Thermocouple

CP406R0008, (V1.0) PART I
COMPUTER PROGRAM CONTRACT END ITEM
BLOCK II
SPACE SHUTTLE MAIN ENGINE CONTROLLER
OPERATIONAL PROGRAM

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Version 1.0

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MODIFICATIONS SINCE LAST VERSION

The following Requirement Change Notices (RCNs) were incorporated into the Part I Version 2.601 to reflect the change of the HPFT and HPOT Discharge Temperature sensors from RTDs (Resistance Temperature Detectors) to Thermocouples. The resultant thermocouple Part I had its part number and version number changed to CP406R0008 and 1.0 respectively to delineate it from any ensuing Part I based on RTDs. The order of incorporation of the RCNs is shown in the second column.

RCN No.	OR-DER	TITLE AND DESCRIPTION
6164	1	Thermocouple Changes for HPOT and HPFT Discharge Temperatures
6189	3	Correction to RNC 6164 - FID 13 for Last Qualified Sensor Voting for Shutdown
6191	2	Correction to RCN 6164 - Thermocouples, Major Cycle Timing
6239	4	Option to Bypass FASCOS Logic in Thermocouple Software Version
6244	6	Preburner Pump Discharge Temperature Sensor Integrity Monitor Upper Limit
6245	5	Immediate Retry Software Filter for Transient Interrupts
6246	7	Changes to Thermocouple Software
6261	9	Controller Checkout SCP Interrupt Test Erroneous Failure Correction
6262	8	Thermocouple HPOT/HPFT Discharge Temperature Intra-Channel Qualification Test Changes
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FAILURE REPORTING AND RESPONSE (Para. 3.2.4)

TABLE HEADER ABBREVIATIONS

Acronym	Definition
C/O	Checkout phase
COMPONENT(S) DISQUALIFIED	Component(s) disqualified in response to the failure.
DELIM	Failure Delimiter is the 9 least significant bits of the Failure Identification Word. The delimiter is used to uniquely identify a type of FID. DELIM is an octal number.
ESW	Engine Status Word. It is the Vehicle Data Table Word number 3.
ID	Failure ID (FID) which is the 7 most significant bits of the Failure Identification Word. The FID identifies a type of failure. FID is an octal number.
SP	Start Preparation phase.
ST	Start phase.
MS	Mainstage phase.
S/D	Shutdown phase.
PS/D	Post Shutdown phase.

RESPONSE ABBREVIATIONS

All responses include the report of the failure except DSD and the responses of FID 75/76

Acronym	Definition
-	Dash indicates no failure response is applicable in the indicated engine phase (Not monitored).
CR	Command rejection of Purge Sequence 1, 2, 3, 4, Terminate Sequence commands.
CR2	Command rejection of Purge Sequence 1, 2, 3, 4 commands.
D	Disqualification of indicated parameter(s).
D*	Disqualification for Engine Ready Monitoring.
D**	FID 5 or 6 response is taken in Shutdown Phase whether the Emergency Shutdown fail On occurs prior to Shutdown (with a FID 7 or 10 response) or during Shutdown.
DF	Discontinue monitoring; command the function OFF. In the case of Halt Exit, the function is commanded to the disabled state.

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FAILURE REPORTING AND RESPONSE (Para. 3.2.4) (Continued)

RESPONSE ABBREVIATIONS All responses include the report of the failure except DSD and the responses of FID 75/76 (Continued)

Acronym	Definition
DM	Discontinue monitoring; do not command the function OFF.
DSD	DCU Self Disqualification. This response does not include a report of the failure.
E	Emergency Shutdown solenoid deenergized.
E*	Emergency Shutdown solenoid will be deenergized in first major cycle of shutdown, when shutdown occurs.
EL	Electrical Lockup
FD	Fixed Density
FID5	Response is found in FID 5.
FID6	Response is found in FID 6.
FID75/FID76	Response is found in either FID 75 or FID 76 depending on an in-control DCU A or DCU B respectively.
HL	Hydraulic Lockup
I	Inhibit Control. If engine phase/mode is Engine Ready, change engine phase/mode to Purge Sequence No. 4.
I*	Inhibit Control, but remain in Current Component Checkout mode.
M	Continue monitoring for the failed ON condition; do not command the function OFF.
MF	Continue monitoring for the failed ON condition; command the function OFF.
P3	If the engine phase/mode is Purge Sequence No. 4 or Engine Ready, change engine phase/mode to Purge Sequence No. 3.
PS	Pneumatic Shutdown
R	Report only. All other failure responses include a report of the failure except DSD and the responses of FID 75/76.
S	Hydraulic Shutdown
T	Terminate Checkout Sequence - Perform Terminate Sequence.
TO	Takeover by DCU B.

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FAILURE REPORTING AND RESPONSE (Para. 3.2.4) (Continued)

CONDITIONAL RESPONSES ABBREVIATIONS

Acronym	Definition
PS/HL	If the engine phase is start, the response is Pneumatic Shutdown. Else, the response is Hydraulic Lockup.
PS/PS	If ignition has not been confirmed, the response is Pneumatic Shutdown. Else, when shutdown occurs, perform Pneumatic Shutdown.
PS/S	If in Hydraulic Lockup or RVDT comparison has failed, the response is Pneumatic Shutdown. Else, the response is Hydraulic Shutdown.
PS/S*	If in Hydraulic Lockup or RVDT comparison has failed, the response is Pneumatic Shutdown. Else, the response is Hydraulic Shutdown. For failures occurring between Start + 0.80 sec and Start + 1.48 sec, Hydraulic Shutdown will be delayed until Start + 1.50 sec.
S/EL	If the engine phase is Start with no prior RVDT miscompare, the response is Hydraulic Shutdown. If the engine phase is Start with a prior RVDT miscompare, the response is Pneumatic Shutdown. If the engine phase is Mainstage, the response is Electrical Lockup.
S*/EL	If the engine phase is Start, the response is Hydraulic Shutdown with no prior RVDT Miscompare and Pneumatic Shutdown with a prior RVDT miscompare. For failures occurring between Start + 0.80 sec and Start + 1.48 sec, Hydraulic Shutdown will be delayed until Start + 1.50 sec. Else, the response is Electrical Lockup.

ESW SELF TEST ABBREVIATIONS

Acronym	Definition
MCF	Major Component Failure (Resumable, reference paragraph 3.2.4:2).
MCF-I	Major Component Failed - an MCF is reported only in Checkout or Start Prep and then only if I-Response is indicated. (Resumable, reference paragraph 3.2.4:2).
MCF-N	Major Component Failed - not resumable.
SLE	Shutdown Limit Exceeded.

FAILURE PARAMETER USAGE ABBREVIATIONS

Acronym	Definition
IWn	Input Word, where n varies from 1 through 32.
PBD	Power Bus Down Status bit.
mnemonic	As defined in Table XXX, for example, Q1A1. The unscaled IE DPM value is used.
Sensor Value	The value which has been scaled, as it would be reported in the normal VDT.
IW7+ Polarity	IW7 bits 15-4, with the polarity of the test indicated in bits 3-0 as follows: %0100 = positive test, %0011 = negative test.
.OR.	Logical OR (i.e., A + B)

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
001		DCU, Ch A (3.2.1:6.5)								
		First DCU Failure (Reported by DCU B)								
	000	DCU disqual without power loss (3.2.1:9)	(DCU)	D+I+TO	D+I+TO	D+TO	D+TO	D+TO	MCF	IW4 Bits 2-0 +PBD in bit 3
	001	DCU disqual with power loss (3.2.1:9.3.1)	(DCU, IE, Sensors, OE, Act)	D+I+TO	D+I+TO	D+TO	D+TO	D+TO	MCF	IW4 Bits 2-0 +PBD in bit 3
	002	Power loss after DCU disqual (3.2.1:9.3.2)	(IE, Sensors, OE, Act)	D+I	D+I	D	D	D	MCF	IW4 Bits 2-0 +PBD in bit 3
	003	Simulated DCU/OE failure (3.2.3:2.4.3:1)	(DCU, OE, Act)	D+I+TO	D+I+TO	D+TO	D+TO	D+TO	MCF	IW4 Bits 2-0 +PBD in bit 3
002		DCU, Ch B (3.2.1:6.5)								
		First DCU Failure (Reported by DCU A)								
	000	DCU disqual without power loss (3.2.1:9)	(DCU)	D+I	D+I	D	D	D	MCF	IW4 Bits 2-0 +PBD in bit 3
	001	DCU disqual with power loss (3.2.1:9.3.1)	(DCU, IE, Sensors, OE, Act)	D+I	D+I	D	D	D	MCF	IW4 Bits 2-0 +PBD in bit 3
	002	Power Loss after DCU disqual. (3.2.1:9.3.2)	(IE, Sensors, OE, Act)	D+I	D+I	D	D	D	MCF	IW4 Bits 2-0 +PBD in bit 3
	003	Simulated DCU/OE failure (3.2.3:2.4.3:1)	(DCU, OE, Act)	D+I	D+I	D	D	D	MCF	IW4 Bits 2-0 +PBD in bit 3

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FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	F A I L U R E T Y P E FUNCTION, DEVICE OR CHANNEL	COMPO-NENT(S) DISQUAL-IFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
003		Input Electronics Ch A (3.2.1:6.2)	(IE, Selected Sensors)							
		Address/Data Bus Error (3.2.3:3.3.1)								
	001	Test Word TW1A 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	TW1A
	002	Test Word TW2A 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	TW2A
	012	Press Mux Cal 3A RC15 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC15
	013	Press Mux Cal 4A RC19 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC19
		Analog to Digital Converter (3.2.3:3.3.3)								
	201	IE -10V Ref IE1A 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	IE1A
	202	IE +10V Ref IE2A 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	IE2A
	203	Press Mux Gnd 2A RC05 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC05
	204	Press Mux Gnd 3A RC09 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC09
	205	Press Mux Gnd 4A RC21 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC21
	206	Press Mux Cal 1A RC03 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC03
	207	Press Mux Cal 2A RC07 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC07
	210	Temp Mux Cal 1A RC13 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC13
	211	Temp Mux Cal 2A RC17 1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC17
	501	OE Register 1 (3.2.3:3.2.3) Group Switch 1 failed ON bit 9 Group Switch 2 failed ON bit 8 PRC Overflow failed ON bit 5 1st IE Failure 2nd IE Failure		D+I+CR D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	IW15 IW15

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FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
004		Input Electronics Ch B (3.2.1:6.2)		(IE, Selected Sensors)							
		Address/Data Bus Error (3.2.3:3.3.1)									
	001	Test Word TW1B	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	TW1B
	002	Test Word TW2B	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	TW2B
	012	Press Mux Cal 3B RC14	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC14
	013	Press Mux Cal 4B RC18	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC18
		Analog to Digital Converter (3.2.3:3.3.3)									
	201	IE -10V Ref IE1B	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	IE1B
	202	IE +10V Ref IE2B	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	IE2B
	203	Press Mux Gnd 2B RC04	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC04
	204	Press Mux Gnd 3B RC08	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC08
	205	Press Mux Gnd 4B RC20	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC20
	206	Press Mux Cal 1B RC02	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC02
	207	Press Mux Cal 2B RC06	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC06
	210	Temp Mux Cal 1B RC12	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC12
	211	Temp Mux Cal 2B RC16	1st IE Failure 2nd IE Failure		D+I D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	RC16
	501	OE Register 1 (3.2.3:3.2.3) Group Switch 1 failed ON bit 9 Group Switch 2 failed ON bit 8 PRC Overflow failed ON bit 5	1st IE Failure 2nd IE Failure		D+I+CR D+I+CR	D+I D+DSD	D D+DSD	D D+DSD	D D+PS	MCF MCF-N	IW16 IW16

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
005		<u>Output Electronics Ch A</u> (3.2.1:6.3)		(OE, Act, Position Sensors)							
		OE Storage Register (3.2.3:3.1.7)									
	000	no prior IE failure									
	010	prior IE A failure									
	020	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW21 Format,
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	Failed Bits=1
		Hold failed bit 6 (3.2.3:3.2.3)									
	100	no prior IE failure									
	110	prior IE A failure									
	120	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW15
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Emergency Shutdown failed ON (3.2.3:3.2.3)									
	101	no prior IE failure									
	111	prior IE A failure									
	121	prior IE B failure									
			1st OE Failure		-	-	-	D**	-	MCF	IW15
			2nd OE Failure		-	-	-	D+DSD	-	MCF-N	
		Igniter failed ON bits 4-2 (3.2.3:3.2.3)									
	102	no prior IE failure									
	112	prior IE A failure									
	122	prior IE B failure									
			1st OE Failure		D+I	D+I	-	-	-	MCF	IW15
			2nd OE Failure		D+I+CR	D+DSD	-	-	-	MCF-N	
		Act FS failed ON (3.2.3:3.2.3)									
	300	no prior IE failure									
	310	prior IE A failure									
	320	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW19
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		RVDT/LVDT Amplitude (3.2.3:3.3.4)									
	400	no prior IE failure									
	410	prior IE A failure									
	420	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	FRVA
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		RVDT/LVDT Frequency (3.2.3:3.3.4)									
	401	no prior IE failure									
	411	prior IE A failure									
	421	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	TRCA
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
005		Output Electronics Ch A (3.2.1:6.3) (Continued)		(OE, Act, Position Sensors)							
		CIE Data MUX Reported by DCU B (3.2.3:3.2.1)									
	402,403	no prior IE failure									
	412,413	prior IE A failure									
	422,423	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW9,IW23
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Servoactuator Model/Monitor (3.2.3:3.2.4)									
	404	no prior IE failure									
	414	prior IE A failure									
	424	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW7+Polarity
			2nd OE Failure		FID75/FID76, Delimiter 031 in all phases					-	-
		Multiple SEIs pending (3.2.3:6.1.3:1(d))									
	405	no prior IE failure									
	415	prior IE A failure									
	425	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW7
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Different SEI pending (3.2.3:6.1.3:1(e)(2))									
	406	no prior IE failure									
	416	prior IE A failure									
	426	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW7
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		RVDT/LVDT PRC not updated (3.2.3:3.3.2:1)									
	407	no prior IE failure									
	417	prior IE A failure									
	427	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	TRCA
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		DCU B with no RCFI1 or RCFI2 (3.2.1:9.1.2(c))									
	500	no prior IE failure									
	510	prior IE A failure									
	520	prior IE B failure									
			1st OE Failure		D+I	D+I	D	D	D	MCF	IW4
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
006		<u>Output Electronics Ch B</u> (3.2.1:6.3)	(OE, Act, Position Sensors)							
		OE Storage Register (3.2.3:3.1.7)								
	000	no prior IE failure								
	010	prior IE A failure								
	020	prior IE B failure								
		1st OE Failure		D+I	D+I	D	D	D	MCF	IW22 Format, Failed Bits=1
		2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Hold failed bit 6 (3.2.3:3.2.3)								
	100	no prior IE failure								
	110	prior IE A failure								
	120	prior IE B failure								
		1st OE Failure		D+I	D+I	D	D	D	MCF	IW16
		2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Emergency Shutdown failed ON (3.2.3:3.2.3)								
	101	no prior IE failure								
	111	prior IE A failure								
	121	prior IE B failure								
		1st OE Failure		-	-	-	D**	-	MCF	IW16
		2nd OE Failure		-	-	-	D+DSD	-	MCF-N	
		Igniter failed ON bits 4-2 (3.2.3:3.2.3)								
	102	no prior IE failure								
	112	prior IE A failure								
	122	prior IE B failure								
		1st OE Failure		D+I	D+I	-	-	-	MCF	IW16
		2nd OE Failure		D+I+CR	D+DSD	-	-	-	MCF-N	
		Act FO failed ON/OFF (3.2.3:3.2.3)								
	200	no prior IE failure								
	210	prior IE A failure								
	220	prior IE B failure								
		1st OE Failure		D+I	D+I	D	D	D	MCF	IW18
		2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Act FS failed ON (3.2.3:3.2.3)								
	300	no prior IE failure								
	310	prior IE A failure								
	320	prior IE B failure								
		1st OE Failure		D+I	D+I	D	D	D	MCF	IW20
		2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		RVDT/LVDT Amplitude (3.2.3:3.3.4)								
	400	no prior IE failure								
	410	prior IE A failure								
	420	prior IE B failure								
		1st OE Failure		D+I	D+I	D	D	D	MCF	FRVB
		2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
006		Output Electronics Ch B (3.2.1:6.3) (Continued)		(OE, Act, Position Sensors)							
		RVDT/LVDT Frequency (3.2.3:3.3.4)									
	401	no prior IE failure									
	411	prior IE A failure									
	421	prior IE B failure	1st OE Failure		D+I	D+I	D	D	D	MCF	TRCB
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		CIE Data MUX Reported by DCU A (3.2.3:3.2.1)									
	402,403	no prior IE failure									
	412,413	prior IE A failure									
	422,423	prior IE B failure	1st OE Failure		D+I	D+I	D	D	D	MCF	IW10,IW24
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Servoactuator Model/Monitor (3.2.3:3.2.4)									
	404	no prior IE failure									
	414	prior IE A failure									
	424	prior IE B failure	1st OE Failure		D+I	D+I	D	D	D	MCF	IW7+Polarity
			2nd OE Failure		FID 75/FID 76, Delimiter 031 in all phases					-	-
		Multiple SEIs pending (3.2.3:6.1.3:1(d)									
	405	no prior IE failure									
	415	prior IE A failure									
	425	prior IE B failure	1st OE Failure		D+I	D+I	D	D	D	MCF	IW7
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		Different SEI pending (3.2.3:6.1.3:1(e)(2))									
	406	no prior IE failure									
	416	prior IE A failure									
	426	prior IE B failure	1st OE Failure		D+I	D+I	D	D	D	MCF	IW7
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	
		RVDT/LVDT PRC not updated (3.2.3:3.3.2:1)									
	407	no prior IE failure									
	417	prior IE A failure									
	427	prior IE B failure	1st OE Failure		D+I	D+I	D	D	D	MCF	TRCB
			2nd OE Failure		D+I+CR	D+DSD	D+DSD	D+DSD	D+PS	MCF-N	

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
007		Output Electronics Non-Disqualifying Ch A (3.2.3:3.2.3)	(N/A)							
			Command & Monitor Failed ON/OFF							
		Register 1								
	100	Bleed Valve Solenoid failed ON/OFF bit 15	DF/DF	I	I	R	R	R	MCF-I	IW15
		Fuel System Purge Solenoid failed ON/OFF bit 14	DF/DF	I	I	R	R	R	MCF-I	IW15
		Pogo Precharge Purge Solenoid failed ON/OFF bit 13	DF/DF	I	I	R	R	R	MCF-I	IW15
		Preburner Shutdown Purge Sol. failed ON/OFF bit 12	DF/DF	I	I	R	R	R	MCF-I	IW15
		Emergency Shutdown Solenoid failed ON bit 11	DF/-	I+D**	I+D**	D**	FID5	R	MCF-I	IW15
		Emergency Shutdown Solenoid failed OFF bit 11	-/MF	I	I	R	R	R	MCF-I	IW15
		HPOP IMSL failed ON/OFF bit 10	DF/DF	I	I	R	R	R	MCF	IW15
		Group 1 Switch failed OFF bit 9	-/MF	I	-	-	-	-	MCF-I	IW15
		Group 2 Switch failed OFF bit 8	-/MF	I	I	R	R	R	MCF-I	IW15
		DCU B Power Off Time Exceeded failed ON bit 7	DF/-	I	I	R	R	R	MCF-I	IW15
		Pull-in failed bit 6	-/MF	I	I	R	R	R	MCF-I	IW15
		PRC Overflow failed OFF bit 5	-/MF	I	I	R	R	R	MCF-I	IW15
		Register 2								
	200	2Khz failed ON/OFF bit 8	DF/DM	I	I	R	R	R	MCF	IW17
		Halt exit failed ON/OFF bit 7	DF/DF	I	I	R	R	R	MCF-I	IW17
		Register 3								
	300	One or more Ch A Fail-safe (FS) bits (15-11) Failed OFF								
		All corresponding Ch B FS bits ON	-/M	I	I	R	R	R	MCF	IW19
		Any corresponding Ch B FS bit OFF	-/MF (Both Act Chs)	D+I+CR	D+CR+PS	D+PS/HL	D+PS	D+PS	MCF	IW19

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
010		Output Electronics Non-Disqualifying Ch B (3.2.3:3.2.3)	(N/A)							
		Register 1	Command & Monitor Failed ON/OFF							
	100	Bleed Valve Solenoid failed ON/OFF bit 15	DF/DF	I	I	R	R	R	MCF-I	IW16
		Fuel System Purge Solenoid failed ON/OFF bit 14	DF/DF	I	I	R	R	R	MCF-I	IW16
		Pogo Precharge Purge Solenoid failed ON/OFF bit 13	DF/DF	I	I	R	R	R	MCF-I	IW16
		Preburner Shutdown Purge Sol. failed ON/OFF bit 12	DF/DF	I	I	R	R	R	MCF-I	IW16
		Emergency Shutdown Solenoid failed ON bit 11	DF/-	I+D**	I+D**	D**	FID6	R	MCF-I	IW16
		Emergency Shutdown Solenoid failed OFF bit 11	-/MF	I	I	R	R	R	MCF-I	IW16
		HPOP IMSL failed ON/OFF bit 10	DF/DF	I	I	R	R	R	MCF	IW16
		Group 1 Switch failed OFF bit 9	-/MF	I	-	-	-	-	MCF-I	IW16
		Group 2 Switch failed OFF bit 8	-/MF	I	I	R	R	R	MCF-I	IW16
		DCU A Power Off Time Exceeded failed ON bit 7	DF/-	I	I	R	R	R	MCF-I	IW16
		Pull-in failed bit 6	-/MF	I	I	R	R	R	MCF-I	IW16
		PRC Overflow failed OFF bit 5	-/MF	I	I	R	R	R	MCF-I	IW16
		Register 2								
	200	2Khz failed ON/OFF bit 8	DF/DM	I	I	R	R	R	MCF	IW18
		Halt exit failed ON/OFF bit 7	DF/DF	I	I	R	R	R	MCF-I	IW18
		Register 3								
	300	One or more Ch B Fail-safe (FS) bits (15-11) Failed OFF								
		All corresponding Ch A FS bits ON	-/M	I	I	R	R	R	MCF	IW20
		Any corresponding Ch A FS bit OFF	-/MF (Both Act Chs)	D+I+CR	D+CR+PS	D+PS/HL	D+PS	D+PS	MCF	IW20

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
111		<u>Sensor First Channel Disqualification</u> (3.2.3:4.2, Table XVII)	(Sensor(s))							
		Fuel Flowrate Prop Drop & Control (3.2.3:4.2.2 and 3.2.3:4.2.5)								
		Sensor Qualification Limits (3.2.3:4.2.2(b))								
	103,104	Sensor A1, B1								
	105,106	Sensor A2, B2								
		1st Sensor Failure		D+I	D+I	D	-	-	MCF-I	Sensor Value
		2nd Sensor Failure		D+I	D+I	D	-	-	MCF	Sensor Value
		3rd Sensor Failure		D+I	D+I	D	-	-	MCF	Sensor Value
		Pulse Rate Converter not updated (3.2.3:3.3.2:3)								
	107,110	Sensor A1, B1								Q1A1/Q1B1
	111,112	Sensor A2, B2								Q1A2/Q1B2
		1st Sensor Failure		-	-	D	D	-	-	
		2nd Sensor Failure		-	-	D	D	-	MCF	
		3rd Sensor Failure		-	-	D	D	-	MCF	
		MCC Pc - Control & Ignition Confirmation								
	201,202	Intra-Channel Test Ch A, B		D+I	D+I	D	D	D	MCF	Delta
	203,204	Fixed Limit and Pc Ref Channel Reasonableness Tests Ch A, B		-	D+I	D	-	-	MCF	Channel Value
		Density Parameters - Control								
	301,302	LPFP Discharge Press Ch A, B		-	D+I	D	-	-	MCF-I	Sensor Value
	303,304	LPFP Discharge Temp Ch A, B		-	D	D	-	-	-	Sensor Value
		Shutdown Limit Monitor Parameters								
	401,402	HPOP IMSL Purge Pr Ch A, B		-	D+I	D	-	-	MCF	Sensor Value
	403,404	HPOT Sec Seal Cav Pr Ch A, B		-	D+I	D	-	-	MCF	Sensor Value
	411,412	HPFP Coolant Liner Pr Ch A, B		-	D+I	D	-	-	MCF	Sensor Value
	413	Fuel Preburner S/D Purge Pr (First Preburner S/D Purge Pr Disqualified)		-	D+I	D	-	-	MCF-I	Sensor Value
	414	Oxid Preburner S/D Purge Pr (First Preburner S/D Purge Pr Disqualified)		-	D+I	D	-	-	MCF-I	Sensor Value
		MCC Pc - Shutdown Tests								
	415,416	Reasonableness Test Ch A, B		-	-	D	-	-	MCF	Channel Value
	417,420	Intra-Channel Test Ch A, B		-	-	D	-	-	MCF	Delta

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
111		Sensor First Channel Disqualification (3.2.3:4.2, Table XVII) (Continued)	(Sensor(s))							
		Shutdown Limit Monitor Parameters (3.2.3:4.2.3 (b))								
		HPOT Discharge Temperature								
		Individual Sensor Test								
	431,432	Sensor A2, B2								
	433,434	Sensor A3, B3								
		1st Sensor Failure		-	D	D	-	-	-	Sensor Value
		2nd or 3rd Sensor Failure		-	D+I	D	-	-	MCF	Sensor Value
		Intra-Channel Test								
	435,436	Sensor A2, B2								
	437,440	Sensor A3, B3								
		1st Sensor Failure		-	-	D	-	-	-	Delta
		2nd or 3rd Sensor Failure		-	-	D	-	-	MCF	Delta
		Inter-Channel Test								
	441,442	Sensor A2, B2								
	443,444	Sensor A3, B3								
		2nd or 3rd Sensor Failure		-	-	D	-	-	MCF	Delta

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
111		Sensor First Channel Disqualification (3.2.3:4.2, Table XVII) (Continued)	(Sensor(s))							
		HPFT Discharge Temperature								
		Individual Sensor Test								
	445,446	Sensor A2, B2								
	447,450	Sensor A3, B3								
		1st Sensor Failure		-	D	D	-	-	-	Sensor Value
		2nd or 3rd Sensor Failure		-	D+I	D	-	-	MCF	Sensor Value
		Intra-Channel Test								
	451,452	Sensor A2, B2								
	453,454	Sensor A3, B3								
		1st Sensor Failure		-	-	D	-	-	-	Delta
		2nd or 3rd Sensor Failure		-	-	D	-	-	MCF	Delta
		Inter-Channel Test								
	455,456	Sensor A2, B2								
	457,460	Sensor A3, B3								
		2nd or 3rd Sensor Failure		-	-	D	-	-	MCF	Delta
	461,462	Cold Junction Temp Ch A, B (3.2.3:4.2.16)		-	D	D	-	-	-	Sensor Value
		Ignition Confirmation								
	505,506	AFV Position Ch A, B		-	-	D	-	-	-	Sensor Value
		HPFP Shaft Speed								
	507,510	Qualification Limits Ch A, B		-	-	D	-	-	-	Sensor Value
	511,512	Pulse Rate Converter not updated Ch A, B (3.2.3:3.3.2:2)		-	-	D	-	-	-	N2A/N2B
		Pogo GOX Flow Check								
	601,602	Pogo Precharge Pressure Ch A, B		-	-	D	-	-	-	Sensor Value
		Purge & Ancillary System Monitor Parameters								
	701,702	Pogo Precharge Pressure Ch A, B		-	D+I	D	D	-	MCF-I	Sensor Value

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
011		Sensor Second Channel Disqualification (3.2.3:4.2, Table XVII)	(Sensor(s))							
		Fuel Flowrate Prop Drop & Control (3.2.3:4.2.2 and 3.2.3:4.2.5)								
		Sensor Qualification Limits (3.2.3:4.2.2(b))								
	103,104	Sensor A1, B1								
	105,106	Sensor A2, B2								
		4th Sensor Failure		D+I+ CR2	D+CR2+ PS	D+S/EL	-	-	MCF-N	Sensor Value
		Pulse Rate Converter not updated (3.2.3:3.3.2:3)								
	107,110	Sensor A1, B1								Q1A1/Q1B1
	111,112	Sensor A2, B2								Q1A2/Q1B2
		4th Sensor Failure		-	-	D+S/EL	D	-	MCF-N	
		MCC Pc								
	201,202	Intra-Channel Test Ch A, B		D+I+ CR2	D+CR2+ PS	D+S*/EL	D	D	MCF-N	Delta
	203,204	Fixed Limit and Pc Ref. Channel Reasonableness Tests Ch A, B		-	D+CR2+ PS	D+S/EL	-	-	MCF-N	Channel Value
		Density Parameters								
	301,302	LPFP Discharge Press Ch A, B		-	D+I	D+FD	-	-	MCF-N	Sensor Value
	303,304	LPFP Discharge Temp Ch A, B		-	D+I	D+FD	-	-	MCF-I	Sensor Value
		Shutdown Limit Monitor Parameters								
	401,402	HPOP IMSL Purge Pr Ch A, B		-	D+I	D	-	-	MCF-N	Sensor Value
	403,404	HPOT Sec Seal Cav Pr Ch A, B		-	D+I	D	-	-	MCF-N	Sensor Value
	411,412	HPFP Coolant Liner Pr Ch A, B		-	D+I	D	-	-	MCF-N	Sensor Value
	413	Fuel Preburner S/D Purge Pr (Second Preburner S/D Purge Pr Disqualified)		-	D+I	PS/S*	-	-	MCF-N	Sensor Value
	414	Oxid Preburner S/D Purge Pr (Second Preburner S/D Purge Pr Disqualified)		-	D+I	PS/S*	-	-	MCF-N	Sensor Value
		MCC Pc - Shutdown Tests								
	415,416	Reasonableness Test Ch A, B		-	-	D	-	-	MCF	Channel Value
	417,420	Intra-Channel Test Ch A, B		-	-	D	-	-	MCF	Delta

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
011		Sensor Second Channel Disqualification (3.2.3:4.2, Table XVII) (Continued)	(Sensor(s))							
		Shutdown Limit Monitor Parameters (3.2.3:4.2.3(b))								
		HPOT Discharge Temperature								
		Individual Sensor Test								
	431,432	Sensor A2, B2								
	433,434	Sensor A3, B3								
		4th Sensor Failure		-	D+I	D	-	-	MCF-N	Sensor Value
		HPFT Discharge Temperature								
		Individual Sensor Test								
	445,446	Sensor A2, B2								
	447,450	Sensor A3, B3								
		4th Sensor Failure		-	D+I	D	-	-	MCF-N	Sensor Value
	461,462	Cold Junction Temp Ch A, B (3.2.3:4.2.16)		-	Pre PSN4 Yes/No D+I/D	D	-	-	MCF-I	Sensor Value
		Ignition Confirmation								
	505,506	AFV Positions Ch A, B		-	-	D	-	-	-	Sensor Value
		HPFP Shaft Speed								
	507,510	Qualification Limits Ch A, B		-	-	D	-	-	-	Sensor Value
	511,512	Pulse Rate Converter not updated Ch A, B(3.2.3:3.3.2:2)		-	-	D	-	-	-	N2A/N2B
		Pogo GOX Flow Check								
	601,602	Pogo Precharge Pressure Ch A, B		-	-	D	-	-	MCF	Sensor Value
		Preburner Pump Discharge Temperature								
		Sensor Integrity Monitor								
	620	Preburner Pump Discharge Temperature (3.2.3:6.8)		-	I	R	-	-	MCF	Either Sensor Value
		Purge and Ancillary System Monitor Parameters								
	701,702	Pogo Precharge Pressure Ch A, B		-	D+I	D	D	-	MCF-N	Sensor Value

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
012		Engine Ready (3.2.3:1.2.6(b), 3.2.3:5.1, Table XVIII)	(N/A)							
	001,002	LPFP Discharge Pressure Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
	003,004	LPFP Discharge Temperature Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
	005,006	Preburner Pump Discharge Temp Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
	007,010	LPOP Discharge Pressure Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
	011,012	Emergency Shutdown Pressure Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
	013	Fuel Preburner S/D Purge Pressure		-	I+D*	-	-	-	MCF	Sensor Value
	014	Oxidizer Preburner S/D Purge Pressure		-	I+D*	-	-	-	MCF	Sensor Value
	015,016	MOV Hydraulic Temperature Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
	017,020	MFV Hydraulic Temperature Ch A, B		-	I+D*	-	-	-	MCF	Sensor Value
113		Shutdown Limit (Redline) Monitor (3.2.3:5.3, Table XX)	(N/A)							
		(Limit exceeded on all qualified channels/sensors with Limit Control Inhibited)								
	401,402	HPOP IMSL Purge Press Ch A, B		-	-	E*	-	-	SLE	Sensor Value
	403,404	HPOT Sec Seal Cav Press Ch A, B		-	-	R	-	-	SLE	Sensor Value
	411,412	HPFP Coolant Liner Press Ch A, B		-	-	R	-	-	SLE	Sensor Value
	413	Fuel Preburner S/D Purge Press		-	-	R	-	-	SLE	Sensor Value
	414	Oxid Preburner S/D Purge Press		-	-	R	-	-	SLE	Sensor Value
	415,416	MCC Pc Ch A, B		-	-	R	-	-	SLE	Channel Value
		HPOT Discharge Temperature		-	-	R	-	-	SLE	Sensor Value
	431,432	Sensor A2, B2								
	433,434	Sensor A3, B3								
		HPFT Discharge Temperature		-	-	R	-	-	SLE	Sensor Value
	445,446	Sensor A2, B2								
	447,450	Sensor A3, B3								

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FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
113		<u>Shutdown Limit (Redline) Monitor</u> <u>(3.2.3:5.3, Table XX)</u> (Continued)	(N/A)							
		(Fewer than all qualified channels/sensors voting for shutdown)								
	401,402	HPOP IMSL Purge Press Ch A, B		-	-	R	-	-	MCF	Sensor Value
	403,404	HPOT Sec Seal Cav Press Ch A, B		-	-	R	-	-	MCF	Sensor Value
	411,412	HPFP Coolant Liner Press Ch A, B		-	-	R	-	-	MCF	Sensor Value
	415,416	MCC Pc Ch A, B		-	-	R	-	-	MCF	Channel Value
		HPOT Discharge Temperature		-	-	R	-	-	MCF	Sensor Value
	431,432	Sensor A2, B2								
	433,434	Sensor A3, B3								
		HPFT Discharge Temperature		-	-	R	-	-	MCF	Sensor Value
	445,446	Sensor A2, B2								
	447,450	Sensor A3, B3								

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FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
013		Shutdown Limit Exceeded	(N/A)							
		Ignition confirm failures (3.2.3:5.2)								
	001,002	HPFP Shaft Speed Ch A, B		-	-	S	-	-	SLE	Sensor Value
	003,004	MCC Pc Ch A, B at 1.7 sec		-	-	S	-	-	SLE	Channel Value
	005,006	MCC Pc Ch A, B at 2.3 sec		-	-	S	-	-	SLE	Channel Value
	007,010	Antiflood Valve Ch A, B		-	-	S	-	-	SLE	Sensor Value
		Shutdown Limit (Redline) Monitor Parameters (Limit Control Enabled) (3.2.3:5.3, Table XX)								
	401,402	HPOP IMSL Purge Press Ch A, B		-	-	PS/S+E*	-	-	SLE	Sensor Value
	403,404	HPOT Secondary Seal Cavity Press Ch A, B		-	-	PS/S	-	-	SLE	Sensor Value
	411,412	HPFP Coolant Liner Pressure Ch A, B		-	-	PS/S	-	-	SLE	Sensor Value
	413	Fuel Preburner S/D Purge Press		-	-	PS/S*	-	-	SLE	Sensor Value
	414	Oxid Preburner S/D Purge Press		-	-	PS/S*	-	-	SLE	Sensor Value
	415,416	MCC Pc Ch A, B		-	-	PS/S	-	-	SLE	Channel Value
		HPOT Discharge Temperature		-	-	PS/S	-	-	SLE	Sensor Value
	431,432	Sensor A2, B2								
	433,434	Sensor A3, B3								
		HPFT Discharge Temperature		-	-	PS/S	-	-	SLE	Sensor Value
	445,446	Sensor A2, B2								
	447,450	Sensor A3, B3								

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
014		Purge and Ancillary Monitor (3.2.3:6.4, Table XXI)			Start Enabled No/Yes					
	001,002	Pogo Precharge Press Ch A, B Not all qualified channels failed (Start)	(Sensors)	-	-	D	-	-	MCF-N	Sensor Value
		Not all qualified channels failed (otherwise)		-	D+I/D+I	-	D	D	MCF-I	Sensor Value
		All qualified channels failed		-	D+I/D+I	D	D	D	MCF-N	Sensor Value
	005,006	Fuel System Purge Press Ch A, B	(N/A)	-	I/R	-	-	R	MCF-I	Sensor Value
	007,010	MOV Hyd Temp Ch A, B		-	I/R	-	-	R	MCF-I	Sensor Value
	011,012	MFV Hyd Temp Ch A, B		-	I/R	-	-	R	MCF-I	Sensor Value
	013,014	HPOP IMSL Purge Press Ch A, B		-	I/I	-	-	R	MCF-I	Sensor Value
	015,016	Antiflood Valve Position Ch A, B 1st Failure		-	I/R	-	-	R	MCF-I	Sensor Value
		2nd Failure		-	I/I	-	-	R	MCF-I	Sensor Value
	017	Fuel Bleed Valve Position		-	I/I	-	-	R	MCF-I	Sensor Value
	020	Oxidizer Bleed Valve Position		-	I/I	-	-	R	MCF-I	Sensor Value
	021	Pogo RIV Position		-	I/I	-	-	R	MCF-I	Sensor Value
	023,024	Emergency Shutdown Press Ch A, B		-	I/-	R	-	-	MCF	Sensor Value
		Pogo GOX Flow Check (3.2.3:6.5, Table XIX)								
	025,026	Pogo Precharge Press Ch A, B		-	-	R	-	-	MCF	Sensor Value
		Backdoor Purge Initiation Monitoring (3.2.3:5.5)								
	030	Pogo Precharge Press		-	-	-	E	-	-	Either Sensor Value
	031	Oxidizer and Fuel Preburner S/D Purge Press		-	-	-	E	-	-	Either Sensor Value
	033	HPOP IMSL Purge Press		-	-	-	E	-	-	Either Sensor Value
		GN2/He Purge Monitor (3.2.3:6.6)								
	041,042	HPOP IMSL Purge Pressure Ch A, B		-	R/-	-	-	-	-	Sensor Value
		MCC LOX Dome Temperature Monitor (3.2.3:6.7)								
	052	MCC LOX Dome Temperature		-	R/-	-	-	-	-	Sensor Value

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
015		Actuator (3.2.1:6.4)		(Act Ch; HL: Both Act Chs)							
		SEII Occurred (3.2.3:6.1.3:1, 3.2.3:6.1.4)									
	011	MFV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	012	MFV Ch B	2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	021	MOV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	022	MOV Ch B	2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	031	CCV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	032	CCV Ch B	2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	041	FPOV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	042	FPOV Ch B	2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
015		Actuator (3.2.1:6.4) (Continued)		(Act Ch; HL: Both Act Chs)							
		SEII Occurred (3.2.3:6.1.3:1, 3.2.3:6.1.4) (Continued)									
	051	OPOV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	052	OPOV Ch B	2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
		RVDT miscompare (3.2.3:6.1.4)		(None)							
	110	MFV			-	I+P3	PS/PS	PS	-	MCF	Delta Position
	120	MOV			-	I+P3	PS/PS	PS	-	MCF	Delta Position
	130	CCV			-	I+P3	PS/PS	PS	-	MCF	Delta Position
	140	FPOV			-	I+P3	PS/PS	PS	-	MCF	Delta Position
	150	OPOV			-	I+P3	PS/PS	PS	-	MCF	Delta Position
		Software SEII Occurred (3.2.1:2.3(k))		(Act Ch; HL: Both Act Chs)							
	211	MFV Ch A	1st Act Failure with no miscompare		-	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		-	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	212	MFV Ch B	2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	221	MOV Ch A	1st Act Failure with no miscompare		-	D+I	D	D	D	MCF	Servo Current
			1st Act Failure with prior miscompare		-	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
			2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	222	MOV Ch B	2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	F A I L U R E T Y P E FUNCTION, DEVICE OR CHANNEL	COMPO-NENT(S) DISQUAL-IFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
015		Actuator (3.2.1:6.4) (Continued)	(Act Ch; HL: Both Act Chs)							
		Software SEII Occurred (3.2.1:2.3(k)) (Continued)								
	231	CCV Ch A — 1st Act Failure with no miscompare		-	D+I	D	D	D	MCF	Servo Current
		1st Act Failure with prior miscompare		-	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
		2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	232	CCV Ch B — 2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	241	FPOV Ch A — 1st Act Failure with no miscompare		-	D+I	D	D	D	MCF	Servo Current
		1st Act Failure with prior miscompare		-	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
		2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	242	FPOV Ch B — 2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	251	OPOV Ch A — 1st Act Failure with no miscompare		-	D+I	D	D	D	MCF	Servo Current
		1st Act Failure with prior miscompare		-	D+PS	D+PS/HL	-	D+PS	MCF	Servo Current
		2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
	252	OPOV Ch B — 2nd Act Failure regardless of miscompare		-	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	Servo Current
		Blueline (3.2.3:6.1.4(a))	(Act Ch A)							
	401	HPOT Disch Temp		-	-	D	-	-	MCF	Any Sen Value
	471	HPFT Disch Temp		-	-	D	-	-	MCF	Any Sen Value
		-3% Test failure Ch B (3.2.3:6.1.5)	(Act Ch B)							
	512	MFV		-	D+PS	-	-	-	MCF-N	Ch B position
	522	MOV		-	D+PS	-	-	-	MCF-N	Ch B position
	532	CCV		-	D+PS	-	-	-	MCF-N	Ch B position
	542	FPOV		-	D+PS	-	-	-	MCF-N	Ch B position
	552	OPOV		-	D+PS	-	-	-	MCF-N	Ch B position

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL		COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
015		Actuator (3.2.1:6.4) (Continued)		(Act Ch; HL: Both Act Chs)							
		D to A Converter Failure (3.2.3:3.3.5, 3.2.3:6.1.4)									
	611	MFV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	D	D+PS	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	612	MFV Ch B	1st Act Failure regardless of miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	621	MOV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	D	D+PS	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	622	MOV Ch B	1st Act Failure regardless of miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	631	CCV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	D	D+PS	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	632	CCV Ch B	1st Act Failure regardless of miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	641	FPOV Ch A	1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	D	D+PS	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	642	FPOV Ch B	1st Act Failure regardless of miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
			2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
015		Actuator (3.2.1:6.4) (Continued)	(Act Ch; HL: Both Act Chs)							
		D to A Converter Failure (3.2.3:3.3.5, 3.2.3:6.1.4) (Continued)								
	651	OPOV Ch A 1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
		1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	D	D+PS	MCF	LDA Difference
		2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
	652	OPOV Ch B 1st Act Failure regardless of miscompare		D+I	D+I	D	D	D	MCF	LDA Difference
		2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	LDA Difference
		Servoactuator Model/Monitor Failure (3.2.3:3.2.4, 3.2.3:6.1.4)								
		One or more but not all servoactuators fail on the same channel								
	701	Ch A 1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	IW7+Polarity
		1st Act Failure with prior miscompare		D+I	D+PS	D+PS/HL	-	D+PS	MCF	IW7+Polarity
		2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	IW7+Polarity
	702	Ch B 1st Act Failure with no miscompare		D+I	D+I	D	D	D	MCF	IW7+Polarity
		1st Act Failure with prior miscompare		D+I	D+I	D	-	D	MCF	IW7+Polarity
		2nd Act Failure regardless of miscompare		D+CR+I	D+PS	D+PS/HL	D+PS	D+PS	MCF-N	IW7+Polarity
	704	Standby channel SEI pending prior to the start of test								
		Ch B 1st Act Failure regardless of miscompare		D+I	D+I	D	D	D	MCF	IW7

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
015		<u>Actuator</u> (3.2.1:6.4) (Continued)	(N/A)							
		Actuator Settling Check (3.2.3:6.1.7)								
	710	MFV		-	I	-	-	-	MCF-N	In-Control Channel PSN3-PSN4 Average Position Delta
	711	MOV		-	I	-	-	-	MCF-N	In-Control Channel PSN3-PSN4 Average Position Delta
	712	FPOV		-	I	-	-	-	MCF-N	In-Control Channel PSN3-PSN4 Average Position Delta
	713	OPOV		-	I	-	-	-	MCF-N	In-Control Channel PSN3-PSN4 Average Position Delta
		Pre-operational Conditioning Cycle (3.2.3:2.3.8) Actuator Channel Commanded Open A, B								
	721,722	MFV		I	-	-	-	-	MCF	Position
	723,724	MOV		I	-	-	-	-	MCF	Position
	725,726	CCV		I	-	-	-	-	MCF	Position
	727,730	FPOV		I	-	-	-	-	MCF	Position
	731,732	OPOV		I	-	-	-	-	MCF	Position
116		<u>FASCOS First Channel Disqualification (3.2.3:4.2.8, 3.2.3:4.3.2, Table XVII)</u>								
		In Monitor Only Option, the failure responses will be report only; no inhibits or MCFs will be posted. In Bypass Option, this monitor is bypassed (3.2.5:2).								
		HPFP Vibration Channels								
	101	Ch V1A Failure	(V1A)	-	D	D	-	-	-	Channel Value
	102	Ch V1B Failure	(V1B)	-	D	D	-	-	-	Channel Value
	103	Ch V1C Failure (Both V1CA & V1CB Failed)	(V1C)	-	D	D	-	-	-	Channel Value
	104	Sensor V1CA Failure	(V1CA)	-	D	D	-	-	-	Sensor Value
	105	Sensor V1CB Failure	(V1CB)	-	D	D	-	-	-	Sensor Value
		HPOP Vibration Channels								
	201	Ch V2A Failure	(V2A)	-	D	D	-	-	-	Channel Value
	202	Ch V2B Failure	(V2B)	-	D	D	-	-	-	Channel Value
	203	Ch V2C Failure (Both V2CA & V2CB Failed)	(V2C)	-	D	D	-	-	-	Channel Value
	204	Sensor V2CA Failure	(V2CA)	-	D	D	-	-	-	Sensor Value
	205	Sensor V2CB Failure	(V2CB)	-	D	D	-	-	-	Sensor Value

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
116		FASCOS First Channel Disqualification (3.2.3:4.2.8, 3.2.3:4.3.2, Table XVII) (Continued)								
		Ch C +15 VDC Power Supply (3.2.3:3.3.7)								
	301	Both Ch A & Ch B Failed	(IE3CA, IE3CB, V1CA, V1CB, V2CA, V2CB)	D+I	D+I	D	D	D	MCF-N	Either IE3CA or IE3CB
	302	1st Failure - Ch A	(IE3CA)	D	D	D	D	D	-	IE3CA
	303	1st Failure - Ch B	(IE3CB)	D	D	D	D	D	-	IE3CB
		Ch C -15 VDC Power Supply (3.2.3:3.3.7)								
	401	Both Ch A & Ch B Failed	(IE4CA, IE4CB, V1CA, V1CB, V2CA, V2CB)	D+I	D+I	D	D	D	MCF-N	Either IE4CA or IE4CB
	402	1st Failure - Ch A	(IE4CA)	D	D	D	D	D	-	IE4CA
	403	1st Failure - Ch B	(IE4CB)	D	D	D	D	D	-	IE4CB
016		FASCOS Second Channel Disqualification (3.2.3:4.2.8, 3.2.3:4.3.2, Table XVII)								
		In Monitor Only Option, the failure responses will be report only; no inhibits or MCFs will be posted. In Bypass Option, this monitor is bypassed (3.2.5:2).								
		HPFP Vibration Channels								
	101	Ch V1A Failure	(V1A)	-	D+I	D	-	-	MCF	Channel Value
	102	Ch V1B Failure	(V1B)	-	D+I	D	-	-	MCF	Channel Value
	103	Ch V1C Failure	(V1C)	-	D+I	D	-	-	MCF	Channel Value
		HPOP Vibration Channels								
	201	Ch V2A Failure	(V2A)	-	D+I	D	-	-	MCF	Channel Value
	202	Ch V2B Failure	(V2B)	-	D+I	D	-	-	MCF	Channel Value
	203	Ch V2C Failure	(V2C)	-	D+I	D	-	-	MCF	Channel Value
		Ch C +15 VDC Power Supply (3.2.3:3.3.7)								
	301	Both Ch A & Ch B Failed	(IE3CA, IE3CB, V1CA, V1CB, V2CA, V2CB)	D+I	D+I	D	D	D	MCF-N	Either IE3CA or IE3CB
		Ch C -15 VDC Power Supply (3.2.3:3.3.7)								
	401	Both Ch A & Ch B Failed	(IE4CA, IE4CB, V1CA, V1CB, V2CA, V2CB)	D+I	D+I	D	D	D	MCF-N	Either IE4CA or IE4CB

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
117		<u>FASCOS Shutdown Limit Monitor (3.2.3:5.4, 3.2.3:5.4.1)</u>	(N/A)							
		In Monitor Only Option, the failure response will be report only; no MCFs or SLEs will be posted. In Bypass Option, this monitor is bypassed (3.2.5:2).								
		Limit exceeded on fewer than all qualified channels								
		HPFP Vibration Channels								
	101	Ch V1A		-	-	R	-	-	MCF	Channel Value
	102	Ch V1B		-	-	R	-	-	MCF	Channel Value
	103	Ch V1C		-	-	R	-	-	MCF	Channel Value
		HPOP Vibration Channels								
	201	Ch V2A		-	-	R	-	-	MCF	Channel Value
	202	Ch V2B		-	-	R	-	-	MCF	Channel Value
	203	Ch V2C		-	-	R	-	-	MCF	Channel Value
		Limit exceeded on all qualified channels with Limit Control Inhibited and at least two channels are qualified								
		HPFP Vibration Channels								
	101	Ch V1A		-	-	R	-	-	SLE	Channel Value
	102	Ch V1B		-	-	R	-	-	SLE	Channel Value
	103	Ch V1C		-	-	R	-	-	SLE	Channel Value
		HPOP Vibration Channels								
	201	Ch V2A		-	-	R	-	-	SLE	Channel Value
	202	Ch V2B		-	-	R	-	-	SLE	Channel Value
	203	Ch V2C		-	-	R	-	-	SLE	Channel Value

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
017		<u>FASCOS Shutdown Limit Exceeded (3.2.3:5.4, 3.2.3:5.4.1)</u>	(N/A)							
		In Monitor Only Option, the failure response will be report only; no SLEs will be posted and no shutdown responses will occur. In Bypass Option, this monitor is bypassed (3.2.5:2).								
		Limit exceeded on all qualified channels with Limit Control Enabled and at least two channels are qualified								
		HPFP Vibration Channels								
	101	Ch V1A		-	-	PS/S	-	-	SLE	Channel Value
	102	Ch V1B		-	-	PS/S	-	-	SLE	Channel Value
	103	Ch V1C		-	-	PS/S	-	-	SLE	Channel Value
		HPOP Vibration Channels								
	201	Ch V2A		-	-	PS/S	-	-	SLE	Channel Value
	202	Ch V2B		-	-	PS/S	-	-	SLE	Channel Value
	203	Ch V2C		-	-	PS/S	-	-	SLE	Channel Value
020		<u>Miscellaneous Reports</u>	(N/A)							
	003	Thrust Limiting (3.2.3:1.7.3)		-	-	R	-	-	MCF	Desired OPOV Command
	004	Report Pc Ref as MCC Pc Control Value in VDT (3.2.3:4.4.2)		-	-	R	-	-	-	None
	100	Switch VRC Commanded (3.2.2:2.2.4)		R	R	R	R	R	MCF	None
	200	PSE Internal Voltages Ch B, Reported by DCU A (3.2.3:3.3.6)		R	R	R	R	R	MCF	P/S+5B

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
021		Propellant Drop Monitoring (3.2.3:2.1)	(N/A)							
	001,002	LPFP Discharge Temperature Ch A, B		T	T	T	T	T	-	Sensor Value
	003,004	Preburner Pump Discharge Temp Ch A, B		T	T	T	T	T	-	Sensor Value
		Fuel Flowrate								
	005	Sensor A1		T	T	T	T	T	-	Sensor Value
	006	Sensor B1		T	T	T	T	T	-	Sensor Value
	007	Sensor A2		T	T	T	T	T	-	Sensor Value
	010	Sensor B2		T	T	T	T	T	-	Sensor Value
022		Igniter Checkout (3.2.3:2.3.2)	(N/A)							
		Channel A Igniters failed OFF								
	001	Fuel Preburner		I*	-	-	-	-	MCF	Failure count
	002	Oxidizer Preburner		I*	-	-	-	-	MCF	Failure count
	003	Main Combustion Chamber		I*	-	-	-	-	MCF	Failure count
		Channel B Igniters failed OFF								
	101	Fuel Preburner		I*	-	-	-	-	MCF	Failure count
	102	Oxidizer Preburner		I*	-	-	-	-	MCF	Failure count
	103	Main Combustion Chamber		I*	-	-	-	-	MCF	Failure count

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
023		<u>PSE Logic/Redundancy Tests Support</u>	(N/A)							
		OE A Registers not deactivated/cleared on Power Recovery (3.2.1:1.6(e)(1))								
	001	On/Off Register 1		R	-	-	-	-	-	IW15
	002	On/Off Register 2		R	-	-	-	-	-	IW17
	003	On/Off Register 3		R	-	-	-	-	-	IW19
	004	Storage Register		R	-	-	-	-	-	IW21
		OE B Registers not deactivated/cleared on Power Recovery (3.2.1:1.6(e)(1))								
	011	On/Off Register 1		R	-	-	-	-	-	IW16
	012	On/Off Register 2		R	-	-	-	-	-	IW18
	013	On/Off Register 3		R	-	-	-	-	-	IW20
	014	Storage Register		R	-	-	-	-	-	IW22
		Checkout Standby Mode Test								
		PSE Output Voltages Maintenance Monitoring, Ch A Voltages out of limits (3.2.3:2.2.2)								
	100	GSE Battery Input		R	-	-	-	-	-	BATA1
	101	Cross-Channel Power		R	-	-	-	-	MCF	CCPA
	102	AC Supplied +5 VDC for Memory		R	-	-	-	-	-	AC+5MA
	103	Processor +5 VDC		R	-	-	-	-	-	C1P3
	104	Memory +5 VDC		R	-	-	-	-	-	C1M3
	105	I/O Electronics +15 VDC		R	-	-	-	-	-	OE3A
	106	DC Supplied +5 VDC for memory/processor		R	-	-	-	-	-	DC+5MPA
	107	I/O Electronics -15 VDC		R	-	-	-	-	-	OE5A
	110	CIE +5 VDC (Ch C)		R	-	-	-	-	MCF	CI1C
	111	Logic +5 VDC		R	-	-	-	-	-	LOG5A
	112	Cross-Channel Power Voltage minus I/O Electronics -15 VDC		R	-	-	-	-	MCF	CCPA minus OE5A
		PSE Output Voltages Maintenance Monitoring, Ch B Voltages out of limits (3.2.3:2.2.2)								
	200	GSE Battery Input		R	-	-	-	-	-	BATB1
	201	Cross-Channel Power		R	-	-	-	-	MCF	CCPB
	202	AC Supplied +5 VDC for Memory		R	-	-	-	-	-	AC+5MB
	203	Processor +5 VDC		R	-	-	-	-	-	C2P3
	204	Memory +5 VDC		R	-	-	-	-	-	C2M3
	205	I/O Electronics +15 VDC		R	-	-	-	-	-	OE3B
	206	DC Supplied +5 VDC for memory/processor		R	-	-	-	-	-	DC+5MPB
	207	I/O Electronics -15 VDC		R	-	-	-	-	-	OE5B
	210	CIE +5 VDC (Ch C)		R	-	-	-	-	MCF	CI2C
	211	Logic +5 VDC		R	-	-	-	-	-	LOG5B
	212	Cross-Channel Power Voltage minus I/O Electronics -15 VDC		R	-	-	-	-	MCF	CCPB minus OE5B

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
034		Hydraulic Conditioning (3.2.3:2.3.9)	(N/A)							
		Opening Failure for Actuator not under test								
	100	MFV		R	-	-	-	-	MCF	Position
	200	MOV		R	-	-	-	-	MCF	Position
	300	CCV		R	-	-	-	-	MCF	Position
	400	FPOV		R	-	-	-	-	MCF	Position
	500	OPOV		R	-	-	-	-	MCF	Position
	600	Hydraulic Pressure failure		I	-	-	-	-	MCF	Sensor Value
135		Opening Failure for Actuator not under test during Actuator Checkout on Channel A (3.2.3:2.3.4)	(N/A)							
	100	MFV		R	-	-	-	-	MCF	Position
	200	MOV		R	-	-	-	-	MCF	Position
	300	CCV		R	-	-	-	-	MCF	Position
	400	FPOV		R	-	-	-	-	MCF	Position
	500	OPOV		R	-	-	-	-	MCF	Position
035		Actuator Checkout Ch A (Table XXIV)	(N/A)							
	1YY	MFV		I*	-	-	-	-	MCF	Table XXIV
	2YY	MOV		I*	-	-	-	-	MCF	Table XXIV
	3YY	CCV		I*	-	-	-	-	MCF	Table XXIV
	4YY	FPOV		I*	-	-	-	-	MCF	Table XXIV
	5YY	OPOV		I*	-	-	-	-	MCF	Table XXIV
	600	Hydraulic Pressure (3.2.3:2.3.4)		I*	-	-	-	-	MCF	Sensor Value
		YY is the step number in Table XXIV								

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	F A I L U R E T Y P E FUNCTION, DEVICE OR CHANNEL	COMPO-NENT(S) DISQUAL-IFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
136		Opening Failure for Actuator not under test during Actuator Checkout on Channel B (3.2.3:2.3.4)	(N/A)							
	100	MFV		R	-	-	-	-	MCF	Position
	200	MOV		R	-	-	-	-	MCF	Position
	300	CCV		R	-	-	-	-	MCF	Position
	400	FPOV		R	-	-	-	-	MCF	Position
	500	OPOV		R	-	-	-	-	MCF	Position
036		Actuator Checkout Ch B (Table XXIV)	(N/A)							
	1YY	MFV		I*	-	-	-	-	MCF	Table XXIV
	2YY	MOV		I*	-	-	-	-	MCF	Table XXIV
	3YY	CCV		I*	-	-	-	-	MCF	Table XXIV
	4YY	FPOV		I*	-	-	-	-	MCF	Table XXIV
	5YY	OPOV		I*	-	-	-	-	MCF	Table XXIV
	600	Hydraulic Pressure (3.2.3:2.3.4)		I*	-	-	-	-	MCF	Sensor Value
		YY is the step number in Table XXIV								
037		Power Recovery (3.2.1:2.2.3, 3.2.1:9.3.1)	(N/A)							
	001	In-Channel Power Recovery		-	R	R	R	R		None
	002	Cross-Channel Power Recovery		-	R	R	R	R		Transient Duration (msec)
041		Single Command Channel Shutdown (3.2.2:1.3(c))	(N/A)							
	CBA	Single Channel Commanded Shutdown C is the Ch C shutdown condition C = 0 is no shutdown C = 1 is shutdown B is the Ch B shutdown condition B = 0 is no shutdown B = 1 is shutdown A is the Ch A shutdown condition A = 0 is no shutdown A = 1 is shutdown Note: The shutdowns may occur concurrently.		-	-	R	-	-	-	Time Reference

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	F A I L U R E T Y P E FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
042		Command Voting Failures (3.2.2:1.2, Table III)	(N/A)							
	101	Command Ch A failed								
		Start Enable or Start commands		R	I	R	R	R	MCF	Failed command
		All other Commands		R	R	R	R	R	MCF	Failed command
	102	Command Ch B failed								
		Start Enable or Start commands		R	I	R	R	R	MCF	Failed command
		All other Commands		R	R	R	R	R	MCF	Failed command
	103	Command Ch C failed								
		Start Enable or Start commands		R	I	R	R	R	MCF	Failed command
		All other Commands		R	R	R	R	R	MCF	Failed command
043		Sensor Checkout, Ch A (3.2.3:2.3.1, Table XXVI)	(N/A)							
		Simulated Conditions								
	0ZZ	Substep 2 (Sensor Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
		Ambient Conditions								
	1ZZ	Substep 5 (Sensor Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
	2ZZ	Substep 8 (Group Switch Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
	3ZZ	Substep 10 (Group Switch Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
		ZZ is the sensor identifier								
044		Sensor Checkout, Ch B (3.2.3:2.3.1, Table XXVI)	(N/A)							
		Simulated Conditions								
	0ZZ	Substep 2 (Sensor Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
		Ambient Conditions								
	1ZZ	Substep 5 (Sensor Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
	2ZZ	Substep 8 (Group Switch Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
	3ZZ	Substep 10 (Group Switch Test)		I*	-	-	-	-	MCF	Table XXVI Part A, Note 4
		ZZ is the sensor identifier								

Table I
FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST *	FAILURE PARAMETER
045		Pneumatic Checkout Ch A (3.2.3:2.3.3, Table XXV)	(N/A)							
	1YY	Fuel System Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
	2YY	HPOP IMSL Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
	3YY	Bleed Valve Control Valve		I*	-	-	-	-	MCF	Table XXV
	4YY	Emergency Shutdown Control Valve		R	-	-	-	-	MCF	Table XXV
	5YY	Pogo Precharge Control Valve		I*	-	-	-	-	MCF	Table XXV
	6YY	Preburner S/D Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
		YY is the step number in Table XXV								
046		Pneumatic Checkout Ch B (3.2.3:2.3.3, Table XXV)	(N/A)							
	1YY	Fuel System Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
	2YY	HPOP IMSL Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
	3YY	Bleed Valve Control Valve		I*	-	-	-	-	MCF	Table XXV
	4YY	Emergency Shutdown Control Valve		R	-	-	-	-	MCF	Table XXV
	5YY	Pogo Precharge Control Valve		I*	-	-	-	-	MCF	Table XXV
	6YY	Preburner S/D Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
		YY is the step number in Table XXV								
047		Pneumatic Checkout Ch A & B (3.2.3:2.3.3, Table XXV)	(N/A)							
	1YY	Fuel System Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
	2YY	HPOP IMSL Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
	3YY	Bleed Valve Control Valve		I*	-	-	-	-	MCF	Table XXV
	4YY	Emergency Shutdown Control Valve		R	-	-	-	-	MCF	Table XXV
	5YY	Pogo Precharge Control Valve		I*	-	-	-	-	MCF	Table XXV
	6YY	Preburner S/D Purge Control Valve		I*	-	-	-	-	MCF	Table XXV
		YY is the step number in Table XXV								

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
051		Controller Checkout Ch A (3.2.3:2.3.5)	(N/A)							
	001	SCP Comparator (3.2.3:2.3.5:1)		I	-	-	-	-	MCF	See Table II
	002	SCP Interrupt (3.2.3:2.3.5:2)		I	-	-	-	-	MCF	See Table II
	003	N/A								
	004	VRC DPM Write/Read (3.2.3:2.3.5:4)		I	-	-	-	-	MCF	See Table II
	005	VRC Output (3.2.3:2.3.5:5)		I	-	-	-	-	MCF	See Table II
	006	IE DPM Write/Read (3.2.3:2.3.5:6)		I	-	-	-	-	MCF	See Table II
	007	IE Address Counter (3.2.3:2.3.5:7)		I	-	-	-	-	MCF	See Table II
	010	IE Range Counter (3.2.3:2.3.5:8)		I	-	-	-	-	MCF	See Table II
	011	IE Terminate Sequence (3.2.3:2.3.5:9)		I	-	-	-	-	MCF	See Table II
	012	IE Pulse Rate Converter Control Bit (3.2.3:2.3.5:10)		I	-	-	-	-	MCF	See Table II
	013	IE Pulse Rate Converter (3.2.3:2.3.5:11)		I	-	-	-	-	MCF	See Table II
	014	OE Storage Registers (3.2.3:2.3.5:12)		I	-	-	-	-	MCF	See Table II
	015	N/A								
	016	Watchdog Timer Counter/Time Reference Interrupt (3.2.3:2.3.5:14)		I	-	-	-	-	MCF	See Table II
	017	Watchdog Timer Interrupt (3.2.3:2.3.5:15)		I	-	-	-	-	MCF	See Table II
	020	Watchdog Timer OE Data Switch (3.2.3:2.3.5:16)		I	-	-	-	-	MCF	See Table II
	021	Watchdog Timer IE Data Switch (3.2.3:2.3.5:17)		I	-	-	-	-	MCF	See Table II
	022	Watchdog Timer VRC Data Switch (3.2.3:2.3.5:18)		I	-	-	-	-	MCF	See Table II
	023	OE Power Safety Switch DCU Control (3.2.3:2.3.5:19)		I	-	-	-	-	MCF	See Table II
	024	OE Power Safety Switch Power Down Matrix (3.2.3:2.3.5:20)		I	-	-	-	-	MCF	See Table II
	025	OE Power Safety Switch Voltage Monitor/Power Up Reset (3.2.3:2.3.5:21)		I	-	-	-	-	MCF	See Table II
	026	PSE Power Off Indicator (3.2.3:2.3.5:22)		I	-	-	-	-	MCF	See Table II
	027	N/A								
	030	RVDT/LVDT Excitation Power Supply Source (3.2.3:2.3.5:24)		I	-	-	-	-	MCF	See Table II

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
051		Controller Checkout, Ch A (3.2.3:2.3.5) (Continued)	(N/A)							
	031	Pneumatic Solenoid (3.2.3:2.3.5:25)		I	-	-	-	-	MCF	See Table II
	032	Servoactuator Error Indication Interrupt (3.2.3:2.3.5:26)		I	-	-	-	-	MCF	See Table II
	033	N/A								
	034	Failure Data Recorder (3.2.3:2.3.5:28)		R	-	-	-	-	-	See Table II
	040	Protocol Procedures (3.2.3:2.3.5(d))		I	-	-	-	-	MCF	See Table II
	041	N/A								
	042	Engine/Controller On/Off Devices, Commanded Bit Failed ON (3.2.3:2.3.5(j))		I	-	-	-	-	MCF	See Table II
	043	Engine/Controller On/Off Devices, Commanded Bit Failed OFF (3.2.3:2.3.5(j))		I	-	-	-	-	MCF	See Table II
052		Controller Checkout, Ch B (3.2.3:2.3.5)	(N/A)							
	001	SCP Comparator (3.2.3:2.3.5:1)		I	-	-	-	-	MCF	See Table II
	002	SCP Interrupt (3.2.3:2.3.5:2)		I	-	-	-	-	MCF	See Table II
	003	N/A								
	004	VRC DPM Write/Read (3.2.3:2.3.5:4)		I	-	-	-	-	MCF	See Table II
	005	VRC Output (3.2.3:2.3.5:5)		I	-	-	-	-	MCF	See Table II
	006	IE DPM Write/Read (3.2.3:2.3.5:6)		I	-	-	-	-	MCF	See Table II
	007	IE Address Counter (3.2.3:2.3.5:7)		I	-	-	-	-	MCF	See Table II
	010	IE Range Counter (3.2.3:2.3.5:8)		I	-	-	-	-	MCF	See Table II
	011	IE Terminate Sequence (3.2.3:2.3.5:9)		I	-	-	-	-	MCF	See Table II
	012	N/A								
	013	N/A								
	014	OE Storage Registers (3.2.3:2.3.5:12)		I	-	-	-	-	MCF	See Table II
	015	N/A								

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
052		Controller Checkout, Ch B (3.2.3:2.3.5) (Continued)	(N/A)							
	016	Watchdog Timer Counter/Time Reference Interrupt (3.2.3:2.3.5:14)		I	-	-	-	-	MCF	See Table II
	017	Watchdog Timer Interrupt (3.2.3:2.3.5:15)		I	-	-	-	-	MCF	See Table II
	020	Watchdog Timer OE Data Switch (3.2.3:2.3.5:16)		I	-	-	-	-	MCF	See Table II
	021	Watchdog Timer IE Data Switch (3.2.3:2.3.5:17)		I	-	-	-	-	MCF	See Table II
	022	Watchdog Timer VRC Data Switch (3.2.3:2.3.5:18)		I	-	-	-	-	MCF	See Table II
	023	OE Power Safety Switch DCU Control (3.2.3:2.3.5:19)		I	-	-	-	-	MCF	See Table II
	024	OE Power Safety Switch Power Down Matrix (3.2.3:2.3.5:20)		I	-	-	-	-	MCF	See Table II
	025	OE Power Safety Switch Voltage Monitor/Power Up Reset (3.2.3:2.3.5:21)		I	-	-	-	-	MCF	See Table II
	026	PSE Power Off Indicator (3.2.3:2.3.5:22)		I	-	-	-	-	MCF	See Table II
	027	N/A								
	030	N/A								
	031	N/A								
	032	Servoactuator Error Indication Interrupt (3.2.3:2.3.5:26)		I	-	-	-	-	MCF	See Table II
	033	N/A								
	034	Failure Data Recorder (3.2.3:2.3.5:28)		R	-	-	-	-	-	See Table II
	040	Protocol Procedures (3.2.3:2.3.5(d))		I	-	-	-	-	MCF	See Table II
	041	N/A								
	042	Engine/Controller On/Off Devices, Commanded Bit Failed ON (3.2.3:2.3.5(j))		I	-	-	-	-	MCF	See Table II
	043	Engine/Controller On/Off Devices, Commanded Bit Failed OFF (3.2.3:2.3.5(j))		I	-	-	-	-	MCF	See Table II
071		PROM tests, Ch A (See Honeywell DSCP 34053988, Table III)	(N/A)	-	-	-	-	-	-	
072		PROM tests, Ch B (See Honeywell DSCP 34053988, Table III)	(N/A)	-	-	-	-	-	-	

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
075		DCU/CIE Self-disqualification Ch A (3.2.1:6.1)	(DCU)							
		Self-Test Failures								
	001	CIE Inter-DCU Status Register (write/read fail) (3.2.3:3.1.2:1)		D	D	D	D	D		IW25 Format, Failed bits=1
	010	WDT1 Status (3.2.3:3.1.8)		D	D	D	D	D		None
	011	WDT2 Status (3.2.3:3.1.8)		D	D	D	D	D		None
	020,021	CIE Data MUX (3.2.3:3.2.1)		D	D	D	D	D		IW9,IW23
		Interrupt Decoder (3.2.3:3.1.5)								
	030	Interrupt (other than SEII), but not pending		D	D	D	D	D		IW4 Format, Failed bit=1
		SEII, but none pending (Spare not monitored)								
	031	Within OE Servoactuator Model/Monitor Self-Test (3.2.3:3.2.4)		D	D	D	D	D		IW7+Polarity
	032	Not within OE Servoactuator Model/Monitor Self-Test		D	D	D	D	D		IW7
	033	Interrupt (other than SEII), pending but not enabled		D	D	D	D	D		IW4 Format, Failed bit=1
	034	SEII, pending, but not enabled		D	D	D	D	D		IW7 Format, Failed bit(s)=1
		Interrupt Pending (3.2.3:3.2.5)								
	040	Interrupt (other than SEII) pending, but not serviced		D	D	D	D	D		IW4 Format, Failed bit(s)=1
	041	SEII pending, but not serviced		D	D	D	D	D		IW7 Format, Failed bit(s)=1
		Real Time Clock/IE Timing (3.2.3:3.1.4)								
	050	IE Address Counter mismatched values		D	D	D	D	D		IW11 (4th value)
	051	RTC/IE timing out of tolerance		D	D	D	D	D		Time difference (usec)
	060	VEEI Command MUX Even (3.2.3:3.1.1)		D	D	D	D	D		IW1
	061	VEEI Command MUX Odd (3.2.3:3.1.1)		D	D	D	D	D		IW8
	100	IE Sequencer Initial Values (3.2.3:3.1.6)		D	D	D	D	D		IW11
	101	IE Sequencer Final Values (3.2.3:3.1.6)		D	D	D	D	D		IW11

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
075		DCU/CIE Self-disqualification Ch A (3.2.1:6.1) (Continued)	(DCU)							
		Self-Test Failure (Continued)								
		IE Address and Range Counters (3.2.3:3.2.2)								
	110	Case 1		D	D	D	D	D		IW11
	111	Case 2		D	D	D	D	D		IW11
		IE Address and Data Bus (3.2.3:3.3.1)								
		Loaded data does not verify								
	114	TW1A or TW1B		D	D	D	D	D		Either TW1A or TW1B
	115	TW2A or TW2B		D	D	D	D	D		Either TW2A OR TW2B
	116	RC15 or RC14		D	D	D	D	D		Either RC15 or RC14
	117	RC19 or RC18		D	D	D	D	D		Either RC19 or RC18
		Parameter pair failure								
	120	TW1A/TW1B		D	D	D	D	D		TW1A .OR. TW1B Failed bits=1
	121	TW2A/TW2B		D	D	D	D	D		TW2A .OR. TW2B Failed bits=1
	122	RC15/RC14		D	D	D	D	D		RC15 .OR. RC14 Failed bits=1
	123	RC19/RC18		D	D	D	D	D		RC19 .OR. RC18 Failed bits=1
	130	OE Servoactuator Model/Monitor No SEII (3.2.3:3.2.4)		D	D	D	D	D		IW7+Polarity
	131	OE Servoactuator Model/Monitor one or more (but not all) SEIs not pending on both Ch A & Ch B (3.2.3:3.2.4)		D	D	D	D	D		IW7+Polarity
	140	PSE Internal Voltages (3.2.3:3.3.6)		D	D	D	D	D		P/S+5A
	300	Power Off Time Exceeded bit failed Off for DCU B (not exceeded) (3.2.3:3.2.3)		D	D	D	D	D		IW15
		Assured Pneumatic Shutdown (3.2.3:1.5.1)								
	301,302	Emergency Shutdown failed ON Ch A, B		-	-	-	D	-		IW15,IW16
	303,304	Actuator Fail-safe failed ON Ch A, B		-	-	-	D	-		IW19,IW20

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
075		DCU/CIE Self-disqualification Ch A (3.2.1:6.1) (Continued)	(DCU)							
		Checkout Standby Mode Test								
		DCU Exception Processing (3.2.3:2.2.1)								
	400	Address Error		D	-	-	-	-		None
	401	Execute Illegal Instruction		D	-	-	-	-		None
	402	Perform Zero Divide		D	-	-	-	-		None
	403	CHK Instruction		D	-	-	-	-		None
	404	TRAPV Instruction		D	-	-	-	-		None
	405	Illegal Exception A		D	-	-	-	-		None
	406	Illegal Exception F		D	-	-	-	-		None
	407	TRAP Instruction		D	-	-	-	-		None
	410	ANDI with Status Register		D	-	-	-	-		None
	411	EORI with Status Register		D	-	-	-	-		None
	412	MOVE to Status Register		D	-	-	-	-		None
	413	MOVE to User Stack Pointer		D	-	-	-	-		None
	414	ORI with Status Register		D	-	-	-	-		None
	415	Reset		D	-	-	-	-		None
	417	RTE/Stop		D	-	-	-	-		None
		Executive major failures								
	500	All required functions in major cycle not complete (3.2.1:2.1)		D	D	D	D	D		None
	503	WDT1 and WDT2 not timed-out (no WDTH1/WDTH2 interrupt pending) (3.2.1:2.2(d))		D	D	D	D	D		IW4
	504	Power Off Time Exceeded for DCU A (3.2.1:2.2.1(f))		D	D	D	D	D		None
	505	Power Off Time Exceeded for DCU A (3.2.1:2.2.2(e))		D	D	D	D	D		None
	510	Simulated DCU/OE Failure (3.2.3:2.4.3:1)		D	D	D	D	D		None

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	F A I L U R E T Y P E FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
075		DCU/CIE Self-disqualification Ch A (3.2.1:6.1) (Continued)	(DCU)							
		Interrupts or Exceptions								
	601	Reset Exception Vector (RAM) (3.2.1:5.2)		D	D	D	D	D		None
	602	Bus Error Exception (3.2.1:5.3)		D	D	D	D	D		None
	603	Address Error Exception (3.2.1:5.4)		D	D	D	D	D		None
	604	Illegal Instruction Exception (3.2.1:5.5)		D	D	D	D	D		None
	605	Zero Divide Exception (3.2.1:5.6)		D	D	D	D	D		None
	606	CHK Instruction Exception (3.2.1:5.7)		D	D	D	D	D		None
	607	TRAPV Instruction Exception (3.2.1:5.8)		D	D	D	D	D		None
	610	Privilege Violation Exception (3.2.1:5.9)		D	D	D	D	D		None
	611	Trace Exception (3.2.1:5.10)		D	D	D	D	D		None
	612	Illegal Exception Vector (3.2.1:5.11)		D	D	D	D	D		None
	613	Spurious Interrupt Exception (3.2.1:5.12)		D	D	D	D	D		None
	614	TRAP Instruction Exception (3.2.1:5.13)		D	D	D	D	D		None
		Power Recovery Interrupt								
	630	Previous PRI/PFI in 440 msec (3.2.1:2.2.2)		-	D	D	D	D		Delta Time (major cycles)
	631	PRI in Major Cycle Initiation (3.2.1:1.6(f))		-	D	D	D	D		None
	632	PRI in DCU already disqualified (3.2.1:1.6(c))		D	D	D	D	D		None
	633	PRI in Checkout Phase (3.2.1:1.6(e))		D	-	-	-	-		None
	640	Self-Checking Pair Interrupt (all others) (3.2.1:5.16)		D	D	D	D	D		IW4
	650	WDTH1 Interrupt (3.2.1:3(f))		D	D	D	D	D		None
	651	WDTH2 Interrupt (3.2.1:3(f))		D	D	D	D	D		None
	660	CIE Erroneous Acknowledge Level Interrupt (3.2.1:5.22)		D	D	D	D	D		None
	661	Spurious CIE Interrupt (3.2.1:5.23)		D	D	D	D	D		None
	700	Stop DCU Command		D	D	D	D	D		None

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
076		DCU/CIE Self-disqualification Ch B (3.2.1:6.1)	(DCU)							
		Self-Test Failures								
	001	CIE Inter-DCU Status Register (write/read fail) (3.2.3:3.1.2:1)		D	D	D	D	D		IW26 Format, Failed bits=1
	002	CIE Inter-DCU Status Register (Update Timeout) (3.2.3:3.1.2)		D	D	D	D	D		None
	010	WDT1 Status (3.2.3:3.1.8)		D	D	D	D	D		None
	011	WDT2 Status (3.2.3:3.1.8)		D	D	D	D	D		None
	020,021	CIE Data MUX (3.2.3:3.2.1)		D	D	D	D	D		IW10,IW24
		Interrupt Decoder (3.2.3:3.1.5)								
	030	Interrupt (other than SEII), but not pending		D	D	D	D	D		IW4 Format, Failed bit=1
		SEII, but none pending (Spare not monitored)								
	031	Within OE Servoctuator Model/ Monitor Self-Test (3.2.3:3.2.4)		D	D	D	D	D		IW7+Polarity
	032	Not within OE Servoactuator Model/Monitor Self-Test		D	D	D	D	D		IW7
	033	Interrupt (other than SEII), pending but not enabled		D	D	D	D	D		IW4 Format, Failed bit=1
	034	SEII, pending, but not enabled		D	D	D	D	D		IW7 Format, Failed bit(s)=1
		Interrupt Pending (3.2.3:3.2.5)								
	040	Interrupt (other than SEII) pending, but not serviced		D	D	D	D	D		IW4 Format, Failed bit(s)=1
	041	SEII pending, but not serviced		D	D	D	D	D		IW7 Format, Failed bit(s)=1
		Real Time Clock/IE Timing (3.2.3:3.1.4)								
	050	IE Address Counter mismatched values		D	D	D	D	D		IW12 (4th value)
	051	RTC/IE timing out of tolerance		D	D	D	D	D		Time difference (usec)
	060	VEEI Command MUX Even (3.2.3:3.1.1)		D	D	D	D	D		IW1
	061	VEEI Command MUX Odd (3.2.3:3.1.1)		D	D	D	D	D		IW8
	100	IE Sequencer Initial Values (3.2.3:3.1.6)		D	D	D	D	D		IW12
	101	IE Sequencer Final Values (3.2.3:3.1.6)		D	D	D	D	D		IW12

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
076		DCU/CIE Self-disqualification Ch B (3.2.1:6.1) (Continued)	(DCU)							
		Self-Test Failures (Continued)								
		IE Address and Range Counters (3.2.3:3.2.2)								
	110	Case 1		D	D	D	D	D		IW12
	111	Case 2		D	D	D	D	D		IW12
		IE Address and Data Bus (3.2.3:3.3.1)								
		Loaded data does not verify								
	114	TW1A or TW1B		D	D	D	D	D		Either TW1A or TW1B
	115	TW2A or TW2B		D	D	D	D	D		Either TW2A or TW2B
	116	RC15 or RC14		D	D	D	D	D		Either RC15 or RC14
	117	RC19 or RC18		D	D	D	D	D		Either RC19 or RC18
		Parameter pair failure								
	120	TW1A/TW1B		D	D	D	D	D		TW1A .OR. TW1B Failed bits=1
	121	TW2A/TW2B		D	D	D	D	D		TW2A .OR. TW2B Failed bits=1
	122	RC15/RC14		D	D	D	D	D		RC15 .OR. RC14 Failed bits=1
	123	RC19/RC18		D	D	D	D	D		RC19 .OR. RC18 Failed bits=1
	130	OE Servoactuator Model/Monitor No SEII (3.2.3:3.2.4)		D	D	D	D	D		IW7+Polarity
	131	OE Servoactuator Model/Monitor one or more (but not all) SEIs not pending on both Ch A and Ch B (3.2.3:3.2.4)		D	D	D	D	D		IW7+Polarity
	140	PSE Internal Voltages (3.2.3:3.3.6)		D	D	D	D	D		P/S+5B
	300	Power Off Time Exceeded bit failed Off for DCU A (not exceeded) (3.2.3:3.2.3)		D	D	D	D	D		IW16
		Assured Pneumatic Shutdown (3.2.3:1.5.1)								
	301,302	Emergency Shutdown failed ON Ch A, B		-	-	-	D	-		IW15,IW16
	303,304	Actuator Fail-safe failed ON Ch A, B		-	-	-	D	-		IW19,IW20

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
076		DCU/CIE Self-disqualification Ch B (3.2.1:6.1) (Continued)	(DCU)							
		Checkout Standby Mode Test								
		DCU Exception Processing (3.2.3:2.2.1)								
	400	Address Error		D	-	-	-	-		None
	401	Execute Illegal Instruction		D	-	-	-	-		None
	402	Perform Zero Divide		D	-	-	-	-		None
	403	CHK Instruction		D	-	-	-	-		None
	404	TRAPV		D	-	-	-	-		None
	405	Illegal Exception A		D	-	-	-	-		None
	406	Illegal Exception F		D	-	-	-	-		None
	407	TRAP Instruction		D	-	-	-	-		None
	410	ANDI with Status Register		D	-	-	-	-		None
	411	EORI with Status Register		D	-	-	-	-		None
	412	MOVE to Status Register		D	-	-	-	-		None
	413	MOVE to User Stack Pointer		D	-	-	-	-		None
	414	ORI with Status Register		D	-	-	-	-		None
	415	Reset		D	-	-	-	-		None
	417	RTE/Stop		D	-	-	-	-		None
		Executive Major Failures								
	500	All required functions in major cycle not complete (3.2.1:2.1)		D	D	D	D	D		None
	503	WDT1 and WDT2 not timed-out (no WDTH1/WDTH2 interrupt pending) (3.2.1:2.2(d))		D	D	D	D	D		IW4
	504	Power Off Time Exceeded for DCU B (3.2.1:2.2.1(f))		D	D	D	D	D		None
	505	Power Off Time Exceeded for DCU B (3.2.1:2.2.2(e))		D	D	D	D	D		None
	510	Simulated DCU/OE Failure (3.2.3:2.4.3:1)		D	D	D	D	D		None

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	FAILURE TYPE FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
076		DCU/CIE Self-disqualification Ch B (3.2.1:6.1) (Continued)	(DCU)							
		Tracking Response of the Standby DCU								
	520	No acceptable IDSR codes 3.2.1:8.1(g))		-	D	-	-	-		IDSR EDW
	521	Non-commanded transition into a Start Prep Mode (3.2.1:8.1(h))		D	D	D	D	D		IDSR EDW
	522	Non-commanded transition into Start Phase (3.2.1:8.1(h))		D	D	D	D	D		IDSR EDW
	523	Non-commanded transition into a configuration (3.2.1:8.1(h))		D	D	D	D	D		IDSR EDW
		Interrupts or Exceptions								
	601	Reset Exception Vector (RAM) (3.2.1:5.2)		D	D	D	D	D		None
	602	Bus Error Exception (3.2.1:5.3)		D	D	D	D	D		None
	603	Address Error Exception (3.2.1:5.4)		D	D	D	D	D		None
	604	Illegal Instruction Exception (3.2.1:5.5)		D	D	D	D	D		None
	605	Zero Divide Exception (3.2.1:5.6)		D	D	D	D	D		None
	606	CHK Instruction Exception (3.2.1:5.7)		D	D	D	D	D		None
	607	TRAPV Instruction Exception (3.2.1:5.8)		D	D	D	D	D		None
	610	Privilege Violation Exception (3.2.1:5.9)		D	D	D	D	D		None
	611	Trace Exception (3.2.1:5.10)		D	D	D	D	D		None
	612	Illegal Exception Vector (3.2.1:5.11)		D	D	D	D	D		None
	613	Spurious Interrupt Exception (3.2.1:5.12)		D	D	D	D	D		None
	614	TRAP Instruction Exception (3.2.1:5.13)		D	D	D	D	D		None

Table I

FAILURE REPORTING AND RESPONSE (Para 3.2.4) (Continued)

FAILURE IDENTIFICATION WORD (OCTAL) ID	DELIM	F A I L U R E T Y P E FUNCTION, DEVICE OR CHANNEL	COMPONENT(S) DISQUALIFIED	RESPONSE IN ENGINE PHASE C/O	SP	ST/MS	S/D	PS/D	ESW SELF TEST	FAILURE PARAMETER
076		DCU/CIE Self-disqualification Ch B (3.2.1:6.1) (Continued)	(DCU)							
		Interrupts or Exceptions (Continued)								
		Power Recovery Interrupt								
	630	Previous PRI/PFI in 440 msec (3.2.1:2.2.2)		-	D	D	D	D		Delta Time (major cycles)
	631	PRI in Major Cycle Initiation (3.2.1:1.6(f))		-	D	D	D	D		None
	632	PRI in DCU already disqualified (3.2.1:1.6(c))		D	D	D	D	D		None
	633	PRI in Checkout Phase (3.2.1:1.6(e))		D	-	-	-	-		None
	640	Self-Checking Pair Interrupt (all others) (3.2.1:5.16)		D	D	D	D	D		IW4
	650	WDTH1 interrupt (3.2.1:3(f))		D	D	D	D	D		None
	651	WDTH2 interrupt (3.2.1:3(f))		D	D	D	D	D		None
	660	CIE Erroneous Acknowledge Level Interrupt (3.2.1:5.22)		D	D	D	D	D		None
	661	Spurious CIE Interrupt (3.2.1:5.23)		D	D	D	D	D		None
	700	Stop DCU Command		D	D	D	D	D		None

Table Header Abbreviations

Acronym	Definition
DELIM	Failure Delimiter is the 9 least significant bits of the Failure Identification Word. The delimiter is used to uniquely identify a type of FID. DELIM is an octal number.
FID	Failure ID which is the 7 most significant bits of the Failure Identification Word. The FID identifies a type of failure. FID is an octal number.

Failure Descriptions

IE input sequence setup error	IE Address and/or Range Counter write/read failure and/or IE Channel Indicator not equal to zero, that is, does not indicate Channel A.
IE input sequence completion error	IE Address and/or Range Counter not equal to correct final value and/or IE Conversion Complete not equal to zero and/or IE Channel Indicator not equal to 1, that is, does not indicate Channel B.
primary DCU	The DCU that initiates a test which requires test coordination between both DCUs, and in turn, performs its own test sequences.
secondary DCU	The DCU that performs its test sequences when advised to do so by the primary DCU, and in coordination with the primary DCU.

Table II
CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
SCP COMPARATOR TEST (3.2.3:2.3.5:1)				
051	001	0000XX XX = 01 to @40 is data miscompare pattern number 1 to 32	(3,6,9) SCP Comparator data error indiction absent or address error indication present	IW4
		0000YY YY = @41 to @76 is address miscompare pattern number 1 to 30	(12,14) SCP Comparator address error indication absent or data error indication present	IW4
SCP INTERRUPT TEST (3.2.3:2.3.5:2)				
			SCP Data Bus Interrupt	
051	002	000001	(3) No SCPI within 3 instructions	None
		000002	(4) WDTs (either 1, 2, or both) not timed-out	IW6
		000003	(4) FDR recording not inhibited	IW17
		000004	(5) No SCPI pending	IW4
			SCP Address Bus Interrupt	
		000005	(9) No SCPI within 3 instructions	None
		000006	(10) WDTs (either 1, 2, or both) not timed-out	IW6
		000007	(10) FDR recording not inhibited	IW17
		000010	(11) No SCPI pending	IW4
		000011	(13) SCPI still pending	IW4
		000012	(16) SCPI still pending	IW4
DTACK MONITOR/BUS ERROR GENERATOR TEST (3.2.3:2.3.5:3)				
If DCU A fails this test, it will halt. DCU B will report the DCU A failure under protocal procedures (Delimiter 040)				
VRC DPM WRITE/READ TEST (3.2.3:2.3.5:4)				
051	004	CN0XXX C = 0 is read error C = 1 is write to wrong location N = 0 is test pattern $5555 N = 1 is test pattern $AAAA XXX = 001 to @200 is targeted DPM address number	(2) Test pattern not read successfully	Erroneous pattern
		CN0XXX	(3) Predetermined test pattern altered in other than the targeted VRC DPM memory address	Untargeted VRC DPM address number

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
VRC OUTPUT TEST (3.2.3:2.3.5:5)				
051	005	000001	(2) Address register(s) not = 0 or indicator(s) not set to incomplete within 2 usec after initiation	IW13
		000002	(3) Address register(s) not = 1 within time	IW13
		000003	(4) Test time > 2.482 msec	Actual time (usec)
		000004	(4) Address register(s) incremented wrong	IW13
		000005	(4) Test time < 2.402 msec	Actual time (usec)
		000006	(5) Address register(s) not = 0 or indicator(s) not set to complete within time	IW13
IE DPM WRITE/READ TEST (3.2.3:2.3.5:6)				
051	006	CN0YYY (C & N are defined in test 4) YYY = 001 to @400 is targeted DPM address	(N/A) Test pattern not read successfully	Erroneous pattern
		CN0YYY	(N/A) Predetermined pattern altered in other than the targeted IE DPM address	Untargeted IE DPM address number
IE ADDRESS COUNTER TEST (3.2.3:2.3.5:7)				
051	007	0000XX XX = 01 to @16 is pattern number	(N/A) IE Address Counter not equal to test pattern	IW11
IE RANGE COUNTER TEST (3.2.3:2.3.5:8)				
051	010	0000XX XX = 01 to @16 is pattern number	(N/A) IE Range Counter not equal to test pattern	IW11
IE TERMINATE SEQUENCE TEST (3.2.3:2.3.5:9)				
051	011	000001	(2) IE input sequence setup error	IW11 failed bits=1
		000002	(3) IE conversion complete	IW11
		000003	(5) IE conversion not complete	IW11
		CP0004 C = 0 is Channel A, C = 1 is Channel B, P = 0 is TW1A/B, P = 1 is TW2A/B	(6) At least one of the specified IE DPM locations (TW1A thru TW2B) is not equal to the expected test pattern	TW1A/1B/2A/2B
		CQ0005 Q = 0 is TW4A/B, Q = 1 is TW5A/B	(6) At least one of the specified IE DPM locations (TW4A thru TW5B) is not equal to the expected test pattern	TW4A/4B/5A/5B

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
IE PULSE RATE CONVERTER CONTROL BIT TEST (3.2.3:2.3.5:10)				
051	012	000001	(2) Error loading OE A storage register	IW21 failed bits=1
		000002	(2) Error loading OE B storage register	IW22 failed bits=1
		000003	(3) IE input sequence setup error	IW11 failed bits=1
		000004	(3) IE input sequence completion error	IW11
		000005	(4) PRC Overflow Test on Channel A not off	IW15
		000006	(4) PRC Overflow Test on Channel B not off	IW16
		CQ0007 C = 0 is Channel A C = 1 is Channel B Q = 0 is HPFP Shaft Speed A/B (N2A/N2B) Q = 1 is N/A Q = 2 is Shaft Speed: LPFP(Ch A) (N1)/LPOP(Ch B) (N3) Q = 3 is N/A Q = 4 is N/A Q = 5 is Fuel Flowrate A1/B1 (Q1A1/Q1B1) Q = 6 is Fuel Flowrate A2/B2 (Q1A2/Q1B2)	(4) PRC test pattern has been altered	Pattern
		000010	(5) Error loading OE B storage register	IW22 failed bits=1
		000011	(5) Error loading OE A storage register	IW21 failed bits=1
		000012	(6) IE input sequence setup error	IW11 failed bits=1
		000013	(6) IE input sequence completion error	IW11
		000014	(7) PRC Overflow Test on Channel A not off	IW15
		000015	(7) PRC Overflow Test on Channel B not off	IW16
		CQ0016	(7) PRC test pattern has been altered	Pattern
		000017	(8) Error loading OE A storage register	IW21 failed bits=1
IE PULSE RATE CONVERTER TEST (3.2.3:2.3.5:11)				
051	013	000001	(3) Error loading OE A storage register	IW21 failed bits=1
		000002	(3) Error loading OE B storage register	IW22 failed bits=1
		000003	(5) IE input sequence setup error	IW11 failed bits=1
		000004	(6) IE input sequence completion error	IW11
		CQ0005 C = 0 is Channel A C = 1 is Channel B Q = 0 is HPFP Shaft Speed A/B (N2A/N2B) Q = 1 is N/A Q = 2 is Shaft Speed: LPFP (Ch A) (N1)/LPOP (Ch B) (N3) Q = 3 is 2 khz LVDT/RVDT Excitation Freq A/B (TRCA/TRCB) Q = 4 is N/A Q = 5 is Fuel Flowrate A1/B1 (Q1A1/Q1B1) Q = 6 is Fuel Flowrate A2/B2 (Q1A2/Q1B2)	(7) Initial test pattern has changed	Pattern
		000006	(9) IE input sequence setup error	IW11 failed bits=1
		000007	(10) IE input sequence completion error	IW11
		CQ0010	(11) PRC test pattern is not $0000 or $FFFF	Pattern

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
IE PULSE RATE CONVERTER TEST (3.2.3:2.3.5:11) (Continued)				
051	013	000011	(13) IE input sequence setup error	IW11 failed bits=1
		000012	(14) IE input sequence completion error	IW11
		CQ0013	(15) PRC test pattern is not one's complement of first PRC counter overflow	Pattern
		000014	(17) IE input sequence setup error	IW11 failed bits=1
		000015	(18) IE input sequence completion error	IW11
		CQ0016	(19) PRC test pattern is not one's complement of second PRC counter overflow	Pattern
		000017	(21) Error loading OE A storage register	IW21 failed bits=1
		000020	(21) Error loading OE B storage register	IW22 failed bits=1
		000021	(22) IE input sequence setup error	IW11 failed bits=1
		000022	(23) IE input sequence completion error	IW11
		CQ0023	(24) PRC test pattern is not one's complement of third PRC counter overflow	Pattern
		000024	(27) IE input sequence setup error	IW11 failed bits=1
		000025	(28) IE input sequence completion error	IW11
		CQ0026	(29) PRC final test pattern has changed	Pattern
OE STORAGE REGISTERS TEST (3.2.3:2.3.5:12)				
051	014	CPP001 C = 0 is Channel A C = 1 is Channel B PP = 01 to @40 is pattern number	(N/A) Read after write error	IW21/22 failed bits=1

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
WATCHDOG TIMER (WDT) COUNTER/TIME REFERENCE INTERRUPT TEST (3.2.3:2.3.5:14)				
			When DCU A is primary DCU	
051	016	000001	(4) Error setting IDSR A	IW25 failed bits=1
		000002	(4) DCU B test failure	IW26
		000003	(4) Bad response from DCU B	IW26
		000004	(4) DCU B time-out	None
		000005	(6) Error setting IDSR A	IW25 failed bits=1
		000006	(7) WDT1 and/or WDT2 timed-out	IW6
		000007	(8) WDTH1 or WDTH2 was not serviced in specified time interval	None
		000010	(9) WDT1 and/or WDT2 not timed-out	IW6
		000011	(10) DCU B test failure	IW26
		000012	(10) Bad response from DCU B	IW26
		000013	(10) DCU B time-out	None
		000014	(13) TRI pending	IW4
		000015	(15) TRI not serviced in time	None
		000016	(16) TRI not pending	IW4
		000017	(16) Error Setting IDSR A	IW25 failed bits=1
			When DCU A is secondary DCU	
		000020	(1) DCU B test failure	IW26
		000021	(1) Bad response from DCU B	IW26
		000022	(1) DCU B time-out	None
		000023	(4) Error setting IDSR A	IW25 failed bits=1
		000024	(4) DCU B test failure	IW26
		000025	(4) Bad response from DCU B	IW26
		000026	(4) DCU B time-out	None
		000027	(5) RCFI1 or RCFI2 not serviced in time	None
		000030	(5) DCU B Test Failure	IW26
		000031	(5) Bad response from DCU B	IW26
		000032	(5) DCU B time-out	None

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
WATCHDOG TIMER (WDT) INTERRUPT TEST (3.2.3:2.3.5:15)				
051	017	000001	(3) Error setting IDSR A	IW25 failed bits=1
		000002	(3) DCU B test failure	IW26
		000003	(3) Bad response from DCU B	IW26
		000004	(3) DCU B time-out	None
		000005	(6) WDTH1 pending	IW4
		000006	(8) WDTH1 not pending and/or WDTH2 pending	IW4
		000007	(10) WDTH1 not serviced	None
		000010	(12) Error setting IDSR A	IW25 failed bits=1
		000011	(12) DCU B test failure	IW26
		000012	(12) Bad response from DCU B	IW26
		000013	(12) DCU B time-out	None
		000014	(13) RCFI1 pending	IW4
		000015	(15) RCFI1 not pending and/or RCFI2 pending	IW4
		000016	(17) RCFI1 not serviced	None
		000017	(20) WDTH2 pending	IW4
		000020	(22) WDTH1 pending and/or WDTH2 not pending	IW4
		000021	(24) WDTH2 not serviced	None
		000022	(26) Error setting IDSR A	IW25 failed bits=1
		000023	(26) DCU B test failure	IW26
		000024	(26) Bad response from DCU B	IW26
		000025	(26) DCU B time-out	None
		000026	(27) RCFI2 pending	IW4
		000027	(29) RCFI1 pending and/or RCFI2 not pending	IW4
		000030	(31) RCFI2 not serviced	None
		000031	(32) Error setting IDSR A	IW25 failed bits=1
WATCHDOG TIMER OE DATA SWITCH TEST (3.2.3:2.3.5:16)				
051	020	000001	(2) Error loading OE A storage register	IW21 failed bits=1
		000002	(2) Error loading OE B storage register	IW22 failed bits=1
		000003	(3) Error setting IDSR A	IW25 failed bits=1
		000004	(3) DCU B test failure	IW26
		000005	(3) Bad response from DCU B	IW26
		000006	(3) DCU B time-out	None
		000007	(4) Error loading OE A storage register	IW21 failed bits=1
		000010	(4) Error loading OE B storage register	IW22 failed bits=1
		000011	(6) Error loading OE A storage register	IW21 failed bits=1
		000012	(6) Error loading OE B storage register	IW22 failed bits=1
		000013	(7) Error setting IDSR A	IW25 failed bits=1
		000014	(7) DCU B test failure	IW26
		000015	(7) Bad response from DCU B	IW26
		000016	(7) DCU B time-out	None

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
WATCHDOG TIMER OE DATA SWITCH TEST (3.2.3:2.3.5:16) (Continued)				
051	020	000017	(8) Error loading OE A storage register	IW21 failed bits=1
		000020	(8) Error loading OE B storage register	IW22 failed bits=1
		000021	(10) Error loading OE A storage register	IW21 failed bits=1
		000022	(10) Error loading OE B storage register	IW22 failed bits=1
		000023	(11) Error setting IDSR A	IW25 failed bits=1
		000024	(11) DCU B test failure	IW26
		000025	(11) Bad response from DCU B	IW26
		000026	(11) DCU B time-out	None
		000027	(12) Error loading OE A storage register	IW21 failed bits=1
		000030	(12) Error loading OE B storage register	IW22 failed bits=1
		000031	(12) Error setting IDSR A	IW25 failed bits=1
WATCHDOG TIMER IE DATA SWITCH TEST (3.2.3:2.3.5:17)				
051	021	000001	(4) IE input sequence setup error	IW11 failed bits=1
		C00002 C = 0 is Channel A C = 1 is Channel B	(6) TW1A or TW1B not = 0	TW1A/1B
		000003	(8) IE input sequence setup error	IW11 failed bits=1
		C00004	(10) TW1A or TW1B not = 0	TW1A/1B
		000005	(12) Error setting IDSR A	IW25 failed bits=1
		000006	(12) DCU B test failure	IW26
		000007	(12) Bad response from DCU B	IW26
		000010	(12) DCU B time-out	None
		C00011	(14) TW1A or TW1B not = 0	TW1A/1B
		000012	(14) Error setting IDSR A	IW25 failed bits=1
WATCHDOG TIMER VRC DATA SWITCH TEST (3.2.3:2.3.5:18)				
051	022	000001	(5) VRCA-VDT1A or VRCB-VDT2A is in non-complete state or either address register is not = 0	IW13
		000002	(9) VRCA-VDT1A or VRCB-VDT2A is in non-complete state or either address register is not = 0	IW13
		000003	(10) Error setting IDSR A	IW25 failed bits=1
		000004	(10) DCU B test failure	IW26
		000005	(10) Bad response from DCU B	IW26
		000006	(10) DCU B time-out	None

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH DCU CONTROL TEST (3.2.3:2.3.5:19)					
051	023	000001		(4) OE A Power Safety Switch is not on	IW15
		000002		(5) OE B Power Safety Switch is not on	IW16
		CP0003	C = 0 is Channel A C = 1 is Channel B P = 0 is 2Khz RVDT/LVDT P = 1 is Fuel System Purge P = 2 is CCV fail-safe	(6-8) Error loading OE A/B storage register	IW21/22 failed bits=1
		000004		(10) IE input sequence setup error	IW11 failed bits=1
		000005		(10) IE input sequence completion error	IW11
		CQ0006	Q = 0 is FRVA/B Q = 1 is OE1A/B Q = 2 is OE2A/B Q = 3 is OE7A/B	(10) Power supply outputs not on	Power supply output
		C00007		(11) SL1/SL2 not at pull-in level	SL1/SL2
		000010		(12) Error setting IDSR A	IW25 failed bits=1
		000011		(12) DCU B test failure	IW26
		000012		(12) Bad response from DCU B	IW26
		000013		(12) DCU B time-out	None
		000014		(13) OE A Power Safety Switch is not on	IW15
		000015		(13) OE B Power Safety Switch is not on	IW16
		000016		(15) IE input sequence setup error	IW11 failed bits=1
		000017		(15) IE input sequence completion error	IW11
		CQ0020		(15) Power supply outputs not on	Power supply output
		C00021		(16) SL1/SL2 not at pull-in level	SL1/SL2
		000022		(19) OE A Power Safety Switch is not off	IW15
		000023		(19) OE B Power Safety Switch is not off	IW16
		000024		(21) IE input sequence setup error	IW11 failed bits=1
		000025		(21) IE input sequence completion error	IW11
		CR0026	R = 0 is FRVA/B R = 1 is OE1A/B R = 2 is N/A R = 3 is OE7A/B	(21) Specified power supply outputs not off	Power supply output
		C00027		(21) SL1/SL2 not off	SL1/SL2
		CS0030	S = 0 is IW15/16 S = 1 is IW18 S = 2 is IW19/20	(22) A device controlled by OE A/B registers not deactivated	IW15/16/18/ 19/20
		000031		(24) IE input sequence setup error	IW11 failed bits=1
		000032		(24) IE input sequence completion error	IW11
		C00033		(24) OE2A/B power supply outputs not off	OE2A/B
		000034		(25) Error setting IDSR A	IW25 failed bits=1
		000035		(25) DCU B test failure	IW26
		000036		(25) Bad response from DCU B	IW26
		000037		(25) DCU B time-out	None

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH DCU CONTROL TEST (3.2.3:2.3.5:19) (Continued)					
051	023	000040		(26) OE A Power Safety Switch is not off	IW15
		000041		(26) OE B Power Safety Switch is not off	IW16
		000042		(31) OE A Power Safety Switch is not off	IW15
		000043		(31) OE B Power Safety Switch is not off	IW16
		000044		(32) Error setting IDSR A	IW25 failed bits=1
		000045		(32) DCU B test failure	IW26
		000046		(32) Bad response from DCU B	IW26
		000047		(32) DCU B time-out	None
		000050		(35) Error setting IDSR A	IW25 failed bits=1
		000051		(35) DCU B test failure	IW26
		000052		(35) Bad response from DCU B	IW26
		000053		(35) DCU B time-out	None
OE POWER SAFETY SWITCH POWER DOWN MATRIX TEST (3.2.3:2.3.5:20)					
051	024	000001		(4) OE A Power Safety Switch is not on	IW15
		000002		(4) OE B Power Safety Switch is not on	IW16
		CP0003	(C & P are defined in test 19 step 3)	(5-7) Error loading OE A/B storage register	IW21/22 failed bits=1
		000004		(9) IE input sequence setup error	IW11 failed bits=1
		000005		(9) IE input sequence completion error	IW11
		CQ0006	(Q is defined in test 19 step 6)	(9) Power supply outputs not on	Power supply output
		C00007		(10) SL1/SL2 not at hold level	SL1/SL2
		000010		(11) Error setting IDSR A	IW25 failed bits=1
		000011		(11) DCU B test failure	IW26
		000012		(11) Bad response from DCU B	IW26
		000013		(11) DCU B time-out	None
		000014		(14) OE A Power Safety Switch is not off	IW15
		000015		(14) OE B Power Safety Switch is not off	IW16
		000016		(16) Error setting IDSR A	IW25 failed bits=1
		000017		(16) DCU B test failure	IW26
		000020		(16) Bad response from DCU B	IW26
		000021		(16) DCU B time-out	None
		000022		(20) OE A Power Safety Switch is not on	IW15
		000023		(20) OE B Power Safety Switch is not on	IW16
		CP0024		(21-23) Error loading OE A/B storage register	IW21/22 failed bits=1
		000025		(25) IE input sequence setup error	IW11 failed bits=1
		000026		(25) IE input sequence completion error	IW11
		CQ0027		(25) Power supply outputs not on	Power supply output
		C00030		(26) SL1/SL2 not at hold level	SL1/SL2
		000031		(27) Error setting IDSR A	IW25 failed bits=1
		000032		(27) DCU B test failure	IW26

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH POWER DOWN MATRIX TEST (3.2.3:2.3.5:20) (Continued)				
051	024	000033	(27) Bad response from DCU B	IW26
		000034	(27) DCU B time-out	None
		000035	(30) OE A Power Safety Switch is not off	IW15
		000036	(30) OE B Power Safety Switch is not off	IW16
		000037	(31) Error setting IDSR A	IW25 failed bits=1
		000040	(31) DCU B test failure	IW26
		000041	(31) Bad response from DCU B	IW26
		000042	(31) DCU B time-out	None
OE POWER SAFETY SWITCH VOLTAGE MONITOR/POWER UP RESET TEST (3.2.3:2.3.5:21)				
051	025	000001	(4) OE A Power Safety Switch is not on	IW15
		000002	(4) OE B Power Safety Switch is not on	IW16
		CP0003 (C & P are defined in test 19 step 3)	(5-7) Error loading OE A/B Storage register	IW21/22 failed bits=1
		000004	(9) IE input sequence setup error	IW11 failed bits=1
		000005	(9) IE input sequence completion error	IW11
		CQ0006 (Q is defined in test 19 step 6)	(9) Power supply outputs not on	Power supply output
		C00007	(10) SL1/SL2 not at hold level	SL1/SL2
		000010	(11) Error setting IDSR A	IW25 failed bits=1
		000011	(11) DCU B test failure	IW26
		000012	(11) Bad response from DCU B	IW26
		000013	(11) DCU B time-out	None
		000014	(12) IE input sequence setup error	IW11 failed bits=1
		000015	(12) IE input sequence completion error	IW11
		CU0016 U = 0 is FRVA/B U = 1 is OE1B U = 2 is OE2B U = 3 is OE7B	(12) Power supply outputs not off	Power supply output
		000017	(12) SL2 is not off	SL2
		0V0020 V = 0 is IW16 V = 1 is IW18 V = 2 is IW20	(13) A device controlled by OE B registers not deactivated	IW16/18/20
		000021	(14) Error setting IDSR A	IW25 failed bits=1
		000022	(14) DCU B test failure	IW26
		000023	(14) Bad response from DCU B	IW26
		000024	(14) DCU B time-out	None
		000025	(17) OE A Power Safety Switch not on	IW15
		000026	(17) OE B Power Safety Switch not on	IW16
		CP0027	(18-20) Error loading OE A/B storage register	IW21/22 failed bits=1
		000030	(22) IE input sequence setup error	IW11 failed bits=1
		000031	(22) IE input sequence completion error	IW11
		CQ0032	(22) Power supply outputs not on	Power supply output

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH VOLTAGE MONITOR/POWER UP RESET TEST (3.2.3:2.3.5:21) (Continued)				
051	025	C00033	(23) SL1/SL2 not at hold level	SL1/SL2
		000034	(27) OE A Power Safety Switch not off	IW15
		000035	(28) OE B Power Safety Switch not on	IW16
		000036	(29) WDT2 not timed-out	IW6
		000037	(31) Error setting IDSR A	IW25 failed bits=1
		000040	(31) DCU B test failure	IW26
		000041	(31) Bad response from DCU B	IW26
		000042	(31) DCU B time-out	None
		000043	(32) Error setting IDSR A	IW25 failed bits=1
PSE POWER OFF INDICATOR (POI) TEST (3.2.3:2.3.5:22)				
051	026	000001	(3) POI state cannot be changed	IW4
		000002	(5) POI state cannot be changed	IW4
RVDT/LVDT EXCITATION POWER SUPPLY SOURCE TEST (3.2.3:2.3.5:24)				
051	030	0P0001 P = 0 is OE 2A bit 8 (off) P = 1 is OE 2A bit 8 (on) P = 2 is OE 2A bit 8 (off) P = 3 is OE 2A bit 8 (on)	(1) Error loading OE A storage register	IW21 failed bits=1
		0P0002 P = 0 is OE 2B bit 8 (off) P = 1 is OE 2B bit 8 (off) P = 2 is OE 2B bit 8 (on) P = 3 is OE 2B bit 8 (on)	(1) Error loading OE B storage register	IW22 failed bits=1
		000003	(3) IE input sequence setup error	IW11 failed bits=1
		000004	(3) IE input sequence completion error	IW11
		0R0005 R = 0 is FRVA (off) R = 1 is FRVA (on) R = 2 is FRVA (on) R = 3 is FRVA (off)	(4) FRVA not in expected state	FRVA
		0R0006 R = 0 is FRVB (off) R = 1 is FRVB (on) R = 2 is FRVB (on) R = 3 is FRVB (on)	(4) FRVB not in expected state	FRVB

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
PNEUMATIC SOLENOID TEST (3.2.3:2.3.5:25)					
051	031	CP0001	C = 0 is Channel A C = 1 is Channel B P is for solenoids: P = 0 is Bleed Valve P = 1 is Fuel System Purge P = 2 is Pogo Precharge P = 3 is Preburner S/D Purge P = 4 is Emergency S/D P = 5 is HPOP IMSL Purge	(1) Error loading OE A/B storage register	IW21/22 failed bits=1
		OP0002		(2) IE input sequence setup error	IW11 failed bits=1
		OP0003		(2) IE input sequence completion error	IW11
		CP0004		(2) SL1/SL2 not at pull-in level	SL1/SL2
		CP0005		(3) Solenoid coil under test not energized	IW15/16
		CP0006		(3) A coil not under test is energized	IW15/16
		CP0007		(4) Error loading OE A/B storage register	IW21/22 failed bits=1
		CP0010		(5) Solenoid coil under test not energized	IW15/16
		CP0011		(6) Error loading OE A/B storage register	IW21/22 failed bits=1
		OP0012		(7) IE input sequence setup error	IW11 failed bits=1
		OP0013		(7) IE input sequence completion error	IW11
		CP0014		(7) SL1/SL2 not at hold level	SL1/SL2
		CP0015		(8) Solenoid coil under test not energized	IW15/16
		CP0016		(9) Error loading OE A/B storage register	IW21/22 failed bits=1
		CP0017		(10) Solenoid coil under test is energized	IW15/16
SERVOACTUATOR ERROR INDICATION INTERRUPT TEST (3.2.3:2.3.5:26)					
051	032	CP0001	C = 0 is Channel A C = 1 is Channel B P = 0 is OPOV A/B P = 1 is FPOV A/B P = 2 is MOV A/B P = 3 is MFV A/B P = 4 is CCV A/B	(1) Error loading OE A/B storage register	IW21/22 failed bits=1
		CP0002		(3) SEII not serviced	None
		CP0003		(4) No SEI pending for SEI under test or SEI pending for any other SEI	IW7
		CP0004		(5) Error loading OE A/B storage register	IW21/22 failed bits=1
		CP0005		(7) An SEI is pending	IW7

Table II
CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
FAILURE DATA RECORDER TEST (3.2.3:2.3.5:28)					
				Reported by DCU A for failure detected in cross-channel	
051	034	000001		(13) Expected FDR address not reached	IW32
		000002		(12) Not including bits 7 and 8, each bit of IW29 has not toggled at least once	IW29 failed bits=1
		000003		(12) Each bit of IW30 has not toggled at least once	IW30 failed bits=1
		000004		(12) Each bit of IW31 has not toggled at least once	IW31 failed bits=1
PROTOCOL PROCEDURES (3.2.3:2.3.5(d))					
051	040	000001		(N/A) Error setting IDSR A during initialization before first test	IW25 failed bits=1
		0001YY	YY = 05, @11, @14, @16, @32 is the test number	(N/A) Error setting IDSR A at mid-test transfer when DCU B becomes primary or in-control	IW25 failed bits=1
		0002ZZ	ZZ = 01 to @14, @16 to @26, @30 to @32, @34 is the test number	(N/A) Error setting IDSR A at end of test	IW25 failed bits=1
		010001		(N/A) Bad response from DCU B during initialization before first test	IW26
		0101YY		(N/A) Bad response from DCU B at mid-test transfer when DCU B becomes primary or in-control	IW26
		0102ZZ		(N/A) Bad response from DCU B at end of test	IW26
		020001		(N/A) DCU B timed-out during initialization before first test	None
		0201YY		(N/A) DCU B timed-out at mid-test transfer when DCU B becomes primary or in-control	None
		0202ZZ		(N/A) DCU B timed-out at end of test	None
		0301XX	XX = @16 is the test number	(N/A) DCU B test failure reported at mid-test transfer when DCU B becomes primary	IW26
		0302WW	WW = 01,02,04 to @11,@14, @20,@21,@26,@32,@34 is the test number	(N/A) DCU B test failure reported at end of test	IW26
		030001		(N/A) DCU B failure reported during initialization before first test	IW26

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
ENGINE/CONTROLLER ON/OFF DEVICES, Commanded Bit Failed ON (3.2.3:2.3.5(j))					
051	042	00R0XX	XX = @12, @13, @23, @24, @25, @30, @32 is the test number R = 0 is On/Off Register 1A R = 1 is On/Off Register 2A R = 2 is N/A R = 3 is On/Off Register 1B R = 4 is On/Off Register 2B R = 5 is N/A	(N/A) Commanded bit failed ON	IW15/16/17/18 failed bits=1
ENGINE/CONTROLLER ON/OFF DEVICES, Commanded Bit Failed OFF (3.2.3:2.3.5(j))					
051	043	00R0XX	XX = @13, @23, @24, @25, @30, @32 is the test number R = 0 is On/Off Register 1A R = 1 is On/Off Register 2A R = 2 is On/Off Register 3A R = 3 is On/Off Register 1B R = 4 is On/Off Register 2B R = 5 is On/Off Register 3B	(N/A) Commanded bit failed OFF	IW15/16/17/18/19/20 failed bits=1
SCP COMPARATOR TEST (3.2.3:2.3.5:1)					
052	001	0000XX	XX = 01 to @40 is data miscompare pattern number 1 to 32	(3,6,9) SCP Comparator data error indication absent or address error indication present	IW4
		0000YY	YY = @41 to @76 is address miscompare pattern number 1 to 30	(12,14) SCP Comparator address error indication absent or data error indication present	IW4

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
SCP INTERRUPT TEST (3.2.3:2.3.5:2)				
			SCP Data Bus Interrupt	
052	002	000001	(3) No SCPI within 3 instructions	None
		000002	(4) WDTs (either 1, 2, or both) not timed-out	IW6
		000003	(4) FDR recording not inhibited	IW18
		000004	(5) No SCPI pending	IW4
			SCP Address Bus Interrupt	
		000005	(9) No SCPI within 3 instructions	None
		000006	(10) WDTs (either 1, 2, or both) not timed-out	IW6
		000007	(10) FDR recording not inhibited	IW18
		000010	(11) No SCPI pending	IW4
		000011	(13) SCPI still pending	IW4
		000012	(16) SCPI still pending	IW4
DTACK MONITOR/BUS ERROR GENERATOR TEST (3.2.3:2.3.5:3)				
If DCU B fails this test, it will halt. DCU A will report the DCU B failure under protocal procedures (Delimiter 040)				
VRC DPM WRITE/READ TEST (3.2.3:2.3.5:4)				
052	004	CN0XXX C = 0 is read error C = 1 is write to wrong location N = 0 is test pattern $5555 N = 1 is test pattern $AAAA XXX = 001 to @200 is targeted DPM address number	(2) Test pattern not read successfully	Erroneous pattern
		CN0XXX	(3) Predetermined pattern altered in other than the targeted VRC DPM memory address	Untargeted VRC DPM address number
VRC OUTPUT TEST (3.2.3:2.3.5:5)				
052	005	000001	(2) Address register(s) not = 0 or indicator(s) not set to incomplete within 2 usec after initiation	IW14
		000002	(3) Address register(s) not = 1 within time	IW14
		000003	(4) Test time > 2.482 msec	Actual time (usec)
		000004	(4) Address register(s) incremented wrong	IW14
		000005	(4) Test time < 2.402 msec	Actual time (usec)
		000006	(5) Address register(s) not = 0 or indicator(s) not set to complete within time	IW14

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
IE DPM WRITE/READ TEST (3.2.3:2.3.5:6)				
052	006	CN0YYY (C & N are defined in test 4) YYY = 001 to @400 is targeted DPM address	(N/A) Test pattern not read successfully	Erroneous pattern
		CN0YYY	(N/A) Predetermined pattern altered in other than the targeted IE DPM address	Untargeted IE DPM address number
IE ADDRESS COUNTER TEST (3.2.3:2.3.5:7)				
052	007	0000XX XX = 01 to @16 is pattern number	(N/A) IE Address Counter not equal to test pattern	IW12
IE RANGE COUNTER TEST (3.2.3:2.3.5:8)				
052	010	0000XX XX = 01 to @16 is pattern number	(N/A) IE Range Counter not equal to test pattern	IW12
IE TERMINATE SEQUENCE TEST (3.2.3:2.3.5:9)				
052	011	000001	(2) IE input sequence setup error	IW12 failed bits=1
		000002	(3) IE conversion complete	IW12
		000003	(5) IE conversion not complete	IW12
		CP0004 C = 0 is Channel A C = 1 is Channel B P = 0 is TW1A/B P = 1 is TW2A/B	(6) At least one of the specified IE DPM locations (TW1A thru TW2B) is not equal to the expected test pattern	TW1A/1B/2A/2B
		CQ0005 Q = 0 is TW4A/B Q = 1 is TW5A/B	(6) At least one of the specified IE DPM locations (TW4A thru TW5B) is not equal to the expected test pattern	TW4A/4B/5A/5B
OE STORAGE REGISTERS TEST (3.2.3:2.3.5:12)				
052	014	CPP001 C = 0 is Channel A C = 1 is Channel B PP = 01 to @40 is pattern number	(N/A) Read after write error	IW21/22 failed bits=1

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
WATCHDOG TIMER (WDT) COUNTER/TIME REFERENCE INTERRUPT TEST (3.2.3:2.3.5:14)				
			When DCU B is primary DCU	
052	016	000001	(4) Error setting IDSR B	IW26 failed bits=1
		000002	(4) DCU A test failure	IW25
		000003	(4) Bad response from DCU A	IW25
		000004	(4) DCU A time-out	None
		000005	(6) Error setting IDSR B	IW26 failed bits=1
		000006	(7) WDT1 and/or WDT2 timed-out	IW6
		000007	(8) WDTH1 or WDTH2 was not serviced in specified time interval	None
		000010	(9) WDT1 and/or WDT2 not timed-out	IW6
		000011	(10) DCU A test failure	IW25
		000012	(10) Bad response from DCU A	IW25
		000013	(10) DCU A time-out	None
		000014	(13) TRI pending	IW4
		000015	(15) TRI not serviced in time	None
		000016	(16) TRI not pending	IW4
		000017	(16) Error setting IDSR B	IW26 failed bits=1
			When DCU B is secondary DCU	
		000020	(1) DCU A test failure	IW25
		000021	(1) Bad response from DCU A	IW25
		000022	(1) DCU A time-out	None
		000023	(4) Error setting IDSR B	IW26 failed bits=1
		000024	(4) DCU A test failure	IW25
		000025	(4) Bad response from DCU A	IW25
		000026	(4) DCU A time-out	None
		000027	(5) RCFI1 or RCFI2 not serviced in time	None
		000030	(5) DCU A test failure	IW25
		000031	(5) Bad response from DCU A	IW25
		000032	(5) DCU A time-out	None
WATCHDOG TIMER (WDT) INTERRUPT TEST (3.2.3:2.3.5:15)				
052	017	000001	(1) DCU A test failure	IW25
		000002	(1) Bad response from DCU A	IW25
		000003	(1) DCU A time-out	None
		000004	(5) Error setting IDSR B	IW26 failed bits=1
		000005	(5) DCU A test failure	IW25
		000006	(5) Bad response from DCU A	IW25
		000007	(5) DCU A time-out	None
		000010	(6) RCFI1 pending	IW4
		000011	(8) RCFI1 not pending and/or RCFI2 pending	IW4
		000012	(10) RCFI1 not serviced	None
		000013	(12) WDTH1 pending	IW4
		000014	(14) WDTH1 not pending and/or WDTH2 pending	IW4

Table II
CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
WATCHDOG TIMER (WDT) INTERRUPT TEST (3.2.3:2.3.5:15) (Continued)				
052	017	000015	(16) WDTH1 not serviced	None
		000016	(18) Error setting IDSR B	IW26 failed bits=1
		000017	(18) DCU A test failure	IW25
		000020	(18) Bad response from DCU A	IW25
		000021	(18) DCU A time-out	None
		000022	(19) RCFI2 pending	IW4
		000023	(21) RCFI2 not pending and/or RCFI1 pending	IW4
		000024	(23) RCFI2 not serviced	None
		000025	(25) WDTH2 pending	IW4
		000026	(27) WDTH1 pending and/or WDTH2 not pending	IW4
		000027	(29) WDTH2 not serviced	None
		000030	(30) Error setting IDSR B	IW26 failed bits=1
		000031	(30) DCU A test failure	IW25
		000032	(30) Bad response from DCU A	IW25
		000033	(30) DCU A time-out	None
WATCHDOG TIMER OE DATA SWITCH TEST (3.2.3:2.3.5:16)				
052	020	000001	(1) DCU A test failure	IW25
		000002	(1) Bad response from DCU A	IW25
		000003	(1) DCU A time-out	None
		000004	(4) Error setting IDSR B	IW26 failed bits=1
		000005	(4) DCU A test failure	IW25
		000006	(4) Bad response from DCU A	IW25
		000007	(4) DCU A time-out	None
		000010	(6) Error setting IDSR B	IW26 failed bits=1
		000011	(6) DCU A test failure	IW25
		000012	(6) Bad response from DCU A	IW25
		000013	(6) DCU A time-out	None
		000014	(7) Error setting IDSR B	IW26 failed bits=1
		000015	(7) DCU A test failure	IW25
		000016	(7) Bad response from DCU A	IW25
		000017	(7) DCU A time-out	None

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	F A I L U R E D E S C R I P T I O N (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
WATCHDOG TIMER IE DATA SWITCH TEST (3.2.3:2.3.5:17)				
052	021	000001	(1) DCU A test failure	IW25
		000002	(1) Bad response from DCU A	IW25
		000003	(1) DCU A time-out	None
		000004	(3) IE input sequence setup error	IW12 failed bits=1
		000005	(3) Error setting IDSR B	IW26 failed bits=1
		000006	(3) DCU A test failure	IW25
		000007	(3) Bad response from DCU A	IW25
		000010	(3) DCU A time-out	None
WATCHDOG TIMER VRC DATA SWITCH TEST (3.2.3:2.3.5:18)				
052	022	000001	(2) DCU A test failure	IW25
		000002	(2) Bad response from DCU A	IW25
		000003	(2) DCU A time-out	None
		000004	(5) VRCA-VDT1B or VRCB-VDT2B is in non-complete state or either address register is not = 0	IW14
		000005	(5) Error setting IDSR B	IW26 failed bits=1
OE POWER SAFETY SWITCH DCU CONTROL TEST (3.2.3:2.3.5:19)				
052	023	000001	(2) DCU A test failure	IW25
		000002	(2) Bad response from DCU A	IW25
		000003	(2) DCU A time-out	None
		000004	(4) Error setting IDSR B	IW26 failed bits=1
		000005	(4) DCU A test failure	IW25
		000006	(4) Bad response from DCU A	IW25
		000007	(4) DCU A time-out	None
		000010	(6) Error setting IDSR B	IW26 failed bits=1
		000011	(6) DCU A test failure	IW25
		000012	(6) Bad response from DCU A	IW25
		000013	(6) DCU A time-out	None
		CP0014 C = 0 is Channel A C = 1 is Channel B P = 0 is 2Khz RVDT/LVDT P = 1 is Fuel System Purge P = 2 is CCV fail-safe	(8-10) Error loading OE A/B storage register	IW21/22 failed bits=1
		000015	(12) IE input sequence setup error	IW12 failed bits=1
		000016	(12) IE input sequence completion error	IW12
		CQ0017 Q = 0 is FRVA/B Q = 1 is OE1A/B Q = 2 is OE2A/B Q = 3 is OE7A/B	(12) Power supply outputs not on	Power supply output

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH DCU CONTROL TEST (3.2.3:2.3.5:19) (Continued)					
052	023	C00020		(13) SL1/SL2 not at hold level	SL1/SL2
		000021		(14) Error setting IDSR B	IW26 failed bits=1
		000022		(14) DCU A test failure	IW25
		000023		(14) Bad response from DCU A	IW25
		000024		(14) DCU A time-out	None
		000025		(15) OE A Power Safety Switch is not on	IW15
		000026		(15) OE B Power Safety Switch is not on	IW16
		000027		(17) IE input sequence setup error	IW12 failed bits=1
		000030		(17) IE input sequence completion error	IW12
		CQ0031		(17) Power supply outputs not on	Power supply output
		C00032		(18) SL1/SL2 not at hold level	SL1/SL2
		000033		(21) OE A Power Safety Switch is not off	IW15
		000034		(21) OE B Power Safety Switch is not off	IW16
		000035		(23) IE input sequence setup error	IW12 failed bits=1
		000036		(23) IE input sequence completion error	IW12
		CR0037	R = 0 is FRVA/B R = 1 is OE1A/B	(23) Specified power supply outputs not off	Power supply output
		C00040		(23) SL1/SL2 not off	SL1/SL2
		CS0041	S = 0 is IW15/16 S = 1 is IW18 S = 2 is IW19/20	(24) A device controlled by OE A/B registers not deactivated	IW15/16/18/ 19/20
		000042		(26) IE input sequence setup error	IW12 failed bits=1
		000043		(26) IE input sequence completion error	IW12
		C00044		(26) OE2A/B power supply outputs not off	OE2A/B
		000045		(26) Error setting IDSR B	IW26 failed bits=1

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH POWER DOWN MATRIX TEST (3.2.3:2.3.5:20)					
052	024	000001		(2) DCU A test failure	IW25
		000002		(2) Bad response from DCU A	IW25
		000003		(2) DCU A time-out	None
		000004		(4) Error setting IDSR B	IW26 failed bits=1
		000005		(4) DCU A test failure	IW25
		000006		(4) Bad response from DCU A	IW25
		000007		(4) DCU A time-out	None
		000010		(5) IE input sequence setup error	IW12 failed bits=1
		000011		(5) IE input sequence completion error	IW12
		CQ0012	(C & Q are defined in test 19 steps 8-10 and 12)	(5) Power supply outputs not off	Power supply output
		C00013		(5) SL1/SL2 not off	SL1/SL2
		CS0014	S = 0 is IW15/16 S = 1 is IW17/18 S = 2 is IW19/20	(6) A device controlled by OE A/B registers not deactivated	IW15/16/17/18/ 19/20
		000015		(7) Error setting IDSR B	IW26 failed bits=1
		000016		(7) DCU A test failure	IW25
		000017		(7) Bad Response from DCU A	IW25
		000020		(7) DCU A time-out	None
		000021		(9) Error setting IDSR B	IW26 failed bits=1
		000022		(9) DCU A test failure	IW25
		000023		(9) Bad response from DCU A	IW25
		000024		(9) DCU A time-out	None
		000025		(10) IE input sequence setup error	IW12 failed bits=1
		000026		(10) IE input sequence completion error	IW12
		CQ0027		(10) Power supply outputs not off	Power supply output
		C00030		(10) SL1/SL2 not off	SL1/SL2
		CS0031		(11) A device controlled by OE A/B registers not deactivated	IW15/16/17/18/ 19/20
		000032		(11) Error setting IDSR B	IW26 failed bits=1

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
OE POWER SAFETY SWITCH VOLTAGE MONITOR/POWER UP RESET TEST (3.2.3:2.3.5:21)					
052	025	000001		(2) DCU A test failure	IW25
		000002		(2) Bad response from DCU A	IW25
		000003		(2) DCU A time-out	None
		000004		(6) OE A Power Safety Switch is not on	IW15
		000005		(6) OE B Power Safety Switch is not off	IW16
		000006		(7) WDT2 not timed-out	IW6
		000007		(9) Error setting IDSR B	IW26 failed bits=1
		000010		(9) DCU A test failure	IW25
		000011		(9) Bad response from DCU A	IW25
		000012		(9) DCU A time-out	None
		000013		(12) Error setting IDSR B	IW26 failed bits=1
		000014		(12) DCU A test failure	IW25
		000015		(12) Bad response from DCU A	IW25
		000016		(12) DCU A time-out	None
		000017		(13) IE input sequence setup error	IW12 failed bits=1
		000020		(13) IE input sequence completion error	IW12
		CU0021	C = 0 is Channel A C = 1 is Channel B U = 0 is FRVA/B U = 1 is OE1A U = 2 is OE2A U = 3 is OE7A	(13) Power supply outputs not off	Power supply output
		000022		(13) SL1 is not off	SL1
		0V0023	V = 0 is IW15 V = 1 is IW17 V = 2 is IW19	(14) A device controlled by OE A registers not deactivated	IW15/17/19
		000024		(14) Error setting IDSR B	IW26 failed bits=1
		000025		(14) DCU A test failure	IW25
		000026		(14) Bad response from DCU A	IW25
		000027		(14) DCU A time-out	None
PSE POWER OFF INDICATOR (POI) TEST (3.2.3:2.3.5:22)					
052	026	000001		(3) POI state cannot be changed	IW4
		000002		(5) POI state cannot be changed	IW4

Table II
CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)		FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
SERVOACTUATOR ERROR INDICATION INTERRUPT TEST (3.2.3:2.3.5:26)					
052	032	CP0001	C = 0 is Channel A C = 1 is Channel B P = 0 is OPOV A/B P = 1 is FPOV A/B P = 2 is MOV A/B P = 3 is MFV A/B P = 4 is CCV A/B	(1) Error loading OE A/B storage register	IW21/22 failed bits=1
		CP0002		(3) SEII not serviced	None
		CP0003		(4) No SEI pending for SEI under test or SEI pending for any other SEI	IW7
		CP0004		(5) Error loading OE A/B storage register	IW21/22 failed bits=1
		CP0005		(7) An SEI is pending	IW7
FAILURE DATA RECORDER TEST (3.2.3:2.3.5:28)				Reported by DCU B for failure detected in cross-channel	
052	034	000001		(13) Expected FDR address not reached	IW32
		000002		(12) Not including bits 7 and 8, each bit of IW29 has not toggled at least once	IW29 failed bits=1
		000003		(12) Each bit of IW30 has not toggled at least once	IW30 failed bits=1
		000004		(12) Each bit of IW31 has not toggled at least once	IW31 failed bits=1
PROTOCOL PROCEDURES (3.2.3:2.3.5(d))					
052	040	000001		(N/A) Error setting IDSR B during initialization before first test	IW26 failed bits=1
		0001YY	YY = 05, @11, @14, @16, @32 is the test number	(N/A) Error setting IDSR B at mid-test transfer when DCU B becomes primary or in-control	IW26 failed bits=1
		0002ZZ	ZZ = 01 to @14, @16 to @26, @30 to @32, @34 is the test number	(N/A) Error setting IDSR B at end of test	IW26 failed bits=1
		010001		(N/A) Bad response from DCU A during initialization before first test	IW25
		0101YY		(N/A) Bad response from DCU A at mid-test transfer when DCU B becomes primary or in-control	IW25
		0102ZZ		(N/A) Bad response from DCU A at end of test	IW25

Table II

CONTROLLER CHECKOUT (Continued)

FID (OCTAL)	DELIM (OCTAL)	FAILURE STEP NUMBER (OCTAL)	FAILURE DESCRIPTION (3.2.3:2.3.5:X) where X is the test number. (n) is the Part I test sequence number or subparagraph number.	FAILURE PARAMETER
PROTOCOL PROCEDURES (3.2.3:2.3.5(d)) (Continued)				
052	040	020001	(N/A) DCU A timed-out during initialization before first test	None
		0201YY	(N/A) DCU A timed-out at mid-test transfer when DCU B becomes primary or in-control	None
		0202ZZ	(N/A) DCU A timed-out at end of test	None
		0301YY	(N/A) DCU A test failure reported at mid-test transfer when DCU B becomes primary or in-control	IW25
		0302WW WW = 01,02,04 to @14,@20, @21,@26,@30 to @32,@34 is the test number	(N/A) DCU A test failure reported at end of test	IW25
		030001	(N/A) DCU A failure reported during initialization before first test	IW25
ENGINE/CONTROLLER ON/OFF DEVICES, Commanded Bit Failed ON (3.2.3:2.3.5(j))				
052	042	00R0XX XX = @23, @32 is the test number R = 0 is N/A R = 1 is On/Off Register 2A R = 2 is N/A R = 3 is N/A R = 4 is N/A R = 5 is N/A	(N/A) Commanded bit failed ON	IW17 failed bits=1
ENGINE/CONTROLLER ON/OFF DEVICES, Commanded Bit Failed OFF (3.2.3:2.3.5(j))				
052	043	00R0XX XX = @23, @32 is the test number R = 0 is On/Off Register 1A R = 1 is N/A R = 2 is On/Off Register 3A R = 3 is On/Off Register 1B R = 4 is On/Off Register 2B R = 5 is On/Off Register 3B	(N/A) Commanded bit failed OFF	IW15/16/18/19/20 failed bits=1

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Table III
VEHICLE COMMAND CHANNEL VOTING

COMMAND CHANNEL WORD COMBINATIONS (NOTE 1)	COMMAND VOTING RESULT	ENGINE STATUS WORD (VDT WORD 3) (See Table VIII) (NOTE 7)		VEHICLE COMMAND ENTRY (VDT WORDS 98-99)	OPERATIONAL RESPONSE (NOTE 3)
		COMMAND STATUS	CHANNEL STATUS (NOTE 2)		
No change	No vote	00	None	No Entry	None
3Z	Vote Fails	01	Zero Channels	No Entry	FID 42 (All Channels)
2Z, 1S	Vote Fails	01	Zero Channels	No Entry	FID 42 (All Channels)
1Z, 2S	Vote Fails (0 agree)	01	Zero Channel	No Entry	FID 42 (All Channels)
	Vote Fails (2 agree) (Note 5)	01 (Note 6)	Zero Channel	No Entry	FID 42 (Zero Channel)
	Vote OK (2 agree)	10 or 11 (Notes 4,6)	Zero Channel	Voted Command (Note 6)	Execute, FID 42 (Zero Channel)
3S	Vote Fails (0 agree)	01	None	No Entry	FID 42 (All Channels)
	Vote Fails (2 agree) (Note 5)	01 (Note 6)	Out-Voted Channel	No Entry	FID 42 (Out-Voted Channel)
	Vote OK (2 agree)	10 or 11 (Notes 4,6)	Out-Voted Channel	Voted Command (Note 6)	Execute, FID 42 (Out-Voted Channel)
	Vote OK (3 agree)	10 or 11 (Notes 4,6)	None	Voted Command (Note 6)	Execute
Single command channel word change (3.2.2:1.2 (b)(1))	Vote OK	10 or 11 (Note 4)	Unsuccessfully Voted Channels	Voted Command (3.2.2:1.2, (c)(2) or (c)(3))	Execute, FID 42 per 3.2.2:1.2(f), FID 41 for accepted Shutdown

Table III
VEHICLE COMMAND CHANNEL VOTING (Continued)

NOTES:

1. The figure preceding each letter indicates the number of Vehicle Command Channel Words in each category.

    Z = all-zero Vehicle Command Channel Word,

    S = Vehicle Command Channel Word is significant: non-zero.

   The success of voting depends on the command indicated, see 3.2.2:1.2. This information will be reported in the Engine Status Word per Table VIII.

2. Channel Status bit is set to logical 1 for the indicated channel(s).

3. Execute = If command passes acceptance checks then commanded function will be performed.

   FID 41 = See Table I for shutdown response(s)

   FID 42 = See Table I for failure response(s)

   No Command Voting Failures (FID 42) will be reported in the first major cycle following a Major Cycle Restart or anytime following a permanent channel power loss.

4. Command Status code depends on outcome of Command Acceptance check, see 3.2.2:1.3.

5. All three Command Channel Words must agree in order for a Start or Start Enable command to successfully pass Command Voting per 3.2.2:1.2.

6. Indicated entry is not updated if two or more significant channels agree and are the same as the last Voted Majority Command.

7. Subsequent to a VDT transmission the Command Status field of the ESW will be initialized to indicate no command received since last VDT transmission, and the Channel Status field of the ESW will be initialized to indicate all channels are okay.

8. Deleted

9. Deleted

Table IV
MEMORY CONFIGURATION/PHASE/MODE ORGANIZATION

MEMORY CONFIGU-RATION	PROM PHASE	CHECKOUT PHASE								START PREPARATION PHASE					START PHASE			MAINSTAGE PHASE					SHUTDOWN PHASE			POST SHUTDOWN PHASE		
	SB	SB	AC	IG	SN	ELD	PN	CN	HC	P1	P2	P3	P4	ER	SI	TB	FD	NC	TL	EL	HL	FD	TZ	PVC	PS	SB	OD	TS
PROM	X																											
FLIGHT		X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FRT (1) FRT MODE		X (2)								X (2)	X (2)	X (3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X (2)	X (2)	X (2)
FRT (1) NRM OPR		X																							X	X	X	X
GROUND CHECKOUT		X	X	X	X	X	X	X	X																X	X		X

X Denotes the phase/modes that are used by the memory configuration.

(1) The FRT memory configuration refers to either FRT-1 or FRT-2. Each of these configurations can be in either one of two conditions:
FRT MODE - Selected sensor inputs are simulated. In addition, some failures can be simulated on command.

NRM OPR - Normal operating conditions, where actual sensor inputs are used.

(2) In the FRT Mode, this phase/mode uses actual sensor inputs.

(3) In the FRT-2 configuration, this phase/mode uses actual sensor inputs.

ENGINE MODE ABBREVIATIONS:

AC - Actuator Checkout
CN - Controller Checkout
EL - Electrical Lockup
ELD - Engine Leak Detection
ER - Engine Ready
FD - Fixed Density
HC - Hydraulic Conditioning
HL - Hydraulic Lockup
IG - Igniter Checkout
NC - Normal Control
OD - Oxidizer Dump
Px - Purge Sequence No. x where x is 1,2,3, or 4
PN - Pneumatic Checkout
PS - Pneumatic Shutdown
PVC - Propellant Valve Closed
SB - Standby
SI - Start Initiation
SN - Sensor Checkout
TB - Thrust Buildup
TL - Thrust Limiting
TS - Terminate Sequence
TZ - Throttling to Zero

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Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4)

ABBREVIATIONS

CONFIGURATION / PHASE / MODE		CONDITIONS FOR REJECTION	
CO	Checkout	CR	CR response (See Table I) is in effect.
ELD	Engine Leak Detection	CR2	CR2 response (See Table I) is in effect.
ER	Engine Ready	CCV	CCV is less than 94% open.
GCO	Ground Checkout	ENB	The associated Enable command is not in effect.
FLT	Flight	FRT	In an FRT configuration and FRT Mode is deactivated.
FRT	Flight Readiness Test	PS	Previous shutdown is a Pneumatic Shutdown.
OD	Oxidizer Dump	I	I-Response is in effect.
PROM	Programmable Read Only Memory	LIM	A qualified sensor is outside its Engine Ready limit.
PSD	Post Shutdown	RO	Readout A command is received while a Switch VRC command is in effect, or a Readout command requests readout of a disqualified DCU.
Px	Purge Sequence No. x where x is 1,2,3, or 4	SCV	A shutdown command does not satisfy the Shutdown command acceptance conditions of 3.2.2:1.3 (c) and (d).
SB	Standby	ST	Stop DCU command indicator is set to reject command.
SP	Start Preparation	T	T-Response is in effect.
		VRC	Command is attempting to switch VRC source to disqualified DCU.

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Activate FRT Simulation	@136000 ($BC00)	FRT-1, FRT-2	CO/SB	I, T	Activates FRT Mode, and initiates FRT simulation, 3.2.3:2.4.
Checkout Bleed Valve Control Valve	@127400 ($AF00)	GCO	CO/SB	I, T	Enters Pneumatic Checkout mode for this valve, 3.2.3:2.3.3 and Table XXV.
Checkout CCV	@132400 ($B500)	GCO	CO/SB	I, T	Enters Actuator Checkout mode for the CCV, 3.2.3:2.3.4 and Table XXIV.
Checkout Emergency Shutdown Control Valve	@130000 ($B000)	GCO	CO/SB	I, T	Enters Pneumatic Checkout mode for this valve, 3.2.3:2.3.3 and Table XXV.
Checkout FPOV	@133000 ($B600)	GCO	CO/SB	I, T	Enters Actuator Checkout mode for the FPOV, 3.2.3:2.3.4 and Table XXIV.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Checkout Fuel System Purge Control Valve	@126400 ($AD00)	GCO	CO/SB	I, T	Enters Pneumatic Checkout mode for this valve, 3.2.3:2.3.3 and Table XXV.
Checkout HPOP IMSL Purge Control Valve	@127000 ($AE00)	GCO	CO/SB	I, T	Enters Pneumatic Checkout mode for this valve, 3.2.3:2.3.3 and Table XXV.
Checkout MFV	@131400 ($B300)	GCO	CO/SB	I, T	Enters Actuator Checkout mode for the MFV, 3.2.3:2.3.4 and Table XXIV.
Checkout MOV	@132000 ($B400)	GCO	CO/SB	I, T	Enters Actuator Checkout mode for the MOV, 3.2.3:2.3.4 and Table XXIV.
Checkout OPOV	@133400 ($B700)	GCO	CO/SB	I, T	Enters Actuator Checkout mode for the OPOV, 3.2.3:2.3.4 and Table XXIV.
Checkout Pogo Precharge Control Valve	@130400 ($B100)	GCO	CO/SB	I, T	Enters Pneumatic Checkout mode for this valve, 3.2.3:2.3.3 and Table XXV.
Checkout Preburner Shutdown Purge Control Valve	@131000 ($B200)	GCO	CO/SB	I, T	Enters Pneumatic Checkout mode for this valve, 3.2.3:2.3.3 and Table XXV.
Checkout Standby	@116400 ($9D00)	All RAM	CO, SP, PSD/SB, PSD/OD	I	Returns Controller to Checkout Standby without clearing failure indications, 3.2.3:1.1.2 and 3.2.3:1.2.7.
Close Emergency Shutdown Control Valve	@124400 ($A900)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode. Disables CCV servoactuator error indications, energizes Ch A and B fail-safes, and closes Emergency Shutdown Control Valve, 3.2.3:2.3.6.
Controller Checkout	@135400 ($BB00)	GCO	CO/SB	I, T	Enters Controller Checkout mode for Controller hardware tests, 3.2.3:2.3.5.
Controller Reset	@120000 ($A000)	All RAM	CO, SP, PSD/SB, PSD/OD	-	Returns Controller to Checkout Standby and clears all failure indications, 3.2.3:1.1.1 and 3.2.3:1.2.7.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Deactivate All Valves (Propellant and Pneumatic)	@125400 ($AB00)	GCO	CO	-	Deenergizes all pneumatic solenoids, closes all propellant valves hydraulically, and then enters Checkout Standby, 3.2.3:2.3.7.
Deactivate FRT Simulation	@140000 ($C000)	FRT-1, FRT-2	All	FRT, I	Deactivates FRT simulation and enters Post Shutdown Standby, 3.2.3:2.4.1:2.
Deenergize Group 1 Sensor Switches	@142400 ($C500)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to deenergize the Group 1 Sensor Checkout Switches, 3.2.3:2.3.6.
Deenergize Group 2 Sensor Switches	@143400 ($C700)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to deenergize the Group 2 Propellant Drop Sensor Switches, 3.2.3:2.3.6.
Energize Group 1 Sensor Switches	@142000 ($C400)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to energize the Group 1 Sensor Checkout Switches, 3.2.3:2.3.6.
Energize Group 2 Sensor Switches	@143000 ($C600)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to energize the Group 2 Propellant Drop Sensor Switches, 3.2.3:2.3.6.
Enter Flight	@113000 ($9600)	All RAM	CO/SB	I	Changes the configuration to Flight, 3.2.3:1.
Enter FRT-1	@113400 ($9700)	All RAM	CO/SB	I, T	Changes the configuration to FRT-1, 3.2.3:2.4.
Enter FRT-2	@114000 ($9800)	All RAM	CO/SB	I, T	Changes the configuration to FRT-2, 3.2.3:2.4.
Enter Ground Checkout	@112400 ($9500)	All RAM	CO/SB	I, T	Changes the configuration to Ground Checkout, 3.2.3:2.
Exit PROM	@177400 ($FF00)	All RAM	All	-	This command is reported but no other action will be taken.
		PROM	PROM/SB	N/A	Used to exit from PROM and enter Flight configuration Pneumatic Shutdown (see PROM Spec DSCP34053988).

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
FDR Cross-Channel Readout A/B	@173002/ 173001 ($F602/ F601)	PROM	PROM/SB	N/A	Outputs cross channel Failure Data Recorder contents via the VRC.
FDR Enable A/B	@172402/ 172401 ($F502/ F501)	PROM	PROM/SB	N/A	Enables the Failure Data Recorder to record.
Hello A/B	@170402/ 170401 ($F102/ F101)	PROM	PROM/SB	N/A	Outputs existing VRC contents, then a dummy VDT from PROM.
Hydraulic Conditioning	@141000 ($C200)	GCO	CO/SB	I, T	Initiates the Hydraulic Conditioning Sequence per 3.2.3:2.3.9.
Inhibit Igniters In FRT-1	@140400 ($C100)	FRT-1	All	FRT, T	Eliminates energization of igniters in FRT-1 configuration, 3.2.3:2.4.1:1.1. Upon deactivation of the FRT Mode the effects of the command will be removed.
IO Readout High IE DPM A/B	@171442/ 171441 ($F322/ F321)	All RAM	CO, SP, PSD	RO	Initiates a readout of 128 words of IE DPM, beginning with address $820100, 3.2.2:2.1.2.
		PROM	PROM/SB	N/A	
IO Readout Input Space A/B	@171462/ 171461 ($F332/ F331)	All RAM	CO, SP, PSD	RO	Initiates a readout of 128 words of IE DPM, beginning with address $820C00, 3.2.2:2.1.2.
		PROM	PROM/SB	N/A	
IO Readout Low IE DPM A/B	@171422/ 171421 ($F312/ F311)	All RAM	CO, SP, PSD	RO	Initiates a readout of 128 words of IE DPM, beginning with address $820000, 3.2.2:2.1.2.
		PROM	PROM/SB	N/A	

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Limit Control Enable	@104400 ($8900)	FLT, FRT-1, FRT-2	All	-	Enables controller initiated engine shutdown based upon Shutdown Limit Monitoring (3.2.3:5.3), or FASCOS (3.2.3:5.4).
Limit Control Inhibit	@104000 ($8800)	FLT, FRT-1, FRT-2	All	-	Inhibits controller initiated engine shutdown based upon Shutdown Limit Monitoring (3.2.3:5.3), or FASCOS (3.2.3:5.4).
Main Chamber Pressure (MCC Pc) Level	@043400-071400 ($4700-7300)	All RAM	All	-	The implementation of the command codes in this range is based upon the configuration. If the configuration is Ground Checkout when the command is received, the command will be interpreted as a Set Propellant Valve Position or Set Propellant Valve Ramp Rate command. Otherwise, the command sets the MCC PC Reference Level. If the MCC Pc Reference Level is to be set, the range of commands from @043400 to @071400 will correspond to 65 to 109 percent RPL. An octal @400 represents 1 percent RPL. The range can be expanded using Operational Data.
Memory Load A/B	@10200/ 102400 ($8400/ 8500)	PROM	PROM/SB	N/A	Initiates a memory load of DCU A/B.
Memory Load A&B	@101400 ($8300)	PROM	PROM/SB	N/A	Initiates a memory load of DCU A and DCU B. Accepted by PROM Rev 5 and subsequent versions.
Memory Readout A/B	@177762/ 177761 ($FFF2/ FFF1)	All RAM	CO, SP, PSD	RO	Initiates memory readout of DCU A/B, 3.2.2:2.1.
		PROM	PROM/SB	N/A	
No Operation	@112000 ($9400)	All RAM	All	-	This command is reported but no other action will be taken. Accepted by PROM Rev 5 and subsequent versions.
		PROM	PROM/SB	N/A	

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Open Bleed Valve Control Valve	@124000 ($A800)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open this valve, 3.2.3:2.3.6.
Open CCV	@121400 ($A300)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open CCV, 3.2.3:2.3.6.
Open FPOV	@122000 ($A400)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open FPOV, 3.2.3:2.3.6.
Open Fuel System Purge Control Valve	@123000 ($A600)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open this valve, 3.2.3:2.3.6.
Open HPOP IMSL Purge Control Valve	@123400 ($A700)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open this valve, 3.2.3:2.3.6.
Open MFV	@120400 ($A100)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open MFV, 3.2.3:2.3.6.
Open MOV	@121000 ($A200)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open MOV, 3.2.3:2.3.6.
Open OPOV	@122400 ($A500)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open OPOV, 3.2.3:2.3.6.
Open Pogo Precharge Control Valve	@125000 ($AA00)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open this valve, 3.2.3:2.3.6.
Open Preburner Shutdown Purge Control Valve	@126000 ($AC00)	GCO	CO/SB, CO/ELD	I, T	Enters Engine Leak Detection mode to open this valve, 3.2.3:2.3.6.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Oxidizer Dump	@110400 ($9100)	FLT, FRT-1, FRT-2	PSD/SB, PSD/OD	I, PS	Starts Oxidizer Dump and maintains MOV open, ends mode by entering Post Shutdown Standby mode, 3.2.3:1.6.2.
PROM Sum Check A/B	@171002/ 171001 ($F202/ F201	PROM	PROM/SB	N/A	Verifies the integrity of PROM content.
Purge Sequence 1	@105400 ($8B00)	FLT, FRT-1, FRT-2	CO/SB, SP/P1, SP/P2, PSD/SB	CR, CR2, FRT, I	Enters Start Preparation phase, Purge Sequence 1 mode. Set Time Reference to zero, closes all valves, 3.2.3:1.2.1.
Purge Sequence 2	@106000 ($8C00)	FLT, FRT-1, FRT-2	CO/SB, SP/P1, SP/P2, PSD/SB	CR, CR2, FRT, I	Enters Start Preparation phase, Purge Sequence 2 mode. Open Fuel System Purge Control Valves to initiate Fuel System Purge, 3.2.3:1.2.2.
Purge Sequence 3	@106400 ($8D00)	FLT, FRT-1, FRT-2	CO/SB, SP, PSD/SB	CR, CR2, FRT, I	Enters Start Preparation phase, Purge Sequence 3 mode. Opens Bleed Valves and terminates Fuel System Purge, 3.2.3:1.2.3.
Purge Sequence 4	@107000 ($8E00)	FLT, FRT-1, FRT-2	CO/SB, SP, PSD/SB	CR, CR2, FRT, I	Enters Start Preparation phase, Purge Sequence 4 mode. Initiates Fuel System Purge during propellant recirculation. Energizes fail-safe servoswitches and commands initial position of CCV, 3.2.3:1.2.4.
RAM Sum Check A/B	@174002/ 174001 ($F802/ F801)	PROM	PROM/SB	N/A	Verifies integrity of RAM content after intial memory load.
RAM Write/Read Test A/B	@173402/ 173401 ($F702/ F701)	PROM	PROM/SB	N/A	Verifies RAM functions.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Reset Channel A/B	@117000/ 117400 ($9E00/ 9F00) Code is not used by RAM	N/A	N/A	N/A	Only hardware accepts and implements these commands by initiating PROM Executive in DCU A/B (Reference DSCP34053988). These commands will be rejected by the RAM program as invalid codes. If hardware detects a voted Reset Channel command and the associated Halt Exit bit is enabled, a Reset Exception will be generated which initiates the PROM program.
Restore VRC	@115000 ($9A00)	All RAM	All	VRC	If the source of the VRC data is DCU B, switch the source of the VRC data to DCU A, 3.2.2:2.2.4.
Resume	@100000 ($8000)	All RAM	All	-	Overrides an I-response (3.2.4:4(r)) and/or Major Component Failed (3.2.4:2(e)), and resumes a checkout sequence.
Sensor Checkout and Calibration	@134000 ($B800)	GCO	CO/SB	I, T	Enters Sensor Checkout mode and calibrates selected pressure sensors, 3.2.3:2.3.1.
Set Propellant Valve Position	@000400- 043377 ($0100- 46FF)	GCO	All	-	Sets the targeted propellant valve position to be implemented upon execution of an Open Propellant command (i.e., Open MOV, Open MFV, etc.), 3.2.3:2.3.6.
	@043400- 064400 ($4700- 6900)	All RAM	All	-	Implementation of the command code is same as the Main Chamber Pressure Level command.
Set Propellant Valve Ramp Rate	@064401- 071400 ($6901- 7300)	All RAM	All	-	Implementation of the command code is same as the Main Chamber Pressure Level command.
	@071401- 077740 ($7301- 7FE0)	GCO	All	-	Sets the targeted propellant valve ramp rate to be implemented upon execution of an Open Propellant Valve command (i.e., Open MOV, Open MFV, etc.), 3.2.3:2.3.6.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Shutdown	@116000 ($9C00)	All RAM	All	ENB, SCV	The command will only execute shutdown if the phase is Start Preparation, Start, or Mainstage, 3.2.3:1.5. Implementation of the command will be delayed until Start + 1.50 sec if acceptance occurs between Start + 0.80 sec for the in-control DCU/ Start + 0.76 sec for the standby DCU and Start + 1.48 sec.
Shutdown Enable	@105000 ($8A00)	FLT, FRT-1, FRT-2	All	-	Acceptance of this command is a condition for acceptance of the Shutdown command, 3.2.2:1.3.
Shutdown Pneumatically in FRT-1	@141400 ($C300)	FRT-1	All	FRT	Initiates Pneumatic Shutdown in FRT-1, 3.2.3:2.4.1:1.1.
Simulate Channel A/B Failure	@136400/ 137000 ($BD00/ BE00)	FRT-1	All	FRT, I, T	Simulates DCU A/OE A or DCU B/OE B failure in FRT-1, 3.2.3:2.4.3.
Simulate Out-Of-Limits	@137400 ($BF00)	FRT-1, FRT-2	All	FRT, I, T	Simulates a high HPOT Discharge Temperature condition, 3.2.3:2.4.3:2.
Spark Igniter Checkout	@134400 ($B900)	GCO	CO/SB	I, T	Enters Igniter Checkout mode, 3.2.3:2.3.2.
Start	@100400 ($8100)	All RAM	SP/ER	ENB	Initiates Start phase and terminates Fuel System Purge, 3.2.3:1.3.
Start Enable	@107400 ($8F00)	FLT, FRT-1, FRT-2	SP/P4	CCV, I, LIM	Acceptance of this command is a condition for acceptance of the Start Command. Close Bleed Valves and energize Pogo Precharge Control Valves, Table X Part F, 3.2.3:1.2.6.
			SP/ER	CCV	If any command is voted after the Enable command other than a Start command, the effectivity of the Enable command will be immediately terminated.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Notes 1,2,3,4) (Continued)

VEHICLE COMMAND	COMMAND CODE (OCTAL) (HEX)	MEMORY CONFIG.	OPERATING PHASE/MODE	CONDITIONS FOR REJECTION	FUNCTION
Stop DCU A/B for the in-channel	@111000/ 111400 ($9200/ 9300)	GCO, FRT-1, FRT-2	All	I	DCU A/B performs self-disqualification, 3.2.1:6.1. Acceptance during Checkout is necessary to support the PSE Logic/Redundancy Tests.
		FLT	CO, SP, PSD	I	
		FLT	Start, Main-stage, Shutdown	ST	DCU A/B performs self-disqualification, 3.2.1:6.1. The Stop DCU command indicator is changeable by operational data. The indicator is nominally set to reject the command.
		PROM	PROM/SB	N/A	DCU A/B performs self-disqualification. Accepted by PROM Rev 5 and subsequent versions.
Stop DCU A/B for the cross-channel	@111000/ 111400 ($9200/ 9300)	All RAM	All	-	This command is reported but no other action will be taken. Accepted by PROM Rev 5 and subsequent versions.
		PROM	PROM/SB	N/A	
Switch VRC	@115400 ($9B00)	All RAM	All	VRC	If the source of the VRC data is DCU A, switch the source of the VRC data to DCU B, 3.2.2:2.2.4.
Terminate Sequence	@110000 ($9000)	FLT, FRT-1, FRT-2	CO/SB, SP, PSD/SB, PSD/OD	CR, PS	Terminates sequence by closing all propellant valves, deenergizing all solenoids, deactivating the FRT simulation and at the completion of this mode, Post Shutdown Standby is entered, 3.2.3:1.2.7 and 3.2.3:1.6.1.

NUMBER	NOTES
1	The acceptance criteria are as follows: (a) The voted command code must either match or be within range of one of the RAM Command Codes listed. (b) The current memory configuration must match one of the Memory Configurations listed for the RAM command selected in (a). Where "All RAM" is listed under Memory Configuration, the command is acceptable in all RAM memory configurations.

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Continued)

NUMBER	NOTES
	(c) The current engine phase/mode must match one of the Operating Phase/Modes listed for the RAM command selected in (a). If a phase is listed without a specific mode then the command is acceptable in all modes of the phase. Where "All" is listed under Operating Phase/Mode, the command is acceptable in all RAM phases and modes. (d) The current conditions must not match any of the Conditions for Rejection listed for the RAM command selected in (a).
2	Command Codes not listed and codes listed with no acceptance criteria will be rejected.
3	During Controller Checkout and Igniter Checkout, command interrogation will not occur.
4	The following is a cross reference between the Vehicle Command Code (octal and hex) and the Command:

OCTAL COMMAND	HEX COMMAND	COMMAND DESCRIPTION
000400-064400	0100-6900	Set Propellant Valve Position (@20000($2000)is used by PROM for Terminate Load Word 1)
043400-071400	4700-7300	Main Chamber Pressure Level (MCC Pc)
064401-077740	6901-7FE0	Set Propellant Valve Ramp Rate
100000	8000	Resume
100400	8100	Start
101000	8200	Not used
101400	8300	Used by PROM Rev 5 and subsequent versions for Memory Load A&B
102000	8400	Used by PROM and Block I for Memory Load A
102400	8500	Used by PROM and Block I for Memory Load B
103000	8600	Not used (Used by Block I for Memory Readout Computer 1)
103400	8700	Not used (Used by Block I for Memory Readout Computer 2)
104000	8800	Limit Control Inhibit
104400	8900	Limit Control Enable
105000	8A00	Shutdown Enable
105400	8B00	Purge Sequence 1
106000	8C00	Purge Sequence 2
106400	8D00	Purge Sequence 3
107000	8E00	Purge Sequence 4

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Continued)

NUMBER	NOTES
4	Cross reference continues:

OCTAL COMMAND	HEX COMMAND	COMMAND DESCRIPTION
107400	8F00	Start Enable
110000	9000	Terminate Sequence
110400	9100	Oxidizer Dump
111000	9200	Stop DCU A; also used by PROM Rev 5 and subsequent versions
111400	9300	Stop DCU B; also used by PROM Rev 5 and subsequent versions
112000	9400	No Operation; also used by PROM Rev 5 and subsequent versions
112400	9500	Enter Ground Checkout
113000	9600	Enter Flight
113400	9700	Enter FRT-1
114000	9800	Enter FRT-2
114400	9900	Not used
115000	9A00	Restore VRC
115400	9B00	Switch VRC
116000	9C00	Shutdown
116400	9D00	Checkout Standby
117000	9E00	Used by hardware, PROM, and Block I for Reset Channel A
117400	9F00	Used by hardware, PROM, and Block I for Reset Channel B
120000	A000	Controller Reset (Used by PROM for Terminate Load Word 2)
120400	A100	Open MFV
121000	A200	Open MOV
121400	A300	Open CCV
122000	A400	Open FPOV
122400	A500	Open OPOV
123000	A600	Open Fuel System Purge Control Valve
123400	A700	Open HPOP IMSL Purge Control Valve
124000	A800	Open Bleed Valve Control Valve
124400	A900	Close Emergency Shutdown Control Valve
125000	AA00	Open Pogo Precharge Control Valve
125400	AB00	Deactivate All Valves
126000	AC00	Open Preburner Shutdown Purge Control Valve

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Continued)

NUMBER	NOTES
4	Cross reference continues:

OCTAL COMMAND	HEX COMMAND	COMMAND DESCRIPTION
126400	AD00	Checkout Fuel System Purge Control Valve
127000	AE00	Checkout HPOP IMSL Purge Control Valve
127400	AF00	Checkout Bleed Valve Control Valve
130000	B000	Checkout Emergency Shutdown Control Valve
130400	B100	Checkout Pogo Precharge Control Valve
131000	B200	Checkout Preburner Shutdown Purge Control Valve
131400	B300	Checkout MFV
132000	B400	Checkout MOV
132400	B500	Checkout CCV
133000	B600	Checkout FPOV
133400	B700	Checkout OPOV
134000	B800	Sensor Checkout and Calibration
134400	B900	Spark Igniter Checkout
135000	BA00	Not used (Used by Block I for FASCOS Checkout)
135400	BB00	Controller Checkout (Used by Block I for Engine Redundancy Checkout)
136000	BC00	Activate FRT Simulation (Used by Block I for Enter FRT)
136400	BD00	Simulate Channel A Failure
137000	BE00	Simulate Channel B Failure
137400	BF00	Simulate Out-Of-Limits
140000	C000	Deactivate FRT Simulation (Used by Block I for Exit FRT)
140400	C100	Inhibit Igniters in FRT-1
141000	C200	Hydraulic Conditioning
141400	C300	Shutdown Pneumatically in FRT-1
142000	C400	Energize Group 1 Sensor Checkout Switches
142400	C500	Deenergize Group 1 Sensor Checkout Switches
143000	C600	Energize Group 2 Propellant Drop Sensor Switches
143400	C700	Deenergize Group 2 Propellant Drop Sensor Switches
170400-177776	F100-FFFE	Reserved for PROM (Exceptions: 171421/2, 171441/2, 171461/2, 177400, 177761/2)

Table V
VEHICLE COMMANDS AND ACCEPTANCE CRITERIA (Continued)

NUMBER	NOTES		
4	Cross reference continues:		
	OCTAL COMMAND	HEX COMMAND	COMMAND DESCRIPTION
	171421/2	F311/2	IO Readout Low IE DPM B/A (Also used by PROM)
	171441/2	F321/2	IO Readout High IE DPM B/A (Also used by PROM)
	171461/2	F331/2	IO Readout Input Space B/A (Also used by PROM)
	177400	FF00	Exit PROM (Also used by PROM) (Used by Block I for Exit Special Memory Loader)
	177761/2	FFF1/2	Memory Readout B/A (Also used by PROM)

TABLE VI
STANDARD VEHICLE DATA TABLE (VDT) (Note 1)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE	SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Identification Word No. 1	1				6
Identification Word No. 2	2				7
Engine Status Word	3				
Time Reference	4	0-65535 major cycle counts		20 msec	8
Failure Identification Word	5				9
MCC Pc	6	0-3500 psia	F3	±2% FS	10,12
Fuel Flowrate	7	0-24000 gpm	F0	±1% FS	10,13
Oxidizer Flowrate (Calculated)	8	0-7000 gpm	F2	N/A	13
LPFP Discharge Pressure	9	0-300 psia	F6	±2% FS	10
LPFP Discharge Temperature	10	30-55 R	F9	±2%	10
Preburner Pump Disch Temp Ch A	11	160-230 R	F7	±2%	
HPOT Secondary Seal Cavity Pressure Ch A	12	0-300 psia	F6	±2% FS	
HPOT Secondary Seal Cavity Pressure Ch B	13	0-300 psia	F6	±2% FS	
HPFP Coolant Liner Press Ch A	14	0-4500 psia	F2	±2% FS	
HPFP Coolant Liner Press Ch B	15	0-4500 psia	F2	±2% FS	
HPFT Disch Temp Ch A2/A3	16	150-2450 R	F-4/F-4	±2%	28
HPFT Disch Temp Ch B2/B3	17	150-2450 R	F-4/F-4	±2%	28
HPOT Disch Temp Ch A2/A3	18	150-2450 R	F-4/F-4	±2%	28
HPOT Disch Temp Ch B2/B3	19	150-2450 R	F-4/F-4	±2%	28
HPOP IMSL Purge Pressure Ch A	20	0-600 psia	F5	+2%	
HPOP IMSL Purge Pressure Ch B	21	0-600 psia	F5	+2%	
MCC Pc Ch A	22	0-3500 psia	F3	+2%	10,12
MCC Pc Ch B	23	0-3500 psia	F3	+2%	10,12
MFV Actuator Position	24	0-100 %	F8	+1% FS	21
MOV Actuator Position	25	0-100 %	F8	+1% FS	21
CCV Actuator Position	26	0-100 %	F8	+1% FS	21
FPOV Actuator Position	27	0-100 %	F8	+1% FS	21
OPOV Actuator Position	28	0-100 %	F8	+1% FS	21
HPFP Discharge Pressure	29	0-9500 psia	F1	+2% FS	
HPOP Discharge Pressure	30	0-7000 psia	F2	+2% FS	

TABLE VI

STANDARD VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Fuel Preburner Chamber Press	31	0-7000	psia	F2	+2% FS	
Hydraulic System Pressure Ch B	32	0-4000	psia	F2	+2% FS	
Preburner Pump Discharge Press	33	0-9500	psia	F1	+2% FS	
Fuel Flowrate Sensor A1	34	0-24000	gpm	F0	+1% FS	13
MCC Pc Sensor A2	35	0-3500	psia	F3	+2% FS	12
MCC Pc Sensor A1	36	0-3500	psia	F3	+2% FS	12
Fuel Flowrate	37	0-24000	gpm	F0	±1% FS	10,13, 14
Servovalve Currents MFV/MOV	38	-48 to +48 ma		F1/F1	±2% FS	21,27
MCC Pc	39	0-3500	psia	F3	±2% FS	10,12, 14
MFV Actuator Position	40	0-100	%	F8	±1% FS	14,21
MOV Actuator Position	41	0-100	%	F8	±1% FS	14,21
CCV Actuator Position	42	0-100	%	F8	±1% FS	14,21
FPOV Actuator Position	43	0-100	%	F8	±1% FS	14,21
OPOV Actuator Position	44	0-100	%	F8	±1% FS	14,21
HPFT Disch Temp Ch A2	45	150-2450	R	F3	±2%	
HPFT Disch Temp Ch B2	46	150-2450	R	F3	±2%	
HPOT Disch Temp Ch A2	47	150-2450	R	F3	±2%	
HPOT Disch Temp Ch B2	48	150-2450	R	F3	±2%	
Cold Junction Temperature Ch A	49	140-760	R	F5	±2%	
Fuel Flowrate Sensor A1	50	0-24000	gpm	F0	±1% FS	13,14
MCC Pc Sensor B2	51	0-3500	psia	F3	±2% FS	12
MCC Pc Sensor B1	52	0-3500	psia	F3	±2% FS	12
Fuel System Purge Press Ch A	53	0-600	psia	F5	±2% FS	
Fuel System Purge Press Ch B	54	0-600	psia	F5	±2% FS	
Preburner Pump Disch Temp Ch B	55	160-230	R	F7	±2% FS	
Selectable Entry (Cold Junction Temperature Ch B)	56	140-760	R	F5	±2%	15
Pogo Precharge Pressure Ch A	57	0-1500	psia	F4	±2% FS	
Pogo Precharge Pressure Ch B	58	0-1500	psia	F4	±2% FS	

TABLE VI

STANDARD VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
MOV Hydraulic Temperature Ch A	59	360-760	R	F5	±2%	
MOV Hydraulic Temperature Ch B	60	360-760	R	F5	±2%	
MFV Hydraulic Temperature Ch A	61	360-760	R	F5	±2%	
MFV Hydraulic Temperature Ch B	62	360-760	R	F5	±2%	
Pogo RIV Position/ CCV Servocurrent	63	0-100 %/ -48 to +48 ma		F0/ F1	±3% FS/ ±2% FS	27/ 21
HPFT Disch Temp Ch A3	64	150-2450	R	F3	±2%	
Bleed Valve Positions Oxid/Fuel	65	0-100	%	F0/F0	±3% FS	27
Input Power Bus A	66	0-250	Vac	F7	±3% FS	
Input Power Bus B	67	0-250	Vac	F7	±3% FS	
Antiflood Valve Positions Ch A/B	68	0-100	%	F0/F0	±3% FS	27
HPFT Disch Temp Ch B3	69	150-2450	R	F3	±2%	
LPOP Discharge Pressure Ch A	70	0-600	psia	F5	±2% FS	
LPOP Discharge Pressure Ch B	71	0-600	psia	F5	±2% FS	
Emergency Shutdown Press Ch A	72	0-1500	psia	F4	±2% FS	
Emergency Shutdown Press Ch B	73	0-1500	psia	F4	±2% FS	
FPB S/D Purge Pressure	74	0-1500	psia	F4	±2% FS	
OPB S/D Purge Pressure	75	0-1500	psia	F4	±2% FS	
Oxidizer Tank Pressurant Press	76	0-7000	psia	F2	±2% FS	
MCC Fuel Injection Pressure	77	0-4500	psia	F2	±2% FS	
MCC Coolant Pressure	78	0-7000	psia	F2	±2% FS	
Controller Internal Pressure Ch A or B	79	0-50	psia	F9	±2% FS	16
Controller Internal Temperature Ch A or B	80	140-760	R	F5	±2%	16
MCC Coolant Temperature	81	50-650	R	F3	±2%	
LPFP Shaft Speed	82	0-20000	rpm	F0	±1% FS	17
LPOP Shaft Speed	83	0-6000	rpm	F2	±1% FS	17
Command Controlling MFV	84	0-100	%	F8		
Command Controlling MOV	85	0-100	%	F8		
Command Controlling CCV	86	0-100	%	F8		
Command Controlling FPOV	87	0-100	%	F8		
Command Controlling OPOV	88	0-100	%	F8		
Selectable Entry (Fuel Flowrate Sensor B1)	89	0-24000	gpm	F0	±1% FS	15

TABLE VI
STANDARD VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Selectable Entry (I-response Count)	90	0-65535	counts			8,15
Selectable Entry (Failure Counter)	91	0-65535	counts			8,15
Selectable Entry (LPFP Disch Press Ch A)	92	0-300	psia	F6	±2% FS	15
Selectable Entry (LPFP Disch Temp Ch A)	93	30-55	R	F9	±2% FS	15
Selectable Entry (Pc Ref)	94	0-3500	psia	F3		15,18
Selectable Entry (Mixture Ratio)	95	0-16		F11		15,18
HPFP Shaft Speed Ch A	96	0-45000	rpm	F-1	±1% FS	17
HPFP Shaft Speed Ch B	97	0-45000	rpm	F-1	±1% FS	17
Vehicle Command	98					19
Vehicle Command	99					19
Failure Identification Word (List)	100-102					9
Failure Parameter Value (List)	103-105					9
Selectable Entry (MFV Actuator Position)	106	0-100	%	F8	±1% FS	15,21
Selectable Entry (MOV Actuator Position)	107	0-100	%	F8	±1% FS	15,21
Selectable Entry (CCV Actuator Position)	108	0-100	%	F8	±1% FS	15,21
Selectable Entry (FPOV Actuator Position)	109	0-100	%	F8	±1% FS	15,21
Selectable Entry (OPOV Actuator Position)	110	0-100	%	F8	±1% FS	15,21
Selectable Entry (Input Word 15)	111					15
Selectable Entry (Input Word 16)	112					15
Selectable Entry (Note 23)	113					15,23
Selectable Entry (Fail-Safe Servoswitch Status)	114					15,23

TABLE VI
STANDARD VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Selectable Entry (Calculated C2 Value)	115	0-4.0		F13		15
Selectable Entry (Calculated Kf Value*(1/3*10^6))	116	68-80	gpm/pps	F-10		15,26
Selectable Entry (OPOV Command Upper Limit)	117	0-100	%	F8	±1% FS	15
Selectable Entry (Vibration Channels V1A/V2A)	118	0-20	Grms	F2/F2	±3% FS	15,25
Selectable Entry (Vibration Channels V1B/V2B)	119	0-20	Grms	F2/F2	±3% FS	15,25
Selectable Entry (MCC LOX Dome Temp)	120	110-610	R	F5	±2%	15
Selectable Entry (Vibration Channels V1C/V2C)	121	0-20	Grms	F2/F2	±3% FS	15,25
Selectable Entry (HPOT Disch Temp Ch A3)	122	150-2450	R	F3	±2%	15
Selectable Entry (HPOT Disch Temp Ch B3)	123	150-2450	R	F3	±2%	15
Selectable Entry (Fuel Flowrate Sensor A2)	124	0-24000	gpm	F0	±1% FS	15
Selectable Entry (Fuel Flowrate Sensor B2)	125	0-24000	gpm	F0	±1% FS	15
Selectable Entry (Servovalve Currents OPOV/FPOV)	126	-48 to +48	ma	F1/F1	±2% FS	15,21, 22,27
Selectable Entry (LPFP Disch Press Ch B)	127	0-300	psia	F6	±2% FS	15
Selectable Entry (LPFP Disch Temp Ch B)	128	30-55	R	F9	±2% FS	15

Table VI
STANDARD VEHICLE DATA TABLE (VDT) (Continued)

Notes:

1. Vehicle Data Tables will be transmitted at a rate of 25 VDTs per second. Data transmission may be interrupted for cases specified in paragraph 3.2.2:2.2.2.

2. Parameter sampling for single entry data is within 20 msec of transmission initiation, paragraph 3.2.2:2.2.1. Sampling rate for multi-entry parameters is per paragraph 3.2.2:2.2.1.

3. Order of data transmission is same as data word order in table.

4. Scale factors indicated will represent the data scaling per the following:

   Fk: applies to scaled data. "k" is the location of the binary (fractional) point to the left of the least significant bit (LSB) when the parameter value is expressed in the listed engineering units.

   e.g. F0 = Binary point is at (immediately to the right of) the LSB; The word is an integer.
   F15 = Binary point is at (immediately to the right of) the MSB (i.e., sign bit).

   Scale factor in terms of physical units of controller inputs is as defined in Table XXVIII.

   All VDT words will be represented in two's complement notation except for those which do not have a scale factor.

5. Precisions stated for data are desired values. Final precision values are determined by hardware performance. Ranges of sensors depicted in table are for information only.

Table VI
STANDARD VEHICLE DATA TABLE (VDT) (Continued)

6. BITS DEFINITION

BITS	DEFINITION
15	Most Significant Bit (MSB)
15-5	Of Identification Word 1 may be altered by memory load only.
15-10	6 MSB will have nominal binary code of %101010.
9-7	Vehicle number

Code	Vehicle
% 000	Not Used
% 001	Columbia OV-102
% 010	Challenger OV-099
% 011	Discovery OV-103
% 100	Atlantis OV-104
% 101	Endeavour OV-105
% 110	Single Engine (Default Value)
% 111	Spare

6-5 Engine Position

Code	Position
% 00	Not Used
% 01	Center (Default Value)
% 10	Left
% 11	Right

4 DCU Identifier: 0 for DCU A, 1 for DCU B.

Is loaded as a zero in both DCUs at software load;
In DCU A remains zero after software load;
In DCU B is set to one; See 3.2.1:1.3.

3-0 Memory Configuration (updated by software)

Code	Memory Configuration
% 0000	Not Used
% 0001	FRT-1
% 0011	Ground Checkout
% 0111	FRT-2
% 1001	PROM
% 1010	Reserved
% 1111	Flight
All Others	Not Used

7. Identification Word 2 is the one's complement of Identification Word 1. It is altered per the same requirements as Identification Word 1.

Table VI
STANDARD VEHICLE DATA TABLE (VDT) (Continued)

8. Counts are 16-bit unsigned integers.

9. Failure Identification Word and Failure Parameter values are defined in 3.2.4, Table I, and Table II.

10. These control values are generated per 3.2.3:4.4.2.

11. Deleted

12. MCC Pc Definitions:

VDT Word	Content
6	MCC Pc control value based on valid MCC Pc measurements used during the current VDT major cycle. For computation of Control Parameters, see 3.2.3:4.4.2.
22	Average of the most recent MCC Pc Channel A measurements (independent of qualification).
23	Same as word 22 except Channel B.
35-36	MCC Pc sensor A2 and A1 data values used during the current VDT major cycle.
39	Same as word 6 except for previous (non-VDT) major cycle.
51-52	MCC Pc sensor B2 and B1 data values used during the previous (non-VDT) major cycle.

13. Usable range of flow data will extend from 6% of full scale to 100% of full scale.

14. Data words no. 37, 39-44, and 50 are the same as the previous entries for the parameters of data words no. 7, 6, 24-28, and 34 respectively, i.e., 20 msec older sampling.

15. These selectable entry parameters will be alterable by requirements of 3.2.5:2.

16. Nominal entry is sensor channel A. Channel B is selectable by operational data constant alterable at memory load only. Selection of a channel remains in effect until the operational data constant is updated.

17. Usable range of speed data will extend from 3% of full scale to 100% of full scale.

Table VI

STANDARD VEHICLE DATA TABLE (VDT) (Continued)

18. VDT Words 94 and 95 will be changed during sensor checkout (see Table XXVI, Part B).

19. Data words 98 and 99 are a push-down list for vehicle commands. Commands are entered into data word 98, pushed down by subsequent command to data word 99, then off list. For Memory Readout, data word 98 contains the Starting Address command.

20. Deleted

21. Actuator Definitions:

VDT Word	Content
24-28	Current major cycle data from the in-control servoactuator channel.
40-44	Previous major cycle data from the in-control servoactuator channel.
106-110	Current major cycle data from the servoactuator channel not in control.
38,63, 126	Current major cycle data from the in-control servoactuator channel. If neither servoactuator channel is controlling the actuators, then Channel B values will be reported.

22. The VDT word 126 is used for a selectable entry when Component Checkout is not enabled. During Component Checkout Word 126 is the Checkout Test Step Number, with F0 binary scaling.

23. The following is the format of the VDT words 113 and 114:

WORD	BIT	LOGIC	DATA
113	15	0	OPOV Fail-Op Servoswitch Energized
	14	0	FPOV Fail-Op Servoswitch Energized
	13	0	MOV Fail-Op Servoswitch Energized
	12	0	MFV Fail-Op Servoswitch Energized
	11	0	CCV Fail-Op Servoswitch Energized
	10	0	OE A 2khz Excitation On
	09	0	OE B 2khz Excitation On
	08	0	Halt Exit Enabled/Disabled A
	07	0	Halt Exit Enabled/Disabled B
	06	0	FDR A Recording Enabled
	05	0	FDR B Recording Enabled

Table VI

STANDARD VEHICLE DATA TABLE (VDT) (Continued)

WORD	BIT	LOGIC	DATA
114	15	0	OPOV Fail-Safe Servoswitch A Energized
	14	0	FPOV Fail-Safe Servoswitch A Energized
	13	0	MOV Fail-Safe Servoswitch A Energized
	12	0	MFV Fail-Safe Servoswitch A Energized
	11	0	CCV Fail-Safe Servoswitch A Energized
	10	0	OPOV Fail-Safe Servoswitch B Energized
	09	0	FPOV Fail-Safe Servoswitch B Energized
	08	0	MOV Fail-Safe Servoswitch B Energized
	07	0	MFV Fail-Safe Servoswitch B Energized
	06	0	CCV Fail-Safe Servoswitch B Energized

24. Deleted

25. Two accelerometer channel values are packed into one VDT word. The 8 MSBs of V1 will be placed in the upper byte, while the 8 MSBs of V2 will be placed in the lower byte. When the accelerometer channel values are not packed into a VDT word each value is scaled F10.

26. Kf is synonymous with the calculated C1 Fuel Flowrate scaling coefficient specified in Note 5 of Table XXVII. In order to reduce major cycle processing time, the conversion to gpm/pps is not performed prior to reporting the Kf value in the VDT. The actual full scale range represented in the VDT is from 68 x (1/3 x 10**6) to 80 x (1/3 x 10**6) gpm/pps x counts/sec. The value in VDT word 116 must be divided by 333,333.3333 counts/sec to determine the actual Kf value (gpm/pps).

27. Two sensor values are packed into one VDT word. The 8 MSBs of the first parameter will be placed in the upper byte, while the 8 MSBs of the second parameter will be placed in the lower byte.

28. Two sensor values are packed into one VDT word. Each sensor value is rounded by adding 8 deg R, the sign bit is deleted, and the 8 MSBs of the result are retained. The 8 MSBs of the first parameter will be placed in the upper byte, while the 8 MSBs of the second parameter will be placed in the lower byte.

TABLE VII
ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Identification Word No. 1	1					6
Identification Word No. 2	2					7
Engine Status Word	3					
Time Reference	4	0-65535	major cycle counts		20 msec	8
Failure Identification Word	5					9
MFV S/V Current Ch A	6	-48 to 48	ma	F9	±2% FS	
MOV S/V Current Ch A	7	-48 to 48	ma	F9	±2% FS	
CCV S/V Current Ch A	8	-48 to 48	ma	F9	±2% FS	
FPOV S/V Current Ch A	9	-48 to 48	ma	F9	±2% FS	
OPOV S/V Current Ch A	10	-48 to 48	ma	F9	±2% FS	
MFV S/V Current Ch A (Previous)	11	-48 to 48	ma	F9	±2% FS	
MOV S/V Current Ch A (Previous)	12	-48 to 48	ma	F9	±2% FS	
CCV S/V Current Ch A (Previous)	13	-48 to 48	ma	F9	±2% FS	
FPOV S/V Current Ch A (Previous)	14	-48 to 48	ma	F9	±2% FS	
OPOV S/V Current Ch A (Previous)	15	-48 to 48	ma	F9	±2% FS	
6% Model Check (Opening)	16	-1 to +101	%	F8		
6% Model Check (Closing)	17	-1 to +101	%	F8		
10% Model Check (Opening)	18	-1 to +101	%	F8		
10% Model Check (Closing)	19	-1 to +101	%	F8		
HPOP IMSL Purge Pressure Ch A	20	0-600	psia	F5	±2% FS	
HPOP IMSL Purge Pressure Ch B	21	0-600	psia	F5	±2% FS	
Input Word 15 (Previous)	22					
Fail-Op Servoswitches Status (Previous)	23					11
MFV Actuator Position Ch A	24	0-100	%	F8	±1% FS	
MOV Actuator Position Ch A	25	0-100	%	F8	±1% FS	
CCV Actuator Position Ch A	26	0-100	%	F8	±1% FS	
FPOV Actuator Position Ch A	27	0-100	%	F8	±1% FS	
OPOV Actuator Position Ch A	28	0-100	%	F8	±1% FS	
Input Word 16 (Previous)	29					
Fail-Safe Servoswitches Status (Previous)	30					11

TABLE VII

ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Hydraulic System Pressure Ch B (Previous)	31	0-4000	psia	F2	±2% FS	
Hydraulic System Pressure Ch B	32	0-4000	psia	F2	±2% FS	
MFV S/V Current Ch B	33	-48 to 48	ma	F9	±2% FS	
MOV S/V Current Ch B	34	-48 to 48	ma	F9	±2% FS	
CCV S/V Current Ch B	35	-48 to 48	ma	F9	±2% FS	
FPOV S/V Current Ch B	36	-48 to 48	ma	F9	±2% FS	
OPOV S/V Current Ch B	37	-48 to 48	ma	F9	±2% FS	
Input Word 7	38					
Input Word 7 (Previous)	39					
MFV Actuator Position Ch A (Previous)	40	0-100	%	F8	±1% FS	
MOV Actuator Position Ch A (Previous)	41	0-100	%	F8	±1% FS	
CCV Actuator Position Ch A (Previous)	42	0-100	%	F8	±1% FS	
FPOV Actuator Position Ch A (Previous)	43	0-100	%	F8	±1% FS	
OPOV Actuator Position Ch A (Previous)	44	0-100	%	F8	±1% FS	
MFV Latching D/A Output Ch A	45	0-100	%	F8	±2% FS	
MOV Latching D/A Output Ch A	46	0-100	%	F8	±2% FS	
CCV Latching D/A Output Ch A	47	0-100	%	F8	±2% FS	
FPOV Latching D/A Output Ch A	48	0-100	%	F8	±2% FS	
OPOV Latching D/A Output Ch A	49	0-100	%	F8	±2% FS	
MFV Latching D/A Output Ch A (Previous)	50	0-100	%	F8	±2% FS	
MOV Latching D/A Output Ch A (Previous)	51	0-100	%	F8	±2% FS	
CCV Latching D/A Output Ch A (Previous)	52	0-100	%	F8	±2% FS	
FPOV Latching D/A Output Ch A (Previous)	53	0-100	%	F8	±2% FS	
OPOV Latching D/A Output Ch A (Previous)	54	0-100	%	F8	±2% FS	
RVDT/LVDT Excitation Amplitude Ch B (Previous)	55	0-20	Vpp	F10		
RVDT/LVDT Excitation Amplitude Ch A	56	0-20	Vpp	F10		

TABLE VII
ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Pogo Precharge Pressure Ch A	57	0-1500	psia	F4	±2% FS	
Pogo Precharge Pressure Ch B	58	0-1500	psia	F4	±2% FS	
MOV Hydraulic Temp Ch A	59	360-760	R	F5	±2% FS	
MFV S/V Current Ch B (Previous)	60	-48 to 48	ma	F9	±2% FS	
MFV Hydraulic Temp Ch A	61	360-760	R	F5	±2% FS	
MOV S/V Current Ch B (Previous)	62	-48 to 48	ma	F9	±2% FS	
CCV S/V Current Ch B (Previous)	63	-48 to 48	ma	F9	±2% FS	
FPOV S/V Current Ch B (Previous)	64	-48 to 48	ma	F9	±2% FS	
OPOV S/V Current Ch B (Previous)	65	-48 to 48	ma	F9	±2% FS	
Input Power Bus A	66	0-250	Vac	F7	±3% FS	
Input Power Bus B	67	0-250	Vac	F7	±3% FS	
Actuator Command for Channel Under Test (Previous)	68	-1 to +101	%	F8		
Step Number (Previous)	69	0-35	counts			8
MFV Latching D/A Output Ch B	70	0-100	%	F8	±2% FS	
MOV Latching D/A Output Ch B	71	0-100	%	F8	±2% FS	
Emergency Shutdown Press Ch A	72	0-1500	psia	F4	±2% FS	
Emergency Shutdown Press Ch B (Previous)	73	0-1500	psia	F4	±2% FS	
FPB S/D Purge Pressure	74	0-1500	psia	F4	±2% FS	
OPB S/D Purge Pressure	75	0-1500	psia	F4	±2% FS	
CCV Latching D/A Output Ch B	76	0-100	%	F8	±2% FS	
FPOV Latching D/A Output Ch B	77	0-100	%	F8	±2% FS	
OPOV Latching D/A Output Ch B	78	0-100	%	F8	±2% FS	
MFV Latching D/A Output Ch B (Previous)	79	0-100	%	F8	±2% FS	
MOV Latching D/A Output Ch B (Previous)	80	0-100	%	F8	±2% FS	
CCV Latching D/A Output Ch B (Previous)	81	0-100	%	F8	±2% FS	
FPOV Latching D/A Output Ch B (Previous)	82	0-100	%	F8	±2% FS	
OPOV Latching D/A Output Ch B (Previous)	83	0-100	%	F8	±2% FS	

TABLE VII
ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE	SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Command Controlling MFV	84	-1 to +101 %	F8		
Command Controlling MOV	85	-1 to +101 %	F8		
Command Controlling CCV	86	-1 to +101 %	F8		
Command Controlling FPOV	87	-1 to +101 %	F8		
Command Controlling OPOV	88	-1 to +101 %	F8		
Channel Determination Flag (1 = Ch A)	89	0 or 1			
I-response Count	90	0-65535 counts			8
Failure Counter	91	0-65535 counts			8
MFV Actuator Position Ch B (Previous)	92	0-100 %	F8	±1% FS	
MOV Actuator Position Ch B (Previous)	93	0-100 %	F8	±1% FS	
CCV Actuator Position Ch B (Previous)	94	0-100 %	F8	±1% FS	
FPOV Actuator Position Ch B (Previous)	95	0-100 %	F8	±1% FS	
OPOV Actuator Position Ch B (Previous)	96	0-100 %	F8	±1% FS	
Actuator Command for Channel Under Test	97	-1 to +101 %	F8		
Vehicle Command	98				10
Vehicle Command	99				10
Failure Test No. (List)	100-102				9
Failure Parameter Value (List)	103-105				9
MFV Actuator Position Ch B	106	0-100 %	F8	±1% FS	
MOV Actuator Position Ch B	107	0-100 %	F8	±1% FS	
CCV Actuator Position Ch B	108	0-100 %	F8	±1% FS	
FPOV Actuator Position Ch B	109	0-100 %	F8	±1% FS	
OPOV Actuator Position Ch B	110	0-100 %	F8	±1% FS	
Input Word 15	111				
Input Word 16	112				
Fail-Op Servoswitch Status	113				11
Fail-Safe Servoswitch Status	114				11

TABLE VII
ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

DATA (Note 2)	DATA WORD (Note 3)	FULL SCALE RANGE		SCALE FACTOR (Note 4)	PRECISION OF DATA (Note 5)	NOTES
Ch A Fail-Safe Lockup Delta Position (Opening)	115	0-100	%	F8	±1% FS	
Ch A Fail-Safe Lockup Delta Position (Closing)	116	0-100	%	F8	±1% FS	
Fail-Op Switchover Delta Position	117	0-100	%	F8	±1% FS	
OE +29 Voltage Ch A	118	0-34.3	Vdc	F9	±3% FS	
OE +24 Voltage Ch B	119	0-34.3	Vdc	F9	±3% FS	
Ch B Fail-Safe Lockup Delta Position (Opening)	120	0-100	%	F8	±1% FS	
Ch B Fail-Safe Lockup Delta Position (Closing)	121	0-100	%	F8	±1% FS	
Current Command minus Current Latching D/A	122	-2 to 2	%	F8	±1% FS	12
Previous Command minus Previous Latching D/A	123	-2 to 2	%	F8	±1% FS	12
Previous Command minus Current Position	124	-100 to 100	%	F8	±1% FS	12
Previous Command minus Current Position (Previous)	125	-100 to 100	%	F8	±1% FS	12
Step Number	126	0-35	counts			8
Stop Check (Full Open)	127	-1 to +101	%	F8	±1% FS	
Stop Check (Full Closed)	128	-1 to +101	%	F8	±1% FS	

TABLE VII

ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

Notes:

1. Vehicle Data Tables will be transmitted at a rate of 25 VDTs per second. Data transmission may be interrupted for cases specified in paragraph 3.2.2:2.2.2.

2. Parameter sampling for single entry data is within 20 msec of transmission initiation, paragraph 3.2.2:2.2.1. Sampling rate for multi-entry parameters is per paragraph 3.2.2:2.2.1.

3. Order of data transmission is same as data word order in table.

4. Scale factors indicated will represent the data scaling per the following:

   Fk: applies to scaled data. "k" is the location of the binary (fractional) point to the left of the least significant bit (LSB) when the parameter value is expressed in the listed engineering units.

   e.g. F0 = Binary point is at (immediately to the right of) the LSB; The word is an integer.
   F15 = Binary point is at (immediately to the right of) the MSB (i.e., sign bit).

   Scale factor in terms of physical units of controller inputs is as defined in Table XXVIII.

   All VDT words will be represented in two's complement notation except for those which do not have a scale factor.

5. Precisions stated for data are desired values. Final precision values are determined by hardware performance. Ranges of sensors depicted in table are for information only.

TABLE VII
ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

6. Bits 15-5 (MSB=15) Of Identification Word 1 may be altered by memory load only.

Bits 15-10 (MSB=15) 6 MSB will have nominal binary code of %101010.

Bits 9-7 (MSB=15) Vehicle number

Code	Vehicle
% 000	Not Used
% 001	Columbia OV-102
% 010	Challenger OV-099
% 011	Discovery OV-103
% 100	Atlantis OV-104
% 101	Endeavour OV-105
% 110	Single Engine (Default Value)
% 111	Spare

Bits 6-5 (MSB=15) Engine Position.

Code	Position
% 00	Not Used
% 01	Center (Default Value)
% 10	Left
% 11	Right

Bit 4 (MSB=15) Is loaded as a zero in both DCUs at software load;
In DCU A remains zero after software load;
In DCU B is set to one;
See 3.2.1:1.3.

Bits 3-0 (MSB=15) Memory Configuration (updated by software)

Code	Memory Configuration
% 0000	Not Used
% 0001	FRT-1
% 0011	Ground Checkout
% 0111	FRT-2
% 1001	PROM
% 1010	Reserved
% 1111	Flight
All others	Not Used

TABLE VII

ACTUATOR CHECKOUT VEHICLE DATA TABLE (VDT) (Note 1) (Continued)

7. Identification Word 2 is the one's complement of Identification Word 1. It is altered per the same requirements as Identification Word 1.

8. Counts are 16-bit unsigned integers.

9. Failure Identification Word and Failure Parameter values are defined in 3.2.4, Table I, and Table XXIV.

10. Data words 98 and 99 are a push-down list for vehicle commands. The first command is entered into data word 98, pushed down by a subsequent command to data word 99, then off list. For Memory Readout, data word 98 contains the Starting Address command.

11. The following is the format of the VDT words 23, 30, 113, and 114:

DATA WORD	BIT	LOGIC	DATA
23 & 113	15	0	OPOV Fail-Op Servoswitch Energized
	14	0	FPOV Fail-Op Servoswitch Energized
	13	0	MOV Fail-Op Servoswitch Energized
	12	0	MFV Fail-Op Servoswitch Energized
	11	0	CCV Fail-Op Servoswitch Energized
	10	0	OE A 2khz Excitation On
	09	0	OE B 2khz Excitation On
	08	0	Halt Exit Enabled/Disabled A
	07	0	Halt Exit Enabled/Disabled B
	06	0	FDR A Recording Enabled
	05	0	FDR B Recording Enabled
30 & 114	15	0	OPOV Fail-Safe Servoswitch A Energized
	14	0	FPOV Fail-Safe Servoswitch A Energized
	13	0	MOV Fail-Safe Servoswitch A Energized
	12	0	MFV Fail-Safe Servoswitch A Energized
	11	0	CCV Fail-Safe Servoswitch A Energized
	10	0	OPOV Fail-Safe Servoswitch B Energized
	09	0	FPOV Fail-Safe Servoswitch B Energized
	08	0	MOV Fail-Safe Servoswitch B Energized
	07	0	MFV Fail-Safe Servoswitch B Energized
	06	0	CCV Fail-Safe Servoswitch B Energized

12. VDT words 122-125 will be continuously updated throughout Actuator Checkout as applicable to the actuator channel in control.

Table VIII
ENGINE STATUS WORD (ESW)

BITS	DEFINITION	COMMENTS
15	Load Mode	0 = Not in Load Mode. 1 = Load Mode (Only used by PROM)
14-13	Command Status of last command received since last VDT transmission per Table III.	0 = No command received since last VDT transmission, or voted command is the same as the last voted command. 1 = Command failed voting. 2 = Command voted but rejected, incompatible with phase/mode or invalid code. 3 = Command accepted.
12	Command Channel 3 (Ch C) Status, per Table III.	0 = OK, 1 = Failed
11	Command Channel 2 (Ch B) Status, per Table III.	0 = OK, 1 = Failed
10	Command Channel 1 (Ch A) Status, per Table III.	0 = OK, 1 = Failed
09	FRT Status	0 = Normal Operation, 1 = FRT Mode
08	Limit Control Status	0 = Inhibited, 1 = Enabled
07-05	Phase	0 is not used, 1 for Checkout, 2 for Start Preparation, 3 for Start, 4 for Mainstage, 5 for Shutdown, 6 for Post Shutdown, 7 Reserved for PROM.
04-02	Mode	Depends on Phase as shown on next page.
01-00	Self-Test Status	0 Not Used 1 = Engine OK 2 = Major Component Failed 3 = Shutdown Limit Exceeded

Table VIII

ENGINE STATUS WORD (ESW) (Continued)

MODE (BITS 4-2) BY PHASE

PHASE	MODE DEFINITION	
Checkout	0 = Hydraulic Conditioning	1 = Standby,
	2 = Actuator Checkout,	3 = Engine Leak Detection,
	4 = Igniter Checkout,	5 = Pneumatic Checkout,
	6 = Sensor Checkout,	7 = Controller Checkout.
Start Prep.	0 Not Used,	1 = Purge Sequence 1,
	2 = Purge Sequence 2,	3 = Purge Sequence 3,
	4 = Purge Sequence 4,	5 Not Used,
	6 = Engine Ready,	7 Not Used.
Start	0 Not Used,	1 = Start Initiation,
	2 = Thrust Buildup,	3 Not Used,
	4 Not Used,	5 = Fixed Density,
	6 Not Used,	7 Not Used.
Main-stage	0 Not Used,	1 = Normal Control,
	2 = Thrust Limiting,	3 = Electrical Lockup,
	4 = Hydraulic Lockup,	5 = Fixed Density,
	6 Not Used,	7 Not Used.
Shutdown	0 Not Used,	1 Not Used
	2 = Throttling to zero,	3 = Propellant Valves Closed,
	4 = Fail-Safe Pneumatic,	5 Not Used,
	6 Not Used,	7 Not Used.
Post Shutdown	0 Not Used,	1 = Standby,
	2 = Oxidizer Dump,	3 Not Used,
	4 Not Used,	5 Not Used,
	6 Not Used,	7 = Terminate Sequence.
PROM	0 Not Used,	1 = Standby,
	2 Not Used,	3 Not Used,
	4 Not Used	5 Not Used,
	6 Not Used,	7 Not Used.

Table IX
ENGINE CONTROL MODE DEFINITION

CHECKOUT	START PREPARATION	START
<u>STANDBY</u> A waiting mode of controller operation during which active engine control sequence operations are not in progress. Monitoring functions which do not affect engine hardware configuration are continually active during this mode. Such functions include processing of vehicle commands, status update, and controller Self-Test.	<u>PURGE SEQUENCE NO. 1</u> First purge sequence of the Start Preparation phase. Functions include Oxidizer System Purge and ISP operation. <u>PURGE SEQUENCE NO. 2</u> Second purge sequence of Start Preparation phase. Functions include Fuel System Purge Operation. <u>PURGE SEQUENCE NO. 3</u> Third purge sequence of Start Preparation phase. Functions include propellant recirculation.	<u>START INITIATION</u> Initial functions associated with the Start Sequences are in progress. These include all functions prior to ignition confirmed. <u>THRUST BUILDUP</u> Ignition has been detected, the MCC Pc control loop has been closed, and MCC Pc pressure is building up. <u>FIXED DENSITY</u> A constant fuel density is used in fuel flowrate computations.
<u>ACTUATOR CHECKOUT</u> Actuators are being tested.	<u>PURGE SEQUENCE NO. 4</u> Fourth purge sequence of Start Preparation phase. Functions include Fuel System Purge after propellant drop and activation of Fail-Safe valves.	
<u>ENGINE LEAK DETECTION</u> Actuators are commanded opened and closed in support of Test/Flight facility operations.		

TABLE IX
ENGINE CONTROL MODE DEFINITION (Continued)

CHECKOUT	START PREPARATION	START
IGNITER CHECKOUT Igniters are being tested. Normal major cycle processing is suspended. PNEUMATIC CHECKOUT Pneumatic valves are being tested. SENSOR CHECKOUT Sensors are being tested and selected pressure sensors are calibrated. CONTROLLER CHECKOUT Controller components are being tested. Normal major cycle processing is suspended. HYDRAULIC CONDITIONING Exercises the hydraulic system and servoactuators.	ENGINE READY The ready stage of Start Preparation in which proper engine pressure/temperature conditions for Start have been attained and other criteria for Start have been satis-fied. Functions include a continuation of Purge Sequence No. 4 functions.	

TABLE IX
ENGINE CONTROL MODE DEFINITION (Continued)

MAINSTAGE	SHUTDOWN	POST SHUTDOWN
<u>NORMAL CONTROL</u> Mixture ratio control has been initiated. MCC Pc Pressure control is operating normally.		<u>STANDBY</u> A waiting mode of controller operation with functions identical to those of Checkout Standby (with conditional exception of Bleed Valve as specified in 3.2.3:1.6).
<u>ELECTRICAL LOCKUP</u> Engine propellant valves are electrically held in a fixed configuration as exists at initiation of this mode. All control loop computations are suspended. Shutdown Limit monitoring and actuator monitoring are maintained.	<u>THROTTLING TO ZERO THRUST</u> Shutdown is at a stage where open-loop valve reference scheduling is in progress.	This is the normal mode of Post-Shutdown entered after completion of the Shutdown phase.

TABLE IX
ENGINE CONTROL MODE DEFINITION (Continued)

MAINSTAGE	SHUTDOWN	POST SHUTDOWN
<u>HYDRAULIC LOCKUP</u> All Fail-safe servoswitches are deenergized to hydraulically hold the propellant valves in a fixed configuration as exists at initiation of this mode. Engine Limit monitoring and sensor monitoring are maintained. All control loop computations are suspended. <u>THRUST LIMITING</u> Mode initiated whenever OPOV position command is limited for at least 3 consecutive major cycles. Control loop computations, Shutdown Limit Monitoring, and sensor monitoring are retained. <u>FIXED DENSITY</u> A constant fuel density is used in fuel flowrate computations.	<u>PROPELLANT VALVES CLOSED</u> The shutdown sequence is in the stage following closure of all liquid propellant valves. Shutdown purge and safety sequences are in progress. <u>FAIL-SAFE PNEUMATIC</u> Fail-Safe pneumatic shutdown is in progress.	<u>OXIDIZER DUMP</u> The Oxidizer Dump sequence is being performed. <u>TERMINATE SEQUENCE</u> Termination of a purge or dump sequence by command from the VEEI is in progress. All valves are being closed. All solenoids and servoswitches are then being deenergized.

TABLE X

START PREPARATION SEQUENCE AND FUNCTIONS

STEP

- Only controlling functions are shown in this table as numbered steps. Monitoring functions keyed to time are shown under REMARKS.

OPERATION

- Functions are initiated at the times indicated and maintained until changed by subsequent steps for that function.
- When a ramp is initiated, the first increment of the ramp is executed at the listed time.
- Units for valve commands in this table, such as "Ramp CCV to 100% at 100%/sec", are the goal position in percent of full open actuator position, and the ramp rate in percent actuator position per second.
- ON/OFF device steps apply to both channels A and B, unless otherwise specified.

TIME

- Values shown give the required times in seconds from the first major cycle of the specific mode. Each time applies to subsequent steps until another time is indicated.

REMARKS

- Monitoring functions are shown in this table in the appropriate relative time sequences. Full requirements for these functions are given in the indicated paragraphs or tables.

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART A	PURGE SEQUENCE NO. 1		
1	Update Engine Status Word to Start Preparation Phase and Purge Sequence No. 1 Mode.	0	Begin Start Preparation Phase
2	Reset Time Reference to Zero.	-	Same VDT update as Step 1
3	Deenergize Bleed Valve solenoids, Channels A and B.	-	
4	Deenergize Fuel System Purge solenoids, Channels A and B.	-	
5	Deenergize Pogo Precharge solenoids, Channels A and B.	-	
6	Deenergize Preburner Shutdown Purge solenoids, Channels A and B.	-	
7	Deenergize HPOP IMSL Purge solenoids, Channels A and B.	-	
8	Deenergize Emergency Shutdown solenoids, Channels A and B.	-	
9	Deenergize all igniters.	-	
10	Command MOV, MFV, OPOV, FPOV, and CCV closed at 150%/sec.	-	
11	Deenergize all fail-safe servoswitches.	-	
12	Initiate sensor qualification for HPOT Discharge Temperature, HPOP IMSL Purge Pressure, HPOT Secondary Seal Cavity Pressure, HPFP Coolant Liner Pressure, and HPFT Discharge Temperature.	-	See Table XVII for Start Prep limits

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART B - PURGE SEQUENCE NO. 2			
1	Update Engine Status Word to Start Preparation Phase and Purge Sequence 2 Mode.	0	
2	Energize Fuel System Purge solenoids, Channels A and B.	-	
3	Deenergize Bleed Valve solenoids, Channels A and B.	-	
4	Deenergize Pogo Precharge solenoids, Channels A and B.	-	
5	Deenergize Preburner Shutdown Purge solenoids, Channels A and B.	-	
6	Deenergize HPOP IMSL Purge solenoids, Channels A and B.	-	
7	Deenergize Emergency Shutdown solenoids, Channels A and B.	-	
8	Deenergize all igniters.	-	
9	Command MOV, MFV, OPOV, FPOV and CCV closed at 150%/sec.	-	
10	Deenergize all fail-safe servoswitches	-	

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART C - PURGE SEQUENCE NO. 3			
1	Update Engine Status Word to Start Preparation Phase and Purge Sequence 3 mode.	0	
2	Energize Bleed valve solenoids, Channels A and B.	-	
3	Energize Fuel System Purge solenoids, Channels A and B.	-	
4	Deenergize Pogo Precharge solenoids, Channels A and B.	-	
5	Deenergize Preburner Shutdown Purge solenoids, Channels A and B.	-	
6	Energize HPOP IMSL Purge solenoids, Channels A and B.	-	
7	Deenergize Emergency Shutdown solenoids, Channels A and B.	-	
8	Deenergize all igniters	-	
9	Ramp CCV closed at 150%/sec	-	See Note 1
10	Command MOV, MFV, OPOV, FPOV closed.	-	
11	Begin accumulation of 128 point actuator position averages per 3.2.3:6.1.7.	0.02	If fail-safes are deenergized, an accurate average requires 2.56 seconds (minimum) to complete. If fail-safes are energized, an accurate average requires 5.12 seconds (minimum) to complete.

TABLE X

START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART C - PURGE SEQUENCE NO. 3 (Continued)			
12	Deenergize all Fail-safe servoswitches.	1.0	
13	Deenergize Fuel System Purge solenoids, Channels A and B.	10.0	
14	Deenergize HPOP IMSL Purge solenoids, Channels A and B.	-	
15	Energize Fuel System Purge solenoids, Channels A and B. Begin Actuator Exercise Sequence.	57.0 min	Energize Fuel System Purge solenoids and conditionally perform the Actuator Exercise Sequence (3.2.3:6.1.6) for 3 minutes of each 60 minute period in Purge Sequence 3
16	Deenergize Fuel System Purge solenoids, Channels A and B. Discontinue Actuator Exercise Sequence.	60.0 min	

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART D - PURGE SEQUENCE NO. 4			
1	Update Engine Status Word to Start Preparation Phase and Purge Sequence 4 mode.	0	
2	Energize Fuel System Purge solenoids, Channels A and B.	-	
3	Energize Emergency Shutdown solenoids, Channels A and B.	-	
4	Energize HPOP IMSL Purge solenoids, Channels A and B.	-	
5	Energize Bleed Valve solenoids, Channels A and B.	-	
6	Deenergize Pogo Precharge solenoids, Channels A and B.	-	
7	Deenergize Preburner Shutdown Purge solenoids, Channels A and B.	-	
8	Deenergize all igniters.	-	
9	Ramp CCV closed at 150%/sec.	-	See Note 1
10	Command MOV, MFV, OPOV, and FPOV closed.	-	
11	Energize actuator fail-safe servoswitches.	0.02	
12	Ramp CCV to 100% open at 100%/sec.	10.0	

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
13	Verify conditions for Engine Ready per 3.2.3:1.2.5 and 3.2.3:5.1. Change Engine Status Word to indicate Engine Ready mode when and if applicable.	-	Verification starts at time indicated and proceeds per requirements indicated.
14	Perform Actuator Settling Check per 3.2.3:6.1.7.	10.04	This check requires 7.68 seconds (maximum) to complete.

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART E - ENGINE READY MODE PRIOR TO START ENABLE			
1	Continue Engine Ready Monitoring.	--	
PART F - ENGINE READY MODE WITH START ENABLE IN EFFECT			
1	Terminate Engine Ready Monitoring.	0	
2	Deenergize Bleed Valve solenoids, Channels A and B.	--	
3	Energize Pogo Precharge solenoids, Channels A and B.	--	
4	Suspend Purge and Ancillary monitoring of Antiflood Valve Position, HPOP IMSL Purge Pressure, MFV/MOV Hydraulic Temperatures, and Fuel System Purge Pressure (3.2.3:6.4).	--	
-		--	Sensor Qualification Monitoring concludes for: * Fuel Flowrate (reasonableness) (Table XVII)
5	Deenergize Pogo Precharge solenoids Channels A and B.	0.44	
6	Resume all Purge and Ancillary monitoring suspended in Step 4.	1.0	

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART G - ENGINE READY MODE WITH START ENABLE TERMINATED			
1	Maintain Engine Ready mode and suspend Engine Ready monitoring (3.2.3:5.1).	0	
2	Energize Bleed Valve solenoids, Channels A and B.	--	
3	Deenergize Pogo Precharge solenoids, Channels A and B.	--	
4	Suspend Purge and Ancillary System parameters (3.2.3:6.4).	--	
-		--	Sensor Qualification Monitoring begins for: * Fuel Flowrate (reasonableness) (Table XVII)
5	Resume Purge and Ancillary monitoring suspended in Step 4.	5.0	
6	Resume Engine Ready Monitoring suspended in Step 1.	--	

TABLE X
START PREPARATION SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
PART H - PURGE SEQUENCE 4 ROLLBACK			
1	Update Engine Status Word to Start Preparation Phase and Purge Sequence 4 mode.	0	
2	Energize Bleed Valve solenoids, Channels A and B.	--	
3	Deenergize Pogo Precharge solenoids, Channels A and B.	--	
4	Verify conditions for Engine Ready per 3.2.3:1.2.5 and 3.2.3:5.1. Change Engine Status Word to indicate Engine Ready mode when and if applicable.	--	
-		--	Sensor Qualification Monitoring begins for: * Fuel Flowrate (reasonableness) (Table XVII)
5	Resume all Purge and Ancillary monitoring suspended in Part F, Step 4 or Part G, Step 4 upon completion of the delay.	T2	T2 is defined to be the first time Purge and Ancillary monitoring is resumed.

NOTES:

1. For Information Only -

   The requirement to energize fail-safe servoswitches in Purge Sequences 1, 2, 3, and 4 before closing CCV is unnecessary. Depending on the previous Purge Sequence, the CCV will already be closed (Purge Sequences 1, 2, and 3) or else the fail-safes will already be energized (Purge Sequence 4).

TABLE XI
START SEQUENCE AND FUNCTIONS

STEP

- Only controlling functions are shown in this table as numbered steps. Monitoring functions keyed to time are shown under REMARKS.

OPERATION

- Functions are initiated at the times indicated and maintained until changed by subsequent steps for that function.
- When a ramp is initiated, the first increment of the ramp is executed at the listed time.
- When closed-loop control is in effect, the indicated ramp rates apply to the total computed valve command, including control loop inputs.
- Units for valve commands in this table, such as "Ramp MOV to 100% at 200%/sec", are the goal position in percent of full open actuator position, and the ramp rate in percent actuator position per second.
- ON/OFF device steps apply to both channels A and B, unless otherwise specified.
- MOV position commands will be dynamically compensated per the Laplace transform function of Figure 10.

TIME

- Values shown give the required times in seconds from the first major cycle of the Start phase. Each time applies to subsequent steps until another time is indicated.

REMARKS

- Monitoring functions are shown in this table in the appropriate relative time sequences. Full requirements for these functions are given in the indicated paragraphs or tables.
- "Concludes" indicates the last major cycle in which a monitor is performed.
- "Discontinued" indicates the first major cycle in which a monitor is no longer performed.

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
			Initial conditions of the servoactuators (propellant valves) and the solenoids (pneumatic valves) assumed per ending of Start Prep phase. (Table X)
Start Initiation:			
1	Set Engine Status Word to Start phase, Start Initiation mode.	0.0	First major cycle of Start phase.
2	Set Time Reference to 0.	-	
3	Set Pc Ref to 731 psia.	-	Initializes MCC Pressure Reference
4	Energize all igniters.	-	
5	Deenergize Fuel System Purge Control Valve solenoid	-	
6	Ramp MFV command to 100% at 150%/sec.	-	Initial MFV command (MFST of Figure 10). Establishes fuel flow.
7	Set CCV command to 100% and ramp rate to 100%/sec.	-	Maintains CCV command (CCST of Figure 10) from previous phase. (Table X Part D)
8	Set FPOV command limit to 56.1%.	-	
9	Set OPOV command limit to 70%. For FRT1 or FRT2, set OPOV command limit to 100%.	-	If FRT1 or FRT2, OPOV command limit remains 100% throughout Start and Mainstage.

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
-		-	Sensor Qualification Monitoring continues from previous phase for: * MCC Pr (intra-ch compare) * HPOP IMSL Purge Pr * HPOT Sec Seal Cav Pr (Table XVII)
-		-	Sensor Qualification Monitoring begins for: * Preburner S/D Purge Pr's (Table XVII)
-		-	Shutdown Limit Monitoring begins for: * HPOP IMSL Purge Pr * HPOT Sec Seal Cav Pr * Preburner S/D Purge Pr's (Table XX)
10	Ramp MOV command to 59.3% at 60%/sec.	0.10	Initial MOV command (MOST of Figure 10). Establishes main chamber oxidizer flow.
11	Ramp FPOV command to 30% at 200%/sec.	-	Initial FPOV command (FPST of Figure 9). Establishes oxidizer flow to fuel preburner.
12	Ramp OPOV command to 30% at 200%/sec.	0.12	Initial OPOV command (OPST of Figure 8). Establishes oxidizer flow to oxidizer preburner.
13	Ramp FPOV command to 56.1% at 200%/sec.	0.26	FPOV open loop command.

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
14	Ramp OPOV command to 48% at 20%/sec.	0.28	OPOV open loop command.
15	Ramp FPOV command to 47% at 200%/sec.	0.68	FPOV first notch level.
16	Initiate closed-loop MCC Pc control (proportional error control only); set gain to 0.01444%/psi.	0.74	See Figure 8.
17	Ramp Pc Ref to 406 psia at 400 psi/sec.	-	
18	Set FPOV ramp rate to 100%/sec.	-	Ramp rate will apply to the total computed valve command including control loop output.
19	Set OPOV ramp rate to 100%/sec.	-	Ramp rate will apply to the total computed valve command including control loop output.
20	Set FPOV crossfeed gain to 0.4596%/% and ramp to 1.15%/% at 0.5676%/%/sec.	0.80	
21	Ramp FPOV command to 51.5% at 200%/sec.	0.88	FPOV first notch return level.
22	Ramp OPOV command to 38.5% at 200%/sec.	1.10	OPOV notch level.
23	Ramp FPOV command to 49% at 200%/sec.	1.16	FPOV second notch level.
-		1.24	Ignition Confirmation check begins for: * HPFP Shaft Speed (PRC Self-Test) (Sensor Qualification) (Tables XVII and XIX)

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
-		1.28	Ignition Confirmation check concludes for: * HPFP Shaft speed (PRC Self-Test) (Sensor Qualification) (Tables XVII and XIX)
24	Ramp CCV command to 70% at 100%/sec.	1.46	CCV first ramp level.
25	Ramp OPOV command to 38.5% at 200%/sec.	1.50	OPOV notch first return level. (Same as OPOV notch level.)
26	Ramp FPOV command to 54.6% at 200%/sec.	1.68	FPOV second notch return level.
-		1.70	Ignition Confirmation check begins for: * MCC Pressure (Table XIX)
-		1.74	Ignition Confirmation check concludes for: * MCC Pressure (Table XIX)
27	Ramp OPOV command to 48.5% at 200%/sec.	2.10	OPOV notch second return level.
-		-	Sensor Qualification Monitoring begins for: * MCC Pr (Pc Ref compare) (Table XVII)

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
28	Set FPOV command limit to 102%.	2.30	Sensor Qualification Monitoring begins for: * HPOT Discharge Temp (Table XVII)
-		-	Ignition Confirmation checks begin for: * Antiflood Valve * MCC Pressure (Table XIX)
-		-	Shutdown Limit Monitoring begins for: * HPOT Discharge Temp * HPOT Discharge Temp Blueline (Table XX)
-		2.34	Ignition Confirmation checks conclude for: * Antiflood Valve * MCC Pressure (Table XIX)
29	Switch to Mainstage gain value of 0.01130%/psia for proportional error control and initiate integral error control for MCC Pc control loop. Initial value of integrator = 0.	2.40	See Figure 8.
30	Step Pc Ref to 737 psia.	-	
31	Energize Pogo Precharge Control Valve solenoid.	-	
32	Ramp MOV command to 100% at 31.5%/sec.	-	
33	Ramp CCV command to 52% at 45%/sec.	-	

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
34	Ramp FPOV command to 56.85% at 100%/sec.	-	FPOV position @ thrust buildup. Ramp rate applies to the total computed valve command including control loop output.
35	Ramp OPOV command to 49.1% at 100%/sec.	-	OPOV position @ thrust buildup. Ramp rate applies to the total computed valve command including control loop output.
		-	Sensor Qualification Monitoring concludes for: * MCC Pressure (Pc Ref comparison) (Table XVII)
Thrust Buildup:			
36	Set Engine Status Word to indicate Thrust Buildup mode.	2.42	Start Thrust Buildup
37	Ramp Pc Ref to commanded level at 1723 psi/sec.	-	
		-	Sensor Qualification Monitoring begins for: * MCC Pressure (Pc Ref band test) (Table XVII)
38	Initiate scheduled operation of the CCV as a function of Pc Ref.	2.80	See Figure 10. (CCV is stepped in response to Pc Reference.)

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
		3.50	Sensor Qualification Monitoring begins for: * Fuel Flowrate * LPFP Discharge Pr * LPFP Discharge Temp (Table XVII)
39	Initiate closed loop mixture ratio control. Initial value of integrator is zero.	3.60	Closed loop control includes both proportional and integral control.
40	Initialize OPOV Delta Power Level to 9.65517%.	-	See Thrust Limiting, 3.2.3:1.7.3.
41	Initiate OPOV command limiting as a function of Pc Reference.	-	See Thrust Limiting, 3.2.3:1.7.3.
-		4.16	Shutdown Limit Monitoring concludes for: * Preburner S/D Purge Pr's (Table XX)
-		-	Sensor Qualification Monitoring concludes for: * Preburner S/D Purge Pr's (Table XVII)
42	Deenergize Pogo Precharge Control Valve solenoid.	4.40	
43	Deenergize all igniters.	-	
44	Perform Pogo GOX Flow Check.	4.94	Pogo GOX Flow Check begins for: * Pogo Precharge Pr (Tables XVII and XIX)

TABLE XI
START SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
45	Set the OPOV schedule command (OPST of Figure 8) and FPOV schedule command (FPST of Figure 9) to zero.	4.98	Start to Mainstage transition.
	Set crossfeed gain schedule for Mainstage phase.	-	See Figure 9.
	Reinitialize the control loop integrators so that the OPOV and FPOV commands remain unchanged by reinitialization.		
		-	Pogo GOX Flow Check concludes for: * Pogo Precharge Pr (Tables XVII and XIX)
46	Set Pc Ref ramp rate limit to 300 psi/sec.	-	This rate applies to Pc Ref ramping throughout Mainstage. See Figure 8 note 3.
47	Set FPOV ramp rate to 200%/sec.	-	This applies to FPOV ramping throughout Mainstage.
48	Set OPOV ramp rate to 200%/sec.	-	This applies to OPOV ramping throughout Mainstage.
		-	Sensor Qualification Monitoring concludes for: * MCC Pressure (Pc Ref band test) (Table XVII)

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TABLE XII
MAINSTAGE SEQUENCE AND FUNCTIONS

STEP
- Only controlling functions are shown in this table as numbered steps. Monitoring functions keyed to time are shown under REMARKS.

OPERATION
- Functions are initiated at the times indicated and maintained until changed by subsequent steps for that function.
- When a ramp is initiated, the first increment of the ramp is executed at the listed time.
- When closed-loop control is in effect, the indicated ramp rates apply to the total computed valve command, including control loop inputs.
- Units for valve commands in this table, such as "Ramp MOV to 100% at 200%/sec", are the goal position in percent of full open actuator position, and the ramp rate in percent actuator position per second.
- ON/OFF device steps apply to both channels A and B, unless otherwise specified.
- MOV position commands will be dynamically compensated per the Laplace transform function of Figure 10.

TIME
- Values shown in Mainstage are a continuation from the Start phase time values and give the required time in seconds from the first major cycle of the Start phase. Each time applies to subsequent steps until another time is indicated.

REMARKS
- Monitoring functions are shown in this table in the appropriate relative time sequences. Full requirements for these functions are given in the indicated paragraphs or tables.
- "Concludes" indicates the last major cycle in which a monitor is performed.
- "Discontinued" indicates the first major cycle in which a monitor is no longer performed.

TABLE XII
MAINSTAGE SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM ENGINE START (SECONDS)	REMARKS
			Initial conditions of the servoactuators (propellant valves) and the solenoids (pneumatic valves) are assumed per ending status of the Start phase.
Normal Control:			
1	Set Engine Status Word to Mainstage phase, Normal Control mode; unless Fixed Density mode is in effect.	5.0	First major cycle of Mainstage phase.
2	Not Used.	-	
		-	Sensor Qualification Monitoring begins for: * MCC Pressure (Pc Ref "delta" test) (Table XVII)
3	Begin OPOV position monitor for OPOV Delta Power Level calculation.	5.02	See Thrust Limiting, 3.2.3:1.7.3.
		5.04	Sensor Qualification Monitoring begins for: * MCC Pc * HPFT Discharge Temp * HPFP Coolant Liner Pr * HPFP Vibration * HPOP Vibration (Table XVII)

TABLE XII
MAINSTAGE SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM ENGINE START (SECONDS)	REMARKS
		-	Calculate HPFP Coolant Liner Pr redline each major cycle as a function of MCC Pc. (Table XX note 1)
		-	Shutdown Limit and FASCOS Monitoring begins for: * MCC Pc (Intra-Channel) (Reasonableness) * HPFT Discharge Temp * HPFP Coolant Liner Pr * HPFP Vibration * HPOP Vibration (Table XX)
4	Conclude OPOV position monitor for OPOV Delta Power Level calculation.	5.5	See 3.2.3:1.7.3.
5	Calculate OPOV Delta Power Level.		See 3.2.3:1.7.3. The Delta Power Level is used in the OPOV Command Limit calculation (if not FRT1 or FRT2).
		5.62	Averaging of HPFT Discharge Temp channel values concludes for lower qualification limit calculation. (Table XVII note 1(b)(i))
		5.64	Offset is calculated for HPFT Discharge Temp lower qualification limit calculation. (Table XVII note 1(b)(ii))

TABLE XII
MAINSTAGE SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM ENGINE START (SECONDS)	REMARKS
		5.8	Calculation each major cycle begins for HPFT Discharge Temp lower qualification limit. (Table XVII note 1(b)(iii))
		-	Shutdown Limit Monitoring redlines set to Mainstage values for: * HPOT Discharge Temp * HPFT Discharge Temp * HPOT Discharge Temp Blueline * HPFT Discharge Temp Blueline (Table XX)

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS

STEP

- Only controlling functions are shown in this table as numbered steps. Monitoring functions keyed to time are shown under REMARKS.

OPERATION

- Functions are initiated at the times indicated and maintained until changed by subsequent steps for that function.
- When a ramp is initiated, the first increment of the ramp is executed at the listed time.
- When closed-loop control is in effect, the indicated ramp rates apply to the total computed valve command, including control loop inputs.
- Units for valve commands in this table, such as "Ramp MOV to 100% at 200%/sec", are the goal position in percent of full open actuator position, and the ramp rate in percent actuator position per second.
- ON/OFF device steps apply to both channels A and B, unless otherwise specified.
- MOV position commands will be dynamically compensated per the Laplace transform function of Figure 10.

TIME

- Values shown give the required times in seconds from the first major cycle of the Shutdown phase. Each time applies to subsequent steps until another time is indicated.

REMARKS

- Monitoring functions are shown in this table in the appropriate relative time sequences. Full requirements for these functions are given in the indicated paragraphs or tables.
- "Concludes" indicates the last major cycle in which a monitor is performed.
- "Discontinued" indicates the first major cycle in which a monitor is no longer performed.

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
Throttling to Zero Thrust:			
1	Set Engine Status Word to Shutdown phase, Throttling to Zero Thrust mode.	0	First major cycle of Shutdown phase.
2	Set Time Reference to 0.	-	
3	Discontinue all control loops: MCC Pc, Mixture Ratio, and CCV (function of Pc Ref).	-	See Figures 8, 9 and 10.
4	Deenergize igniters.	-	
5	Deenergize the Emergency Shutdown Control Valve solenoid if the HPOP IMSL Purge Pressure has been Shutdown Limit Exceeded during Start or Mainstage.	-	Paragraph 3.2.3:5.3.1.
6	Set the initial value of each actuator command to the RVDT position of the respective actuator. The actuators will be ramped in steps 11-14, 16, 18-20, 22 and 23.	-	
7	Set the MOV lag initial values to represent that the valve has been steady at its RVDT position.	-	
8	Set MFV actuator schedule ramp rate to 0.	-	
9	Set the OPOV Command Limit to 100%.	-	

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
-		-	All sensor qualification monitoring is discontinued except for MCC Pc intrachannel comparisons. (Table XVII)
-		-	All Shutdown Limit and FASCOS Monitoring is discontinued. (Table XX)
-		-	Backdoor Purge Initiation Monitoring begins for: * HPOP IMSL Purge Pr (3.2.3:5.5)
10	Energize the Preburner Shutdown Purge Control Valve solenoid at the time below, which corresponds to the time of Shutdown initiation and Power Level (PL=MCC Pc/RPL) at Shutdown.	-	Earliest time to energize is S/D + 0 seconds if S/D occurs at Start + 1.98 sec.

Time of S/D	Time to Energize
Start (T=sec)	
$T < 2$	2 sec after Start
$2 \leq T < 5$	S/D + [PL*(8/7)+(37/35)] sec; Minimum Time = S/D + 1.5 sec
Mainstage	S/D + 1.5 sec

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
11	**OPOV Schedule** Ramp OPOV command to full closed, using the ramp rate below which corresponds to the current command and the phase that Shutdown occurs from. OPOV Command (OPST) — OPOV Rate 52% < OPST — 45%/sec 40% < OPST ≤ 52% — 30%/sec OPST ≤ 40%, S/D from Start — 70%/sec OPST ≤ 40%, S/D from Mainstage — 30%/sec Change the ramp rate as the OPOV command passes a boundary.	-	
12	**FPOV Schedule** If (FPST - OPST) ≥ 12%, or if FPST ≤ 12%, then ramp FPOV, MOV, and CCV commands closed according to the following schedules (steps 12, 13, and 14). Ramp rates correspond to the current actuator command and the phase that Shutdown occurs from. If upon entry into Shutdown the conditions to begin these schedules are not met then hold the current actuator commands. Begin the the schedules whenever the conditions are met. Once the schedules have been initiated, continue until complete.	-	

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
	<u>FPOV Command (FPST)</u> <u>FPOV Rate</u> <u>S/D from Start</u> 60% < FPST 28%/sec 43% < FPST ≤ 60% 14%/sec FPST ≤ 43% 70%/sec <u>S/D from M/S</u> 60% < FPST 28%/sec 40% < FPST ≤ 60% 18%/sec FPST ≤ 40% 70%/sec Change the ramp rate as the FPOV command passes a boundary.		
13	**MOV Schedule** When the FPOV conditions of step 12 are met, ramp MOV command to full closed according to the following schedule: <u>OPOV Command (OPST)</u> <u>MOV Rate</u> 52% < OPST 33%/sec OPST ≤ 52% 40%/sec Change the MOV ramp rate as the OPOV command passes a boundary.	-	

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
14	**CCV Schedule** If PC Ref at S/D > 100% RPL, then hold the CCV command as exists. Otherwise, when the FPOV conditions of step 12 are met ramp CCV command to 52% according to the following schedule. CCV Command (CCST) — CCV Rate 52% < CCST — 100%/sec CCST ≤ 52% — 0%/sec (hold) Change the ramp rate as the CCV command passes a boundary.	-	
15	Energize Pogo Precharge Control Valve solenoid if Thrust Buildup mode in Start was attained (Ignition Confirmed).	0.02	
-		0.12	Backdoor Purge Initiation Monitoring begins for: * Pogo Precharge Pr (3.2.3:5.5)
-		T1	T1 is defined as the first time either: a) the OPOV position ≤ 52% and the OPOV command ≤ 52% or b) the OPOV command ≤ 50%

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
16	Discontinue the CCV schedule of step 14, and hold the CCV command as exists.	-	
17	Set Pc Ref to 0 psia.	-	This assures that VDT word 6 will indicate < 30% RPL if S/D is entered from Electrical Lockup due to Pc sensor failures; the orbiter requires a value less than 30% RPL to confirm Main Engine cutoff.
18	Ramp CCV command to 75% at 75%/sec.	T1 + 0.32	
19	If MFV command is > 62%, ramp MFV command to 62% at 50%/sec; else continue to hold MFV command.	T1 + 1.24	
20	Discontinue the OPOV schedule of step 11, and continue ramping OPOV command to full closed, using the following ramp rates: S/D occurred from — OPOV Rate Start — 70%/sec Mainstage — 200%/sec	1.42	

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
-		2.0	Backdoor Purge Initiation Monitoring begins for: * Fuel Preburner S/D Prg Pr * Oxid Preburner S/D Prg Pr (3.2.3:5.5)
21	Deenergize Pogo Precharge Control Valve solenoid.	4.0	
-		-	Backdoor Purge Initiation Monitoring concludes for: * Pogo Precharge Pr (3.2.3:5.5)
22	If OPOV command is 0%, then ramp MFV command to full closed at 75%/sec; else hold MFV command until OPOV condition is met, and then initiate MFV ramp.	T1 + 4.30	
23	Ramp CCV command to 0% at 100%/sec.	-	
Propellant Valves Closed:			
24	Set Engine Status Word to Propellant Valves Closed mode.	T1 + 5.82	

TABLE XIII
HYDRAULIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
25	Deenergize the Emergency Shutdown Control Valve solenoid.	13.50	The EMSD may already be deenergized by the Backdoor Purge Initiation Monitoring. (3.2.3:5.5)
-		-	Backdoor Purge Initiation Monitoring: concludes for: * HPOP IMSL Purge Pr * Fuel Preburner S/D Prg Pr * Oxid Preburner S/D Prg Pr (3.2.3:5.5)
26	Deenergize Preburner Shutdown Purge Control Valve solenoid.	15.0	
27	Deenergize all fail-safe servoswitches.	15.50	
28	Deenergize HPOP IMSL Purge Control Valve solenoid.	16.0	
29	Set Engine Status Word to Post Shutdown phase, Standby mode.	16.20	First major cycle of Post Shutdown phase.
-		-	Monitoring of Purge & Ancillary parameters begins. (3.2.3:6.4)

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TABLE XIV
PNEUMATIC SHUTDOWN SEQUENCE AND FUNCTIONS

STEP
- Only controlling functions are shown in this table as numbered steps. Monitoring functions keyed to time are shown under REMARKS.

OPERATION
- Functions are initiated at the times indicated and maintained until changed by subsequent steps for that function.
- When a ramp is initiated, the first increment of the ramp is executed at the listed time.
- When closed-loop control is in effect, the indicated ramp rates apply to the total computed valve command, including control loop inputs.
- Units for valve commands in this table, such as "Ramp MOV to 100% at 200%/sec", are the goal position in percent of full open actuator position, and the ramp rate in percent actuator position per second.
- ON/OFF device steps apply to both channels A and B, unless otherwise specified.
- MOV position commands will be dynamically compensated per the Laplace transform function of Figure 10.

TIME
- Values shown give the required times in seconds from the first major cycle of the Shutdown phase. Each time applies to subsequent steps until another time is indicated.

REMARKS
- Monitoring functions are shown in this table in the appropriate relative time sequences. Full requirements for these functions are given in the indicated paragraphs or tables.
- "Concludes" indicates the last major cycle in which a monitor is performed.
- "Discontinued" indicates the first major cycle in which a monitor is no longer performed.

TABLE XIV
PNEUMATIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
Fail-safe Pneumatic:			
1	Set Engine Status Word to Shutdown phase, Fail-safe Pneumatic mode.	0.0	First major cycle of Shutdown phase. Self-test status in ESW indicates 'Major Component Failed' or 'Shutdown Limit Exceeded' if failure condition caused Pneumatic Shutdown.
2	Set Time Reference to 0.	-	Same VDT update as Step 1.
3	Set Pc Ref to 0 psia.	-	This assures that VDT word 6 will indicate less than 30% RPL if S/D is entered from Electrical Lockup due to Pc sensor failures; the orbiter requires a value less than 30% RPL to confirm Main Engine cutoff.
4	Deenergize all igniters.	-	
5	Deenergize all fail-safe servoswitches.	-	
6	Deenergize all Pneumatic valve solenoids, including the Emergency Shutdown Control Valve.	-	
7	Discontinue all control loops and actuator schedules. Ramp all actuator commands to 0% at the following rates:	-	

Valve	Rate
MFV	16.0%/sec
MOV	37.0%/sec
CCV	13.8%/sec
FPOV	40.0%/sec
OPOV	70.0%/sec

TABLE XIV
PNEUMATIC SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (SECONDS)	REMARKS
8	Discontinue SEII monitoring. Continue VDT reporting of actuator positions.	-	
		-	All sensor qualification monitoring is discontinued except for MCC Pc intra-channel comparisons. Calculation of HPFT Discharge Temp lower qualification limits is discontinued. (Table XVII)
		-	All Shutdown Limit and FASCOS Monitoring, including calculation of HPFP Coolant Liner Pr redlines, is discontinued. (Table XX)
		0.02	The Assured Pneumatic Shutdown monitor (3.2.3:1.5.1) will be activated if an OE has been disqualified.
Post Shutdown Standby:			
9	Set Engine Status Word to Post Shutdown phase, Standby mode. Maintain output device configuration per 3.2.3:1.6. Resume SEII monitoring of all qualified servoactuators.	16.20	First major cycle of Post Shutdown phase.
		-	Begin monitoring of Purge & Ancillary parameters. (Table XXI)

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TABLE XV
POST SHUTDOWN SEQUENCE AND FUNCTIONS

STEP

- Only controlling functions are shown in this table as numbered steps. Monitoring functions keyed to time are shown under REMARKS.

OPERATION

- Functions are initiated at the time indicated and maintained until changed by subsequent steps for that function.
- When a ramp is initiated, the first increment of the ramp is executed at the listed time.
- Units for valve commands in this table, such as "Ramp MOV to 100% at 200%/sec", are the goal position in percent of full open actuator position, and the ramp rate in percent actuator position per second.
- ON/OFF device steps apply to both channels A and B, unless otherwise specified.
- MOV position commands will be dynamically compensated per the Laplace transform function of Figure 10.

TIME

- Values shown give the required times in seconds from the first major cycle of Post Shutdown Standby or Oxidizer Dump. Each time applies to subsequent steps until another time is indicated.

REMARKS

- Monitoring functions are shown in this table in the appropriate relative time sequences. Full requirements for these functions are given in the indicated paragraphs or tables.

TABLE XV
POST SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (Note 1) (SECONDS)	REMARKS
PART A - TERMINATE SEQUENCE			
1	Change the phase/mode to Post Shutdown Terminate Sequence mode. Retain current configuration. If the configuration is FRT deactivate the FRT Mode.	0.0	
2	Reset Time Reference to zero	--	Same VDT update as Step 1.
3	Deenergize all igniters, all pneumatic solenoids, all fail-safe servoswitches, and all group switches. Set the fail-operational servoswitches to the state dictated by the hardware qualification status. Terminate Propellant Drop Monitoring (3.2.3:2.1).	--	
4	Deactivate all control loops and all actuator scheduled commands.	--	
5	Upon entry into Terminate Sequence, if the configuration was FRT-2 or the mode was Hydraulic Lockup or both servoactuator channels were disqualified, then skip steps 6 through 9 and go to step 10; otherwise perform the following steps.		
6	Energize all fail-safe servoswitches.	--	
7	Ramp all actuator commands to full closed at 180 percent per second.	0.02	

TABLE XV
POST SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (Note 1) (SECONDS)	REMARKS
PART A - TERMINATE SEQUENCE (Continued)			
8	Deenergize all fail-safe servoswitches.	0.64	
9	Suspend SEII monitoring.	--	
10	Change phase/mode to Post Shutdown Standby mode.	16.20	
11	Resume SEII monitoring.	--	
12	If applicable resume for Propellant Drop Monitoring.	--	

TABLE XV
POST SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

STEP	OPERATION	TIME FROM START OF SEQUENCE (Note 1) (SECONDS)	REMARKS
PART B - OXIDIZER DUMP SEQUENCE			
1	Change Engine Status Word to indicate Post Shutdown phase and Oxidizer Dump mode.	0.0	
2	Reset Time Reference to zero.	--	Same as VDT update as Step 1.
3	Deenergize all solenoids (pneumatic valves) except the Bleed Valve solenoids. Deenergize all igniters.	--	
4	Retain all actuator valve commands at full closed position.		
5	Energize the MOV Fail-Safe servoswitches.	0.08	
6	Ramp MOV from existing position to full open at 100 percent per sec.	0.10	Start Oxidizer Dump

TABLE XV
POST SHUTDOWN SEQUENCE AND FUNCTIONS (Continued)

NOTES:

1. Operations listed within each part, A and B, of this table will be performed in the listed sequence and with the indicated timing. Parts A and B may be performed in any sequence. Where time for the operation is not stated, the operation will be performed in the least time practical after the previous operation.

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Table XVI
FUEL DENSITY, LOX, AND FUEL FLOWRATE CALCULATIONS

Part A: Fuel Density rho_h

(1) For MCC Pc less than 40% RPL, $rho_h = 4.323$ lb/ft^3

(2) For MCC Pc greater than or equal to 40% RPL, compute rho_h per the following:

Start rho_h computation after both control parameters P_h and T_h are determined per 3.2.3:4.4.2, otherwise keep rho_h equal to 4.323 lb/ft^3.

$$rho_h = (B_2 * P_h + A_2) * T_h^2 + (B_1 * P_h + A_1) * T_h + B_0 * P_h + A_0 \text{ lb/ft}^3$$

P_h = LPFP Discharge Pressure, psia

T_h = LPFP Discharge Temperature, degrees R

B_2 = 3.0926 ($\pm$0.1) * 10^{-6} lb/ft^3/degrees R^2/psia

A_2 = -1.4013 ($\pm$0.025) * 10^{-3} lb/ft^3/degrees R^2

B_1 = -2.1467 ($\pm$0.04) * 10^{-4} lb/ft^3/degrees R/psia

A_1 = 6.522 ($\pm$0.1) * 10^{-2} lb/ft^3/degrees R

B_0 = 4.2739 ($\pm$0.2) * 10^{-3} lb/ft^3/psia

A_0 = 3.8956 ($\pm$0.04) lb/ft^3

Values in parentheses are the range of variation of the constants as selected at time of software program loading.

(3) When fuel density is to be fixed due to failure of either LPFP Discharge Pressure or LPFP Discharge Temperature: $rho_h = 4.323$ lb/ft^3

Table XVI
FUEL DENSITY, LOX, AND FUEL FLOWRATE CALCULATIONS (Continued)

Part B: Fuel Flowrate

The fuel flowrate (mass) is:

$$W_h = Kc * Q * rho_h$$

where

W_h = fuel flowrate (mass) lb/sec

Kc = 0.002228 ft^3/sec/GPM

Q = volumetric fuel flowrate in GPM

rho_h = fuel density lb/ft^3 calculated above

Table XVI
FUEL DENSITY, LOX, AND FUEL FLOWRATE CALCULATIONS (Continued)

Part C: Oxidizer Flowrate

(1) The oxidizer flowrate (mass) during normal engine operation is:

$W_o = (Pc + 14.5) / C_2 - W_h$ lb/sec

W_o = oxidizer flowrate (weight) lb/sec

Pc = MCC Pc psia

$C_2 = a * (Pc/RPL)^2 + b * Pc/RPL + c$ psia sec/lb

a = -0.030621 ($\pm$0.03) psia sec/lb

b = 0.016555 ($\pm$0.1) psia sec/lb

c = 2.92104 ($\pm$1.0) psia sec/lb

RPL = Rated Power Level psia

Values in parentheses are the range of variation of the constants as selected at time of software program loading.

(2) The oxidizer flowrate during Thrust Limiting mode is:

$W_o = (Pc\ Ref + 14.5)/C_2 - W_h$ lb/sec

W_o = oxidizer flowrate (weight) lb/sec

Pc Ref = Pc Reference psia

C_2 is as defined in (1) above.

(3) Oxidizer Volumetric Flowrate is:

Q_o(gal/min) =

$$\frac{W_o(\text{lb/sec})}{rho_o(\text{lb/ft}^3)} * 7.4805195(\text{gal/ft}^3) * 60(\text{sec/min})$$

rho_o = oxidizer density

= 70.3 lb/ft^3

W_o is defined in (1) or (2) above

Note: Any modification to the above calculations may affect the Q Reference calculation, Part E.

Table XVI
FUEL DENSITY, LOX, AND FUEL FLOWRATE CALCULATIONS (Continued)

Part D: Mixture Ratio

Mixture Ratio is the ratio of oxygen to hydrogen mass flowrates.

Part E: Q Reference

(1) The Q Reference value during normal engine operation is:

$$Q\ Ref = [(Pc + 14.5)/C2] * [1/(1 + MR)] * [448.8/rho_h]$$

Pc = MCC Pc psia

C2 = oxidizer flowrate coefficient psia sec/lb calculated in Part C

MR = 6.011 (mixture ratio reference value)

rho_h = fuel density lb/ft^3 calculated in Part A

(2) The Q Reference value during Thrust Limiting mode is:

$$Q\ Ref = [(Pc\ Ref + 14.5)/C2] * [1/(1 + MR)] * [448.8/rho_h]$$

Pc Ref = Pc Reference psia

C2 is as defined in (1) above.

MR is as defined in (1) above.

rho_h is as defined in (1) above.

Table XVII
SENSOR/CHANNEL MONITORING

Parameter	Sensors	Monitoring Period	Qualification Limits (S = each sensor) (Ch = each channel)	Test Designation
MCC Pc (3.2.3:4.2.2(a)) and (3.2.3:4.2.4(a))	A1, A2	All phases except during Sensor Checkout	$\lvert A1 - A2 \rvert \le 75$ psi	Intra-Channel Comparison
	B1, B2	All phases except during Sensor Checkout	$\lvert B1 - B2 \rvert \le 75$ psi	Intra-Channel Comparison
	Ch A, Ch B	Purge Sequence 4, Engine Ready modes	0 psia $\le$ Ch $\le$ 37 psia	Fixed Limits Channel Reasonableness
	Ch A, Ch B	START + 2.1 sec through START + 2.4 sec	Ch $\ge$ PcRef	Pc Ref Channel Reasonableness
	Ch A, Ch B	START + 2.42 sec through START + 4.98 sec	PcRef - 600 psi $\le$ Ch $\le$ PcRef + 350 psi	Pc Ref Channel Reasonableness
	Ch A, Ch B	Mainstage	$\lvert$Ch - PcRef$\rvert \le$ delta Delta = 200 psi during throttling and 50 major cycles thereafter. Delta = 200 psi during steady state conditions if commanded power level $\le$ 75% RPL. Delta = 200 psi for 50 major cycles following Major Cycle Restart. Delta = 75 psi if none of the above conditions pertain.	Pc Ref Channel Reasonableness

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

Parameter	Sensors	Monitoring Period	Qualification Limits (S = each sensor) (Ch = each channel)	Test Designation
MCC Pc (3.2.3:4.2.3(a))	A1, A2	START + 5.04 sec through Mainstage	$\|A1 - A2\| \le 125$ psi	Shutdown Limit Monitoring Intra-Channel Comparison
	B1, B2	START + 5.04 sec through Mainstage	$\|B1 - B2\| \le 125$ psi	Shutdown Limit Monitoring Intra-Channel Comparison
	Ch A, Ch B	START + 5.04 sec through Mainstage	1000 psia $\le$ Ch $\le$ 3500 psia	Shutdown Limit Monitoring Reasonableness
Fuel Flowrate (3.2.3:4.2.2(b) and 3.2.3:4.2.5)	A1, A2 B1, B2	Checkout Standby and Start Prep before Start Enable (note 4)	Q Ref - 0 gpm $\le$ S $\le$ Q $\overline{\text{Ref}}$ $\mp$ 1800 gpm (note 3)	Sensor Qualification
	A1, A2 B1, B2	Start + 3.5 sec through Start + 4.98 sec (note 4)	Q Ref - 3600 gpm $\le$ S $\le$ Q $\overline{\text{Ref}}$ $\mp$ 3600 gpm (note 3)	Sensor Qualification
	A1, A2 B1, B2	Start + 5 sec through Mainstage (note 4)	Q Ref - 1800 gpm $\le$ S $\le$ Q $\overline{\text{Ref}}$ $\mp$ 1800 gpm (note 3)	Sensor Qualification
	A1, A2 B1, B2	Measured Power Level > 49% RPL (note 4)	PRC updates per 3.2.3:3.3.2:3	PRC Self-Test of Fuel Flowrate
LPFP Discharge Pressure (3.2.3:4.2.2(c))	A, B	Start Prep before Start Enable	0 psia $\le$ S $\le$ 61 psia	Sensor Qualification
	A, B	START + 3.5 sec through Mainstage	140 psia $\le$ S $\le$ 300 psia	Sensor Qualification
LPFP Discharge Temp (3.2.3:4.2.2(c))	A, B	Purge Sequence 4, Engine Ready modes before Start Enable	35 R $\le$ S $\le$ 45 R	Sensor Qualification
	A, B	START + 3.5 sec through Mainstage	40 R $\le$ S $\le$ 45 R	Sensor Qualification

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

Parameter	Sensors	Monitoring Period	Qualification Limits (S = each sensor) (Ch = each channel)	Test Designation
HPOT Discharge Temperature (3.2.3:4.2.3(b)) (3.2.3:4.2.10) (3.2.3:4.4.1(d))	A2, A3 B2, B3	Start Prep	420 R $\leq$ S $\leq$ 600 R	Sensor Qualification
	A2, A3 B2, B3	START + 2.3 sec through Mainstage	S $\leq$ 2650 R	Sensor Qualification
	A2	START + 2.3 sec through START + 5.78 sec	A3 - S $\leq$ 100 R	Shutdown Limit Monitoring Intra-Channel Comparison
	A3		A2 - S $\leq$ 100 R	
	A2	START + 5.8 sec through Mainstage	A3 - S $\leq$ 50 R	Shutdown Limit Monitoring Intra-Channel Comparison
	A3		A2 - S $\leq$ 50 R	
	B2	START + 2.3 sec through START + 5.78 sec	B3 - S $\leq$ 100 R	Shutdown Limit Monitoring Intra-Channel Comparison
	B3		B2 - S $\leq$ 100 R	
	B2	START + 5.8 sec through Mainstage	B3 - S $\leq$ 50 R	Shutdown Limit Monitoring Intra-Channel Comparison
	B3		B2 - S $\leq$ 50 R	
	Ai	START + 2.3 sec through Mainstage	(Ch B + Delta) - S $\leq$ 150 R	Shutdown Limit Monitoring Inter-Channel Comparison (Notes 5, 6)
	Bi		Ch A - (S + Delta) $\leq$ 150 R	

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

Parameter	Sensors	Monitoring Period	Qualification Limits (S = each sensor) (Ch = each channel)	Test Designation
HPFT Discharge Temperature	A2, A3 B2, B3	Start Prep	$420\ R \le S \le 600\ R$	Sensor Qualification
(3.2.3:4.2.3(b)) (3.2.3:4.2.10) (3.2.3:4.4.1(d))	A2, A3 B2, B3	START + 5.04 sec through Mainstage	$S \le 2650\ R$	Sensor Qualification
	A2 A3	START + 5.04 sec through START + 5.78 sec	$A3 - S \le 100\ R$ $A2 - S \le 100\ R$	Shutdown Limit Monitoring Intra-Channel Comparison
	A2 A3	START + 5.8 sec through Mainstage	$A3 - S \le 50\ R$ $A2 - S \le 50\ R$	Shutdown Limit Monitoring Intra-Channel Comparison
	B2 B3	START + 5.04 sec through START + 5.78 sec	$B3 - S \le 100\ R$ $B2 - S \le 100\ R$	Shutdown Limit Monitoring Intra-Channel Comparison
	B2 B3	START + 5.8 sec through Mainstage	$B3 - S \le 50\ R$ $B2 - S \le 50\ R$	Shutdown Limit Monitoring Intra-Channel Comparison
	Ai Bi	START + 5.04 sec through Mainstage	$(Ch\ B + Delta) - S \le 150\ R$ $Ch\ A - (S + Delta) \le 150\ R$	Shutdown Limit Monitoring Inter-Channel Comparison (Notes 5, 7)
Cold Junction Temperature (3.2.3:4.2.16)	A, B	Start Prep, Start and Mainstage	$360\ R \le S \le 660\ R$	Sensor Qualification

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

Parameter	Sensors	Monitoring Period	Qualification Limits (S = each sensor) (Ch = each channel)	Test Designation
HPOP IMSL Purge Pressure (3.2.3:4.2.3(b)) (3.2.3:4.2.9) (3.2.3:4.2.11) (3.2.3:4.2.12)	A, B	Start Prep, Start and Mainstage	0 psia $\leq$ S $\leq$ 650 psia	Sensor Qualification
HPOT Sec. Seal Cav. Pressure (3.2.3:4.2.3(b))	A, B	Start Prep	4 psia $\leq$ S	Sensor Qualification
		Start Prep except the first 10 seconds of PSN-3 and PSN-4	S $\leq$ 20 psia	Sensor Qualification
	A, B	Start and Mainstage	4 psia $\leq$ S $\leq$ 300 psia	Sensor Qualification
HPFP Coolant Liner Pressure (3.2.3:4.2.3(b))	A, B	Start Prep	-30 psia $\leq$ S $\leq$ 50 psia	Sensor Qualification
	A, B	START + 5.04 sec through Mainstage	1800 psia $\leq$ S $\leq$ 4500 psia	Sensor Qualification
Fuel Preburner S/D Purge Press (3.2.3:4.2.3(b)) (3.2.3:4.2.9)	A	Start Prep before Start Enable except the first second of PSN-3	0 psia $\leq$ S $\leq$ 160 psia	Sensor Qualification
	A	START through START + 4.16 sec	0 psia $\leq$ S $\leq$ 1200 psia	Sensor Qualification
Oxidizer Preburner S/D Purge Press (3.2.3:4.2.3(b)) (3.2.3:4.2.9)	B	Start Prep before Start Enable except the first second of PSN-3	0 psia $\leq$ S $\leq$ 535 psia	Sensor Qualification
	B	START through START + 4.16 sec	0 psia $\leq$ S $\leq$ 1200 psia	Sensor Qualification

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

Parameter	Sensors	Monitoring Period	Qualification Limits (S = each sensor) (Ch = each channel)	Test Designation
HPFP Vibration (3.2.3:4.2.8)	A, B CA, CB	Start Prep	Min Mem $\leq$ s $\leq$ 1.5 Grms	Vibration Sensor Qualification
		START + 5.04 sec through Mainstage	0.25 Grms $\leq$ s $\leq$ Max Mem	Vibration Sensor Qualification
HPOP Vibration (3.2.3:4.2.8)	A, B CA, CB	Start Prep	Min Mem $\leq$ s $\leq$ 1.5 Grms	Vibration Sensor Qualification
		START + 5.04 sec through Mainstage	0.25 Grms $\leq$ s $\leq$ Max Mem	Vibration Sensor Qualification
HPFP Shaft Speed (3.2.3:4.2.4(b))	A, B	START + 1.24 sec through termination of Ignition Confirmation Monitoring of the HPFP Shaft Speed	PRC Updates per 3.2.3:3.3.2:2	PRC Self-Test of HPFP Shaft Speed for Ignition Confirmation Qualification
		START + 1.24 sec through termintion of Ignition Confirmation Monitoring of the HPFP Shaft Speed	500 rpm $\leq$ s $\leq$ 12500 rpm	Ignition Confirmation Sensor Qualification
Antiflood Valve (3.2.3:4.2.4(c)) (3.2.3:4.2.11)	A, B	START + 2.3 sec through termination of Ignition Confirmation Monitoring of the Antiflood Valve	-10% $\leq$ s $\leq$ 40% or 60% $\leq$ s $\leq$ 110% (Note 2)	Ignition Confirmation Sensor Qualification
Pogo Precharge Purge Pressure	A, B	Start Preparation	0 psia $\leq$ s $\leq$ 1600 psia	Purge and Ancillary Sensor Qualification
(3.2.3:4.2.7) (3.2.3:4.2.9) (3.2.3:4.2.11)	A, B	Start through Shutdown but only while Pogo Precharge Solenoid is energized	0 psia $\leq$ s $\leq$ 1600 psia	Purge and Ancillary Sensor Qualification
	A, B	START + 4.94 sec through START + 4.98	0 psia $\leq$ s $\leq$ 1600 psia	Pogo GOX Flow Check Qualification

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

KEY

Sensors:

A	Single sensor on IE A
B	Single sensor on IE B
A1, A2	Sensors 1, 2 on IE A
B1, B2	Sensors 1, 2 on IE B
A2, A3	Sensors 2, 3 on IE A
B2, B3	Sensors 2, 3 on IE B
Ai	Only qualified sensor on channel, either A2 or A3
Bi	Only qualified sensor on channel, either B2 or B3
CA	Channel C Sensor on IE A
CB	Channel C Sensor on IE B
Ch A	Calculated parameter value per IE A data
Ch B	Calculated parameter value per IE B data

Period: Numbers given are times in seconds from the indicated time or within the indicated phase. "Start" refers to the phase; "START" refers to the time of initiation of Start phase. "Through" indicates that the given monitoring times or phases are inclusive.

Limits: All numerical limits are inclusive; a sensor value or calculated difference of sensor values equal to the given limit passes the monitoring test. "Pc Ref" means the MCC Pc Reference value.

Paragraph 3.2.3:4.2 describes all monitoring tests including conditions which supersede the monitoring criteria in this table as well as sensor data averaging requirements.

Paragraph 3.2.3:2.4.1:1 points to specific cases where monitoring is not performed during FRT.

Table XVII
SENSOR/CHANNEL MONITORING (Continued)

NOTES:

1. Not Used

2. The two sets of limits correspond to the operational range of the Antiflood Valve Position sensors when the Antiflood Valve is closed (off), and open (on), respectively.

3. Fuel Flowrate Reference Value (Ω Ref) calculations:

   (a) During Checkout and Start Prep, Ω Ref equals 0.

   (b) During Start and Mainstage, Ω Ref is calculated per Table XVI Part E.

4. Monitor periods only apply to Flight configuration.

5. Only one qualification limit test is performed based on which channel has the single qualified sensor, either Ai or Bi.

6. HPOT Discharge Temperature Delta = 0 R from START + 2.3 sec through Mainstage.

7. HPFT Discharge Temperature Delta = 0 R from START + 5.04 sec through START + 5.78 sec
   = 0 R from START + 5.80 sec through Mainstage.

Table XVIII
PROPELLANT INLET CONDITIONS FOR ENGINE READY MODE

PARAMETER (Notes 1-4)	LOWER LIMIT	UPPER LIMIT	UNIT
LPFP Discharge Temperature	37	42	deg R
LPFP Discharge Pressure	47	61	psia
Preburner Pump Discharge Temperature	-	186.5	deg R
LPOP Discharge Pressure	95	Max Memory	psia
Emergency S/D Pressure	-	50	psia
Fuel/Oxidizer Preburner S/D Purge Pressure	-	50	psia
MOV Hydraulic Temperature	490	-	deg R
MFV Hydraulic Temperature	490	-	deg R

Notes:

1. Reference 3.2.3:5.1 for Engine Ready requirements.
2. The limit values shown are within the range of acceptable conditions.
3. Each sensor channel of the listed parameters is individually checked against the limits.
4. Engine ready monitor of the MFV or MOV Hydraulic Temperature will be bypassed if both sensor channels fail for that parameter in Start Prep (FID 14), and the sequence is continued by Resume command.

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Table XIX
IGNITION CONFIRMATION POGO/GOX FLOW CHECK CRITERIA

Parameter	Time to Begin Monitor	Ignition Confirmation Sensor Qualification Criteria	Confirmation Criteria
HPFP Shaft Speed (3.2.3:5.2)	START + 1.24 sec	Sensor Qualification for Ignition Confirmation Table XVII (3.2.3:4.2.4(b))	4600 rpm $\leq$ Sensor
MCC Pc (3.2.3:5.2)	START + 1.7 sec	Intra-channel Comparison test Table XVII (3.2.3:4.2.4(a))	290 psia $\leq$ Channel
	START + 2.3 sec	Intra-channel Comparison, Fixed Limits and Pc Ref Channel Reasonableness tests Table XVII (3.2.3:4.2.4(a))	610 psia $\leq$ Channel $\leq$ 1000 psia
Antiflood Valve Position (3.2.3:5.2)	START + 2.3 sec	Sensor Qualification Table XVII (3.2.3:4.2.4(c))	80% $\leq$ Sensor

Parameter	Time to Begin Monitor	Pogo GOX Flow Check Sensor Qualification Criteria	Flow Criteria
Pogo Precharge Pressure (3.2.3:6.5)	START + 4.94 sec	Pogo GOX Flow Check Qualification Table XVII (3.2.3:4.2.7)	800 psia $\leq$ Sensor $\leq$ 1425 psia

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Table XX

ENGINE SHUTDOWN (REDLINE), BLUELINE, AND VIBRATION LIMITS

Parameter	Monitoring Times	Limits Lower	Limits Upper
	(See KEY on next page for explanation of format and abbreviations)		
HPOT Discharge Temp	START + 2.3 sec through START + 3.78 sec	-	1560 R
	START + 3.8 sec through START + 5.78 sec	720 R	1560 R
	START + 5.8 sec through Mainstage	720 R	1760 R
HPOT Discharge Temp Blueline (3.2.3:6.1.4)	Monitoring times are the same for the corresponding Engine Shutdown Redlines	50 R Above sensor lower redline limit	50 R Below sensor upper redline limit
HPFT Discharge Temp	START + 5.04 sec through START +5.78 sec	-	1820 R
	START + 5.8 sec through Mainstage	-	1960 R
HPFT Discharge Temp Blueline (3.2.3:6.1.4)	Monitoring times are the same for the corresponding Engine Shutdown Redlines	-	50 R Below sensor upper redline limit
HPOP Intermediate Seal Purge Pr	Start through Mainstage	170 psia	-
HPOT Secondary Seal Cavity Pr	Start through Mainstage	-	100 psia
HPFP Coolant Liner Pr	START + 5.04 sec through Mainstage	-	(Note 1)
Fuel Preburner S/D Purge Pr	START through START + 4.10 sec	-	400 psia
	START + 4.12 sec through START + 4.16 sec	-	100 psia
Oxidizer Preburner S/D Purge Pr	START through START + 4.10 sec	-	400 psia
	START + 4.12 sec through START + 4.16 sec	-	100 psia
HPFP Vibration	START + 5.04 sec through Mainstage	-	16 Grms
HPOP Vibration	START + 5.04 sec through Mainstage	-	11 Grms
MCC Pc	START + 5.04 sec through Mainstage	Pc Ref - 400 psia	-

Table XX
ENGINE SHUTDOWN (REDLINE), BLUELINE, AND VIBRATION LIMITS (Continued)

KEY

Times: "Start" refers to the phase; "START" refers to the time of the initiation of Start phase. The given monitoring times or phases are inclusive.

Limits: A sensor value equal to the given limit will pass the Shutdown Limit Monitoring Test.

Paragraph 3.2.3:5.3 describes the Shutdown Limit Monitoring tests.

Paragraph 3.2.3:5.3.1 describes Shutdown Limit failure responses.

Paragraph 3.2.3:5.4 describes the FASCOS Limit Monitoring tests for the vibration channels.

Paragraph 3.2.3:5.4.1 describes FASCOS Limit failure responses.

NOTES:

1. The upper redline limits for HPFP Coolant Liner Pressure will be initialized at START + 5.04 seconds to 4000 psia. Beginning at that time the limit for each channel will be calculated in each major cycle as follows:

   limit = $A_0 + A_1$* (MCC Pc) + (limit margin)

   Nominal values for the coefficients for both channels will be:

   A_0 = 37.3 psia

   A_1 = 1.1161

   limit margin = 151 psia

Calculation of the limits will be bypassed when both channels of MCC Pc are temporarily or permanently disqualified, per 3.2.3:4.2.2, in which case the limits remain at the last calculated values.

Table XXI
ENGINE COMPONENT RESPONSE LIMITS AND DELAYS

COMMANDED DEVICES:

PARAMETER	CONTROLLING SIGNAL/COMMAND	MONITORING TIME	ON LIMIT	OFF LIMIT	MONITOR DELAY (MSEC)
Emergency Shutdown Pressure (psia)	OE 1A/1B Emergency Shutdown Solenoid bits	PSN-3	$600 \leq s \leq 900$	$600 \leq s \leq 900$	2000.0
		PSN-4 until Start Enable	$s \leq 50$	$s \leq 50$	2000.0
		Start & Mainstage	$s \leq 600$ OR $900 \leq s$	$s \leq 600$ OR $900 \leq s$	2000.0
Fuel/Oxidizer Bleed Valve (%FS)	OE 1A/1B Propellant Bleed Solenoid bits	Start Preparation & Post Shutdown	$s \geq 80$	$s \leq 20$	2000.0
Fuel System Purge Pressure (psia)	OE 1A/1B Fuel Purge Solenoid bits	Start Preparation & Post Shutdown	$200 \leq s \leq 425$	$s \leq 50$	200.0
HPOP IMSL Purge Pressure (psia)	OE 1A/1B HPOP IMSL Purge Solenoid bits	Start Preparation Except PSN-3 through PSN-3 + 10 seconds, & from deenergization of HPOP IMSL Purge Solenoid in Shutdown through Post Shutdown	$s \geq 175$	$s \leq 250$	120000.0
Pogo Precharge Pressure (psia)	OE 1A/1B Pogo Precharge Solenoid bits	Start Preparation Without Start Enable & Post Shutdown	$s \geq 600$	$s \leq 1425$	120.0
		Start Preparation Start Enable except upon deenergization	$s \geq 600$	$s \leq 150$	120.0
		Start Preparation Start Enable upon deenergization	-	$s \leq 150$	200.0
		Start, Mainstage & Shutdown	$s \geq 600$	-	120.0
Pogo Recirculation Isolation Valve (%FS)	Complement of OE 1A/1B Propellant Bleed Solenoid bits	Start Preparation & Post Shutdown	$s \geq 80$	$s \leq 20$	2000.0

Table XXI
ENGINE COMPONENT RESPONSE LIMITS AND DELAYS (Continued)

NON-COMMANDED DEVICES:

PARAMETER	MONITORING TIME	LIMIT
Antiflood Valve (%FS)	Start Preparation & Post Shutdown	$s \leq 10$
MOV Hydraulic Temperature (R)	Start Preparation & Post Shutdown	$s \geq 450$
MFV Hydraulic Temperature (R)	Start Preparation Post Shutdown	$s \geq 460$

Table XXII
FRT SIMULATION MODEL

SIMULATED PARAMETER	SIMULATED VALUES (Note 3) Part A	Part B	Part C
	Purge Seq 4 & Engine Ready & Start Enable	Engine ON, Simulated MCC Pc is less than 40% RPL	Engine ON, Simulated MCC Pc is greater than or equal to 40% RPL
1. Fuel Flowrate (GPM)	Actual Sensor Inputs	8800.0	618.18 * FPOV - 33972.6 (Notes 2 and 6)
2. MCC Pc (psia)	Actual Sensor Inputs	(Notes 1 & 5)	99.27 * OPOV - 3681.8 (Notes 1 and 2)
3. LPOP Discharge Pressure (psia)	Average of upper and lower limits (Note 4)	Actual Sensor Inputs	Actual Sensor Inputs
4. LPFP Discharge (psia) Pressure	Average of upper and lower limits (Note 4)	185.0	185.0
5. LPFP Discharge Temperature (deg R)	39.0	39.0	42.5
6. Preburner Pump Discharge Temperature (deg R)	178.0	178.0	178.0
7. HPFP Shaft Speed (RPM)	Actual Sensor Inputs	8000.0	35000.0
8. HPFT Discharge Temp. (deg R)	Actual Sensor Inputs	1285.0	1285.0
9. HPOT Discharge Temp. (deg R)	Actual Sensor Inputs	1103.0	1103.0
10. Antiflood Valve (%open)	Actual Sensor Inputs	Actual Sensor Inputs or 100.00 (Note 7)	100.00 (Note 7)
11. HPFP Coolant Liner Pressure (psia)	Actual Sensor Inputs	Actual Sensor Inputs	Simulated PC * 1.1161 + 37.3
12. HPFP and HPOP Vibration (Grms)	0.5	0.5	0.5
13. Cold Junction Temp. (deg R)	Actual Sensor Inputs	489.0	489.0

Table XXII
FRT SIMULATION MODEL (Continued)

PART D ADDITIONAL SIMULATION FOR FRT-1 ONLY

	Simulated Parameter	Simulated Value	
1.	HPOP IMSL Purge Pressure	150 psia during Purge Sequence 3	

PART E ADDITIONAL SIMULATION FOR FRT-2 ONLY

	Simulated Parameter	Simulated Values	
1.	Actuator Positions	Rate Limited Commanded Position	
2.	Pogo RIV Position	Off = 100%	On = 0%
3.	Fuel Bleed Valve Position	Off = 0%	On = 100%
4.	Oxidizer Bleed Valve Position	Off = 0%	On = 100%
5.	Fuel System Purge Pressure	Off = 40 psia	On = 315 psia
6.	Pogo Precharge Pressure	Off = 75 psia	On = 700 psia
7.	Emergency Shutdown Pressure	Off = 700 psia	On = 14.7 psia
8.	HPOP IMSL Purge Pressure	Off = 200 psia	On = 620 psia
9.	MCC Pc Early in Start	From START through START + 1.7 sec set simulated MCC Pc = 0.0; otherwise use FRT simulation for MCC Pc (Note 5).	

Table XXII
FRT SIMULATION MODEL (Continued)

Notes:

1. Simulated MCC Pc, which is a function of OPOV, will be compensated by the lag defined by the Laplace transform 12/(S+12). For information regarding Laplace equations see Tustin Method 6.3.

   If the Simulated MCC Pc is negative before applying the lag, a zero value will be used.

2. FPOV and OPOV are the measured positions in % of full open of the FPOV and OPOV respectively.

3. The simulated physical parameters are to be converted to the units and scaling appropriate to the points where they are inserted in the program. Conversions will be based on nominal sensor coefficients except for FPOV and OPOV measurements which will use the calibrated coefficients.

4. The upper and lower limits of each parameter are normally per Table XVIII and are operational data constants.

5. Simulated MCC Pc = 61.6 * OPOV - 1862.0, with the following exceptions:

   Simulated MCC Pc = Pc Reference when time is less than 2.1 sec in Start.

   Simulated MCC Pc = 0.0 psia when phase is Mainstage or Shutdown, and OPOV position is less than 41%.

6. Flowmeter scaling coefficients for C1 (calculated using Tables XXVII and XXVIII) will be the same for actual Sensor Data Processing and FRT Simulation Model calculations.

7. Antiflood Valve position will be simulated at 100% full open when either Ch A or Ch B MOV is greater than or equal to 50% full open. When MOV is less than 50% full open, normal DPM data will be used for the Antiflood Valve position. Antiflood Valve position will be simulated in Start phase only.

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Table XXIII
HYDRAULIC CONDITIONING SEQUENCE (NOTE 1)

STEP NO. (NOTE 2) OCTAL	COMMAND POSITION (%)	SLEW RATE (% SEC)	FAIL-OP STATUS (NOTE 3)	FAIL-SAFE STATUS (NOTE 3)	TIME TO PERFORM STEP (SEC) (NOTE 4)
1	90	50	D	E	1.92
2	10	50	D	E	1.72
3	90	50	D	E	1.72
4	10	50	D	E	1.72
5	90	50	D	E	1.72
6	10	50	D	E	1.72
7	90	50	D	E	1.72
10	10	50	D	E	1.72
11	90	50	D	E	1.72
12	10	50	D	E	1.72
13	90	50	D	E	1.72
14	10	50	D	E	1.72
15	90	50	D	E	1.72
16	10	50	D	E	1.72
17	90	50	D	E	1.72
20	10	50	D	E	1.72
21	90	50	D	E	1.72
22	10	50	D	E	1.72
23	90	50	D	E	1.72
24	10	50	D	E	1.72
25	90	100	D	E	0.92
26	10	100	D	E	0.92
27	90	100	D	E	0.92
30	10	100	D	E	0.92
31	90	100	D	E	0.92
32	10	100	D	E	0.92
33	90	100	D	E	0.92
34	10	100	D	E	0.92
35	90	100	D	E	0.92
36	10	100	D	E	0.92
37	90	100	D	E	0.92
40	10	100	D	E	0.92
41	90	100	D	E	0.92
42	10	100	D	E	0.92
43	90	100	D	E	0.92
44	10	100	D	E	0.92
45	90	100	D	E	0.92
46	10	100	D	E	0.92
47	90	100	D	E	0.92
50	10	100	D	E	0.92

Table XXIII
HYDRAULIC CONDITIONING SEQUENCE (NOTE 1) (Continued)

STEP NO. (NOTE 2) OCTAL	COMMAND POSITION (%)	SLEW RATE (% SEC)	FAIL-OP STATUS (NOTE 3)	FAIL-SAFE STATUS (NOTE 3)	TIME PERFORM STEP (SEC) (NOTE 4)
51	90	50	E	E	1.72
52	10	50	E	E	1.72
53	90	50	E	E	1.72
54	10	50	E	E	1.72
55	90	50	E	E	1.72
56	10	50	E	E	1.72
57	90	50	E	E	1.72
60	10	50	E	E	1.72
61	90	50	E	E	1.72
62	10	50	E	E	1.72
63	90	50	E	E	1.72
64	10	50	E	E	1.72
65	90	50	E	E	1.72
66	10	50	E	E	1.72
67	90	50	E	E	1.72
70	10	50	E	E	1.72
71	90	50	E	E	1.72
72	10	50	E	E	1.72
73	90	50	E	E	1.72
74	10	50	E	E	1.72
75	90	100	E	E	0.92
76	10	100	E	E	0.92
77	90	100	E	E	0.92
100	10	100	E	E	0.92
101	90	100	E	E	0.92
102	10	100	E	E	0.92
103	90	100	E	E	0.92
104	10	100	E	E	0.92
105	90	100	E	E	0.92
106	10	100	E	E	0.92
107	90	100	E	E	0.92
110	10	100	E	E	0.92
111	90	100	E	E	0.92
112	10	100	E	E	0.92
113	90	100	E	E	0.92
114	10	100	E	E	0.92
115	90	100	E	E	0.92
116	10	100	E	E	0.92
117	90	100	E	E	0.92
120	0	100	E	E	1.02

TABLE XXIII
HYDRAULIC CONDITIONING SEQUENCE (NOTE 1) (Continued)

NOTES:

1. The ambient and engine conditions during the Hydraulic Conditioning Sequence are:

   (a) Ambient pressure is 13 to 15 psia and temperature is 35 to 95 degrees F.

   (b) No propellants are present in the engine.

   (c) Hydraulic supply is pressurized.

2. The Step Number is always reported in VDT Word 126. Upon entry into the Hydraulic Conditioning mode the Step Number is initialized to 0. This is to prevent any Step Number misinterpretation with a previously run checkout test.

3. E = Energized; D = Deenergized.

4. The times given are those to perform each individual step as opposed to a cumulative time. They are derived from the time it takes the valve to move to the commanded position based on the given slew rate, plus six major cycles. Also, all times have a tolerance of +/-10 milliseconds.

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Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
				CHANNEL A ACTUATOR CHECKOUT
035	X01 (Note 3) Where X is: 1 = MFV 2 = MOV 3 = CCV 4 = FPOV 5 = OPOV	Emergency Shutdown Pressure	0.00	STEP 1: INITIALIZATION AND EMERGENCY SHUTDOWN SOLENOID ENERGIZE CHECK 1. The following initial conditions will be met: a. Reset Time Reference to zero in the 1st VDT major cycle after completion of the Actuator Pre-operational Conditioning Cycle. b. Energize Channel A Emergency Shutdown solenoid. c. Deenergize Channel B Emergency Shutdown solenoid. d. Switch source of RVDT/LVDT excitation to CIE A. e. Energize all Channel A fail-safe servoswitches. f. Deenergize all Channel B fail-safe servoswitches. g. Disable (in the CIE) all servoactuator error indications (SEIs) for both channels. h. Deenergize all fail-op servoswitches. i. Load zero values into VDT words 16 thru 19, 115 thru 117, 120 thru 121 and 127 thru 128. 2. Step all Channel A and B actuator commands to 0%. 3. Delay 2.0 sec. 4. Verify Channel A and B Emergency Shutdown Pressure is less than or equal to 50.0 psia.
035	X02	Channel A-B Position Delta	2.10	STEP 2: RVDT SCALING COEFFICIENTS - FULL CLOSED 1. Verify Channel A and Channel B actuator position difference is less than 1.5%.
035	X03	Channel A Actuator Position	2.20	STEP 3: MAXIMUM SLEWRATE - OPENING DIRECTION 1. Step Channel A actuator command to 50% and leave Channel B command at 0%. 2. Verify that Channel A actuator position reaches and stays at 50 $\pm$ 2% for 2 consecutive major cycles in 300 msec or less from the step command.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
035	X04	Change in Channel B Actuator Position	2.70	<u>STEP 4: CHANNEL B ISOLATION TEST</u> 1. Store Channel B actuator position. 2. Step Channel B actuator command to 100%. 3. Delay 80 msec. 4. Compare new Channel B actuator position with the stored position and verify the two positions are within 0.6% of each other. 5. Step Channel B actuator command to 50%.
035	X05	Channel A-B Position Delta	2.90	<u>STEP 5: RVDT SCALING COEFFICIENTS AND DEMOD GAIN</u> 1. Verify Channel A and Channel B actuator position difference is less than 1.5%.
035	X06	Channel A Actuator Command	3.00	<u>STEP 6: 6% MODEL CHECK - OPENING DIRECTION</u> 1. Deenergize Channel A fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Step Channel A actuator command to 53.75%. 4. Delay 100 msec. 5. Clear/enable the SEI for Channel A of the actuator under test. 6. Ramp Channel A actuator command to 58.25% at 6.25%/second. 7. Verify the SEI occurs for the actuator under test, via Input Word 7, when the Channel A actuator command is at least 54% and no more than 58%. 8. Disable the SEI for Channel A of the actuator under test after the SEI is detected or at the completion of the ramp. 9. Record in VDT word 16 the actuator command minus actuator position that existed when the SEI was detected.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER		FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
FAILURE ID. (OCTAL)	FAILURE DELIMITER (OCTAL)			
035	X07	Channel A Actuator Command	4.00	STEP 7: 6% MODEL CHECK - CLOSING DIRECTION 1. Step Channel A actuator command to 46.25%. 2. Delay 100 msec. 3. Clear/enable the SEI for Channel A of the actuator under test. 4. Ramp Channel A actuator command to 41.75% at 6.25%/second. 5. Verify the SEI occurs for the actuator under test, via Input Word 7, when the Channel A actuator command is at least 42% and no more than 46%. 6. Disable the SEI for Channel A of the actuator under test after the SEI is detected or at the completion of the ramp. 7. Record in VDT word 17 the actuator command minus actuator position that existed when the SEI was detected.
035	X10	Channel A Actuator Command	5.00	STEP 8: ACTUATOR TRACKING CHECK - OPENING DIRECTION 1. Step Channel A actuator command to 50%. 2. Energize Channel A fail-safe servoswitch for the actuator under test. 3. Delay 100 msec. 4. Leave Channel B actuator command at 50%. 5. Ramp Channel A actuator command toward 100% at 150%/second for 60 msec. 6. Verify in each major cycle that the Channel A actuator position is within 7% of the actuator command during the ramp.
035	X11	- -	5.18	STEP 9: COMMAND MAXIMUM OPENING SLEWRATE 1. Step Channel A actuator command to 100%.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	T E S T D E S C R I P T I O N (Notes 4,5,6)
035	X12	Channel A Actuator Position Delta	5.24	STEP 10: FAIL-SAFE LOCKUP - OPENING DIRECTION 1. Deenergize Channel A fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Verify Channel A actuator position is no more than a fixed percent greater than the position immediately preceding deenergization of the fail-safe servoswitch. The fixed percent is: a. 4.0% for OPOV, FPOV, and CCV. b. 4.3% for MOV and MFV. 4. Record actuator position delta in VDT word 115.
035	X13	Channel A Actuator Command	5.50	STEP 11: ACTUATOR TRACKING CHECK - CLOSING DIRECTION 1. Step Channel A actuator command to 50%. 2. Energize Channel A fail-safe servoswitch for the actuator under test. 3. Delay 200 msec. 4. Ramp Channel A actuator command toward 0% at 150%/second for 60 msec. 5. Verify in each major cycle that the Channel A actuator position is within 7% of the actuator command during the ramp.
035	X14	- -	5.78	STEP 12: COMMAND MAXIMUM CLOSING SLEWRATE 1. Step Channel A actuator command to 0%.
035	X15	Channel A Actuator Position Delta	5.84	STEP 13: FAIL-SAFE LOCKUP - CLOSING DIRECTION 1. Deenergize Channel A fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Verify Channel A actuator position is no more than a fixed percent less than the position immediately preceding deenergization of the fail-safe servoswitch. The fixed percent is: a. 4.0% for OPOV, FPOV, and CCV. b. 4.3% for MOV and MFV. 4. Record actuator position delta in VDT word 116.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
035	X16	Channel A Servovalve Current	6.00	STEP 14: CLOSE ACTUATOR 1. Step Channel A and Channel B actuator commands to -2%. 2. Energize Channel A fail-safe servoswitch for the actuator under test. 3. Delay 280 msec. 4. Clear/enable the SEI for Channel A of the actuator under test. 5. Verify no SEI is present. 6. Disable the SEI for Channel A of the actuator under test.
035	X17	Channel A Actuator Command	6.30	STEP 15: HARDWARE TRACKING - CLOSED TO OPEN 1. Step Channel A and Channel B actuator commands to 0%. 2. Delay 40 msec. 3. Clear/enable the SEI for Channel A of the actuator under test. 4. Ramp Channel A actuator command to 101% at the following rates: a. 180%/sec for the MFV and MOV. b. 180%/sec for the CCV. c. 200%/sec for the OPOV and FPOV at actuator commands less than 60% and 180%/sec for those greater than or equal to 60%. 5. Leave Channel B actuator command at 0%. 6. Verify in each major cycle that the Channel A actuator position is within 7% of the actuator command during the ramp. 7. Report a failure at the end of the ramp if an actuator checkout failure is encountered during this step and delay I-response until completion of the next step.
035	X20	Channel A Actuator Command	7.20	STEP 16: ACTUATOR INTERRUPT CHECK 1. Verify no SEI has been detected. 2. Disable the SEI for Channel A of the actuator under test.
035	X21	Channel A-B Position Delta	7.30	STEP 17: RVDT SCALING COEFFICIENTS - FULL OPEN 1. Verify Channel A and Channel B actuator position difference is less than 1.5%.
035	X22	Channel A Servovalve Current	7.40	STEP 18: SERVOVALVE NULL CURRENT - OPEN 1. Step Channel A actuator command to 90%. 2. Delay 200 msec. 3. Verify Channel A servovalve current is 0 $\pm$ 3.5 ma.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
035	X23	Channel A Servovalve Current	7.62	<u>STEP 19: ACTUATOR STOP CHECK - FULL OPEN</u> (Note 7) 1. Step Channel A actuator command to 95%. 2. Delay 200 msec. 3. Verify that the Channel A servovalve current is 0 $\pm$ 3.5 ma. 4. If the above step is not verified, record the starting command (95%) in VDT word 127. 5. Step Channel A actuator command to 101% in increments of +0.25% per step. 6. Delay 200 msec after each step. 7. When the Channel A servovalve current decreases in the negative direction for two consecutive steps and the second decrease is at least -1.0 ma, record the actuator command for the first of these steps in VDT word 127. 8. Report a failure if the recorded command is the starting command or if no stop is encountered when the actuator command reaches 101%. The failure parameter is the servovalve current at the time the failure was detected. 9. Step Channel A actuator command to 110%.
035	X24	- -	12.82	<u>STEP 20: POSITION ACTUATOR FOR LOCKUP TEST</u> 1. Step Channel A actuator command to 90%.
035	X25	Channel A Actuator Position Delta	13.02	<u>STEP 21: ACTUATOR LOCKUP CAPABILITY</u> 1. Deenergize Channel A fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Step Channel A actuator command to 80%. 4. Delay 200 msec. 5. Verify that the Channel A actuator position is not more than 0.5% different from the position immediately preceding the fail-safe deenergization.
035	X26	Channel A Servovalve Current	13.32	<u>STEP 22: MAXIMUM SERVOVALVE CURRENT - CLOSING</u> (Note 7) 1. Verify Channel A servovalve current is in the range of 22 to 48 ma inclusive.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
035	X27	Channel A Actuator Position	13.38	STEP 23: MAXIMUM CLOSING SLEWRATE 1. Step Channel A actuator command to -1%. 2. Delay 20 msec. 3. Step Channel B actuator command to 100%. 4. Energize Channel A fail-safe servoswitch for the actuator under test. 5. For OPOV, FPOV, and CCV, verify that the Channel A actuator position reaches 10% in 480 msec or less from energization of the fail-safe servoswitch. 6. For MOV and MFV, verify that the Channel A actuator position reaches 10% in 420 msec or less from energization of the fail-safe servoswitch.
035	X30	Channel A Servovalve Current	14.28	STEP 24: SERVOVALVE NULL CURRENT - CLOSED 1. Step Channel A actuator command to 10%. 2. Delay 200 msec. 3. Verify Channel A servovalve current is 0 ± 3.5 ma.
035	X31	Channel A Servovalve Current	14.50	STEP 25: ACTUATOR STOP CHECK - FULL CLOSED (Note 7) 1. Step Channel A actuator command to 5%. 2. Delay 200 msec. 3. Verify that the Channel A servovalve current is 0 ± 3.5 ma. 4. If the above step is not verified, record the starting command (5%) in VDT word 128. 5. Step Channel A actuator command to -1% in increments of -0.25% per step. 6. Delay 200 msec after each step. 7. When the Channel A servovalve current increases in the positive direction for two consecutive steps and the second increase is at least +1.0 ma, record the actuator command for the first of these steps in VDT word 128. 8. Report a failure if the recorded command is the starting command or if no stop is encountered when the command reaches -1%. The failure parameter is the servovalve current at the time the failure was detected. 9. Step Channel A actuator command to -10%.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	T E S T D E S C R I P T I O N (Notes 4,5,6)
035	X32	- -	19.70	STEP 26: POSITION ACTUATOR 1. Step Channel A actuator command to 10%.
035	X33	Channel A Servovalve Current	19.90	STEP 27: MAXIMUM SERVOVALVE CURRENT - OPENING (Note 7) 1. Deenergize Channel A fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Step Channel A actuator command to 20%. 4. Delay 200 msec. 5. Verify Channel A servovalve current is in the range of -22 to -48 ma inclusive.
035	X34	Channel A Actuator Position	20.22	STEP 28: MAXIMUM OPENING SLEWRATE 1. Step Channel A actuator command to 100%. 2. Energize Channel A fail-safe servoswitch for the actuator under test. 3. For OPOV, FPOV, and CCV, verify that the Channel A actuator position reaches 90% in 480 msec or less from energization of the fail-safe servoswitch. 4. For MOV and MFV, verify that the Channel A actuator position reaches 90% in 420 msec or less from energization of the fail-safe servoswitch.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	T E S T D E S C R I P T I O N (Notes 4,5,6)
035	X35	Channel A Actuator Command	21.16	<u>STEP 29: HARDWARE TRACKING - OPEN TO CLOSED</u> 1. Clear/enable the SEI for Channel A of the actuator under test. 2. Ramp Channel A actuator command to 0% at the following rates: a. 180%/sec for the MFV and MOV. b. 180%/sec for the CCV. c. 200%/sec for the OPOV and FPOV at actuator command less than 60% and 180%/sec for those greater than or equal to 60%. 4. Maintain Channel B actuator command at 100%. 5. Verify in each major cycle that the Channel A actuator position is within 7% of the actuator command during the ramp. 6. Report a failure at the end of the ramp if an actuator checkout failure is encountered during this step and delay I-response until completion of the next step.
035	X36	Channel A Actuator command	21.96	<u>STEP 30: ACTUATOR INTERRUPT CHECK</u> 1. Verify no SEI has been detected. 2. Disable the SEI for Channel A of the actuator under test.
035	X37	Channel A Actuator Position Delta	22.06	<u>STEP 31: FAIL-OP CHANNEL SWITCHOVER</u> 1. Step Channel A actuator command to 100%. 2. Delay 20 msec. 3. Step Channel B actuator command to 0%. 4. Delay 120 msec. 5. Energize the fail-op servoswitch of the actuator under test. 6. Verify that switchover occurs within 26 msec. This will be accomplished per the following: a. Suspend major cycle processing and reset both WDTs every 4 msec or less. b. Initiate high sample rate actuator position monitoring. c. Verify that the Channel A actuator position maximum delta (position from time fail-op servoswitch is energized to peak of travel) is 3.4% or less for the OPOV, FPOV, and CCV, or 4.1% or less for MOV and MFV. d. Resume major cycle processing after 26 msec. 7. Record the fail-op delta position in VDT word 117.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER		FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
FAILURE ID. (OCTAL)	FAILURE DELIMITER (OCTAL)			
035	X40	Emergency Shutdown Pressure	23.06	STEP 32: EMERGENCY SHUTDOWN SOLENOID DEENERGIZE CHECK 1. Step Channel A actuator command to 0%. 2. Deenergize Channel A fail-safe servoswitch for the actuator under test. 3. Deenergize Channel A of the Emergency Shutdown solenoid. 4. Delay 2.0 sec. 5. Verify Channel A and Channel B Emergency Shutdown Pressure is greater than or equal to 600 psia.
035	X41	Input Word 7	25.56	STEP 33: CHANNEL A SERVOVALVE DITHER CHECK 1. Clear/enable SEIs for both channels of the actuator under test. 2. Step Channel A actuator command to 3.0%. 3. Delay 100 msec. 4. Verify no SEI has been detected. 5. Step Channel A actuator command to 0%.
035	X42	Input Word 7	26.06	STEP 34: CHANNEL B SERVOVALVE DITHER CHECK 1. Deenergize fail-op servoswitch of the actuator under test. 2. Step Channel B actuator command to 3.0%. 3. Delay 100 msec. 4. Verify no SEI has been detected. 5. Step Channel B actuator command to 0%. 6. Disable all SEIs
035	X43	- -	26.56	STEP 35: SECURE FROM CHANNEL A ACTUATOR CHECKOUT TEST 1. Deenergize all fail-safe servoswitches. 2. Delay 2.0 sec.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
				C H A N N E L B A C T U A T O R C H E C K O U T
036	X01 (Note 3) Where X is: 1 = MFV 2 = MOV 3 = CCV 4 = FPOV 5 = OPOV	Emergency Shutdown Pressure	0.00	STEP 1: INITIALIZATION AND EMERGENCY SHUTDOWN SOLENOID ENERGIZE CHECK 1. The following initial conditions will be met: a. Reset Time Reference to zero in the 1st VDT major cycle after completion of the Channel A checkout sequence. b. Energize Channel B Emergency Shutdown solenoid. c. Deenergize Channel A Emergency Shutdown solenoid. d. Switch source of RVDT/LVDT excitation to CIE B. e. Energize all Channel B fail-safe servoswitches. f. Deenergize all Channel A fail-safe servoswitches. g. Disable (in the CIE) all servoactuator error indications (SEIs) for both channels. h. Energize all fail-op servoswitches. i. Load zero values into VDT words 127 thru 128. 2. Step all Channel A and B actuator commands to 0%. 3. Delay 2.0 sec. 4. Verify Channel A and B Emergency Shutdown Pressure is less than or equal to 50.0 psia.
036	X02	- -	2.10	STEP 2: RVDT SCALING COEFFICIENTS - FULL CLOSED 1. Not applicable to Channel B checkout.
036	X03	Channel B Actuator Position	2.20	STEP 3: MAXIMUM SLEWRATE - OPENING DIRECTION 1. Step Channel B actuator command to 50% and leave Channel A actuator command at 0%. 2. Verify that Channel B actuator position reaches and stays at 50 $\pm$ 2% for 2 consecutive major cycles in 300 msec or less from the step command.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X04	Change in Channel A Actuator Position	2.70	<u>STEP 4: CHANNEL A ISOLATION TEST</u> 1. Store Channel A actuator position. 2. Step Channel A actuator command to 100%. 3. Delay 80 msec. 4. Compare new Channel A actuator position with the stored actuator position and verify the two positions are within 0.6% of each other. 5. Step Channel A actuator command to 50%.
036	X05	– –	2.90	<u>STEP 5: RVDT SCALING COEFFICIENTS AND DEMOD GAIN</u> 1. Not applicable to Channel B checkout.
036	X06	Channel B Actuator Command	3.00	<u>STEP 6: 10% MODEL CHECK - OPENING DIRECTION</u> 1. Deenergize Channel B fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Step Channel B actuator command to 57.75%. 4. Delay 100 msec. 5. Clear/enable the SEI for Channel B of the actuator under test. 6. Ramp Channel B actuator command to 62.25% at 6.25%/second. 7. Verify the SEI occurs for the actuator under test, via Input Word 7, when the Channel B actuator command is at least 58% and no more than 62%. 8. Disable the SEI for Channel B of the actuator under test after the SEI is detected or at the completion of the ramp. 9. Record in VDT word 18 the actuator command minus actuator position that existed when the SEI was detected.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X07	Channel B Actuator Command	4.00	STEP 7: 10% MODEL CHECK - CLOSING DIRECTION 1. Step Channel B actuator command to 42.25%. 2. Delay 100 msec. 3. Clear/enable the SEI for Channel B of the actuator under test. 4. Ramp Channel B actuator command to 37.75% at 6.25%/second. 5. Verify the SEI occurs for the actuator under test, via Input Word 7, when the Channel B actuator command is at least 38% and no more than 42%. 7. Disable the SEI for Channel B of the actuator under test after the SEI is detected or at the completion of ramp. 8. Record in VDT word 19 the actuator command minus actuator position that existed when the SEI was detected.
036	X10	Channel B Actuator Command	5.00	STEP 8: ACTUATOR TRACKING CHECK - OPENING DIRECTION 1. Step Channel A and Channel B actuator command to 50%. 2. Energize Channel B fail-safe servoswitch for the actuator under test. 3. Delay 100 msec. 4. Leave Channel A actuator command at 50%. 5. Ramp Channel B actuator command toward 100% at 150%/second for 60 msec. 6. Verify in each major cycle that the Channel B actuator position is within 7% of the actuator command during the ramp.
036	X11	- -	5.18	STEP 9: COMMAND MAXIMUM OPENING SLEWRATE 1. Step Channel B actuator command to 100%.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X12	Channel B Actuator Position Delta	5.24	STEP 10: FAIL-SAFE LOCKUP - OPENING DIRECTION 1. Deenergize Channel B fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Verify Channel B actuator position is no more than a fixed percent greater than the position immediately preceding deenergization of the fail-safe servoswitch. The fixed percent is: a. 4.0% for OPOV, FPOV and CCV. b. 4.3% for MOV and MFV. 4. Record actuator position delta in VDT word 120.
036	X13	Channel B Actuator Command	5.50	STEP 11: ACTUATOR TRACKING CHECK - CLOSING DIRECTION 1. Step Channel B actuator command to 50%. 2. Energize Channel B fail-safe servoswitch for the actuator under test. 3. Delay 200 msec. 4. Ramp Channel B actuator command toward 0% at 150%/second for 60 msec. 5. Verify in each major cycle that the Channel B actuator position is within 7% of the actuator command during the ramp.
036	X14	- -	5.78	STEP 12: COMMAND MAXIMUM CLOSING SLEWRATE 1. Step Channel B actuator command to 0%.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X15	Channel B Actuator Position Delta	5.84	<u>STEP 13: FAIL-SAFE LOCKUP - CLOSING DIRECTION</u> 1. Deenergize Channel B fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Verify Channel B actuator position is no more than a fixed percent less than the position immediately preceding deenergization of the fail-safe servoswitch. The fixed percent is: a. 4.0% for OPOV, FPOV, and CCV. b. 4.3% for MOV and MFV. 4. Record actuator position delta in VDT word 121.
036	X16	Channel B Servovalve Current	6.00	<u>STEP 14: CLOSE ACTUATOR</u> 1. Step Channel A and Channel B actuator commands to -2%. 2. Energize Channel B fail-safe servoswitch for the actuator under test. 3. Delay 280 msec. 4. Clear/enable the SEI for Channel B of the actuator under test. 5. Verify no SEI is present. 6. Disable the SEI for Channel B of the actuator under test.
036	X17	Channel B Actuator Command	6.30	<u>STEP 15: HARDWARE TRACKING - CLOSED TO OPEN</u> 1. Step Channel A and Channel B actuator commands to 0%. 2. Delay 40 msec. 3. Clear/enable the SEI for Channel B of the actuator under test. 4. Ramp Channel B actuator command to 101% at the following rates: a. 180%/sec for the MFV and MOV. b. 180%/sec for the CCV. b. 200%/sec for the OPOV and FPOV at actuator command less than 60% and 180%/sec for those greater than or equal to 60%. 5. Maintain Channel A actuator command at 0%. 6. Verify in each major cycle that the Channel B actuator position is within 7% of the actuator command during the ramp. 7. Report a failure at the end of the ramp if an actuator checkout failure is encountered during this step and delay I-response until completion of the next step.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X20	Channel B Actuator Command	7.20	STEP 16: ACTUATOR INTERRUPT CHECK 1. Verify no SEI has been detected. 2. Disable the SEI for Channel B of the actuator under test.
036	X21	- -	7.30	STEP 17: RVDT SCALING COEFFICIENTS - FULL OPEN 1. Not applicable to Channel B checkout.
036	X22	Channel B Servovalve Current	7.40	STEP 18: SERVOVALVE NULL CURRENT - OPEN 1. Step Channel B actuator command to 90%. 2. Delay 200 msec. 3. Verify Channel B servovalve current is 0 $\pm$ 3.5 ma.
036	X23	Channel B Servovalve Current	7.62	STEP 19: ACTUATOR STOP CHECK - FULL OPEN (Note 7) 1. Step Channel B actuator command to 95%. 2. Delay 200 msec. 3. Verify that the Channel B servovalve current is 0 $\pm$ 3.5 ma. 4. If the above step is not verified, record the starting command (95%) in VDT word 127. 5. Step Channel B actuator command to 101% in increments of +0.25% per step. 6. Delay 200 msec after each step. 7. When the Channel B servovalve current decreases in the negative direction for two consecutive steps and the second decrease is at least -1.0 ma, record the actuator command for the first of these steps in VDT word 127. 8. Report a failure if the recorded command is the starting command or if no stop is encountered when the actuator command reaches 101%. The failure parameter is the servovalve current at the time the failure was detected. 9. Step Channel B actuator command to 110%.
036	X24	- -	12.82	STEP 20: POSITION ACTUATOR FOR LOCKUP TEST 1. Step Channel B actuator command to 90%.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	T E S T D E S C R I P T I O N (Notes 4,5,6)
036	X25	Channel B Actuator Position Delta	13.02	<u>STEP 21: ACTUATOR LOCKUP CAPABILITY</u> 1. Deenergize Channel B fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Step Channel B actuator command to 80%. 4. Delay 200 msec. 5. Verify that the Channel B actuator position is not more than 0.5% different from the position immediately preceding the fail-safe deenergization.
036	X26	Channel B Servovalve current	13.32	<u>STEP 22: MAXIMUM SERVOVALVE CURRENT - CLOSING</u> (Note 7) 1. Verify Channel B servovalve current is in the range of 22 to 48 ma inclusive.
036	X27	Channel B Actuator Position	13.38	<u>STEP 23: MAXIMUM CLOSING SLEWRATE</u> 1. Step Channel B actuator command to -1%. 2. Delay 20 msec. 3. Step Channel A actuator command to 100%. 4. Energize Channel B fail-safe servoswitch for the actuator under test. 5. For OPOV, FPOV, and CCV, verify that the Channel B actuator position reaches 10% in 480 msec or less from energization of the fail-safe servoswitch. 6. For MOV and MFV, verify that the Channel B actuator position reaches 10% in 420 msec or less from energization of the fail-safe servoswitch.
036	X30	Channel B Servovalve Current	14.28	<u>STEP 24: SERVOVALVE NULL CURRENT - CLOSED</u> 1. Step Channel B actuator command to 10%. 2. Delay 200 msec. 3. Verify Channel B servovalve current is 0 $\pm$ 3.5 ma.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	T E S T D E S C R I P T I O N (Notes 4,5,6)
036	X31	Channel B Servovalve Current	14.50	<u>STEP 25: ACTUATOR STOP CHECK - FULL CLOSED</u> (Note 7) 1. Step Channel B actuator command to 5%. 2. Delay 200 msec. 3. Verify that the Channel B servovalve current is 0 ± 3.5 ma. 4. If the above step is not verified, record the starting command (5%) in VDT word 128. 5. Step Channel B actuator command to -1% in increments of -0.25% per step. 6. Delay 200 msec after each step. 7. When the Channel B servovalve current increases in the positive direction for two consecutive steps and the second increase is a least +1.0 ma, record the actuator command for the first of these steps in VDT word 128. 8. Report a failure if the recorded command is the starting command or if no stop is encountered when the command reaches -1%. The failure parameter is the servovalve current at the time the failure was detected. 9. Step Channel B actuator command to -10%.
036	X32	- -	19.70	<u>STEP 26: POSITION ACTUATOR</u> 1. Step Channel B actuator command to 10%.
036	X33	Channel B Servovalve Current	19.90	<u>STEP 27: MAXIMUM SERVOVALVE CURRENT - OPENING</u> (NOTE 7) 1. Deenergize Channel B fail-safe servoswitch for the actuator under test. 2. Delay 80 msec. 3. Step Channel B actuator command to 20%. 4. Delay 200 msec. 5. Verify Channel B servovalve current is in the range of -22 to -48 ma inclusive.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X34	Channel B Actuator Position	20.22	STEP 28: MAXIMUM OPENING SLEWRATE 1. Step Channel B actuator command to 100%. 2. Energize Channel B fail-safe servoswitch for the actuator under test. 3. For OPOV, FPOV, and CCV, verify that the Channel B actuator position reaches 90% in 480 msec or less from energization of the fail-safe servoswitch. 4. For MOV and MFV, verify that the Channel B actuator position reaches 90% in 420 msec or less from energization of the fail-safe servoswitch.
036	X35	Channel B Actuator Command	21.16	STEP 29: HARDWARE TRACKING - OPEN TO CLOSED 1. Clear/enable the SEI for Channel B of the actuator under test. 2. Ramp Channel B actuator command to 0% at the following rates: a. 180%/sec for the MFV and MOV. b. 180%/sec for the CCV. b. 200%/sec for the OPOV and FPOV at actuator command less than 60% and 180%/sec for those greater than or equal to 60%. 4. Maintain Channel A actuator command at 100%. 5. Verify in each major cycle that the Channel B actuator position is within 7% of the actuator command during the ramp. 6. Report a failure at the end of the ramp if an actuator checkout failure is encountered during this step and delay I-response until completion of the next step.
036	X36	Channel B Actuator command	21.96	STEP 30: ACTUATOR INTERRUPT CHECK 1. Verify no SEI has been detected. 2. Disable the SEI for Channel B of the actuator under test.
036	X37	- -	22.06	STEP 31: FAIL-OP CHANNEL SWITCHOVER 1. Not applicable to Channel B checkout.

Table XXIV
ACTUATOR CHECKOUT (NOTES 1,2) (Continued)

FAILURE NUMBER: FAILURE ID. (OCTAL)	FAILURE NUMBER: FAILURE DELIMITER (OCTAL)	FAILURE PARAMETER	START TIME (SECONDS)	TEST DESCRIPTION (Notes 4,5,6)
036	X40	- -	23.06	<u>STEP 32: EMERGENCY SHUTDOWN SOLENOID DEENERGIZE CHECK</u> 1. Not applicable to Channel B checkout.
036	X41	- -	25.56	<u>STEP 33: CHANNEL A SERVOVALVE DITHER CHECK</u> 1. Not applicable to Channel B checkout.
036	X42	- -	26.06	<u>STEP 34: CHANNEL B SERVOVALVE DITHER CHECK</u> 1. Not applicable to Channel B checkout.
036	X43	- -	26.56	<u>STEP 35: SECURE FROM CHANNEL B ACTUATOR CHECKOUT TEST</u> 1. Step Channel A and Channel B actuator commands to 0%. 2. Deenergize all Channel B fail-safe servoswitches. 3. Deenergize all fail-op servoswitches. 4. Switch source of RVDT/LVDT excitation to CIE A. 5. Deenergize Channel A and Channel B of the Emergency Shutdown solenoid. 6. Delay 2.0 sec. 7. Clear all SEIs on qualified servoactuator and enable all SEIs on the controlling servoactuators. 8. Return to Checkout Standby mode.

Table XXIV
ACTUATOR CHECKOUT (Continued)

NOTES:

1. The ambient and engine conditions during Actuator Checkout are:

   a. Ambient pressure is 13 to 15 psia and temperature is 35 to 95 degrees F.
   b. No propellants are in the engine.
   c. Pneumatic and hydraulic pressures are supplied per the SSME Interface Control Document (ICD-13M15000) requirements for engine operation.

2. Upon entry into step 1 of Actuator Checkout the parameters and data reported in the VDT will be those indicated in Table VII. Upon completion of Actuator Checkout the data contents of the VDT will return to those specified in Table VI.

3. The Delimiter is composed of three octal digits. The first octal digit identifies the actuator under test and the last two octal digits represent the Step Number.

4. The Step Number is reported in VDT words 69 and 126. VDT word 69 reports the previous major cycle Step Number. Upon entry into the Actuator Checkout mode the Step Number is initialized to zero. This is to prevent any Step Number misinterpretation with a previously run checkout test.

5. If an error occurs during Actuator Checkout the valve will continue to ramp to the last requested position, unless fail-safe servoswitches are deenergized.

6. When issuing a Resume command following a failure, enough time should be given for the actuator to reach the requested position or failures may be induced in subsequent steps.

7. When the servovalve is commanded open, the current valve stored in memory is negative. When the servovalve is commanded closed, the current valve stored in memory is positive.

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Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
			FUEL SYSTEM PURGE CONTROL VALVE	
45	1	01	Activate Fuel System Purge Control Valve Channel A. Wait 200 msec.	
		02	Verify that at least one sensor channel of Fuel System Purge Pressure is greater than or equal to 200 psia and less than or equal to 425 psia. Skip to step 5 if a Resume command is accepted subsequent to a failure in this step.	Either sensor channel reading
		03	Verify that sensor Channel A is greater than or equal to 200 psia and less than or equal to 425 psia.	Sensor Ch A
		04	Verify that sensor Channel B is greater than or equal to 200 psia and less than or equal to 425 psia.	Sensor Ch B
		05	Deactivate Fuel System Purge Control Valve Channel A. Wait 200 msec.	
		06	Verify that at least one sensor channel of Fuel System Purge Pressure is at most 50 psia. Skip steps 7 and @10 if a Resume command is accepted subsequent to a failure in this step.	Either sensor channel reading
		07	Verify that sensor Channel A is at most 50 psia.	Sensor Ch A
		10	Verify that sensor Channel B is at most 50 psia.	Sensor Ch B

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
46		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate Channel B of Fuel System Purge Control Valve.	
47		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate both Channel A and Channel B of the Fuel System Purge Control Valve.	
		11	Return to Checkout Standby mode.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
			HPOP IMSL PURGE CONTROL VALVE	
45	2	01	Activate HPOP IMSL Purge Control Valve Channel A. Wait 200 msec.	
		02	Verify that at least one sensor channel of HPOP IMSL Purge Pr is at least 170 psia. Skip to step 5 if a Resume command is accepted subsequent to a failure in this step.	Either sensor channel reading
		03	Verify that sensor Channel A is at least 170 psia.	Sensor Ch A
		04	Verify that sensor Channel B is at least 170 psia.	Sensor Ch B
		05	Deactivate HPOP IMSL Purge Control Valve Channel A. Wait 200 msec.	
		06	Verify that at least one sensor channel of HPOP IMSL Purge Pressure is at most 50 psia. Skip steps 7 and @10 if a Resume command is accepted subsequent to a failure in this step.	Either sensor channel reading
		07	Verify that sensor Channel A is at most 50 psia.	Sensor Ch A
		10	Verify that sensor Channel B is at most 50 psia.	Sensor Ch B

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
46		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate Channel B of HPOP IMSL Purge Control Valve.	
47		01 to 10	Repeat the same steps use to verify Channel A but activate and deactivate both Channel A and Channel B of the HPOP IMSL Purge Control Valve.	
		11	Return to Checkout Standby mode.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
			BLEED VALVE CONTROL VALVE	
45	3	01	Activate Bleed Valve Control Valve Channel A. Wait 1.0 second.	
		02	Verify that either the Fuel or Oxidizer Bleed Valve position is at least 80%. Skip to Step 5 if a Resume command is accepted subsequent to a failure in this step.	Either Fuel or Oxidizer Bleed Valve position
		03	Verify that the Fuel Bleed Valve position is at least 80%.	Fuel Bleed Valve position
		04	Verify that the Oxidizer Bleed Valve position is at least 80%.	Oxidizer Bleed Valve position
		05	Verify that Recirculation Isolation Valve position is at most 10%.	Recirculation Isolation Valve position
		06	Deactivate Bleed Valve Control Valve Channel A. Wait 1.0 second.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
		07	Verify that either the Fuel or Oxidizer Bleed Valves are at a position at most 10%. Skip to step @12 if a Resume command is accepted subsequent to a failure in this step.	Either Fuel or Oxidizer Bleed position.
		10	Verify that the Fuel Bleed Valve position is at most 10%.	Fuel Bleed Valve position
		11	Verify that the Oxidizer Bleed Valve position is at most 10%.	Oxidizer Bleed Valve position
		12	Verify that the Antiflood Valve Channel A position is at most 10%.	Antiflood Valve position Channel A
		13	Verify that the Antiflood Valve Channel B position is at most 10%.	Antiflood Valve position Channel B
		14	Verify that the RIV position is at least 80%.	Recirculation Isolation Valve position
46		01 to 14	Repeat the same steps used to verify Channel A but activate and deactivate Channel B of Bleed Valve Control Valve.	
47		01 to 14	Repeat the same steps used to verify Channel A but activate and deactivate both Channel A and Channel B of the Bleed Valve Control Valve.	
		15	Return to Checkout Standby Mode.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
			EMERGENCY SHUTDOWN	
45	4	01	Activate Emergency S/D Control Valve Channel A only. Activate all Fail-Safe valves. Wait 24.0 seconds.	
		02	Verify that Emergency Shutdown Pressure Channel A is at most 50 psia.	Sensor Ch A
		03	Verify that Emergency Shutdown Pressure Channel B is at most 50 psia. Wait 2.0 seconds.	Sensor Ch B
		04	Ramp MFV, MOV, CCV, FPOV and OPOV to 100% open from current position, at 100% per second actuator rate. Wait 2.0 seconds.	
		05	Deactivate all Fail-Safe Valves, and disable servoactuator error indication interrupts. Maintain Emergency Shutdown Control Valve Channel A and actuator commands per Step 4. Wait 2.0 seconds.	
		06	Verify that no servoactuator error indications are pending.	Input Word 7
		07	Deactivate Emergency S/D Control Valve. Maintain actuator commands per Step 4. Wait 400 msec. Actuator positions should begin closing pneumatically upon deactivation of the Emergency Shutdown Control Valve. (OPOV closes first, followed by FPOV).	
		10	Verify that Emergency Shutdown Pressure Channel A is at least 600 psia.	Sensor Ch A

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
		11	Verify that Emergency Shutdown Pressure Channel B is at least 600 psia. Wait 400 msec.	Sensor Ch B
		12	Verify that OPOV (Channel A or B) is at most 95% open.	Either channel of OPOV position
		Note:	The following 5 steps will be performed in parallel. Wait 2.9 seconds before proceeding to step @20. If a failure is detected during steps @13 through @17, then after the 2.9 second delay skip to step @20.	
		13	Verify the OPOV (Channel A or B) reaches full closed (0 ± 6%) within 1.7 seconds.	Either channel of OPOV position
		14	When the OPOV (Channel A or B) reaches 42% open, verify the FPOV (Channel A or B) is at least 97% open.	Either channel of FPOV position
		15	When the OPOV (Channel A or B) reaches 42% open, verify the MOV (Channel A or B) is at least 97% open.	Either channel of MOV position
		16	When the FPOV (Channel A or B) reaches 42% open, verify the MFV (Channel A or B) is at least 95% open.	Either channel of MFV position
		17	When the FPOV (Channel A or B) reaches 42% open, verify the CCV (Channel A or B) is at least 95% open.	Either channel of CCV position

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
		20	Verify FPOV (Channel A or B) is full closed (0 ±6%). Wait 500 msec.	Either channel of FPOV position
		21	Verify MOV (Channel A or B) is full closed (0 ±6%).	Either channel of MOV position
		22	Verify MFV (Channel A or B) is at least 45% open.	Either channel of MFV position
		23	Verify CCV (Channel A or B) is at least 45% open. Wait 1.8 seconds.	Either channel of CCV position
		24	Verify Pogo Precharge pressure (Channel A or B) is at least 600 psia.	Pogo Precharge pressure
		25	Verify HPOP IMSL Purge pressure (Channel A or B) is at least 170 psia.	HPOP IMSL Purge pressure
		26	Verify Fuel Preburner S/D Purge pressure is at least 450 psia.	Fuel PB S/D Purge pressure
		27	Verify Oxidizer Preburner S/D Purge pressure is at least 600 psia. Wait 2.56 seconds.	Oxidizer PB S/D Purge pressure
		30	Verify MFV (Channel A or B) is full closed (0 ±6%). Wait 2.24 seconds.	Either channel of MFV position
		31	Verify that CCV (Channel A or B) is full closed (0 ±6%).	Either channel of CCV position
		32	Verify Pogo Precharge pressure (Channel A or B) is at most 50 psia.	Pogo Precharge pressure
		33	Verify HPOP IMSL Purge pressure (Channel A or B) is at most 50 psia.	HPOP IMSL Purge pressure

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
		34	Verify Fuel Preburner S/D Purge pressure is at most 50 psia.	Fuel PB S/D Purge pressure
		35	Verify Oxidizer Preburner S/D Purge pressure is at most 50 psia. Activate all Fail-safe valves. Wait 2.0 seconds.	Oxidizer PB S/D Purge pressure
		36	Verify that OPOV (Channel A or B) is full open (100 ±6%).	Either channel of OPOV position
		37	Verify that FPOV (Channel A or B) is full open (100 ±6%).	Either channel of FPOV position
		40	Verify that CCV (Channel A or B) is full open (100 ±6%).	Either channel of CCV position
		41	Verify that MOV (Channel A or B) is full open (100 ±6%).	Either channel of MOV position
		42	Verify that MFV (Channel A or B) is full open (100 ±6%).	Either channel of MFV position
		43	Clear and enable servoactuator Error Indication Interrupts. Ramp all valves to 0% from current positions, at 100% per second. Wait 10.0 seconds.	
46		01 to 43	Repeat the same steps used to verify Channel A but activate and deactivate Channel B of Emergency Shutdown Control Valve.	
47		01 to 43	Repeat the same steps used to verify Channel A but activate and deactivate both Channel A and Channel B of the Emergency Shutdown Control Valve.	
		44	Deactivate all Fail-Safe Valves. Return to Checkout Standby mode.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
			POGO PRECHARGE CONTROL VALVE	
45	5	01	Activate Pogo Precharge Control Valve Channel A. Wait 160 msec.	
		02	Verify that at least one sensor channel of Pogo Precharge Pressure is as least 600 psia. Skip to step 5 if a Resume command is accepted subsequent to a failure in this step.	Either sensor channel reading
		03	Verify that sensor Channel A is at least 600 psia.	Sensor Ch A
		04	Verify that sensor Channel B is at least 600 psia.	Sensor Ch B
		05	Deactivate Pogo Precharge Control Valve Channel A. Wait 160 msec.	
		06	Verify that at least one sensor channel of Pogo Precharge Pressure is at most 50 psia. Skip steps 7 and @10 if a Resume command is accepted subsequent to a failure in this step.	Either sensor channel reading
		07	Verify that sensor Channel A is at most 50 psia.	Sensor Ch A
		10	Verify that sensor Channel B is at most 50 psia.	Sensor Ch B
46		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate Channel B of Pogo Precharge Control Valve.	
47		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate both Channel A and Channel B of the Pogo Precharge Control Valve.	
		11	Return to Checkout Standby mode.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
			PREBURNER S/D PURGE CONTROL VALVE	
45	6	01	Activate Preburner S/D Purge Control Valve Channel A. Wait 200 msec.	
		02	Verify that either FPB or OPB S/D Purge Pressure is at least 450 psia. Skip to step 5 if a Resume command is accepted subsequent to a failure in this step.	Either FPB or OPB S/D Purge Pressure
		03	Verify that FPB S/D Purge Pressure is at least 450 psia.	FPB S/D Purge Pressure
		04	Verify that OPB S/D Purge Pressure is at least 600 psia.	OPB S/D Purge Pressure
		05	Deactivate Preburner S/D Purge Control Valve Channel A. Wait 200 msec.	
		06	Verify that either FPB or OPB S/D Purge Pressure is at most 50 psia. Skip steps 7 and @10 if a Resume command is accepted subsequent to a failure in this step.	Either FPB or OPB S/D Purge Pressure
		07	Verify that FPB S/D Purge Pressure is at most 50 psia.	FPB S/D Purge Pressure
		10	Verify that OPB S/D Purge Pressure is at most 50 psia.	OPB S/D Purge Pressure
46		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate Channel B of Preburner Shutdown Purge Control Valve.	

Table XXV
PNEUMATIC CHECKOUT (Notes 1, 2) (Continued)

FID (Note 3) (OCTAL)	DEVICE ID (OCTAL)	STEP NO. (Note 4) (OCTAL)	TEST DESCRIPTION (Note 5)	FAILURE PARAMETER
47		01 to 10	Repeat the same steps used to verify Channel A but activate and deactivate both Channel A and Channel B of the Preburner Shutdown Purge Control Valve.	
		11	Return to Checkout Standby mode.	

Table XXV
PNEUMATIC CHECKOUT (Continued)

NOTES:

1. The ambient and engine conditions during Valve Component Checkout are:

   (a) Ambient pressure is 13 to 15 psia and temperature is 35 to 95 degrees F.

   (b) No propellants have dropped in the system.

   (c) Pneumatic System gas supplies are pressurized.

   (d) Hydraulic supply is pressurized at least for the test of the Emergency Shutdown Control Valve.

2. Purge and Ancillary Systems Monitoring or its associated failure responses are suspended/masked.

3. Reference Table I for Failure Identification Word.

4. The Step Number is always reported in VDT Word 126. Upon entry into the Pneumatic Checkout mode the Step Number is initialized to 0. This is to prevent any Step Number misinterpretation with a previously run checkout test.

5. All times given in milliseconds have a tolerance of ± 10 milliseconds.

Table XXVI
SENSOR CHECKOUT AND CALIBRATION

PART A - CHECKOUT AND CALIBRATION SEQUENCE

The sensor checkout and calibration sequence operates on a single sensor at a time, going through all the tests and then proceeding to the next sensor. The format of the step number in VDT Word 126 is @0XX0YY where @XX is the step number identifying a particular sensor and @YY is the substep identifying the particular test being performed on that sensor. The substep is reset to 1 as the step number increments to the next sensor.

SUB STEP	DESCRIPTION OF TEST
0	Command acceptance and VDT transmitted reporting the command. Discontinue normal sensor monitoring and failure reporting. The index is set to start sequencing through the sensor list. Wait 40 msec. VDT word 126 indicates substep 0.
1	In the first major cycle in substep 1, the Group 1A and 1B Sensor Checkout Switches are set on; the Group 2A and 2B Propellant Drop Sensor Switches are set off. Complete time for this substep is 120 msec. VDT Word 126 indicates substep 1.
2	For 64 VDT cycles report the unscaled input with simulated operating conditions for the sensor under test in VDT Word 95. VDT Word 94 will contain a count of the current VDT cycle for this substep. Check that the sensor data in each of the 64 VDT reports is within or equal to the limits for simulated operating conditions. Limits and responses are per Part C. Retain the total number of values which are out of limits. If the sensor under test is a pressure sensor listed in Part D then accumulate a running sum of the input values passing the limit check. This sum will be used in substep 6 for pressure sensor calibration. Upon completion of this substep, report the failure if the sensor was out of limits. The first 3 bits of the delimiter will be %000 with the last 6 bits set to indicate the sensor under test. For contents of Failure Parameter reference note 4. Wait 40 msec. VDT Word 126 indicates substep 2.

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART A - CHECKOUT AND CALIBRATION SEQUENCE (Continued)

SUB STEP	DESCRIPTION OF TEST
3	In the first major cycle of substep 3, set both Group 1A and 1B Sensor Checkout and both Group 2A and 2B Propellant Drop Sensor Switches off. Complete time for this step is 40 msec. VDT Word 126 indicates substep 3.
4	Preset speed and flow IE DPM values to $7FFF (saturation); these correspond to 30.52 hz and and 10.16 hz respectively. Complete time for this substep is 80 msec. VDT Word 126 indicates substep 4.
5	For 64 VDT cycles report the unscaled input with ambient operating conditions for the sensor under test in VDT Word 95. VDT Word 94 will contain a count of the current VDT cycle for this substep. Check that the sensor datum in each of the 64 VDT reports is within or equal to the limits for ambient operating conditions. Limits and responses are per Part C. Retain the total number of values which are out of limits. If the sensor under test is a pressure sensor listed in Part D then accumulate a running sum of the input values passing the limit check. This sum will be used in substep 6 for pressure sensor calibration. Upon completion of this substep, report the failure if the sensor was out of limits. The first 3 bits of the delimiter will be %001 with the last 6 bits set to indicate the sensor under test. For content of Failure Parameter reference note 4. Wait 40 msec. VDT Word 126 indicates substep 5.
6	If applicable, use data saved in substeps 2 and 5 to obtain calibration scale factor coefficients for pressure sensor. Algorithms are defined in Part D. Complete time for this substep is 40 msec. VDT Word 126 indicates substep 6.
7	In the first major cycle in substep 7, set Group 1A Sensor Checkout and Group 2A Propellant Drop Sensor Switches on, and Group 1B Sensor Checkout and Group 2B Propellant Drop Sensor Switches off. Complete time for this substep is 280 msec. VDT Word 126 indicates substep 7.

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART A - CHECKOUT AND CALIBRATION SEQUENCE (Continued)

SUB STEP	DESCRIPTION OF TEST
8	Report unscaled sensor input under ambient conditions. Complete time for this substep is 40 msec. VDT Word 126 indicates substep 8. Failure to be within the ambient limits as specified in Part C will be reported. The first 3 bits of the delimiter will be %010 with the last 6 bits set to indicate the sensor under test. The Failure Parameter will contain the IE DPM failed sensor value.
9	In the first major cycle of substep 9, set Group 1A Sensor Checkout and Group 2A Propellant Drop Sensor Switches off, and Group 1B Sensor Checkout and Group 2B Propellant Drop Sensor Switches on. Complete time for this substep is 280 msec. VDT Word 126 indicates substep 9.
10	Report unscaled sensor input under ambient conditions. Complete time for this substep is 40 msec. VDT Word 126 indicates substep 10. Failure to be within the ambient limits as specified in Part C will be reported. The first 3 bits of the delimiter will be %011 with the last 6 bits set to indicate the sensor under test. The Failure Parameter will contain the IE DPM failed sensor value.
11	Increment step number (next sensor), reset substep to 1. When all sensors have been tested, set both Group 1A and 1B Sensor Checkout Switches off, and Group 2A and 2B Propellant Drop Sensor Switches on. Complete time for this substep is 120 msec. VDT Word 126 indicates substep 11.
12	Exit the Sensor Checkout mode. It is the first major cycle in Checkout Standby mode. Resume Propellant Drop Monitoring.

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART A - CHECKOUT AND CALIBRATION SEQUENCE (Continued)

Notes:

1. Waiting periods are specified following each change in Sensor Checkout switch configuration to allow for signal settling. The sensor data entries of the VDT transmissions during a waiting period may be inaccurate.

2. Boundary conditions will be considered within the qualification region, i.e. qualified.

3. The ambient and engine conditions during Sensor Checkout are:

   . Ambient pressure will be 13 to 15 psia.

   . Ambient temperature will be 35 to 95 degrees F.

   . No propellants dropped in the system.

   . GN_2 purge gas to oxidizer system and HPOT seal will be turned off.
   . GN_2 and He pneumatic supplies should not be pressurized, otherwise anomalous errors may occur.
   . Hydraulic supply should not be pressurized, otherwise anomalous errors may occur.

4. Failure Parameters reported for substeps 2 and 5 of Part A contain the 10 most significant bits of the last out-of-limits sensor value (unscaled) as well as the number of out-of-limits sensor readings in the substep. Subfields of the Failed Parameter are as follows:

Bits (MSB=15)	Value
0-5	Count of failures @77 = 63 failures @00 = 64 failures
6-15	Bits 6-15 of the last bad sensor value

Failure Parameters reported for the remainder of the substeps in Part A contain all bits of the failed sensor value.

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART B - SENSOR OUTPUT REPORTING FORMAT

The normal reporting VDT format will be retained for Sensor Checkout reporting except for the following entries:

VDT WORD NO.	NORMAL PROCESSING	SENSOR CHECKOUT
94	Selected Appended Data	Test Counter
95	Selected Appended Data	Unscaled DPM Input Value For Sensor Under Test
126	Selected Appended Data	Step And Substep Counter

Note: Normal reporting of the VDT will be restored upon completion of Sensor Checkout

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART C - TEST LIMITS AND FAILURE IDENTIFICATIONS

Sensor Identifier (Note 1)	SENSOR	TEST LIMITS (MEMORY DATA) (Notes 2 & 3) AMBIENT CONDITIONS MINIMUM	MAXIMUM	SIMULATED OPERATION MINIMUM	MAXIMUM
Pressure Sensors:					
1,2	MCC Pc (Main Combustion Chamber) (P9A1, P9B1, P9A2, P9B2)	$FBC8 (-128 psia)	$0518 (154 psia)	$57E8 (2665 psia)	$6138 (2948 psia)
3	HPOP Discharge (P5)	$FB98 (-267 psia)	$04D8 (294 psia)	$57E8 (5329 psia)	$6138 (5894 psia)
4	LPFP Discharge (P1A, P1B)	$0068 (1 psia)	$0A68 (27 psia)	$57E8 (228.3 psia)	$6138 (252.5 psia)
5	Preburner Pump Discharge (P6)	$FB88 (-367 psia)	$04C8 (393 psia)	$57E8 (7234 psia)	$6138 (7996 psia)
6	LPOP Discharge (P4A, P4B)	$FDE8 (-11 psia)	$0788 (39 psia)	$57E8 (456.6 psia)	$6138 (505 psia)
7	Fuel System Purge (P8A, P8B)	$FDE8 (-11 psia)	$0788 (39 psia)	$57E8 (456.6 psia)	$6138 (505 psia)
@10	HPOP Intermediate Seal (IMSL) Purge (P15A, P15B)	$FDE8 (-11 psia)	$0788 (39 psia)	$57E8 (456.6 psia)	$6138 (505 psia)
@11	HPFP Discharge (P2)	$FB88 (-367 psia)	$04C8 (393 psia)	$57E8 (7234 psia)	$6138 (7996 psia)
@12	Hydraulic System (P12)	$FBC8 (-146 psia)	$06A8 (229 psia)	$57E8 (3045 psia)	$6308 (3431 psia)
@13	Fuel Preburner Chamber (P3)	$FB98 (-267 psia)	$04D8 (294 psia)	$57E8 (5329 psia)	$6138 (5894 psia)

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART C - TEST LIMITS AND FAILURE IDENTIFICATIONS

Sensor Identifier (Note 1)	SENSOR	TEST LIMITS (MEMORY DATA) (Notes 2 & 3) AMBIENT CONDITIONS MINIMUM	AMBIENT CONDITIONS MAXIMUM	SIMULATED OPERATION MINIMUM	SIMULATED OPERATION MAXIMUM
Pressure Sensors (Continued)					
@14	Fuel Preburner S/D Purge (P13)	$FC68 (-47 psia)	$05C8 (75 psia)	$57E8 (1142 psia)	$6138 (1263 psia)
@15	Oxidizer Tank Pressurant (P14)	$FB98 (-267 psia)	$04D8 (294 psia)	$57E8 (5329 psia)	$6138 (5894 psia)
@16	MCC Fuel Injection (P10)	$FBB8 (-167 psia)	$0508 (196 psia)	$57E8 (3425 psia)	$6138 (3788 psia)
@17	Controller Internal (P17A, P17B)	$22C8 (15.35 psia)	$4488 (30.26 psia)	$22C8 (15.35 psia)	$4488 (30.26 psia)
@20	MCC Coolant (P11)	$FB98 (-267 psia)	$04D8 (294 psia)	$57E8 (5329 psia)	$6138 (5894 psia)
@21	Oxidizer Preburner S/D Purge (P19)	$FC68 (-47 psia)	$05C8 (75 psia)	$57E8 (1142 psia)	$6138 (1263 psia)
@22	Emergency Shutdown (P20A, P20B)	$FC68 (-47 psia)	$05C8 (75 psia)	$57E8 (1142 psia)	$6138 (1263 psia)
@23	Pogo Precharge (P18A, P18B)	$FC68 (-47 psia)	$05C8 (75 psia)	$57E8 (1142 psia)	$6138 (1263 psia)
@24	HPOT Secondary Seal Cavity (P16A, P16B)	$0068 (1 psia)	$0A68 (27 psia)	$57E8 (228.3 psia)	$6138 (252.5 psia)
@25	HPFP Coolant Liner (P21A, P21B)	$FBB8 (-167 psia)	$0508 (196 psia)	$57E8 (3425 psia)	$6138 (3788 psia)

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART C - TEST LIMITS AND FAILURE IDENTIFICATIONS (Continued)

Sensor Identifier (Note 1)	SENSOR	TEST LIMITS (MEMORY DATA) (Notes 2,3 & 4) AMBIENT CONDITIONS MINIMUM	AMBIENT CONDITIONS MAXIMUM	SIMULATED OPERATION MINIMUM	SIMULATED OPERATION MAXIMUM
Temperature Sensors:					
@30	LPFP Discharge (T3A, T3B)	$7FF8 (58R)	$7FF8 (58R)	$1858 (36.5R)	$4728 (48.24R)
@31	Preburner Pump Discharge (T4A, T4B)	$7FF8 (242R)	$7FF8 (242R)	$3298 (188.11R)	$49D8 (203.63R)
@32	Deleted				
@33	Deleted				
@34	Controller Internal (T6A, T6B)	$10F8 (479.2R)	$4768 (632.3R)	$F1A8 (394.6R)	$1788 (497.2R)
@35	MCC Coolant (T5)	$E3B8 (482.3R)	$EEA8 (575.9R)	$D3A8 (348.5R)	$DF38 (444.4R)
@36	MOV Hydraulic (T7A, T7B)	$2208 (489R)	$3318 (559.3R)	$2ED8 (541.7R)	$3F28 (610R)
@37	MFV Hydraulic (T8A, T8B)	$2208 (489R)	$3318 (559.3R)	$2ED8 (541.7R)	$3F28 (610R)
@40	MCC LOX Dome (T9B)	$4E58 (488R)	$5C38 (560.7R)	$2E58 (325R)	$36D8 (367.5R)
@41	HPFT Discharge (T10A, T10B)	$FCE8 (427R)	$0318 (554R)	$35C8 (1544R)	$3808 (1587R)
@42	HPFT Discharge (T11A, T11B)	$FCE8 (427R)	$0318 (554R)	$35C8 (1544R)	$3808 (1587R)
@43	HPOT Discharge (T12A, T12B)	$FCE8 (427R)	$0318 (554R)	$35C8 (1544R)	$3808 (1587R)
@44	HPOT Discharge (T13A, T13B)	$FCE8 (427R)	$0318 (554R)	$35C8 (1544R)	$3808 (1587R)
@45	Cold Junction (T14A, T14B)	$13F8 (487R)	$3B98 (598R)	$F3A8 (400R)	$1028 (477R)

Table XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART C - TEST LIMITS AND FAILURE IDENTIFICATIONS (Continued)

Sensor Identifier (Note 1)	SENSOR	TEST LIMITS (MEMORY DATA) (Notes 2,3 & 5) AMBIENT CONDITIONS MINIMUM	AMBIENT CONDITIONS MAXIMUM	SIMULATED OPERATION MINIMUM	SIMULATED OPERATION MAXIMUM
Speed And Flow Sensors (bits 14-0):					
@50	HPFP Shaft Speed (N2A, N2B)	$7FFF (30.52 pps)	$0000 (30.52 pps)	$07A9 (510 pps)	$07F9 (490 pps)
@51, @52	Fuel Flowrate (Q1A1, Q1B1, (Q1A2, Q1B2)	$7FFF (10.16 pps)	$0000 (10.16 pps)	$0292 (506 pps)	$02A3 (494 pps)
@53	LPFP Shaft Speed (N1)	$7FFF (30.52 pps)	$0000 (30.52 pps)	$07A9 (510 pps)	$07F9 (490 pps)
@54	LPOP Shaft Speed (N3)	$7FFF (30.52 pps)	$0000 (30.52 pps)	$07A9 (510 pps)	$07F9 (490 pps)

Table XXVI

SENSOR CHECKOUT AND CALIBRATION (Continued)

PART C - TEST LIMITS AND FAILURE IDENTIFICATIONS (Continued)

Sensor Identifier (Note 1)	SENSOR	TEST LIMITS (MEMORY DATA) (Notes 2 & 3) AMBIENT CONDITIONS MINIMUM	AMBIENT CONDITIONS MAXIMUM	SIMULATED OPERATION MINIMUM	SIMULATED OPERATION MAXIMUM
Vibration Sensors:					
@60, @61	HPFP Accelerometers (V1A, V1B, V1CA, V1CB)	$F75C (-1.5 Grms)	$08A4 (1.5 Grms)	$4F6D (13.786 Grms)	$6B7C (18.656 Grms)
@62, @63	HPOP Accelerometers (V2A, V2B, V2CA, V2CB)	$F75C (-1.5 Grms)	$08A4 (1.5 Grms)	$4F6D (13.786 Grms)	$6B7C (18.656 Grms)

TABLE XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART C - TEST LIMITS AND FAILURE IDENTIFICATION (Continued)

Notes:

1. Failure Identification Words generated during Sensor Checkout are composed of three fields: the FID, sub step pointer, and sensor (under test) identifier.

   The FID field consists of bits 15 through 9. Contents of this field are 43/44 for a Channel A/B failure.

   The sub step pointer field consists of bits 8 through 6. Contents of this field are delineated in sub steps 2, 5, 8, and 10 in Part A.

   The sensor (under test) identifier field consists of bits 5 through 0. Contents of this field are specified in the Sensor Identifier column of this table.

2. Boundary conditions will be considered within the qualification region, i.e. qualified.

3. The ambient and engine conditions during Sensor Checkout are:

   - Ambient pressure will be 13 to 15 psia.
   - Ambient temperature will be 35 to 95 degrees F.
   - No propellants dropped in the system.
   - GN_2 purge gas to oxidizer system and HPOT seal will be turned off.
   - GN_2 and He pneumatic supplies should not be pressurized, otherwise anomalous errors may occur.
   - Hydraulic supply should not be pressurized, otherwise anomalous errors may occur.

4. Negative values are represented in two's complement with a 1 in the MSB.

5. The speed and flow sensors during ambient conditions will be verified to be either of the saturated values (i.e., $7FFF or $0000).

TABLE XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART D - SENSOR CALIBRATION

1) The scale factor coefficients shown in Table XXVII have the form:

$P = C_1 * S + C_o$ Where P = Physical Parameter Measurement (psia)
S = Sensor Output (mv)

2) The preflight calibration will compute the coefficients C_1 and C_0 as follows:

$C_1 = K80/(S80-Sa)$

$C_0 = Ka - C_1 * Sa$ Note: C_1 and C_0 must be computed for each MCC Pc sensor in each channel.

Where

S80 = Sensor channel input for simulated (80%) operating conditions from the average value of the accumulated running sum from substep 2 of sequence in Part A.

Sa = Sensor channel input for ambient conditions from the average value of the accumulated running sum from sub-step 5 of sequence in Part A.

3) Scaling coefficients D_1 and D_0 of Table XXVIII can then be calculated.

$$D_1 = \frac{C_1 * 2^{15}}{985.44}$$

and

$$D_0 = C_0$$

TABLE XXVI
SENSOR CHECKOUT AND CALIBRATION (Continued)

PART D - SENSOR CALIBRATION (Continued)

K80 and Ka = Individual sensor channel adaptation data constants as follows:

PRESSURE SENSORS	K80 (PSIA)	KA (PSIA)
MCC Pc (Main Combustion Chamber)	2785.3 (±140)	14.7
HPOP Discharge	5585.3 (±280)	14.7
LPFP Discharge	225.3 (±12)	14.7
Preburner Pump Discharge	7585.3 (±380)	14.7
LPOP Discharge	465.3 (±24)	14.7
Fuel System Purge	465.3 (±24)	14.7
HPOP Intermediate Seal (IMSL) Purge	465.3 (±24)	14.7
HPFP Discharge	7585.3 (±380)	14.7
Hydraulic System	3185.3 (±160)	14.7
Fuel Preburner Chamber	5585.3 (±280)	14.7
Fuel Preburner S/D Purge	1185.3 (±60)	14.7
Oxidizer Tank Pressurant	5585.3 (±280)	14.7
MCC Fuel Injection	3585.3 (±180)	14.7
Controller Internal	NA	NA
MCC Coolant	5585.3 (±280)	14.7
Oxidizer Preburner S/D Purge	1185.3 (±60)	14.7
Emergency Shutdown	1185.3 (±60)	14.7
Pogo Precharge	1185.3 (±60)	14.7
HPOT Secondary Seal Cavity	225.3 (±12)	14.7
HPFP Coolant Liner	3585.3 (±180)	14.7

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Table XXVII
SENSOR SCALE FACTORS

PART A - TEMPERATURE SENSORS
NOMINAL SENSOR DESIGN CRITERIA

Parameter	Parameter Range (R)	Characteristics (Notes 1, 2, 3)	Sensor Output Range
LPFP Discharge Temp	30 to 55	Corruccini Curve Fit	12 - 90 ohms
Preburner Pump Discharge Temp	160 to 230	Callendar-Van Dusen Equation	1188 - 2035 ohms
HPFT Discharge Temp (Thermocouple)	150 to 2450	Thermocouple Equation	-5.8 - 47 MV
HPOT Discharge Temp (Thermocouple)	150 to 2450	Thermocouple Equation	-5.8 - 47 MV
MOV Hydraulic Temp	360 to 760	Callendar-Van Dusen Equation	974 - 2177 ohms
MFV Hydraulic Temp	360 to 760	Callendar-Van Dusen Equation	974 - 2177 ohms
MCC Coolant Temp	50 to 650	Callendar-Van Dusen Equation	1 - 67 ohms
MCC LOX Dome Temp	110 to 610	Callendar-Van Dusen Equation	164 - 1735 ohms
Controller Internal Temp	140 to 760	Callendar-Van Dusen Equation	38 - 316 ohms
Cold Junction Temp	140 to 760	Callendar-Van Dusen Equation	38 - 316 ohms

Notes:

1. The Corruccini curve fit for LPFP discharge temp. sensors has the following nominal and envelope values:

Temperature (R)	:	0	36	37	38	39	40	41
Nominal (ohms)	:	0	25.0	27.0	29.5	31.5	34.5	37.0
Upper Limit (ohms)	:	0	28.6	30.8	33.2	35.6	38.4	41.2
Lower Limit (ohms)	:	0	20.6	23.0	25.4	27.4	30.2	33.4
Temperature (R)	:	42	43	44	45	46	47	48
Nominal (ohms)	:	39.5	43.0	46.5	49.3	53.5	57.0	61.0
Upper Limit (ohms)	:	44.0	47.0	50.4	54.0	57.6	61.2	65.4
Lower Limit (ohms)	:	36.2	39.2	42.6	45.6	49.4	53.0	57.0
Temperature (R)	:	49	50	51	52	53	54	55
Nominal (ohms)	:	65.3	69.5	74.5	79.0	83.5	89.0	94.0
Upper Limit (ohms)	:	69.6	74.2	79.0	83.4	88.2	93.0	98.0
Lower Limit (ohms)	:	61.0	66.0	70.0	75.0	80.0	85.0	90.0

The upper and lower limits represent an overall envelope, not a specific sensor calibration. The characteristics of individual sensors may have any curvature(s) within the envelope.

Table XXVII
SENSOR SCALE FACTORS (Continued)

PART A - TEMPERATURE SENSORS (Continued)
NOMINAL SENSOR DESIGN CRITERIA

Notes:

2. The Callendar-Van Dusen Equation for temperatures greater than or equal to -183.0 degrees C is:

$R_S/R_0 = 1 + A*[T - D*T*(T - 100)/10^4 - B*T^3*(T-100)/10^8]$

where

R_S = Sensor resistance in ohms at temperature T.

R_0 = Sensor resistance in ohms at 0 degrees centigrade
= 5000 ± 10 ohms for LPFP and Preburner Pump Discharge Temp. sensors
= 50 ± 1 ohms for the MCC Coolant Temp. sensors.
= 1380 ± 3 ohms for MOV and MFV Hydraulic and MCC Lox Dome Temp. sensors.
= 100 ± 1 ohms for spare Skin Temp. sensors.
= 200 ± 2 ohms for Controller Internal Temp. and Cold Junction Temp. sensors.

T = Temperature in degrees centigrade.

A = 0.00389 to 0.0039275

B = 0.11 ± 0.035, below 0 degrees centigrade; 0, above 0 degrees centigrade

D = 1.492 ± 0.07

3. The NBS Thermocouple Equation for a temperature range of 0 to 1370 degrees Centigrade at a reference cold junction temperature of 0 degrees Centigrade is:

$$T = a_0 + a_1x^1 + a_2x^2 + a_3x^3 + . . . + a_8x^8$$

Where: T = Temperature (Centigrade)
x = Thermocouple voltage (Vdc)
a = Polynomial coefficients

For type K (Chromel-Alumel) Thermocouple:

a_0 = 0.226584602	a_5 = 4.83506E+10
a_1 = 24152.10900	a_6 = -1.18452E+12
a_2 = 67233.4248	a_7 = 1.38690E+13
a_3 = 2210340.682	a_8 = -6.33708E+13
a_4 = -860963914.9	

The cold junction temperature will be provided by a Resistance Temperature Detector temperature sensor mounted on the controller case at the thermocouple interface connector.

Table XXVII
SENSOR SCALE FACTORS (Continued)

Part B - NON-TEMPERATURE SENSORS

Non-temperature sensors use a first degree correlation:

$P = C_1*S + C_0$ **Where** P = Physical Parameter Measurement
S = Sensor output

Parameter	Parameter Range	C_1 (Note 3)	C_0 (Note 3)	Sensor Output Range
MCC Pc (Note 1)	0 to 3500 psia	116.7	0.0	0 to 30mv
LPFP Discharge Press. (Note 1)	0 to 300 psia	10.0	0.0	0 to 30mv
LPOP Discharge Press. (Note 1)	0 to 600 psia	20.0	0.0	0 to 30mv
HPOP IMSL Purge Press. (Note 1)	0 to 600 psia	20.0	0.0	0 to 30mv
Fuel System Purge Press. (Note 1)	0 to 600 psia	20.0	0.0	0 to 30mv
FPB S/D Purge Press. (Note 1)	0 to 1500 psia	50.0	0.0	0 to 30mv
OPB S/D Purge Press. (Note 1)	0 to 1500 psia	50.0	0.0	0 to 30mv
Emergency S/D Press. (Note 1)	0 to 1500 psia	50.0	0.0	0 to 30mv
Pogo Precharge Press. (Note 1)	0 to 1500 psia	50.0	0.0	0 to 30mv
HPOT Secondary Seal Cavity Press. (Note 1)	0 to 300 psia	10.0	0.0	0 to 30mv
HPFP Coolant Liner Press. (Note 1)	0 to 4500 psia	150.0	0.0	0 to 30mv
PBP Discharge Press. (Notes 1,2)	0 to 9500 psia	316.7	0.0	0 to 30mv
HPOP Discharge Press. (Notes 1,2)	0 to 7000 psia	233.3	0.0	0 to 30mv
HPFP Discharge Press. (Notes 1,2)	0 to 9500 psia	316.7	0.0	0 to 30mv
Hydraulic System Press. (Notes 1,2)	0 to 4000 psia	133.3	0.0	0 to 30mv
Fuel Preburner Chamber Press. (Notes 1,2)	0 to 7000 psia	233.3	0.0	0 to 30mv
Oxidizer Tank Pressurant Press. (Notes 1,2)	0 to 7000 psia	233.3	0.0	0 to 30mv
MCC Fuel Injection Press. (Notes 1,2)	0 to 4500 psia	150.0	0.0	0 to 30mv
Controller Int Press. (Notes 1,2)	0 to 50 psia	1.7	0.0	0 to 30mv
MCC Coolant Press. (Notes 1,2)	0 to 7000 psia	233.3	0.0	0 to 30mv

Table XXVII
SENSOR SCALE FACTORS (Continued)

Part B - NON-TEMPERATURE SENSORS (Continued)

Non-temperature sensors use a first degree correlation:

$P = C_1 * S + C_0$ Where P = Physical Parameter Measurement
S = Sensor output

Parameter	Parameter Range	C_1 (Note 3)	C_0 (Note 3)	Sensor Output Range
Fuel Flowrate	0 to 24000 gpm	(Note 5)	0.0 (+150,-50)	10 to 350 pps
HPFP Shaft Speed	0 to 45000 rpm	15.0	0.0	40 to 3k pps
LPFP Shaft Speed (Note 2)	0 to 20000 rpm	7.5	0.0	40 to 3k pps
LPOP Shaft Speed (Note 2)	0 to 6000 rpm	4.0	0.0	40 to 3k pps
MFV Position RVDT (Note 6,7)	0 to 100 % Open	66.87 ($\pm$6.7)	-12.11 (+5,-2)	0.09289 to 1.765 Vrms
MOV Position RVDT (Note 6,7)	0 to 100 % Open	66.87 ($\pm$6.7)	-12.11 (+5,-2)	0.09289 to 1.765 Vrms
CCV Position RVDT (Note 6,7)	0 to 100 % Open	71.31 ($\pm$7.1)	-16.24 (+5,-2)	0.09289 to 1.765 Vrms
FPOV Position RVDT (Note 6,7)	0 to 100 % Open	71.31 ($\pm$7.1)	-16.24 (+5,-2)	0.09289 to 1.765 Vrms
OPOV Position RVDT (Note 6,7)	0 to 100 % Open	71.31 ($\pm$7.1)	-16.24 (+5,-2)	0.09289 to 1.765 Vrms
HPFP Accel. #1 (V1A)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPFP Accel. #2 (V1B)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPFP Accel. #3 (V1CA)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPFP Accel. #3 (V1CB)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPOP Accel. #1 (V2A)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPOP Accel. #2 (V2B)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPOP Accel. #3 (V2CA)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
HPOP Accel. #3 (V2CB)	0 to 20 Grms	0.4651 ($\pm$0.04)	0.0	0 to 43 mv rms
Pogo RIV RVDT	0 to 100 % Open	69.93 ($\pm$7.0)	-11.89 ($\pm$10)	0.17 to 1.60 Vrms
Fuel Bleed Valve LVDT (Note 8)	0 to 100 % Open	If phase < 5° (i.e., position < 50%) -100 ($\pm$5.0) If phase > 175° (i.e., position > 50%) 100 ($\pm$5.0)	 50 ($\pm$2.0) 50 ($\pm$2.0)	0.5 to 0.0 Vpp; 0° to 180° phase shift
Oxidizer Bleed Valve LVDT (Note 8)	0 to 100 % Open	If phase < 5° (i.e., position < 50%) -100 ($\pm$5.0) If phase > 175° (i.e., position > 50%) 100 ($\pm$5.0)	 50 ($\pm$2.0) 50 ($\pm$2.0)	0.5 to 0.0 Vpp; 0° to 180° phase shift
Antiflood Valve LVDT (Note 9)	0 to 100 % Open	If phase > 175° (i.e., position < 50%) -100 ($\pm$5.0) If phase < 5° (i.e., position > 50%) 100 ($\pm$5.0)	 50 ($\pm$2.0) 50 ($\pm$2.0)	0.5 to 0.0 Vpp; 180° to 0° phase shift

Table XXVII
SENSOR SCALE FACTORS (Continued)

Part B - NON-TEMPERATURE SENSORS (Continued)

NOTES:

1. Coefficients for this parameter are computed during sensor calibration. (See 3.2.3:2.3.1 and Table XXVI, Part D).

2. These parameters are only reported as scaled values in the VDT. No other processing or monitoring is performed by the operational program except for Sensor Checkout.

3. Values shown are nominal with the range of adaptation given in parentheses.

4. Deleted.

5. This coefficient will be a function of MCC Pc as follows:

   C_1 = M*X+B

   Where

   M is defined nominally as 4.3513 ($\pm$0.3) and will be an adaptation data constant (gpm/pps)

   X is MCC_Pc (psia)/Rated_Power_Level (psia)

   B is 64.2201 ($\pm$10.0) and will be an adaptation data constant (gpm/pps)

   Calculated C_1 value will be constrained by lower limit. If calculated C_1 is less than the lower limit, then C_1 will be set to the lower limit (adaptation data).

   Nominal value of the lower limit will be 68.5714 gpm/pps.

   C_1 is synonymous with K_f.

6. Position RVDT scaling coefficients to be used when determining RVDT position for monitoring purposes (for example, RVDT comparison test). The coefficients are required to compensate for physical/calibration differences of the actuators.

7. The sensor output range values represent the maximum range of voltage that the RVDT position sensors are designed to output. This range is larger than the maximum range of the propellant valves.

Table XXVII
SENSOR SCALE FACTORS (Continued)

8. For Fuel Bleed Valve and Oxidizer Bleed Valve LVDTs, phase shift ($^\circ$) and amplitude (Vpp) are dependent on LVDT position:

Position	Amplitude	Phase Shift
0 % Open	0.5 Vpp	0° (+/- 5°)
50 % Open	Electrical Null	Not Specified
100 % Open	0.5 Vpp	180° (+/- 5°)

9. For the Antiflood Valve LVDTs phase shift ($^\circ$) and amplitude (Vpp) are dependent on LVDT position:

Position	Amplitude	Phase Shift
0 % Open	0.5 Vpp	180° (+/-5°)
50 % Open	Electrical Null	Not Specified
100 % Open	0.5 Vpp	0° (+/- 5°)

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE

PART A. SHAFT SPEED, FREQUENCY and FLOWRATE SENSORS (Notes 1,2)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 3)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 4)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 5,6)
1. HPFP Shaft Speed 2. 0-45000 rpm	N2A N2B	$820160 $820162	40 pps to 3k pps	a. $6C81 to $014A b. $07A9 to $07F9 c. $7FFF or $0000	$M_{DEC} = (1.0 \times 10^6)/$ (Sensor Output [pps])	$D_1 = 15.0 \times 10^6$ $D_0 = 0.0$
1. Spare Shaft Speed 2. N/A	N4A N4B	$820164 $820166	N/A	N/A	N/A	N/A
1. LPFP Shaft Speed 2. 0-20000 rpm	N1 no B	$820168 no B	40 pps to 3k pps	Same as N2A	Same as N2A	$D_1 = 7.5 \times 10^6$ $D_0 = 0.0$
1. LPOP Shaft Speed 2. 0-6000 rpm	no A N3	no A $82016A	40 pps to 3k pps	Same as N2A	Same as N2A	$D_1 = 4.0 \times 10^6$ $D_0 = 0.0$
1. LVDT/RVDT 2khz Excitation 2. N/A	TRCA TRCB	$82016C $82016E	N/A	a. (Note 7) b. N/A c. N/A	Same as N2A	$D_1 = 1.0 \times 10^6$ $D_0 = 0.0$
1. Fuel Flowrate 2. 0-24000 gpm	Q1A1 Q1B1 Q1A2 Q1B2 (Note 9)	$820174 $820176 $820178 $82017A	12 pps to 340 pps	a. $6E41 to $03D2 b. $0292 to $02A3 c. $7FFF or $0000	$M_{DEC} = ((1/3) \times 10^6)/$ (Sensor Output [pps])	$D_1 =$ (Note 8) $D_0 = 0.0$

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART A. SHAFT SPEED, FREQUENCY and FLOWRATE SENSORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 3)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 4)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 5,6)
1. AAAA Pattern 2. N/A	TW1A TW2B TW3A TW4B TW5A TW6B TW7A TW8B	$820000 $820006 $820008 $82000E $820010 $820016 $820018 $82001E	N/A	a. $AAAA b. N/A c. N/A	N/A Note: This is an IE hardware test pattern.	N/A
1. 5555 Pattern 2. N/A	---- TW1B TW2A TW3B TW4A TW5B TW6A TW7B TW8A ----	------- $820002 $820004 $82000A $82000C $820012 $820014 $82001A $82001C -------	N/A	a. $5555 b. N/A c. N/A	N/A Note: This is an IE hardware test pattern.	N/A
1. CCCC Pattern 2. N/A	TW9A TW9B	$82017C $82017E	N/A	a. $CCCC b. N/A c. N/A	N/A Note: This is an IE hardware test pattern.	N/A

NOTES:

1. The hardware requires 51.0 usec to write the contents of the first PRC into its DPM memory location and 50.0 usec for each subsequent location.

2. The lowest detectable value of the Shaft Speeds, RVDT/LVDT Excitation Frequency and Fuel Flowrate corresponds to the maximum value that can be retained in the PRC registers. As the value of the physical parameter approaches zero, the value in the IE DPM will be constrained by hardware in the CIE, thereby yielding a detectable sensor output range indicated in this table.

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART A. SHAFT SPEED, FREQUENCY and FLOWRATE SENSORS (Continued)

NOTES:

3. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Ranges a and b include Controller monitor circuit tolerances only.

4. M_{DEC} contains the 15 LSBs of the 16-bit data word stored in the IE DPM. The MSB of each PRC data word is a toggle bit generated by hardware.

5. The function IE DPM value to Shaft Speed, RVDT/LVDT Excitation Frequency or Fuel Flowrate is of the form:

   Physical Parameter = $(D_1 / X) + D_0$

   Where a) $X = M_{DEC}$; with binary scale factors associated with $0 \leq X < 2^{15}$, i.e., F0.

   b) The nominal values for D_1 and D_0 are specified in this table.

6. With the exception of Fuel Flowrate, D_1 and D_0 for each sensor are independent adaptation data constants, alterable during memory load only. All 4 Fuel Flowrate sensors will have identical scaling coefficients (D_0, D_1).

7. See Table XXXIV for values.

8. $D_1 = (C_1 \times 1/3) \times 10^6$, where C1 for Fuel Flowrate is a function of MCC Pc as defined in Table XXVII, Part B, Note 5.

9. Flowrate sensors Channels A1 and A2 are outputs of the same device, as are Channels B1 and B2.

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART B. PRESSURE SENSORS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. Pressure MUX Ground 2. N/A	RC01 RC00	$820180 $820182	0.0 Vdc Nominal	a. $FED8 to $0138 b. $FED8 to $0138 c. $FED8 to $0138	M_{DEC} = (Vdc) x (985440)	N/A
1. Pressure MUX Calibration 2. N/A	RC03 RC02	$820184 $820186	0.02526 Vdc Nominal	a. $6038 to $6238 b. $6038 to $6238 c. $6038 to $6238	Same as RC01	N/A
1. MCC Pc (Main Combustion Chamber) 2. 0-3500 psia	P9A1 P9B1 P9A2 P9B2	$82018C $82018E $820194 $820196	0-30 mv	a. $FED8 to $74A8 b. $57E8 to $6138 c. $FBC8 to $0518	M_{DEC} = (Sensor Output [mv]) x (985.44)	D_1 = 3880.89 D_0 = 0.0
1. LPFP Discharge 2. 0-300 psia	P1A P1B	$82019C $82019E	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $0068 to $0A68	Same as P9A1	D_1 = 332.648 D_0 = 0.0
1. HPOP Discharge 2. 0-7000 psia	P5 no B	$8201A0 no B	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FB98 to $04D8	Same as P9A1	D_1 = 7761.78 D_0 = 0.0
1. Preburner Pump Discharge 2. 0-9500 psia	no A P6	no A $8201A2	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FB88 to $04C8	Same as P9A1	D_1 = 10533.8 D_0 = 0.0
1. HPOP Intermediate Seal (IMSL) Purge 2. 0-600 psia	P15A P15B	$8201A4 $8201A6	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FDE8 to $0788	Same as P9A1	D_1 = 665.295 D_0 = 0.0
1. HPOT Secondary Seal Cavity 2. 0-300 psia	P16A P16B	$8201A8 $8201AA	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $0068 to $0A68	Same as P9A1	D_1 = 332.648 D_0 = 0.0
1. HPFP Coolant Liner 2. 0-4500 psia	P21A P21B	$8201AC $8201AE	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FBB8 to $0508	Same as P9A1	D_1 = 4989.71 D_0 = 0.0
1. LPOP Discharge 2. 0-600 psia	P4A P4B	$8201B0 $8201B2	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FDE8 to $0788	Same as P9A1	D_1 = 665.295 D_0 = 0.0

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART B. PRESSURE SENSORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. Fuel System Purge 2. 0-600 psia	P8A P8B	$8201B4 $8201B6	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FDE8 to $0788	Same as P9A1	D_1 = 665.295 D_0 = 0.0
1. HPFP Discharge 2. 0-9500 psia	P2 no B	$8201B8 no B	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FB88 to $04C8	Same as P9A1	D_1 = 10533.8 D_0 = 0.0
1. Hydraulic System 2. 0-4000 psia	no A P12	no A $8201BA	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6308 c. $FBC8 to $06A8	Same as P9A1	D_1 = 4435.30 D_0 = 0.0
1. Fuel Preburner Chamber 2. 0-7000 psia	P3 no B	$8201BC no B	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FB98 to $04D8	Same as P9A1	D_1 = 7761.78 D_0 = 0.0
1. Fuel Preburner S/D Purge 2. 0-1500 psia	P13 no B	$8201C0 no B	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FC68 to $05C8	Same as P9A1	D_1 = 1663.24 D_0 = 0.0
1. Oxidizer Tank Pressurant 2. 0-7000 psia	no A P14	no A $8201C2	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FB98 to $04D8	Same as P9A1	D_1 = 7761.78 D_0 = 0.0
1. MCC Fuel Injection 2. 0-4500 psia	P10 no B	$8201C4 no B	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FBB8 to $0508	Same as P9A1	D_1 = 4989.71 D_0 = 0.0
1. Controller Internal 2. 0-50 psia	P17A P17B	$8201C8 $8201CA	0-30 mv	a. $FE48 to $7538 b. $22C8 to $4488 c. $22C8 to $4488	Same as P9A1	D_1 = 55.4413 D_0 = 0.0
1. MCC Coolant 2. 0-7000 psia	P11 no B	$8201CC no B	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FB98 to $04D8	Same as P9A1	D_1 = 7761.78 D_0 = 0.0
1. Oxidizer Preburner S/D Purge 2. 0-1500 psia	no A P19	no A $8201CE	0-30 mv	a. $FE48 to $7538 b. $57E8 to $6138 c. $FC68 to $05C8	Same as P9A1	D_1 = 1663.24 D_0 = 0.0

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART B. PRESSURE SENSORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. Emergency Shutdown 2. 0-1500 psia	P20A P20B	\$8201D0 \$8201D2	0-30 mv	a. \$FE48 to \$7538 b. \$57E8 to \$6138 c. \$FC68 to \$05C8	Same as P9A1	D_1 = 1663.24 D_0 = 0.0
1. Pogo Precharge 2. 0-1500 psia	P18A P18B	\$8201D4 \$8201D6	0-30 mv	a. \$FE48 to \$7538 b. \$57E8 to \$6138 c. \$FC68 to \$05C8	Same as P9A1	D_1 = 1663.24 D_0 = 0.0
1. Spare One 2. N/A	PS1A PS1B	\$8201D8 \$8201DA	0-30 mv	a. \$FE48 to \$7538 b. \$5AA8 to \$5E18 c. N/A	Same as P9A1	N/A
1. Spare Two 2. N/A	PS2A PS2B	\$8201DC \$8201DE	0-30 mv	a. \$FE48 to \$7538 b. \$5AA8 to \$5E18 c. N/A	Same as P9A1	N/A
1. Pressure MUX Calibration 2. N/A	RC07 RC06	\$8201E0 \$8201E2	0.02526 Vdc Nominal	a. \$6038 to \$6238 b. \$6038 to \$6238 c. \$6038 to \$6238	Same as RC01	N/A

NOTES:

1. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Ranges include Controller monitor circuit tolerances except P17A/P17B which include sensor tolerances also. Except for P17A/P17B ranges b and c include the combination of sensor and IE tolerances for a total of 4%.

2. To change M_{DEC} to a Hex value: Convert M_{DEC} to M_{HEX} and then change the least significant Hex digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit Hex numbers which translate to a 16-bit memory word.

   Example: M_{DEC} at 30 mv Sensor Output = 30 x 985.44 = 29563, where 29563 = $737B which corresponds to the value of $7378.

3. The function relating IE DPM value to pressure is of the form:

   Pressure (psia) = $(D_1 * X) + D_0$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.
   b) The nominal values of D_1 and D_0 are specified in this table.

4. D_1 and D_0 for each sensor are independent adaptation data constants, alterable during load and sensor checkout.

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART C. TEMPERATURE SENSORS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE (Note 1)	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 2)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Notes 1,3)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 4,5,6)
1. Temperature MUX Ground 2. N/A	RC11 RC10	\$820100 \$820102	0.0 Vdc Nominal	a. \$FED8 to \$0138 b. \$FED8 to \$0138 c. \$FED8 to \$0138	M_{DEC} = (VDC) x (169321)	N/A
1. Temperature MUX Calibration 2. N/A	RC13 RC12	\$820104 \$820106	0.143585 Vdc Nominal	a. \$5DF8 to \$5FF8 b. \$5DF8 to \$5FF8 c. \$5DF8 to \$5FF8	Same as RC11	N/A
1. Spare HPFT Discharge 2. 150R to 2450R	T1A T1B	\$820108 \$82010A	R_s	a. \$01C8 to \$7118 b. \$34D8 to \$3F48 c. \$1588 to \$1C28	$M_{DEC} = (R_s - 4.99) / (1.2408 \times 10^{-6} R_s + .0076031)$	N/A
1. Spare HPOT Discharge 2. 150R to 2450R	T2A T2B	\$82010C \$82010E	R_s	Same as T1A	Same as T1A	N/A
1. HPOT Discharge (Thermocouple) 2. 150R to 2450R	T13A T13B	\$820110 \$820112	V_s (Note 7)	a. \$F348 to \$6758 b. \$35C8 to \$3808 c. \$FE48 to \$0518	$M_{DEC} = V_s$(mVDC) x 564.685 (Note 8)	D_4 = -1522.81 D_3 = 3516.28 D_2 = -2431.19 D_1 = 3056.02 D_0 = 475.685
1. LPFP Discharge 2. 30R to 55R For Propellant Drop 360R to 700R	T3A T3B	\$820114 \$820116	R_s	a. \$0218 to \$6798 b. \$1858 to \$4728 c. \$7FF8 to \$7FF8 d. \$D408 to \$B938 360R = \$BA18 390R = \$BD48 700R = \$D238 720R = \$D318	$M_{DEC} = (R_s - 10.0) / (0.8408 \times 10^{-6} R_s + .0029864)$ For Propellant Drop $M_{DEC} = (-1.2665 \times 10^{8}) / (3551 + R_s)$	D_4 = -14.2993 D_3 = 50.9754 D_2 = -72.1493 D_1 = 66.6143 D_0 = 26.1094

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART C. TEMPERATURE SENSORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE (Note 1)	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 2)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Notes 1,3)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 4,5,6)
1. Cold Junction 2. 140R to 760R	T14A T14B	$820118 $82011A	R_s	a. $8918 to $7958 b. $F3A8 to $1028 c. $13F8 to $3B98	$M_{DEC} = (R_s - 174)/(0.9684 \times 10^{-6} R_s + 0.0045352)$	D_4 = 0.147408 D_3 = 1.41303 D_2 = 20.2529 D_1 = 345.47 D_0 = 433.06
1. Preburner Pump Discharge 2. 160R to 230R For Propellant Drop 360R to 700R	T4A T4B	$82011C $82011E	R_s	a. $0418 to $7358 b. $3298 to $49D8 c. $7FF8 to $7FF8 d. $DE08 to $E598 360R = $DE48 390R = $DF08 700R = $E4F8 720R = $E5F8	$M_{DEC} = (R_s - 1150)/(2.2349 \times 10^{-6} R_s + .0256836)$ For Propellant Drop $M_{DEC} = (-1.2975 \times 10^8)/(11492 + R_s)$	D_4 = 0.0594892 D_3 = 0.52213 D_2 = 5.64012 D_1 = 79.5378 D_0 = 155.776
1. MCC Coolant 2. 50R to 650R	no A T5	no A $820122	R_s	a. $AEE8 to $F868 b. $D3A8 to $DF38 c. $E3B8 to $EEA8	$M_{DEC} = (R_s - 75)/(0.7487 \times 10^{-6} R_s + .0036120)$	D_4 = 11.856 D_3 = 29.4636 D_2 = 144.8564 D_1 = 1144.6 D_0 = 728.681
1. Controller Internal 2. 140R to 760R	T6A T6B	$820124 $820126	R_s	a. $8918 to $7958 b. $F1A8 to $1788 c. $10F8 to $4768	$M_{DEC} = (R_s - 174)/(0.9684 \times 10^{-6} R_s + 0.0045352)$	D_4 = 0.147408 D_3 = 1.41303 D_2 = 20.2529 D_1 = 345.47 D_0 = 433.06
1. MOV Hydraulic 2. 360R to 760R	T7A T7B	$820128 $82012A	R_s	a. $00B8 to $6268 b. $2ED8 to $3F28 c. $2208 to $3318	$M_{DEC} = (R_s - 953)/(0.8852 \times 10^{-6} R_s + 0.0471343)$	D_4 = 18.7672 D_3 = -31.87 D_2 = 58.6608 D_1 = 496.321 D_0 = 353.494

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART C. TEMPERATURE SENSORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE (Note 1)	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 2)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Notes 1,3)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 4,5,6)
1. MFV Hydraulic 2. 360R to 760R	T8A T8B	\$82012C \$82012E	R_s	a. \$00B8 to \$6268 b. \$2ED8 to \$3F28 c. \$2208 to \$3318	Same as T7A	D_4 = 18.7672 D_3 = -31.87 D_2 = 58.6608 D_1 = 496.321 D_0 = 353.494
1. Spare MCC LOX Dome 2. 110R to 610R	T9A no B	\$820130 no B	R_s	a. \$FFD8 to \$6618 b. N/A c. \$4E58 to \$5C38	Same as T9B	N/A
1. MCC LOX Dome 2. 110R to 610R	no A T9B	no A \$820132	R_s	a. \$FFD8 to \$6618 b. \$2E58 to \$36D8 c. \$4E58 to \$5C38	$M_{DEC} = (R_s - 150) / (1.0350 \times 10^{-6} R_s + 0.0594522)$	D_4 = 17.3227 D_3 = -51.598 D_2 = 115.937 D_1 = 566.848 D_0 = 106.883
1. HPFT Discharge (Thermocouple) 2. 150R to 2450R	T10A T10B	\$820134 \$820136	V_s (Note 7)	Same as T13A	Same as T13A (Note 8)	Same as T13A
1. HPFT Discharge (Thermocouple) 2. 150R to 2450R	T11A T11B	\$820138 \$82013A	V_s (Note 7)	Same as T13A	Same as T13A (Note 8)	Same as T13A

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART C. TEMPERATURE SENSORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE (Note 1)	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 2)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Notes 1,3)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 4,5,6)
1. Spare Hot Gas 2. 150R to 2450R	T15A T15B	$82013C $82013E	R_s	a. $01C8 to $7118 b. N/A c. $1588 to $1C28	Same as T1A	N/A
1. HPOT Discharge (Thermocouple) 2. 150R to 2450R	T12A T12B	$820140 $820142	V_s (Note 7)	Same as T13A	Same as T13A (Note 8)	Same as T13A
1. Temperature MUX Calibration 2. N/A	RC17 RC16	$820144 $820146	0.143585 Vdc Nominal	a. $5DF8 to $5FF8 b. $5DF8 to $5FF8 c. $5DF8 to $5FF8	Same as RC11	N/A

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

NOTES:

1. R_s is the sensor output in ohms and is a function of temperature. See Table XXVII for the methods used to correlate sensor resistance (R_s) with temperature.

2. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)
   d. Checkout Group 2 Switches Energized (Propellant Drop)

   Ranges include Controller monitor circuit tolerances except T6A/T6B which include sensor tolerances also. Except for T6A/T6B ranges b and c include the combination of sensor and IE tolerances for a total of 1.5%.

3. To change M_{DEC} to the equivalent Hex value: Convert M_{DEC} to M_{HEX} and then change the least significant Hex digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit Hex numbers which translate to a 16-bit memory word.

   Example: Reference Note 2 of Part B.

4. The function relating IE DPM value to temperature is of the form:

$$\text{Temperature } [^{\circ}R] = (D_4 * X^4) + (D_3 * X^3) + (D_2 * X^2) + (D_1 * X^1) + D_0$$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.
   b) The nominal values of D_4, D_3, D_2, D_1 and D_0 are specified in this table.

5. D_4, D_3, D_2, D_1 and D_0 for each sensor are independent adaptation data constants alterable during memory load only.

6. D_4, D_3, D_2, D_1 and D_0 coefficients in this table only refer to scaling used when both Group Switches are deactivated.

7. V_s is the sensor output in millivolts and is a function of temperature. See Table XXVII for the methods used to correlate sensor millivolts (V_s) with temperature.

8. Prior to scaling, these raw M_{DEC} values must be adjusted by adding the value of the following correction function:

   For each channel, determine the cold junction temperature correction from the following function:

   Delta Mdec = A0 + (A1 * Tcj)

   where:

   Delta Mdec = Correction for cold junction temperature
   A0, A1 = Coefficients for the correction function
   A0 = -6041.07
   A1 = 12.3560
   Tcj = Temperature (Cold Junction), Deg R

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART D. VIBRATION SENSORS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. HPFP Accelerometers 2. 0-20 Grms	V1A V1B	$820064 $820066	0-43.0 mv rms	a. $F7C8 to $7BD8 b. $4F6D to $6B7C c. $F75C to $08A4	M_{DEC} = (Sensor Output [mv rms]) x (686.01)	D_1 = 22.2168 D_0 = 0.0
1. HPOP Accelerometers 2. 0-20 Grms	V2A V2B	$820068 $82006A	0-43.0 mv rms	Same as V1A	Same as V1A	D_1 = 22.2168 D_0 = 0.0
1. HPFP Accel Ch C 2. 0-20 Grms	V1CA V1CB	$82006C $82006E	0-43.0 mv rms	Same as V1A	Same as V1A	D_1 = 22.2168 D_0 = 0.0
1. HPOP Accel Ch C 2. 0-20 Grms	V2CA V2CB	$820070 $820072	0-43.0 mv rms	Same as V1A	Same as V1A	D_1 = 22.2168 D_0 = 0.0

NOTES:

1. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Ranges a and b include Controller monitor circuit tolerances only. Range c includes a total tolerance of 7.5%.

2. To change M_{DEC} to the equivalent Hex value: Convert M_{DEC} to M_{HEX} and then change the least significant Hex digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit Hex numbers which translate to a 16-bit memory word.

   Example: Reference Note 2 of Part B.

3. The function relating IE DPM value to acceleration is of the form:

   Acceleration $[G_{rms}] = (D_1 * X) + D_0$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.

   b) The nominal values of D_1 and D_0 are specified in this table.

4. D_1 and D_0 for each sensor are independent adaptation data constants, alterable during memory load only.

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART E. ACTUATOR and ON-OFF VALVE POSITIONS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. MFV Actuator RVDT 2. 0% (Closed) to 100% (Open)	A1A A1B	$820024 $820026	0.18113 Vrms to 1.67660 Vrms	a. $F618 to $9788 b. N/A c. N/A	M_{DEC} = (Sensor Output [Vrms]) x (-15765)	D_1 = -138.988 D_0 = -12.11
1. MOV Actuator RVDT 2. 0% (Closed) to 100% (Open)	A2A A2B	$820028 $82002A	0.18113 Vrms to 1.67660 Vrms	a. $F618 to $9788 b. N/A c. N/A	Same as A1A (MFV)	D_1 = -138.988 D_0 = -12.11
1. CCV Actuator RVDT 2. 0% (Closed) to 100% (Open)	A3A A3B	$82002C $82002E	0.2277 Vrms to 1.630 Vrms	a. $F328 to $9A68 b. N/A c. N/A	Same as A1A (MFV)	D_1 = -148.222 D_0 = -16.237
1. FPOV Actuator RVDT 2. 0% (Closed) to 100% (Open)	A4A A4B	$820030 $820032	0.2277 Vrms to 1.630 Vrms	a. $F328 to $9A68 b. N/A c. N/A	Same as A1A (MFV)	D_1 = -148.222 D_0 = -16.237
1. OPOV Actuator RVDT 2. 0% (Closed) to 100% (Open)	A5A A5B	$820034 $820036	0.2277 Vrms to 1.630 Vrms	a. $F328 to $9A68 b. N/A c. N/A	Same as A1A (MFV)	D_1 = -148.222 D_0 = -16.237
1. Spare Actuator 2. N/A	A6A A6B	$820038 $82003A	N/A	N/A	Same as A1A (MFV)	N/A
1. Pogo RIV 2. 0% (Closed) to 100% (Open)	RIV no B	$82003C no B	0.17 Vrms to 1.60 Vrms	a. $09B8 to $7598 b. N/A c. N/A	M_{DEC} = (Sensor Output [Vrms]) x (18405)	D_1 = 124.502 D_0 = -11.888
1. Fuel Bleed Valve LVDT 2. 0% (Closed) to 100% (Open)	FBV no B	$820044 no B	0.5 V_{pp} at 0° 0.5 V_{pp} at 180°	a. $7C08 to $83F8 b. N/A c. N/A	If phase < 5° (i.e., position < 50%) M_{DEC} = (V_{pp}) x (59341.0) If phase > 175° (i.e., position > 50%) M_{DEC} = -(V_{pp}) x (59341.0)	D_1 = -55.22 D_0 = 50.0

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART E. ACTUATOR and ON-OFF VALVE POSITIONS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. Oxidizer Bleed Valve LVDT 2. 0% (Closed) to 100% (Open)	no A OBV	no A $820046	0.5 V_{pp} at 0° 0.5 V_{pp} at 180°	a. $7C08 to $83F8 b. N/A c. N/A	If phase < 5° (i.e., position < 50%) $M_{DEC} = (V_{pp}) \times (59341.0)$ If phase > 175° (i.e., position > 50%) $M_{DEC} = -(V_{pp}) \times (59341.0)$	$D_1 = -55.22$ $D_0 = 50.0$
1. Antiflood Valve LVDT 2. 0% (Closed) to 100% (Open)	AFVA AFVB	$820048 $82004A	0.5 V_{pp} at 180° 0.5 V_{pp} at 0°	a. $83F8 to $7C08 b. N/A c. N/A	If phase > 175° (i.e., position < 50%) $M_{DEC} = -(V_{pp}) \times (59341.0)$ If phase < 5° (i.e., position > 50%) $M_{DEC} = (V_{pp}) \times (59341.0)$	$D_1 = 55.22$ $D_0 = 50.0$
1. Spare On-Off Valve 2. N/A	POS1A POS1B	$82004C $82004E	N/A	N/A	Same as FBV	N/A
1. Spare On-Off Valve 2. N/A	POS2A POS2B	$820050 $820052	N/A	N/A	Same as FBV	N/A
1. Spare On-Off Valve 2. N/A	POS3A POS3B	$820054 $820056	N/A	N/A	Same as FBV	N/A
1. Spare On-Off Valve 2. N/A	POS4A POS4B	$820058 $82005A	N/A	N/A	Same as FBV	N/A
1. Spare On-Off Valve 2. N/A	POS5A POS5B	$82005C $82005E	N/A	N/A	Same as FBV	N/A

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART E. ACTUATOR and ON-OFF VALVE POSITIONS (Continued)

NOTES:

1. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Ranges include Controller monitor circuit tolerances only.

2. To change M_{DEC} to the equivalent Hex value: Convert M_{DEC} to M_{HEX} and then change the least significant Hex digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit Hex numbers which translate into a 16-bit memory word.

   Example: Reference Note 2 of Part B.

3. The function relating IE DPM value to valve position is of the form:

   Valve Position [% of full scale] = $(D_1 * X) + D_0$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.

   b) The nominal values of D_1 and D_0 are specified in this table.

4. D_1 and D_0 for each sensor are independent adaptation data constants, alterable during memory load only.

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART F. DIGITAL-TO-ANALOG CONVERTER MONITORS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Note 3)
1. MFV LDA Input 2. 3860 (Closed to -5%) to 226 (Open to 105%) counts	DA1A DA1B	\$820080 \$820082	0.574 Vdc to 9.445 Vdc	a. \$0678 to \$6CE8 b. N/A c. N/A	M_{DEC} = (DA Output [Vdc]) x (2923.0)	D_1 = -4591.78 D_0 = 4095.0
1. MOV LDA Input 2. 3860 (Closed to -5%) to 226 (Open to 105%) counts	DA2A DA2B	\$820084 \$820086	0.574 Vdc to 9.445 Vdc	a. \$0678 to \$6CE8 b. N/A c. N/A	Same as DA1A (MFV)	D_1 = -4591.78 D_0 = 4095.0
1. CCV LDA Input 2. 3747 (Closed to -5%) to 339 (Open to 105%) counts	DA3A DA3B	\$820088 \$82008A	0.850 Vdc to 9.169 Vdc	a. \$0998 to \$69B8 b. N/A c. N/A	Same as DA1A (MFV)	D_1 = -4591.78 D_0 = 4095.0
1. FPOV LDA Input 2. 3747 (Closed to -5%) to 339 (Open to 105%) counts	DA4A DA4B	\$82008C \$82008E	0.850 Vdc to 9.169 Vdc	a. \$0998 to \$69B8 b. N/A c. N/A	Same as DA1A (MFV)	D_1 = -4591.78 D_0 = 4095.0
1. OPOV LDA Input 2. 3747 (Closed to -5%) to 339 (Open to 105%) counts	DA5A DA5B	\$820090 \$820092	0.850 Vdc to 9.169 Vdc	a. \$0998 to \$69B8 b. N/A c. N/A	Same as DA1A (MFV)	D_1 = -4591.78 D_0 = 4095.0
1. Spare LDA Input 2. N/A	DA6A DA6B	\$820094 \$820096	N/A	N/A	Same as DA1A (MFV)	N/A

NOTES:

1. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Note that ranges include Controller monitor circuit tolerances only.

2. To change M_{DEC} to the equivalent Hex value: Convert M_{DEC} to M_{HEX} and then change the least significant Hex digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit Hex numbers which translate to a 16-bit memory word.
   Example: Reference Note 2 of Part B.

3. The function relating IE DPM value to LDA Input is of the form:

   LDA Input = $(D_1 * X) + D_0$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.
   b) The nominal values of D_1 and D_0 are specified in this table.

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART G. POWER SUPPLY MONITORS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT NOMINAL VALUE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. Solenoid Drive Level 2. N/A	SL1 SL2	$820020 $820022	29.0/16.0 Vdc 24.0/8.0 Vdc (Pull-In/ Hold)	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vdc) x (910.65)	D_1 = 35.9831 D_0 = 0.0
1. LVDT/RVDT Amplitude 2. N/A	FRVA FRVB	$820040 $820042	20.0 Vpp	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vpp) x (1494.9)	D_1 = 21.9199 D_0 = 0.0
1. Input Power Bus (115Vac) 2. N/A	VPBA VPBB	$820074 $820076	115.0 Vac	a. $34E8 to $4858 b. N/A c. N/A	M_{DEC} = (Vac) x (142.5)	D_1 = 229.951 D_0 = 0.0
1. Battery Input (GSE) (Note 6) 2. N/A	BATA1 BATB1	$820078 $82007A	3.6 Vdc	a. $45A8 to $6878 b. N/A c. N/A	M_{DEC} = (Vdc) x (6555.2)	D_1 = 4.99878 D_0 = 0.0
1. Battery Input (Main) (Note 7) 2. N/A	BATA2 BATB2	$82007C $82007E	3.6 Vdc	a. $45A8 to $6878 b. N/A c. N/A	M_{DEC} = (Vdc) x (6555.2)	D_1 = 4.99878 D_0 = 0.0
1. Cross-Channel Power 2. N/A	CCPA CCPB	$820098 $82009A	-12.8 Vdc/ -11.6 Vdc (Normal/ Group 1)	a. $A858 to $D0D8 b. N/A c. N/A	M_{DEC} = (Vdc) x (1500.9)	D_1 = 21.8322 D_0 = 0.0
1. Memory +5V (AC Source) 2. N/A	AC+5MA AC+5MB	$82009C $82009E	5.8 Vdc	a. $6088 to $7698 b. N/A c. N/A	M_{DEC} = (Vdc) x (4742.8)	D_1 = 6.909 D_0 = 0.0
1. Processor +5Vdc 2. N/A	C1P3 C2P3	$8200A0 $8200A2	5.0 Vdc	a. $5958 to $6708 b. N/A c. N/A	M_{DEC} = (Vdc) x (4924.6)	D_1 = 6.65394 D_0 = 0.0
1. Memory +5Vdc 2. N/A	C1M3 C2M3	$8200A4 $8200A6	5.0 Vdc	a. $3838 to $47D8 b. N/A c. N/A	M_{DEC} = (Vdc) x (3277.6)	D_1 = 9.99756 D_0 = 0.0

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART G. POWER SUPPLY MONITORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT NOMINAL VALUE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. OEA +39Vdc 2. N/A	OE1A	$8200A8	39.0 Vdc	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vdc) x (710.0)	D_1 = 46.1521 D_0 = 0.0
1. OEB +34Vdc 2. N/A	OE1B	$8200AA	34.0 Vdc	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vdc) x (710.0)	D_1 = 46.1521 D_0 = 0.0
1. OE +26Vdc 2. N/A	OE2A OE2B	$8200AC $8200AE	26.0 Vdc	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vdc) x (838.6)	D_1 = 39.0746 D_0 = 0.0
1. OE/IE +15Vdc 2. N/A	OE3A OE3B	$8200B0 $8200B2	15.0 Vdc	a. $5378 to $5C68 b. N/A c. N/A	M_{DEC} = (Vdc) x (1500.9)	D_1 = 21.8322 D_0 = 0.0
1. Memory/Processor +5V 2. N/A	DC+5MPA DC+5MPB	$8200B4 $8200B6	5.6 Vdc	a. $5D38 to $7248 b. N/A c. N/A	M_{DEC} = (Vdc) x (4742.8)	D_1 = 6.909 D_0 = 0.0
1. OE/IE -15Vdc 2. N/A	OE5A OE5B	$8200B8 $8200BA	-15.0 Vdc	a. $A398 to $AC88 b. N/A c. N/A	M_{DEC} = (Vdc) x (1500.9)	D_1 = 21.8322 D_0 = 0.0
1. Power Supply +5V 2. N/A	P/S+5A P/S+5B	$8200BC $8200BE	5.0 Vdc	a. $5478 to 6BE8 b. N/A c. N/A	M_{DEC} = (Vdc) x (4924.6)	D_1 = 6.65394 D_0 = 0.0
1. IE -10Vdc 2. N/A	IE1A IE1B	$8200C0 $8200C2	-10.0 Vdc	a. $AA08 to $ABA8 b. N/A c. N/A	M_{DEC} = (Vdc) x (2180.2)	D_1 = 15.029 D_0 = 0.0
1. IE +10Vdc 2. N/A	IE2A IE2B	$8200C4 $8200C6	10.0 Vdc	a. $5298 to $57B8 b. N/A c. N/A	M_{DEC} = (Vdc) x (2180.2)	D_1 = 15.029 D_0 = 0.0

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART G. POWER SUPPLY MONITORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT NOMINAL VALUE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. CIE +5Vdc 2. N/A	CI1C CI2C	$8200C8 $8200CA	5.0 Vdc	a. $5478 to $6BE8 b. N/A c. N/A	M_{DEC} = (Vdc) x (4924.6)	D_1 = 6.65394 D_0 = 0.0
1. IEC +15Vdc 2. N/A	IE3CA IE3CB	$8200CC $8200CE	15.0 Vdc	a. $5378 to $5C68 b. N/A c. N/A	M_{DEC} = (Vdc) x (1500.9)	D_1 = 21.8322 D_0 = 0.0
1. IEC -15Vdc 2. N/A	IE4CA IE4CB	$8200D0 $8200D2	-15.0 Vdc	a. $A398 to $AC88 b. N/A c. N/A	M_{DEC} = (Vdc) x (1500.9)	D_1 = 21.8322 D_0 = 0.0
1. OEA +29Vdc 2. N/A	OE7A	$8200D8	29.0 Vdc	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vdc) x (838.6)	D_1 = 39.0746 D_0 = 0.0
1. OEB +24Vdc 2. N/A	OE7B	$8200DA	24.0 Vdc	a. (Note 5) b. N/A c. N/A	M_{DEC} = (Vdc) x (838.6)	D_1 = 39.0746 D_0 = 0.0
1. Logic +5Vdc 2. N/A	LOG5A LOG5B	$8200DC $8200DE	5.0 Vdc	a. $5478 to $6BE8 b. N/A c. N/A	M_{DEC} = (Vdc) x (4924.6)	D_1 = 6.65394 D_0 = 0.0
1. Pressure MUX Ground 2A/2B 2. N/A	RC05 RC04	$8201E4 $8201E6	0.0 Vdc	a. $FED8 to $0138 b. N/A c. N/A	M_{DEC} = (Vdc) x (985440)	D_1 = 0.0332522 D_0 = 0.0

Table XXVIII
SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART G. POWER SUPPLY MONITORS (Continued)

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT NOMINAL VALUE	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 3,4)
1. Pressure MUX Calibration 4A/4B 2. N/A	RC19 RC18	\$8201E8 \$8201EA	-0.13125 Vdc	a. \$8008 b. N/A c. N/A	Same as RC05	D_1 = 0.0332522 D_0 = 0.0
1. Pressure MUX Ground 3A/3B 2. N/A	RC09 RC08	\$8201EC \$8201EE	0.0 Vdc	a. \$FE48 to \$01C8 b. N/A c. N/A	Same as RC05	D_1 = 0.0332522 D_0 = 0.0
1. Pressure MUX Calibration 3A/3B 2. N/A	RC15 RC14	\$8201F0 \$8201F2	0.13125 Vdc	a. \$7FF8 b. N/A c. N/A	Same as RC05	D_1 = 0.0332522 D_0 = 0.0
1. Pressure MUX Ground 4A/4B 2. N/A	RC21 RC20	\$8201F4 \$8201F6	0.0 Vdc	a. \$FE48 to \$01C8 b. N/A c. N/A	Same as RC05	D_1 = 0.0332522 D_0 = 0.0

NOTES:

1. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Note the ranges include Controller monitor circuit tolerances only.

2. To change M_{DEC} to the equivalent Hex value: Convert M_{DEC} to M_{HEX} and then change the least significant Hex digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit Hex numbers which translate to a 16-bit memory word.

   Example: Reference Note 2 of Part B.

3. The function relating IE DPM to voltage is of the form:

   Electrical Parameter [Volts] = $(D_1 * X) + D_0$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.

   b) The nominal value of D_1 and D_0 are specified in this table.

4. For voltages that are to be scaled D_1 and D_0 are adaptation data constants, alterable during memory load only.

5. See Table XXXIV for values.

6. BATA1/BATB1 values only when external battery is connected to GSE connectors J302 and J304 respectively. A BATA1/BATB1 value of less than \$0CC8 (+0.55Vdc) indicates no battery is connected.

7. BATA2/BATB2 values only when external battery is connected to GSE connectors J7 and J8 respectively. A BATA2/BATB2 value of less than \$0CC8 (+0.55Vdc) indicates no battery is connected.

Table XXVIII

SENSOR OUTPUT TO EQUIVALENT DPM INPUT VALUE (Continued)

PART H. SERVOVALVE CURRENT MONITORS

PARAMETER 1. NAME 2. RANGE	MNEMONIC CH A CH B	DPM ADDRESS CH A CH B	SENSOR OUTPUT RANGE (Note 3)	EQUIVALENT MEMORY VALUE NOMINAL RANGE (Note 1)	FORMULA FOR EQUIVALENT MEMORY VALUE IN DECIMAL AS FUNCTION OF SENSOR OUTPUT (Note 2)	COEFFICIENTS FOR PHYSICAL PARAMETER AS A FUNCTION OF MEMORY VALUE (Notes 4,5)
1. MFV 2. N/A	SV1A SV1B	\$8200E0 \$8200E2	-48 ma to 48 ma	a. \$8288 to \$7D78 b. N/A c. N/A	M_{DEC} = (ma) x (655.52)	D_1 = 49.9878 D_0 = 0.0
1. MOV 2. N/A	SV2A SV2B	\$8200E4 \$8200E6	-48 ma to 48 ma	a. \$8288 to \$7D78 b. N/A c. N/A	Same as SV1A	D_1 = 49.9878 D_0 = 0.0
1. CCV 2. N/A	SV3A SV3B	\$8200E8 \$8200EA	-48 ma to 48 ma	a. \$8288 to \$7D78 b. N/A c. N/A	Same as SV1A	D_1 = 49.9878 D_0 = 0.0
1. FPOV 2. N/A	SV4A SV4B	\$8200EC \$8200EE	-48 ma to 48 ma	a. \$8288 to \$7D78 b. N/A c. N/A	Same as SV1A	D_1 = 49.9878 D_0 = 0.0
1. OPOV 2. N/A	SV5A SV5B	\$8200F0 \$8200F2	-48 ma to 48 ma	a. \$8288 to \$7D78 b. N/A c. N/A	Same as SV1A	D_1 = 49.9878 D_0 = 0.0
1. Spare 2. N/A	SV6A SV6B	\$8200F4 \$8200F6	N/A	a. \$8288 to \$7D78 b. N/A c. N/A	Same as SV1A	N/A

NOTES:

1. a. Normal Operation
   b. Checkout Group 1 Switches Energized (Simulated)
   c. Checkout Group 1 Switches Deenergized (Ambient)

   Note the ranges include Controller monitor circuit tolerances only.

2. To change M_{DEC} to the equivalent HEX value: Convert M_{DEC} to M_{HEX} and then change the least significant HEX digit in the answer to 8. All M_{DEC} values result in equivalent 4-digit HEX numbers which translate into a 16 bit memory word.
   Example: Reference Note 2 of Part B.

3. The equivalent memory value nominal range represents the maximum ($\pm$48 ma) positive and negative current. When the servovalve is commanded open the current value stored in memory is negative. When the servovalve is commanded closed the current value stored in memory is positive.

4. The function relating IE DPM to milliamps is of the form:

   Electrical Parameter [ma] = $(D_1 * X) + D_0$

   Where: a) $X = M_{DEC}/2^{15}$; with binary scale factor associated with $-1 \leq X < 1$, i.e., F15.
   b) The nominal values of D_1 and D_0 are specified in this table.

5. D_1 and D_0 for each sensor are independent adaptation data constants, alterable during memory load only.

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TABLE XXIX
ACTUATOR COMMAND TO LDA COEFFICIENTS

The relationship between the actuator command and the LDA Input is as follows:

(LDA Input) = C1 * (Actuator Command) + C0

where C1 and C0 for each actuator are independent adaptation data constants, alterable during memory load only.

The nominal C1 and C0 are defined as follows:

Servovalve	C1	C0
MFV & MOV	-33.03238014	3694.727685
CCV & OPOV & FPOV	-30.97693275	3591.955316

The LDA Input is placed into the bits 15-4 of the storage register (See Figure 7) where it is converted by the D/A converter to an analog signal which is used to drive the selected actuator.

The following notes were used to develop the above coefficients:

1. D/A Output (Vdc) = 10 * (b1/2**1 + b2/2**2 + . . + b12/2**12) where b1 through b12 are the complement of the storage register output bits 15 through 04 respectively. The "*", "/" and "**" are the symbols for multiplication, division, and powers respectively. Thus conversion method is defined as" complementary straight binary" (CSB) by Analog Devices. (Reference: Analog Devices, Inc., Data - Acquisition Databook 1984, Vol. I - Integrated Circuits, Norwood, Mass, p. 9-95).

2. The D/A output used to drive the servovalves between full closed (-5%) to full open (+105%) is as follows:

Servovalve	-5%	+105
MFV & MOV	0.574 Vdc	9.445 Vdc
CCV & OPOV & FPOV	0.850 Vdc	9.169 Vdc

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Table XXX
IE DPM GROUP AND ADDRESS DEFINITIONS

GROUP	ADDRESSES	MNEMONICS	FUNCTIONS
0	$820000/$820002	TW1A/TW1B	Test Word 1A/1B $AAAA/$5555
	$820004/$820006	TW2A/TW2B	Test Word 2A/2B $5555/$AAAA
	$820008/$82000A	TW3A/TW3B	Test Word 3A/3B $AAAA/$5555
	$82000C/$82000E	TW4A/TW4B	Test Word 4A/4B $5555/$AAAA
	$820010/$820012	TW5A/TW5B	Test Word 5A/5B $AAAA/$5555
	$820014/$820016	TW6A/TW6B	Test Word 6A/6B $5555/$AAAA
	$820018/$82001A	TW7A/TW7B	Test Word 7A/7B $AAAA/$5555
	$82001C/$82001E	TW8A/TW8B	Test Word 8A/8B $5555/$AAAA
1	$820020/$820022	SL1/SL2	Solenoid Voltage Level A/B
	$820024/$820026	A1A/A1B	MFV Actuator 1A/1B
	$820028/$82002A	A2A/A2B	MOV Actuator 2A/2B
	$82002C/$82002E	A3A/A3B	CCV Actuator 3A/3B
	$820030/$820032	A4A/A4B	FPOV Actuator 4A/4B
	$820034/$820036	A5A/A5B	OPOV Actuator 5A/5B
	$820038/$28003A	A6A/A6B	Spare Actuator 6A/6B
	$82003C/---	RIV/---	Pogo Recirculation/Isolation Valve
	-------/$82003E	---/---	Unused B
2	$820040/$820042	FRVA/FRVB	2khz LVDT/RVDT Excitation Voltage Amplitude A/B
	$820044/---	FBV/---	Fuel Bleed Valve Position
	-------/$820046	---/OBV	Oxidizer Bleed Valve Position
	$820048/$82004A	AFVA/AFVB	Antiflood Valve Position A/B
	$82004C/$82004E	POS1A/POS1B	Spare Position Sensors 1A/1B
	$820050/$820052	POS2A/POS2B	Spare Position Sensors 2A/2B
	$820054/$820056	POS3A/POS3B	Spare Position Sensors 3A/3B
	$820058/$82005A	POS4A/POS4B	Spare Position Sensors 4A/4B
	$82005C/$82005E	POS5A/POS5B	Spare Position Sensors 5A/5B
3	$820060/$820062	---/---	Unused
	$820064/$820066	V1A/V1B	High Pressure Fuel Pump Accelerometer A/B
	$820068/$82006A	V2A/V2B	High Pressure Oxidizer Pump Accelerometer A/B
	$82006C/$82006E	V1CA/V1CB	High Pressure Fuel Pump Accelerometer CA/CB
	$820070/$820072	V2CA/V2CB	High Pressure Oxidizer Pump Accelerometer CA/CB
	$820074/$820076	VPBA/VPBB	Primary (AC) Input Voltage A/B
	$820078/$82007A	BATA1/BATB1	GSE Battery Input Voltage A/B
	$82007C/$82007E	BATA2/BATB2	Main Battery Input Voltage A/B

Table XXX
IE DPM GROUP AND ADDRESS DEFINITIONS (Continued)

GROUP	ADDRESSES	MNEMONICS	FUNCTIONS
4	$820080/$820082	DA1A/DA1B	MFV Servovalve Command A/B
	$820084/$820086	DA2A/DA2B	MOV Servovalve Command A/B
	$820088/$82008A	DA3A/DA3B	CCV Servovalve Command A/B
	$82008C/$82008E	DA4A/DA4B	FPOV Servovalve Command A/B
	$820090/$820092	DA5A/DA5B	OPOV Servovalve Command A/B
	$820094/$820096	DA6A/DA6B	Spare Servovalve Command A/B
	$820098/$82009A	CCPA/CCPB	Cross-Channel Power Voltage A/B
	$82009C/$82009E	AC+5MA/ AC+5MB	AC Supplied +5 Vdc for memory A/B
5	$8200A0/$8200A2	C1P3/C2P3	Processor +5 Vdc A/B
	$8200A4/$8200A6	C1M3/C2M3	Memory +5 Vdc A/B
	$8200A8/---	OE1A/---	Output Electronics +39 Vdc A
	-------/$8200AA	----/OE1B	Output Electronics +34 Vdc B
	$8200AC/$8200AE	OE2A/OE2B	Output Electronics +26 Vdc A/B
	$8200B0/$8200B2	OE3A/OE3B	I/O Electronics +15 Vdc A/B
	$8200B4/$8200B6	DC+5MPA/ DC+5MPB	DC Supplied +5 Vdc for memory/ processor A/B
	$8200B8/$8200BA	OE5A/OE5B	I/O Electronics -15 Vdc A/B
	$8200BC/$8200BE	P/S+5A/ P/S+5B	Power Supply +5 Vdc A/B
6	$8200C0/$8200C2	IE1A/IE1B	Input Electronics -10 Vdc Ref. A/B
	$8200C4/$8200C6	IE2A/IE2B	Input Electronics +10 Vdc Ref. A/B
	$8200C8/$8200CA	CI1C/CI2C	CIE +5 Vdc (C) A/B
	$8200CC/$8200CE	IE3CA/IE3CB	IE +15 Vdc (C) A/B
	$8200D0/$8200D2	IE4CA/IE4CB	IE -15 Vdc (C) A/B
	$8200D4/$8200D6	---/---	Unused
	$8200D8/---	OE7A/---	OE +29 Vdc A
	-------/$8200DA	---/OE7B	OE +24 Vdc B
	$8200DC/$8200DE	LOG5A/LOG5B	Logic +5 Vdc A/B
7	$8200E0/$8200E2	SV1A/SV1B	MFV Servovalve Current A/B
	$8200E4/$8200E6	SV2A/SV2B	MOV Servovalve Current A/B
	$8200E8/$8200EA	SV3A/SV3B	CCV Servovalve Current A/B
	$8200EC/$8200EE	SV4A/SV4B	FPOV Servovalve Current A/B
	$8200F0/$8200F2	SV5A/SV5B	OPOV Servovalve Current A/B
	$8200F4/$8200F6	SV6A/SV6B	Spare Servovalve Current A/B
	$8200F8/$8200FA	----/----	Unused
	$8200FC/$8200FE	----/----	Unused

Table XXX
IE DPM GROUP AND ADDRESS DEFINITIONS (Continued)

GROUP	ADDRESSES	MNEMONICS	FUNCTIONS
8 (Note 1)	$820100/$820102	RC11/RC10	Temperature MUX Ground 1A/1B
	$820104/$820106	RC13/RC12	Temperature MUX Calibration 1A/1B
	$820108/$82010A	T1A/T1B	Spare HPFT Discharge Temp A/B
	$82010C/$82010E	T2A/T2B	Spare HPOT Discharge Temp A/B
	$820110/$820112	T13A/T13B	HPOT Discharge Temp A3/B3 (Thermocouple)
	$820114/$820116	T3A/T3B	LPFP Discharge Temperature A/B
	$820118/$82011A	T14A/T14B	Cold Junction Temperature A/B
	$82011C/$82011E	T4A/T4B	PBP Discharge Temperature A/B
9 (Note 1)	$820120/---	---/---	Unused A
	-------/$820122	---/T5	MCC Coolant Temperature
	$820124/$820126	T6A/T6B	Controller Internal Temperature A/B
	$820128/$82012A	T7A/T7B	MOV Hydraulic Temperature A/B
	$82012C/$82012E	T8A/T8B	MFV Hydraulic Temperature A/B
	$820130/------	T9A/---	Spare Temperature A (MCC LOX Dome)
	$------/$820132	---/T9B	MCC LOX Dome Temperature B
	$820134/$820136	T10A/T10B	HPFT Discharge Temp A2/B2 (Thermocouple)
	$820138/$82013A	T11A/T11B	HPFT Discharge Temp A3/B3 (Thermocouple)
	$82013C/$82013E	T15A/T15B	Spare Temperature A/B (Hot Gas)
10 (Note 1)	$820140/$820142	T12A/T12B	HPOT Discharge Temp A2/B2 (Thermocouple)
	$820144/$820146	RC17/RC16	Temperature MUX Calibration 2A/2B
	$820148/$82014A	---/---	Unused
	$82014C/$82014E	---/---	Unused
	$820150/$820152	---/---	Unused
	$820154/$820156	---/---	Unused
	$820158/$82015A	---/---	Unused
	$82015C/$82015E	---/---	Unused
11	$820160/$820162	N2A/N2B	HPFP Shaft Speed A/B
	$820164/$820166	N4A/N4B	Spare Shaft Speed A/B
	$820168/---	N1/---	LPFP Shaft Speed
	-------/$82016A	---/N3	LPOP Shaft Speed
	$82016C/$82016E	TRCA/TRCB	2 khz LVDT/RVDT Excitation Voltage Frequency A/B
	$820170/$820172	---/---	Unused
	$820174/$820176	Q1A1/Q1B1	Fuel Flowrate A1/B1
	$820178/$82017A	Q1A2/Q1B2	Fuel Flowrate A2/B2
	$82017C/$82017E	TW9A/TW9B	Test Patterns A/B $CCCC/$CCCC

Table XXX
IE DPM GROUP AND ADDRESS DEFINITIONS (Continued)

GROUP	ADDRESSES	MNEMONICS	FUNCTIONS
12 (Notes 2 & 3)	$820180/$820182	RC01/RC00	Pressure MUX Ground 1A/1B
	$820184/$820186	RC03/RC02	Pressure MUX Calibration 1A/1B
	$820188/$82018A	P9A1/P9B1	MCC Pc A1/B1
	$82018C/$82018E	P9A1/P9B1	MCC Pc A1/B1
	$820190/$820192	P9A2/P9B2	MCC Pc A2/B2
	$820194/$820196	P9A2/P9B2	MCC Pc A2/B2
	$820198/$82019A	P1A/P1B	LPFP Discharge Pressure A/B
	$82019C/$82019E	P1A/P1B	LPFP Discharge Pressure A/B
13 (Note 2)	$8201A0/---	P5/--	HPOP Discharge Pressure
	-------/$8201A2	---/P6	Preburner Pump Discharge Pressure
	$8201A4/$8201A6	P15A/P15B	HPOP Intermediate Seal Purge Pressure A/B
	$8201A8/$8201AA	P16A/P16B	HPOT Secondary Seal Cavity Pressure A/B
	$8201AC/$8201AE	P21A/P21B	HPFP Coolant Liner Pressure A/B
	$8201B0/$8201B2	P4A/P4B	LPOP Discharge Pressure A/B
	$8201B4/$8201B6	P8A/P8B	Fuel System Purge Pressure A/B
	$8201B8/---	P2/---	HPFP Discharge Pressure
	-------/$8201BA	---/P12	Hydraulic System Pressure
	$8201BC/---	P3/---	Fuel Preburner Chamber Pressure
	-------/$8201BE	---/---	Unused B
14 (Note 2)	$8201C0/---	P13/---	Fuel Preburner S/D Purge Pressure
	-------/$8201C2	---/P14	Oxidizer Tank Pressurant Pressure
	$8201C4/---	P10/---	MCC Fuel Injection Pressure
	-------/$8201C6	---/---	Unused B
	$8201C8/$8201CA	P17A/P17B	Controller Internal Pressure A/B
	$8201CC/---	P11/---	MCC Coolant Pressure
	-------/$8201CE	---/P19	Oxidizer Preburner S/D Purge Pressure
	$8201D0/$8201D2	P20A/P20B	Emergency Shutdown Pressure A/B
	$8201D4/$8201D6	P18A/P18B	Pogo Precharge Pressure A/B
	$8201D8/$8201DA	PS1A/PS1B	Spare Pressure Sensor A/B
	$8201DC/$8201DE	PS2A/PS2B	Spare Pressure Sensor A/B

Table XXX
IE DPM GROUP AND ADDRESS DEFINITIONS (Continued)

GROUP	ADDRESSES	MNEMONICS	FUNCTIONS
15 (Note 2)	$8201E0/$8201E2	RC07/RC06	Pressure MUX Calibration 2A/2B
	$8201E4/$8201E6	RC05/RC04	Pressure MUX Ground 2A/2B
	$8201E8/$8201EA	RC19/RC18	Pressure MUX Calibration 4A/4B (= $8008)
	$8201EC/$8201EE	RC09/RC08	Pressure MUX Ground 3A/3B
	$8201F0/$8201F2	RC15/RC14	Pressure MUX Calibration 3A/3B (= $7FF8)
	$8201F4/$8201F6	RC21/RC20	Pressure MUX Ground 4A/4B
	$8201F8/$8201FA	---/---	Unused
	$8201FC/$8201FE	---/---	Unused

Table XXX
IE DPM GROUP AND ADDRESS DEFINITIONS (Continued)

Note 1: The accuracy of temperature parameters in this group requires that parameters RC11/RC10, RC13/RC12, RC17/RC16 be input during the same conversion sequence.

Note 2: The accuracy of pressure parameters in this group requires that RC01/RC00, RC03/RC02, RC07/RC06 be input during the same conversion sequence.

Note 3: A double settling time for the A/D Converter is provided (50 usec is increased to 100 usec by using two memory locations) for MCC Pc (P9) and LPFP Discharge Pressure (P1) in order to improve the accuracy of conversion; therefore, the Operational Program should use the second memory location when accessing data corresponding to these sensors.

Table XXXI
OE ON/OFF REGISTER COMMANDS

Loaded Through OE Storage Register A, Address $820A04

ON/OFF REGISTER	BIT	LOGIC STATE (Notes 1,6)	FUNCTION
1A	15 (MSB)	1	Energize Bleed Valve Solenoid A
1A	14	1	Energize Fuel System Purge Solenoid A
1A	13	1	Energize Pogo Precharge Solenoid A
1A	12	1	Energize Preburner S/D Purge Solenoid A
1A	11	1	Energize Emergency S/D Solenoid A
1A	10	1	Energize HPOP IMSL Purge Solenoid A
1A	9	(Note 2)	Group 1A (Sensor Checkout) Switch
1A	8	(Note 2)	Group 2A (Propellant Drop Sensor) Switch
1A	7	1	Power Off Time Exceeded B
1A	6	(Note 3)	OE A Solenoid Pull-In/Hold Voltage
1A	5	(Note 2)	Start PRC Overflow Test, Channel A
1A	4	1	Energize Igniters A
2A	15	1	Spare (Undesignated)
2A	14	1	Spare (Undesignated)
2A	13	1	Spare (Undesignated)
2A	12	1	Spare (Undesignated)
2A	11	1	Spare (Undesignated)
2A	10	1	Spare (Undesignated)
2A	9	1	Spare
2A	8	1	Energize OE A 2khz Excitation (Note 4)
2A	7	(Note 5)	Halt Exit A Enable/Disable
2A	6	1	Energize Spare Pneumatic Solenoid #1A
2A	5	1	Spare
2A	4	1	Spare
3A	15	1	Energize OPOV Fail-Safe Servoswitch A
3A	14	1	Energize FPOV Fail-Safe Servoswitch A
3A	13	1	Energize MOV Fail-Safe Servoswitch A
3A	12	1	Energize MFV Fail-Safe Servoswitch A
3A	11	1	Energize CCV Fail-Safe Servoswitch A
3A	10	1	Energize Spare Fail-Safe Servoswitch A
3A	9	1	Energize Spare Pneumatic Solenoid #2A
3A	8	1	Energize Spare Pneumatic Solenoid #3A
3A	7	1	Energize Spare Pneumatic Solenoid #4A
3A	6	1	Energize Spare Pneumatic Solenoid #5A
3A	5	1	Energize Spare Pneumatic Solenoid #6A
3A	4	1	Energize Spare Pneumatic Solenoid #7A

Table XXXI
OE ON/OFF REGISTER COMMANDS (Continued)

Loaded Through OE Storage Register B, Address $820A06

ON/OFF REGISTER	BIT	LOGIC STATE (Note 1,6)	FUNCTION
1B	15	1	Energize Bleed Valve Solenoid B
1B	14	1	Energize Fuel System Purge Solenoid B
1B	13	1	Energize Pogo Precharge Solenoid B
1B	12	1	Energize Preburner S/D Purge Solenoid B
1B	11	1	Energize Emergency S/D Solenoid B
1B	10	1	Energize HPOP IMSL Purge Solenoid B
1B	9	(Note 2)	Group 1B (Sensor Checkout) Switch
1B	8	(Note 2)	Group 2B (Propellant Drop Sensor) Switch
1B	7	1	Power Off Time Exceeded A
1B	6	(Note 3)	OE B Solenoid Pull-In/Hold Voltage
1B	5	(Note 2)	Start PRC Overflow Test Channel B
1B	4	1	Energize Igniters B
2B	15	1	Energize OPOV Fail-Operational Servoswitch
2B	14	1	Energize FPOV Fail-Operational Servoswitch
2B	13	1	Energize MOV Fail-Operational Servoswitch
2B	12	1	Energize MFV Fail-Operational Servoswitch
2B	11	1	Energize CCV Fail-Operational Servoswitch
2B	10	1	Energize Spare Fail-Operational Servoswitch
2B	9	1	Spare
2B	8	1	Energize OE B 2khz Excitation (Note 4)
2B	7	(Note 5)	Halt Exit B Enable/Disable
2B	6	1	Energize Spare Pneumatic Solenoid #1B
2B	5	1	Spare
2B	4	1	Spare
3B	15	1	Energize OPOV Fail-Safe Servoswitch B
3B	14	1	Energize FPOV Fail-Safe Servoswitch B
3B	13	1	Energize MOV Fail-Safe Servoswitch B
3B	12	1	Energize MFV Fail-Safe Servoswitch B
3B	11	1	Energize CCV Fail-Safe Servoswitch B
3B	10	1	Energize Spare Fail-Safe Servoswitch B
3B	9	1	Energize Spare Pneumatic Solenoid #2B
3B	8	1	Energize Spare Pneumatic Solenoid #3B
3B	7	1	Energize Spare Pneumatic Solenoid #4B
3B	6	1	Energize Spare Pneumatic Solenoid #5B
3B	5	1	Energize Spare Pneumatic Solenoid #6B
3B	4	1	Energize Spare Pneumatic Solenoid #7B

Table XXXI
OE ON/OFF REGISTER COMMANDS (Continued)

Note 1: The LOGIC STATE column defines the logic state set by software to activate the function described under the FUNCTION column.

Note 2: Reference Table XXXII

Note 3: 1 selects Pull-In voltage level for all pneumatic solenoids;

0 selects Hold voltage level.

Note 4: The LVDT/RVDT 2khz signal source to the OE LVDT/RVDT power supplies control matrix is as follows:

OE 2A BIT 08	OE 2B BIT 08	CH A POWER SUPPLY	CH B POWER SUPPLY
Off (0)	Off (0)	Off	Off
On (1)	Off (0)	On (Ch A source)	On (Ch A source)
Off (0)	On (1)	On (Ch B source)	On (Ch B source)
On (1)	On (1)	Off	On (Ch B source)

Note 5: 0 enables Halt Exit; 1 disables Halt Exit.

Note 6: All bits of the On/Off Register, as shown, are set to 0 as a result of:

a. Loss of OE +5Vdc Logic or ±5Vdc power (in-channel where loss occurs)

b. Primary power transient, i.e., power up reset condition (in-channel where transient occurs)

c. One or both WDTs in both DCUs is in the timed-out state, i.e., power down matrix (both channels affected)

d. Master Clear (in-channel where Master Clear occurs)

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Table XXXII
SENSOR CHECKOUT CONTROL

ON/OFF COMMAND CONTROL LOGIC (Note 1, 5)

Group 1 (Sensor Checkout) Switch (Note 2)

Channel A	Channel B	Activated
1	1	Yes
0	0	No
all other combinations (Note 4)		No

Group 2 (Propellant Drop Sensor) Switch (Note 3)

Channel A	Channel B	Activated
1	1	Yes
0	0	No
all other combinations (Note 4)		No

PRC Overflow Test

Channel A	Channel B	Activated
1	1	Yes
0	0	No
all other combinations (Note 4)		No

NOTES:

1. Table XXXI provides a complete list of On/Off commands.

2. Group 1 (Sensor Checkout) - 80% pressure checkout, 50% temperature checkout for the RTDs and 62% temperature checkout for the thermocouples, 500 Hz flow/speed checkout, 80% vibration checkout.

3. Group 2 (Propellant Drop) - Sensor ranges for Preburner Pump and LPFP Discharge Temperature sensors are modified.

4. Any combination not shown is undefined, and should be used only for test purposes.

5. The power up reset or Master Clear deactivates these functions.

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Table XXXIII
OE STORAGE REGISTER COMMAND CODES

CODE (Notes 1 and 2)				
BIT 3	BIT 2	BIT 1	BIT 0	FUNCTION ENABLED
1	1	1	1	Spare
1	1	1	0	D/A 1 (MFV)
1	1	0	1	D/A 2 (MOV)
1	1	0	0	D/A 3 (CCV)
1	0	1	1	D/A 4 (FPOV)
1	0	1	0	D/A 5 (OPOV)
1	0	0	1	D/A 6 (SPARE)
1	0	0	0	SPARE
0	1	1	1	On/Off Register 1 (See Table XXXI)
0	1	1	0	On/Off Register 2 (See Table XXXI)
0	1	0	1	On/Off Register 3 (See Table XXXI)
0	1	0	0	Positive Actuator Monitor Test (Note 3)
0	0	1	1	Negative Actuator Monitor Test (Note 3)
0	0	1	0	Spare
0	0	0	1	Solenoid Energize Test (Note 3)
0	0	0	0	Spare

Table XXXIII
OE STORAGE REGISTER COMMAND CODES (Continued)

NOTES:

1. The bit numbering shown corresponds to the Block II H/W specification and Motorola 68000 documentation (msb = bit 15).

2. Codes indicated are logic levels set by the Operational Program.

3. To conduct the Positive/Negative Actuator Monitor Test per 3.2.3:3.2.4 and 3.2.3:2.3.5:26 or the Solenoid Energize Test per 3.2.3:2.3.5:25, the storage register is loaded with the proper bit pattern and a Transfer OE A/B Storage Register is executed. Subsequent to this, any loading of the storage register will result in cancelling any of these test states.

Table XXXIV
POWER SUPPLY ON/OFF TOLERANCES

POWER SUPPLY	OFF MIN	OFF MAX	ON MIN	ON MAX
FRVA/FRVB	$FDA8 (-0.4 Vpp)	$0BC8 (2.0 Vpp)	$6F78 (19.1 Vpp)	$7A18 (20.9 Vpp)
TRCA/TRCB	N/A	N/A	$01F0 (2016 pps)	$01F7 (1988 pps)
OE1A	$FD78 (-0.9 Vdc)	$06E8 (2.5 Vdc)	$53C8 (30.2 Vdc)	$7F98 (46.0 Vdc)
OE1B	$FDC8 (-0.8 Vdc)	$06E8 (2.5 Vdc)	$4908 (26.3 Vdc)	$6F48 (40.1 Vdc)
OE2A/OE2B	$F798 (-2.6 Vdc)	$1068 (5.0 Vdc)	$4CC8 (23.4 Vdc)	$5D88 (28.6 Vdc)
OE7A	$FAE8 (-1.6 Vdc)	$16E8 (7.0 Vdc)	$53B8 (25.6 Vdc)	$7568 (35.8 Vdc)
OE7B	$FAE8 (-1.6 Vdc)	$16E8 (7.0 Vdc)	$4248 (20.2 Vdc)	$6148 (29.7 Vdc)
SL1 (Pull-In)	$FAE8 (-1.4 Vdc)	$0E08 (3.9 Vdc)	$5B58 (25.7 Vdc)	$7F18 (35.7 Vdc)
(Hold)	$FAE8 (-1.4 Vdc)	$0E08 (3.9 Vdc)	$2D58 (12.7 Vdc)	$4AA8 (21.0 Vdc)
SL2 (Pull-In)	$FAE8 (-1.4 Vdc)	$0E08 (3.9 Vdc)	$4868 (20.4 Vdc)	$6938 (29.6 Vdc)
(Hold)	$FAE8 (-1.4 Vdc)	$0E08 (3.9 Vdc)	$1428 (5.7 Vdc)	$3C38 (16.9 Vdc)

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Table XXXV
ALLOCATED MEMORY LOCATIONS

ADDRESS FIELD FROM	TO (inclusive)	FUNCTION
$000000	$00FEFF	Usable RAM Main Memory
$00FF00	$00FFFB	PROM Scratch Pad Area (Note 5)
$00FFFC	$00FFFF	Restricted usage RAM Main Memory (Note 4)
$010000	$7FFFFF	Not Used
$800000	$800FFF	PROM (4k bytes) including
$800FFE	$800FFF	PROM Miscompare Word
$801000	$81FFFF	Not Used
$820000	$8201FF (Note 1)	IE Dual Port Memories
$820200	$8205FF	Spare I/O Addresses (Not Used)
$820600	$8206FF (Note 1)	VRC Dual Port Memories
$820700	$8209FF (Note 1)	Spare I/O Addresses (Not Used)
$820A00	$820BFF (Note 1)	Output Commands (Note 2)
$820C00	$820DFF (Note 1)	Input Commands (Note 3)
$820E00	$820FFF	Spare I/O Addresses (Not Used)
$821000	$FEFFFF	Not Used
$FF0000	$FFFFFB	Usable RAM Main Memory
$FFFFFC	$FFFFFF	Restricted usage RAM Main Memory (Note 4)

Note 1: Operands originating from or destined to these regions must be either a word or long-word in length. Byte size operands are permitted in other regions.

Table XXXV

ALLOCATED MEMORY LOCATIONS (Continued)

Note 2: A Bus Error exception will be triggered by write operations to addresses $820B00 through $820BFE inclusive or triggered by read operations from $820A00 through $820BFE inclusive.

Note 3: A Bus Error exception will be triggered by read operations from addresses $820D00 through $820DFE inclusive or triggered by write operations to $820C00 through $820DFE inclusive.

Note 4: These locations will be accessed only for memory load (via PROM), for memory readout, for the SCP Comparator Test, and for the Failure Data Recorder Test.

Note 5: This area will be written into by PROM. If the Operational Program uses this area it could be overwritten by a re-entry into PROM.

Table XXXVI
I/O INSTRUCTIONS (READ COMMANDS)

Input commands will have one of the following Effective Addresses as a source. See Table XXXVII for the Input Word format.

INPUT WORD	INPUT DATA	EFFECTIVE ADDRESS
1	Command MUX Test Word = $AAAA	$820C00
2	VIE Command Register Channel A	$820C02
3	VIE Command Register Channel B	$820C04
4	Processor Signals	$820C06
5	VIE Command Register Channel C	$820C08
6	RTC	$820C0A
7	SEII Status	$820C0C
8	Command MUX Test Word = $5555	$820C0E
	Unused	$820C10-$820C1E
9	Self-Test Word 1A = $AAAA (Channel A MUX)	$820C20
10	Self-Test Word 1B = $5555 (Channel B MUX)	$820C22
11	Self-Test Word 2A - (DCU/CIE A IE Status)	$820C24
12	Self-Test Word 2B - (DCU/CIE B IE Status)	$820C26
13	Self-Test Word 3A - (DCU/CIE A VRC Status)	$820C28
14	Self-Test Word 3B - (DCU/CIE B VRC Status)	$820C2A
15	Self-Test Word 4A - (OE On/Off Reg. 1A)	$820C2C
16	Self-Test Word 4B - (OE On/Off Reg. 1B)	$820C2E
17	Self-Test Word 5A - (OE On/Off Reg. 2A)	$820C30
18	Self-Test Word 5B - (OE On/Off Reg. 2B)	$820C32
19	Self-Test Word 6A - (OE On/Off Reg. 3A)	$820C34
20	Self-Test Word 6B - (OE On/Off Reg. 3B)	$820C36
21	Self-Test Word 7A - (OE A Stor. Reg.)	$820C38
22	Self-Test Word 7B - (OE B Stor. Reg.)	$820C3A
23	Self-Test Word 8A = $5555 (Channel A MUX)	$820C3C
24	Self-Test Word 8B = $AAAA (Channel B MUX)	$820C3E
25	Inter-DCU Status Register A	$820C40
26	Inter-DCU Status Register B	$820C42
27	$FFFF (Spare)	$820C44
28	$FFFF (Spare)	$820C46

Table XXXVI
I/O INSTRUCTIONS (READ COMMANDS) (Continued)

INPUT WORD	INPUT DATA	EFFECTIVE ADDRESS
29	FDR Word 1 - (SCP Status)	$820C48
30	FDR Word 2 - (Add. Bus Data)	$820C4A
31	FDR Word 3 - (Data Bus Data)	$820C4C
32	FDR Word 4 - (FDR Address)	$820C4E
	Unused	$820C50- $820CFE

Table XXXVII
INPUT DATA WORD FORMAT

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
1	$820C00	15-0	$AAAA	Command MUX Test Word
2	$820C02	15-0	N/A	VIE Command Register Channel A
3	$820C04	15-0	N/A	VIE Command Register Channel B
4	$820C06	15 (MSB)	(Note 1)	Channel A/B Indicator One
		14	(Note 1)	Channel A/B Indicator Two
		13	(Note 8)	SCP MPU One Address Error
		12	(Note 8)	SCP MPU Two Address Error
		11	(Note 7)	SCP MPU One Data Error
		10	(Note 7)	SCP MPU Two Data Error
		09	0	POI Set
		08	0	PFI Pending
		07	0	PRI Pending
		06	0	SCPI Pending
		05	0	WDTH1 Pending
		04	0	WDTH2 Pending
		03	0	TRI Pending
		02	0	RCFI1 Pending
		01	0	RCFI2 Pending
		00 (LSB)	0	ADPFI Pending
5	$820C08	15-00	N/A	VIE Command Register Channel C
6	$820C0A	15	0	WDT1 Timed-Out
		14-02	(Note 2)	RTC Output (Bit 14=MSB)
		01	0	WDT2 Timed-Out
		00	1	Cross-Channel Power Bus Down (PBD)

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
7	$820C0C	15	0	OPOV-A SEI 1 Pending
		14	0	FPOV-A SEI 2 Pending
		13	0	MOV-A SEI 3 Pending
		12	0	MFV-A SEI 4 Pending
		11	0	CCV-A SEI 5 Pending
		10	0	Spare-A SEI 6 Pending
		09	0	OPOV-B SEI 7 Pending
		08	0	FPOV-B SEI 8 Pending
		07	0	MOV-B SEI 9 Pending
		06	0	MFV-B SEI 10 Pending
		05	0	CCV-B SEI 11 Pending
		04	0	Spare-B SEI 12 Pending
		03	1	GSE Input Flag Bit 3
		02	1	GSE Input Flag Bit 2
		01	1	GSE Input Flag Bit 1
		00	1	GSE Input Flag Bit 0
8	$820C0E	15-00	$5555	Command MUX Test Word
9	$820C20	15-00	$AAAA	Channel A MUX Test Word
10	$820C22	15-00	$5555	Channel B MUX Test Word
11	$820C24	15	(Note 9)	IE Conversion Complete for DCU/CIE A
		14-08		IE Range Counter for DCU/CIE A
		07-01		IE Address Counter for DCU/CIE A
		00	(Note 10)	IE Channel Indicator for DCU/CIE A
12	$820C26	15	(Note 9)	IE Conversion Complete for DCU/CIE B
		14-08		IE Range Counter for DCU/CIE B
		07-01		IE Address Counter for DCU/CIE B
		00	(Note 10)	IE Channel Indicator for DCU/CIE B

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
13	$820C28	15	1	VRCA-VDT1A Complete for DCU/CIE A
		14-08		VRCA-VDT1A Address Register for DCU/CIE A
		07	1	VRCB-VDT2A Complete for DCU/CIE A
		06-00		VRCB-VDT2A Address Register for DCU/CIE A
14	$820C2A	15	1	VRCA-VDT1B Complete for DCU/CIE B
		14-08		VRCA-VDT1B Address Register for DCU/CIE B
		07	1	VRCB-VDT2B Complete for DCU/CIE B
		06-00		VRCB-VDT2B Address Register for DCU/CIE B
15 (Note 12)	$820C2C	15	0	Bleed Valve Solenoid A Energized
		14	0	Fuel System Purge Solenoid A Energized
		13	0	Pogo Precharge Solenoid A Energized
		12	0	Preburner S/D Purge Solenoid A Energized
		11	0	Emergency S/D Solenoid A Energized
		10	0	HPOP IMSL Purge Solenoid A Energized
		09	0	Group 1A (Sensor Checkout) Switch
		08	0	Group 2A (Prop Drop Sensor) Switch
		07	0	Power Off Time Exceeded B
		06	0	Pull-In State of OE A Solenoid Pull-In/Hold Voltage
		05	0	PRC Overflow Test On, Channel A
		04	0	Fuel Preburner Igniter A On
		03	0	Oxidizer Preburner Igniter A On
		02	0	Main Combustion Chamber Igniter A On
		01	0	Spare
		00	0	OE A Power Safety Switch On

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
16	$820C2E	15	0	Bleed Valve Solenoid B Energized
(Note 13)		14	0	Fuel System Purge Solenoid B Energized
		13	0	Pogo Precharge Solenoid B Energized
		12	0	Preburner S/D Purge Solenoid B Energized
		11	0	Emergency S/D Solenoid B Energized
		10	0	HPOP IMSL Purge Solenoid B Energized
		09	0	Group 1B (Sensor Checkout) Switch
		08	0	Group 2B (Prop Drop Sensor) Switch
		07	0	Power Off Time Exceeded A
		06	0	Pull-In State of OE B Solenoid Pull-In/Hold Voltage
		05	0	PRC Overflow Test On, Channel B
		04	0	Fuel Preburner Igniter B On
		03	0	Oxidizer Preburner Igniter B On
		02	0	Main Combustion Chamber Igniter B On
		01	0	Spare
		00	0	OE B Power Safety Switch On
17	$820C30	15-10	0	Spare
(Note 14)		09	0	Wired Spare #2
		08	0	OE A 2khz Excitation On
		07	(Note 11)	Halt Exit Enabled/Disabled A
		06	0	Spare Pneu Solenoid #1A Energized
		05	0	Wired Spare #3
		04	0	Wired Spare #4
		03	0	Spare
		02	0	Spare
		01	0	FDR A Recording Enabled
		00	0	Wired Spare #7

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
18 (Note 15)	$820C32	15	0	OPOV Fail-Op Servoswitch Energized
		14	0	FPOV Fail-Op Servoswitch Energized
		13	0	MOV Fail-Op Servoswitch Energized
		12	0	MFV Fail-Op Servoswitch Energized
		11	0	CCV Fail-Op Servoswitch Energized
		10	0	Spare Fail-Op Servoswitch Energized
		09	0	Wired Spare #2
		08	0	OE B 2khz Excitation On
		07	(Note 11)	Halt Exit Enabled/Disabled B
		06	0	Spare Pneu Solenoid #1B Energized
		05	0	Wired Spare #3
		04	0	Wired Spare #4
		03	0	Spare
		02	0	Spare
		01	0	FDR B Recording Enabled
		00	0	Wired Spare #7
19 (Note 16)	$820C34	15	0	OPOV Fail-Safe Servoswitch A Energized
		14	0	FPOV Fail-Safe Servoswitch A Energized
		13	0	MOV Fail-Safe Servoswitch A Energized
		12	0	MFV Fail-Safe Servoswitch A Energized
		11	0	CCV Fail-Safe Servoswitch A Energized
		10	0	Spare Fail-Safe Servoswitch A Energized
		09	0	Spare Pneu. Solenoid #2A Energized
		08	0	Spare Pneu. Solenoid #3A Energized
		07	0	Spare Pneu. Solenoid #4A Energized
		06	0	Spare Pneu. Solenoid #5A Energized
		05	0	Spare Pneu. Solenoid #6A Energized
		04	0	Spare Pneu. Solenoid #7A Energized
		03	0	Spare
		02	0	Spare
		01	0	Spare
		00	0	Wired Spare #5A

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
20 (Note 17)	$820C36	15	0	OPOV Fail-Safe Servoswitch B Energized
		14	0	FPOV Fail-Safe Servoswitch B Energized
		13	0	MOV Fail-Safe Servoswitch B Energized
		12	0	MFV Fail-Safe Servoswitch B Energized
		11	0	CCV Fail-Safe Servoswitch B Energized
		10	0	Spare Fail-Safe Servoswitch B Energized
		09	0	Spare Pneu. Solenoid #2B Energized
		08	0	Spare Pneu. Solenoid #3B Energized
		07	0	Spare Pneu. Solenoid #4B Energized
		06	0	Spare Pneu. Solenoid #5B Energized
		05	0	Spare Pneu. Solenoid #6B Energized
		04	0	Spare Pneu. Solenoid #7B Energized
		03	0	Spare
		02	0	Spare
		01	0	Spare
		00	0	Wired Spare #5B
21	$820C38	15-00	N/A	OE A Storage Register
22	$820C3A	15-00	N/A	OE B Storage Register
23	$820C3C	15-00	$5555	Channel A MUX Test Word
24	$820C3E	15-00	$AAAA	Channel B MUX Test Word
25	$820C40	15-00	N/A	Inter-DCU Status Register A
26	$820C42	15-00	N/A	Inter-DCU Status Register B
27	$820C44	15-00	$FFFF	Spare
28	$820C46	15-00	$FFFF	Spare

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

INPUT WORD	ADDRESS	LOGIC BIT	STATE	DATA/STATUS
29 (Note 6)	$820C48	15	1	FDR SCP MPU Two FC0
		14	1	FDR SCP MPU Two FC1
		13	1	FDR SCP MPU Two FC2
		12	(Note 3)	FDR SCP MPU Two R/W
		11	0	FDR SCP MPU Two IPL0
		10	0	FDR SCP MPU Two IPL1
		09	0	FDR SCP MPU Two IPL2
		08	(Note 7)	FDR SCP MPU Two Data Error
		07	(Note 8)	FDR SCP MPU Two Address Error
		06-00	(Note 4)	7 MSBs of FDR SCP MPU Two Address (Bit 06 = MSB)
30 (Note 6)	$820C4A	15-00	N/A	16 LSBs of FDR SCP MPU Two Address (Bit 00 = LSB)
31 (Note 6)	$820C4C	15-00	N/A	FDR SCP MPU Two Data (Bit 15 = MSB)
32 (Note 6)	$820C4E	15-05	N/A	FDR Address Register
		04-00	0	Spare

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

Notes:

1. Channel A will have bit 15 = 1 and bit 14 = 0.
   Channel B will have bit 15 = 0 and bit 14 = 1.

2. Value will range from 4999 to 0.

3. 1 = Read; 0 = Write.

4. 7 bits of binary data.

5. Deleted.

6. These Input Words contain cross-channel data.

7. A value of 1 indicates a data error miscompare.

8. A value of 1 indicates an address error miscompare.

9. 1 = Conversion not complete; 0 = conversion complete (complete indication will be given for normal conversion completion or for commanded termination).

10. 1 = Channel B; 0 = Channel A

11. 0 = Halt Exit Disabled
    1 = Halt Exit Enabled

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

Notes:

Notes 12 through 17 pertain to the status of the devices commanded by the OE ON/OFF Registers.

12. Bits 15 through 10 correspond to ON/OFF Register 1A bits 15 through 10 respectively.

Bit 09 corresponds to the logical operation of ON/OFF Register 1A bit 09 ANDed with ON/OFF Register 1B bit 09.
0 = Group 1 (Sensor Checkout) switch activated
1 = Group 1 (Sensor Checkout) switch deactivated

Bit 08 corresponds to the logical operation of ON/OFF Register 1A bit 08 ANDed with ON/OFF Register 1B bit 08.
0 = Group 2 (Propellant Drop Sensor) switch activated
1 = Group 2 (Propellant Drop Sensor) switch deactivated

Bit 07 corresponds to ON/OFF Register 1A bit 07.

Bit 06 corresponds to ON/OFF Register 1A bit 06 as follows:

0 = SL1 commanded to pull-in level
1 = SL1 commanded to hold level

Bit 05 corresponds to the logical operation of ON/OFF Register 1A bit 05 ANDed with ON/OFF Register 1B bit 05.
0 = PRC Overflow Test activated
1 = PRC Overflow Test deactivated

Bits 04 through 02 correspond to ON/OFF Register 1A bit 04.

Table XXXVII
INPUT DATA WORD FORMAT (Continued)

Notes:

13. Bits 15 through 10 correspond to ON/OFF Register 1B bits 15 through 10 respectively.

    Bit 09 corresponds to the logical operation of ON/OFF Register 1A bit 09 ANDed with ON/OFF Register 1B bit 09.
    0 = Group 1 (Sensor Checkout) switch activated
    1 = Group 1 (Sensor Checkout) switch deactivated

    Bit 08 corresponds to the logical operation of ON/OFF Register 1A bit 08 ANDed with ON/OFF Register 1B bit 08.
    0 = Group 2 (Propellant Drop Sensor) switch activated
    1 = Group 2 (Propellant Drop Sensor) switch deactivated

    Bit 07 corresponds to ON/OFF Register 1B bit 07.

    Bit 06 corresponds to ON/OFF Register 1B bit 06 as follows:
    0 = SL2 commanded to pull-in level
    1 = SL2 commanded to hold level

    Bit 05 corresponds to the logical operation of ON/OFF Register 1A bit 05 ANDed with ON/OFF Register 1B bit 05
    0 = PRC Overflow Test activated
    1 = PRC Overflow Test deactivated

    Bits 04 through 02 correspond to ON/OFF Register 1B bit 04.

14. Bits 15 through 04 correspond to ON/OFF Register 2A bits 15 through 04 respectively.

15. Bits 15 through 04 correspond to ON/OFF Register 2B bits 15 through 04 respectively.

16. Bits 15 through 04 correspond to ON/OFF Register 3A bits 15 through 04 respectively.

17. Bits 15 through 04 correspond to ON/OFF Register 3B bits 15 through 04 respectively.

Table XXXVIII
I/O INSTRUCTIONS (WRITE COMMANDS)

Output Commands will have one of the following Effective Addresses as a destination.

FUNCTION	LOAD/DISCRETE	EFFECTIVE ADDRESS
Load IE Address Counter	L	$820A00
Load IE Range Counter	L	$820A02
Load OE A Storage Register	L	$820A04
Load OE B Storage Register	L	$820A06
Unused	Undefined	$820A08- $820A0E
Initiate IE Operation	D	$820A10
Transfer OE A Storage Register	D	$820A12
Turn On OE A Power Control Switch	D	$820A14
Turn Off OE A Power Control Switch	D	$820A16
Unused	Undefined	$820A18- $820A1A
Set +5V Under Voltage Test	D	$820A1C
Reset +5V Under Voltage Test	D	$820A1E
Clear Reset Jam Bit	D	$820A20
Transfer OE B Storage Register	D	$820A22
Turn On OE B Power Control Switch	D	$820A24
Turn Off OE B Power Control Switch	D	$820A26
Reset WDT1	D	$820A28
Terminate IE Sequence	D	$820A2A
Initiate VRC Data Transmission	D	$820A2C
Set WDT1 Time-Out	D	$820A2E
Reset WDT2	D	$820A30
Switch VRC to DCU B	D	$820A32
Switch VRC to DCU A	D	$820A34
Decrement Cross-Ch. FDR Address Counter	D	$820A36
Inhibit FDR Recording	D	$820A38
Enable FDR Recording	D	$820A3A
Unused	Undefined	$820A3C
Set WDT2 Time-Out	D	$820A3E

Table XXXVIII
I/O INSTRUCTIONS (WRITE COMMANDS) (Continued)

Output Commands will have one of the following Effective Addresses as a destination.

FUNCTION	LOAD/DISCRETE	EFFECTIVE ADDRESS
Clear PFI	D	$820A40
Clear PRI	D	$820A42
Clear SCPI	D	$820A44
Clear WDTH1	D	$820A46
Clear WDTH2	D	$820A48
Clear TRI	D	$820A4A
Clear SEII	D	$820A4C
Clear SCP Comparator 1	D	$820A4E
Clear SCP Comparator 2	D	$820A50
Clear ADPFI	D	$820A52
Clear RCFI1	D	$820A54
Clear RCFI2	D	$820A56
Reset POI	D	$820A58
Unused	Undefined	$820A5A- $820A5E
Load CIE Inter-DCU Status Register	L	$820A60
Load CIE Interrupt Mask Register One	L	$820A62
Load CIE Interrupt Mask Register Two	L	$820A64
Set POI	D	$820A66
Unused	Undefined	$820A68- $820AFE

Table XXXIX
LOAD COMMAND FORMAT

CIE Interrupt Mask Register One Address $820A62

Mask Bit Assignment (Note 1)

BIT NO.	FUNCTION
15	SCPI - Self-Checking Pair (miscompare) Interrupt
14	WDTH1 - Watchdog Timer Halt One Interrupt
13	WDTH2 - Watchdog Timer Halt Two Interrupt
12	TRI - Timing Reference Interrupt
11	RCFI1 - Redundant Computer (cross-channel DCU) Failure Interrupt One
10	RCFI2 - Redundant Computer (cross-channel DCU) Failure Interrupt Two
09	ADPFI - Alternate (cross-channel) DCU in Power Failure Interrupt
08-00	Spare Bits

CIE Interrupt Mask Register Two Address $820A64

Mask Bit Assignment (Note 1)

BIT NO.	FUNCTION
15	OPOV-A SEI 1
14	FPOV-A SEI 2
13	MOV-A SEI 3
12	MFV-A SEI 4
11	CCV-A SEI 5
10	Spare Valve-A SEI 6
09	OPOV-B SEI 7
08	FPOV-B SEI 8
07	MOV-B SEI 9

Table XXXIX
LOAD COMMAND FORMAT (continued)

06	MFV-B SEI 10
05	CCV-B SEI 11
04	Spare Valve-B SEI 12
03-00	Spare Bits

Input Electronics Address Counter Address $820A00

BIT NO.	FUNCTION
15-8	Spare Bits, values do not affect sequencer
7-1	IE Starting Parameter Pair Address (bit 7 = MSB)
0	Spare Bit, value does not affect sequencer

Input Electronics Range Counter Address $820A02

BIT NO.	FUNCTION
15-7	Spare Bits
6-0	Number of IE Parameter Pair Conversions to be made minus 1 (bit 6 = MSB)

Output Electronics Storage Register (Ch A) Address $820A04

BIT NO.	FUNCTION
15-04	On/Off Commands or D/A Commands
03-00	Command Decodes (Ref. Table XXXIII)

Output Electronics Storage Register (Ch B) Address $820A06

BIT NO.	FUNCTION
15-04	On/Off Commands or D/A Commands
03-00	Command Decodes (Ref. Table XXXIII)

Note 1: A 1 in the mask enables the interrupt in the CIE, 0 in the mask disables the interrupt in the CIE.

Table XL
EXCEPTION VECTOR ASSIGNMENT TABLE

VECTOR NUMBERS	ADDRESS (HEX)	EXCEPTION GROUP & PRIORITY (Note 1)	INTERRUPT LEVEL (Note 2)	ASSIGNMENT
	$000000	N/A	N/A	Illegal Vector (Unused Reset)
	$000004	N/A	N/A	Illegal Vector (Unused Reset)
0	$800000 (See Note 3)	0-1	N/A	Reset: Initial Value for Supervisor Stack Pointer
1	$800004 (See Note 3)	0-1	N/A	Reset: Initial Program Counter Value
2	$000008	0-2	N/A	Bus Error
3	$00000C	0-3	N/A	Address Error
4	$000010	1-3	N/A	Illegal Instruction
5	$000014	2	N/A	Zero Divide
6	$000018	2	N/A	CHK Instruction
7	$00001C	2	N/A	TRAPV Instruction
8	$000020	1-4	N/A	Privilege Violation
9	$000024	1-1	N/A	Trace
10-23	$000028-$00005C	N/A	N/A	Illegal Vectors
24	$000060	0-4	N/A	Spurious Interrupt
25-31	$000064-$00007C	1-2	N/A	Illegal Vectors
32-47	$000080-$0000BC	2	N/A	Trap Instruction Vectors
48-63	$0000C0-$0000FC	N/A	N/A	Illegal Vectors

Table XL
EXCEPTION VECTOR ASSIGNMENT TABLE (Continued)

VECTOR NUMBERS	ADDRESS (HEX)	EXCEPTION GROUP & PRIORITY (Note 1)	INTERRUPT LEVEL (Note 2)	ASSIGNMENT
64	$000100	1-2	7	Power Failure Interrupt (PFI)
65	$000104	1-2	6	Power Recovery Interrupt (PRI)
66	$000108	1-2	5	Self-Checking Pair Interrupt (SCPI)
67	$00010C	1-2	4	WDT Halt One Interrupt (WDTH1)
68	$000110	1-2	4	WDT Halt Two Interrupt (WDTH2)
69	$000114	1-2	4	Servoactuator Error Indication Interrupt (SEII)
70	$000118	1-2	3	Timing Reference Interrupt (TRI)
71	$00011C	1-2	2	Redundant Computer Failure Interrupt One (RCFI1)
72	$000120	1-2	2	Redundant Computer Failure Interrupt Two (RCFI2)
73	$000124	1-2	1	Alternate DCU in Power Failure Interrupt (ADPFI)
74-78	$000128-$000138	1-2	Can occur at any level	Illegal Vectors
79	$00013C	1-2	Can occur at any level	CIE Erroneous Acknowledge Level Interrupt
80	$000140	1-2	Can occur at any level	Spurious CIE Interrupt
81-255	$000144-$0003FC	1-2	Can occur at any level	Illegal Vectors

Table XL

EXCEPTION VECTOR ASSIGNMENT TABLE (Continued)

Notes:

1. Lower-numbered exception groups and priorities within exception groups take precedence over those with higher numbers. (e.g., 0-1 takes precedence over 0-2, and 0-3 takes precedence over 1-1).

2. Higher-numbered interrupt levels take precedence over those with lower numbers. Within an interrupt level, there is no priority.

3. The long-word address $800000 contains the initial state value for the Supervisor Stack Pointer (SSP) in PROM. The hardware will, upon occurrence of a MC68000 Reset Exception, load the contents of this address into the SSP. The long-word address $800004 in PROM contains the value to which the hardware will reset the program counter, and from which subsequent program execution will occur.

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Table XLI
MEMORY READOUT SEQUENCE

STEP	TIME (MSEC.) MINIMUM	MAXIMUM	OPERATION
1	0	0	Either Memory Readout command has been accepted. Next command interpreted as address.
2	22	-	Starting Address command accepted by the DCU currently the source of VRC data. Remarks: This is time T_1
3	$T_1 + 5$	$T_1 + 47$	The DCU which is the source of VRC data will report the Memory Readout command and starting address in next earliest VRC transmission. Remarks: If a Memory Readout A command is received with DCU B as the source of VRC data, the Memory Readout command will be treated as an unacceptable command, the next command will be interpreted as a starting address, and the sequence exited.
4	$T_1 + 43$	$T_1 + 87$	If the Memory Readout command is accepted and the memory being readout is that of DCU which is the source of VRC data, the readout block contents will be substituted for the normal VDT contents for one VRC transmission. Exit sequence.

Table XLI
MEMORY READOUT SEQUENCE (Continued)

STEP	TIME (MSEC.) MINIMUM	TIME (MSEC.) MAXIMUM	OPERATION
5			If DCU A is the current source of VRC data (Switch VDT is not in effect) and a Memory Readout B command is accepted, the following will occur:
	T_1+ 10	T_1+ 50	(a) After completion of VRC transmission, DCU A will switch control of VRC to DCU B, and inform DCU B of the VRC Switch position via the Inter-DCU Status Register (IDSR).
	T_1+ 15	T_1+ 65	(b) Upon verifying via the IDSR that the VRC switch has been changed, DCU B will update its VRC DPM with requested readout data.
	T_1+ 45	T_1+110	(c) Initiate VRC transmission between 30 and 45 milliseconds later.
	T_1+ 50	T_1+ 115	(d) First TRI in DCU B after completion of VRC transmission by DCU B.
	T_1+ 75	T_1+ 115	(e) Earliest time DCU can switch the source of VRC data to DCU A.
	T_1+ 110	T_1+165	(f) DCU A will transmit a VRC 35 to 50 msec subsequent to (e) above.
	-	-	(g) Exit sequence
6	T_1+ 22	-	Next VEEI command accepted (including another memory readout command if any).
7	T_1+ 88	-	Next Starting Address command, if any; if the condition in Step 4 is true.
	T_1+ 166	-	Next Starting Address command, if any; if the condition in Step 5 is true.

Table XLII
INTER-DCU STATUS REGISTER

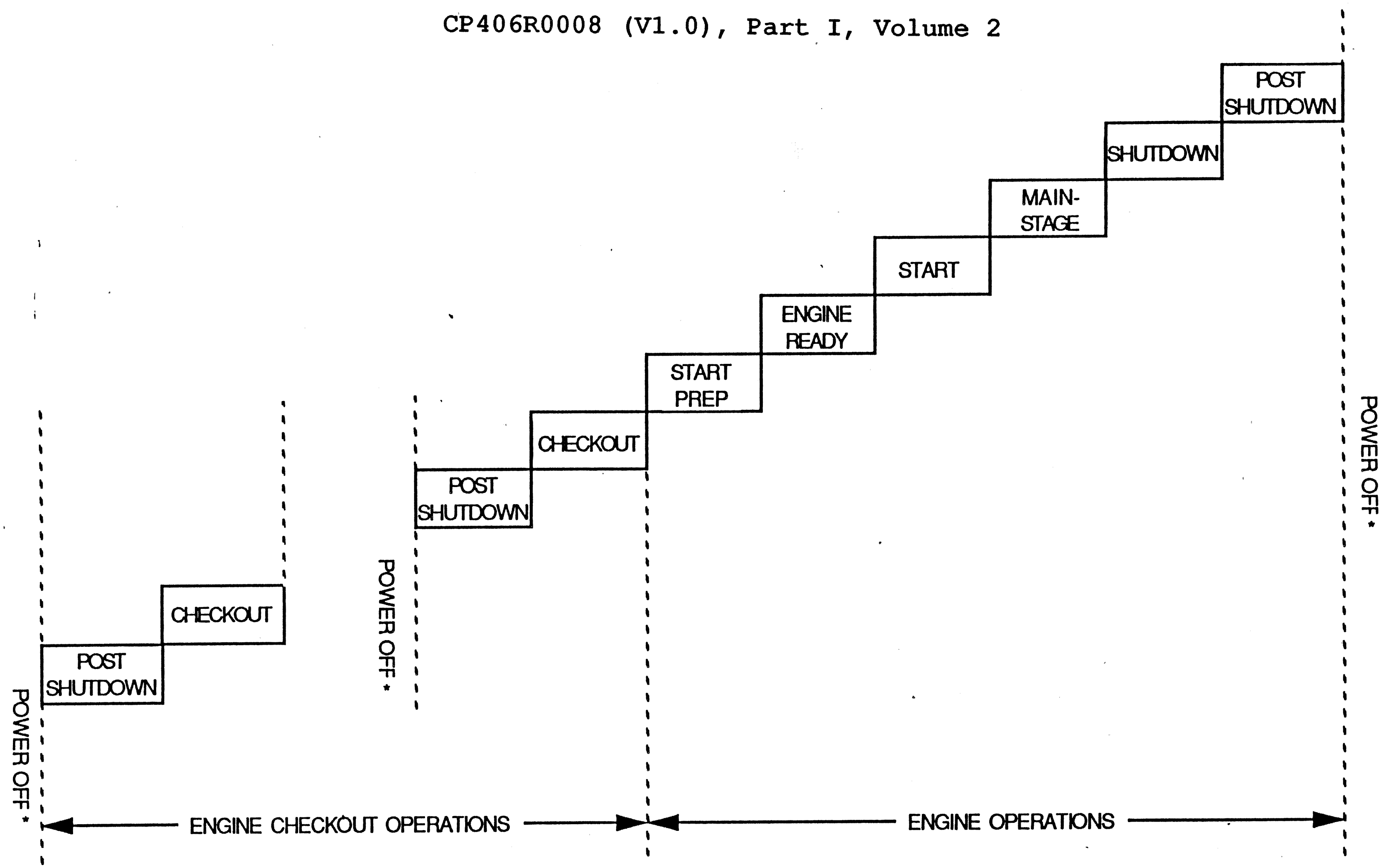
BITS	DEFINITION	COMMENTS
15-14	%00 Engine Data Word (EDW)	Bits 14 & 15 define Word Type
	%11 Confirmation Word	1's complement of previously transmitted Engine Data Word
13	0 if DCU A is the source of VRC data 1 if DCU B is the source of VRC data	
12-5	0 to 255 as specified by design	Message Field: Conditions communicated include: Ground Checkout Configuration FRT-1 Configuration FRT-2 Configuration Flight Configuration Electrical Lockup Hydraulic Lockup Disqualification of OE A Disqualification of Channel A servoactuators Disqualification of Channel B servoactuators RVDT miscompare HPFP Shaft Speed Ignition Confirm (1.24 sec) MCC Pc Ignition Confirm (1.7 sec) MCC Pc Ignition Confirm (2.3 sec) AFV Ignition Confirm (2.3 sec)
4-0	Engine Stage	

Table XLII
INTER-DCU STATUS REGISTER (Continued)

Engine Data Word

Bits 4-0	Engine Stage
1	Checkout Standby
2	Spare
3	Spare
4	Sensor Checkout
5	Spare
6	Controller Checkout
7	Spare
8	Purge 1
9	Purge 2
10	Purge 3
11	Purge 4
12	Engine Ready
13	Start Enable
14	Start Initiation
15	Thrust Buildup (2.4 sec)
16	Mainstage (5 sec)
17	Throttling to Zero Thrust
18	Propellant Valves Closed
19	Pneumatic Shutdown
20	Post Shutdown Standby
21	Oxidizer Dump
22	Terminate Sequence
23-31	Spare

Note: Spare Engine Stage codes may be used at the discretion of software design.



* NOTE: POWER OFF = PRIMARY (AC) WAS OFF, 28V AND/OR BATTERY WAS CONNECTED, AND MEMORY WAS VALID.

FIGURE 1
TYPICAL MISSION PHASE SEQUENCE

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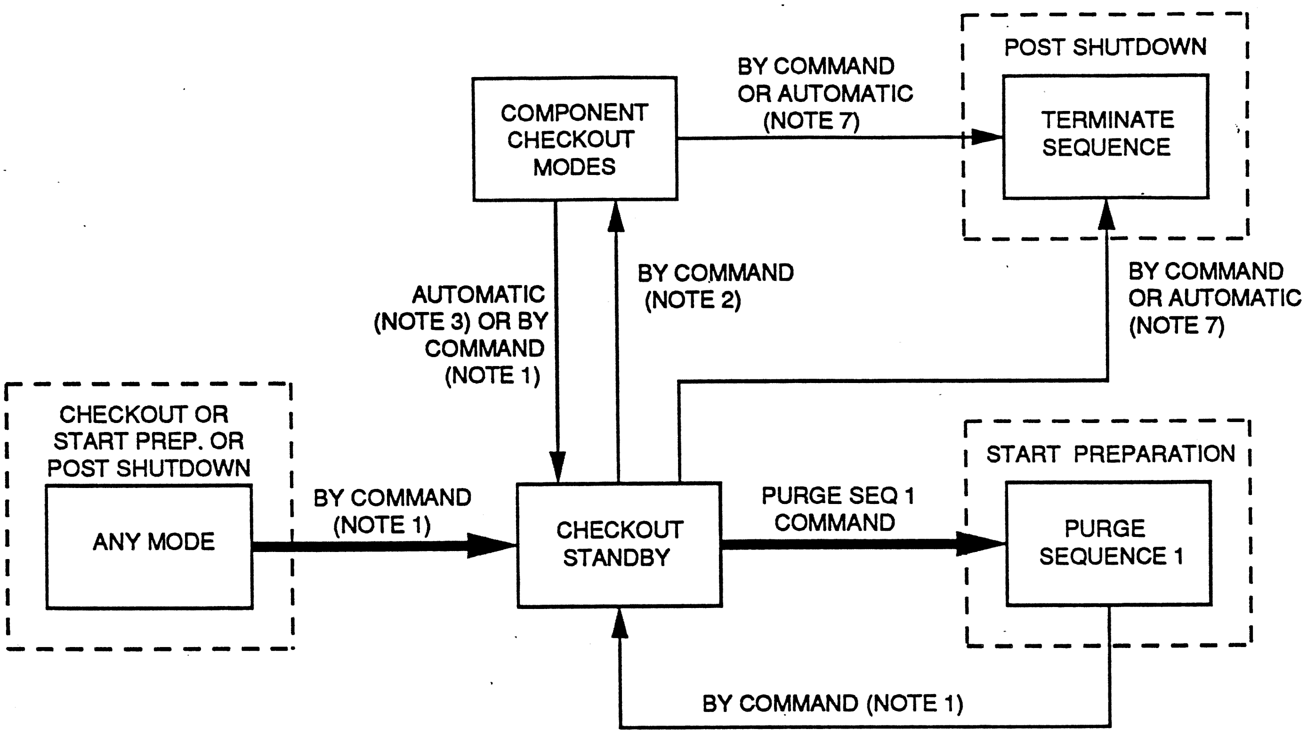

NOTES:

1. CONTROLLER RESET COMMAND OR CHECKOUT STANDBY COMMAND, FROM ANY MODE OF POST SHUTDOWN, CHECKOUT OR START PREPARATION PHASES. DEACTIVATE ALL VALVES COMMAND FROM COMPONENT CHECKOUT.

2. COMMANDS FOR COMPONENT CHECKOUT ARE THOSE COMMANDS ACCEPTABLE ONLY WHEN THE CONFIGURATION IS GROUND CHECKOUT.

3. COMPLETION OF CHECKOUT SEQUENCES.

4. SOLID BLOCKS REPRESENT ENGINE OPERATING SEQUENCES.

5. HEAVY LINES REPRESENT NORMAL OPERATING SEQUENCE.

6. LIGHTER LINES REPRESENT OPTIONAL CAPABILITIES OR DEVIATIONS DUE TO MALFUNCTION DETECTION. THE PATHS SHOWN ARE NOT ALL-INCLUSIVE. THE FULL SET OF POSSIBILITIES IS DEFINED BY THE COMMAND ACCEPTANCE LOGIC AND FAILURE RESPONSES SPECIFIED IN THE TEXT.

7. RESPONSE TO A TERMINATE SEQUENCE COMMAND OR BY FAILURE DETECTION (T-RESPONSE).

FIGURE 2

CHECKOUT PHASE

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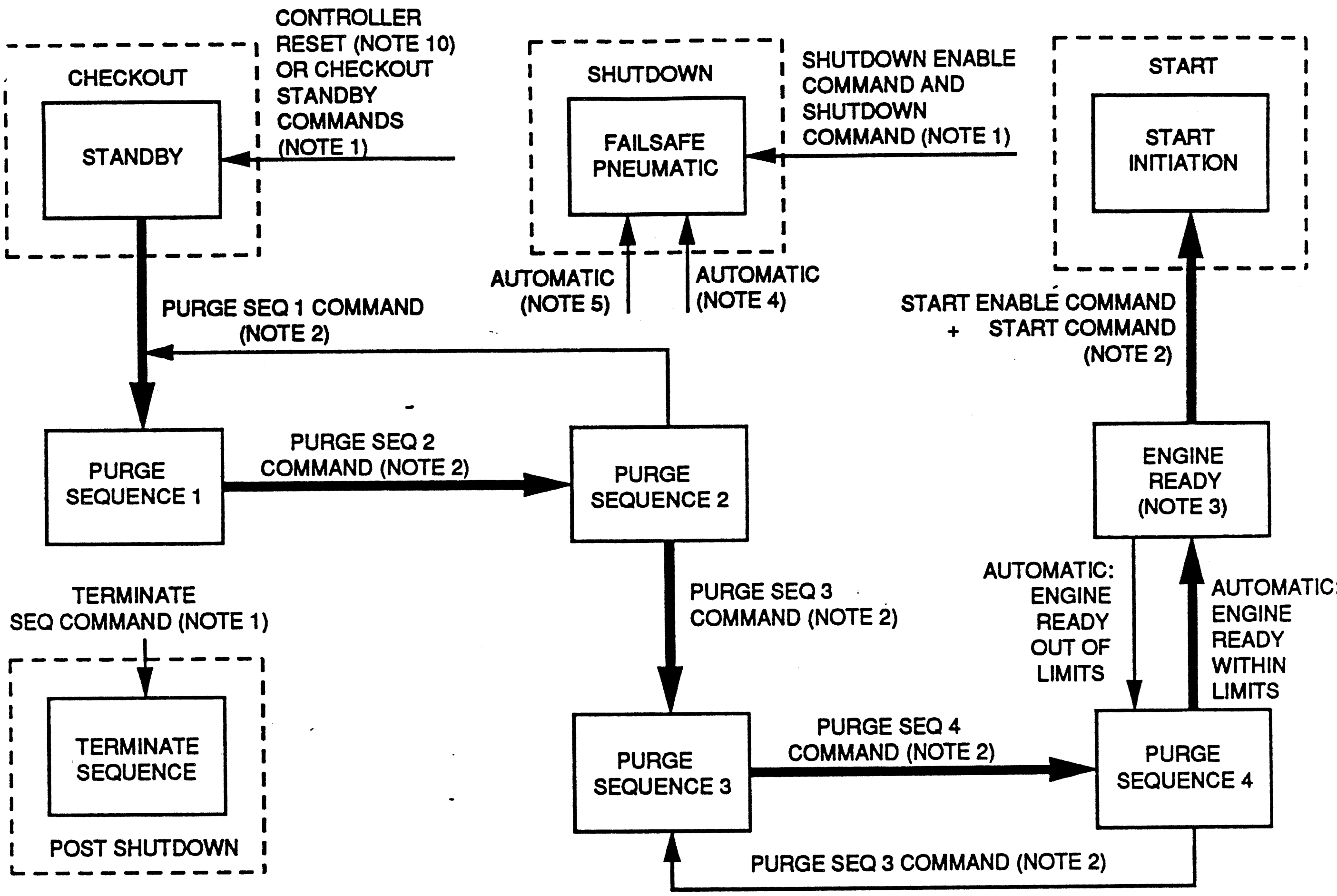

NOTES:

1. FROM ANY MODE OF START PREPARATION PHASE.
2. COMMAND EXECUTED IF NO I (INHIBIT) FAILURE RESPONSE IS IN EFFECT.
3. ENGINE READY CONDITIONS DEFINED IN 3.2.3:1.2.5.
4. FAILURE RESPONSES AS DEFINED UNDER 3.2.4.
5. SHUTDOWN PNEUMATICALLY IN FRT-1 COMMAND, 3.2.3:2.4.1:1.1.
6. ANY OF THE PURGE SEQUENCES MAY BE ENTERED FROM CHECKOUT, START PREPARATION, OR POST SHUTDOWN.
7. SOLID BLOCKS REPRESENT ENGINE OPERATING MODES.
8. HEAVY LINES REPRESENT NORMAL OPERATING SEQUENCE.
9. LIGHTER LINES REPRESENT OPTIONAL CAPABILITIES OR DEVIATIONS DUE TO MALFUNCTION DETECTION. THE PATHS SHOWN ARE NOT ALL-INCLUSIVE. THE FULL SET OF POSSIBILITIES IS DEFINED BY THE ACCEPTANCE LOGIC AND THE FAILURE RESPONSES SPECIFIED IN THE TEXT.
10. INHIBIT FAILURE RESPONSE DOES NOT AFFECT EXECUTION OF THE CONTROLLER RESET COMMAND AS DEFINED IN TABLE V.

FIGURE 3

START PREPARATION PHASE

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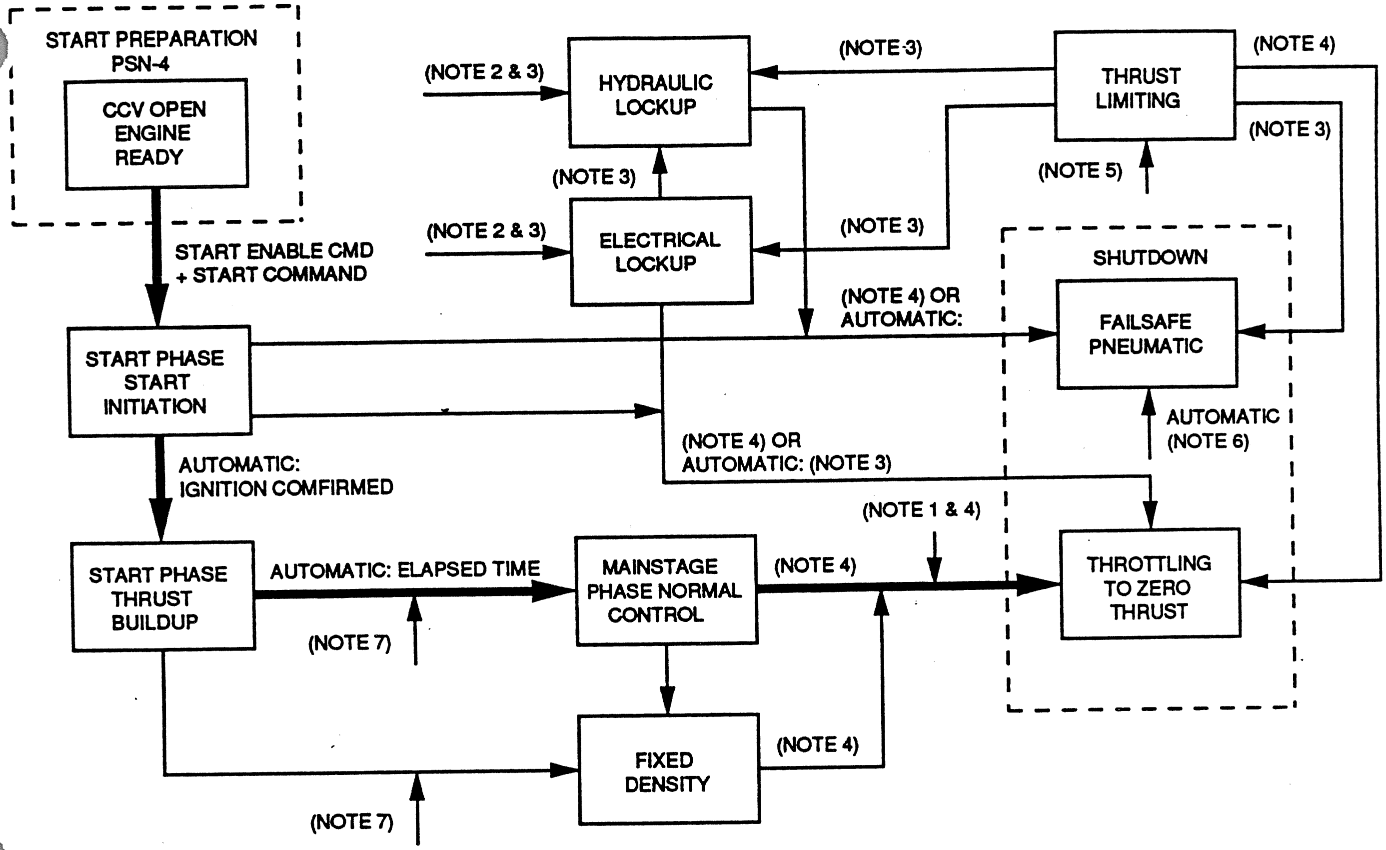

NOTES:

1. FROM ANY MODE OF START OR NON-LOCKUP MODE OF MAINSTAGE.
2. FROM ANY NON-LOCKUP MODE OF MAINSTAGE.
3. FAILURE RESPONSES AS DEFINED UNDER 3.2.4.
4. SHUTDOWN ENABLE COMMAND FOLLOWED BY SHUTDOWN COMMAND.
5. FROM MAINSTAGE NORMAL CONTROL OR FIXED DENSITY MODE WHEN OPOV POSITION COMMAND IS LIMITED FOR 3 CONSECUTIVE MAJOR CYCLES.
6. SHUTDOWN PNEUMATICALLY IN FRT-1 COMMAND, 3.2.3:2.4.1:1.1.
7. FROM THRUST LIMITING MODE WHEN OPOV POSITION COMMAND IS NOT LIMITED FOR 3 CONSECUTIVE MAJOR CYCLES.
8. SOLID BLOCKS REPRESENT ENGINE OPERATING MODES.
9. HEAVY LINES REPRESENT NORMAL OPERATING SEQUENCE.
10. LIGHTER LINES REPRESENT OPTIONAL CAPABILITIES OR DEVIATIONS DUE TO MALFUNCTION DETECTION. THE PATHS SHOWN ARE NOT ALL-INCLUSIVE. THE FULL SET OF POSSIBILITIES IS DEFINED BY THE COMMAND ACCEPTANCE LOGIC AND THE FAILURE RESPONSES SPECIFIED IN THE TEXT.

FIGURE 4

START AND MAINSTAGE PHASE

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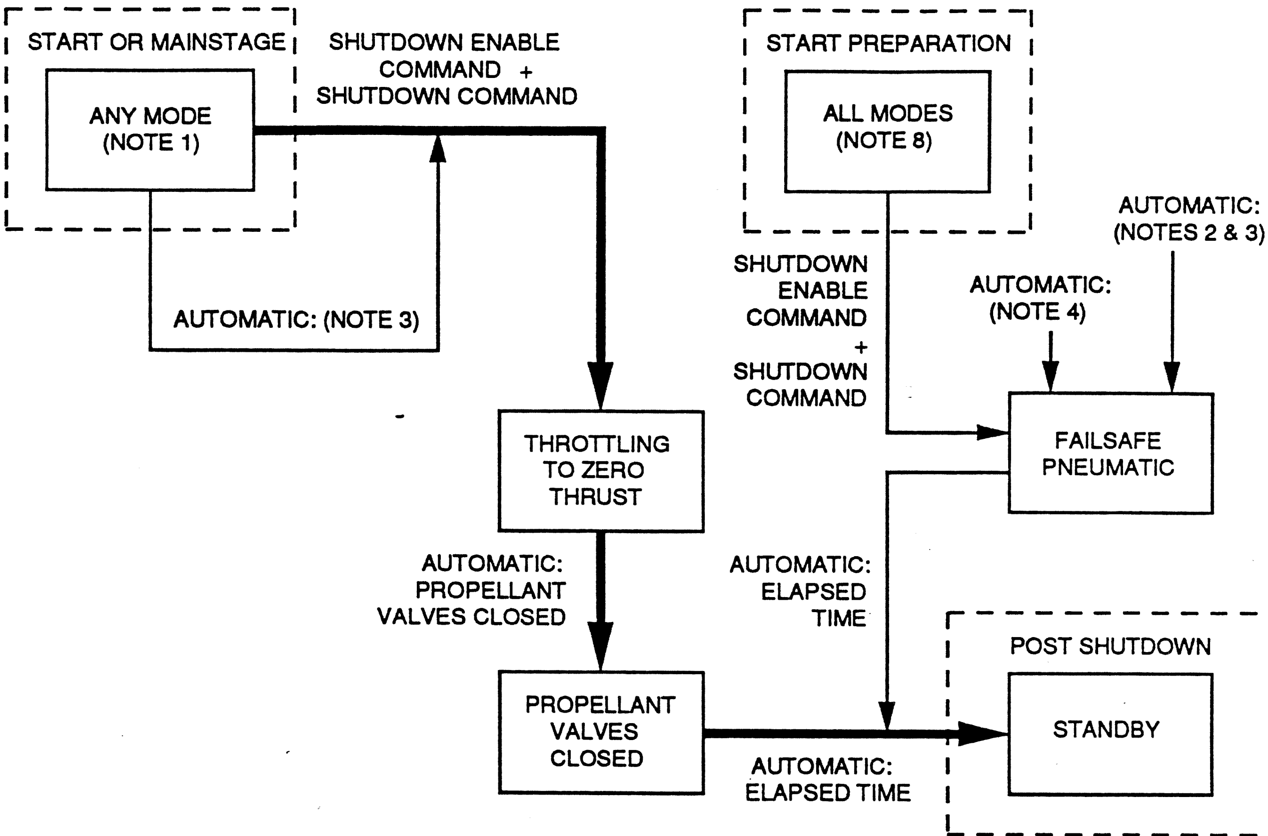

NOTES:

1. FROM ANY MODE OF START OR MAINSTAGE PHASE.
2. FROM ANY MODE OF ANY PHASE.
3. SHUTDOWN FAILURE RESPONSES AS DEFINED UNDER 3.2.4.
4. SHUTDOWN PNEUMATICALLY IN FRT-1 COMMAND, 3.2.3:2.4.1:1.1.
5. SOLID BLOCKS REPRESENT ENGINE OPERATING MODES.
6. HEAVY LINES REPRESENT NORMAL OPERATING SEQUENCE.
7. LIGHTER LINES REPRESENT OPTIONAL CAPABILITIES OR DEVIATIONS DUE TO MALFUNCTION DETECTION. THE PATHS SHOWN ARE NOT ALL-INCLUSIVE. THE FULL SET OF POSSIBILITIES IS DEFINED BY THE COMMAND ACCEPTANCE LOGIC AND FAILURE RESPONSES SPECIFIED IN THE TEXT.
8. FROM ANY MODE OF START PREPARATION PHASE.

FIGURE 5

SHUTDOWN PHASE

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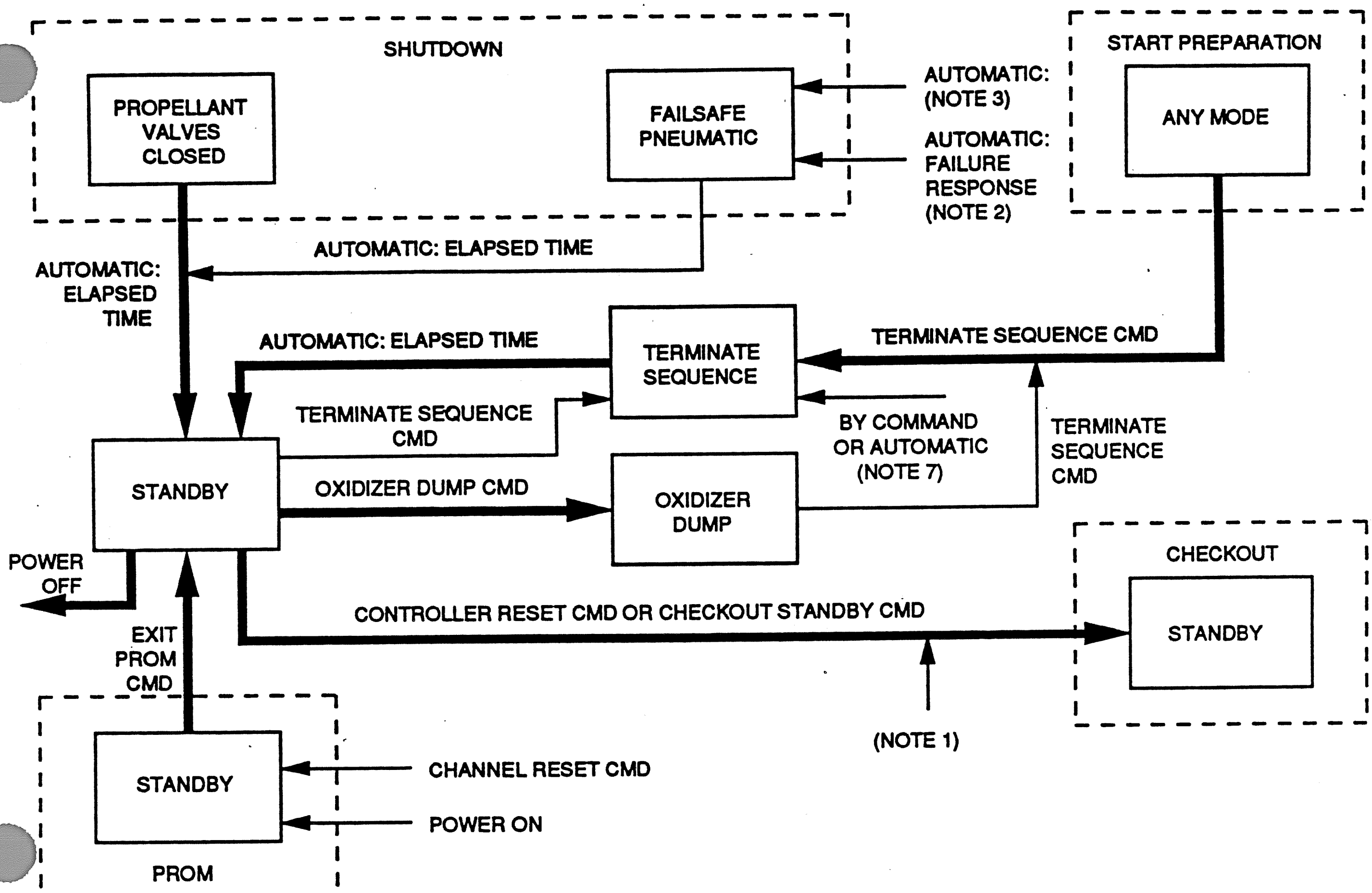

NOTES:

1. CONTROLLER RESET OR CHECKOUT STANDBY COMMANDS FROM ANY MODE OF POST SHUTDOWN PHASE.

2. FROM ANY MODE OF POST SHUTDOWN PHASE OTHER THAN STANDBY.

3. SHUTDOWN PNEUMATICALLY IN FRT-1 COMMAND, 3.2.3:2.4.1:1.1.

4. SOLID BLOCKS REPRESENT ENGINE OPERATING MODES.

5. HEAVY LINES REPRESENT NORMAL OPERATING SEQUENCE.

6. LIGHTER LINES REPRESENT OPTIONAL CAPABILITIES OR DEVIATIONS DUE TO MALFUNCTION DETECTION. THE PATHS SHOWN ARE NOT ALL-INCLUSIVE. THE FULL SET OF POSSIBILITIES IS DEFINED BY THE COMMAND ACCEPTANCE LOGIC AND THE FAILURE RESPONSES SPECIFIED IN THE TEXT.

7. RESPONSE TO A TERMINATE SEQUENCE COMMAND OR FAILURE DETECTION (T-RESPONSE).

FIGURE 6

POST SHUTDOWN PHASE

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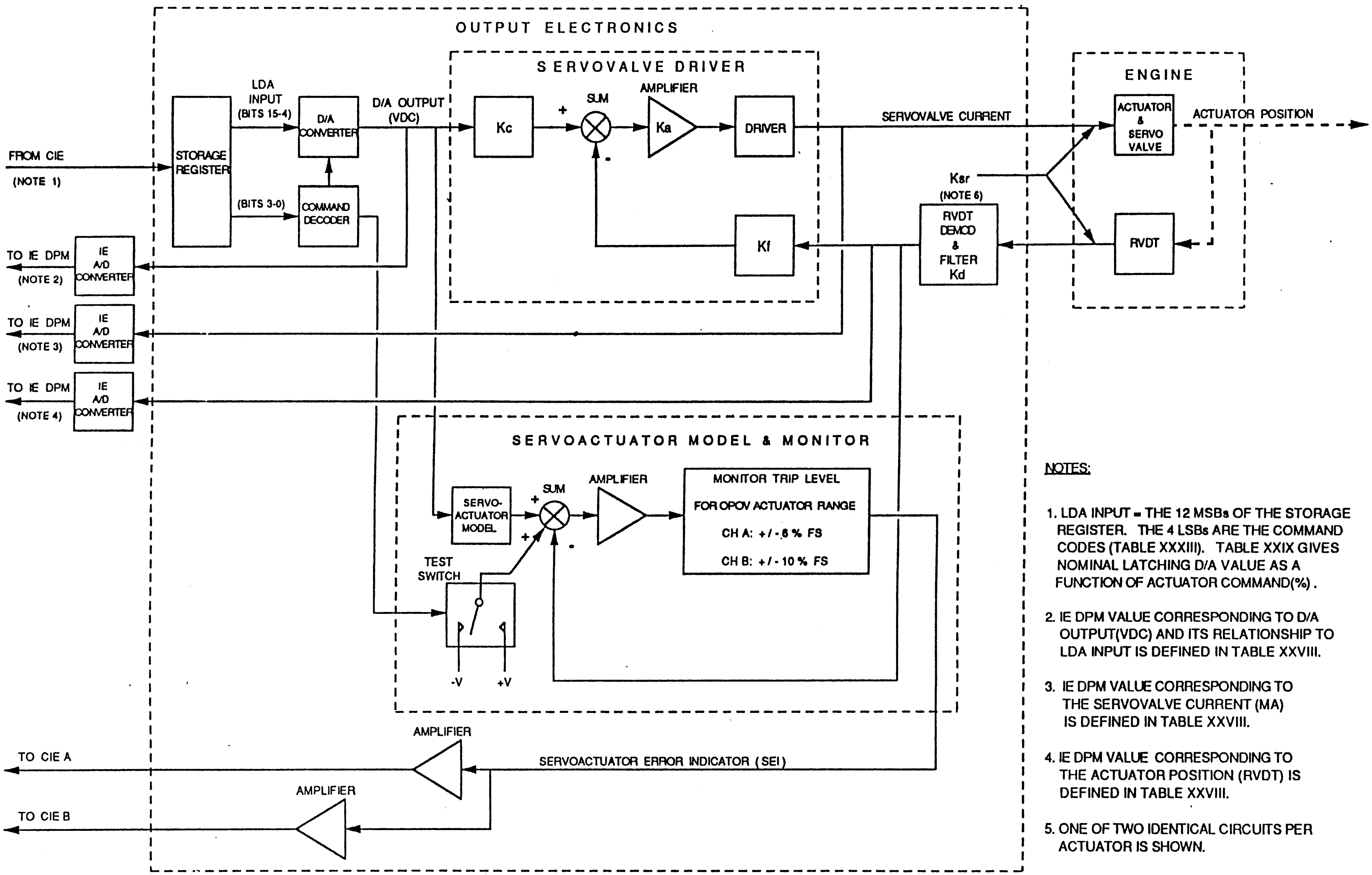

FIGURE 7
D/A - RVDT ACTUATOR CONFIGURATION (NOTE 5)

NOTES:

1. LDA INPUT = THE 12 MSBs OF THE STORAGE REGISTER. THE 4 LSBs ARE THE COMMAND CODES (TABLE XXXIII). TABLE XXIX GIVES NOMINAL LATCHING D/A VALUE AS A FUNCTION OF ACTUATOR COMMAND(%).

2. IE DPM VALUE CORRESPONDING TO D/A OUTPUT(VDC) AND ITS RELATIONSHIP TO LDA INPUT IS DEFINED IN TABLE XXVIII.

3. IE DPM VALUE CORRESPONDING TO THE SERVOVALVE CURRENT (MA) IS DEFINED IN TABLE XXVIII.

4. IE DPM VALUE CORRESPONDING TO THE ACTUATOR POSITION (RVDT) IS DEFINED IN TABLE XXVIII.

5. ONE OF TWO IDENTICAL CIRCUITS PER ACTUATOR IS SHOWN.

6. Kc = Kf = 7.68 V/V
   Ka = -10 MA/VDC
   Kd = -5.4 VDC/VRMS
   Ksr = (Kf)(Ka)(Kd) = 414.7 MA/VRMS

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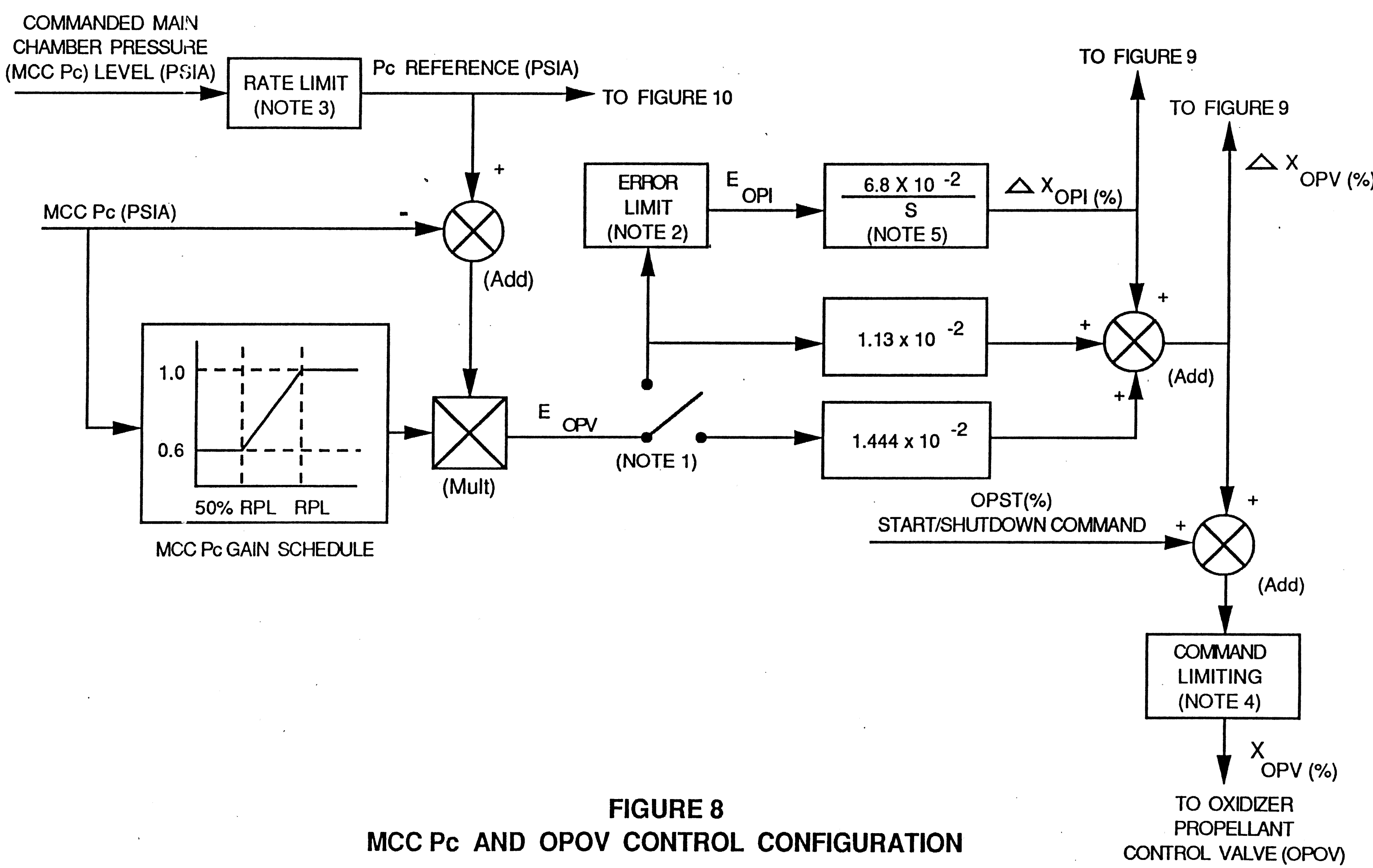


FIGURE 8
MCC Pc AND OPOV CONTROL CONFIGURATION

NOTES:

1. Control loops are activated and deactivated at times defined in control sequences for Start and Shutdown phases. See Tables XX, XXXI and XXXIA.

2. Error limit is: If XOPV G.E. the limits specified in Note 4, and EOPV G.T. 0, then EOPI = 0 else, EOPI = EOPV.

3. Command rate limit is nominally 300 PSIA/Sec during Mainstage and shall be adjustable by operational data. During Start phase, the rates are defined in the control sequence.

4. For OPOV limit requirements see Thrust Limiting, 3.2.3:1.7.3.

5. This equation is a Laplace transform defining an integrator. See 6.3 Tustin Method, Example 1.

FIGURE 8

MCC Pc AND OPOV CONTROL CONFIGURATION

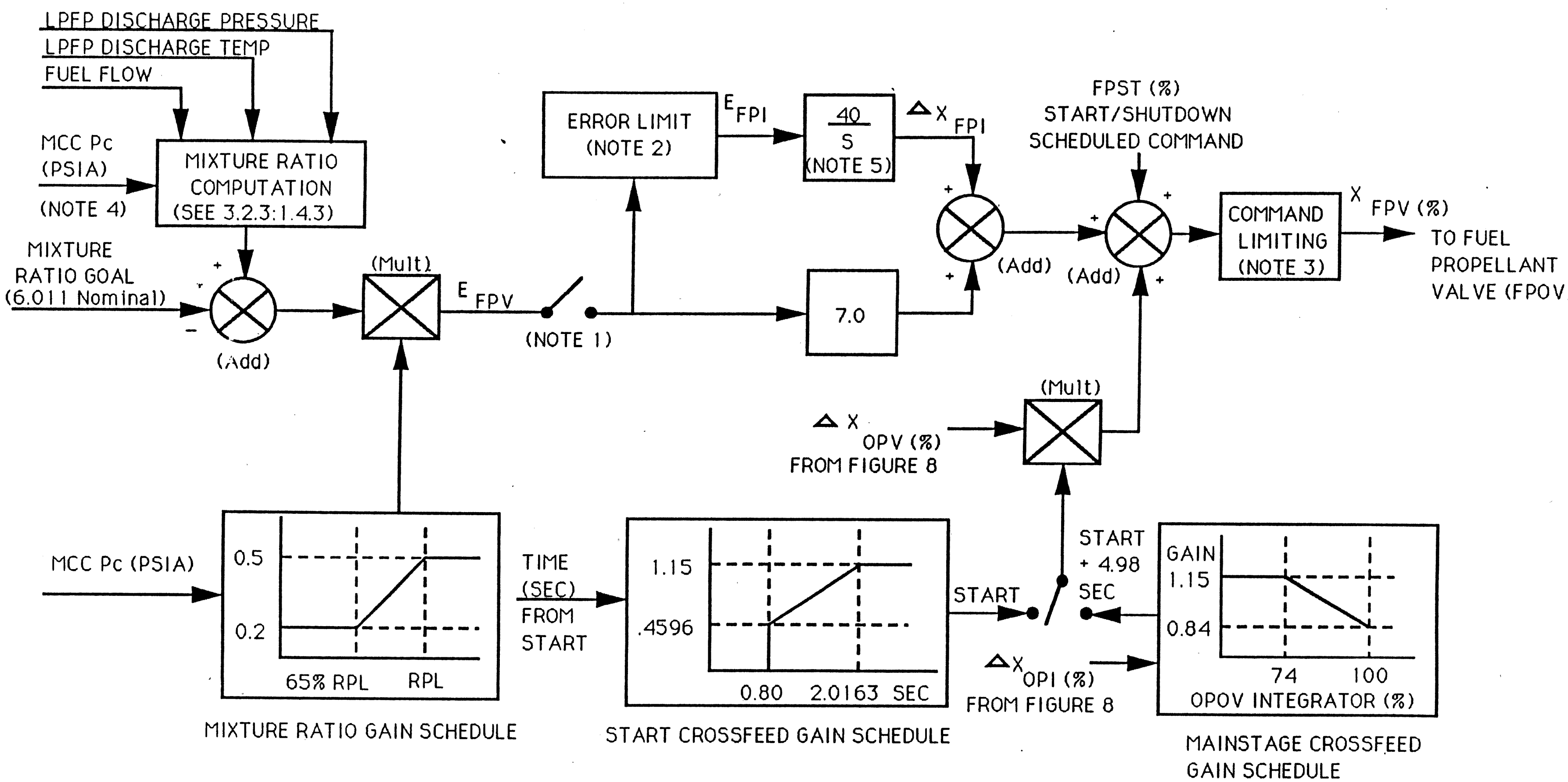


FIGURE 9
MIXTURE RATIO AND FPOV CONTROL CONFIGURATION

NOTES:

1. Control Loop is activated and deactivated at times defined in control sequence for Start and Shutdown Phases, See Tables XX, XXXI, and XXXIA.

2. Error Limit is: If X_{FPV} G.E. the limits specified in Note 3, and E_{FPV} G.T. 0; then E_{FPI}=0; else, E_{FPI}= E_{FPV}.

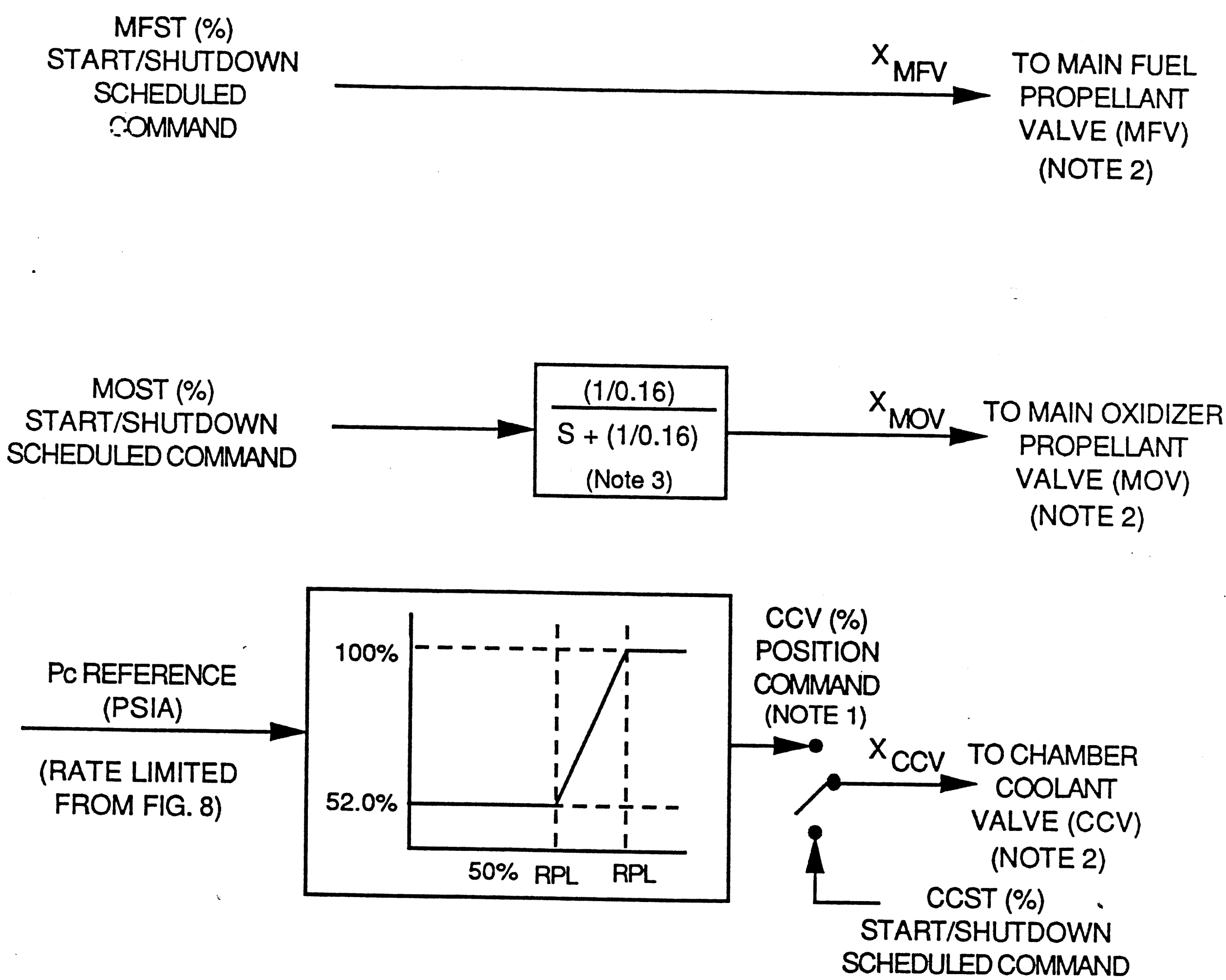
3. FPOV position command will be limited to 56.1% nominal from Start through Start + 2.28 seconds and 102% nominal for all others times, 3.2.3:1.7.3. These limits will be operational constants.

4. During Thrust Limiting this signal will be Pc Reference.

5. This equation is a Laplace transform defining an integrator. See 6.3 Tustin Method, Example 1.

FIGURE 9

MIXTURE RATIO AND FPOV CONTROL CONFIGURATION



NOTES:

1. VALVE CONTROL AND COMMANDS ARE ACTIVATED AND DEACTIVATED AT TIMES DEFINED IN CONTROL SEQUENCES FOR START AND SHUTDOWN PHASES.

2. THE POSITION COMMANDS FOR THESE VALVES ARE RATE LIMITED TO 200 PERCENT PER SECOND DURING ALL PHASES.

3. THIS EQUATION IS A LAPLACE TRANSFORM DEFINING A LAG. SEE 6.3 TUSTIN METHOD, EXAMPLE 2.

FIGURE 10
CONTROL CONFIGURATION OF SCHEDULED PROPELLANT VALVES

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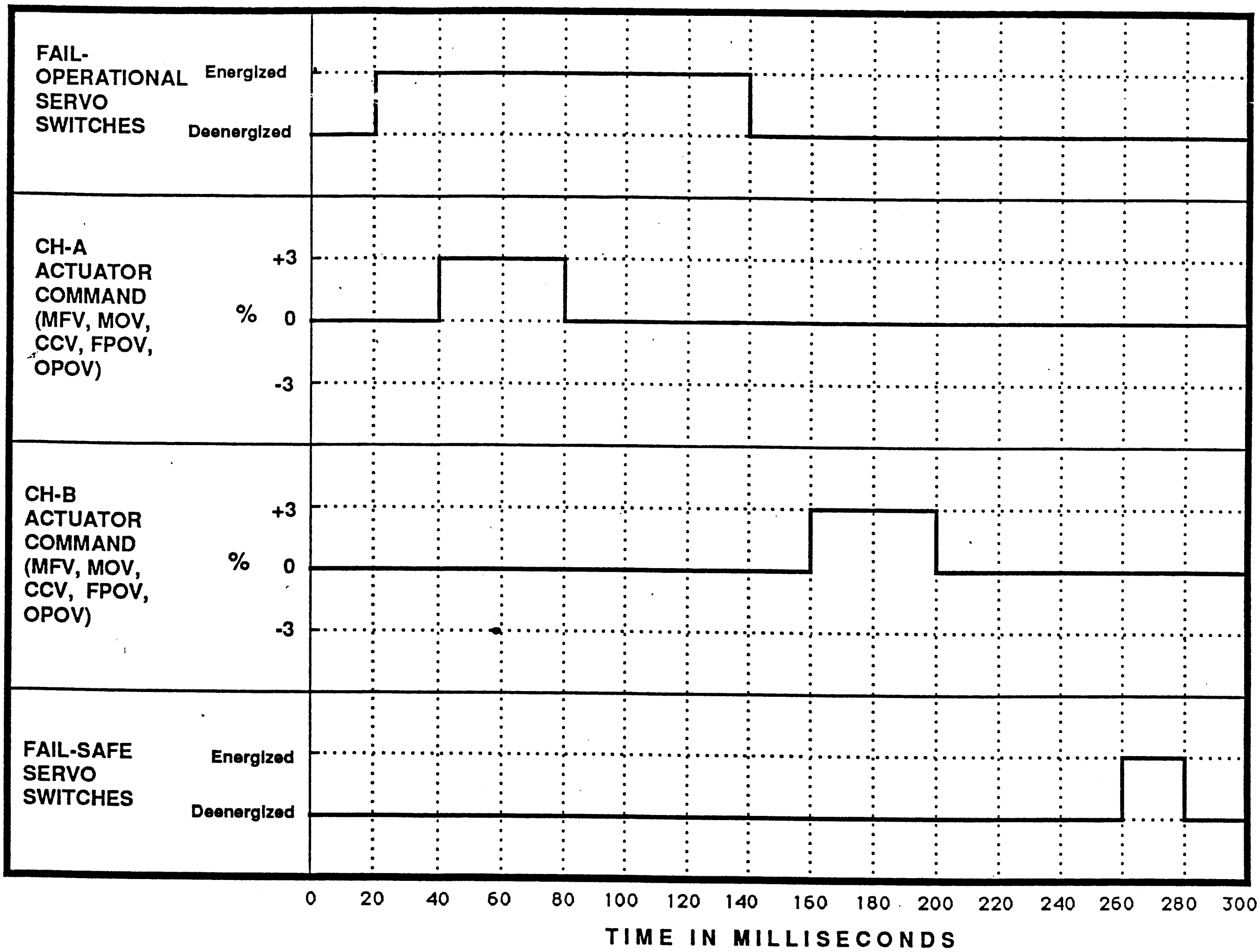

Reference 3.2.3:6.1.6 Actuator Exercise Sequence

FIGURE 11A
ACTUATOR EXERCISE SEQUENCE

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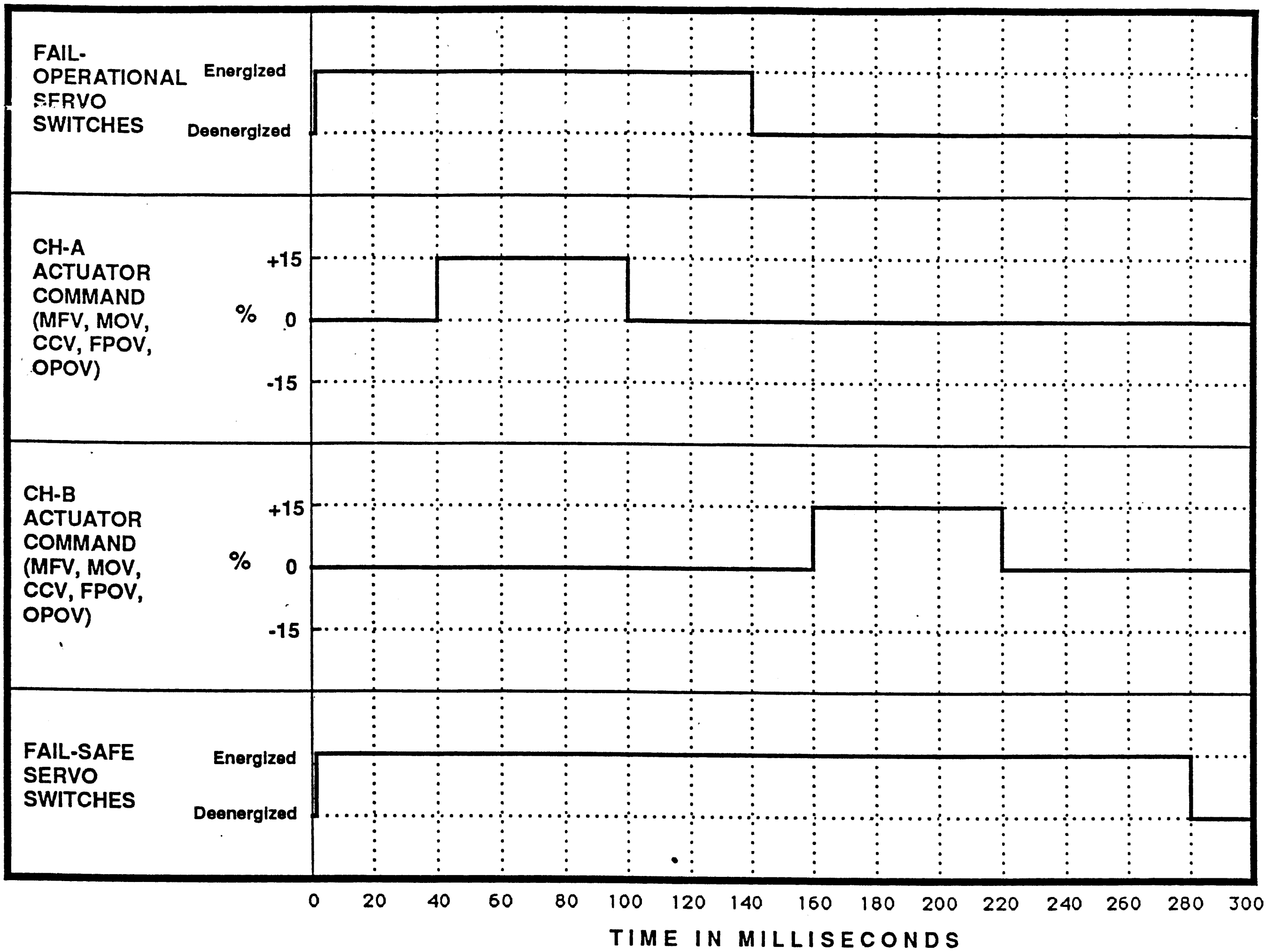

Reference 3.2.3:2.3.8 Actuator Pre-operational Conditioning Cycle

FIGURE 11B
ACTUATOR PRE-OPERATIONAL CONDITIONING CYCLE

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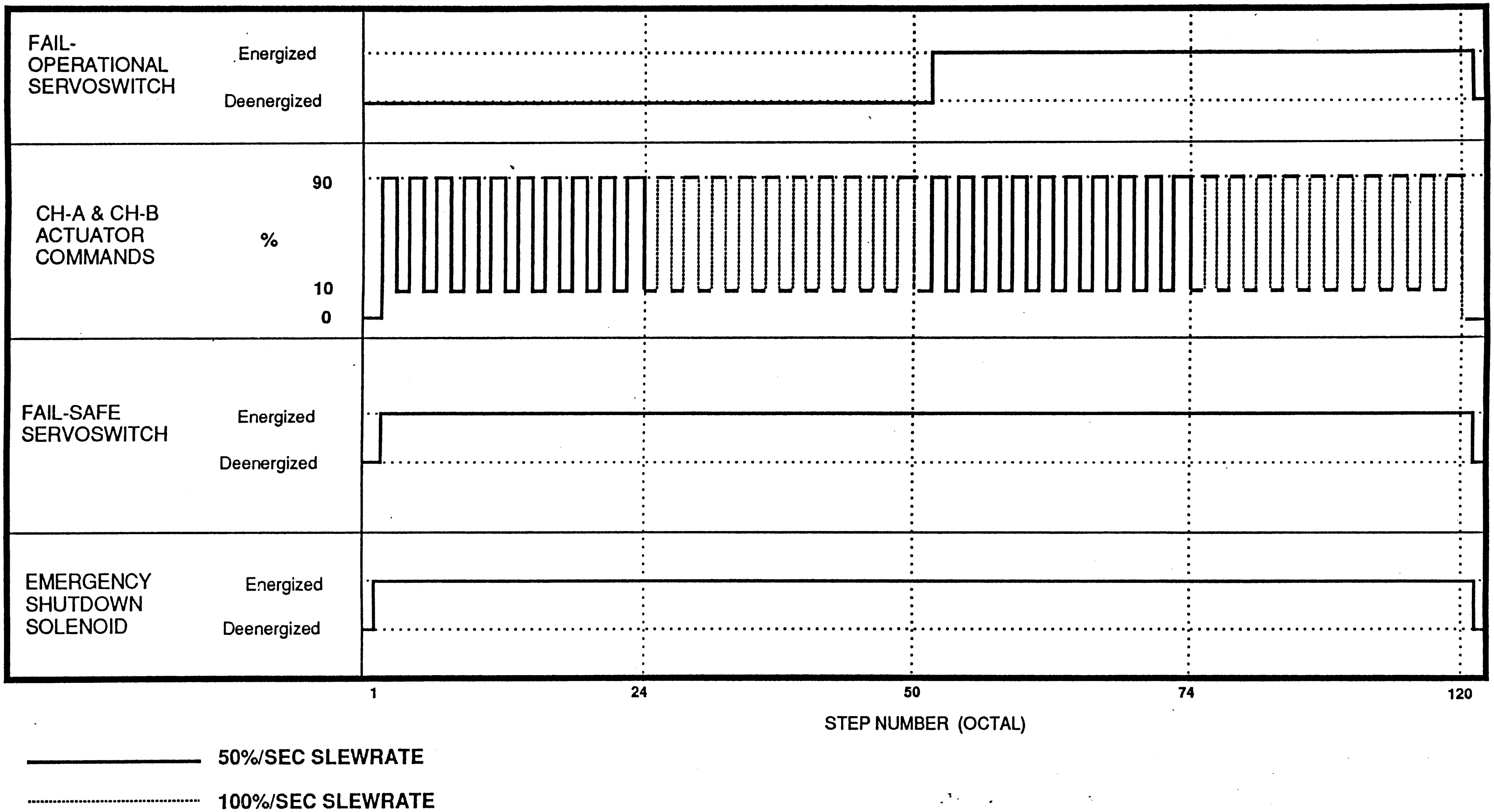

Reference Table XXIII for detailed values

FIGURE 12
HYDRAULIC CONDITIONING SEQUENCE

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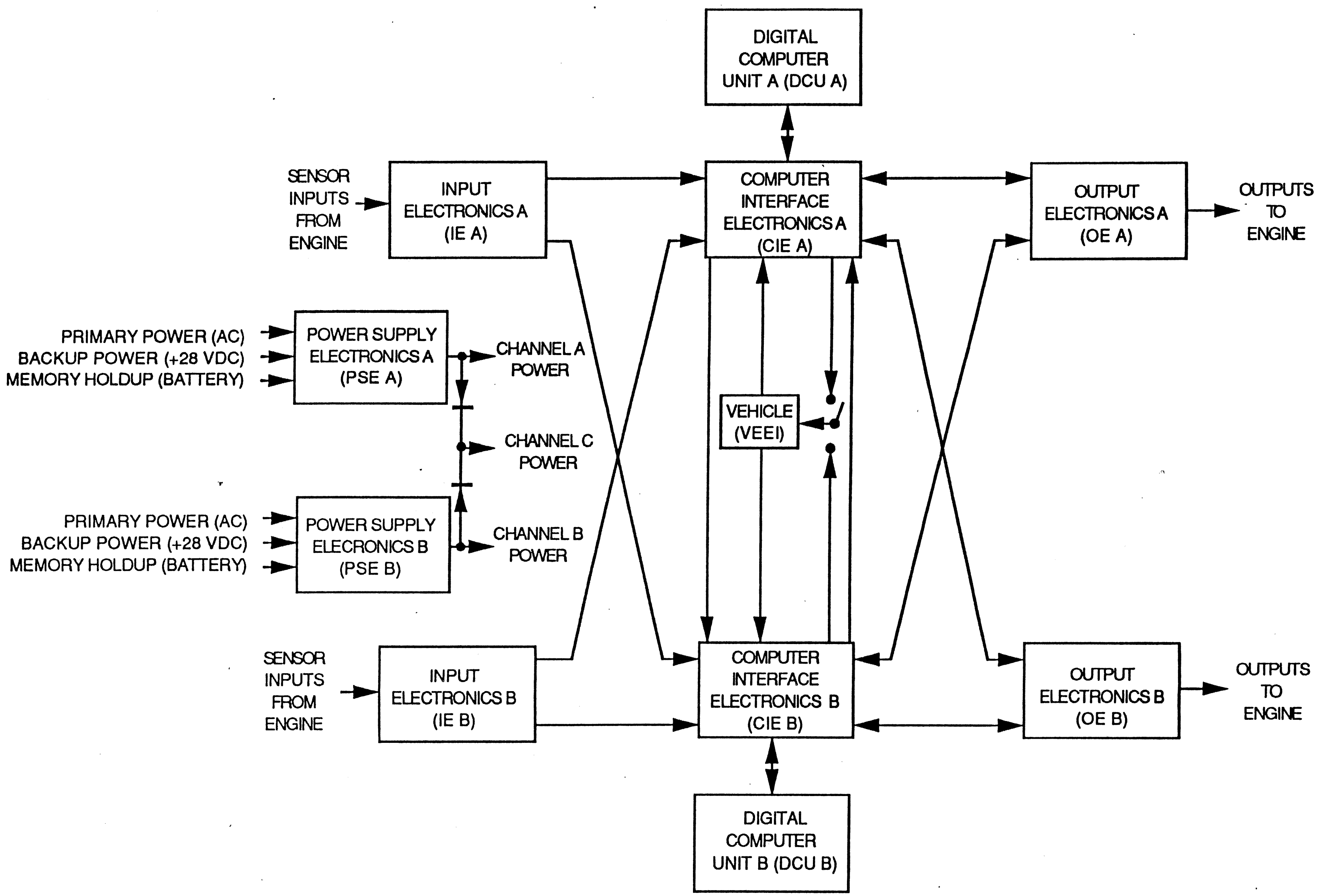

FIGURE 13
INTERFACE BLOCK DIAGRAM OVERVIEW

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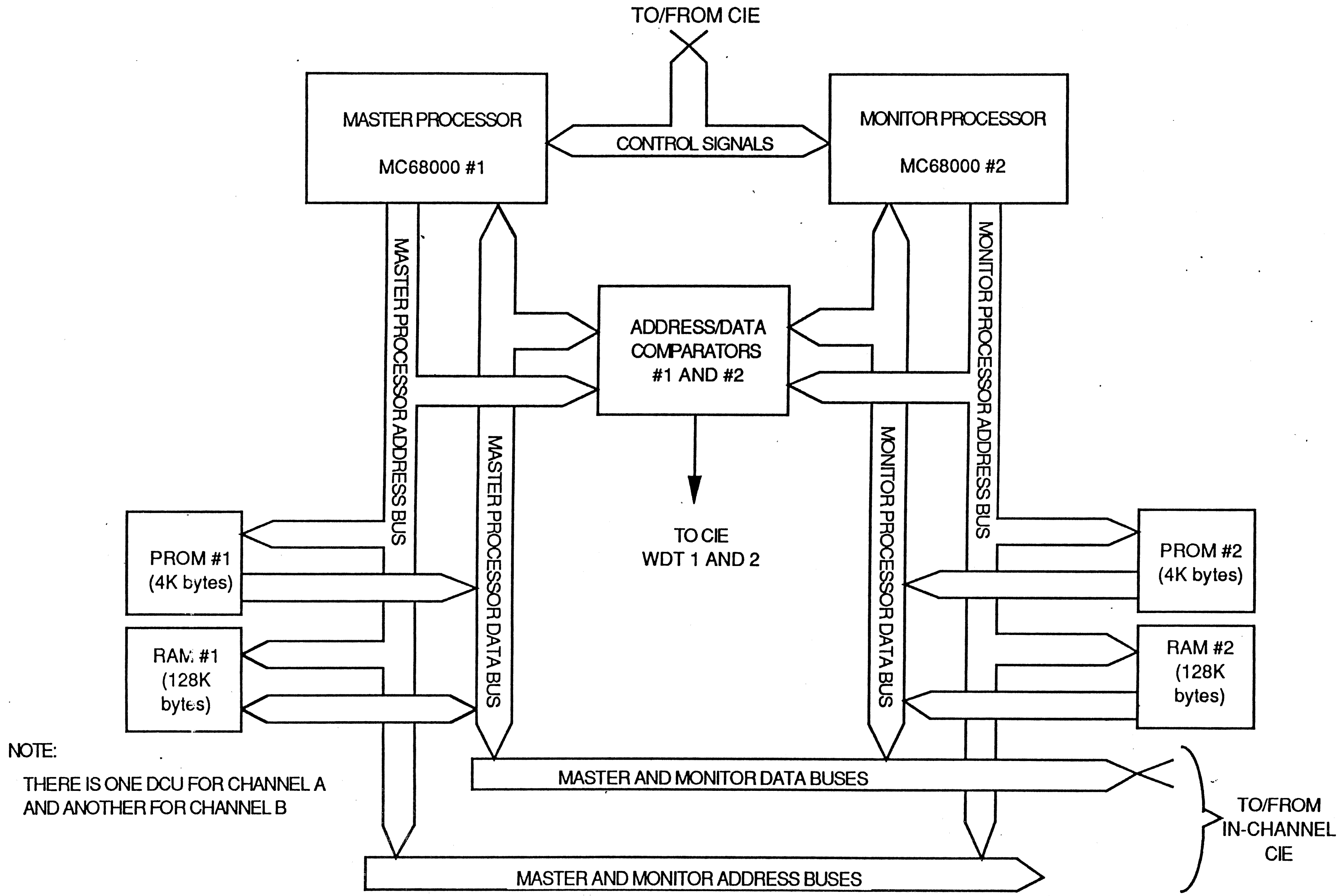

FIGURE 14
DCU INTERFACE BLOCK DIAGRAM (NOTE)

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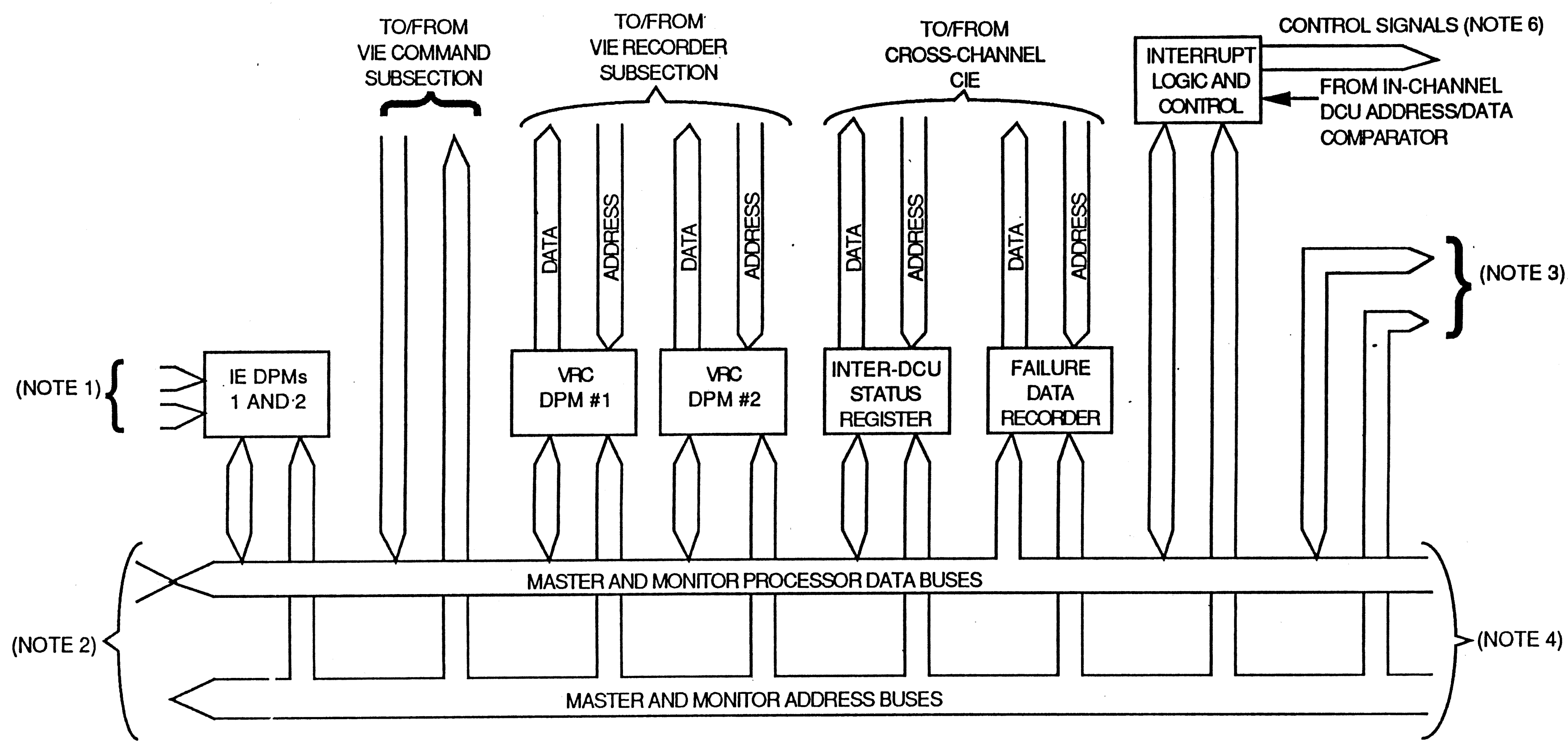

NOTES:
1. SENSOR DATA FROM BOTH CHANNELS
2. IE SEQUENCE CONTROLS BOTH IEs
3. TO/FROM BOTH OEs
4. TO/FROM IN-CHANNEL DCU
5. THERE IS ONE CIE FOR CHANNEL A AND ANOTHER FOR CHANNEL B
6. TO IN-CHANNEL DCU

FIGURE 15
CIE INTERFACE BLOCK DIAGRAM (NOTE 5)

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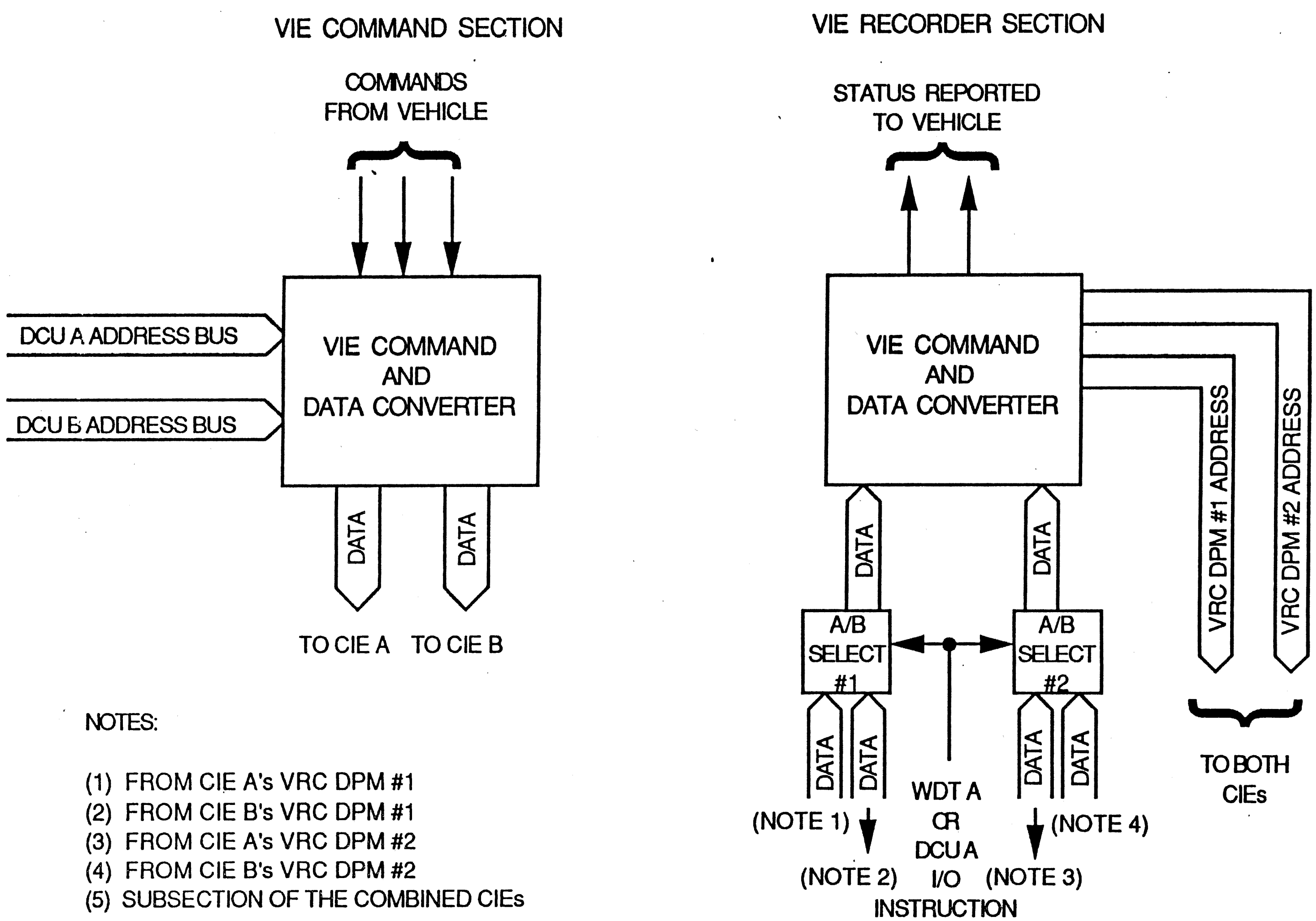

NOTES:

(1) FROM CIE A's VRC DPM #1
(2) FROM CIE B's VRC DPM #1
(3) FROM CIE A's VRC DPM #2
(4) FROM CIE B's VRC DPM #2
(5) SUBSECTION OF THE COMBINED CIEs

FIGURE 16
VIE INTERFACE BLOCK DIAGRAM (NOTE 5)

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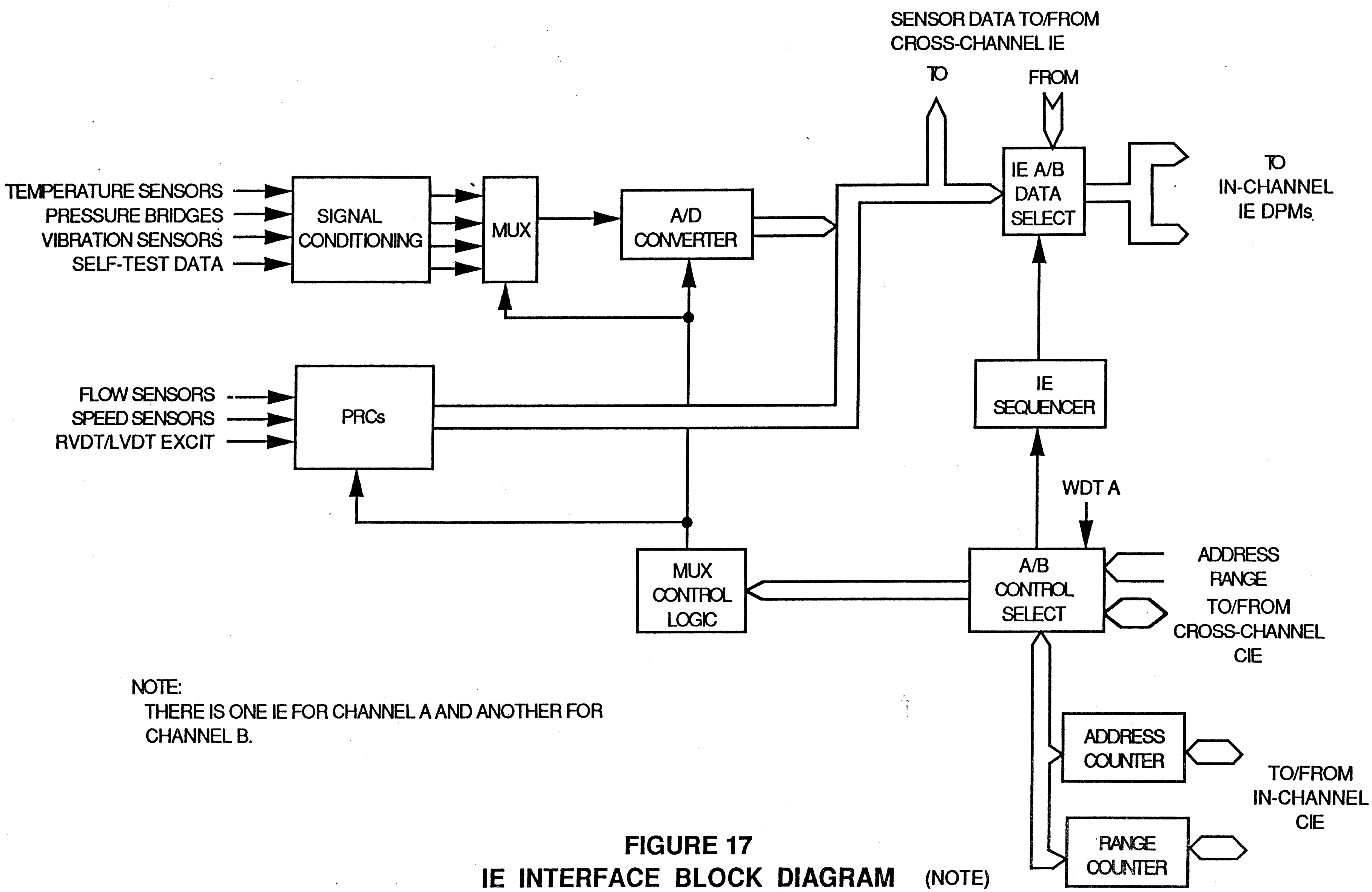

NOTE:
THERE IS ONE IE FOR CHANNEL A AND ANOTHER FOR CHANNEL B.

FIGURE 17
IE INTERFACE BLOCK DIAGRAM (NOTE)

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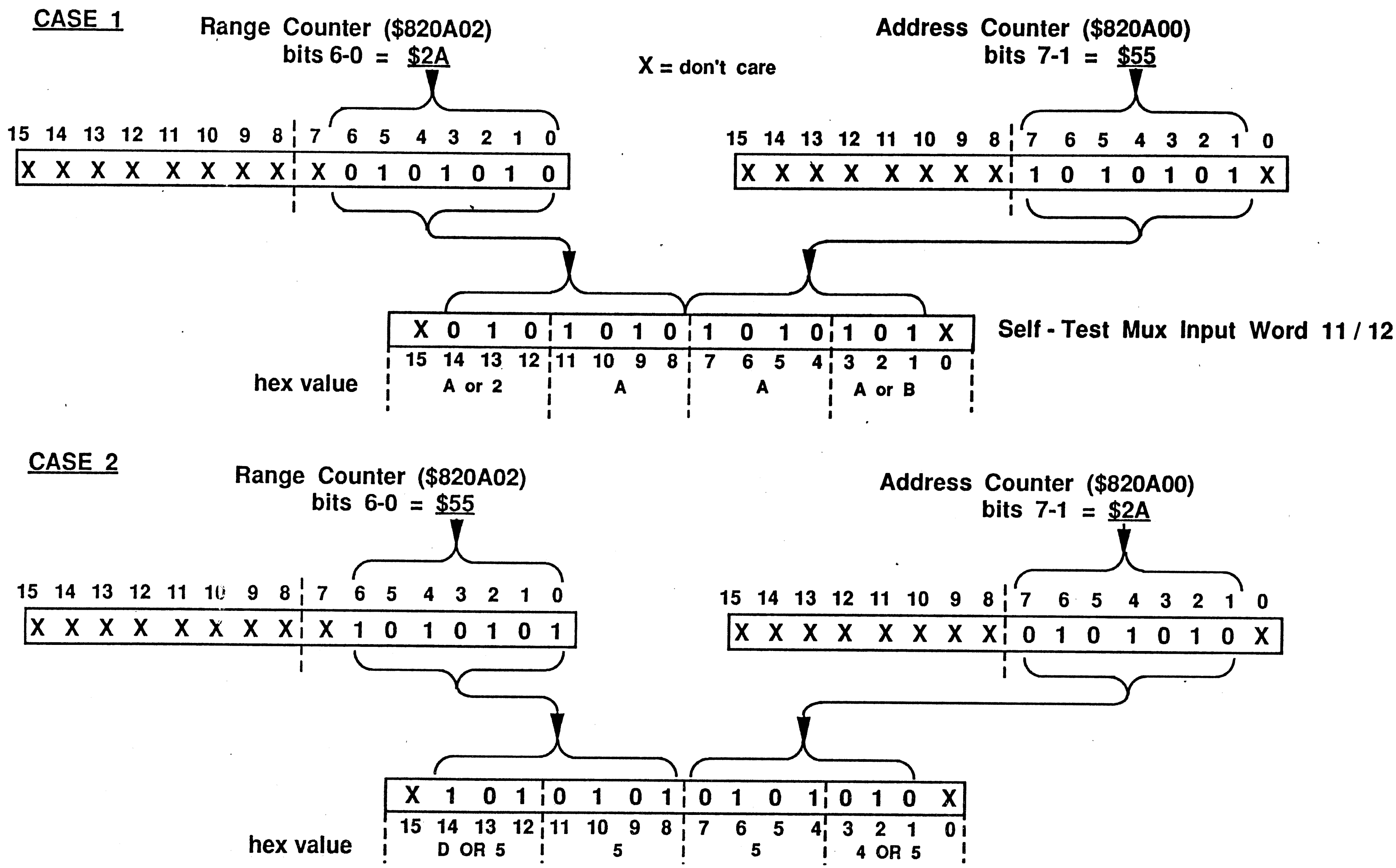

FIGURE 18
IE ADDRESS & RANGE COUNTERS SELF-TEST (3.2.3:3.2.2)

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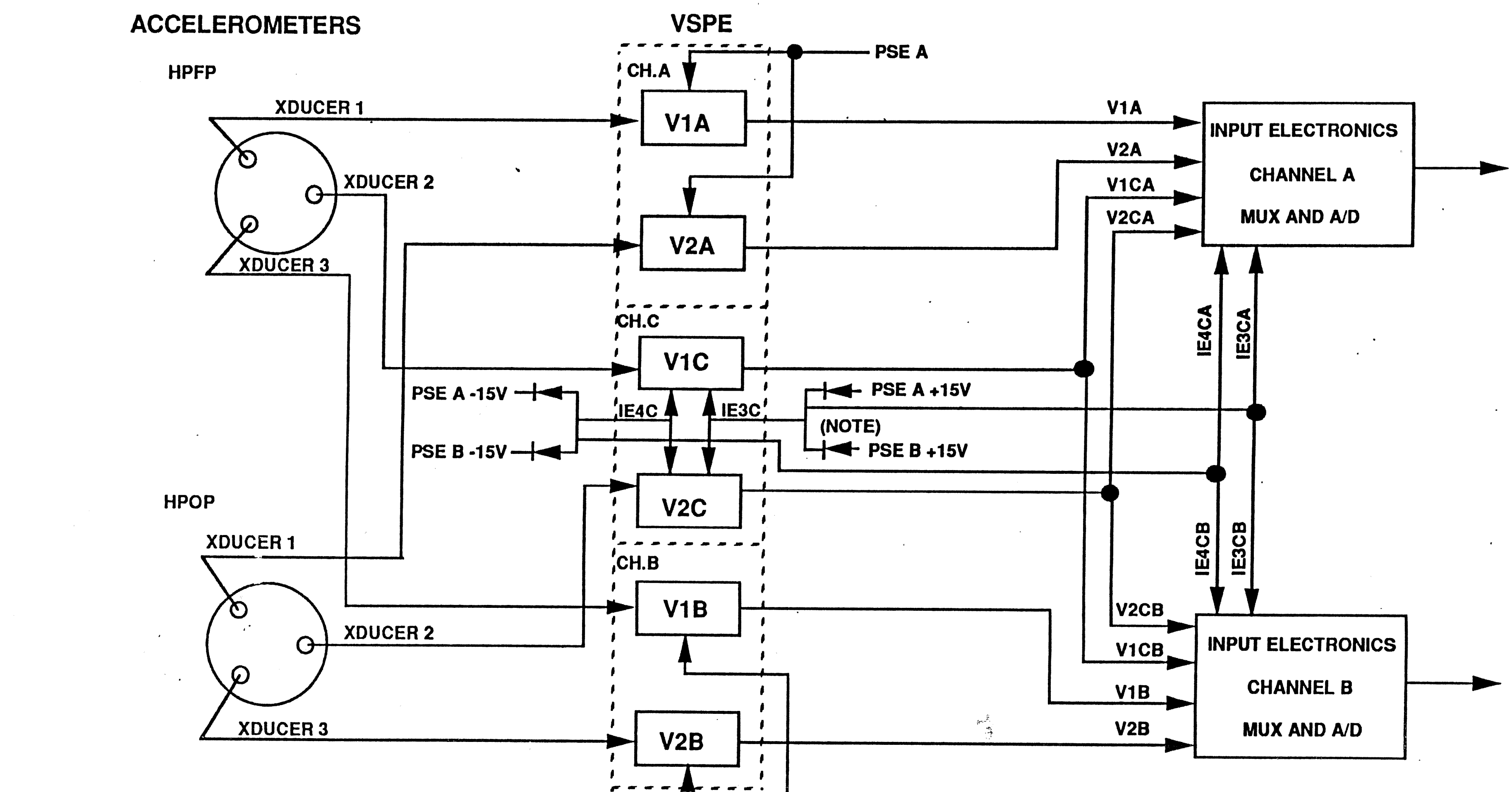

NOTE: 3.2.3.3.3.7 IE (VSPE) CHANNEL C
Power Supply Self-Test monitors these voltages.

FIGURE 19
ACCELEROMETER SIGNAL FLOW FOR FASCOS

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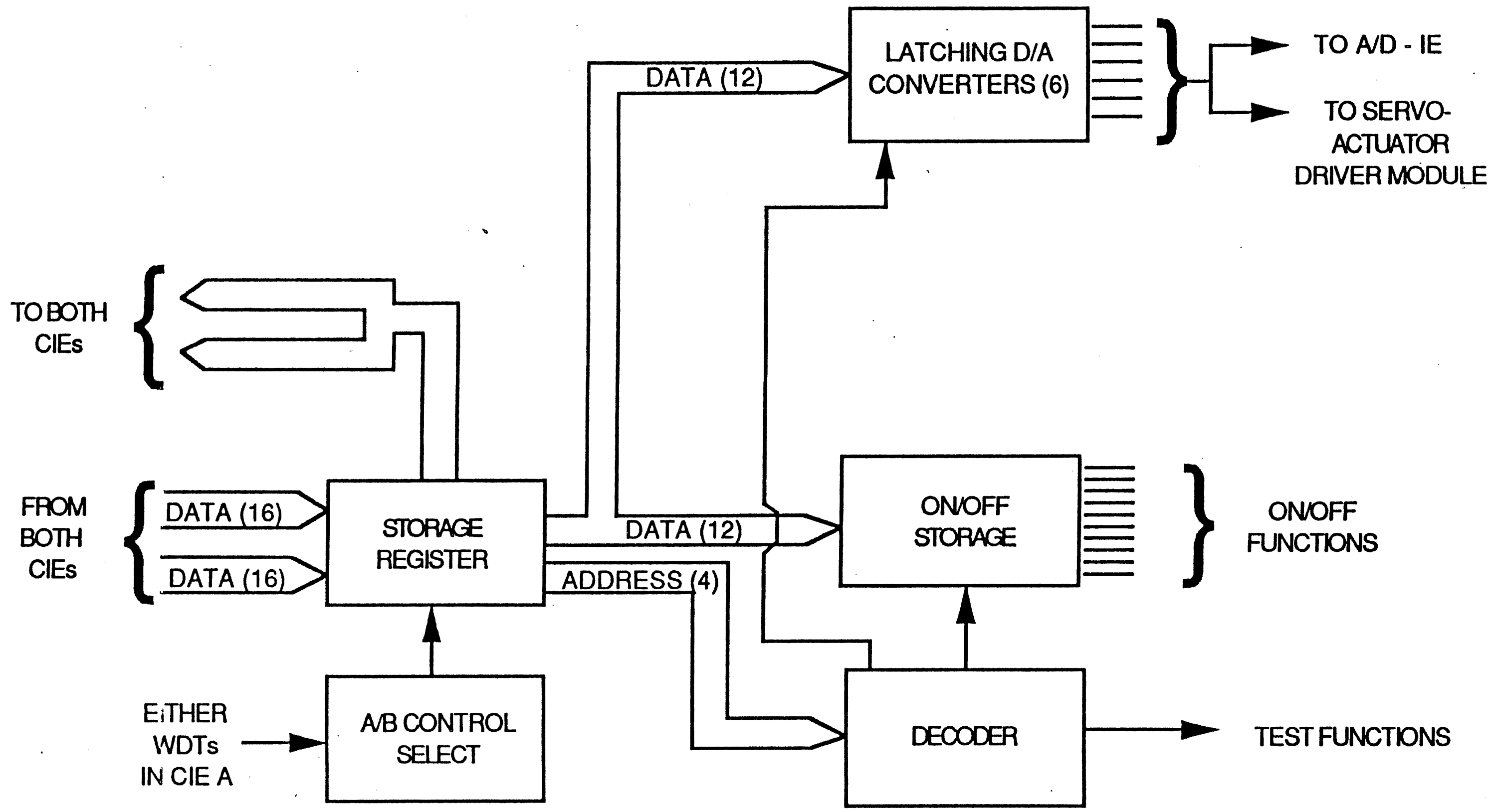

NOTE:
THERE IS ONE OE FOR CHANNEL A AND ANOTHER FOR CHANNEL B.

FIGURE 20
OE INTERFACE BLOCK DIAGRAM (NOTE)

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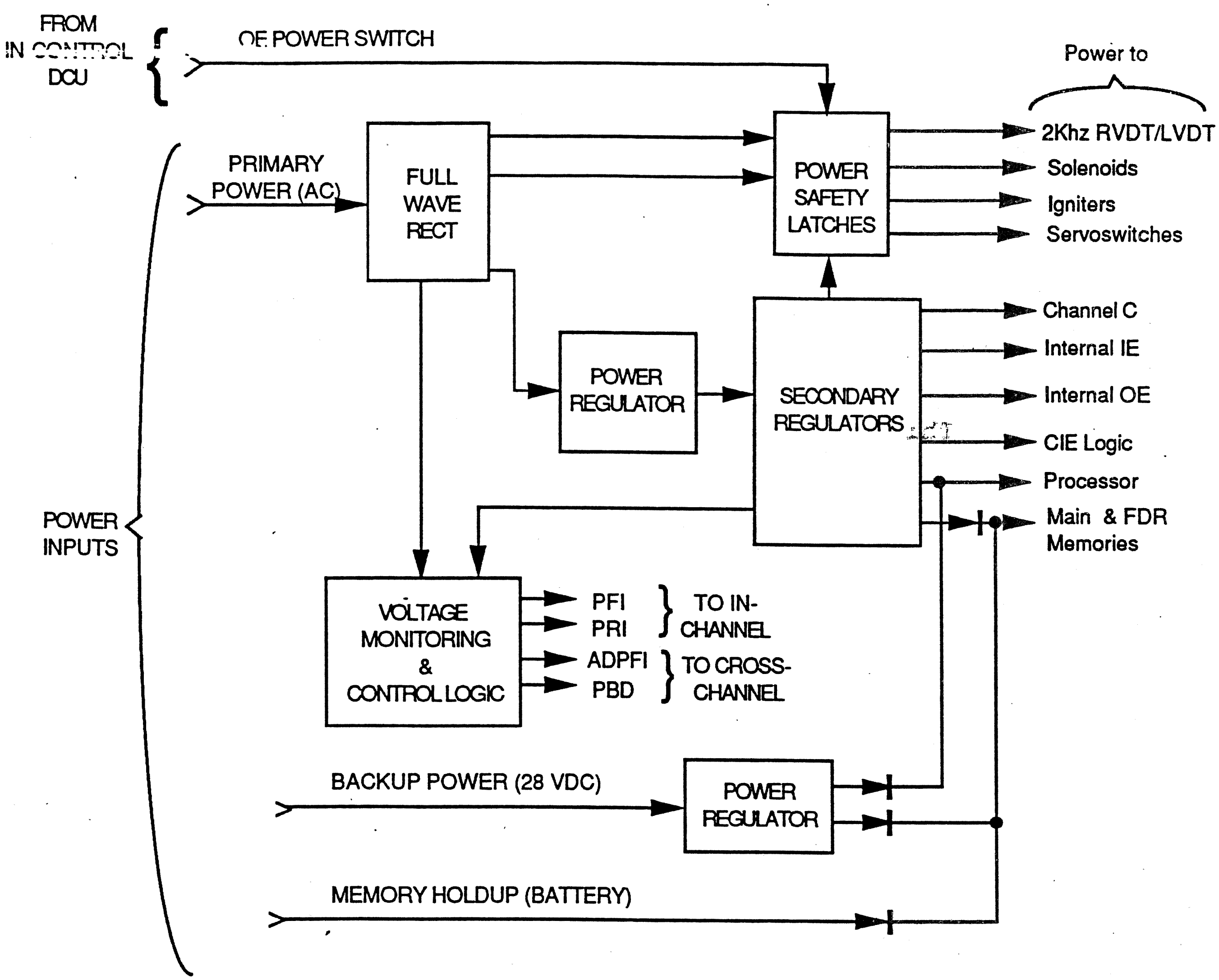

NOTE:

THERE IS ONE PSE FOR CHANNEL A AND ANOTHER FOR CHANNEL B.

FIGURE 21

POWER SUPPLY INTERFACE BLOCK DIAGRAM (NOTE)

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