1.0 FUEL CELL MONITORING SYSTEM (version 2.00, 9/2002)

1.1 FCMS Display and Operation

Once data is being received, FCMS will be opened and the user will see all three substacks for fuel cell 1, as seen below. Each cell is individually numbered. Cells 1 through 16 are added together and compared to cells 17-32 to compute a substack delta-V. This number should be ballpark close to the value seen on the orbiter CRT but will probably not exactly match due to different software algorithms.

-												
File Display Help												
												í l
		UEI	6	CF	11 1	1	G₩	IT : 2	39/13:29:	01.038		- Disalawad Ewal Call
							L					Displayed Fuel Cell
	Subs	tack 1			Subst	ack 2			Subs	tack 3 👘		• Fuel Cell 1
1	954	954	17	33	954	953	49	65	952	952	81	C Fuel Cell <u>2</u>
2	955	961	18	34	956	955	50	66	955	959	82	○ Fuel Cell <u>3</u>
3	960	958	19	35	956	961	51	67	959	961	83	
4	955	961	20	36	961	959	52	68	954	955	84	Freeze Display
5	956	961	21	37	955	959	53	69	958	956	85	
6	959	958	22	38	960	959	54	70	952	959	86	Muto Sound
7	960	956	23	- 39	957	959	55	71	959	958	87	i <u>m</u> ute sound
8	952	956	24	40	958	955	56	72	961	958	88	
9	961	953	25	41	957	961	57	73	952	959	89	1
10	952	960	26	42	961	959	58	- 74	958	957	90	<u>R</u> ecord
11	954	959	27	43	961	960	59	- 75	952	955	91	NOT RECORDING
12	961	952	28	- 44	953	954	60	76	953	961	92	NOT RECORDING
13	958	956	29	45	959	957	61	- 77	959	604	93	
14	957	958	30	46	959	956	62	78	953	1199	94	
15	953	954	31	47	961	958	63	79	959	OSL	95	
16	952	961	32	48	959	959	64	80	956	OSH	96	
	15.299 V	15.318 V			15.327 V	15.324 V			15.292 V	14.544 V		
	SSAV	19 mV			SSAV	3 mV			SSAV	748 mV		
	SS1 30.617 V SS2 30.651 V SS3 29.836 V FCMS is running in						FCMS is running in					
												demonstration mode
Recei	ving fuel	cell data	a fror	n Den	no Data F	ile						

In the lower right corner is a note about the the data being recorded. For the SYS PGSC class, it reads "FCMS is running in demonstration mode". If it's not set to run in Demo mode, it will not be present, meaning it's recording real data.

If FCMS is started and data is not available, all the data will be "XXX" in cyan (the color that signifies missing data).

🚯 Fuel Cell Monitoring System												
File Display Help												
	Subs	tack 1			Subst	ack 2			Subst	tack 3		• Fuel Cell 1
1	XXXX	XXXX	17	33	XXXX	XXXX	49	65	XXXX	XXXX	81	© Fuel Cell <u>2</u>
2	XXXX	XXXX	18	34	XXXX	XXXX	50	66	XXXX	XXXX	82	C Fuel Cell <u>3</u>
3	XXXX	XXXX	19	35	XXXX	XXXX	51	67	XXXX	XXXX	83	E France Direlan
4	XXXX	XXXX	20	36	XXXX	XXXX	52	68	XXXX	XXXX	84	Freeze Display
5 C	XXXX		21	37			53	- 69 - 70			85 96	
0	XXXX	XXXX	22	30 39	XXXX	XXXX	54	70	XXXX	XXXX	00 87	Mute Sound
8	XXXX	XXXX	24	40	XXXX	XXXX	56	72	XXXX	XXXX	88	
9	XXXX	XXXX	25	41	XXXX	XXXX	57	73	XXXX	XXXX	89	
10	XXXX	XXXX	26	42	XXXX	XXXX	58	- 74	XXXX	XXXX	90	<u>R</u> ecord
11	XXXX	XXXX	27	43	XXXX	XXXX	59	75	XXXX	XXXX	91	NOT RECORDING
12	XXXX	XXXX	28	44	XXXX	XXXX	60	76	XXXX	XXXX	92	
14	YYYY	YYYY	30	40	XXXX	YYYY	62	78	YYYY	XXXX	94	
15	XXXX	XXXX	31	47	XXXX	XXXX	63	79	XXXX	XXXX	95	
16	XXXX	XXXX	32	48	XXXX	XXXX	64	80	XXXX	XXXX	96	
	xx.xx v	xx.xx v			xx.xx v	xx.xx v			xx.xx v	xx.xx v		
	SSAV	XX mV			SS∆V	XX mV			SSAV	XX mV		
	SS1 XX.XXX V				SS2 XX	.xxx v			SS3 X)	.xxx v		
Not r	eceiving	fuel cell t	telem	etry (lata							

If data becomes unavailable while running, the data on the screen turns cyan and displays the last known value.

8	🗜 Fuel Cell Monitoring System												
Hie Display Heip													
		F	UEI	_ (CE	LL ′	1	G₩	IT : 1	40/17:13:	37.027		Displayed Fuel Cell
		Subs	tack 1			Substa	ack 2			Subs	tack 3		Fuel Cell 1
	1	968	972	17	33	830	972	49	65	020	967	81	C Fuel Cell <u>2</u>
	2	961	969	18	34	971	966	50	66	968	968	82	Fuel Cell <u>3</u>
	3	965	973	19	35	968	970	51	67	965	967	83	
	4	971	968	20	36	966	965	52	68	968	966	84	🔲 Free <u>z</u> e Display
	5	963	967	21	37	967	969	53	69	973	966	85	
	6	962	970	22	38	964	972	54	70	969	967	86	Mute Sound
	7	964	968	23	- 39	968	966	55	71	964	967	87	<u>m</u> ate sound
	8	969	973	24	40	965	968	56	72	968	972	88	
	9	972	964	25	41	964	970	57	73	972	969	89	Decend
	10	972	965	26	42	971	972	58	- 74	969	971	90	<u> </u>
	11	970	969	27	43	971	969	59	75	971	966	91	NOT RECORDING
	12	967	965	28	44	9/3	9/1	60	76	964	9/3	92	
	13	970	969	29	45	967	9/1	61	- //	964	9/1	93	
	14	968	973	30	46	971	971	62	78	973	968	94	
	10	905	900	32	47	969	971	64	79	900	971	30	
	10	15.479 V	15.503 V	J2	-10	15,489 V	15.515 V		- 00	15.49 V	15.501 V	50	
		SSAV	24 mV			SSAV	26 mV			SSAV	11 mV		
		SS1 3	0.982 V			SS2 3	1.004 V			SS3 3	0.991 V		FCMS is running in demonstration mode
													demonsulation mode
N	ot re	ceiving	fuel cell	telen	netry (data							
	_			-								_	

The program is designed to be used via the keyboard only or using the mouse. All of the radio buttons and check boxes on the right side are duplicated via a pull-down menu selection.



Initialization parameters are read from the fcms.ini file. Initialization settings include display, color and sound settings, data recording and storage, telemetry, error limits, debugging/logging, and the setting for the demonstration mode. A log file can be generated by the FCMS application containing information on activation time, configuration information, user actions, and shut down time. Typically, however, this is not used unless troubleshooting a problem. If the fcms.ini file is changed, it can be reloaded via the File | Reinitialize menu.

The FC1, FC2, and FC3 radio buttons on the right will change the display to show fuel cell 1, 2, or 3. If data is being recorded, this will not affect the recording since it only changes the display to the screen. The picture above shows Fuel Cell 1 data being displayed. Similarly, the Freeze and Record buttons only affect the data that is being displayed on the screen, they have nothing to do with any data that is being recorded. The Mute Sound option allows the user to suppress the synthesized voice audio. When the Freeze or Mute option is selected, the screen clearly labels what has been done.



Data that is out of limits will be flagged by the program by color change. Anything out of limits (less than 920, greater than 1200) will turn yellow, while anything off-scale high or low will be red. This legend can be called up by the Help | Legend pulldown menu, and the limits and colors can be set in the fcms.ini file.

i i i i i i i i i i i i i i i i i i i	-CMS Color Legend	×
	Nominal Data : 900	
	Telemetry Loss: 900	
	Off nominal low (MV < 920) : 920	
	Off nominal high (MV > 1200) : 1200	
	Off scale low (MV < 0) : OSL	
	Off scale high (MV > 1250) : OSH	
	ΟΚ	

Note that the crew is never instructed by the procedures to look at all three fuel cells as displayed on the screen, and they frequently do not look at fuel cells 2 or 3, so fuel cells other than FC1 with bad telemetry may not be seen until the data is downlinked and processed.

1.2 Recording data

Pressing the "Record" button (or selecting the File | Record menu) calls up the "Recording Type" window. FCMS has two recording modes: Full rate or Interval. Full Rate records a sample every 0.96 seconds and records until the maximum file size is achieved. In Interval mode, FCMS records samples at specified intervals for a certain amount of time, as called out by MCC and as selected by the crew. A flag in the fcms.ini initialization file limits the maximum file size to 1.44 MB. Originally, the file was transferred via the wired or wireless network to a second PGSC for downlink, but in case there was a problem with the network, the file needed to be able to fit onto a single floppy disk for transfer to the second PGSC. This functionality is not used any more (the file remains on the WinDecom PGSC and is retrieved by MCC from there) but the file size limitation was never changed, as that file size is still adequate for EGIL's purposes.

Sel	ect Recording Type
	• Full Rate (approx 12 minutes)
	C Every 1 sec(s) for 1 minute(s)
	0 <u>K</u> <u>C</u> ancel

When recording starts, the yellow "NOT RECORDING" label on the main display changes to "RECORDING". The display will also show how big the recorded file is compared to the maximum file size (default is 1.44 MB), expressed as a percent complete (below left). The display that tells the user that the program is recording all three fuel cells, to avoid confusion as to what is being recorded. (One early crew thought they were only recording the data for the fuel cell that was on the screen, so they ran FCMS three times). If the Interval option is selected, the display shows a count-down timer and a completion bar (below right).



FCMS will automatically stop recording when the maximum file size is reached - at the full data rate recording option, this will be about 12 minutes - or the timer runs out. When recording has stopped (either automatically or manually via the "Stop Record" button or pull-down menu), a window pops up with the file name and path of the data on the WinDecom PGSC. The crew then notifies MCC that the data take is complete so that MCC can downlink the data file.

The popup window gives the file name for that data session. The raw data filename is of the form **fcdddhhmm.fcv**, where FC stands for "fuel cell"; DDD is the GMT day, HH is the hour, and MM is the minute of the first data point; and "FCV" is the file type "fuel cell volts." Because it is completely ASCII text, there is a lot of "dead space" in the file that can be compressed within the file, on the order of 90-95%. The FCMS program automatically creates a compressed file (a "zip" file) along with the text file, the only difference being the file extension (.zip instead of .fcv).

When the recording is complete, the "RECORDING" label changes to "COMPLETED" and the raw data file name shows up below that.



2.0 CABIN LEAK (version 4.03, 7/2007)

2.1 Overview

Cabin Leak V4.03		
e <u>U</u> pdate <u>H</u> elp		
с	ABIN LEAK - STS-126 Cabin	Volumes
GMT: 042/18:00:49		# of N2 Tanks: 6
MET: 000/00:00	Data Source	Max N2 Flow: 250 lbm/hr
	PCMMU Feed Manual Entry	Min Acceptable ISS Pressure: 9,5 psia
	Apogee Height = 210 nm MET used for the DDD/HH:MM:SS Computation = 001/12:13:00	
Orbiter Only		Utilize ISS Atmosphere
Cabin Volume = ORB+EXT ARLK=2703	- cft	Hatch Configuration
Spec 66 Data		
dP/dt = -0.1 psi/min		Orbiter + ISS Volume = 22040 oft
Cabin Pressure = 14.7 psia		dP/dt E0 = -0.0122641 pai/win
N2 Quantity 1 = 125 Ibm		
N2 Quantity 2 = 125 Ibm		ISS Pressure = 14.7 psia
<u>S</u> M SYS SUM 1 (Spec 78) Data dP/dt - EQ = -0.1 psi/min		Note: dP/dt -EQ is scaled to show what it would be if hatches are configured to allow use of ISS atmosphere
Manual Compute		Manual Compute
<u>.</u>		DDD/HH:MM DDD/HH:MM:SS
DDD/HH:MM DD	D/HH:MM:SS Time	e to ISS at 9.5 psi 000/11:10 at 001/23:23:09 MET
Time to 8 psi Stabilization is 000/01:58 at 00	1/14:10:58 MET Time from	m 9.5 psito8 psi 000/00:03 at 001/23:26:18 MET
Time at 8 psi to N2 Depletion is 000/06;54 at 00 Time from TIG to TD - 000/01:03	1/21:04:58 MET Time at 8 p: Time	sito N2 Depletion UUU/U6:54 at UU2/U6:20:17 MET e from TIG to TD - 000/01:03
Latest TIG is 000/07:49 at 00	1/20:01:39 MET L	atest TIG is 000/17:04 at 002/05:16:59 MET
CMMU FEED disabled. Enter Spec 66/78 Data and/o	or ISS Pressure data or select PCMMU FE	ED option to compute automatically.

The Cabin Leak application is used primarily to compute the time remaining before the orbiter should perform a deorbit burn to safely reach an Earth landing site. The latest deorbit burn time, or latest Time to Ignition (TIG), is the MET in which enough O2 and N2 exist to sustain survivable orbiter cabin environment until landing.

Cabin Leak is an electronic version of the cabin leak nomographs found in the Orbit Pocket Checklist. The application, reconfigurable for all on-orbit operations, provides the times of 8 psi Stabilization, N2 Depletion, and Latest TIG in both elapsed time from when at which the solution was computed to the event (i.e., Latest TIG, N2 Depletion, etc.) and MET. Cabin Leak is preferred over the nomographs as it provides more precise information without having to interpolate as on the nomographs and is in fact called out in the Flight Data File as the preferred method.

Cabin Leak has both an automatic mode and a manual mode.

- The default mode is Automatic: PCMMU data is received via the Telemetry Server and calculation occurs every 10 seconds or at the user-specified rate.
- Manual Mode is entered by selecting the "Manual Entry" radio button. In Manual Mode, parameters such as dP/dt and cabin pressure can be entered manually and the Manual Compute button is enabled to calculate the times.

The Time/Vector Server supplies current MET and GMT to Cabin Leak and the Update functions for the MET and State Vector. The present Cabin Volume configuration is selected from a treeview Control (a drop down list) specified by the flight specific INI file. Manual and Auto operations will be discussed in following sections.

The Cabin Leak program is located in the <c:\spocapps\cabinleak> directory or can be accessed from the Shuttle Apps window.

Across the top of the display are three menus: File, Update, and Help.

2.1.1 *File*

The File menu has three options: Reset, Settings, and Exit.

- Reset: Resets the Cabin Leak application. Use this if Cabin Leak doesn't attach to the Time-Vector Server or Telemetry Server correctly when first started. If the MET Server or Telemetry Server has not been installed on this computer, Reset will be ineffective. Cabin Leak can still be used in Manual Mode without automatic Telemetry data.
- Settings: Allows the user to change the default update time from every 10 seconds to another value.
- Exit: Closes the Cabin Leak application.

2.1.2 Update

The Update menu has two options: State Vector & Times, and Update Parameters. In general, the Systems Instructor will not have to use any of these.

- State-Vector & Times: Brings up the Update Orbiter State Vector and Update Time Values windows of the Time-Vector Server (MET Server). Cabin Leak is paused until the Update Orbiter State Vector window is closed.
- Update Parameters: Allows the user to change the default values for number of N2 tanks (default = 6, but set flight-specific), maximum N2 flow in lb/hr (default = 250), and minimum acceptable ISS pressure (default = 9.5 psi).

2.1.3 Help

The Help menu has two options: Contents and About.

- Contents calls up the "help file" for the cabin leak program.
- About calls up information on the program version number and programmers (as seen at the top of this section).

2.2 Inputs

The cabin leak program has a number of fields that will be filled in either manually or automatically if telemetry is available, as well as fields that are set prelaunch as part of the initialization file (cableak.ini).

2.2.1 Pre-initialized data

According to the FDF Cabin Leak procedure, the crew is instructed to close all hatches (including airlock) to try to isolate the leak. If the leak is in the crew compartment, the crew opens the airlock hatch to use that volume, and only then are they instructed to use the cabin leak program (as seen below). When they do call up the program, the cabin volume is defaulted to be orbiter plus airlock (2,703 ft³), to match the orbiter hardware config and the nomograph. The crew can change that value by using the pull-down menu to select orbiter only volume (2,475 ft³), if needed.

Determine Type of Deorbit						
Determine latest poss TIG, Tmax, and avail landing sites using PGSC (preferred) or NOMOGRAPHS, 4-8						
Cabin Volume = ORB+EXT ARLK=2703 _ cft						
,,						
Cabin Volume = ORB+EXT ARLK=2703 💽 cft						
ORB Only=2475						
Spec 66 Dat ORB+EXT ARLK=2703						
0.1						

The input fields for the number of N2 tanks, the maximum N2 flow, and the minimum acceptable pressure for the additional volume are all set in the Update | Update Parameters pull-down menu and are generally not changed during the execution of the program (though the values can be updated if needed).

- <u>Number of N2 Tanks</u>: the flight-specific number of N2 tanks flown on the shuttle flight. Valid values are 4, 5, 6, 7, or 8. This has an effect on the amount of N2 that is unusable due to being trapped in the tanks. Default is 6, but this will be set flight-specific.
- Max N2 Flow: Input field for the maximum N2 flow (typically set to 250 lbm/hr).
- <u>Minimum Acceptable Additional Volume Pressure</u>: If the orbiter has a leak while docked to ISS, the volume of air in the ISS segments may be used to extend the time to latest TIG. The nominal value to leave the ISS components is 9.5 psi.



2.2.2 Telemetry input data

Data Source	
C PCMMU Feed	
Manual Entry	

PCMMU FEED disabled. Enter Spec 66/78 Data and/or ISS Pressure data or select PCMMU FEED option to compute automatically.

The telemetry data displayed on the screen can be found by the crew on various CRT MDU displays. The status box at the bottom displays whether telemetry is available or not; if for some reason telemetry is not available to the PGSC (for example, some sort of PCMMU failure) then the user may select the Manual Entry radio button in the Data Source section. When PCMMU Feed is selected, the telemetry data elsewhere on the display is grayed out and the user may not change anything, but when Manual Entry is selected the fields turn white and may be manually entered.

Apogee Height =	210	nm
MET used for the	DDD/HH:MM	4:SS
Computation =	001/12:13	∶00 <mark>↓</mark>

Spec 66 Data	
dP/dt = -0.1 psi/min	
Cabin Pressure = 14.7 psia	Orbiter + ISS Volume = 22040 cft
N2 Quantity 1 = 125 Ibm	dP/dt - EQ = -0.0122641 psi/min
N2 Quantity 2 = 125 Ibm	ISS Pressure = 14.7 psia
<u>S</u> M SYS SUM 1 (Spec 78) Data dP/dt - EQ = -0.1 psi/min	Note: dP/dt -EQ is scaled to show what it would be if hatches are configured to allow use of ISS atmosphere

- <u>Apogee Height</u>: This information is displayed on the crew's GNC MNVR OPS 2 MM202 and OPS 3 MM301, 302, and 303 displays. Although there is a 400 nm default limit, a higher value can be set within the INI file. This field is used in calculating the time from TIG to Touchdown, and will typically be in the neighborhood of 1:05 hr for ISS altitudes. For the paper nomographs in the checklist, this value is assumed to be one hour.
- <u>MET for Computation</u>: The standard format is ddd/hh:mm:ss. The number of hours cannot exceed 23, minutes cannot exceed 59 and seconds cannot exceed 59.
- <u>dP/dt</u>: If dP/dt is positive or less than -0.0001 psi/min a cabin leak is not occurring.
- Cabin Pressure: A valid Cabin Pressure cannot exceed 20 psia.
- <u>N2 Quantity 1 & 2</u>: The maximum value should not exceed 800 for the combined quantities of both N2 tanks.
- <u>dP/dT-EQ</u>: If this is positive or less than -0.0001 psi/min a cabin leak is not occurring. This is just the dP/dt normalized to a 14.7 psi cabin pressure.
- Orbiter + ISS Volume: not telemetry, and will be covered in the next section.
- dP/dt-EQ (ISS): This value is the dP/dt-EQ from the shuttle, scaled to show what it would be (hypothetically) if the hatches to the ISS were open, and is inversely proportional to the total volume (e.g., if the stack volume is 10x greater than the orbiter volume, then the dP/dt will be 10x smaller when the hatches are all open). Recall that when this Cabin Leak program is executed, the hatch from the shuttle to ISS is closed. This value will be used later in determining whether or not the ISS volume may be used to extend the orbiter's time on orbit. This function will be covered later.
- ISS Pressure: this is the pressure in the US Lab module on ISS.

If the PCMMU Feed radio button is selected, meaning the user wants telemetry to populate the fields on the display, but that the telemetry is not available, the white fields are filled in cyan with an "M" to indicate missing data. Manual Entry must be used in this case. The Height of Apogee reverts to a default value of 165 nm and MET reverts to liftoff.

Apogee Height =	165 nm
MET used for the	DDD/HH:MM:SS
Computation =	000/00:00:00





2.2.3 ISS Volume/Hatch Configuration

In the case where the orbiter will remained docked to the ISS in order to use their atmosphere, the user must manually set the ISS volume, as there is no telemetry to be read regarding the status of the various hatches inside the ISS. Any closed hatch seals off the volume behind it (relative to the orbiter), rendering it unusable for the shuttle. The FDF sends the crew to work the "Utilize ISS Atmosphere" steps in the procedure below, but those steps assume that the entire ISS volume is available. The right side of the Cabin Leak display covers the case where the orbiter is remaining docked to conserve air.

Determine Type of Deorbit Determine latest poss TIG, Tmax, and avail landing sites using PGSC (preferred) or NOMOGRAPHS, 4-8 If docked to ISS and TIG > 1 hr 30 min and Orbiter Only Tmax does not support PLS, perform UTILIZE ISS ATMOSPHERE, (SODF: JOINT OPS, <u>EMERGENCY</u> <u>RESPONSE</u>) concurrently with remaining steps below

On the ISS side of the Cabin Leak display, the user is shown a field with the ISS volume. That value cannot be entered manually, but by using the Hatch Configuration tool, the proper volume can be set. The crew must select the hatches in this window to be closed as appropriate to match the current config.

Utilize ISS Atmosphere						
	Hatch Configuration					

This window has a "tree view" control of the various hatches from the orbiter middeck all the way to the back of the ISS. The "Cabin Volume" label at the top of this window will be calculated for that configuration. The check box logic matches the ISS and orbiter configuration so that when an inner hatch is closed, the hatches further out don't matter and are grayed out - for example, when the orbiter inner hatch is closed, it no longer matters to the calculation whether the hatch into the FGB is open or closed. All hatches are always initialized as open when called up for the first time, and the program will remember the hatch status when the window is closed.



Note that it is **VITALLY IMPORTANT** to have the correct volume setting when running the program. An incorrect setting will give the crew an incorrect TIG.

- If the volume setting in the program is <u>bigger</u> than the actual volume at the time the program is run, the
 program will display a time that is less than the crew actually has. This could result in the crew rushing or
 taking a deorbit opportunity that is not as good as another.
- If the volume setting is <u>smaller</u> than the actual volume at the time the program is run, the program will display a time that is more than the crew actually has. This could result in the crew running out of air.

2.2.4 Equivalent dP/dt

With Manual Entry selected, the program automatically calculates the value of Eq dP/dt, given dP/dt, using the formula for calculating Equivalent dP/dt:

$$\frac{dP}{dt}EQ = \frac{dP}{dt} \times \frac{14.7}{cabin_P}$$

Inputting dP/dt will set the value of the Equivalent, so if the cabin pressure is less than 14.7 psi (unlike all of the previous examples), then the two dP/dt values will be different:

Spec 66 Data	
dP/dt = -0.1	psi/min
Cabin Pressure = 12.9	psia
N2 Quantity 1 = 125	lbm
N2 Quantity 2 = 125	lbm
SYS SUM 1 (Spec 78) Data	
dP/dt - EQ = -0.1139535	psi/min

2.2.5 Settings in the cableak.ini initialization file

Following are some of the parameters in the **cableak.ini** file that control how the program operates. Only the parameters that are relevant to training will be discussed. Any line that is preceded by a semicolon is commented out and the program ignores what comes after the semicolon. The file is located at <c:\spocapps\cableak.ini>

[FLIGHT_DATA]

```
Flight=STS-XXX
```

• This controls what is seen on the top of the display

```
[DefaultValues]
;Defaults should be used for flight initialization.
MaxN2Flow=250
;Default DpDt=0 (leak rate)
DpDt=0
;Default DpDtEQ =0( Eq leak rate)
DpDtEQ=0
;Default ISSDpDtEQ =0( Eq leak rate)
ISSDpDtEQ=0
;Default Cabin Pressure=14.7
CabPress=14.7
;Default ISS Pressure=14.7
ISSPress=14.7
;Default N2 Quantity 1=128
N2Q1=128
;Default N2 Quantity 2=128
N202=128
;Default Apogee Height=165
HA=165
```

In general, these default values should not be changed in this file. The dP/dt values, N2 quantities, cabin
pressure, and apogee height will be read in from telemetry if PCMMU data is available, but can be set
from the main window if needed. The default values will appear if there is no telemetry.

[FLT_SPEC_CONSTANT] N2Tanks=6

```
;If the orbiter will not be docked to the ISS, use a value
;Minimum Acceptable Additional Volume Pressure = 8,
;however If the orbiter will dock to the ISS,
;use Minimum Acceptable Additional Volume Pressure =9.5
PSI=9.5
```

• These flight-specific parameters will be determined by EECOM prior to the flight and will be in the flight PGSC load. The minimum cabin pressure for the ISS is 9.5 psi for the Russian segment.

[ORBITER_CONFIG]

<pre>; Inner_Hatch, 228 ; Single_SH, 1211 ; Double_SH, 2422 ORB Only=2475 ORB+EXT ARLK=2703 [HATCH_CONFIG] ; These HATCH_CONFIG parameters are used only when Use_ISS_Volume=True CABIN_ONLY_VOLUME=2475 NUM_HATCHES=22 • The CABIN_ONLY_VOLUME is the default value for the cabin volume, used until something else is chosen from the volume calculator • The number of hatches in this parameter should match the number of "THATCH" parameters below.</pre>
; key it links to (its parent node), name of the hatch, key (usually the name), and ; Volume of that area
 ; Orbiter volume including cabin_only_volume THATCH_1=, Inner Hatch, 228 ;Iss volume THATCH_2=Inner Hatch, ODS Upper Hatch, 1, 40 The sequence of fields for the hatches is: hatch number Name of the hatch immediately upstream (towards the orbiter) of this hatch, aka "parent hatch". If there's nothing between the equals sign and the first comma, like Hatch 1, then it's at the top of the tree and closest to the orbiter and has no "parent". This hatch's display name (what it shows on the volume calculator window) A flag (1, 2, or 3) – see below volume size
THATCH _3=ODS Upper Hatch, APAS Hatch, 1, 183 THATCH _4=APAS Hatch, Node 2 Fwd Hatch, 1, 2237 THATCH _5=Node 2 Fwd Hatch, Node 2 Stbd Hatch, 1, 2308 THATCH _6=Node 2 Stbd Hatch, Node 2 Deck Hatch, 2, 1637 THATCH _7=Node 2 Deck Hatch, Node 2 Port Hatch, 2, 4443 THATCH _8=Node 2 Port Hatch, JPM Ovhd Hatch, 1, 1437 THATCH _8=Node 2 Port Hatch, JPM Ovhd Hatch, 1, 1437 THATCH _0=Node 2 Ovhd Hatch, Lab Fwd Hatch, 3, 3497 THATCH _10=Lab Fwd Hatch, Node 1 Fwd Hatch, 1, 1948 THATCH _11=Node 1 Fwd Hatch, Node 1 Stbd Hatch, 1, 908 THATCH _12=Node 1 Stbd Hatch, IV Hatch, 1, 201 THATCH _13=IV Hatch, Node 1 Aft Hatch, 3, 203 THATCH _14=Node 1 Aft Hatch, FGB GA-SU Hatch, 1, 230 THATCH _15=FGB GA-PMA1 Hatch, FGB GA-SU Hatch, 1, 230 THATCH _16=FGB GA-SU Hatch, Soyuz SA-BO Hatch, 1, 133 THATCH _16=FGB FGO-GA Hatch, FGB PGO-GA Hatch, 3, 1925 THATCH _18=FGB PGO-GA Hatch, FGB PGO-SU Hatch, 1, 262 THATCH _19=FGB PGO-SU Hatch, SM PKhO-SU Hatch, 1, 245 THATCH _20=SM PKhO-SU Hatch, SM RO-PKK Hatch, 1, 124 THATCH _21=SM SM PKhO-SU Hatch, SM RO-PKK Hatch, 1, 124 THATCH _22=SM RO-PKK Hatch, SM PK-SU Hatch, 1, 221 • The last of these hatches should have the same number as the NUM_HATCHES parameter earlier.
;Each natch opens into a certain volume as opened going from the shuttle orbiter. ;Each volume for an open hatch is added to the cabin volume until a closed hatch ; (checked) is found so that the resulting volume is always correct no matter which : hatches are closed or in what order they were closed. Hatches closer to the

; orbiter determine the volume regardless of whether outer hatches are closed or ; open.

;The CABIN_ONLY_VOLUME= parameter specifies the volume when the innermost ;hatch is closed - the smallest volume.

For the explanation of the flag in the hatch sequences above, it helps to refer to this hatch config schematic and to think of it as a "family tree", with parents, children, branches, and generations. A "parent" hatch is the next one immediately above the hatch in question on this diagram, usually closer to the orbiter at the upper left. A "child" hatch is generally the next one immediately after the one in question, farther away from the orbiter. A 'branch" represents a hatch off of the main "core", for a volume that sticks off of the side, which may have more hatches downstream of it.



A "1" means that this hatch is the "child" of the one immediately preceeding it in the list. Thus, **THATCH_11=Node 1** Fwd Hatch, Node 1 Stbd Hatch, 1, 908 means that Hatch #11 is the Node 1 Stbd Hatch and is immediately downstream of the Node 1 Fwd Hatch, and that the next volume after the Node 1 Stbd Hatch (towards the bottom right of the display, or towards the aft of the ISS) has a volume of 908 cu ft.

THATCH_12=Node 1 Stbd Hatch, IV Hatch, 1, 201 means that the IV Hatch is downstream of the Node 1 Stbd Hatch, and the volume after the IV Hatch is 201 cu ft.

Now, the next hatch, **THATCH_13=IV Hatch**, **Node 1 Aft Hatch**, **3**, **203** has a "3" flag instead of a 1. Notice on the picture that the next hatch vertically up from the Node 1 Aft Hatch is the IV Hatch, which is in a different branch. You have to go up 3 "generations" on the diagram in order to get to the previous hatch in sequence from the orbiter, as both the Node 1 Aft and Node 1 Stbd both are downstream (or "children") of the Node 1 Fwd Hatch.

2.2.6 Future volumes on ISS

The current version of the program will be able to handle additional volumes by adding lines as appropriate to the HATCH CONFIG section.

At this writing, only Node 3 and the Cupola remain to be installed. Node 3 will be off of the Node 1 Port Hatch, and the Cupola will be off of the Node 3 Deck Hatch. These will eventually go on the diagram between the Node 1 Stbd and Node 1 Aft hatches:

Node 1 Fwd Hatch Node 1 Stbd Hatch IV Hatch Node 1 Port Hatch Node 3 Deck Hatch Node 1 Aft Hatch FGB GA-PMA1 Hatch Etc.

Thus, the flag for Node 1 Aft Hatch will eventually have to be changed to a "5" to represent the two additional hatches required in the program to get back to the Node 1 Fwd Hatch.

Other volumes not accounted for on this diagram include the MPLM and HTV (both off of the Node 2 Deck Hatch).

Additionally, the program assumes that two of the three docking ports on the Russian segment are occupied: a Soyuz at the FGB Nadir (FGB GA-SU Hatch), and a Progress, Soyuz, or ATV at the SM Aft (SM Ro-PrK Hatch). Left empty is the DC Nadir (SM PkhO-SU Hatch).

2.3 Outputs

Orbiter Only			Utili	ze ISS Atm	iosp	here			
						DDD/HH:MM		DDD/HH:MM:SS	
	DDD/HH:MM		DDD/HH:MM:SS		Time to ISS at 9.5 psi	000/09:48	at	001/22:01:05	MET
Time to 8 psi Stabilization is	000/01:21	at	001/13:33:36	MET	Time from 9.5 psi to 8 psi	000/00:03	at	001/22:03:51	MET
Time at 8 psi to N2 Depletion is	000/06:03	at	001/19:36:54	MET	Time at 8 psi to N2 Depletion	000/06:03	at	002/04:07:09	MET
Time from TIG to TD -	000/01:03				Time from TIG to TD -	000/01:03			
Latest TIG is	000/06:21	at	001/18:33:36	MET	Latest TIG is	000/14:51	at	002/03:03:50	MET

Basically, what we're trying to do is to display two different deorbit TIGs, one that's the most conservative that covers just the orbiter and airlock and gives the soonest they'd have to deorbit, and one that answers the question "if we opened up to the ISS and used some of that air, how much longer could we stay in orbit?"

The bottom section of this display is for the calculated data that the crew will use to base their deorbit plans. It consists of two tables, one with times for the undocked case ("Orbiter Only") and one with times for the docked case ("Utilize ISS Atmosphere"). In each, the first column is read as "time or duration of this event from now" while the second column is read as "this event will occur at this MET (Mission Elapsed Time, from liftoff)".

First, we'll talk about the Orbiter Only case.

- <u>Time to 8 psi stabilization</u>: this is the time it will take for the cabin pressure to fall to 8 psi. Once the pressure is below 8 psi, the emergency cabin regulator valves will open and flow either O2 or N2, depending on how the PCS valves have been configured. In the above example, it will take 1 hours 21 minutes for the pressure to drop to 8 psi, which will occur at 001/13:33:36 MET.
- <u>Time at 8 psi to N2 depletion</u>: assuming the crew has performed the rest of the cabin leak procedures in the Orbit Pocket Checklist, by the time the cabin pressure has dropped to 8 psi, the valves have been configured to flow N2 into the cabin to make up cabin pressure. The cabin P is required to be no less than 8 psi (the lowest pressure at which the hardware in the cabin has been certified). O2 will flow as needed to keep the PPO2 within limits while the crew is not yet in their ACES suits. But since the O2 is also used for fuel cell production, there is far more O2 than N2, thus the N2 is the limiting constraint, so the crew must be on the ground by the time the N2 runs out so the cabin pressure will stay at or above 8 psi. This represents the time from when the cabin pressure first drops to 8 psi until the N2 is depleted and the pressure falls below 8 psi. In the above example, once the cabin pressure drops to 8 psi in 1:21 from now (at 001/13:33:36 MET), the N2 will last a further 6 hours 3 minutes beyond that until 001/19:36:54 MET.
- <u>Time from TIG to TD</u>: is the time between the deorbit burn and touchdown. At ISS altitudes (around 200 nm) this is about 1:05 hr.
- Latest TIG: is the combination of three factors that have already been calculated the time until the cabin pressure drops to 8 psi, the time while at 8 psi until the N2 is depleted, and the time from deorbit burn TIG until touchdown. These factors will determine the latest time that the crew can do the deorbit burn and not run out of N2 before landing. The simple equation is (time to 8 psi) + (time at 8 psi until N2 depletion) (time from TIG to touchdown) = time until latest TIG. This time of Latest TIG is read by the Deorbit Manager PGSC program in order to determine what landing sites are available up to this TIG. In the above example, adding the time to 8 psi (1:21), the time at 8 psi until N2 depletion (6:03), and subtracting the time from TIG to touchdown (1:03) results in a TIG no later than 6 hours 21 minutes from now, or 001/18:33:36 MET.

Things are a little different when docked to ISS. In this case, the objective is to find out how long it will take for the entire stack (orbiter plus ISS) volume to drop to the minimum pressure. The idea is to see how much additional time can be gained remaining on orbit with a shuttle cabin leak, in order to make a better landing site or to perform repairs.

<u>Time to ISS at 9.5 psi</u>: is the time it will take for the total stack volume to fall to the minimum acceptable pressure (9.5 psi is the lower limit for the Russian Segment modules). The hatches to the ISS would be open until the entire stack dropped to 9.5 psi, after which the hatches would be closed and the volume would be the orbiter only from there to landing. In the above example, it will take 9 hours 51 minutes to

bring the entire ISS stack down to 8 psi (9:48 to get down to 9.5 psi, and 0:03 to get from 9.5 to 8.0). The time to N2 depletion is the same regardless of whether it's the orbiter only or the orbiter plus any extra volume, so it's not repeated.

<u>Latest TIG (Utilize ISS Atmosphere)</u>: is calculated similarly to the Latest TIG (Orbiter Only) except that it accounts for orbiter + ISS as well as just orbiter only. In the above example, the ISS/orbiter stack will get to 9.5 psi in 9:48 from now, followed by orbiter-only O2/N2 maintenance which ends 6:03 after that, for a latest TIG of 14:51 from now at 02/02:03:50 MET. By utilizing the ISS atmosphere, the shuttle crew has gained an additional 8 hrs 30 min to complete repairs or land at a more desirable landing site.

3.0 10-2 DEPRESS (version 2.05, 4/2001)

3.1 Overview

The 10-2 Depress application automatically displays the current Cabin Pressure and PPO2 Pressure on the Ten2 Depress Chart. The Cabin and PPO2 Pressures are also displayed numerically, along with the DP/DT value, changing actively as the PCMMU sample rate allows. Ten2 Depress also displays the current valve configuration based on the current zone, the MET and GMT, Approximate Next Zone and its corresponding crossing time.

The 10.2 Depress program is located in the <c:\spocapps\10-2> directory or can be accessed from the Shuttle Apps window.

As data feeds the application, a point will be plotted on the chart representing the Cabin Pressure versus the PPO2 Pressure. As the Cabin and PPO2 pressures change, the application will automatically display the current zone information in the right-side status bar. While points are being displayed, outside the control and target zones, the application plots predictor points for the next five positions. If the values have not changed since the last time a sample was taken from PCMMU, then no prediction is made, based on a stand-still. When a zone boundary is crossed, an audible alert is initiated, as well as making the valve configuration flash in the right-side status bar.



The program is designed for minimal crew intervention. When the program is opened, it immediately begins looking for telemetry. A red "OFF" or green "ON" in the lower right corner indicates whether it is reading demo data from the initialiazation file or telemetry from one of the various packets.

The left side of the screen duplicates the 10.2 depress chart from the EVA checklist, but by automatically plotting data, it frees a crewmember from having to monitor a CRT and plot the points by hand. With the PGSC program, a crewmember can be on the middeck (where the switches that need to be moved are) monitoring the display. The right side of the screen includes information on the predictor bugs, the next zone projected, cabin atmosphere info, and the expected current PCS valve positions.

3.1.1 The "File" Menu

The only option under the File menu (aside from Exit) is to Replay a previously recorded data file. This is analagous to being able to go back to the paper diagram and look at an old depress plot; data on cabin pressure and PPO2 are saved to a file that is uniquely identified. The operation of the Replay option will be discussed later.



3.1.2 The "View" Menu

Through use of the pull-down menus, the user can configure the program in various ways, modifying the reading of the data or how the data is presented. The first option in the View menu allows the user to show the plot either with or without a grid. The "without" option is the default. The use of a grid would make it easier to determine the values of a data point plotted previously. Three other options – Packets, PPO2 Sensor, and Pressure Sensor – are greyed out when the Demo mode is selected. To show these options, select the Update | Data Source | Telemetry menu option (to be discussed shortly).



Selecting View | Packets allows the user to choose between Packet 35 (the default) and Packets 25 & 30. See Section 0 for an overview of packets.



Also under the View menu, the user may choose an alternate PPO2 or Pressure sensor. PPO2 sensor A and the Cabin Pressure sensor are the defaults, but if either is considered failed, the user may bypass that sensor (for example, PPO2 A and Cabin P are both powered by a single circuit breaker on panel O14) in order to use the program.



The user can also select the valve configuration for a particular region by way of the View menu.

File	<u>View</u> <u>U</u> pdate <u>H</u> elp	
1	With <u>G</u> rid Ctrl+G ✔ With <u>O</u> ut Grid Ctrl+O	1////
2 A 1 3 1	Packets PPO2 Sensor Pressure Sensor P	ONE NO O2 TERMINA
4	Show <u>V</u> LV Configs 🔷 🕨	Approach Zone Ctrl+A
, , , , , , ,	Re-initialize file	<u>Control Zone</u> <u>N</u> 2 Repress Zone 02 <u>D</u> eficient Depress Zone Ctrl+D
5 1 5	2.5-	02 <u>R</u> epress Zone 02 <u>T</u> erminate Zone

3.1.3 The "Update" Menu

The Update menu allows the user to make changes to how the program operates and plots points on the display.



The first three options bring up dialog boxes to make selections, while the last option lets the user decide between real telemetry and demo mode. The first one allows for the setting of the "delta-time", that is, the time duration between data points on the display. The default for a typical depress procedure would be 60 (seconds); the EVA Checklist calls for a new data point every 1 minute. For training purposes, this can be set to something like 5 to show a semi-realistic update rate.

Changing Delta Time	×
Delta Time	<u>C</u> hange
J /Sec	Cancel

The predictor rate allows the user to select how many predictor bugs are used in determining the next zone and the time to the next zone. Typically 5 or 6 is good enough.



When the "color chart" button is selected, the color abbreviation chart appears and the text for the particular color becomes a dialog box.

Color abbreviation Chart	DERDESS TONE 125
Black = Blk or 0 Blue = Blue or 1 Green = Grn or 2 Cyan = Cyn or 3 Dark Red = DRed or 4 Magenta = Mag or 5 Yellow Green = Ylw Grn or 6 Silver = Slv or 7 Gray = Gray or 8 Light Blue = Lt Blue or 9 Light Green = Lt Grn or 10 Light Cyan = Lt Cyn or 11 Light Red = Lt Red or 12 Pink = Pink or 13 Yellow = Ylw or 14 White = White or 15	Pict Point Colors XI Edit These are the colors for each plot point. To change a color click on the "Change color" button. Colors 02 Depress = Ylw Grm 02 Depress = Ylw Grm N2 Repress = Ylw Grn 02 Repress = Ylw Grn N2 Repress Flammable = Lt Red Approach = Lt Grn Target = Lt Grn 02 Terminate = Ylw Grn Control = Lt Grn
If color not in chart enter numeric color	Change color Color Chart Exit 1 1 1 Telemetry 3 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 Pkt 35 not CABIN PPO2 PSIA 1 3.4 3.5 3.6 3.7 Pkt 35 not

Finally, the user can select between "real" data and demo telemetry. For training purposes, the only reason to select "telemetry" is to let the View menu show some additional options. If telemetry is selected and no telemetry is available, the data box in the lower right corner turns yellow, warning of the "loss" of data.

🏩 10-2 De	press Version: 2.0)5
<u>File</u> <u>V</u> iew	<u>U</u> pdate <u>H</u> elp	
15.5 c 15.0-	<u>D</u> elta Time Predictor <u>R</u> ate Zone Colors	ZONE
A 14.5- B I 14.0-	Data Source	▶ <u>I</u> elemetry <u>D</u> emo

3.2 *10-2 OPERATION*

The 10-2 program is essentially hands-off unless the user wants to change options. The program will display data as soon as it is called up, and the only manual intervention required is to change valves at the appropriate times.

As the cabin pressure and PPO2 change, a series of dots are plotted on the display. A green dot means a data point inside the Approach Zone, while it is brown outside of it. The small red dots are predictors for the program to calculate the next zone and the time to the next zone. All of these parameters may be changed manually (as discussed above in the Update menu).

Since there is no telemetry associated with the airlock depress valve and both 14.7 psi cabin regulator inlet valves, the program displays the expected valve position for the current region in the lower right.



Moving the cursor over any zone's underlined title (such as O2 REPRESS ZONE or APPROACH ZONE) turns the cursor from an arrow into a pointed-finger, and clicking the region's title brings up a text box with the valve config for that region (for example, to remind the crewmember what the valve config will be for the next zone). The text box can also be called up using the View | Show Valve Configs menu option.

02 Defic	ient Depress Zone	×
•	AIRLK DEPRESS vlv - 5 14.7 CAB REG INLET SYS 1 - 14.7 CAB REG INLET SYS 2 -	CL OP
	ОК	

4.0 WATER DUMP (version 3.0, 9/2002) & CONTROL PANEL (version 2.00, 9/2002)

The Water Dump program (along with the training-only Control Panel demo) is an electronic version of the Flight Data File "Supply/Waste Water Dump" procedure. The Water Dump program uses telemetry to determine when to advance from one step to another, and when telemetry is not available (such as during a standalone training session), the Control Panel must be used to simulate telemetry.

The Water Dump and Control Panel programs are located in the <c:\spocapps\WaterDump> directory or can be accessed from the Shuttle Apps window. The Control Panel will only be installed for standalone training (not in the SMS) and is not part of the regular PGSC load that the crew uses in orbit.

4.1 Control Panel Demo

Because the SST and classrooms do not have simulated PCMMU data to display on the screen, the Water Dump program cannot tell when the supply/waste water switches have been moved, and the program will not automatically advance to the next step when appropriate. For standalone lessons, a demo program may be run to simulate the switches on panels R11L and ML31C in conjunction with the water dump program. This program is only available on standalone PGSCs and must be manually installed.

Water Dump Demonstration 🛛 🔀					
Would you li	ke to run Water	Dump in demons	tration mode?		
	Yes	No			
			l		

In order to run the Water Dump program in demo mode, the Water Dump Demonstration Panel must first be called up.

SYS PGSC 31195 6.0 CLASS NOTES

👔 Water Dump Demonstration Control Panel	
File Help	
Water Dump Is Executing In Demonstration Mode	<u> </u>
	🗹 <u>T</u> elemetry Available
CRT 4 POWER ON TKAINLET TKAOUTLET	Cabin PSI 14.6
	SUPPLY H20
GALLEY SPLY VLV GALLEY SPLY VLV GALLEY SPLY VLV	Тапк в цту 73
╽╶───┝┝┷───┉───┝──┌┝╸╵	
	Dump Line Temp 65
	Nozzle Temp A 30
R11L	Nozzle Temp B 30
	WASTE H20
	Tank Qty <mark>75</mark>
	Dump Line Temp 54
	Nozzle Temp A 30
	Nozzle Temp B 30
Note : This application is for demonstration purposes in conjunction with the Water Dump application and is not a part of flight software.	

The demo panel has simulated switches for the supply and waste system on panels R11L and ML31C (any switch not shown in the up or down position is a dummy switch for display only). The tank quantity and line/nozzle temperatures can all be manually entered, and the "Set" buttons must be pressed to send the data to the main program. Telemetry droputs can also be modeled from a button at the top of this page. By use of a radio button at the top right, you can have the program display either R11L, ML31C, or both.

When using this program for standalone training, the tank valves should be set to either the standard configuration (A outlet closed, B&D tied, C isolated, crossover open) or the water transfer configuration (A&B tied with B inlet closed, C&D tied, crossover closed) depending on the specifics of the mission. Tank quantities should be set appropriately, and the dump line temp should be set to at least 65. The nozzle temps should be set fairly low.

As the Water Dump program progresses through the timeline, the operator will need to change the values of the nozzle temps and tank quantities at various points. Remember to hit the "Set" button to send the data.

The initiliazation file **WtrDemo.ini** contains only the status of the switches, heaters, and temperatures that are set via the demo panel, so there is no need to modify the **WtrDemo.ini** file.

4.2 *Water Dump program*

4.2.1 Menus

There are four pull-down menu options: File, Update, View, and Help. The File menu allows the user to select Exit, to quit the program. The Help menu allows the user to call up the Help file and to view the About information (as seen above). Update and View are discussed below.

4.2.1.1 Update

During operations of the Water Dump program, the user may change the dump target (by duration or quantity) by either pressing the "Change Amount" button in the upper right corner of the display or by the Update pull-down menu and selecting "Dump to Amount".

Select Dump 1	To Amount	
L :	Supply Dump To Amount	
	© Supply Dump Duration 0 0 HH:MM	
	Supply Dump Percentage 7 %	
	0 <u>K</u>	

Also under the "Update" menu is "Time Data" which allows the user to modify the GMT, MET, launch time, and related parameters.

4.2.1.2 View

The View menu has four options: Settings, Schematic, Spec 66, and Event Log.

Settings allows the user to change the sound (no sound; simple sounds, typical of Windows; or voice), the
number of digits to be shown on the display, and the scrolling capability. The program will normally show
only the current step, the one ahead, and the one behind. The scrolling option allows the user to review
steps that have already occurred, but does not allow future scrolling because the next steps are
determined based on various events occurring or not.

Water Dump Settings	
Sound Settings ○ <u>N</u> o Sound ○ <u>S</u> imple Sounds ⓒ <u>V</u> oice	Decimals to display : 0
<u> </u>	<u>C</u> ancel Defaults

The Schematic menu choice calls up the combined supply and waste water schematic. This diagram is
dynamic and will change as appropriate based on the various switch throws and telemetry (simulated or

true). This display notes the most recent action. The Schematic automatically appears when either kind of dump starts, but may be called up separately if desired.



• The "Spec 66" menu choice brings up a digital summary of the dump status as if the crew were looking at it on the Spec 66 display. This is not called up automatically like the Schematic is.

Water Dump Spec 66 Data Display File View Help						
Supply H2O System DataQty A50Dump Line Temp90Qty B80Nozzle Temp A102Qty C95Nozzle Temp B102Qty D8080102	Waste H2O System Data Qty 1 40 Dump Line Temp 75 Nozzle Temp A 12 Nozzle Temp B 12					
Receiving Water System Telemetry From Demo Data File						

4.2.2 Program setup

Before any switches are thrown, the user must first tell the program which type(s) of dump(s) will be performed: supply only, waste only, or simo. Additionally, telling the program whether comm is available or not will suppress some messages. Finally, the user must enter either the duration or the target quantity of the dump. For the waste and simo dumps, a Caution to not dump the waste tank below 5% appears.

Waste Dump Setup Water Dump Setup Set COMM Status Select Desired Dump Type-C Supply H2O COMM Available Waste H2O If comm, MCC will TMBU nozzle temp, tank gty limits, and provide O Simultaneous Supply and Waste dump duration as required. Waste Dump To Amount • Waste Dump Duration 0 :0 HH:MM Waste Dump Percentage > 5% 7 CAUTION Dumping WASTE H20 TK1 QTY below 5% can cause bellows damage 0<u>K</u>

Simo Dump Setup						
Water Dump Setup						
Select Desired Dump Type ○ Supply H2O ○ Waste H2O ⓒ Simultaneous Supply and Waste Set COMM Status Set COMM Status						
Current Supply Dump Configuration : Tanks B and D						
Supply Dump To Amount						
 Supply Dump <u>D</u>uration 0 HH:MM Supply Dump <u>P</u>ercentage % 						
Waste Dump To Amount						
O Waste Dump Duration 10 10 HH:MM						
• waste Dump Percentage 7 > 5%						
CAUTION						
Dumping WASTE H20 TK1 QTY below 5% can cause bellows damage						
0 <u>K</u>						

Supply Dump Setup Water Dump Setup Select Desired Dump Type Set COMM Status • Supply H2O COMM Available If comm, MCC will TMBU nozzle C Waste H2O temp, tank qty limits, and provide C Simultaneous Supply and Waste dump duration as required. Current Supply Dump Configuration : Tanks B and D Supply Dump To Amount • Supply Dump Duration 0 0 HH:MM Supply Dump Percentage % 17 0<u>K</u>

The next window is a series of notes for the crew regarding the dump. The content is based on whether the "Comm available" was checked on the previous window or not.

With comm	No comm
Initialization Note	Initialization Note
NOTE	NOTE
If PASS SM avail, monitor temps and QTY; otherwise, dump only when MCC is avail to monitor.	If PASS SM avail, monitor temps and QTY; otherwise, dump only when MCC is avail to monitor.
Dump in current SPLY H2O tank config (panels R11L, ML31C), unless directed otherwise by MCC.	Dump in current SPLY H2O tank config (panels R11L, ML31C), unless directed otherwise by MCC.
QTY of approx 200% among TKs A,B,C,D is reqd for deorbit/entry FES usage.	No comm: Dump H20 tanks to provide 100% total ullage in any single or combination of TKs A,B,C,D. 100% ullage reqd for FC-produced water for 12 hr.
	QTY of approx 200% among TKs A,B,C,D is reqd for deorbit/entry FES usage.
CAUTION	CAUTION
Tile debonding may	Tile debonding may
occur if nozzle temps	occur if nozzle temps
exceed 350 degF	exceed 350 degF
<<< <u>B</u> ack	<

The various windows from this point on are based on supply, waste, or simo dump. Each follows the FDF procedures.

4.2.3 *Procedures*

4.2.3.1 Step A: Supply/Simo Dump Prep

For a supply or simo dump, the crew is given a note about the Supply Water Dumpline Purge Device. The mechanism is inserted into the Potable quick-disconnect (QD), which lies between the dump valve and the dump isolation valve. It allows air to flow through the device and into the dump line and then overboard, at the point in the procedure when the dump isolation valve is closed and the dump valve is open. This is intended to prevent water accumulating at the dump valve and freezing, which has caused some water to leak overboard through the cracked valve.

Supply/SIMO Dump Prep						
A	. <u>SUPPLY/SIMO DUMP PREP</u>					
WCS Outboard Wall	Unstow and install SPLY H20 Dumpline Purge Device into CONT H20 X-TIE POT QD (Lower QD with blue Velcro and "POTABLE" label)					
	NOTE					
Have towel ready for possible release of water when mating/demating any connections						
<						

The QD is explicitly referred to not only by name but also by color. This is intended to prevent the crew from inadvertantly inserting the device into the wrong QD (the yellow Waste QD), which then contaminates the purge device (as has happened on previous flights). The Next button brings up a window to follow along with the various switch throws.

The top of the display reminds the user that Demo Mode is running, it repeats the dump mode (Supply, Waste, or Simo), and it reminds the dump type (duration or percent), which can be changed at any point.

4.2.3.2 Step B: Pre-Dump FDA

🤰 Wa	ater Dump	
File	Update View Help	
	B. PRE-DUMP FDA	Change Amount HH:MM
Prev		Dump Duration : 1:30
	Press 'Next' to begin procedure	
Next	No comm, change limits via Table A	Dump Type : Supply
	Press 'Next' to begin procedure Next Schematic View Log Skip	Tank Qtys : B:80% D:80% Noz Temps : A:12 B:12 DL:90
		· · ·

If comm is available, a reminder that MCC will TMBU the various limits shows up. If not, a Spec 60 window appears with the various parameters for the crew to change. Tables A and B data will be on this window depending on whether it is a supply, waste, or sim o dump.

ווא <mark>אי</mark> File	ater Dump Update View Help	<u>_</u> _×
	B. PRE-DUMP FDA	Change Amount HH:MM
Prev	Press 'Next' to begin procedure	Dump Duration : 1:30
\Rightarrow	No comm, change limits via Table A	GMT : 2002/249/14:19:03
Next	CRT D1. SUPPLY H2O DMP LN T >= 65	Dump Type : Supply
	Next Schematic View Log Skip	Noz Temps : A:12 B:12 DL:90

👔 5M 60 Table Maintenance 🛛 🔀					
TABLE A					
SM 60 TABLE MAINT					
	PARAMETER	SM A	LERT		
NAME		LOW	HIGH		
SUPPLY H20 QTY A	0620410	*			
В	0620420	*			
C	0620548	*	*		
D	0620544				
NOZ T A	0620440	90	250		
NOZ T B	0620439	90	250		
overfill detection	ABLE B				
SM 60 TABLE MAIN	r				
PARAMETER NAME	PARAMETER ID	SM A LOW	LERT HIGH		
WASTE H20 QTY 1	0620540	*	99		
NOZ T A	0620520	50	250		
NOZ T B	0620519	50	250		
* Limits TMBU'd on orbit to provide leak and overfill detection					
ΟΚ					

At this point, the program is waiting for the crew to hit Next. The black arrow points to the current step.

4.2.3.3 Step C: Simo Dump H2O Tk N2 Reg Config

👔 W	later Dump	
Prev Prev Next	C. SIMO DUMP H20 TK N2 REG CONFIG Wait for MCC to TMBU nozzle temp, tank qty limits, and dump duration MO10W H20 TK N2 REG INLET SYS 1, SYS2 vlv (two) - OP CRT D1. SUPPLY H20 DMP LN T >= 65 Press 'Next' when action has been completed Next Schematic View Log Skip	Change Amount Supply Percent : 7% Waste Percent : 7% GMT : 2002/288/17:41:18 Dump Type : Simultaneous Tank Qtys : Noz Temps :

The program stops on an action: in this case, the crew should open the N2 valves. Since there is no telemetry on those valves, they will have to press Next to continue with the program after opening the valves. The flashing green hand indicates an action for the crew.

At this point for a simo dump, a second window appears so that the user can do both a supply and waste dump in separate windows.

4.2.3.4 Step D: Supply H2O Dump Nozzle Htr Activation

The program first checks the temperature of the supply water dump line. If it is below 65, a star block in the procedures tells the crew to activate dual heaters.

🤰 w	ater Dump	
File	Update View Help	
	D. SUPPLY H20 DUMP NOZZLE HTR ACTIVATION	<u>C</u> hange Amount
Prev	No comm, change limits via Table A and Table B	Dump To Percent : 7% Current Average :
P	ML86B:A * cb MNB(MNA) H2O LINE HTR B(A) - cl *	GMT · 2002/302/14·33·35
Next	CRT D1. SUPPLY H20 DMP LN T >= 65	Dump Type : Supply
	Enable 2nd Heater - Press next when completed Next Schematic View Log Skip	Tank Qtys : B:50% D:50% Noz Temps : A:11 B:11 DL:60
	SUPPLY H20 DUMP LINE TEMP : 60	

Once the temps are above 65, or when the second heater is activated, the program verifies that the dump isol valve is open (step D2), then waits for telemetry on the dump valve enable/nozzle heater to show on. The green flashing hand points to a step that is required. The program will verify the position of the dump valve in step D4.

٦ ،	Vater Dump						
File	Update Viev	v Help					
	D. SUPP	YLY H20 DUMP NOZZLE HTR ACTIVATION					Change Amount
Prev	R11L	D2. SPLY H2O DUMP ISOL VLV - OP (tb-OP) (V	verified by t	telemetr	y)		Dump To Percent : 7%
ß	R11L D3. SPLY H20 DUMP VLV ENA/NOZ HTR - ON R11L D4. SPLY H20 DUMP VLV - CL (tb-CL)					Current	
Nex					Dump Type : Supply		
	Action re	quired to continue	<u>N</u> ext S	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Tank Qtys : B:80% D:80% Noz Temps : A:12 B:12 DL:90

4.2.3.5 Step E: Waste H2O Dump Nozzle Htr Activation

The program first checks the temperature of the supply water dump line. If it is below 50, a star block in the procedures tells the crew to activate dual heaters.

🐧 Wa	ater Dump	
File	Update View Help	
	E. WASTE H20 DUMP NOZZLE HTR ACTIVATION	Change Amount
Prev		Dump To Percent : 7%
P	ML86B:A * cb MNB(MNA) H2O LINE HTR B(A) - cl *	GMT : 2002/302/14:36:54
Next	CRT E1. WASTE H20 DMP LN T > 50	Dump Type : Waste
	Enable 2nd Heater - Press next when completed Next Schematic View Log Skip	Tank Qty : 50% Noz Temps : A:26 B:26 DL:45
	WASTE H20 DUMP LINE TEMP : 45	

Once the temp is above 50, or when the second heater is activated, the program verifies that the dump isol valve is open (step E2), then waits for confirmation of the dump valve enable/nozzle heater to be on. The green flashing hand points to a step that is required. The program will verify the position of the dump valve in step E4.

🍡 Wa	iter Dump				
File	Jpdate View Help				
	E. WASTE H20 DUMP NOZZLE HTR ACTIVATION				Change Amount
Prev	ML31C E2. WASTE H2O DUMP ISOL VLV - OP (tb-OP) (Verit	ied by telemetry)			Dump To Percent : 7%
P	ML31C E3. WASTE H20 DUMP VLV ENA/NOZ HTR -	ON			GMT · 2002/288/17·44·46
Next	ML31C E4. WASTE H20 DUMP VLV - CL (tb-CL)				Dump Type : Waste
	Action required to continue	Next Schem	natic View	Log <u>S</u> kip	Noz Temps : A:12 B:12 DL:75

4.2.3.6 Step F: Supply H2O Dump Initiation

Water Dump					
Prev F. SUPPLY H20 DUMP INITIATION R11L D4. SPLY H20 DUMP VLV - CL (tb-CL) (Veritic CRT F1. Wait for SUPPLY H20 NOZ T A, B (two) to R11L F2. SPLY H20 DUMP VLV - OP (tb-OP) Waiting for NOZ T to INCR SUPPLY H20 NOZ TEMP : A=12 B=12	ied by teleme exceed 100 (<u>N</u> ext S	etry) (~5 min v Sche <u>m</u> atic	warmup t View <u>L</u> og	time) <u>skip</u>	Change Amount Dump To Percent : 72 Current : GMT : 2002/249/14:34:34 Dump Type : Supply Tank Qtys : B:80% D:80% Noz Temps : A:12 B:12 DL:90

The program will proceed when the nozzle temps exceed 100 degrees, so set the temps greater than 100 and hit the "Set" button on the control panel. This is not required if operating in the SMS with "real" telemetry.

When the temps exceed 100 degrees, the background flashes green. The flashing green hand points to the next step, to open the supply dump valve.

🏹 W File	<mark>ater Dump</mark> Update View Help	<u>_ </u>
Prev Prev Next	F. SUPPLY H20 DUMP INITIATION CRT F1. Wait for SUPPLY H20 NOZ T A,B (two) to exceed 100 (~5 min warmup time) (VAR11L F2. SPLY H20 DUMP VLV - OP (tb-OP) CRT F3. Wait for SPLY H20 QTY to decrease to desired level (~1 to 2% per min) Action required to continue Next Schematic View Log Skip	Change Amount Dump To Percent : Current : GMT : 2002/249/14:38:56 Dump Type : Supply Tank Qtys : Noz Temps : A:102 B:102 DL:90

When that's complete, the program waits for the quantity to get down to the specified level (in the upper right corner).

] w	ater Dump							_ 🗆 ×
File	Update View Hel	p						
	F. SUPPLY H	120 DUMP INITIATION					Change Amount	
Prov	B111 E2	SPLY H20 DUMP VI V - OP (th-OP) (Verifier	1 hv telem	netrv)			Dump To Percent :	7%
	CBT F3	Wait for SPLY H20 QTY to decrease to desi	red level (1~1 to 2%	per min)		Current :	80%
Next	R11L H1. SPLY H20 DUMP ISOL VLV - CL (tb-CL)					GMT : 2002/249/14:53:1 Dump Type : Supply	.2	
	Overboard su	apply H2O dump in progress	<u>N</u> ext	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Noz Temps : A:102 B:102	2 DL:90
	SUPPLY H20	NOZ TEMP : A=102 B=102						

A schematic of the supply and waste water system appears when the program starts. The status of the valves, heaters, and water dump is color coded based on telemetry. The view below shows a dump from tanks B and D, with the nozzle heater on and no waste dump in progress.



When the current value of the tank quantities are within 2% of the desired level, the display background flashes dark green.

٦ :	Vater Dump						
File	Update View Help						
	F. SUPPLY H20 DUMP	' INITIATION				Change Amount	
Pre	R11L F2. SPLY H	120 DUMP VLV - OP (tb-OP) (Verifie	ed by telemetry)			Dump To Percent : Current :	7% 8%
F)	CRT F3. Wait for	SPLY H2O QTY to decrease to des	sired level (~1 to 2	% per min)	_	GMT : 2002/249/15:12:3	6
Ne	R11L H1. SPLY	120 DUMP ISOL VLV - CL (tb-CL)			-	Dump Type : Supply	
	Supply dump quantity i	s approaching desired level	<u>N</u> ext Sche <u>m</u> ati	: View <u>L</u> og	<u>S</u> kip	Noz Temps : A:102 B:102	DL:90
	SUPPLY H20 NOZ TEN	IP : A=102 B=102					

Note that the current tank quantities will be close (within 1%) but may not be identical to what's displayed on the crew's displays, if they compare the PGSC output to orbiter data. The WaterDump program apparently truncates while the data on the display is rounded. This would have the effect of triggering the "lower limit" warning on the PGSC slightly sooner than would be annunciated as an SM Alert, but the difference is not significant.

4.2.3.7 Step G: Waste H2O Dump Initiation

When the waste nozzle temps exceed 250 and the tank valve is verified open, the program steps to the next item, to open the dump valve, and shows the warning not to dump to less than 5% on the waste tank.

🏹 🗰 File	'ater Dump Update Viev	w Help					<u>_</u> _×
	G. WAS	TE H20 DUMP INITIATION					Change Amount
Prev	ML31C	E4. WASTE H2O DUMP VLV - CL (tb-CL) (Verified by	telemetry)				Dump To Percent : 7%
⊒>	CRT	G1. Wait for WASTE H2O NOZ T A,B (two) to ex	ceed 250	(~10 min	warmup	time) (Ve	GMT - 2002/288/18-00-51
Next	ML31C	G2. WASTE H2O TK1 VLV - OP (tb-OP)					Dump Type : Waste
	Nozzle t	emperature is nominal	<u>N</u> ext	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Tank Uty: 40% Noz Temps: A:251 B:251 DL:75
	WASTE I	H2O NOZ TEMP : A=251 B=251					

Informati	Informational Note				
	CAUTION				
	Dumping WASTE H20 TK1 QTY below 5% can cause bellows damage				
ΟΚ					

Acknowledging the warning moves the program to the next step.

🚡 w	ater Dump						×
File	Update View Help						
	G. WASTE H20 DUMP INITIATION					Change Amount	
Prev	ML31C G2. WASTE H2O TK1 VLV - OP (tb-OP) (Verified by te	elemetry)				Dump To Percent : 7%	
	ML31C G3. WASTE H2O DUMP VLV - OP (tb-OP)					GMT · 2002/288/18:05:47	-
Next	CRT G4. Wait for WASTE H2O QTY to decrease to desired le	evel (~1 to 2%	6 per min))		Dump Type : Waste	
	Action required to continue	Next S	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Noz Temps : A:251 B:251 DL:75	

When that's complete, the program will wait for the quantity to drop to the lower limit.

🦹 W	ater Dump						_ 🗆 ×
File	Update View Help						
	G. WASTE H20 DUMP INITIATION					Change Amount	
Prev	ML31C G3. WASTE H2O DUMP VLV - OP (tb-OP) (Verified b	/ telemetry)				Dump To Percent :	7%
	CRT G4. Wait for WASTE H20 QTY to decrease to de	esired leve	el (~1 to 2	% per mi	nì	Current :	40%
Next	CRT G5. WASTE H2O NOZ T A,B (two) - not incr (Monitoring during dump)					GMT: 2002/288/18:08:2 Dump Type: Waste	26
	Overboard waste H2O dump in progress	Next	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Noz Temps : A:251 B:25	1 DL:75
	WASTE H20 NOZ TEMP : A=251 B=251						



If the dump is required to be terminated early due to low nozzle temps, the background will flash yellow and give an audible alarm. The next step is to immediately terminate the dump by closing the dump valve, wait for a bakeout of the lines and nozzle, and then try again.

🍡 w	ater Dump	
File	Update View Help	
	G. WASTE H20 DUMP INITIATION	Change Amount
Prev	CRT G5. WASTE H2O NOZ T A,B (two) - not incr (Monitoring during dump)	Dump To Percent : 7%
P	ML31C G6. WASTE H2O DUMP VLV - CL (tb-CL)	GMT + 2002/202/12:25:49
Next	CRT G7. Wait for WASTE H2O NOZ T A,B (two) to exceed 250 (~8 min reheat time)	Dump Type : Waste
	WASTE NOZ T has dropped < 50 Mext Schematic View Log Skip	Noz Temps : A:49 B:49 DL:75
	WASTE H2O NOZ TEMP : A=30 B=30	

🔒 W	rater Dump	
File	Update View Help	
	G. WASTE H20 DUMP INITIATION	Change Amount
Prev	ML31C G6. WASTE H2O DUMP VLV - CL (tb-CL) (Verified by telemetry)	Dump To Percent : 7%
\Rightarrow	CRT G7. Wait for WASTE H2O NOZ T A,B (two) to exceed 250 (~8 min reheat time)	GMT · 2002/302/13·38·24
Next	ML31C G8. WASTE H2O DUMP VLV - OP (tb-OP)	Dump Type : Waste
	Waiting for NOZ T to INCR Mext Schematic View Log Skip	Noz Temps : A:99 B:99 DL:75
	WASTE H20 NOZ TEMP : A=99 B=99	

🧃 w.	ater Dump	
File	Update View Help	
	G. WASTE H20 DUMP INITIATION	Change Amount
Prev	CRT G7. Wait for WASTE H2O NOZ T A.B (two) to exceed 250 (~8 min reheat time) (Verified by teleme	Dump To Percent : 7% Current : 40%
	ML31C G8. WASTE H2O DUMP VLV - OP (tb-OP)	GMT · 2002/302/13·39·40
Next	CRT G4. Wait for WASTE H2O QTY to decrease to desired level (~1 to 2% per min)	Dump Type : Waste
	Action required to continue Next Schematic View Log Skip	Noz Temps : A:255 B:255 DL:75

4.2.3.8 Step H: Supply H2O Dump Termination

When at least one of the tank quantities is at the lower limit, another tone sounds and the background flashes bright green.

🤰 w	ater Dump	
File	Update View Help	
	H. SUPPLY H20 DUMP TERMINATION	Change Amount
Prev	CRT F3. Wait for SPLY H20 QTY to decrease to desired level (~1 to 2% per min)	Dump To Percent : 7%
\mathbf{r}	R11L H1. SPLY H20 DUMP ISOL VLY - CL (tb-CL)	Lurrent : 7%
Next	CRT H2. SUPPLY H2O QTY A(B,C,D) - not decr	GMT: 2002/249/15:16:16 Dump Type: Supply
	Supply dump quantity has reached desired level (7%) Mext Schematic View Log Skip	Tank Qtys : B:7% D:7% Noz Temps : A:102 B:102 DL:90
	SUPPLY H20 NOZ TEMP : A=102 B=102	

Alternatively, if the dump is required to be terminated early due to low nozzle temps, the background will flash yellow and give an audible alarm. The next step is to immediately terminate the dump by closing the dump isol valve, and then proceed to step H (dump termination). The crew should check with MCC about performing a supply dump through the FES to complete the dump.

🍡 w.	ater Dump						IX
File	Update View Help						
	H. SUPPLY H20 DUMP TERMINATION					Change Amount	
Prev	CRT F3. Wait for SPLY H2O QTY to decrease to desired leve	l (~1 to 2%	per min)			Dump To Percent : 7% Current Average : 80%	
P	R11L H1. SPLY H2O DUMP ISOL VLV - CL (tb-CL)				GMT · 2002/302/12·29·25	-	
Next	CRT H2. SUPPLY H2O QTY A(B,C,D) - not decr					Dump Type : Supply	
	NOZ T A,B < 90 - Terminate Dump	<u>N</u> ext	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Noz Temps : A:88 B:88 DL:90	
	SUPPLY H2O NOZ TEMP : A=88 B=88						

The dump isol valve is closed (using the Control Panel if required) and then the program waits 60 seconds to verify that the tank quantities are not decreasing.

🧻 wa	ster Dump	
File	Update View Help	
	H. SUPPLY H20 DUMP TERMINATION	Change Amount
Prev	R11L H1. SPLY H2O DUMP ISOL VLV - CL (tb-CL) (Verified by telemetry)	Dump To Percent : 7%
\Rightarrow	CRT H2. SUPPLY H2O QTY A(B,C,D) - not decr	GMT · 2002/249/15:52:52
Next	CRT H3. Wait for SUPPLY H2O NOZ T A,B (two) to exceed 250 (~10-12 min bakeout time)	Dump Type : Supply
	Verifying quantity not decreasing (54) Next Schematic View Log Skip	Tank Qtys : B:7% D:7% Noz Temps : A:102 B:102 DL:90

If the quantities do continue to decrease, a yellow warning box appears with actions



While water was dumping overboard, the pressure in the lines (31 psi) was greater than the cabin pressure (14.7 psi) so water did not come into the cabin and cabin air did not go overboard. Now that the dump isol is closed, air is flowing through the purge device that was plugged into the contingency cross-tie. This air is meant to purge the line so that water does not collect at the dump valve. Prior to using this purge device, water would freeze at the dump valve and crack the valve, causing trickle flow overboard.

The dump isol valve is kept closed until the nozzle temperatures exceed 250 degrees for the bakeout of water in the lines. For standalone training, this must be done using the Control Panel demo.

🄰 wa	ater Dump							
File Update View Help								
	H. SUF	PPLY H20 DUMP TERMINATION					<u>C</u> hange Amount	
Prev	CRT	H2. SUPPLY H2O QTY A(B,C,D) - not decr (Skipped by	user)				Dump To Percent :	7% 90%
\Rightarrow	CRT	H3. Wait for SUPPLY H2O NOZ T A, B (two) to ex	ceed 250) (~10-12	min bake	eout time	GMT - 2002/302/12-36	·07
Next	R11L	H4. SPLY H2O DUMP VLV - CL (tb-CL)					Dump Type : Supply	
	Waiting	g for NOZ T to INCR	<u>N</u> ext	Sche <u>m</u> atic	View <u>L</u> og	<u>S</u> kip	Noz Temps : A:102 B:10	02 DL:90
	SUPPL	Y H2O NOZ TEMP : A=102 B=102						

The background flashes bright green when that occurs.

N W	ater Dump						<u>- 🗆 ×</u>
File	H. SUPPLY H20 DUMP TERMINATION CRT H3. Wait for SUPPLY H20 NOZ T A, B (two) to exceed 250 (~10-12 min bakeout time) (Verified by				<u>C</u> hange Amount Dump To Percent : 72 Current Average : 802	к к	
Next	R11L H4. SPLY H2O DUMP VLV - CL (tb-CL) Wait 60 secs				GMT:2002/302/12:39:07 Dump Type:Supply Tank Qtys:B:80% D:80%		
	Action required to continue SUPPLY H20 NOZ TEMP : A=251 B=251	<u>N</u> ext	Sche <u>m</u> atic	Vie w <u>L</u>og	<u>S</u> kip	Noz Temps : A:251 B:251 DL:5	90

After the bakeout of the lines, the dump valve is cycled closed for 60 seconds (while the purge device pressurizes the line segment), then open for 60 seconds (while the purge device flows more air), then closed again. This will be reflected on the schematic if it is called up.

🤰 w.	ater Dump	
File	Update View Help	
	H. SUPPLY H20 DUMP TERMINATION	Change Amount
Prev	R11L H5. SPLY H2O DUMP VLV - OP (tb-OP) (Verified by telemetry)	Dump To Percent : 7%
\Rightarrow	Wait 60 secs	GMT · 2002/302/12:40:56
Next	R11L H6. SPLY H2O DUMP VLV - CL (tb-CL)	Dump Type : Supply
	Waiting : 49 seconds Next Schematic View Log Skip	Noz Temps : A:251 B:251 DL:90

Tile	Water Dump					
Prev D Next	H. SUPPLY H20 DUMP TERMINATION Wait 60 secs R11L H6. SPLY H20 DUMP VLV - CL (tb-CL) R11L H7. SPLY H20 DUMP ISOL VLV - OP (tb-OP) Action required to continue Mext	g <u>S</u> kip	Change Amount Dump To Percent : 7% Current Average : 80% GMT : 2002/302/12:42:31 Dump Type : Supply Tank Qtys : B:80% D:80% Noz Temps : A:251 B:251 DL:90			

Once the dump isol valve is closed, the nozzle heater is turned off.

🧎 ₩ File	later Dump Update View Help	
	H. SUPPLY H20 DUMP TERMINATION	Change Amount
Prev	R11L H7. SPLY H2O DUMP ISOL VLV - OP (tb-OP) (Verified by telemetry)	Dump To Percent : 7%
P	R11L H8. SPLY H20 DUMP VLV ENA/NOZ HTR - OFF	GMT · 2002/302/12·44·06
Next	R11L H9. Verify SPLY H2O DUMP VLV tb - bp	Dump Type : Supply
	Action required to continue Next Schematic View Log Skip	Noz Temps : A:251 B:251 DL:90

The program steps through each of these switch throws once the valve or switch position has been verified through telemetry. After 30 seconds, the temperatures are verified to be not increasing.

A yellow warning box appears if the temps are still increasing, with actions for the crew to disable the heaters.

C	heck Supply Nozzle Temperatures
	Verify that the SUPPLY H2O NOZ T A,B (two) 📃 🔤
	is not incr.
	* If SPLY H20 NOZ T A,B (two) incr: *
	ML86B:A * cd MNC SPLY H20 DUMP *
	* VLV/NOZ HTR - op *

The crew is reminded to remove the purge device and stow it until the next dump. The "Next" button completes the nominal dump procedures.

🤰 w	ater Dump	
File	Update View Help	
	H. SUPPLY H20 DUMP TERMINATION	Change Amount
Prev	CRT H10. SUPPLY H2O NOZ T A.B (two) - not incr (Verified by telemetry)	Dump To Percent : 7% Current Average : 80%
	WCS H11. Remove, stow SPLY H20 Dumpline Purge Device from CONT H20 X-TIE POT QD	GMT · 2002/302/12·46·25
Next	End of procedure	Dump Type : Supply
	Press 'Next' when action has been completed Next Schematic View Log Skip	Tank Qtys : B:80% D:80% Noz Temps : A:251 B:251 DL:90
	SUPPLY H20 NOZ TEMP : A=251 B=251	

Next CRT

GMT : 2002/288/18:15:15

Noz Temps : A:251 B:251 DL:75

Dump Type:Waste Tank Qty: 7%

Skip

If the dump was terminated early due to low temperatures (suggesting that the water is freezing at the nozzles), a note tells the crew to check with MCC for future dump acations.

Supply Dump Termination Note			
NOTE Dump was terminated for SUPPLY H20 NOZ T < 90. ✓ MCC about dumping supply water thru FES, thru waste water nozzle, or into CWC to make ullage for fuel cell product water.			

4.2.3.9 Step I: Waste H2O Dump Termination

12. WASTE H2O QTY 1 - not decr

Verifying quantity not decreasing (28)

13. Wait for WASTE H2O NOZ T A,B (two) to exceed 250 (~8 min bakeout time)

When the appropriate point for terminating the dump (based on time or quantity) has occurred, it's time to close the waste dump valve. Then the program verifies that the quantity is not decreasing over 60 seconds.

🤰 W	ater Dump	
File	Update View Help	
Prev	I. WASTE H20 DUMP TERMINATION CRT G5. WASTE H20 NOZ T A,B (two) - not incr (Monitoring during dump) ML31C I1. WASTE H20 DUMP VLV - CL (tb-CL) CRT I2. WASTE H20 QTY 1 - not decr	Change Amount Dump To Percent : 7% Current : 7% GMT : 2002/288/18:12:46 Dump Type : Waste
	Waste dump quantity has reached desired level (7%) Next Schematic View Log Skip WASTE H20 NOZ TEMP : A=251 B=251	Tank Qty : 7% Noz Temps : A:251 B:251 DL:75
N W	Vater Dump	
File	upuate view nep	
	I. WASTE H20 DUMP TERMINATION	Change Amount
Prev	ML31C II. WASTE H2O DUMP VLV - CL (tb-CL) (Verified by telemetry)	Dump To Percent : 7%

Next

Schematic View Log

If the quantity does decrease, a yellow warning block appears to have the crew cycle the dump valve.

Verify that the WASTE H2O QTY is not decr.	A
Verity that the WASIE H2U UIY is not decr.	
* IF WASIE HZU UIY 1 decr: *	
* Cycle WASTE H20 DUMP VLV *	
* If not successful, *	
ML31C * WASTE H2O DUMP ISOL VLV - *	
* UL (TD-UL) *	

Meanwhile, the program is also monitoring the nozzle temps. When they exceed 250 degrees, the background flashes bright green. The next step is to turn the nozzle heater off.

🧃 w	🚡 Water Dump								
File	File Update View Help								
	I. WASTE H20 DUMP TERMINATION	Change Amount							
Prev	CRT I3. Wait for WASTE H2O NOZ T A, B (two) to exceed 250 (~8 min bakeout time) (Verified by telemi	Dump To Percent : Current :	7% 7%						
	ML31C I4. WASTE H20 DUMP VLV ENA/NOZ HTR - OFF	GMT · 2002/288/18·20·45							
Next	ML31C I5. Verify WASTE H2O DUMP VLV tb - bp	Dump Type : Waste							
	Next Schematic View Log Skip	Tank Uty: 7% Noz Temps:A:251 B:251 [DL:75						

Once the dump valve talkback is verified to be barberpole, the program continues to monitor the temps to make sure they are not continuing to increase.

🍡 w	ater Dump								
File Update View Help									
	I. WASTE H20 DUMP TERMINATION			Change Amount					
Prev	ML31C I5. Verify WASTE H2O DUMP VLV tb - bp			Dump To Percent :	7%				
	CRT I5. WASTE H2O NOZ T A, B (two) - not incr			Lurrent :	1%				
Next	End of procedure			Dump Type : Waste	•				
	Verifying Nozzle Temperatures Not Increasing (27)	Sche <u>m</u> atic View <u>L</u> og	<u>S</u> kip	Noz Temps : A:251 B:251	DL:75				
	WASTE H20 NOZ TEMP : A=251 B=251								

If the temps do rise, a yellow warning box appears with actions to disable the heaters.

C	Check Waste Nozzle Temperatures						
	Verify that the WASTE H2O NOZ T A,B (two) is not 🛛 🔼						
	incr.						
	* If WASTE H20 NOZ T A.B (two) incr: *						
	* cd MNA WASTE H20 DUMP *						
	* VLV/NOZ HTR - op *						
	ΟΚ						

Finally, when it is determined that the heaters are indeed off, that's the end of the dump procedure!

] Wa	Water Dump									
File Update View Help										
	END OF DUMP PROCEDURE					Change Amount				
D	CBT IS WASTE H20 NOZ T A B (two) - not incr (Verified by:		Dump To Percent :	7%						
Frev										
<>	End of procedure	GMT : 2002/288/18:25:	03							
Next	Dump Type : Waste									
	End of procedure	Tank Qty : 7% Noz Temps : A:251 B:251 DL:75								

4.2.3.10 Step J: Simo H2O Tk N2 Reg Reconfig

After both the supply and waste dumps are completed, reconfigure the N2 regs. These valves have no telemetry.

J.	J. SIMO DUMP H2O TK N2 REG RECONFIG														
Current Cabin Pressure : 14.7															
	If	Cab	Р <	14.7	' Oł	· PCS	51	Act	tive	:			_		
		MO)10W		1.	H20	TK	N2	REG	INLET	SYS	2	vlv	-	CL
	If	PCS	2 Ac	tive	•										
		MC) 10 W		2.	H20	TK	N2	REG	INLET	SYS	1	vlv	-	CL
	I														
	Press OK when action is complete														

4.2.3.11 Step K: Post-Dump FDA Cleanup

A note says that if comm is available, MCC will reset the FDA limits If not, a window pops up with new limits that the crew should set.

Post-Dump FDA Cleanup	Post-Dump FDA Cleanup					
TABLE C SM 60 TABLE MAINT	TABLE D SM 60 TABLE MAINT					
PARAMETER PARAMETER SM ALERT NAME ID LOW HIGH	PARAMETER PARAMETER SM ALERT NAME ID LOW HIGH					
SUPPLY H20 NOZ T A B 0620439 -82 250 -82 250	WASTE H20 NOZ T A 0620520 250 B 0620519 250					
<u> </u>	<u> </u>					

Finally, the crew is reminded to check with MCC if dual heaters had been used during this supply and/or waste dump.

Second Heater Is Active						
Two heaters were active during this dump. Check MCC for Dumpline Htr Action.	A					
	Ŧ					
0 <u>K</u>						