loaded for OPS 3 and entry. Item 1 on the "PCMMU/PL COMM" display provides fixed formats for telemetry while the programmable formats are being changed. Item 2 then establishes

the new OPS 3 formats. Also, a SM checkpoint is performed on both MMUs 1 and 2. The SM checkpoint is performed in case a transition back to SM OPS is required (e.g., a 24 hour deorbit wave-off). The data in this checkpoint includes current fault detection and annunciation (FDA) status such as limit values, noise filter constants, telemetry constants, parameter annunciation inhibits, and current time. This eliminates the requirement to uplink any changes that were previously made to these parameters since the last SM checkpoint.

Following the transition to OPS 3, the Orbiter is maneuvered back to the deorbit burn attitude. This is necessary since the GPC's snapshot the Orbiter attitude at the transition and use this attitude as the new center of the deadband. This means the attitude could be in error from the original OPS 2 attitude due to deadband drift before and after the transition (OPS 3 deadband is 3.5°). Maneuvering back to the original attitude redefines the deadband center and minimizes drift errors.

The "HORIZ SIT" display is used to update the landing sites, and is available in OPS 1, 3, and 6. Consequently, the landing site update must be performed after the transition to OPS 3. The DEL pad in the entry checklist specifies the correct landing site to be selected. The Land Site Date Chart, located in the back of the Deorbit Prep Flight Supplement, contains specific information about the 15 landing sites loaded into the onboard software.

The crew will compare the targets previously uplinked to the "DEORB MNVR COAST" SPEC with those on the Deorbit Maneuver pad located in the Entry Checklist. The targets are then loaded, at which time the GPC's will compute a deorbit solution and the CRT timers will begin counting down to TIG. The crew will then compare the onboard target solution to the Deorbit Maneuver pad.

Finally, memory configuration 9 table is called up in order to verify correct string assignment for postlanding. This will minimize the number of keystrokes required later. Memory configuration 3 is then recalled to minimize the chance of inadvertent entries on the wrong table (MC 9) should MC3 require modification during entry.

Certain capabilities are affected once in GPC OPS 3. These are summarized below.

Category	Constraint
DAP	TRANS DAP <ul style="list-style-type: none"> • DISC rate 0.5°/sec (manual mode) • Dead band 3.5° • No vernier control hence high RCS usage
Vent doors	Ground cannot command individual doors in GNC OPS 3.
SM	No SM except for BFS; reduced FDA.
PCMMU TFL	If a PCMMU switchover occurs, must use fixed format. (TFL restricted to OPS 2.)
Port moding	Limited to OPS 2.
RGA	A minimum of two RGA's must be on to retain attitude control in GNC OPS 3.
Time	Crew cannot change CRT timer in GPC OPS 3.

DEACT STAR TRKRS AND CLOSE DOORS

TIG -01:51

After the entry IMU alignment is completed, the star trackers are no longer needed. The tracker switches are powered off and the circuit breakers are pulled to prevent inadvertent door opening during entry. The star tracker doors are then closed. The power switches and cb's apply to the star tracker electronics and door open relays and do not affect door closing capabilities. It normally takes 8 seconds for the doors to close.

The star trackers usually will not be used after the nominal entry IMU align and verification are completed. Should another alignment be necessary, the star trackers require 15 minutes for warm-up.

RESET C/W

TIG -01:38

The main propulsion system (MPS) helium regulator pressure caution and warning (C/W) is enabled so that the crew can isolate a failed open regulator independently of the MCC. A failed open regulator will cause its associated relief valve to vent into the aft compartment. This in turn could cause overpressurization of the aft compartment if the vent doors are closed. The MPS helium regulator pressure lower limits are set to zero to prevent nuisance alarms caused by expected bleeding through the MPS helium A leg regulators on the center and right engines after their isolation valves are closed at EI-13. The alarms could result in crew terminating the helium purge of the MPS during entry.

The liquid oxygen (LO2) and liquid hydrogen (LH2) manifold pressure C/W is inhibited since the MPS had been previously inerted. In this configuration, the MPS C/W will sound only for a failed helium regulator.

The hydraulic systems C/W parameters for low hydraulic pressure are activated so that an alarm will be sounded if the pressure drops below 2400 psia during entry. When the parameters are enabled, an alarm will sound and the "HYD PRESS" C/W and "MASTER ALARM" lights will illuminate, since the hydraulic system is still deactivated. The master alarm is then reset, but the "HYD PRESS" C/W will remain lit until the hydraulic systems are activated and brought up to operating pressures.

ENT SWITCH LIST/VER

TIG -01:35

The entry switch list verification procedure is used to configure switches and to verify the position of switches on the flight deck, aft deck, and middeck. It is an overall check of the Orbiter systems configuration in preparation for entry. The switch pictorials in section 3 and the procedures on page FS 1-16 are used to accomplish this task. Each crewmember is responsible for the panels located on a particular area of the vehicle. The commander and pilot accomplish all the forward station panels, one MS configures and verifies switch positions of the aft deck panels, and a second MS handles switches on the middeck panels.

All switches fall into one of three main categories:

1. A switch action is required at this time, i.e., the switch must be configured to its correct entry position. Switches in this category have a solid box around them on the pictorials and are also listed on page FS 1-16.
2. A switch position verification is required at this time, i.e., the switch is already in the correct position for entry but should be checked again. These switches are not boxed and are not shaded.
3. There is no requirement to inspect a switch at this time, i.e., the switch is already in the correct position and there is no need to check it again. These switches are ziptoned (shaded) on the pictorials.

The pictorials assume that all Orbiter systems are healthy and have been configured per nominal management plan.

The following are some notes of interest regarding actions on FS 1-16.

The callouts underneath the MADS/ACIP HTR header will vary depending on which vehicle is flying. The aerodynamic coefficient instrumentation package (ACIP) is only onboard OV102, so the "ACIP HTR - OFF" callout will appear only for OV102 missions. Shuttle infrared leeside temperature sensing (SILTS) equipment is also only onboard OV102, so equipment activation procedures are only called out on OV102 missions. Modular auxiliary data system (MADS) equipment is only onboard OV103 and OV104 so that "MADS STRAIN GAGE - PCM ENA" appears only on OV103 and OV104 missions.

The teleprinter is deactivated by turning the "DC UTILITY PWR MNC" switch to "OFF". The teleprinter power cable is disconnected so that a LES suit fan can be plugged into that outlet. The middeck MS will be required to remove the teleprinter comm cable and install the LES comm cable into panel A15 just prior to MS seat ingress (TIG -00:15). The teleprinter is deactivated this late in the timeline since entry related messages are typically uplinked in the D/O Prep timeframe.

ENTRY REVIEW

TIG -01:20

The crew is allotted 20 minutes for entry review prior to seat ingress. This time may be used to resolve any open items prior to entry and to review the entry procedures. This time period also serves as "padding" in case the crew is behind in the timeline. If everything is on schedule, the crew can use this time to eat a snack.

FLUID LOADING

TIG -01:06

Fluid loading, during which the crew consumes a salt/water mixture similar to body fluids, is a tested standard operating procedure that significantly reduces detrimental heart rate and blood pressure changes resulting from orthostatic stress experienced post flight.

WIRELESS STOW

TIG -00:58

When ready for seat ingress, the commander and pilot will disconnect their wireless headsets and connect their LES comm systems. The aft deck MS will then stow those headsets while waiting until MS seat ingress (TIG - 00:15) to stow his/her own along with the other MS's.

HUD SETUP

TIG -00:57

There is a cover over each of the two heads-up display (HUD) units during the orbit phase. The commander (CDR) and pilot (PLT) will remove these covers prior to entry and ensure that the remaining cloth cover does not obscure the light sensor on the HUD.

WCS DEACTIVATION

TIG -00:57

The WCS is deactivated as late as possible to allow crew use, if necessary. WCS related equipment is stowed and the WCS vacuum valve is closed to isolate the commode outlet valve from the vacuum vent. The vacuum vent isolation valve is closed to protect against an air leak through the vent lines during entry.

LES PRESS INTEGRITY CHECK

TIG -00:53

The LES pressure integrity check is performed to assure proper suit connections and indicate suit pressure integrity. The check is performed after the Orbiter "LEH O2" valves are opened. The crew members each close their visor and suit controller valve, and then opens his/her suit O2 manifold valve, allowing the suit to inflate within a couple minutes. If the suit does not inflate properly, the connections are checked. According to the Flight Rules, the deorbit burn will not be delayed because of a failed integrity test.

SECTION 2
DEORBIT PREP BACKOUT

2.1 OVERVIEW

The deorbit prep backout is used to place the Orbiter systems into a safe configuration for orbit operations in the event of a 24-hour mission extension. Typically, these procedures are used when poor weather conditions exist at the landing site. They may also be used if specific systems failures necessitate a waveoff. The GO/NO GO decision for the deorbit burn is made approximately 17 minutes before the burn (entry checklist), although the decision to waveoff could occur during the burn itself, if a systems failure during the burn resulted in burn termination above a safe height at perigee (Hp). Accordingly, the deorbit prep backout procedures assume that all entry procedures prior to the deorbit burn have been accomplished.

The deorbit prep backout procedures are referenced to the scheduled time of the deorbit burn. The timescale "ET" indicates elapsed time since TIG.

2.2. DETAILED PROCEDURES

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PAYLOAD REACT

ET 0:00 to ET 1:00

Depending on flight-specific requirements, actions may be required to configure a payload for the 24 hour on-orbit period. Since payload procedures and the timing of those procedures vary from flight to flight, a payload reactivation callout was placed at the top of the first two detailed timeline pages. If a payload reactivation is required in the timeframe of a given page, the ET is pen-and-inked onto the appropriate blank as part of the errata package. The associated procedural steps will be located on the aft deck MS page in the Flight Supplement. If a payload reactivation is not required, "N/A" is pen-and-inked onto the blanks as part of the Errata Package.

APU/HYD/MPS CONFIG

ET + 0:03

If the decision to wave off was made within five minutes of TIG, one APU will have been started and the other two will have been placed in a pre-start configuration. If this is the case, the started APU will be deactivated at this time per cue card procedures. All three are then placed back into the on-orbit configuration.

The "BLR N2 SPLY" switches are turned off, thereby closing the gaseous nitrogen (GN2) shutoff valves and preventing pressurization of the water spray boiler (WSB) water tanks. This action will prevent GN2 loss until needed for WSB operation in the event of a leak downstream of the valve.

The "HYD MAIN PUMP PRESS" switches are placed back in the "NORM" position to prevent their corresponding solenoids from burning out. Each solenoid, while powered in the "LOW" position, depressurizes the main pump to reduce pump torque for APU startup.

The helium isolation valves are closed to obtain the nominal on-orbit configuration. This protects against expected helium leakage through the engine pneumatics packages and possible helium system leaks.

LEH O2 CONFIG

ET 0:07 and 0:10

All crewmembers close their LEH valves at the beginning of the D/O PREP backout in preparation for helmet doffing. This action cuts off the oxygen supply to the LES's and routes more oxygen to the cabin regulators.

CONFIG COMM/HTR

ET 0:11

Following seat egress, the middeck MS unstows either the wireless headsets or the handheld microphones (used in conjunction with the speaker boxes) for the rest of the crew. This allows the crew to transfer from the LES comm system to the nominal on-orbit comm system.

The vacuum vent nozzle heater is activated and the isolation valve is opened in preparation for WCS usage. Activating the nozzle heater here allows sufficient warm-up time prior to WCS activation.

CONFIG FOR PLBD OPENING

ET 0:12

During this procedures, the aft deck MS powers up CRT 4 and assigns it to the BFS GPC (GPC 5). The BFS GPC and the "BFS SM PL BAY DOORS" display are used to open the payload bay doors since door opening occurs while still in OPS 3.

The "ANNUN BUS SEL" switch is configured so that power is supplied to the aft panel annunciator lights. Payload bay flood lights are activated in order to provide optimal lighting for PLBD viewing. As in nominal D/O Prep, the number of floodlights activated is dependent on payload constraints.

VERNIER HTR ACT

ET 0:16

The vernier RCS heaters are activated in preparation for vernier usage in OPS 2. The time required for vernier warmup is directly proportional to the amount of time they have been activated. Since flight data (STS 61-C) indicated that jet warmup can take up to 6 hours, heater deactivation for entry was moved from TIG -1:30 to TIG -0:15. The MCC will monitor jet temperatures and give a GO for verniers once acceptable values are reached.

RAD ACT

ET + 00:17

The radiators are reactivated for the extra on-orbit stay in order to take over the cooling requirements from the FES. The radiators are taken from a manually-set full bypass to an automatically controlled mode that will maintain radiator Freon outlet temperatures within normal limits (around 39°).

The procedure is performed before the payload bay doors are opened to prevent radiator exposure to deep space prior to Freon flow. An initial surge of cold Freon could cause automatic shutdown of the controller.

A contingency procedure is included to address incorrect talkback indications during the automatic startup sequence. It should be noted that, unlike the post insertion procedure, the manual mode for configuring the bypass valve will not be used in the deorbit prep backout contingency procedure. The radiators contain very cold Freon from the coldsoak which, if allowed to rush through the bypass valve and flow control valve, could freeze water at the Freon/water interchanger. This in turn could damage the interchanger, water loops, and or freon loops.

At the end of the radiator activation procedure, the water pump is placed under GPC control to prevent freezing of the water at the Freon/water interchanger. It is configured at this time so the pump will cycle on at

the SM transition. If it were configured after the transition, the time that the pump would come on would depend on where the timer was in its 50-hour cycle.

FDF/TPR CONFIG

ET 0:18

The entry-related FDF articles are stowed for the on-orbit phase. The orbit cue cards are unstowed and placed in their proper places.

The teleprinter may be required for message uplink during the mission extension. The teleprinter activation cue card contains the steps necessary to provide power and configure the comm panels for teleprinter operations.

OPEN VENT DOORS

ET 0:20

The vent doors were closed at TIG -0:25 in preparation for entry. They are opened on orbit to prevent forward or aft compartment overpressurization in the event of an RCS leak.

MIDDECK CONFIG

ET 0:22

As stated in section 1, either the galley or the water dispenser is flown every flight. The appropriate cb's and switches are configured to provide power to the system. If the galley is flown, the galley supply and MV3 valves are verified open prior to water heater activation. This will keep the galley hot water tank from overpressurizing, cracking, and leaking water into the cabin (note that the rupture would not be explosive).

The WCS is configured for use by locking down the foot restraints, verifying air flow through the system, and installing WCS equipment and cue cards. Also, the WCS vacuum valve is opened to depressurize the commode.

The backup SPOC will be activated for the on-orbit phase. The SPOC provides information such as day/night cycles, comm acquisition of signal/loss of signal (AOS/LOS) times, ground track, and earth observation cues. The flight deck SPOC is still operating since it is nominally not stowed until EI-11.

The escape pole is stowed on the middeck ceiling at this time so that it will not obstruct on-orbit middeck activities.

PLBD OPENING

ET + 0:24

The payload bay doors are opened to meet Orbiter cooling requirements. The CDR and PLT will open the doors using the "EMERGENCY PLBD OPENING" procedure located in the Entry Pocket checklist. This procedure uses the "BFS, SM 63 PL BAY DOOR" display for the automatic opening sequence. The BFS is used because the transition to OPS 2 has not been performed and a PASS SM GPC is

not available. However, if the BFS GPC fails, the crew will perform the transition at this time so the PASS SM may be substituted. Also, as in the closing procedure, the PLBD opening procedure allows manual operation of the doors in case micro-switch failures prevent the use of the auto sequence.

RAD DEPLOYMENT

ET 0:29

If higher than normal thermal loads are expected for the 24-hour extension, the radiators will be deployed as soon as the payload bay doors are opened. The MCC will make the call. The "PL BAY MECH PWR" switches enable power to the radiator latch and deploy motors. The latch release and radiator deploy are timed separately. Expected drive times are 25 and 40 seconds, respectively, based on operational data. If expected times are exceeded for either radiator, both radiators are stowed and latched and then only the good radiator is deployed.

CLOTHING CONFIG

ET 0:31 & ET 0:50

The entry clothing gear is doffed and stowed for the on-orbit period. This procedure is performed early in the timeline since the suits hinder movement and can get quite warm. Used urine collection devices (UCD) and emesis bags are doffed and placed into the wet trash compartments located in the middeck floor.

KU-BD ANT DEPLOY

ET 0:36

Deployment of the Ku-band antenna for extension days depends on several factors including antenna failure status, specific comm requirements (e.g., TAGS may be required for message uplink) and powerdown requirements (the Ku-band system is powered off as part of the Group C priority powerdown). The MCC will make this call.

FES CONFIG

ET 0:39

FES controller B is turned off and controller A is turned on per the standard on-orbit configuration. Since FES A utilizes water from tanks A and B (as long as the "SPLY H2O XOVR" valve is closed), this configuration preserves water in tanks C and D for entry. The controllers are configured prior to the OPS 2 transition to prevent FES shutdown. The GPC position is not supported through the transition.

DPS CONFIG TO GNC2/SM

ET 0:40

After the payload bay doors are opened and the radiators are activated, the Orbiter can safely stay on orbit for another 24 hours. At this time the GPC's are configured from the entry configuration (GNC OPS 3 and BFS) to the orbit configuration (GNC OPS 2 and SM OPS).

Firstly, GPC's 1 and 2 are transitioned to GNC OPS 201 and are placed in control of all four flight critical strings. At this point the BFC lights on panels F2 and F4 begin flashing since the BFS loses track of the PASS. The "BFS MSG RESET" will deactivate the lights.

GPC 3 will then be freeze-dried with OPS 3 software. This will provide an independent OPS 3 source in the event that both MMUs fail.

GPC 4 is transitioned to SM OPS 201 (or 401). SM OPS 201 and 401 contain identical Orbiter systems software but different payload software. The east tracking and data relay satellite (TDRS) is then selected on the "SM ANTENNA" display so that the SM GPC will know which TDRS satellite track. "UL CNTL AUTO" on the "DPS UTILITY" display establishes automatic GPC control of the uplink enabling function.

GPC 5 is then moded to standby to relinquish control of the payload buses to the SM GPC. GPC 4 output is placed to "TERMINATE" to protect the SM computer from inadvertently communicating with the flight critical strings. GPC 5 output is placed in "NORM" to disable its BFS engage capability, and is then powered off.

The standard PCMMU telemetry formats for OPS 2 are then loaded. Item 1 on the "PCMMU/PL COMM" display provides fixed formats for telemetry while the programmable formats are being changed. Item 2 then establishes the new OPS 2 formats.

The CRT's are placed in their standard on-orbit configuration (CRT 4 had been activated earlier in the timeline). Finally, item 48 on the "GPC MEMORY" display resets the input/output (I/O) error log, restarts the sync history log and extinguishes the computer annunciation matrix (CAM) lights.

RAD VERIF & FLASH EVAP CONFIG

After the transition to OPS 2, radiator cooling is verified by observing a reduction in the Freon loop radiator out temperature on SM SPEC 88 (only available in OPS 2). This is done so the high load evaporator can be deactivated until needed again for cooling on entry. Then the H2O supply crossover valve is closed to allow water tanks C and D to fill. These tanks will be preserved for FES use on entry. Meanwhile tanks A and B feed the topping FES through controller A as needed for extra cooling during the on-orbit stay.

RMS PNL LTS, TEMP MON, HTR ACT / HYD C/W

ET 0:50

If the RMS is flown, the "RMS PRI" cb and "RMS PWR" switch are configured to supply power for RMS display and control functions, including panel lighting. Item 5 on the "PDRS CONTROL" display allows the SM GPC and manipulator controller interface unit (MCIU) to communicate. The "SAFING" switch is configured to cancel any previous manual "SAFE" inputs and enable

the auto safing function. Finally, the RMS heaters are configured so that the arm will be thermostatically maintained at the proper temperature. The hydraulic systems C/W parameters for low hydraulic pressure were enabled for entry. These parameters are inhibited for on-orbit operations since the hydraulic parameters are required only when the hydraulic system is operating. When they are inhibited, the "HYD PRESS" light in the C/W matrix (panel F7) will go out.

CONFIG RJD's

ET 0:55

Vernier RCS jets are selected as early as possible in order to conserve propellant. Verniers may not be used until the transition to OPS 2 is complete, the high load FES is turned off, and the jet temperatures have warmed up to acceptable levels. The MCC will give a GO when all these constraints are met.

There is a five second wait between driver activation and jet selection. This reflects the time required for vernier drivers to fully power up. If vernier jets were selected within five seconds, the jets would not fire on command and a false jet fail off message would be annunciated.

BRAKES, FCS & DED DISP ON-ORBIT CONFIG

ET 1:05

The flight control system and dedicated displays used for atmospheric flight are deactivated at this time to conserve power. The DDU AFT cb's are closed in order to enable aft panel display and control functions for the on-orbit period.

ON-ORBIT HTR/MADS CONFIG

ET 1:20

During this procedure, heaters associated with the water boiler steam vent are turned off since the APU's and water spray boiler are only used during entry. The hydraulic brake heaters are powered off since the hydraulic lines to the main gear brakes only require heating during entry. The high load duct heater is deactivated since the high load FES was powered off earlier. The heater should remain on at least 30 minutes after high load FES deactivation to completely bake out the duct and remove all ice. The hydraulic heaters on panel A12 are activated so that the aerosurface hydraulic actuators are thermostatically maintained at the proper temperature on orbit. The RCS/OMS heaters are activated so that the forward RCS area and the left and right pod areas are thermostatically maintained at the proper temperatures. ACIP, MADS, and SILTS equipment associated with entry are placed in their standard on-orbit configuration. As discussed in section 1, different vehicles carry different entry-related equipment. On OV102, the ACIP heater is activated for orbit and SILTS equipment is powered off. On OV103 and OV104, the MADS STRAIN GAGE is powered off for orbit. Finally, the KU cbs are closed to power the Ku-bd antenna heater and to enable antenna operations and monitoring.

AUTO MNVR -ZLV, +XVV

ET 1:30

Until this time, the Orbiter has been in the deorbit burn attitude. Once the transition to OPS 2 is complete, the tracking option on the UNIV P7G display can be utilized to define an attitude. The specified maneuver places the payload bay towards the earth and the nose forward.

SIG COND CONFIG

ET 1:38

Signal conditioner circuit breakers on panel L4 are closed so that humidity separator speeds and IMU fan speeds can be monitored by the MCC and crew. They are normally not powered for ascent and entry to avoid unnecessary loads that might cause ac phase-to-phase shorts when the wires run in a common wire bundle.

ON-ORBIT PCS CONFIG

ET 1:40

The pressure control system (PCS) is placed in its nominal orbit configuration by both the CDR and the middeck MS. PCS 2 is used to maintain cabin pressure at 14.7 psi, while system 1 is closed.

The O2 bleed orifice assembly is inserted into the "LEH O2 5" quick-disconnect on panel M032M per nominal orbit operations. The bleed orifice provides a constant O2 flow to the cabin that matches the metabolic O2 consumption rate of the crew. This minimizes the number of regulator cycles required to maintain proper O2 levels.

STAR TRKR ACT

ET 1:41

The star trackers are activated so that they may be used for IMU alignments on orbit. The "STAR TRKR" cb's and "STAR TRKR PWR" switches are configured to provide power to the tracker electronics and the door open relays. The "GNC I/O RESET" is performed so that the GPC's and trackers can communicate. The normal opening time for each door is 8 seconds. After a 15 minute warmup period, the star trackers can be used to take star data for IMU alignments.

THERM COND ENA

ET 1:45

This procedure enables GPC cycling of the hydraulic circ pumps on orbit. Hydraulic fluid will be circulated as needed to prevent the landing gear from getting too cold for entry.

APU COOL CONFIG

ET + 1:45

If an APU was started for entry and subsequently deactivated as part of the backout, the "APU FUEL PUMP/VLV COOL" switches will have been powered on to cool the fuel pump package and fuel valves. These switches are powered off at this time since the APU fuel/pump valve temperatures should be at desired levels.

SECTION 3
BFS DEORBIT PREP NOTES

This section contains a list of Orbiter systems limitations for the BFS-engaged scenario. These notes apply to the D/O Prep and entry timeframe, and are included as reference material. The notes are summarized as follows.

Crew optical alignment sight (COAS) calibrations and IMU alignments cannot be performed since the "S TRK/COAS CNTL" and "IMU ALIGN" displays are not available on the BFS. All vehicle attitude maneuvers in all of OPS 3, including deorbit burn thrust vector control, must be performed manually using the rotation hand controller (RHC). The capabilities to select Greenwich mean time (GMT) or MET as the mission time on all CRT displays, update GMT or MET, and set a desired time at which an alert tone sounds do not exist on the BFS. These functions are normally performed using SPEC 2. Only a manual RCS to RCS crossfeed may be performed on the BFS. Finally, the BFS will only recognize a PASS port mode if a "BFS I/O RESET" is performed prior to BFS engage.

There is also a subset of switches that are not supported by the BFS, i.e., these switches are not operational if the BFS is engaged. In many cases, it is only the "GPC" switch position that is not supported by the BFS. This means that the particular system cannot be reconfigured via GPC commands. Manual capability still exists for these switches.

SECTION 4
CONTINGENCY PLBD CLOSURE

This procedure was originally written in response to a PLBD anomaly that occurred on STS-4. It is designed to handle a door closing contingency in which either the port or starboard door gets caught up on the aft bulkhead seal and will not close. It is assumed that this bulkhead/door interference is caused by non-uniform thermal loading. The problem can be identified by failing to get the port door scallop below the top of the target line on the aft bulkhead and not receiving an aft microswitch status of "1" after commanding the door closed and waiting the required time for a nominal closing. This failure is more prone to occur on the port door, but could occur on the starboard as well.

This procedure is referenced from Nominal D/O Prep as well as many contingency deorbit prep procedures. It allows for thermal conditioning of the doors when there is plenty of time available before the deorbit burn, as in nominal end of mission. The procedure also handles "forcing" the doors closed if there is no time for thermal conditioning, as in certain off-nominal deorbit preps, or if thermal conditioning is not successful.

The procedure begins by attempting to cycle the doors open and closed once. If this attempt does not succeed and time permits, the vehicle is thermally conditioned in a top sun attitude for one dayside pass followed by another attempt to close the door. If this attempt does not succeed and door closure is at nominal end of mission, the PLBD's are opened and the crew waves off for 24 hours remaining in a top sun attitude. If not at nominal end of mission, the door is cycled one more time. If still unsuccessful, steps 24 through 37 are used.

Steps 24 through 37 could result in door structure and bulkhead latch mechanism damage and should only be used if absolutely necessary. These steps force the doors closed by creating a zipper effect with the latches. The starboard and port forward latches are closed, and then the centerline latch groups are closed working from the forward latch groups to the aft latch groups. After the doors are closed, the remaining starboard and/or port aft latches are closed.

SECTION 5
CONTINGENCY DELTAS TO NOMINAL DEORBIT PREP

5.1 OVERVIEW

This section contains a list of deltas to the Nominal D/O Prep for certain systems failures. Since these failures result in an off-nominal systems configuration, the D/O Prep (which assumes a healthy Orbiter) must be modified accordingly. Only failures requiring minor modifications to D/O Prep are included in this section. If major modifications are required, a separate, stand-alone procedure tailored to that failure is located in the Contingency Deorbit Prep book.

5.2 DETAILED PROCEDURES

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LOSS OF AV BAY AIR COOLING	5-2
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AV BAY FIRE	5-4

LOSS OF 2 CABIN FANS

This failure results in loss of cooling to the crew and to air-cooled equipment in the cabin. It is very severe in that it results in high humidity and high carbon dioxide (CO2) levels in the cabin. Although a next PLS will be targeted for this failure, the MCC may call for an earlier deorbit to an emergency landing site (ELS) based on real-time monitoring of the crew condition and cabin environment.

A powerdown is performed immediately upon recognition of the failure, and is maintained until the D/O Prep/entry timeframe. The most critical pieces of equipment affected by this failure are CRT's, display driver units (DDU's), flight controller power and instrument power. Consequently, these should be powered only when absolutely necessary. One CRT should be used at a time except for the more involved D/O Prep procedures ("IMU ALIGN", "DPS ENTRY CONFIG"). Since CRT 4 is not used during entry, it should be used as much as possible during D/O Prep. CRT's should be managed such that two are saved for entry. During the "DPS ENTRY CONFIG" procedure, the SM checkpoint and the MC9 reconfiguration are deleted to reduce CRT usage. Any moisture condensing on the cabin walls or equipment should be wiped off with a towel to minimize the risk of electrical shorts. Both the tail-Sun attitude and the window shades keep the cabin cooler by preventing the Sun from shining into the cabin.

LES donning should be delayed until post-TIG since it degrades the body's ability to reject heat into the cabin. Even at temperatures over 95°, the crew can reject body heat into the environment through evaporation of

perspiration (cabin humidity will probably never reach 100 per cent due to condensation on the colder parts of the cabin). If a crewmember becomes uncomfortable, the LES helmet and helmet retention assembly (HRA) can be donned so that cool, dry oxygen can be breathed. The suits should be donned by EI since the crew will be dehydrated both from the zero-g environment and the degraded cabin environment. The suits will help this situation in a gravity environment by minimizing the pooling of body fluids and forcing blood to vital internal organs, thus helping to prevent blackout and cardiovascular collapse.

LOSS OF AV BAY AIR COOLING

Loss of AV bay air cooling can be caused by loss of both fans in an AV bay, ducting blockage or a failed AV bay/water loop heat exchanger. This failure needs to be addressed immediately to prevent equipment from overheating and subsequently failing. GPC FRP-7 in the Malfunctions book takes care of moving GNC, SM, and BFS functions into cooled AV bay GPC's, as well as powering down appropriate line replaceable units (LRU's).

If AV bay 1 or 2 cooling is lost, then GPC 1 or 2 is affected. The affected GPC is removed from the G2 set and is powered down. Consequently, the first part of the "DPS CONFIG FOR D/O PREP" procedure should be skipped.

Tactical air navigation (TACAN) units, microwave landing systems (MLS's), accelerometer assemblies (AA's), air data transducer assemblies (ADTA's), and brakes are also affected by this failure and should be activated as late as possible during entry. The equipment cooling matrix, located in both the Orbit and Entry Pocket checklists, indicates which of these are affected for each AV bay. All of this equipment except for the affected TACAN is powered on at EI. The TACAN has a 3 to 5 minute lifetime without cooling and should be activated as late as possible only if one of the other two TACAN's fails.

Since D/O Prep and entry are accomplished with less than a full complement of GPC's, it is necessary to make a significant number of modifications to the "DPS ENTRY CONFIG" procedure. If AV bay 1 cooling is lost, GPC's 2 and 3 will contain GNC OPS 3 software and GPC 5 will contain the BFS software. If AV bay 2 cooling is lost, GPC's 1 and 4 will contain GNC OPS 3 software and GPC 3 will contain BFS software. If AV bay 3 cooling is lost, GPC's 1, 2 and 4 will contain GNC OPS 3 software and GPC 5 will contain BFS software. In any case, all strings are assigned to the operating GNC OPS 3 GPC's.

In general, one FCS channel is assigned to each GPC via nominal bus assignment table (NBAT) string assignments. If each GPC does not control an equal number of channels, subsequent failure of the GPC with the greatest number of channels could cause bypass of the good channels and loss of vehicle control. If three PASS GPC's are available for entry (loss of cooling in av bay 3), one FCS channel is powered off leaving one active channel per GPC. With the switches in the "AUTO" position, a subsequent GPC failure will result in a 2-on-1 force fight and bypass of the bad channels. If two PASS GPC's are available for entry (loss of cooling in AV bay 1 or 2), each of them will command two FCS channels. With the channels in "AUTO", a GPC

failure could cause a 2-on-2 force fight resulting in bypass of the two good channels before any crew/MCC action can be taken. Consequently, the FCS channels are placed to the "ORIDE" position to prevent automatic bypass of any channels in the event that a GPC failure causes bad flight control commands to be issued. With the channels in "ORIDE" (bypass capability inhibited), it is hoped that if one of the two remaining GPC's fails, the crew/MCC will have time to turn the bad channels off or engage the BFS.

It generally takes about 3 hours for an unpowered GPC to stabilize at ambient temperature if cooling is lost. It then can be expected to operate normally for approximately 1 hour. Consequently, if the affected GPC's have been powered off for 3 hours or more just prior to the OPS 302 transition, they can be powered up and added to the G3 redundant set for entry. The NBAT's are configured so that string 4, considered the least critical string, is assigned to one of the GPC's in the uncooled AV bay. This minimizes the impact of GPC failure due to overheating during entry. Since 4 PASS GPC's are available for entry, each of them will command one FCS channel in the AUTO position per nominal operations.

There is a "GPC/FCS CHANNEL CONFIGURATION" cue card that indicates which FCS channels are assigned to each GPC. This must be updated per the off-nominal stringing. In the event that a GPC fails during entry, this cue card is a quick indication of which FCS channel should be powered off.

8 PSI DEORBIT PREP

This procedure modifies D/O Prep for the 8 psi cabin scenario. If a cabin leak develops, the "O2(N2) FLOW HIGH/CAB P LOW/DP DT" procedure in the Orbit Pocket Checklist configures the PCS system so that cabin pressure is controlled to 8 psi. This action extends the amount of time available before a deorbit is necessary. The cabin pressure leak nomograph in the Orbit Pocket checklist indicates the maximum amount of time until the deorbit burn based on cabin pressure, leak rate and total N2 quantity. The actual time to TIG will depend on landing site availability. The "LOSS OF CABIN PRESSURE" powerdown follows the first Orbit Pocket procedure. A powerdown is necessary since cabin cooling is not as efficient at lower pressures. Depending on the time to TIG, the powerdown will lead into one of two procedures for the orbit case. If TIG <02:40, the Emergency D/O Prep in the Contingency D/O Prep book will be used. If TIG >02:40, the 8 PSI D/O PREP will be used.

The "8 PSI D/O PREP" procedure begins with a decision point based on time available until TIG. If TIG >4 hours, then the time before D/O Prep can be used to perform required end of mission activities normally scheduled in the CAP prior to D/O Prep. Also, GPC's 1 and 5 were powered down and should remain powered down until the "DPS ENTRY CONFIG" procedure. If TIG <4 hours, the required end of mission activities will be integrated into the D/O Prep timeframe and all GPC's will be managed per nominal operations.

Window shades remain installed as long as possible to keep Sun out of the cabin and reduce the cabin heat load. A stand-alone radiator bypass

procedure replaces the nominal "RAD BYPASS/FES C/O" procedure since the FES checkout induces high coolant loop temperatures and decreases cooling efficiently. Checkout of alternate FES controllers reduces ground turn-around time only and is not critical to mission success. ADTA's, TACAN's, MLS's, radar altimeters (RA's), DDU's and instrument power remain unpowered as long as possible in order to minimize cabin heat load and to prevent the units from overheating. The time at which they are powered up corresponds to systems requirements and thermal analysis assumptions.

AV BAY FIRE

If an AV bay fire is detected on orbit, the Orbit Pocket checklist takes care of powering down all affected equipment in that AV bay. All equipment in the affected AV bay will be considered lost until proven otherwise, with the exception of IMU fans and communications equipment. Once the AV bay is considered safe, a malfunction procedure is performed to restore equipment essential for entry to a single fault tolerant configuration, as well as certain instrumentation equipment. Since most of the equipment may not have been in use during the fire or may have suffered failures not immediately detectable, a single fault tolerant configuration is deemed necessary to minimize risk.

The contingency deltas for this scenario are similar to those for the loss of AV bay air cooling in that the same equipment is affected. The difference is that since overheating is not a problem (i.e., AV bay air cooling is available), equipment is powered on at the nominal times. Once equipment is powered, however, it is only to a single fault tolerant level.

ACRONYMS

AA	accelerometer assembly
ac	alternating current
ACIP	aerodynamic coefficient instrumentation package
ADTA	air data transducer assembly
ANG ERR	angular error
AOS	acquisition of signal
APU	auxiliary power unit
ASA	aerosurface amplifier
ATVC	ascent thrust vector control
AV	avionics
BFS	backup flight system
CAM	computer annunciation matrix
cb	circuit breaker
CDR	commander
CO2	carbon dioxide
COAS	crew optical alignment sight
CRT	cathode ray tube
C/W	caution and warning
DAP	digital autopilot
DDU	display driver unit
DEL	deorbit, entry and landing
D/O PREP	deorbit preparations
DPS	data processing system
EI	entry interface
ELS	emergency landing site
ET	elapsed time
FCS	flight control system
FDA	fault detection and annunciation
FDF	flight data file
FES	flash evaporator system
FLT PLN	Flight plan
GMT	Greenwich mean time
GN2	gaseous nitrogen
GNC	guidance, navigation and control
GPC	general purpose computer
HRA	helmet retention assembly
HP	height at perigee
HUD	heads up display
IMU	inertial measurement unit
I/O	input/output

LES	launch and entry suit
LH2	liquid hydrogen
LO2	liquid oxygen
LOS	loss of signal
LRU	line replaceable unit
MADS	modular auxiliary data system
MCA	motor control assembly
MCC	mission control center
MCIU	manipulator controller interface unit
MET	mission elapsed time
MLS	microwave landing system
MMU	mass memory unit
MPS	main propulsion system
MS	mission specialist
N2	nitrogen
N/A	not applicable
NBAT	nominal bus assignment table
O2	oxygen
OMS	orbital maneuvering system
OPS	operational sequence
PASS	primary avionics software system
PCMMU	pulse code modulation master unit
PCS	pressure control system
PLBD	payload bay door
PLS	primary landing site
PLT	pilot
PRCS	primary reaction control system
RA	radar altimeter
RGA	rate gyro assembly
RHC	rotation hand controller
RMS	remote manipulator system
SFOM	Shuttle flight operations manual
SILTS	Shuttle infrared leeside temperature sensing
SM	systems management
SMS	Shuttle mission simulator
SOP	subsystem operating program
SPEC	specialist function display
SPOC	Shuttle portable onboard computer
STBD	starboard
TACAN	tactical air navigation
TAGS	text and graphics system
TDRS	tracking and data relay satellite
TFL	telemetry format load
TIG	time of ignition
TV/VTR	television/video tape recorder

UCD urine collection device
VRCS vernier reaction control system
WCS waste collection system
WSB water spray boiler

·END·