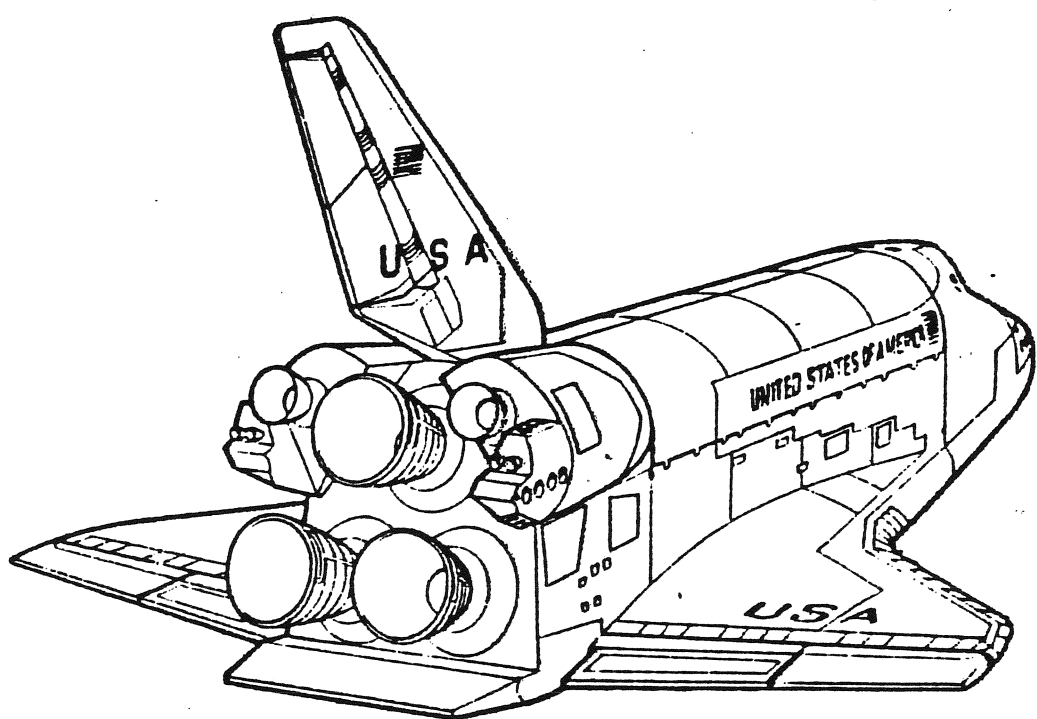


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ORBITER MAIN PROPULSION SUBSYSTEM HANDBOOK

105 L02





ORBITER
MAIN PROPULSION SUBSYSTEM
HANDBOOK

PREPARED BY
STS PROPULSION AND POWER
TEST AND CHECKOUT

G. H. CADWELL
MANAGER



C. E. SCHROEDER
SUPERVISOR



4



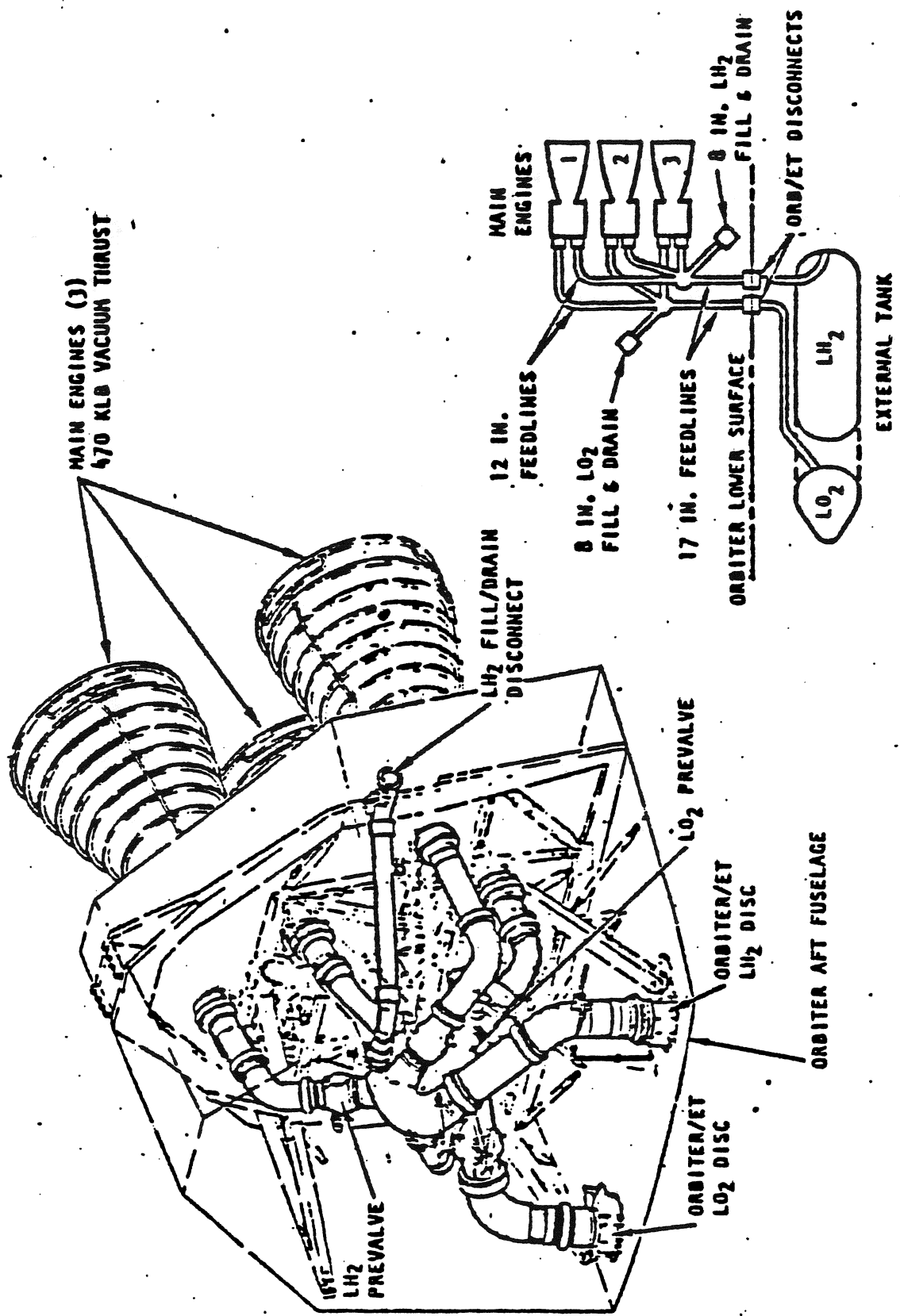
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MAIN PROPULSION SUBSYSTEM





ORBITER MAIN PROPULSION SUBSYSTEM

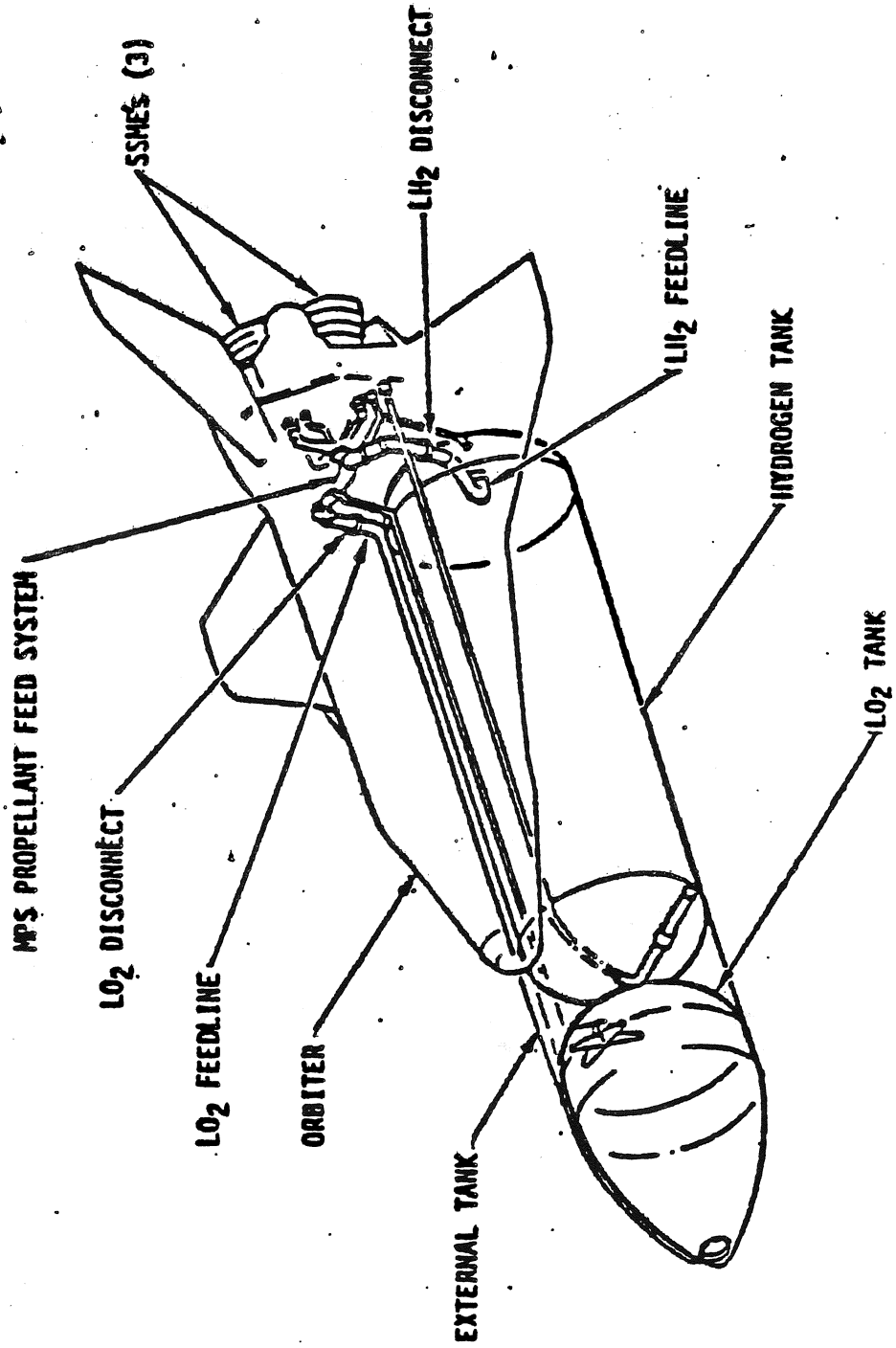
THE SHUTTLE MAIN PROPULSION SYSTEM CONSISTS OF THREE ELEMENTS: (1) THE SPACE SHUTTLE MAIN ENGINES, (2) THE ORBITER MAIN PROPULSION SUBSYSTEM, AND (3) THE EXTERNAL TANK.

THREE SPACE SHUTTLE MAIN ENGINES (SSME) BURN PROPELLANTS SUPPLIED BY THE ORBITER MAIN PROPULSION SUBSYSTEM (MPS) FROM THE EXTERNAL TANK (ET) FOR APPROXIMATELY NINE MINUTES, FROM JUST PRIOR TO LIFT-OFF UNTIL MAIN ENGINE CUTOFF (MECO). FOR THE FIRST TWO MINUTES, THE SOLID ROCKET BOOSTER (SRB) MOTORS OPERATE IN PARALLEL WITH THE MPS ENGINES. THE SRB'S ARE THEN JETTISONED. THE SSME'S AND SRB'S PROVIDE THE THRUST REQUIRED TO ACHIEVE A PREDETERMINED SUBORBITAL VELOCITY. AFTER MECO, THE ET IS SEPARATED FROM THE ORBITER AND ALLOWED TO IMPACT IN THE OCEAN. THE ET IS NOT REUSABLE. THE FINAL VELOCITY INCREMENT REQUIRED TO ACHIEVE THE DESIRED ORBIT IS PROVIDED BY THE ORBITER MANEUVERING SUBSYSTEM (OMS).

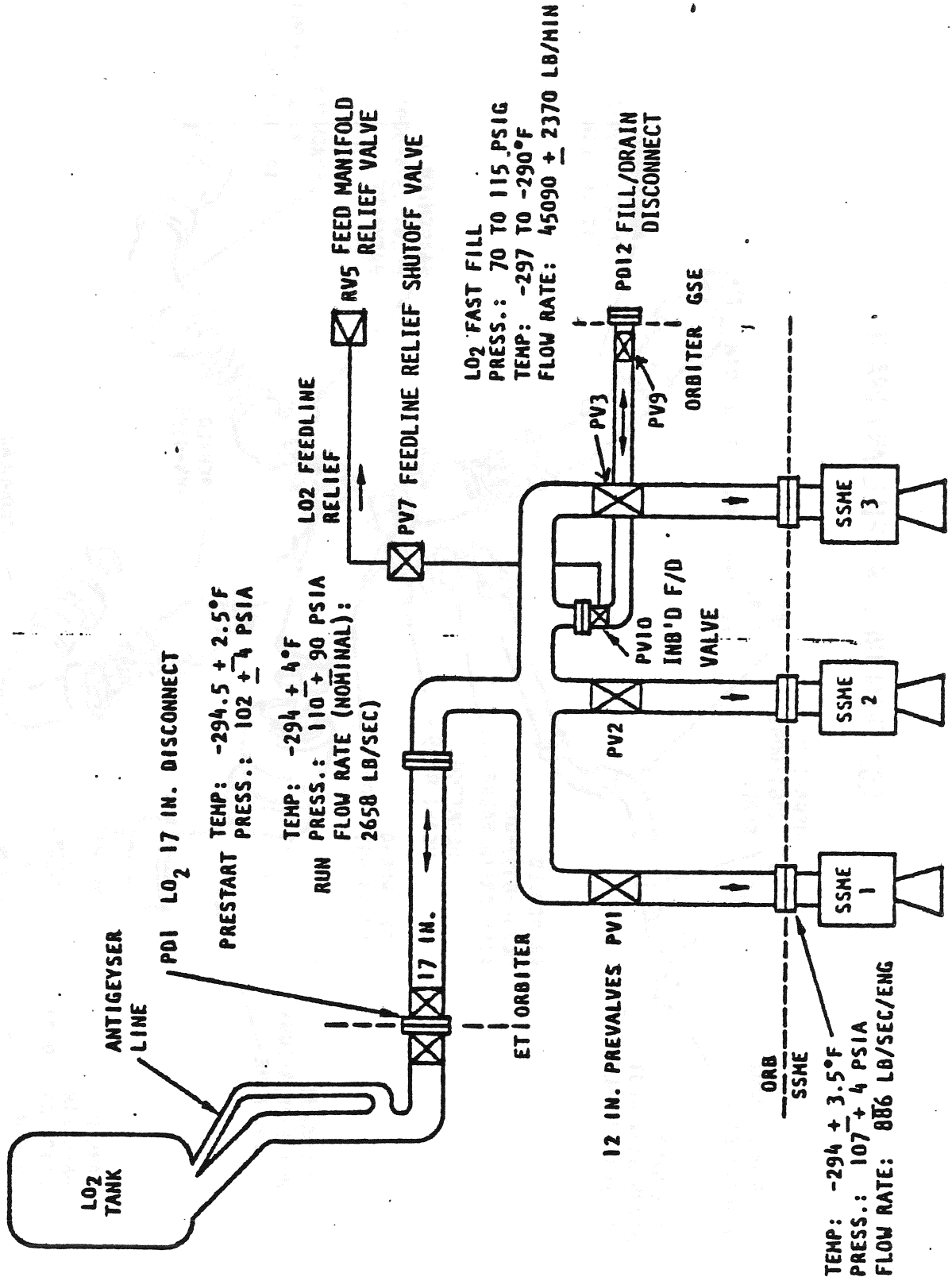
EACH OF THE THREE SPACE SHUTTLE MAIN ENGINES (SSME) OPERATES WITH A FIXED NOZZLE AREA RATIO OF 77.5:1 AT A MIXTURE RATIO (LO₂/LH₂) OF 6:1 AND A CHAMBER PRESSURE OF 3000 PSIA TO PRODUCE A RATED SEA-LEVEL THRUST OF 375,000 POUNDS AND A VACUUM THRUST OF 470,000 POUNDS. THE ENGINES CAN BE THROTTLED OVER A THRUST RANGE OF 65 TO 109 PERCENT OF THE RATED THRUST LEVEL, ALLOWING ORBITER ACCELERATION TO BE LIMITED TO 3 g's. THE ENGINES ARE CAPABLE OF BEING GIMBALED +10.5 DEGREES IN PITCH AND ± 2.5 DEGREES IN YAW FOR FLIGHT CONTROL DURING THE ORBITER BOOST PHASE.

THE ET SUPPLIES, THROUGH THE ORBITER MPS, 1,550,000 POUNDS OF USABLE ASCENT PROPELLANTS REQUIRED FOR SSME OPERATION. FIVE MPS FLUID LINES INTERFACE WITH THE ET THROUGH DISCONNECTS LOCATED AT THE BOTTOM OF THE ORBITER AFT FUSELAGE. THREE HYDROGEN DISCONNECTS ARE MOUNTED ON A CARRIER PLATE ON THE BOTTOM LEFT OF THE ORBITER, AND TWO OXYGEN DISCONNECTS ARE MOUNTED ON THE BOTTOM RIGHT. GROUND SERVICING OF ALL MPS FLUIDS IS PROVIDED THROUGH UMBILICALS ON BOTH SIDES OF THE AFT FUSELAGE; HYDROGEN IS SERVICED FROM THE LEFT SIDE AND OXYGEN FROM THE RIGHT SIDE.

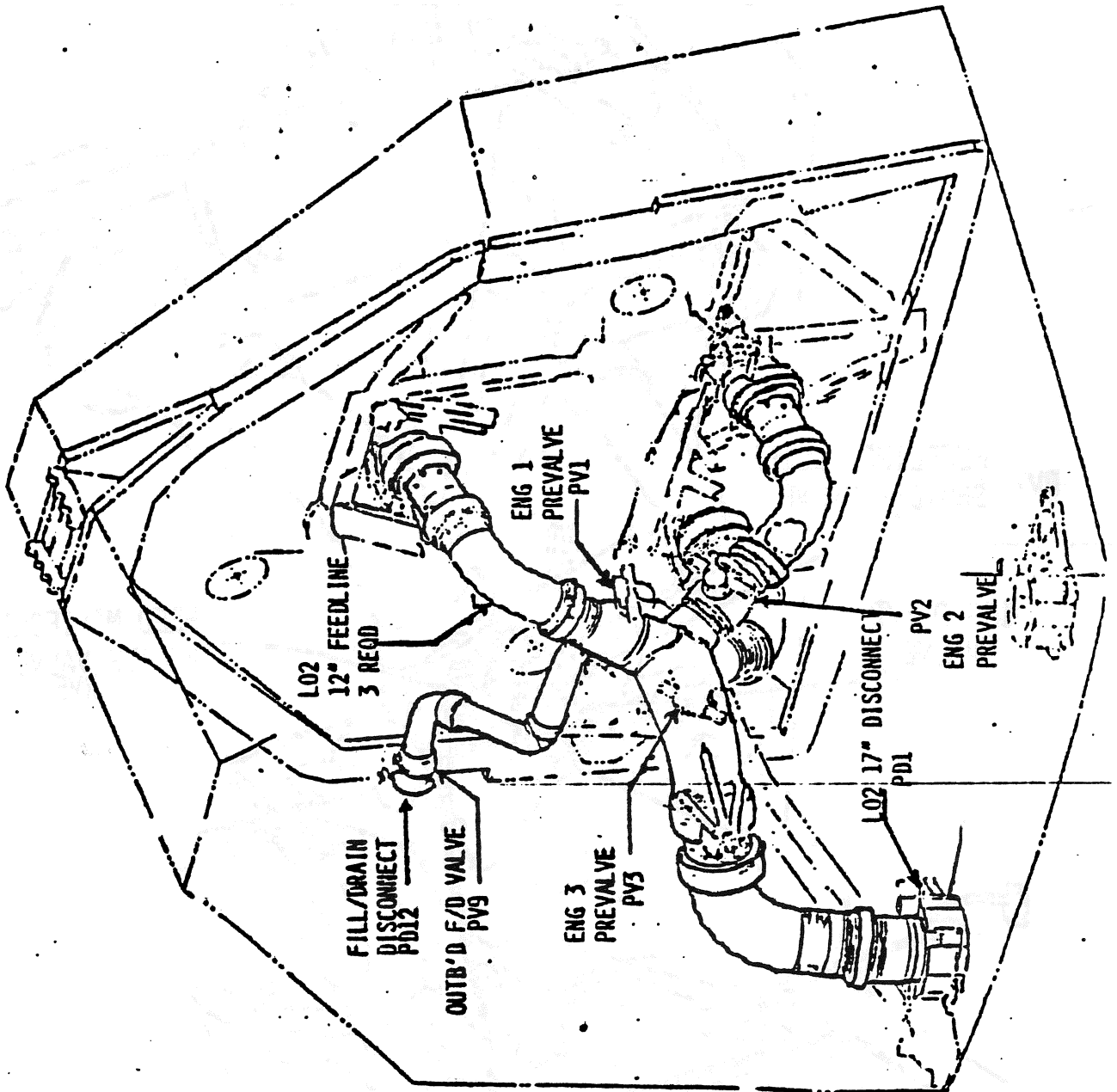
MAIN PROPULSION SYSTEM PERSPECTIVE



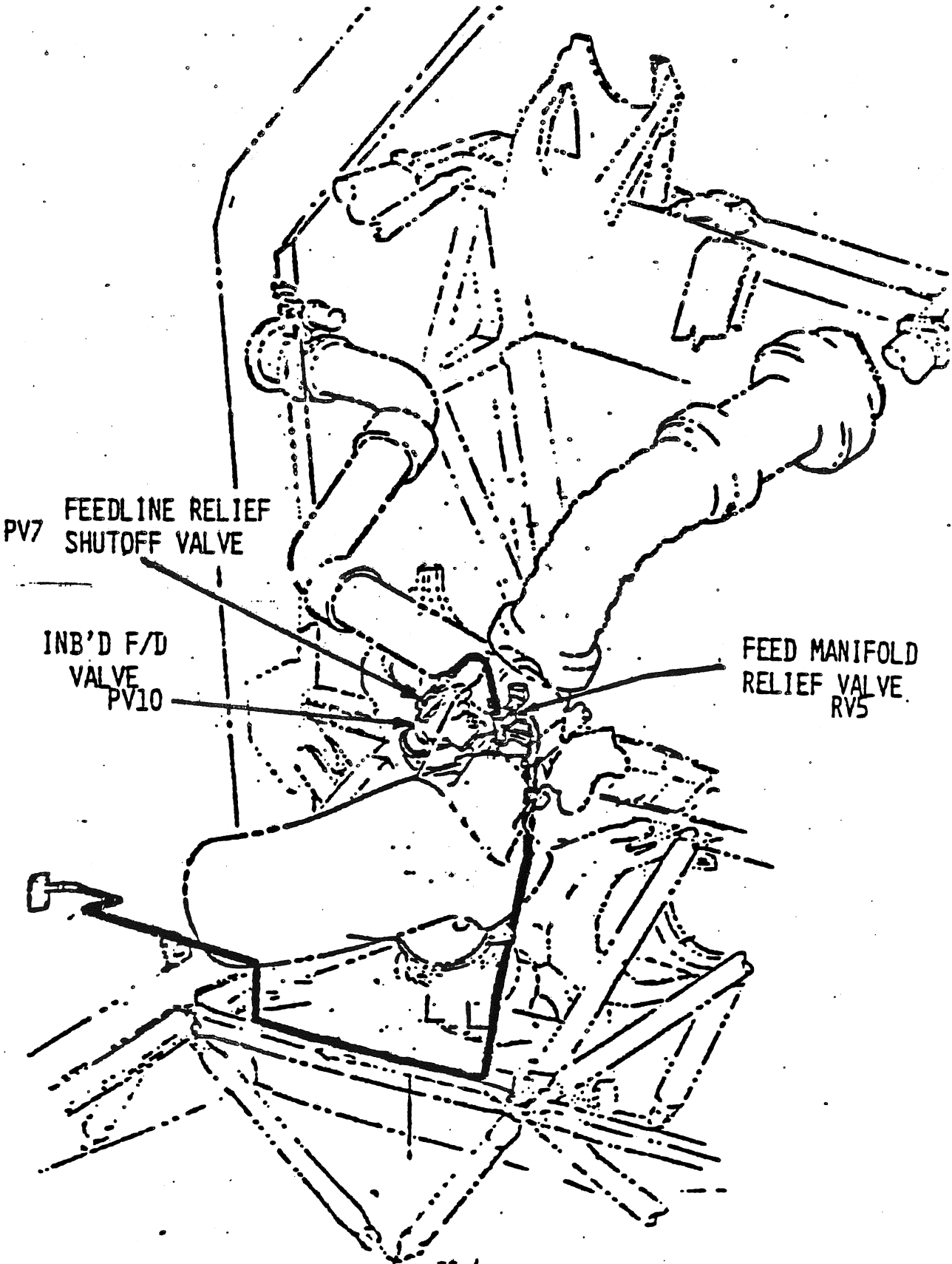
LO₂ FILL AND DRAIN, FEEDLINE RELIEF, AND FEED SYSTEM



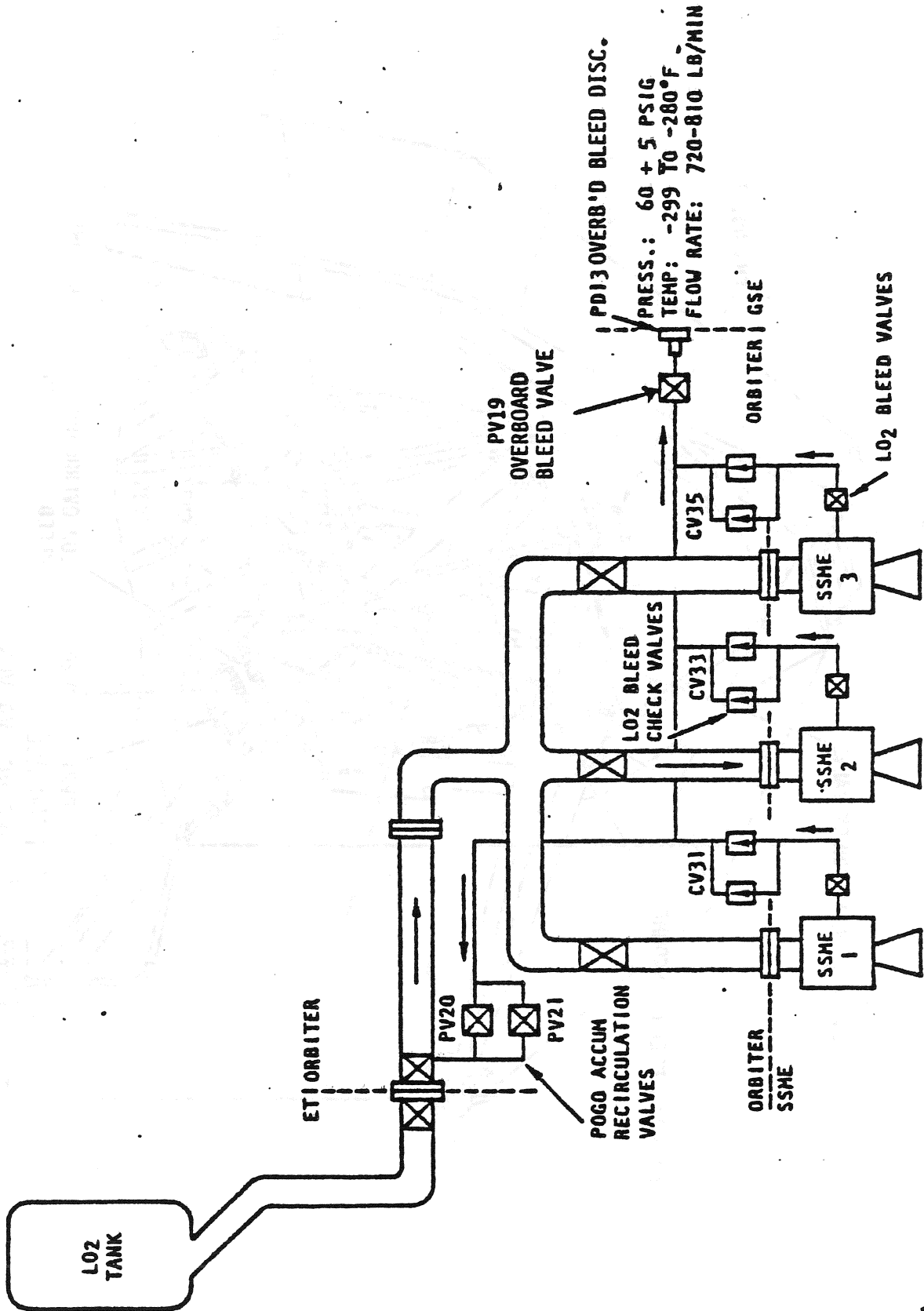
LO2 FEEDLINES AND FILL AND DRAIN LINE



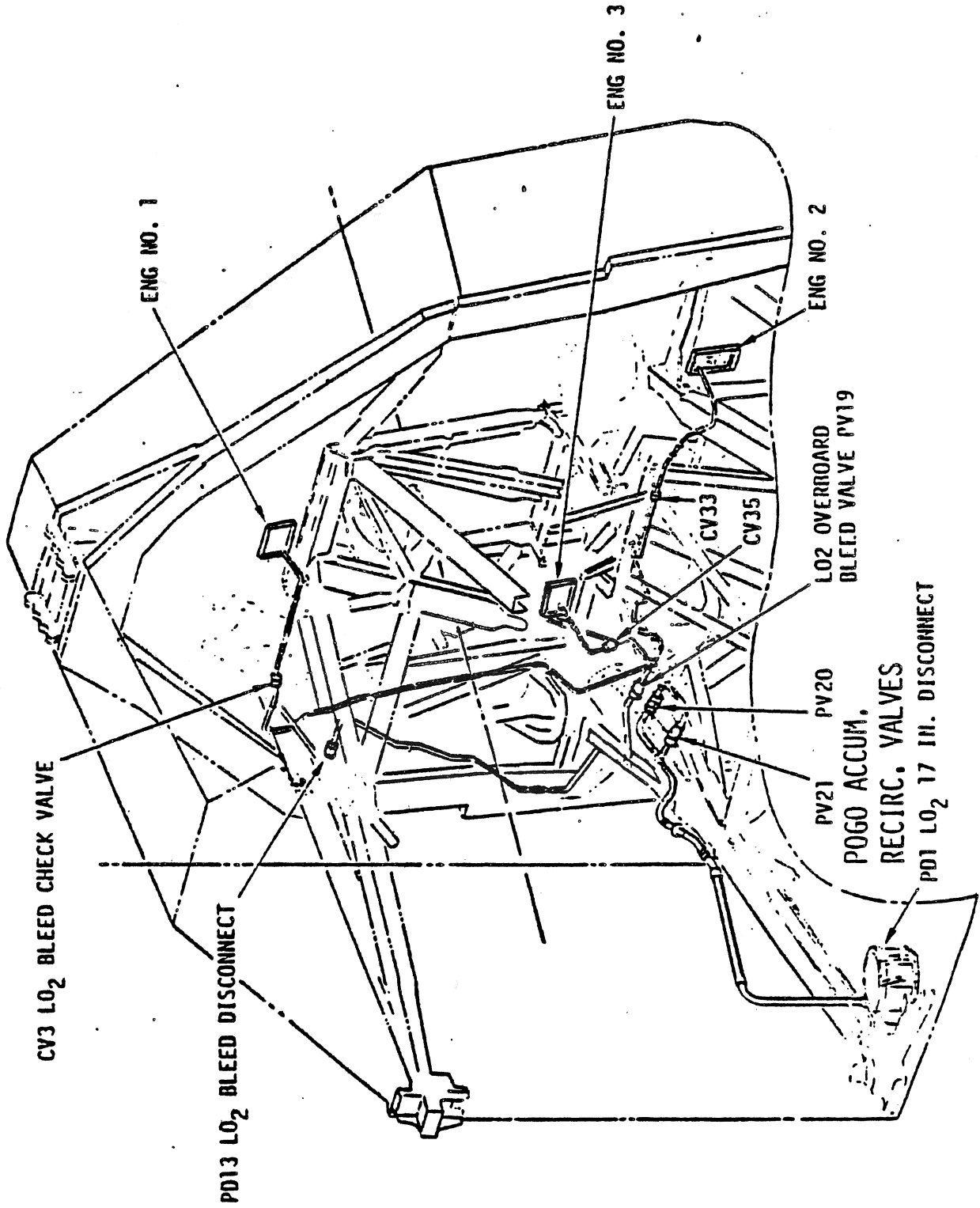
L02 FEEDLINE RELIEF



LO2 OVERBOARD BLEED AND POGO RECIRCULATION LINES

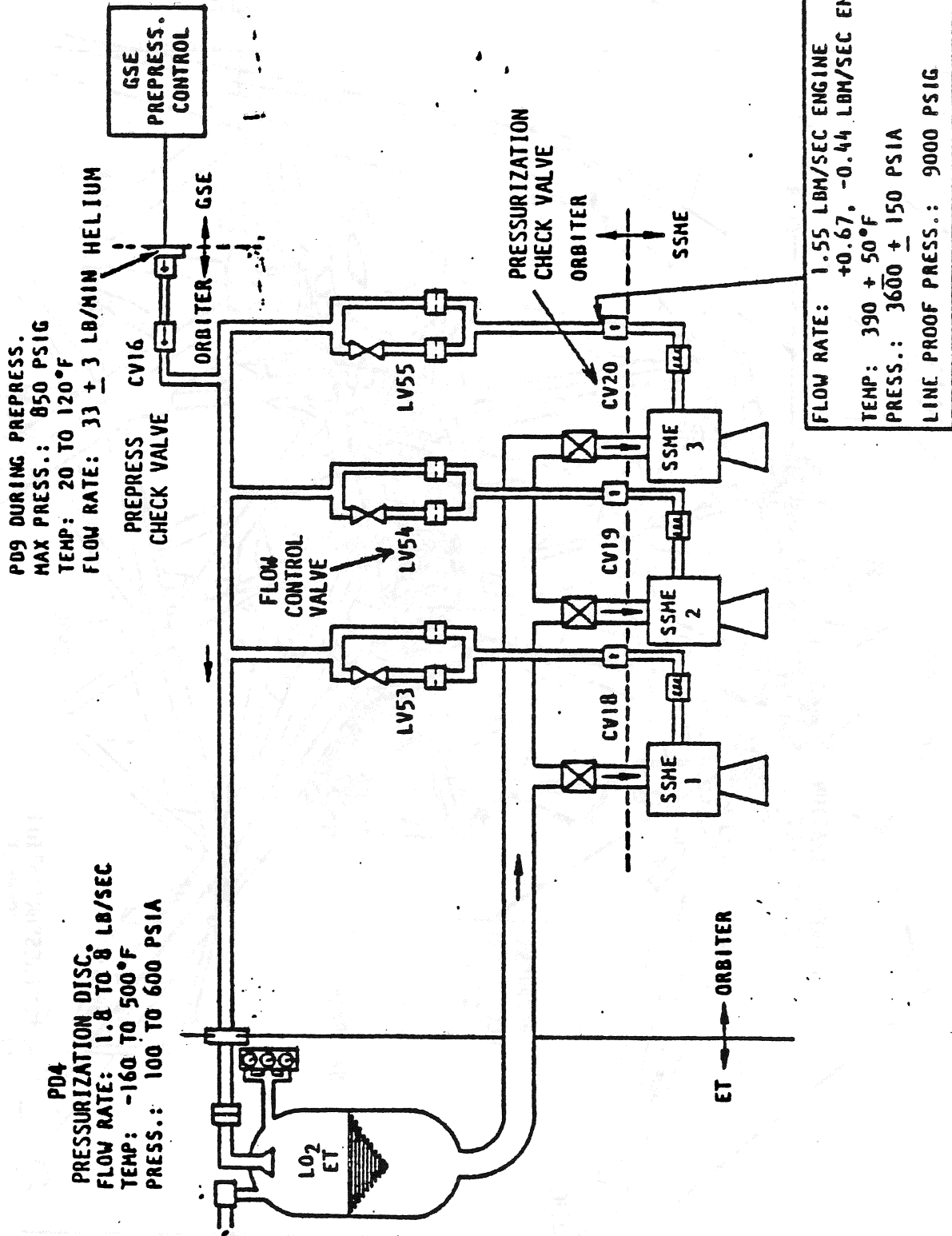


POGO RECIRCULATION AND LO₂ BLEED SYSTEM

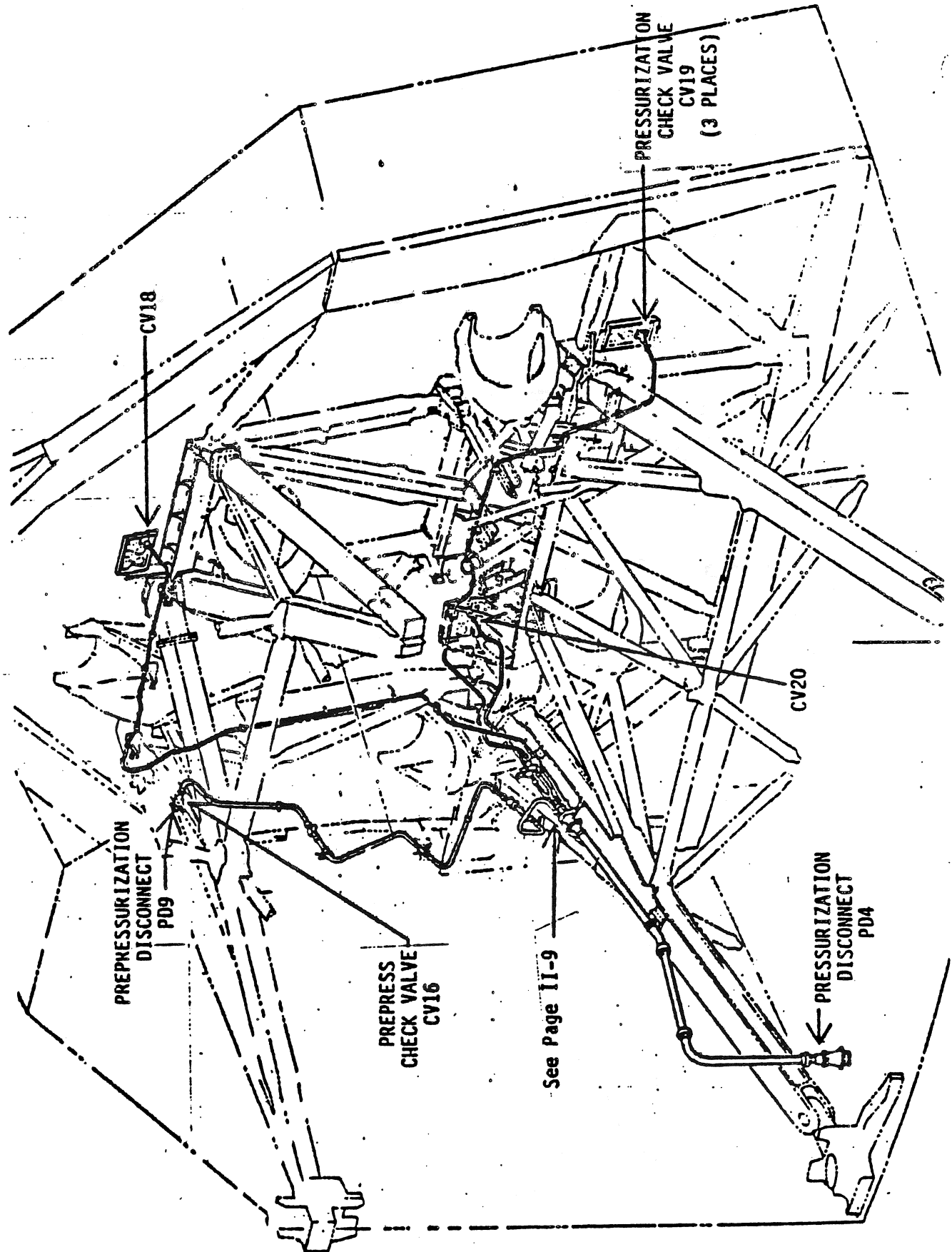


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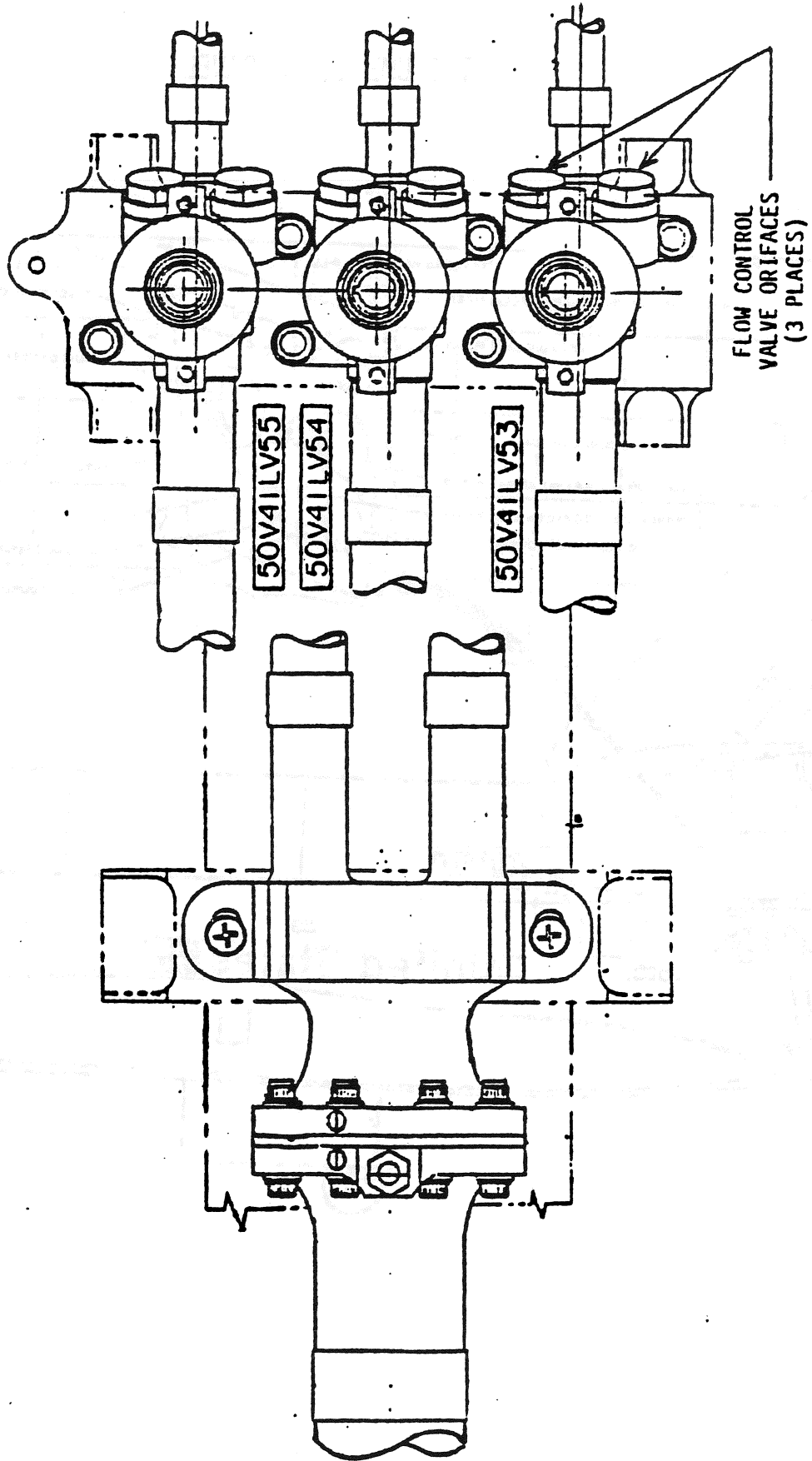
O₂ PREPRESSURIZATION AND PRESSURIZATION



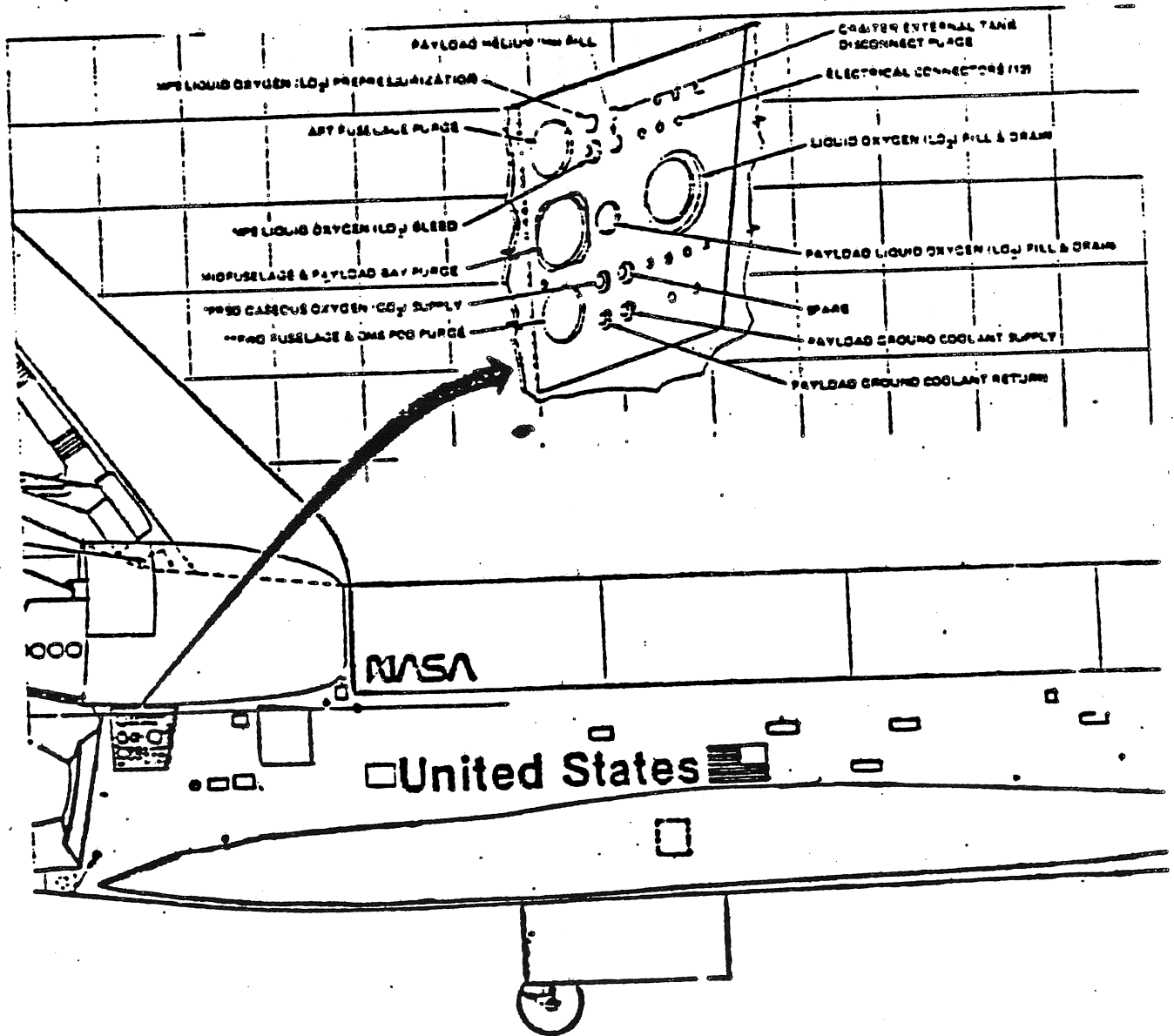
L02 PREPRESSURIZATION AND PRESSURIZATION



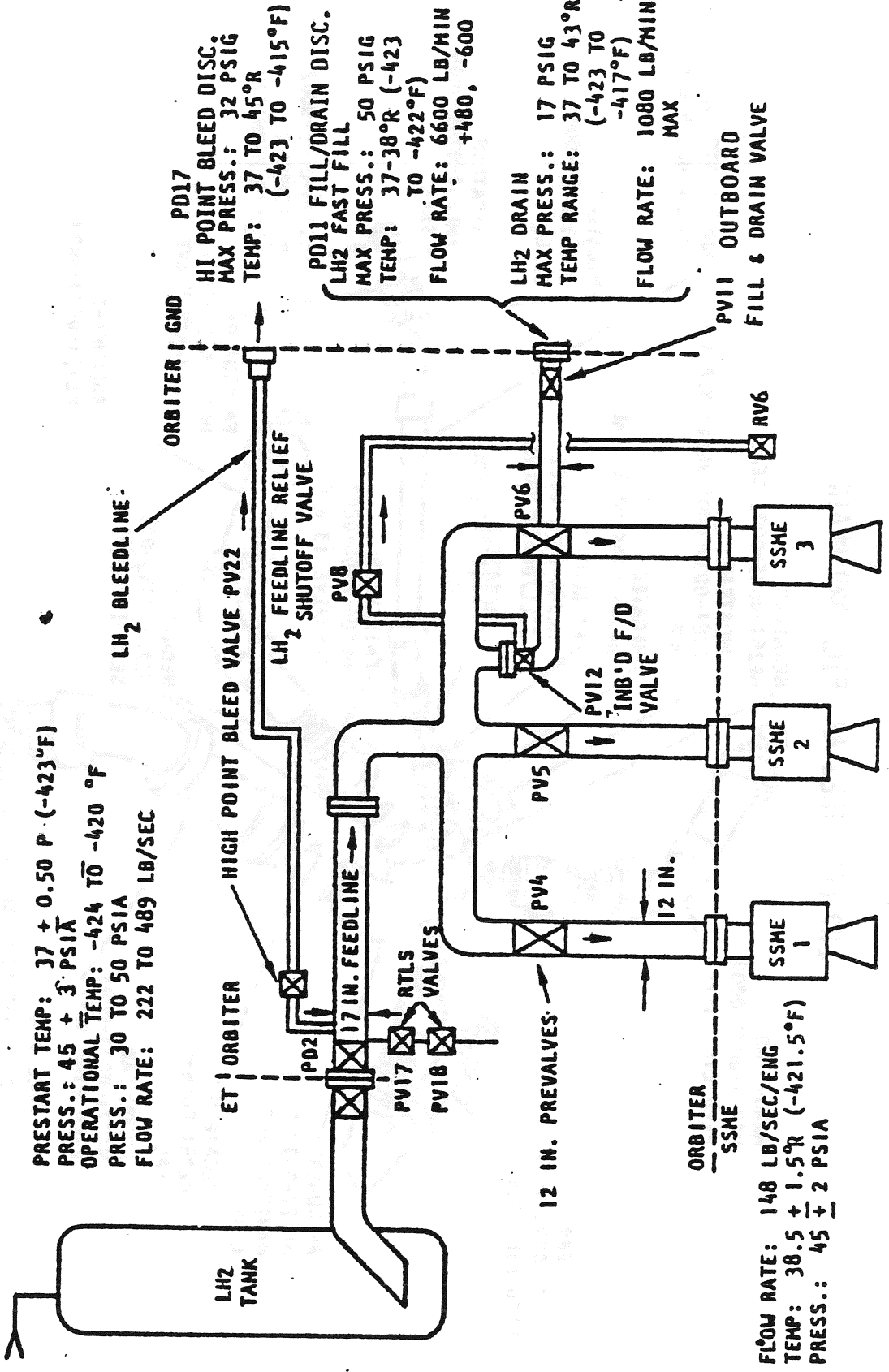
L02 PRESSURIZATION SYSTEM
FLOW CONTROL VALVES



LO2 T-0 UMBILICAL PANEL



LH2 FEED, FILL AND DRAIN, HIGH POINT BLEED, RTSL DUMP AND FILL LINE RELIEF



PRESTART TEMP: 37 ± 0.50 P (-423°F)
 PRESS.: 45 ± 3 PSIA
 OPERATIONAL TEMP: -424 TO -420 °F
 PRESS.: 30 TO 50 PSIA
 FLOW RATE: 222 TO 489 LB/SEC

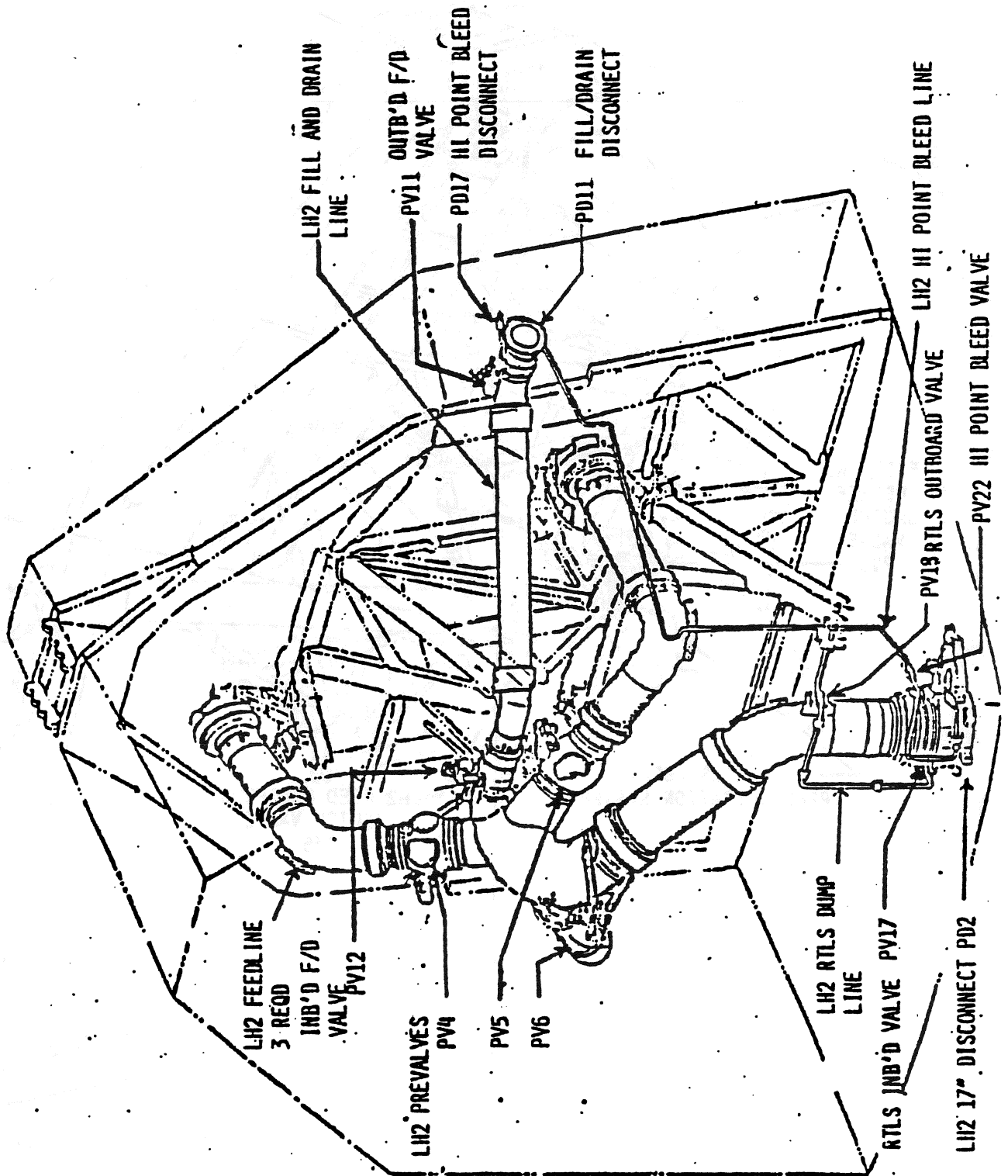
PD17
 HI POINT BLEED DISC.
 MAX PRESS.: 32 PSIG
 TEMP: 37 TO 45°R
 (-423 TO -415°F)

PD11 FILL/DRAIN DISC.
 LH2 FAST FILL
 MAX PRESS.: 50 PSIG
 TEMP: 37-38°R (-423
 TO -422°F)
 FLOW RATE: 6600 LB/MIN
 +480, -600

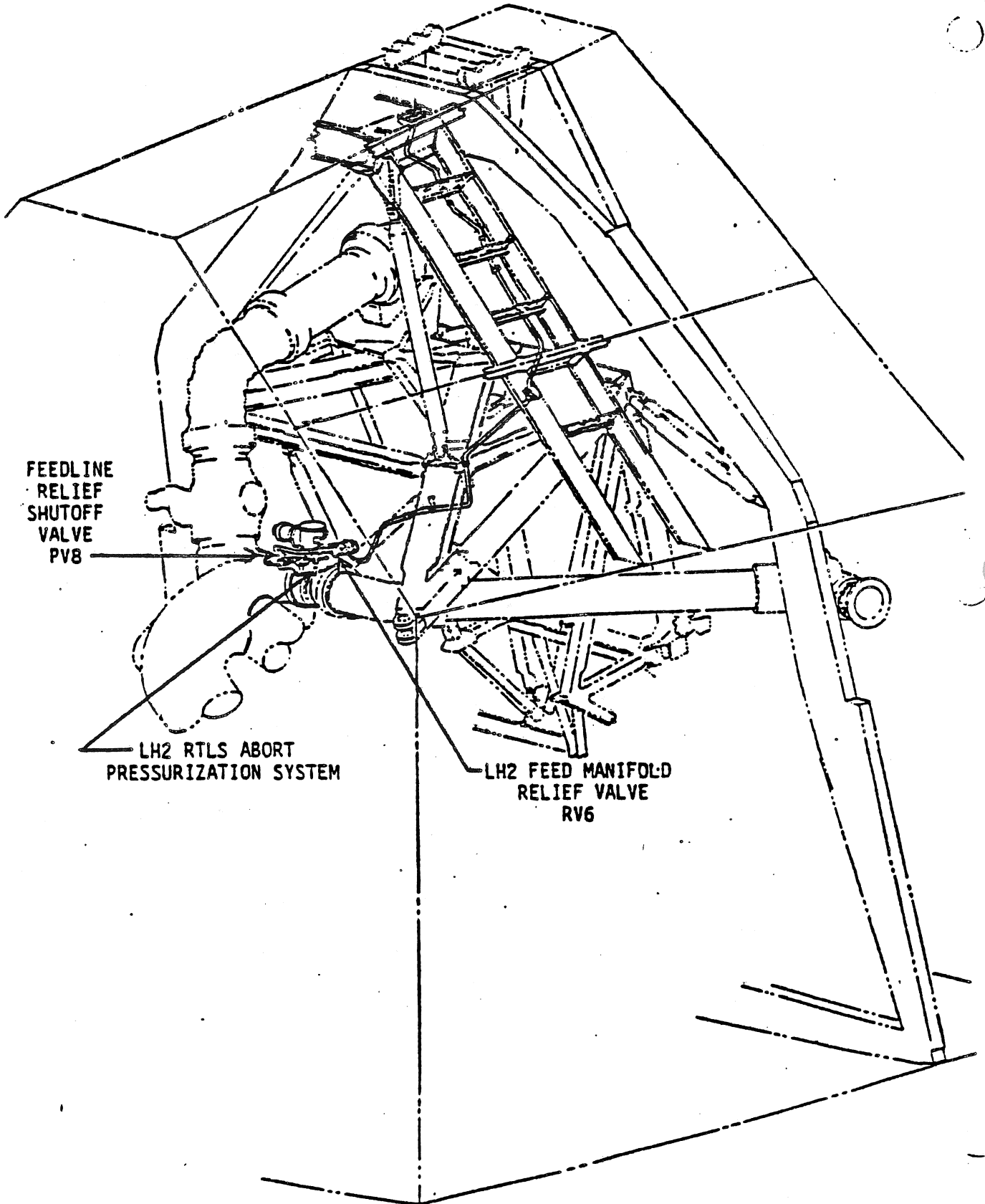
LH2 DRAIN
 MAX PRESS.: 17 PSIG
 TEMP RANGE: 37 TO 43°R
 (-423 TO
 -417°F)
 FLOW RATE: 1080 LB/MIN
 MAX

FLOW RATE: 148 LB/SEC/ENG
 TEMP: 30.5 ± 1.5 °R (-421.5°F)
 PRESS.: 45 ± 2 PSIA

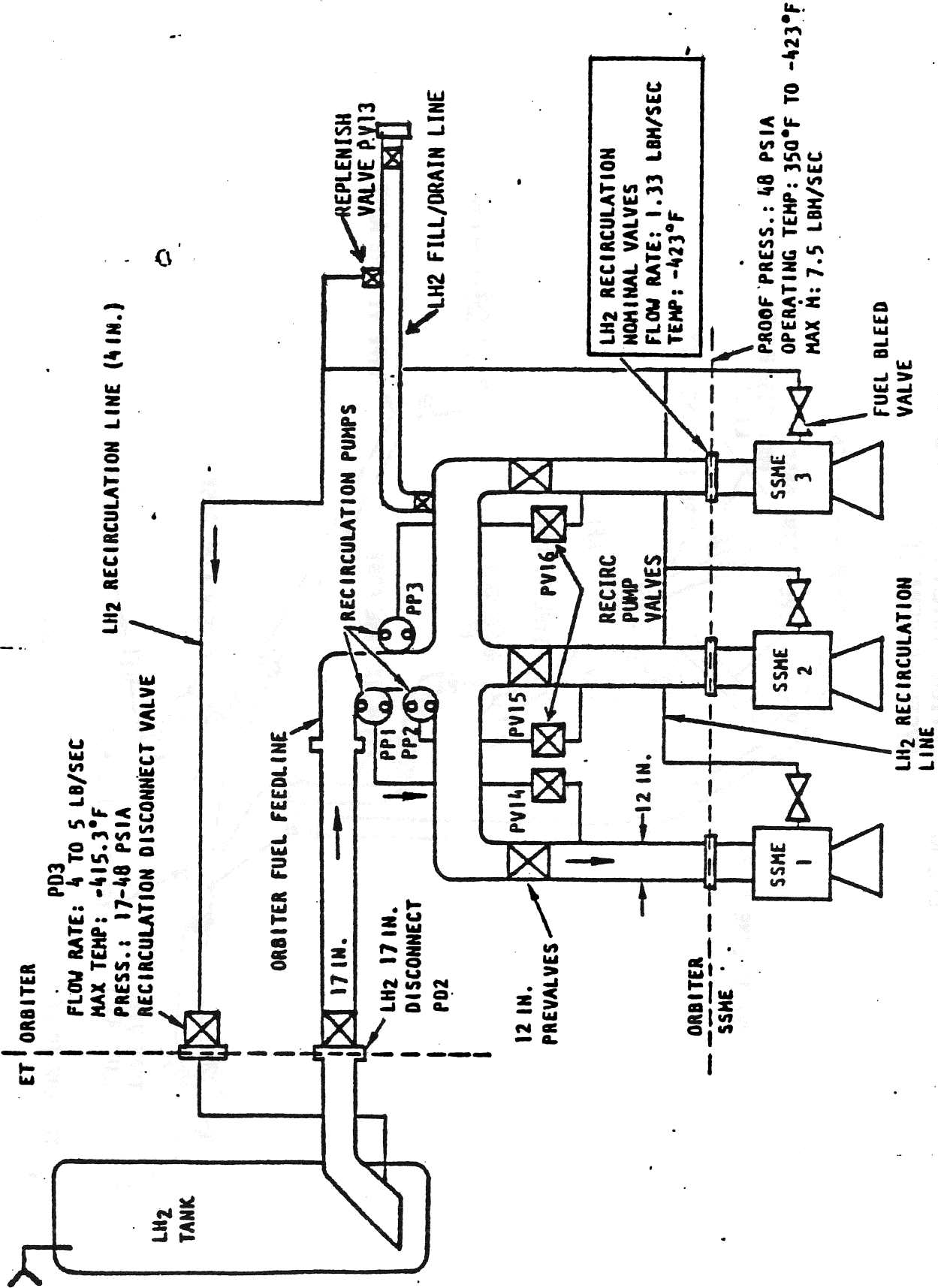
LH2 FEEDLINES AND FILL AND DRAIN LINE



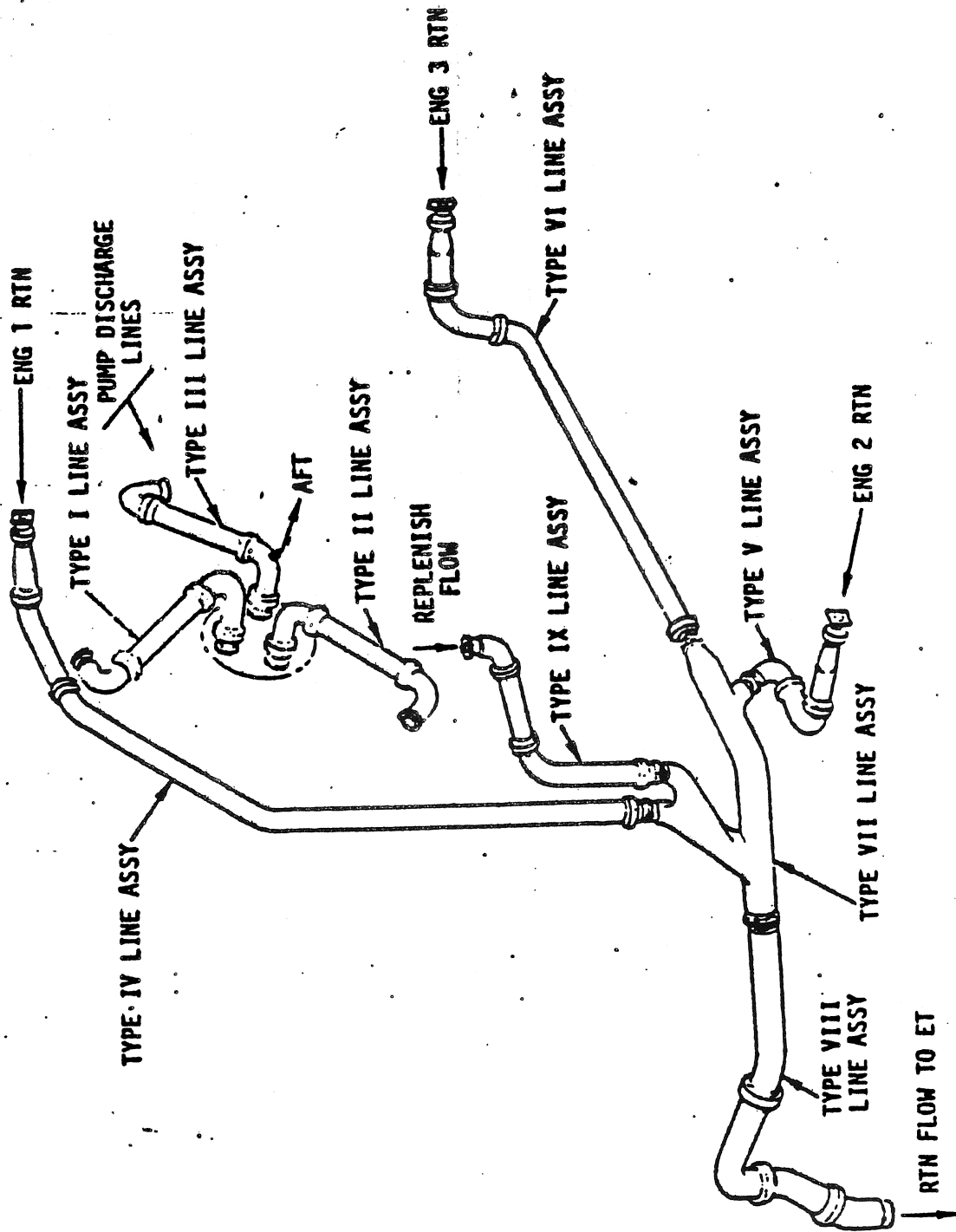
LH2 FEEDLINE RELIEF



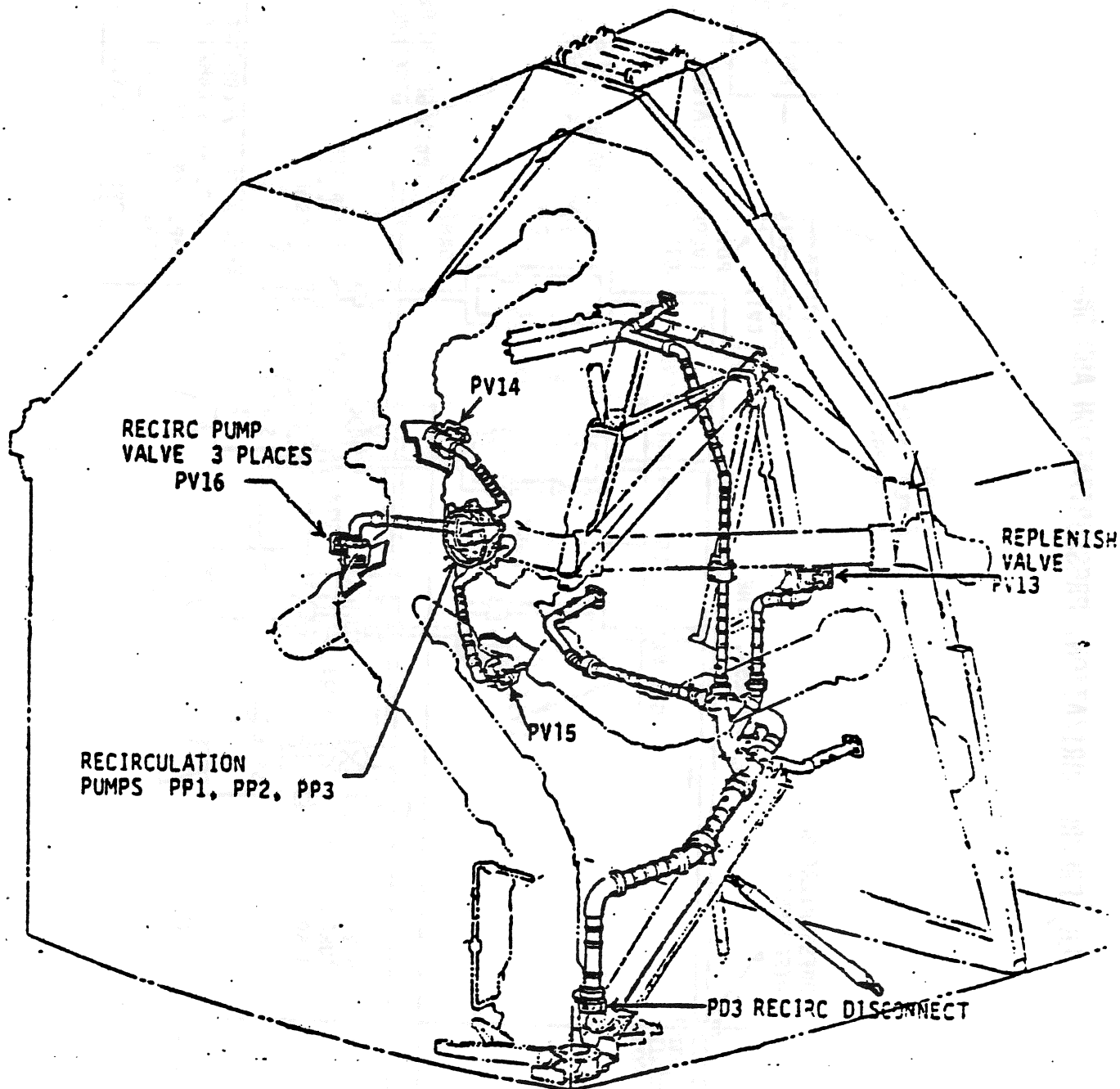
LH2 RECIRCULATION SCHEMATIC



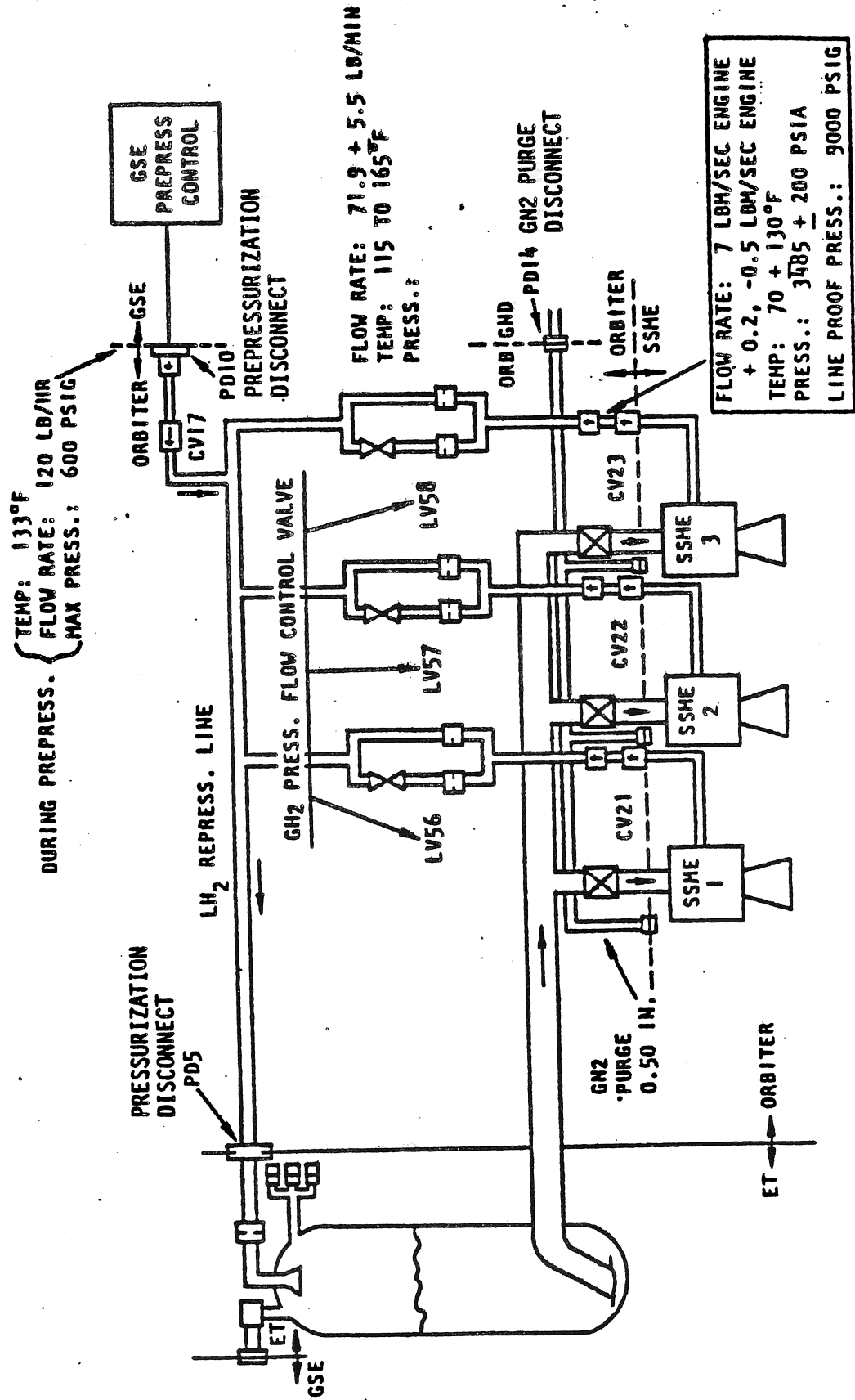
LH2 RECIRCULATION SYSTEM LINE ASSEMBLY SYSTEM SCHEMATIC



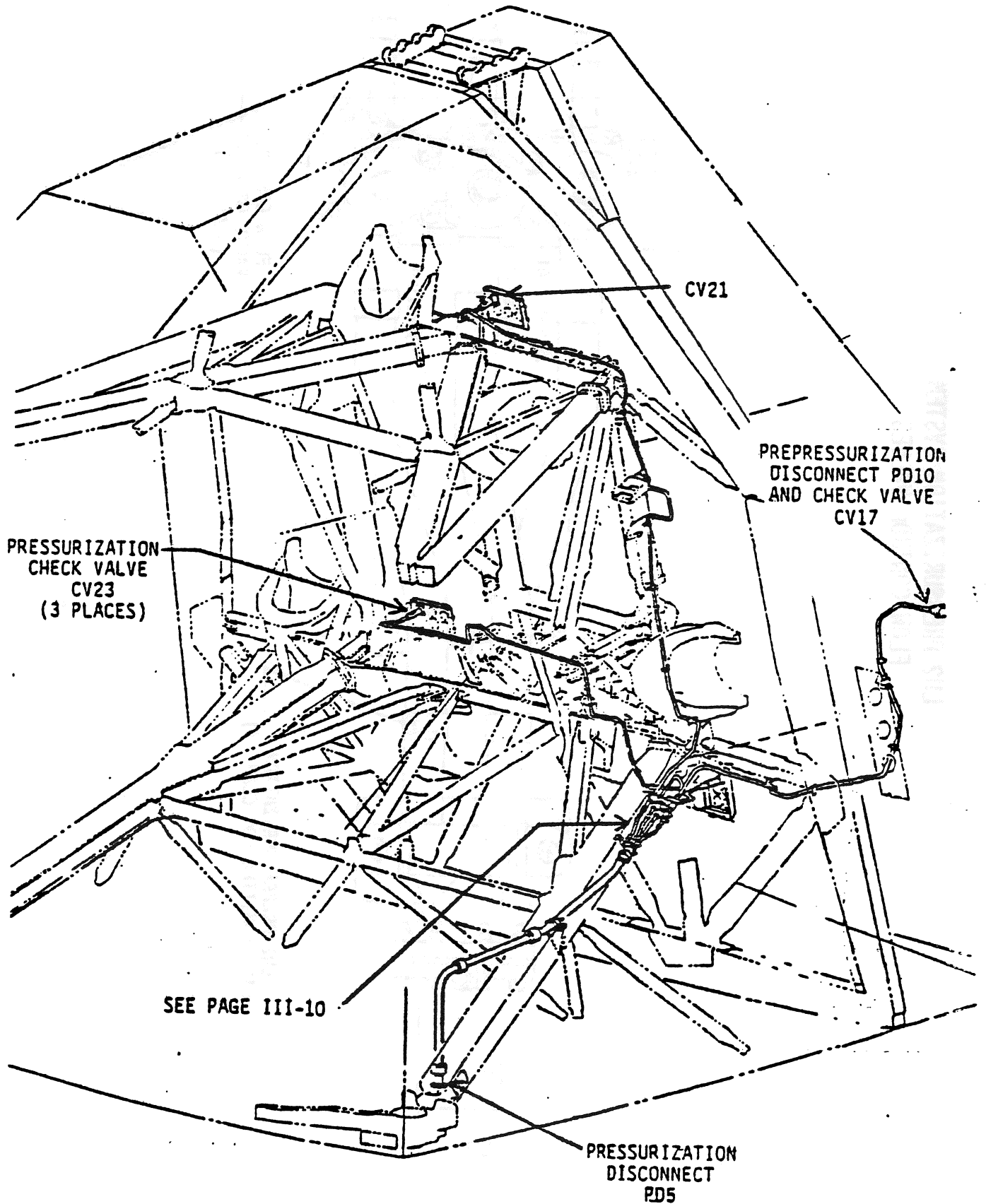
LH2 RECIRCULATION SYSTEM



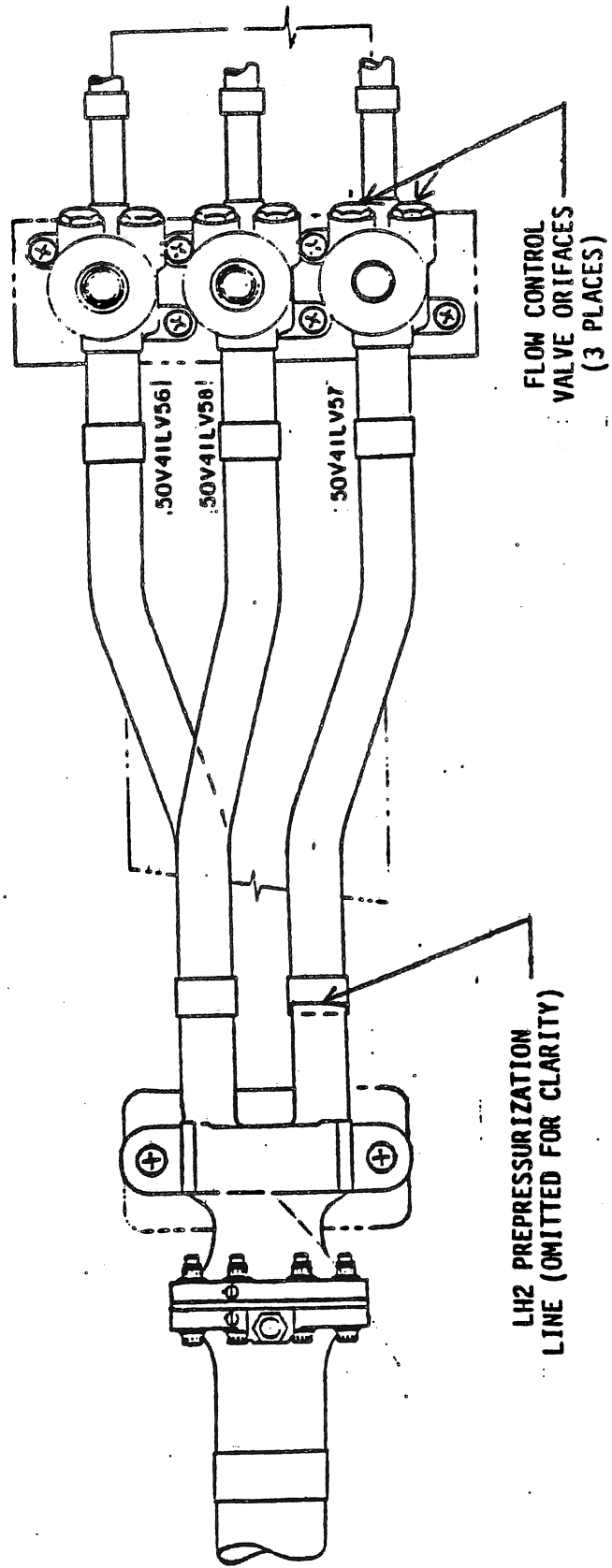
LH₂ PREPRESSURIZATION, PRESSURIZATION AND GN₂ PURGE



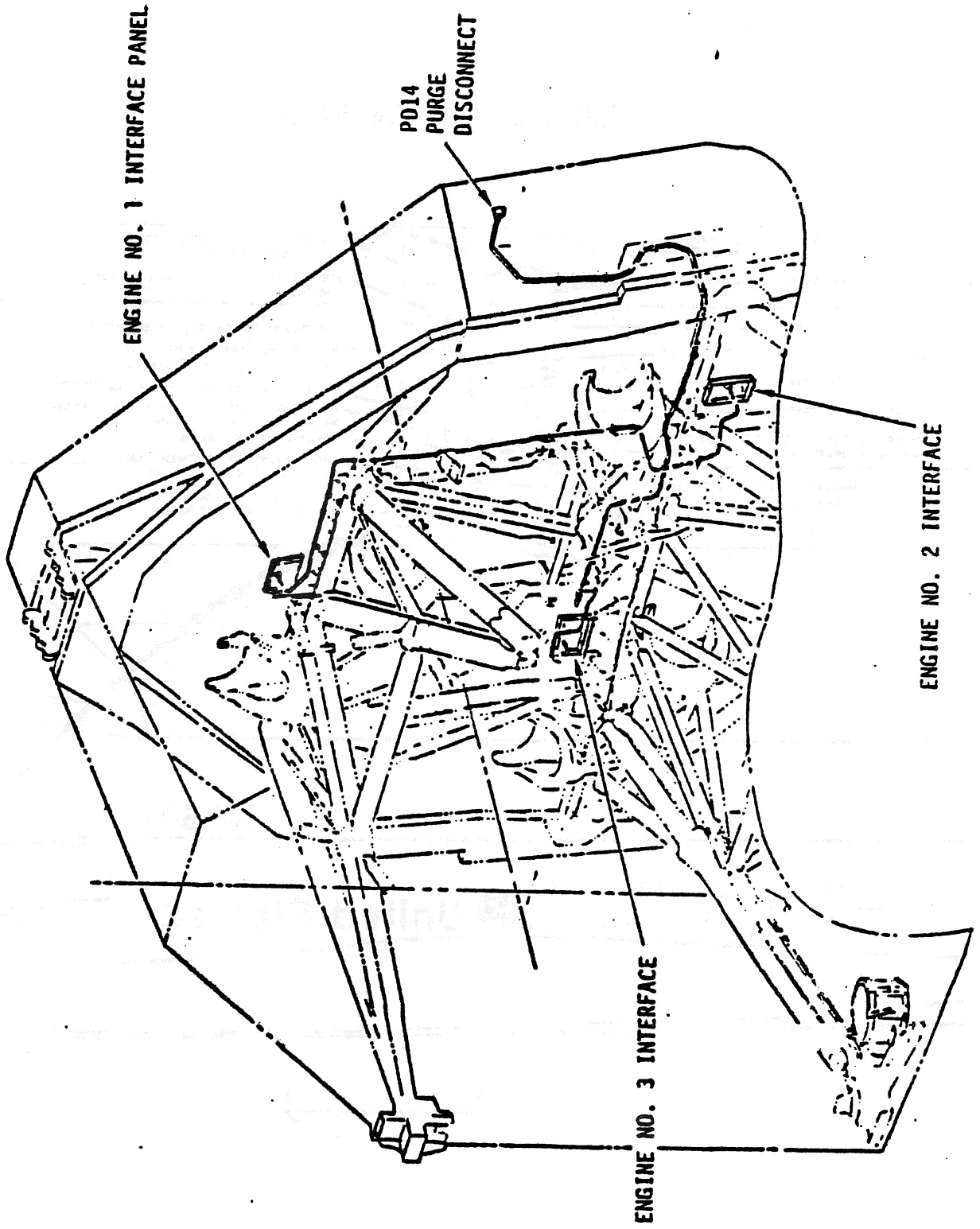
LH2 PREPRESSURIZATION AND PRESSURIZATION SYSTEM



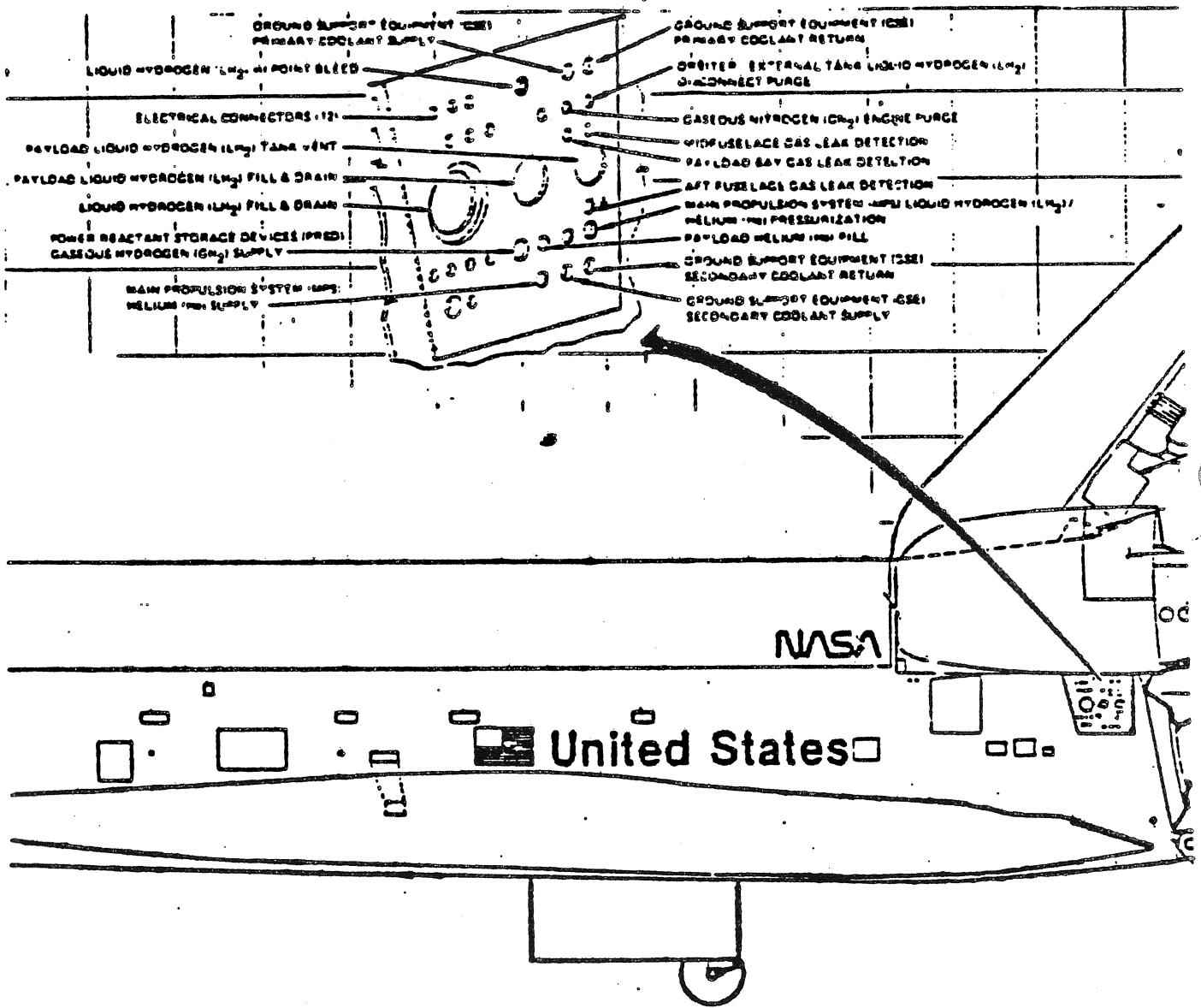
LH2 PRESSURIZATION SYSTEM
FLOW CONTROL VALVES



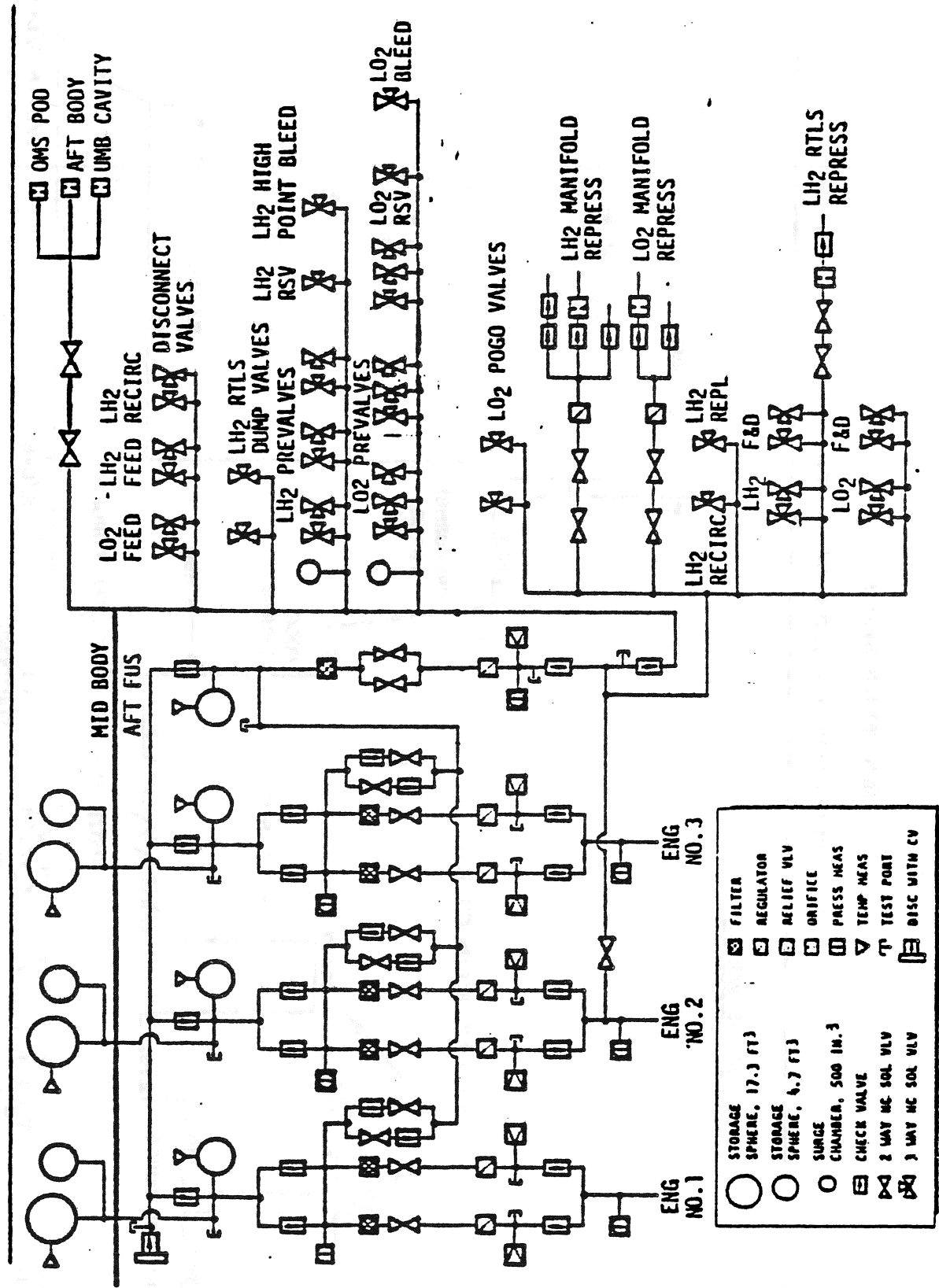
GN₂ PURGE SYSTEM



LH2 T-0 UMBILICAL PANEL



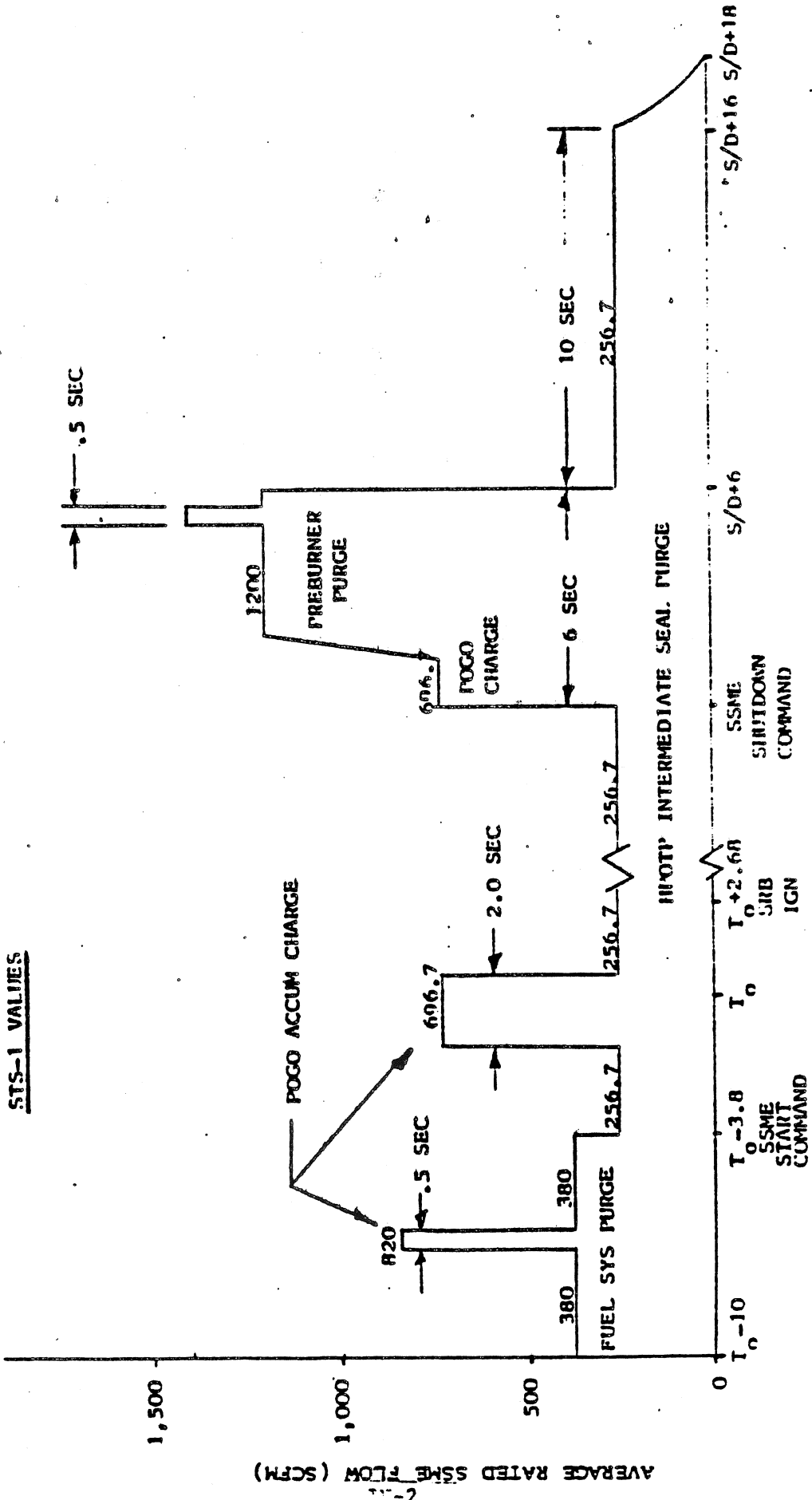
MAIN PROPULSION SYSTEM HELIUM SUBSYSTEM SCHEMATIC



○	STORAGE SPHERE, 17.3 FT ³	⊠	FILTER
○	STORAGE SPHERE, 6.7 FT ³	⊞	REGULATOR
○	SURGE CHAMBER, 500 IN. ³	⊞	RELIEF VLV
⊞	CHECK VALVE	⊞	ORIFICE
⊞	2 WAY NC SOL VLV	⊞	PRESS MEAS
⊞	3 WAY NC SOL VLV	⊞	TEMP MEAS
⊞		⊞	TEST PORT
⊞		⊞	DISC WITH CV

MI'S HELIUM SYSTEM

SSME HELIUM SUPPLY PATED FLOW VS. TIME



2-11
AVERAGE RATED SSME FLOW (SCFM)

TIME (SECONDS)

MPS HELIUM MASSES

The following lists the nominal, maximum and minimum expected Helium System masses at $T_0 - 10$ seconds (GSE helium fill terminate).

<u>Case</u>	<u>Sub-System Location</u>	<u>Pressure & Temperature (PSIA) (°R)</u>		<u>Volume (ft³)</u>	<u>Mass (lbs)</u>
Nominal	SSME Supplies				
	Mid-body	4,150	580	66.24	157.42
	Aft-fuselage	4,150	500	14.25	37.70
	<u>SSME Subtotal</u>			<u>80.49</u>	<u>195.12</u>
	Pneu. Supply	4,300	500	4.75	13.06
	<u>Total Helium System</u>			<u>85.24</u>	<u>208.18</u>
Maximum	SSME Supplies				
	Mid-body	4,350	500	66.24	183.95
	Aft-fuselage	4,350	470	14.25	42.65
	<u>SSME Subtotal</u>			<u>80.49</u>	<u>226.40</u>
	<u>Pneu. Supply</u>	4,450	470	4.75	14.43
	<u>Total Helium System</u>			<u>85.24</u>	<u>240.83</u>
Minimum	SSME Supplies				
	Mid-body	4,000	600	66.24	147.98
	Aft-fuselage	4,000	555	14.25	34.32
	<u>SSME Subtotal</u>			<u>80.44</u>	<u>182.30</u>
	<u>Pneu. Supply</u>	4,000	555	4.75	11.44
	<u>Total Helium System</u>			<u>85.24</u>	<u>193.74</u>

$T_0 = 2.8$ seconds before SRB ignition

STS-2 BURN TIMES

The following Orbiter SSME boost burn times were used in this prediction. T_0 is nominally 2.8 seconds prior to SRB ignition.

Flight Profile

SSME Burn Times (From To)

Nominal
(Orbiter enters planned
orbit)

(3) 513.3 sec. each

*AOA
(Abort Once Around)

(1) 260.5 sec. (2) 626.4 sec. each

*ATO
(Abort to Orbit)

(1) 268.1 sec. (2) 643.9 sec. each

RILS
(Return to Landing Site)

(1) 2.8 (2) 792.6 sec. each

*These flight profiles are part of the Press to Meco (PTM) boost options.

HELIUM USAGE SCHEDULE (LBS)

STS-2 MISSIONS

MISSION HELIUM LOAD	NOM		ATO NOM	RTLS	
	MIN.	NOM		NOM	MIN.
INITIAL MASS	191.74	208.18	208.18	208.18	191.74
<u>USAGE</u>					
Prelaunch (T ₀ -10 T ₀ +2.8)					
SSME Purges	2.64	2.98	2.98	2.98	2.64
Pneumatics	.51	.49	.49	.49	.51
Boost (T ₀ +2.8 S/D+21)					
SSME Purges	66.74	68.53	67.77	69.78	74.69
Pneumatics Boost Leakage	.02	.02	.03	.03	.04
Pneumatics Valve Actuation	.59	.59	.59	.59	.59
Redundant Engine Shutdown	.60	.60	.60	.60	.60
Engine Shutdown	4.89	4.89	4.89	4.89	4.89
Mass Remaining at S/D +21	118.15	130.08	130.83	128.82	123.90
Post Shutdown & Orbital Coast					
L ₂ Propellant Dump	5.55	5.55	5.55	5.55	---
L ₁ Propellant Dump	9.46	9.46	9.46	9.46	6.07
Orbital Coast Leakage	1.24	1.24	.07	1.24	---
Vacuum Inert	1.94	1.94	.97	1.94	---
Re-Entry Mass	99.96	111.89	114.78	110.63	117.81
Re-Entry Purge Usage					
Umbilical CAV/AFT-Fuselage	28.31	30.00	30.41	29.02	14.94***
OMS Pods	12.72	13.48	13.66	13.40	6.77***
L ₂ Feedlines	23.46	23.31	23.27	23.33	β
L ₁ Feedlines	2.67	2.67	2.67	2.67	β
Leakages (PNEU, SSME)	.02	.02	.02	.02	.02
Residual Helium (at rollout)	32.78	42.41	44.75	41.39	73.31
					23.71

* From 4,500 ft/sec G.R.V. → +550 sec.

** SSME supply loss at T₀ + 2.8 sec, of 59.72 lbs, causes 1 SSME to immediately shutdown.

*** Purges for H2 17 Q/D Umb. Cav./Aft-fuselage and OMS pods purges are inadequate to keep hydrogen concentrations below 4% level during re-entry.

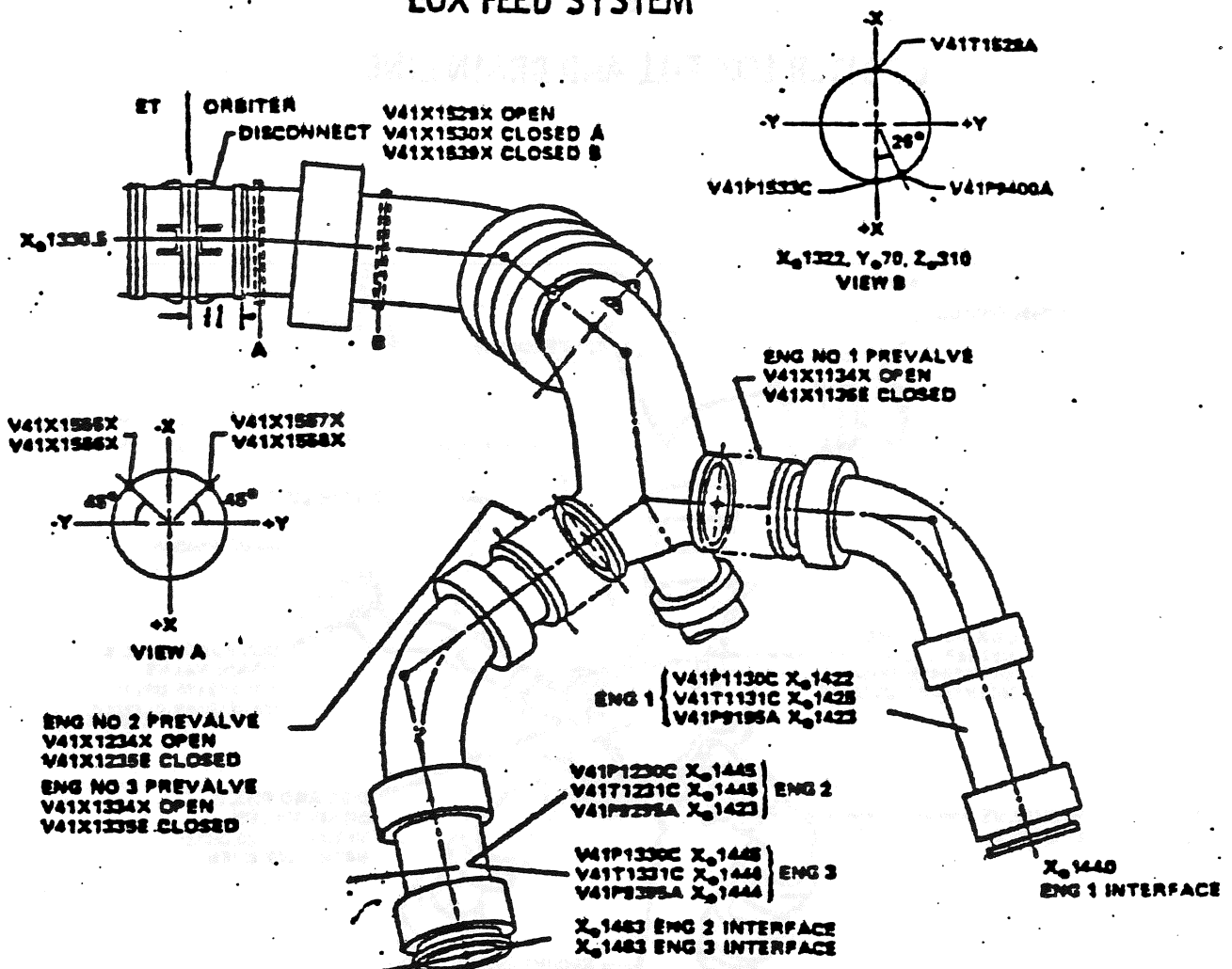
STS-2 MISSIONS

DESIGN MARGIN (LBS.)

MISSION LOAD	NOMINAL		AOA		ATO		RTLS	
	MIN.	NOM.	MIN.	NOM.	MIN.	NOM.	MIN.	MIN.***
<u>RESIDUALS</u>								
Liftoff thru S/D +21 Sec. (No failures)	118.15	130.08	130.83	128.82	123.90	111.18	--	
*Unusable Residual	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	--	
Design Margin	+60.14	+72.07	+72.82	+70.81	+65.80	+53.17	--	
Liftoff thru S/D +21 Sec (W/30 sec. failure)	97.15	109.08	109.83	107.82	102.90	90.18	51.46***	
*Unusable Residual	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-58.01</u>	<u>-40.25***</u>	
Design Margin	+39.14	+51.07	+51.82	+49.81	+44.89	+32.17	+11.21	
Re-entry Residual (W/30 sec. failure)	78.96	90.89	93.78	89.63	96.83	84.11	45.39	
Min. Req'd Mass	<u>-73.50</u>	<u>-73.50</u>	<u>-73.50</u>	<u>-73.50</u>	<u>-73.50</u>	<u>-73.50</u>	<u>-56.00*</u>	
Design Margin	+ 5.46	+17.39	+20.28	+16.13	+23.33	+10.61	-10.61	

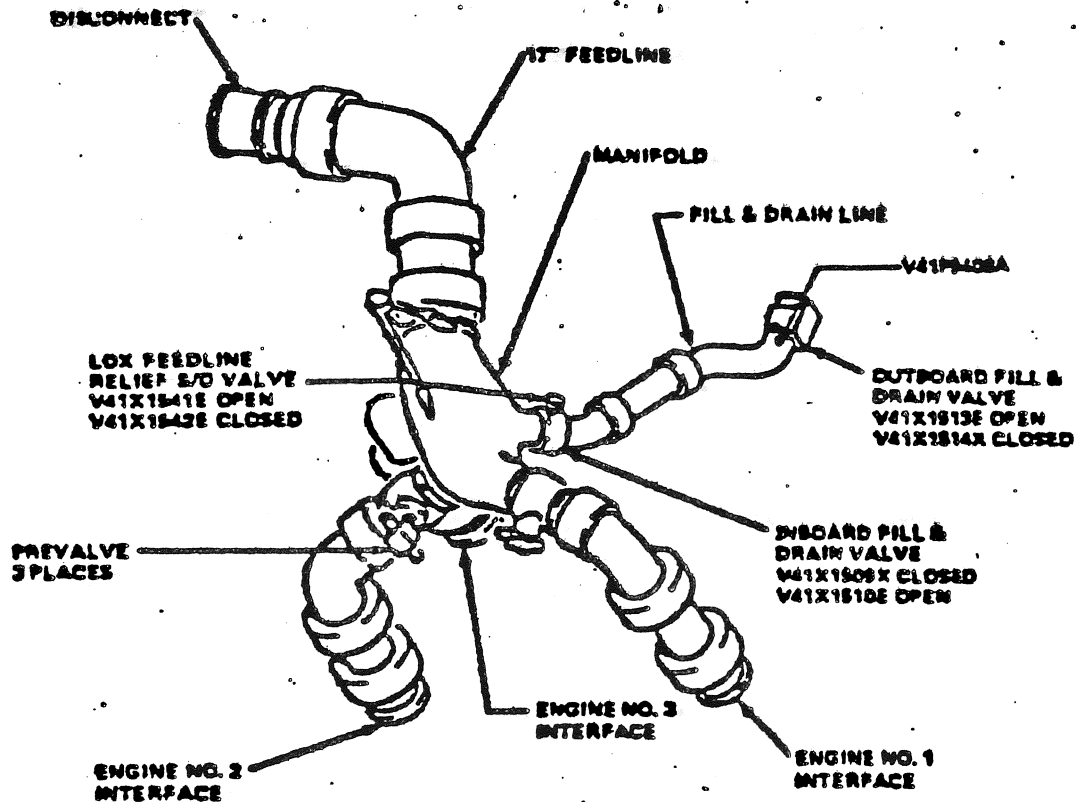
* Design Margin based on 1) 825 psia in SSME bottles & 450°R gas temp. 2) 1400 psia in pneu bottle & 500°R gas temp.
 ** Design Margin based on distributed 73.5 lbs. mass in SSME & Pneu systems.
 *** Loss of complete SSME supply at T₀ +2.8 sec. (SRB IGN). Design Margin based on 2 SSME supplies & Pneu System.

LOX FEED SYSTEM



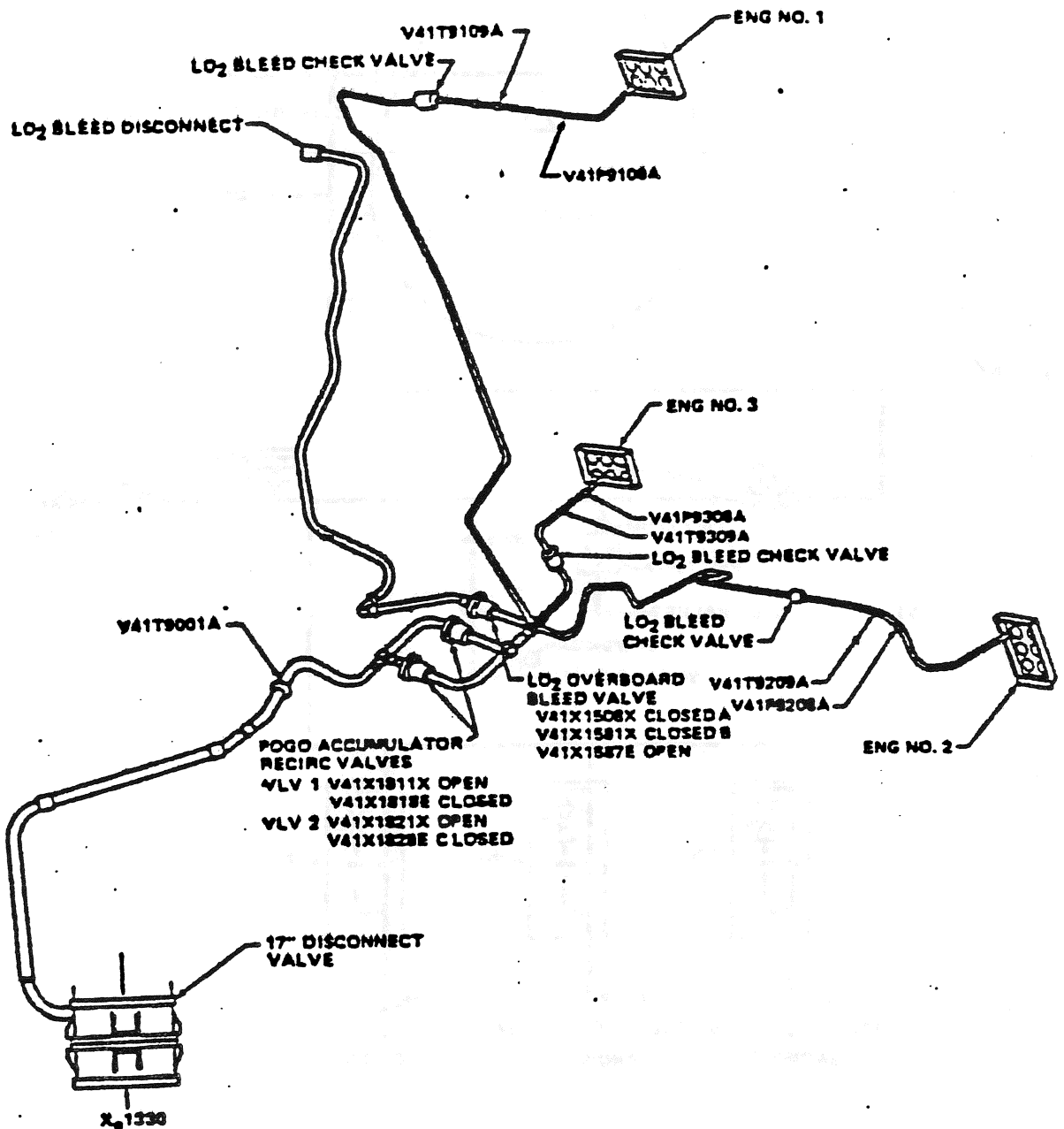
- | | |
|-------------|--|
| V41P1130C | P1 ENG 1 INLET PUMP PRESS, 0 TO 300 PSIA (INSULATED) |
| V41T1131C | T1 ENG 1 INLET PUMP TEMP, -305 TO -255 DEG F |
| V41X1134X | X16 ENG NO. 1 LOX PREVALVE OPEN, ON-OFF EVENT |
| V41X1135E | X19 ENG NO. 1 LOX PREVALVE CLOSED, OFF-ON EVENT |
| V41P1230C | P2 ENG 2 INLET PUMP PRESS, 0 TO 300 PSIA (INSULATED) |
| V41T1231C | T2 ENG 2 INLET PUMP TEMP, -305 TO -255 DEG F |
| V41X1234X | X17 ENG NO 2 LOX PREVALVE OPEN, ON-OFF EVENT |
| V41X1235E | X20 ENG NO 2 LOX PREVALVE CLOSED, OFF-ON EVENT |
| V41P1330C | P3 ENG 3 INLET PUMP PRESS, 0 TO 300 PSIA (INSULATED) |
| V41T1331C | T3 ENG 3 INLET PUMP TEMP, -305 TO -255 DEG F |
| V41X1334X | X18 ENG NO 3 LOX PREVALVE OPEN, ON-OFF EVENT |
| V41X1335E | X21 ENG NO 3 LOX PREVALVE CLOSED, OFF-ON EVENT |
| V41T1528A | T4 FEED MANF DISC TEMP, -305 TO -255 DEG F |
| V41X1529X | MPS LOX FEED DISC VLV OPEN, OFF-ON EVENT |
| V41X1530X | MPS LO ₂ FEED DISC VLV CLOSED A, OFF-ON EVENT |
| V41P1533C | P4 FEED MANIFOLD PRESS, 0 TO 300 PSIA (INSULATED) |
| V41X1534X | MPS LO ₂ FEED DISC VLV CLOSED B, OFF-ON EVENT |
| V41X1555X | X1 LOW LEVEL LIQ SNSR #1, WET DRY EVENT |
| V41X1556X | X1 LOW LEVEL LIQ SNSR #2, WET DRY EVENT |
| V41X1557X | X3 LOW LEVEL LIQ SNSR #3, WET DRY EVENT |
| V41X1558X | X4 LOW LEVEL LIQ SNSR #4, WET DRY EVENT |
| V41P9195A * | P207 ME-1 LPOTP INLET PRESS (POGO), -20 TO +20 PSI |
| V41P9295A * | P208 ME-2 LPOTP INLET PRESS (POGO), -20 TO +20 PSI |
| V41P9395A | P209 ME-3 LPTOP INLET PRESS (POGO), -20 TO +20 PSI |
| V41P9400A | P213 FEED MANIFOLD PRESS (POGO), -20 TO +20 PSI |

ORBITER LOX FILL AND DRAIN LINE



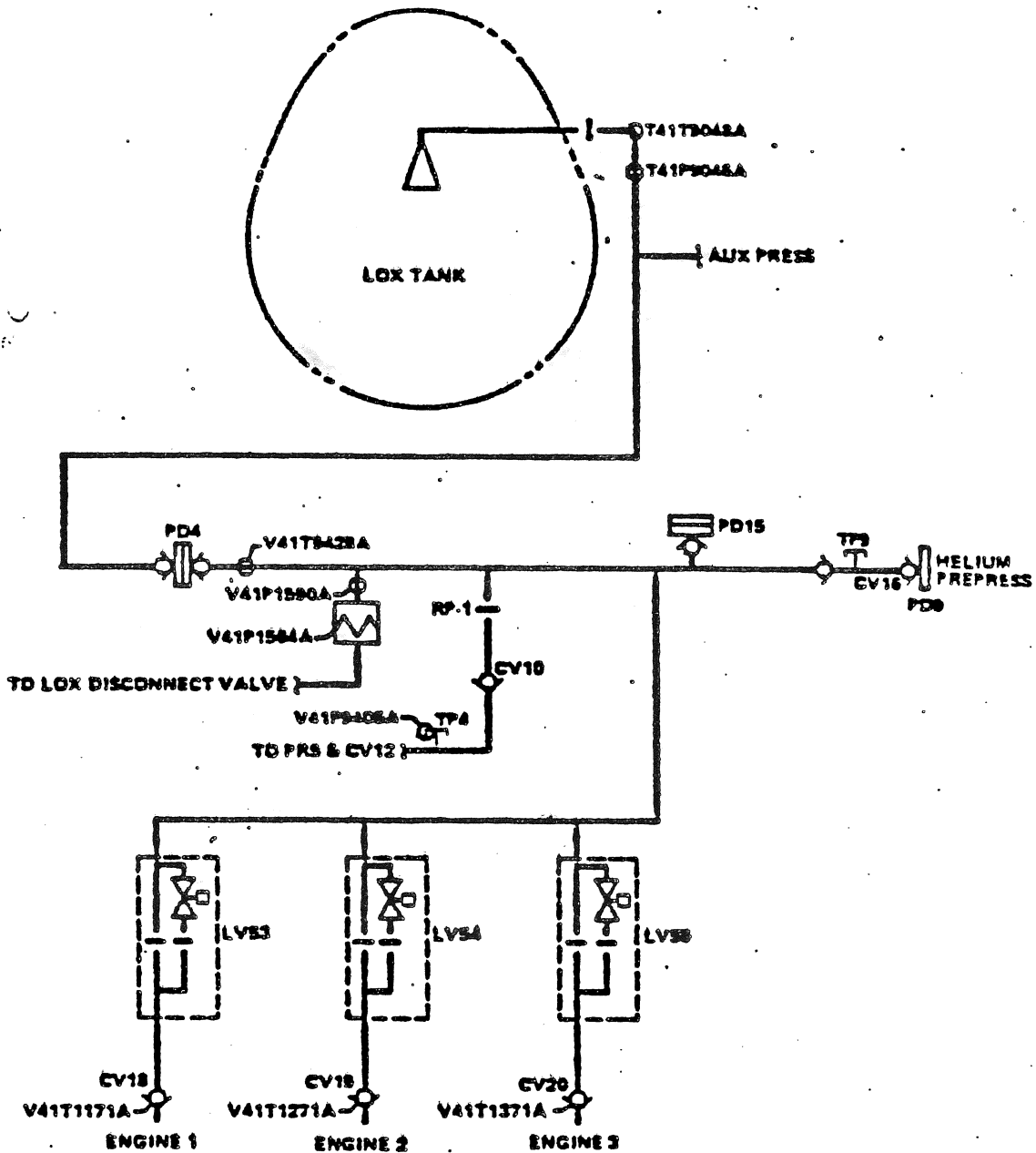
V41X1509X	MPS-LOX INBD FILL VLV CLOSED, OFF-ON EVENT
V41X1510E	MPS-LOX INBD FILL VLV OPEN, OFF-ON EVENT
V41X1513E	MPS-LOX OUTBD FILL VLV OPEN, OFF-ON EVENT
V41X1514X	MPS-LOX OUTBD FILL VLV CLOSED, OFF-ON EVENT
V41X1541E	MPS-LOX FEEDLINE RELIEF SOV OPEN, OFF-ON EVENT
V41X1542E	MPS-LOX FEEDLINE RELIEF SOV CLOSED, OFF-ON EVENT
V41P9408X	MPS-LOX FILL LINE PRESS, 0 TO 200 PSIA (INSULATED)

LOX BLEED AND POGO RECIRCULATION



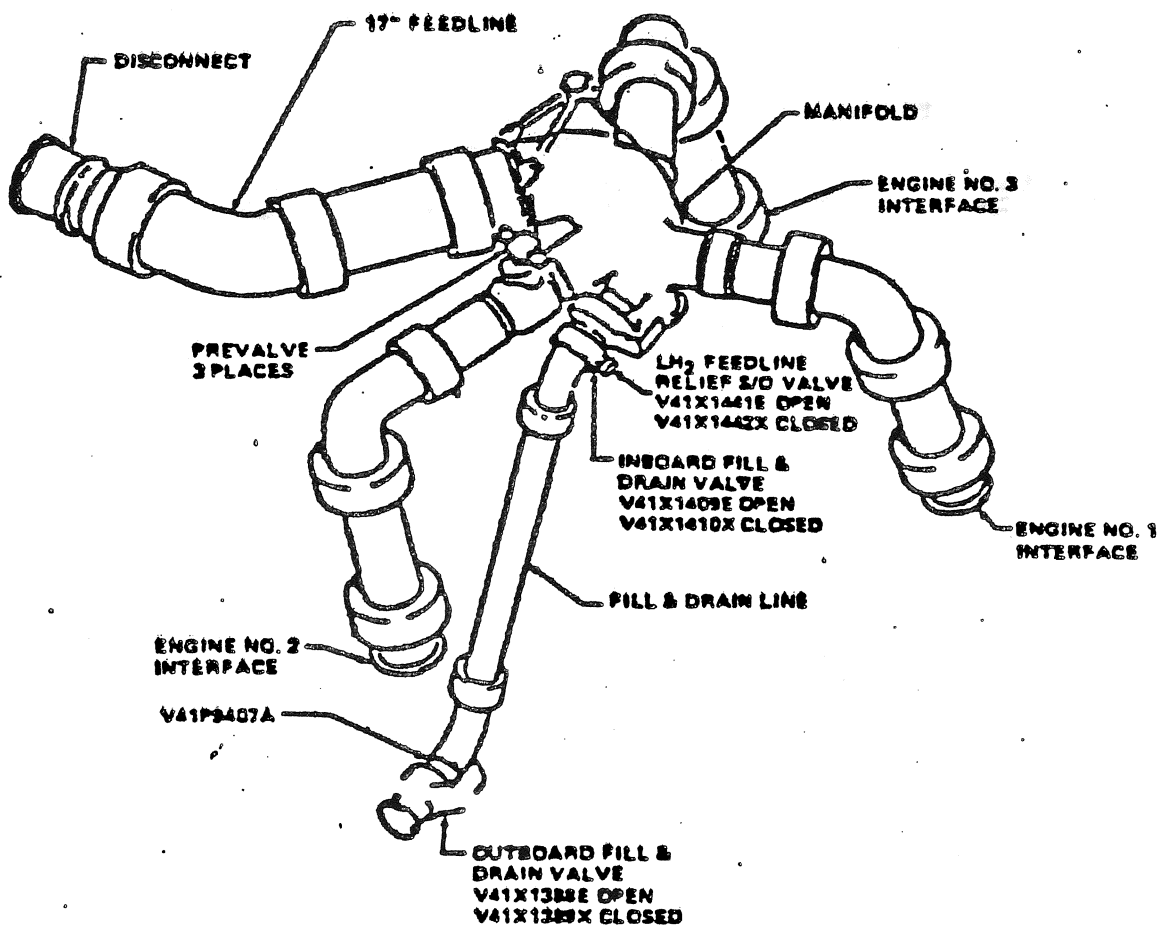
- | | |
|-----------|---|
| V41X1580X | X74 MPS LO ₂ OVERBOARD B/V CLOSED A, CLOSE EVENT |
| V41X1581X | X75 MPS LO ₂ OVERBOARD B/V CLOSED B, CLOSE EVENT |
| V41X1587E | X73 MPS LO ₂ OVERBOARD B/V OPEN, OPEN EVENT |
| V41X1811X | X69 MPS LO ₂ ACCUM RECIRC VLV 1 OPEN, OFF-ON EVENT |
| V41X1818E | X70 MPS LO ₂ ACCUM RECIRC VLV 1 CLOSED, CLOSE EVENT |
| V41X1821X | X71 MPS LO ₂ ACCUM RECIRC VLV 2 OPEN, OFF-ON EVENT |
| V41X1828E | X72 MPS LO ₂ ACCUM RECIRC VLV 2 CLOSED, CLOSE EVENT |
| V41T9001A | T219 ACCUM RECIRC MANF TEMP, -325 TO +300 DEG F |
| V41P9108X | P235 E-1 LO ₂ BLEEDLINE PRESS, 0 TO 300 PSIA (INSULATED) |
| V41T9109A | T201 E-1 LO ₂ BLEEDLINE TEMP, -325 TO +300 DEG F |
| V41P9208A | P236 E-2 LO ₂ BLEEDLINE PRESS, 0 TO 300 PSIA (INSULATED) |
| V41T9209A | T207 E-2 LO ₂ BLEEDLINE TEMP, -325 TO +300 DEG F |
| V41P9308A | P237 E-3 LO ₂ BLEEDLINE PRESS, 0 TO 300 PSIA (INSULATED) |
| V41T9309A | T208 E-3 LO ₂ BLEEDLINE TEMP, -325 TO +300 DEG F |

LOX PRESSURIZATION



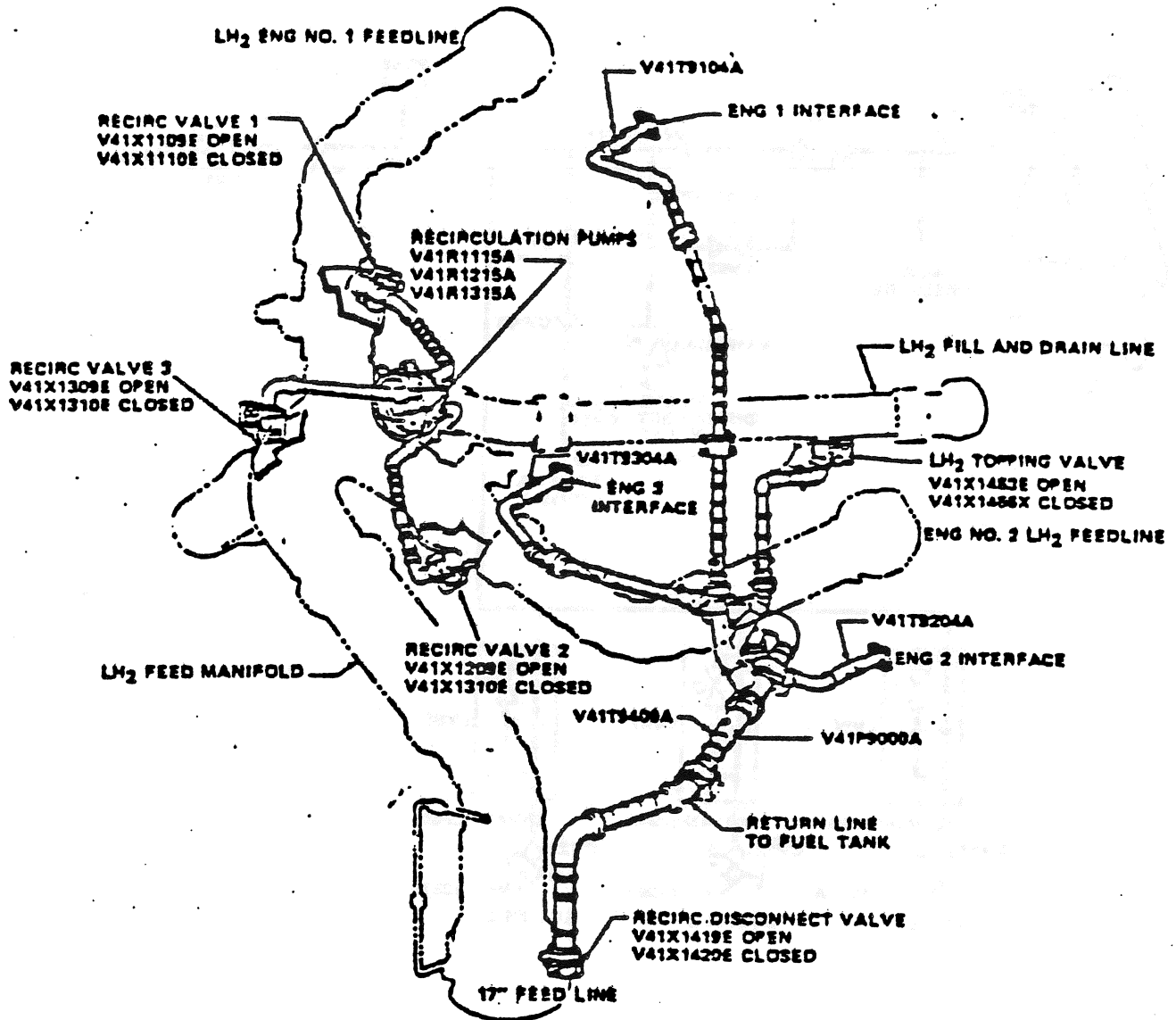
- T41P9046A P301 GOX ORIFICE INLET PRESS, 0 TO 1000 PSIA
- T41T9048A T301 GOX ORIFICE INLET TEMP, -160 TO +790 DEG F
- V41T1171A T9 MPS-ENG NO 1 GOX PRESS OUTLET TEMP, -150 TO +650 DEG F
- V41T1271A T10 MPS-ENG NO 2 GOX PRESS OUTLET TEMP, -150 TO +650 DEG F
- V41T1371A T11 MPS-ENG NO 3 GOX PRESS OUTLET TEMP, -150 TO +650 DEG F
- V41P1564A P22 MPS-LOX SYSTEM DIFFERENTIAL PRESS, 40 TO 70 PSID
- V41P1590A P20 MPS-LOX DISCONNECT PRESS, 0 TO 1000 PSIA
- V41P9405A P204 MPS LO₂ REPRESS MANF PRESS, 0 TO 100 PSIA
- V41T9428A T211 MPS GOX PRES DISC TEMP, -150 TO +650 DEG F

ORBITER FUEL FILL AND DRAIN LINE



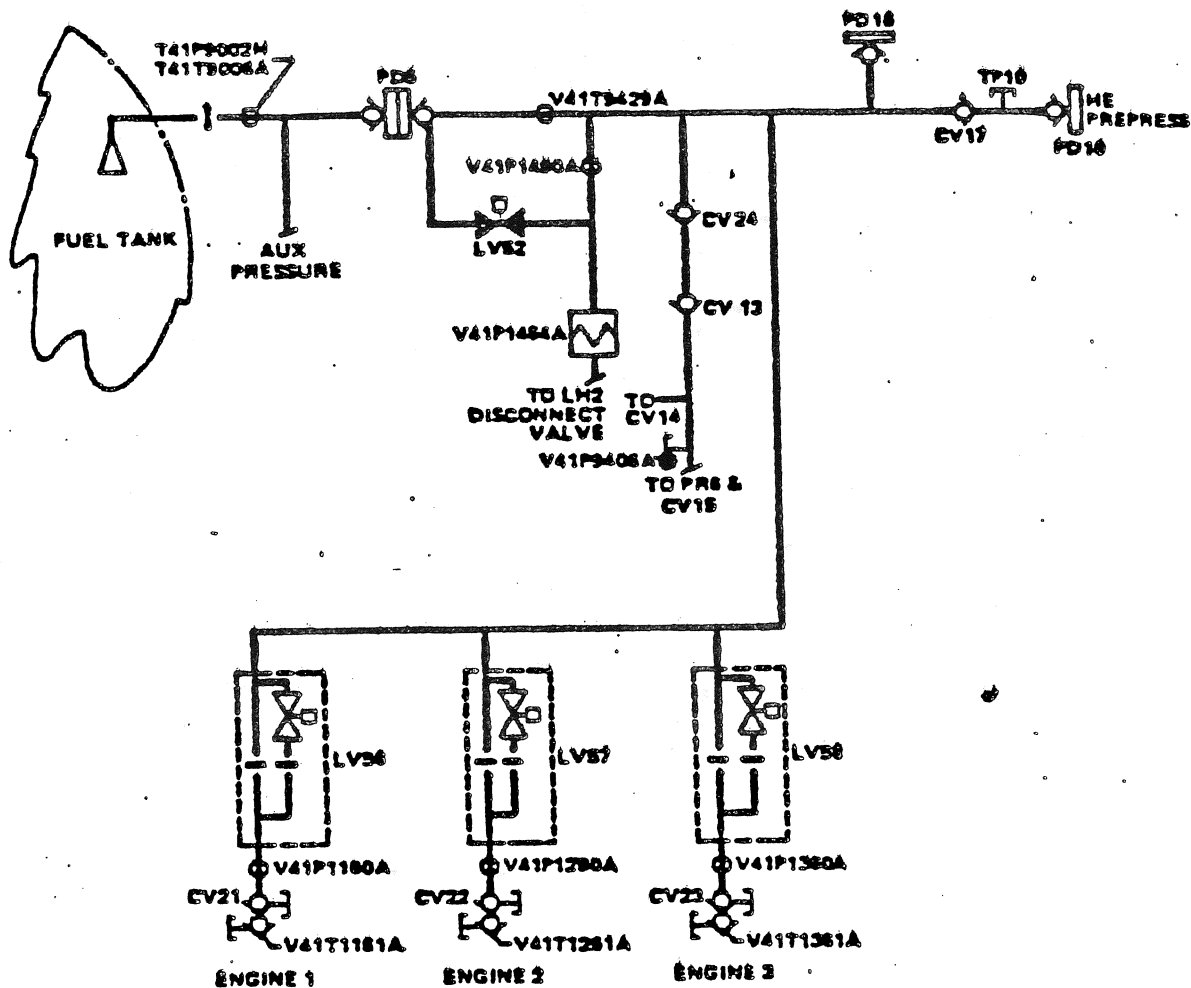
V41X1388E	MPS-LH ₂	OUTBD FILL VLV OPEN, OFF-ON EVENT
V41X1389X	MPS-LH ₂	OUTBD FILL VLV CLOSED, OFF-ON EVENT
V41X1409E	MPS-LH ₂	INBD FILL VLV OPEN, OFF-ON EVENT
V41X1410X	MPS-LH ₂	INBD FILL VLV CLOSED, OFF-ON EVENT
V41X1441E	MPS-LH ₂	FEEDLINE RELIEF SOV OPEN, OFF-ON EVENT
V41X1442E	MPS-LH ₂	FEEDLINE RELIEF SOV CLOSED, OFF-ON EVENT
V41P9407A	MPS LH ₂	FILL LINE PRESS, 0 TO 100 PSIA (INSULATED)

LH2 RECIRCULATION SYSTEM



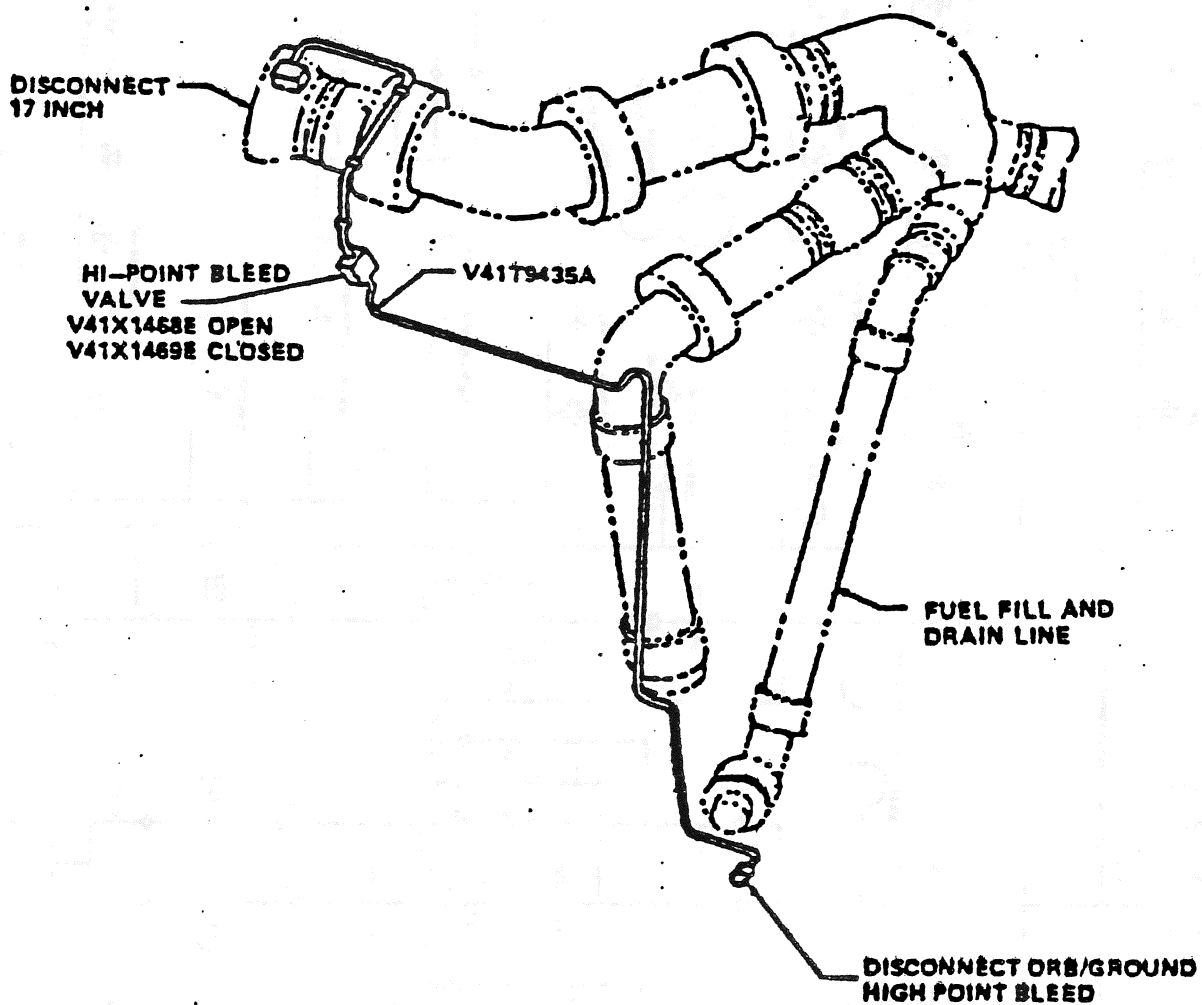
V41X1109E	MPS-ENG NO 1 LH ₂ RECIRC VLV OPEN, OFF-ON EVENT
V41X1110E	MPS-ENG NO 1 LH ₂ RECIRC VLV CLOSED, OFF-ON EVENT
V41R1115A	MPS-ENG NO 1 LH ₂ RECIRC PUMP SPEED, 0 TO 20K RPM
V41X1209E	MPS-ENG NO 2 LH ₂ RECIRC VLV OPEN, OFF-ON EVENT
V41X1210E	MPS-ENG NO 2 LH ₂ RECIRC VLV CLOSED, OFF-ON EVENT
V41R1215A	MPS-ENG NO 2 LH ₂ RECIRC PUMP SPEED, 0 TO 20K RPM
V41X1309E	MPS-ENG NO 3 LH ₂ RECIRC VLV OPEN, OFF-ON EVENT
V41X1310E	MPS-ENG NO 3 LH ₂ RECIRC VLV CLOSED, OFF-ON EVENT
V41R1315A	MPS-ENG NO 3 LH ₂ RECIRC PUMP SPEED, 0 TO 20K RPM
V41X1419E	MPS-LH ₂ RECIRC DISC VLV OPEN, OFF-ON EVENT
V41X1420E	MPS-LH ₂ RECIRC DISC VLV CLOSED, OFF-ON EVENT
V41X1453E	MPS-LH ₂ TOPPING VLV OPEN, OFF-ON EVENT
V41X1456X	MPS-LH ₂ TOPPING VLV CLOSED, OFF-ON EVENT
V41P9000A	LH ₂ RECIRC RN RTN MANF PRESS, 0 TO 100 PSIA (INSULATED)
V41P9104A	MPS ME-1 LH ₂ RECIRC RETURN TEMP, -430 TO -405 DEG F (INSULATED)
V41P9204A	MPS ME-2 LH ₂ RECIRC RETURN TEMP, -430 TO -405 DEG F (INSULATED)
V41P9304A	MPS ME-3 LH ₂ RECIRC RETURN TEMP, -430 TO -405 DEG F (INSULATED)
V41P9409A	MPS LH ₂ REPLENISH/RECIRC TEMP, -430 TO -405 DEG F (INSULATED)

LH2 PREPRESSURIZATION & PRESSURIZATION SYSTEM



T41P9002A	P302 GH ₂ ORIFICE INLET PRESS, 0 TO 1000 PSIA
T41T9006A	T302 GH ₂ ORIFICE INLET TEMP, -160 TO +340 DEG F
V41P1160A	P9 MPS-ENG NO 1 GH ₂ OUTLET PRESS, 0 TO 5000 PSIA
V41T1161A	T13 MPS-ENG NO 1 GH ₂ PRESS OUTLET TEMP, -325 TO +500 DEG F
V41P1260A	P10 MPS-ENG NO 2 GH ₂ OUTLET PRESS, 0 TO 5000 PSIA
V41T1261A	T14 MPS-ENG NO 2 GH ₂ PRESS OUTLET TEMP, -325 TO +500 DEG F
V41P1360A	P11 MPS-ENG NO 3 GH ₂ OUTLET PRESS, 0 TO 5000 PSIA
V41T1361A	T15 MPS-ENG NO 3 GH ₂ PRESS OUTLET TEMP, -325 TO +500 DEG F
V41P1464A	P23 MPS-LH ₂ SYSTEM DIFFERENTIAL PRESS, 0 TO +3 PSID
V41P1490A	P21 MPS-GH ₂ DISCONNECT PRESSURE, 0 TO 1000 PSIA
V41P9406A	P205 MPS-LH ₂ REPRESS MANF PRESS, 0 TO 100 PSIA
V41T9429A	T212 MPS-GH ₂ PRESS DISC TEMP, -325 TO +300 DEG F

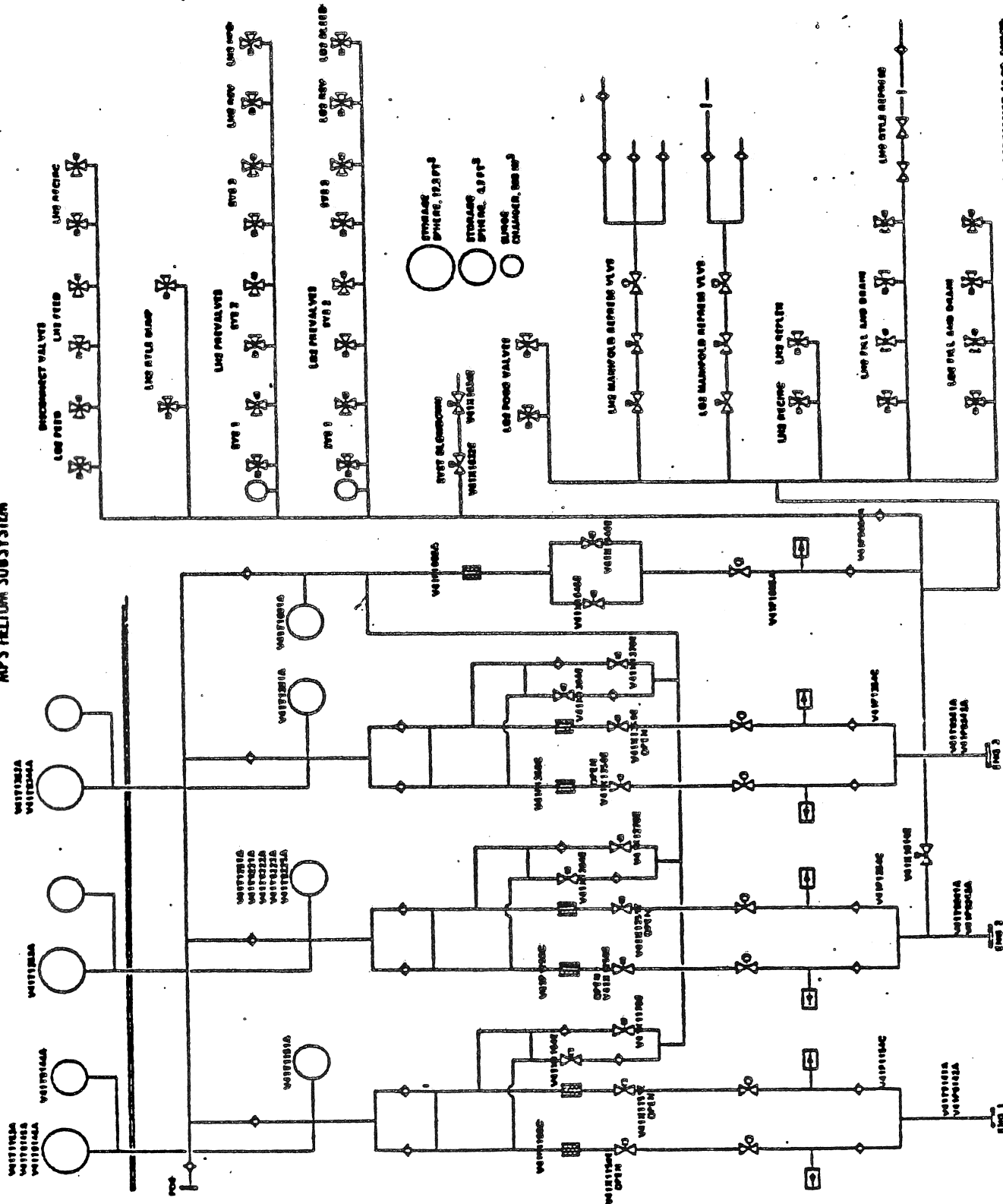
LH2 HI-POINT BLEED LINE



V41X1468E
V41X1469E
V41T9435A

LH₂ HI POINT BLEED OPEN IND, OFF-ON EVENT
LH₂ HI POINT BLEED CLOSED IND, OFF-ON EVENT
T220 LH₂ HI POINT BLEED TEMP, -430 TO -405 DEG F

MPS HELIUM SUBSYSTEM



MPS HELIUM SUBSYSTEM

V41P1150C P12 MPS-ENG NO. 1 HELIUM SUPPLY PRESS, 0 TO 5000 PSIA
 V41T1151A T18 MPS E-1 AFT FUSLG HE SUPPLY TEMP, -325 TO 300 DEG F
 V41T1152A MPS E-1 MID FUSLG HE SUPPLY TEMP, -325 TO 300 DEG F
 V41P1154C P16 MPS ME-1 HELIUM INTERFACE PRESSURE, 0 TO 1000 PSIA
 V41X1158E MPS-E1 HE ISLN VLV 1 OPEN PWR ON, OFF-ON EVENT
 V41X1159E MPS-E1 HE ISLN VLV 2 OPEN PWR ON, OFF-ON EVENT
 V41X1164E MPS E1 HE INTCON IN/OPEN PWR ON, OFF-ON EVENT
 V41X1170E MPS E1 HE INTCON OUT/OPEN PWR ON, OFF-ON EVENT
 V41P1250C P13 MPS-ENG NO. 2 HELIUM SUPPLY PRESS, 0 TO 5000 PSIA
 V41T1251A T19 MPS E-2 AFT FUSLG HE SUPPLY TEMP, -325 TO 300 DEG F
 V41T1252A MPS E-2 MID FUSLG HE SUPPLY TEMP, -325 TO 300 DEG F
 V41P1254C P17 MPS ME-2 HELIUM INTERFACE PRESSURE, 0 TO 1000 PSIA
 V41X1258E MPS-E2 HE ISLN VLV 1 OPEN PWR ON, OFF-ON EVENT
 V41X1259E MPS-E2 HE ISLN VLV 2 OPEN PWR ON, OFF-ON EVENT
 V41X1264E MPS E2 HE INTCON IN/OPEN PWR ON, OFF-ON EVENT
 V41X1270E MPS E2 HE INTCON OUT/OPEN PWR ON, OFF-ON EVENT
 V41P1350C P14 MPS-ENG NO. 3 HELIUM SUPPLY PRESS, 0 TO 5000 PSIA
 V41T1351A T20 MPS E-3 AFT FUSLG HE SUPPLY TEMP, -325 TO 300 DEG F
 V41T1352A MPS E-3 MID FUSLG HE SUPPLY TEMP, -325 TO 300 DEG F
 V41P1354C P18 MPS ME-3 HELIUM INTERFACE PRESSURE, 0 TO 1000 PSIA
 V41X1358E MPS-E3 HE ISLN VLV 1 OPEN PWR ON, OFF-ON EVENT
 V41X1359E MPS-E3 HE ISLN VLV 2 OPEN PWR ON, OFF-ON EVENT
 V41X1364E MPS E3 HE INTCON IN/OPEN PWR ON, OFF-ON EVENT
 V41X1370E MPS E3 HE INTCON OUT/OPEN PWR ON, OFF-ON EVENT
 V41P1600A P15 MPS-PNEUMATIC VLV HE SUPPLY PRESS, 0 TO 5000 PSIA
 V41T1601A T17 MPS-PNEUMATIC VLV HE BOTTLE TEMP, -325 TO 300 DEG F
 V41P1605A P19 MPS PNEU VLV HE RGLTR OUTLET PRESS, 0 TO 1000 PSIA
 V41X1614E MPS-PNEU CROSSOVER 2 OPEN PWR ON, OFF-ON EVENT
 V41X1632E MPS-HE SPLY BLWON 1 OPEN PWR ON, OFF-ON EVENT
 V41X1634E MPS-HE SPLY BLWON 2 OPEN PWR ON, OFF-ON EVENT
 V41X1645E MPS-PNEU HE ISLN VLV 1 OPEN PWR ON, OFF-ON EVENT
 V41X1646E MPS-PNEU HE ISLN VLV 2 OPEN PWR ON, OFF-ON EVENT
 V41T9141A MPS ME-1 HELIUM INTERFACE TEMP, -75 TO 175 DEG F
 V41P9142A MPS ME-1 HE REGULATOR OUTLET PRESS, 0 TO 1000 PSIA
 V41T9144A MPS E1 M-FUS 26-IN HE TK TEMP, SIDE, -75 TO 300 DEG F
 V41T9145A MPS E1 M-FUS 41-IN HE TK TEMP, TOP, -75 TO 300 DEG F
 V41T9146A MPS E1 M-FUS 41-IN HE TK TEMP, BOT, -75 TO 300 DEG F
 V41T9221A MPS ME-2 PORT AFT HE TK SURF T 1, -75 TO 300 DEG F
 V41T9222A MPS ME-2 PORT AFT HE TK SURF T 2, -75 TO 300 DEG F
 V41T9223A MPS ME-2 PORT AFT HE TK SURF T 3, -75 TO 300 DEG F
 V41T9225A MPS ME-2 PORT AFT HE TK BOSS T 1, -75 TO 300 DEG F
 V41T9241A MPS ME-2 HELIUM INTERFACE TEMP, -75 TO 175 DEG F
 V41P9242A MPS ME-2 HE REGULATOR OUTLET PRESS, 0 TO 1000 PSIA
 V41T9341A MPS ME-3 HELIUM INTERFACE TEMP, -75 TO 175 DEG F
 V41P9342A MPS ME-3 HE REGULATOR OUTLET PRESS, 0 TO 1000 PSIA
 V41T9346A MPS E-3 M-FUS HE TK TEMP, BOT, -75 TO 300 DEG F
 V41P9404A MPS PNEU ACCUM PRESSURE, 0 TO 1000 PSIA

MPS OFI/DFI INSTRUMENTATION
CROSS-REFERENCE

<u>REF. DES. NO.</u>	<u>M-L NO.</u>	<u>HPS CODE</u>	<u>FUNCTION DESCRIPTION</u>	<u>OFI TRANSDUCER PART NO.</u>
50V41MT1			LO ₂ Depletion Sensor #1 and 2	MC432-0205-0022
50V41MT2			LO ₂ Depletion Sensor #3 and 4	MC432-0205-0022
50V41MT3				
50V41MT4				
50V41MT5	V41P1130C	(P1)	E1 LO ₂ Engine Inlet Pressure	ME449-0179-0173
50V41MT6	V41T1131C	(T1)	E1 LO ₂ Engine Inlet Temperature	ME449-0013-0017
50V41MT7				
50V41MT8	V41P1150C	(P12)	E1 He Supply Pressure	ME449-0177-8179
50V41MT9	V41T1151A	(T18)	E1 He Supply Temperature	ME449-0156-0002
50V41MT10	V41P1154C	(P16)	E1 He Regulator Outlet Press (PR1) Panel A	ME449-0177-2179
50V41MT11	V41P1160A	(P9)	E1 GH ₂ Pressurization Check Valve Press	ME449-0177-2578
50V41MT12	V41T1161A	(T13)	E1 GH ₂ Pressurization Check Valve Temp.	ME449-0010-0008
50V41MT13	V41T1171A	(T9)	E1 CO ₂ Pressurization Check Valve Temp.	ME449-0010-0008
50V41MT14	V41P1200C	(P6)	E2 LH ₂ Engine Inlet Pressure	ME449-0179-0272
50V41MT15	V41T1201C	(T6)	E2 LH ₂ Engine Inlet Temperature	ME449-0013-0018
50V41MT16				
50V41MT17				
50V41MT18	V41P1230C	(P2)	E2 LO ₂ Engine Inlet Pressure	ME449-0179-0173
50V41MT19	V41T1231C	(T2)	E2 LO ₂ Engine Inlet Temperature	ME449-0013-0017
50V41MT20				

<u>REF. DES. NO.</u>	<u>Mtl. NO.</u>	<u>MPS CODE</u>	<u>FUNCTION DESCRIPTION</u>	<u>OF I TRANSDUCER PART NO.</u>
50V4 1MT21	V41P1250C	(P13)	E2 He Supply Pressure	ME449-0177-8179
50V4 1MT22	V41T1251A	(T19)	E2 He Supply Temperature	ME449-0156-0002
50V4 1MT23	V41P1254C	(P17)	E2 He Regulator Outlet Pressure (PR2) Panel A	ME449-0177-2179
50V4 1MT24	V41P1260A	(P10)	W2 CH2 Pressurization Check Valve Pressure	ME449-0177-2578
50V4 1MT25	V41T1261A	(T14)	E2 CH2 Pressurization Check Valve Temperature	ME449-0010-0008
50V4 1MT26	V41T1271A	(T10)	E2 CO2 Pressurization Check Valve Temperature	ME449-0010-0008
50V4 1MT27	V41P1300C	(P7)	EJ LH2 Engine Inlet Pressure	ME449-0179-0272
50V4 1MT28	V41T1301C	(T7)	EJ LH2 Engine Inlet Temperature	ME449-0013-0018
50V4 1MT29				
50V4 1MT30				
50V4 1MT31	V41P1330C	(P3)	EJ LO2 Engine Inlet Pressure	ME449-0179-0173
50V4 1MT32	V41T1331C	(T3)	EJ LO2 Engine Inlet Temperature	ME449-0013-0017
50V4 1MT33				
50V4 1MT34	V41P1350C	(P14)	EJ He Supply Pressure	ME449-0177-8179
50V4 1MT35	V41T1351A	(T20)	EJ He Supply Temperature	ME449-0156-0002
50V4 1MT36	V41P1354C	(P18)	EJ He Regulator Outlet Pressure (PR3) Panel A	ME449-0177-2179
50V4 1MT37	V41P1360A	(P11)	EJ CH2 Pressurization Check Valve Pressure	ME449-0177-2578
50V4 1MT38	V41T1361A	(T15)	EJ CH2 Pressurization Check Valve Temperature	ME449-0010-0008
50V4 1MT39	V41T1371A	(T11)	EJ CO2 Pressurization Check Valve Temperature	ME449-0010-0008
50V4 1MT40				

OFI TRANSDUCER
PART NO.

REF. DES. NO.	MFR. NO.	MPS CODE	FUNCTION DESCRIPTION	PART NO.
50V4 1MT41				
50V4 1MT42	V41T1428A	(T8)	LH2 17-Inch Feedline Temperature	ME449-0013-0018
50V4 1MT43	V41P1433C	(P8)	LH2 17-Inch Feedline Pressure	ME449-0179-0271
50V4 1MT44	V41P1464A	(P23)	LH2 Tank Δ P	MC449-0164-0002
50V4 1MT45				
50V4 1MT46				
50V4 1MT47	V41P1490A	(P21)	CH2 Pressurization Line Pressure	ME449-0177-2577
50V4 1MT48	V41T1528B	(T4)	LO2 17-Inch Feedline Temperature	ME449-0013-0017
50V4 1MT49	V41P1533C	(P4)	LO2 17-Inch Feedline Pressure	ME449-0179-0173
50V4 1MT50	V41P1564A	(P22)	LO2 Tank Δ P	MC449-0164-0001
50V4 1MT51				
50V4 1MT52				
50V4 1MT53	V41P1590A	(P20)	CO ₂ Pressurization Line Pressure	ME449-0177-2577
50V4 1MT54	V41P1100C	(P5)	E1 LH2 Engine Inlet Pressure	ME449-0179-0272
50V4 1MT55	V41P1600A	(P15)	Pneumatic Valve He Supply Pressure	ME449-0177-8179
50V4 1MT56	V41T1601A	(T17)	Pneumatic Valve He Supply Temperature	ME449-0156-0002
50V4 1MT57	V41P1605A	(P19)	Pneumatic Valve He Regulator Outlet Pressure	ME449-0177-2179
50V4 1MT58	V41T1101C	(T5)	E1 LH2 Engine Inlet Temperature	ME449-0013-0018
50V4 1MT59		(T26)	Pogo Accumulator He Supply Temperature	
50V4 1MT60		(P24)	Pogo Accumulator He Supply Pressure	

OFI TRANSDUCER
PART NO.

<u>REF. DES. NO.</u>	<u>MFR. NO.</u>	<u>MPS CODE</u>	<u>FUNCTION DESCRIPTION</u>	<u>OFI TRANSDUCER PART NO.</u>
50V41MT61		(P25)	Pogo Accumulator He Regulator Outlet Pressure	
50V41MT62				
50V41MT63				
50V41MT64				
50V41MT65				
50V41MT66				
50V41MT67				
50V41MT68				
50V41MT69				
50V41MT70				
40V41MT71	V41T1152A	(T27)	E1 Mid Body He Supply Temperature 17.3 Ft ³	ME449-0010-0007
40V41MT72	V41T1252A	(T28)	E2 Mid Body He Supply Temperature 17.3 Ft ³	ME449-0010-0007
40V41MT73	V41T1352A	(T29)	E3 Mid Body He Supply Temperature 17.3 Ft ³	ME449-0010-0007
50V41MT74	V41P1153A	(P26)	E1 He Regulator (PR7) Outlet Pressure Panel B	ME449-0177-2179
50V41MT75	V41P1253A	(P27)	E2 He Regulator (PR8) Outlet Pressure Panel B	ME449-0177-2179
50V41MT76	V41P1353A	(P28)	E3 He Regulator (PR9) Outlet Pressure Panel B	ME449-0177-2179

<u>REF. DES. NO.</u>	<u>MM. NO.</u>	<u>HPS CODE</u>	<u>FUNCTION DESCRIPTION</u>	<u>DPI TRANSDUCER PART NO.</u>
50V41MT500	V41P9000A	(P202)	LI ₂ Recirculation Manifold Pressure	ME449-0179-0271
50V41MT501	V41P9195A	(P207)	E1 LO ₂ Inlet Pressure	MC449-0190-0001
50V41MT502	V41P9196A	(P210)	E1 LI ₂ Inlet Pressure	MC449-0190-0001
50V41MT503				
50V41MT504				
50V41MT505				
50V41MT506				
50V41MT507				
50V41MT508	V41P9295A	(P208)	E2 LO ₂ Inlet Pressure	MC449-0190-0001
50V41MT509	V41P9296A	(P211)	E2 LI ₂ Inlet Pressure	MC449-0190-0001
50V41MT510	V41P9395A	(P209)	E3 LO ₂ Inlet Pressure	MC449-0190-0001
50V41MT511	V41P9396A	(P212)	E3 LI ₂ Inlet Pressure	MC449-0190-0001
50V41MT512	V41P9400A	(P213)	LO ₂ 17-Inch Feedline (Pogo)	MC449-0190-0001
50V41MT513				
50V41MT514				
50V41MT515				

DFI TRANSDUCER
PART NO.

FUNCTION DESCRIPTION

MPS
CODE

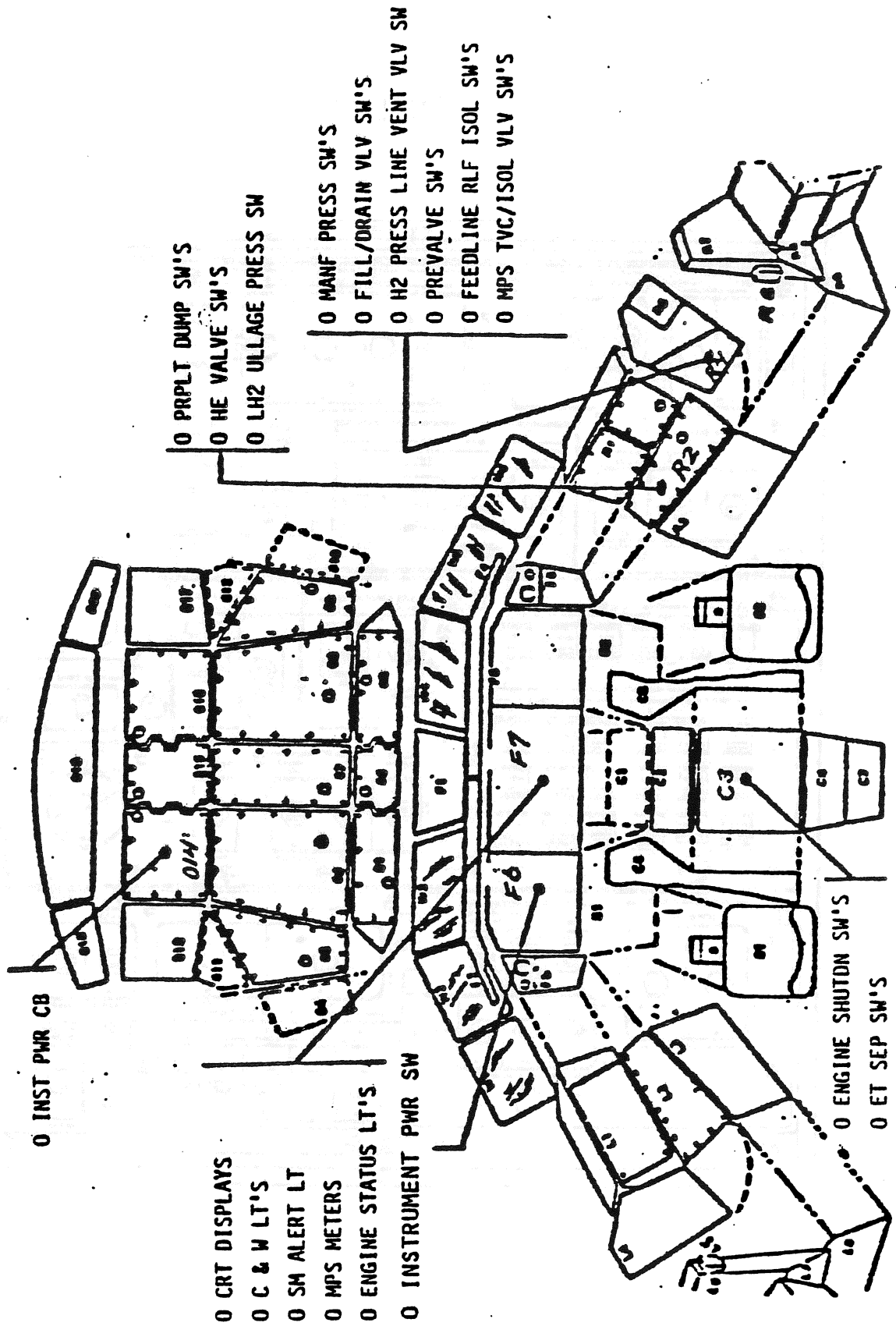
MFL. NO.

REF. DES. NO.

50V41MT516						
50V41MT517						
50V41MT518	V41P9404A	(P203)	Pneumatic Accumulator Pressure	ME449-0177-2179		
50V41MT519	V41P9142A	(P229)	E1 H _e Interface Pressure	ME449-0177-2179		
50V41MT520	V41P9242A	(P230)	E2 H _e Interface Pressure	ME449-0177-2179		
50V41MT521	V41P9342A	(P231)	E3 H _e Interface Pressure	ME449-0177-2179		
50V41MT522	V41T9141A	(T204)	E1 H _e Interface Temperature	ME449-0010-0004		
50V41MT523	V41T9241A	(T205)	E2 H _e Interface Temperature	ME449-0010-0004		
50V41MT524	V41T9341A	(T206)	E3 H _e Interface Temperature	ME449-0010-0004		
50V41MT525	V41T9104A	(T202)	E1 LH ₂ Recirculation Line Temperature	ME449-0013-0019		
50V41MT526	V41T9204A	(T209)	E2 LH ₂ Recirculation Line Temperature	ME449-0013-0019		
50V41MT527	V41T9304A	(T210)	E3 LH ₂ Recirculation Line Temperature	ME449-0013-0019		
50V41MT528	V41T9409A	(T203)	LH ₂ Recirculation Manifold Temperature	ME449-0013-0019		
50V41MT529	V41P9406A	(P205)	LH ₂ Repressurization Regulator Outlet Pressure	ME449-0177-2579		
50V41MT530	V41P9408A	(P227)	LO ₂ Fill & Drain Line Pressure	ME449-0179-0172		
50V41MT531	V41P9407A	(P228)	LH ₂ Fill & Drain Line Pressure	ME449-0179-0271		
50V41MT532	V41T9109A	(T201)	E1 LO ₂ Bleed Temperature	ME449-0010-0004		
50V41MT533	V41T9209A	(T207)	E2 LO ₂ Bleed Temperature	ME449-0010-0004		
50V41MT534	V41T9309A	(T208)	E3 LO ₂ Bleed Temperature	ME449-0010-0004		
50V41MT535	V41T9428A	(T211)	CO ₂ Pressurization Line Temperature	ME449-0010-0008		

<u>REF. DES. NO.</u>	<u>MTL. NO.</u>	<u>HPS CODE</u>	<u>FUNCTION DESCRIPTION</u>	<u>DFI TRANSDUCER PART NO.</u>
50V41MT536	V41P9429A	(T212)	GH ₃ Pressurization Line Temperature	ME449-0010-0004
50V41MT537				
50V41MT538				
50V41MT539				
50V41MT540				
50V41MT541	V41P9405A	(P204)	LO ₂ Repressurization Regulator Outlet Pressure	ME449-0177-2379
50V41MT542				
50V41MT543				
50V41MT544				
50V41MT545				
50V41MT546				
50V41MT547				
50V41MT548	V41P9001A	(T219)	LO ₂ Pogo Accumulator Recirculation Manifold Temperature	ME449-0010-0004
50V41MT549	V41P9108A	(P235)	E1 LO ₂ Bleed Line Pressure	ME449-0179-0173
50V41MT550	V41P9208A	(P236)	E2 LO ₂ Bleed Line Pressure	ME449-0179-0173
50V41MT551	V41P9308A	(P237)	E3 LO ₂ Bleed Line Pressure	ME449-0179-0173
50V41MT552	V41P9435A	(T220)	LO ₂ HI Point Bleed Temperature	ME449-0017-0019

CONTROLS & DISPLAYS



0 INST PWR CB

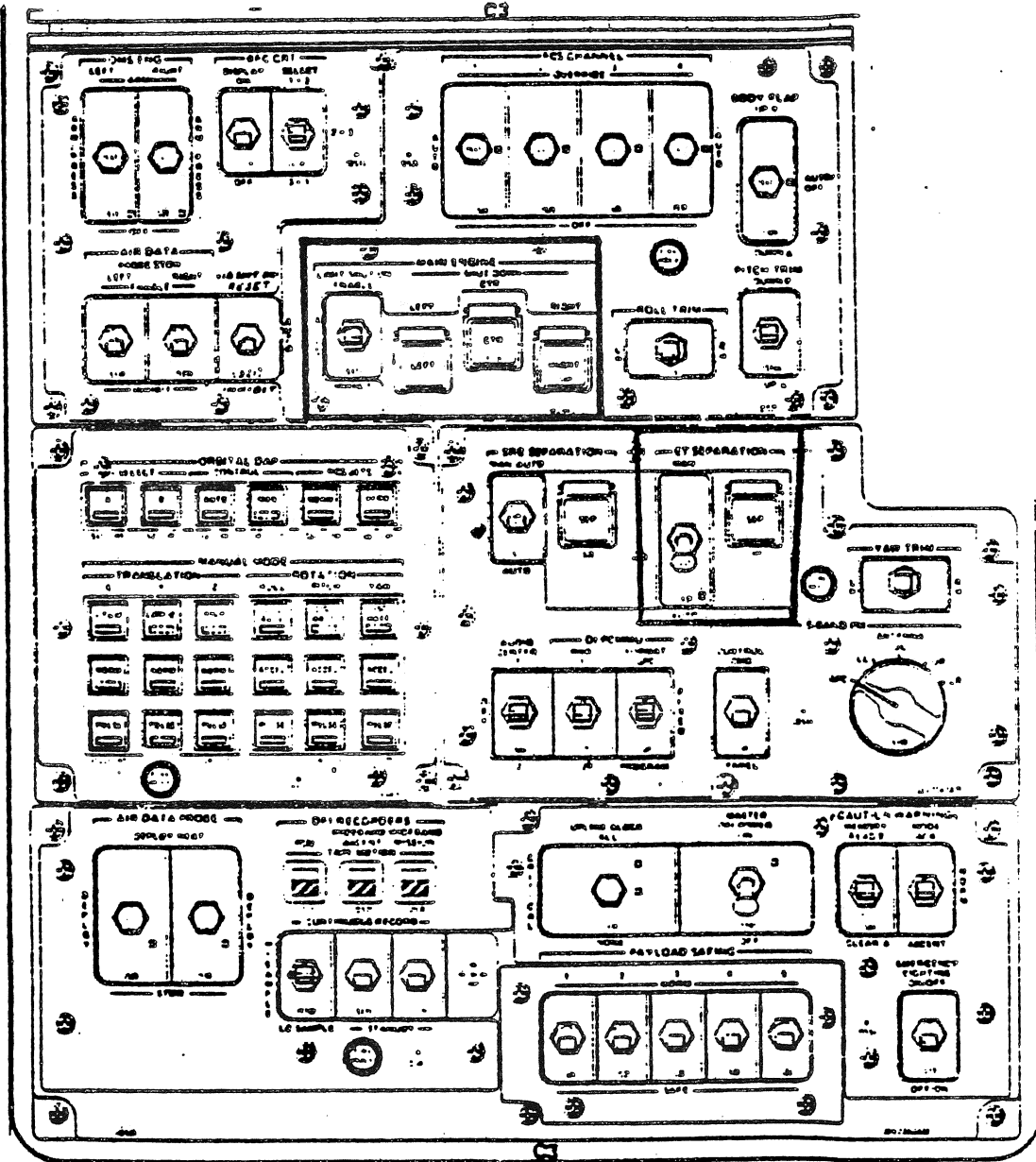
- 0 CRT DISPLAYS
- 0 C & W LT'S
- 0 SM ALERT LT
- 0 MPS METERS
- 0 ENGINE STATUS LT'S
- 0 INSTRUMENT PWR SW

- 0 PRPLT DUMP SW'S
- 0 HE VALVE SW'S
- 0 LH2 ULLAGE PRESS SW

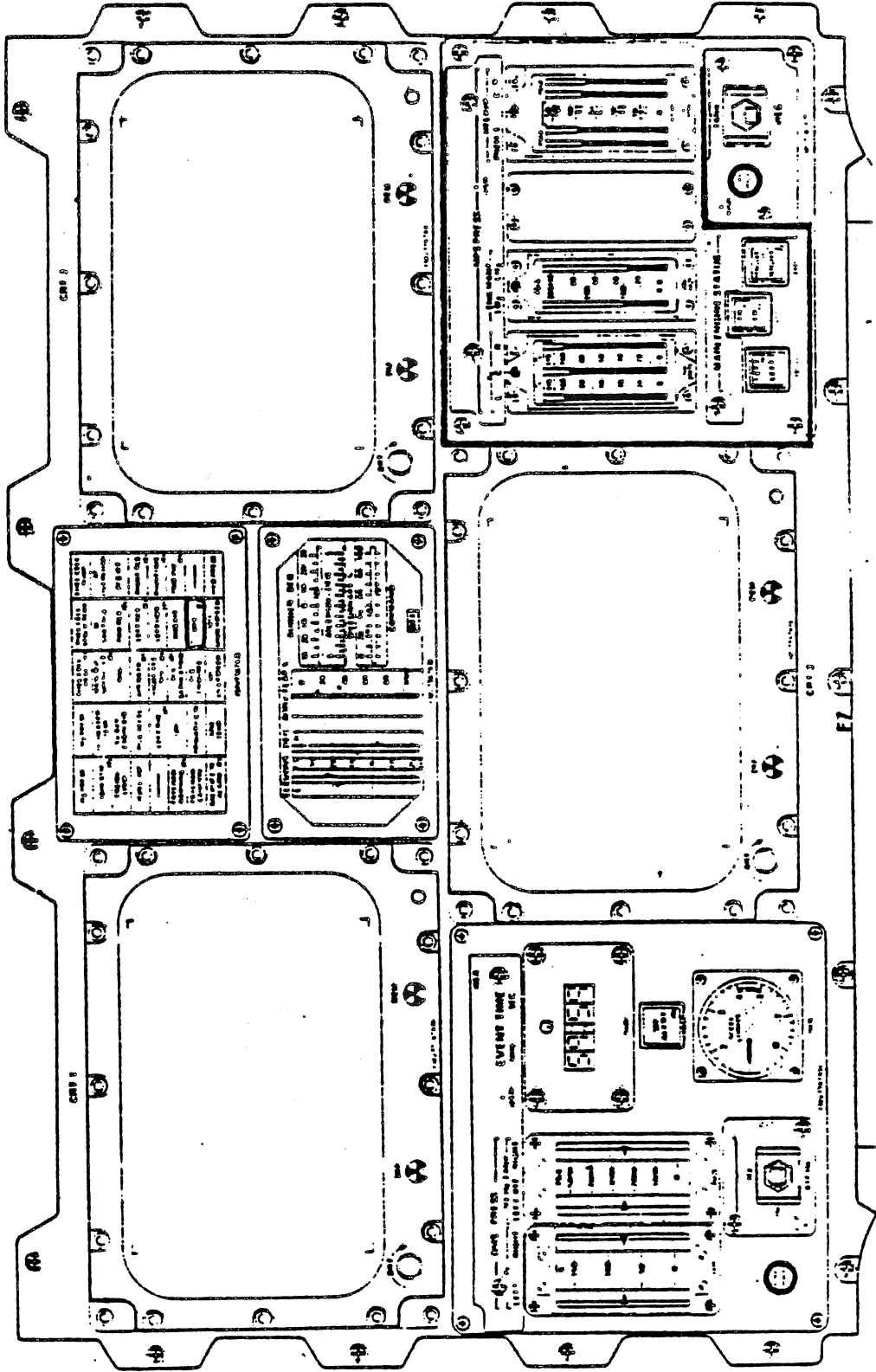
- 0 MANF PRESS SM'S
- 0 FILL/DRAIN VLV SM'S
- 0 H2 PRESS LINE VENT VLV SW
- 0 PREVALVE SW'S
- 0 FEEDLINE RLF ISOL SW'S
- 0 MPS TVC/ISOL VLV SM'S

- 0 ENGINE SHUTDN SW'S
- 0 ET SEP SW'S

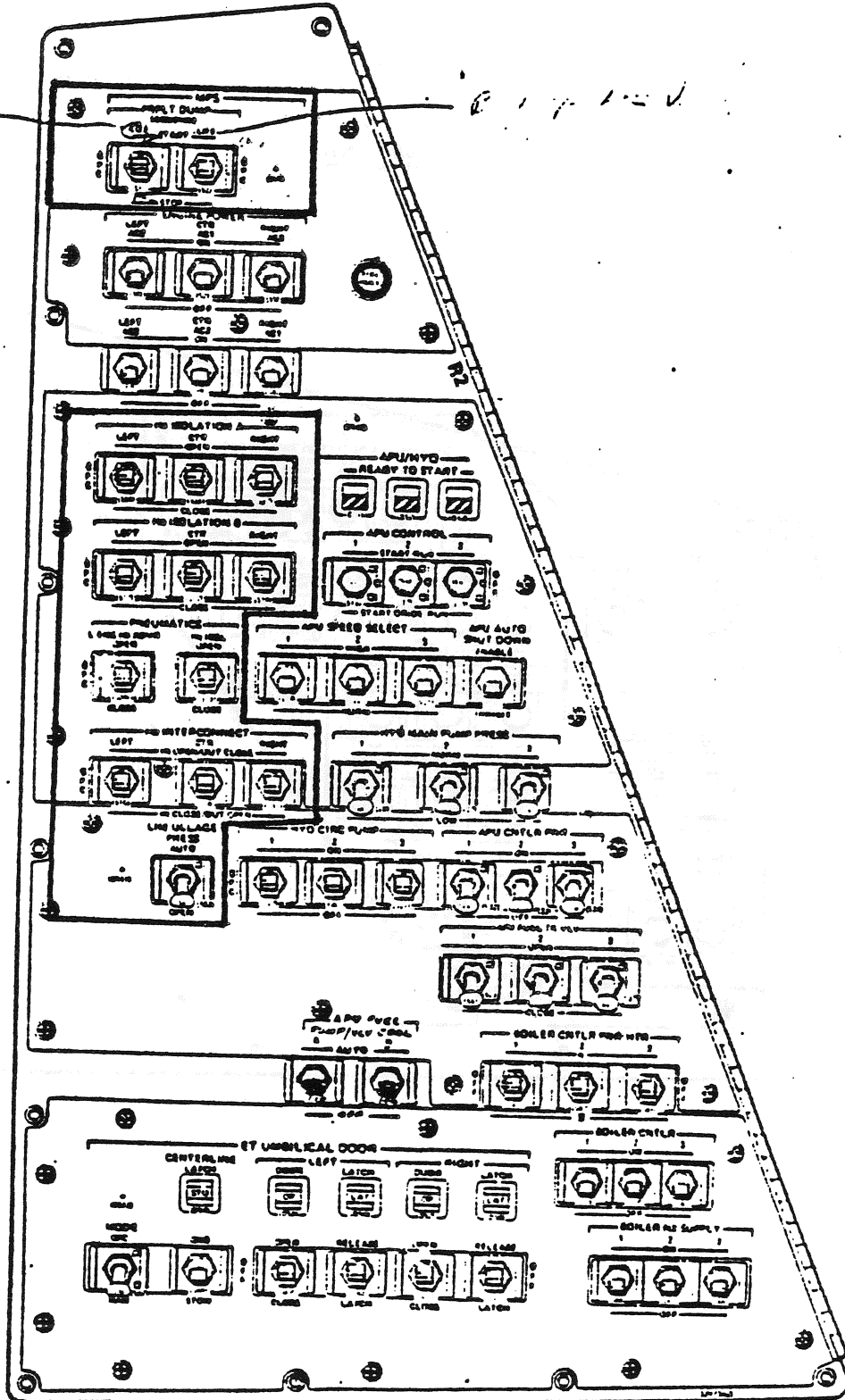
PANEL C3



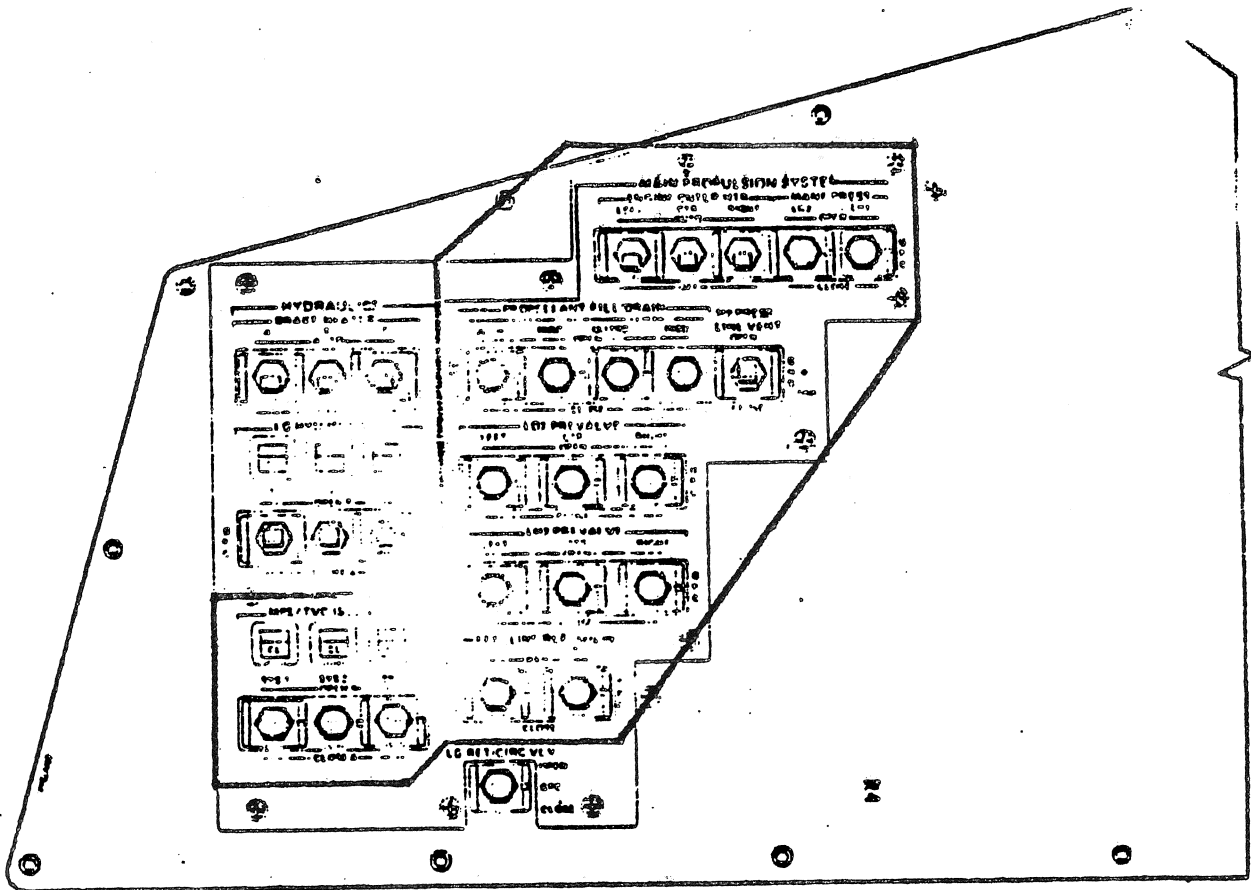
PANEL F7



PANEL R2



PANEL R4



OMRSD REQUIREMENTS FOR THE OPENING
AND CLOSING OF MPS VALVES (AMBIENT TEMP)

Valve	Response Time	
	Open	Close
*LH2 & LO2 prevalues	1.5 sec. max.	.95 + 0.2-0.45 sec
LH2 & LO2 feedline relief solenoid valves	1.5 sec. max.	3.0 sec max
*LH2 & LO2 inboard and outboard fill and drain valves	7.0 + 2-4 sec	7.0 + 2-4 sec
*LO2 & LH2 feed disc. valve	1 to 6.1 sec	3 sec max
LH2 topping valve	1.0 sec. max.	1.0 sec max
LH2 recirculation pump valves	1.0 sec. max	1.0 sec max
LH2 RTLS inboard and outboard dump valve .	1.0 sec. max	1.0 sec max
LH2 hi point bleed valve	1.0 sec. max.	1.0 sec max
*LH2 recirculation disconnect valve	5.1 sec. max.	2.3 sec max
LO2 POGO accumulator recirculation valves 1 & 2	.75 sec. max.	.5 sec max
LO2 overboard bleed valve	.75 sec. max.	.5 sec max

*Bi-stable valves.

REDUNDANT SET LAUNCH SEQUENCE

<u>Mission Time</u>	<u>Sequence Time (Secs)</u>	<u>Δ Time for Event (Secs)</u>	<u>Event</u>
T ₀ - 25 Secs	0		1. On Board Redundant Set Launch Sequence Enabled
T ₀ - 16 Secs	9		1. Close LO ₂ and LH ₂ Outboard Fill/Drain Valves
T ₀ - 10 Secs	15		1. Terminate Helium Fill
T ₀ - 9.5 Secs	15.5		1. Open LO ₂ Accumulator Recirculation Valves (2)
T ₀ - 6.5 Secs	18.5		1. Open LH ₂ Prevalves (3)
		9.5	2. Verify LO ₂ and LH ₂ Outboard Fill/Drain Valves Closed
		3.0	3. Verify LO ₂ Accumulator Recirculation Valves Open (2)
T ₀ - 6 Secs	19		1. Turn off LH ₂ Recirculation Pumps (3)
			2. Close LH ₂ Recirculation Valves (3)
			3. Close LH ₂ High Point Bleed Valve
T ₀ - 5 Secs	20		1. Close LO ₂ Overboard Bleed Valve
T ₀ - 4 Secs	21	2.5	1. Verify LH ₂ Prevalves (3) Open
		1	2. Verify LO ₂ Overboard Bleed Valve Closed
T ₀ - 3.8 Secs	21.2		1. Start Engine 3
T ₀ - 3.680 Secs	21.340		1. Start Engine 2
T ₀ - 3.560 Secs	21.460		1. Start Engine 1
T ₀ + 0.64 Secs	25.64	4.44*	1. Verify all Engine's P _c > 90%
T ₀ + ≈ 3.28 Secs	≈ 28.28	2.64**	1. Fire SRM's 2. On Next Pass, Fire Umbilical Release

*Maximum allowable

**Starts at P_c > 90% for all engines

SSME OPERATIONS SEQUENCE

<u>NOMINAL MISSION TIME (MINS:SECS)</u>	<u>SEQUENCE TIME (SECS)</u>	<u>EVENT</u>
T ₀ 00:00*		1. SRM Ignition
T ₀ + ≈ 00:00.3		1. Liftoff
T ₀ + 00:32		1. Throttle to 65%
T ₀ + 1:00		1. Ramp Engines to 100%
T ₀ + 2:06		1. SRB Separation
T ₀ + 8:36		1. Throttle to 65%
T ₀ + 8:42	0	1. MECO 2. Open "Intr'cn in" for E1, E2, E3
T ₀ + 8:43.2	1.16**	1. Close LO2 Prevalves (3)
T ₀ + 8:48.1	6.06	1. Close LH2 Prevalves (3) 2. Close LH2 Recirculation Disconnect Valve ***
T ₀ + 8:50.1	8.06	1. Remove LO2 and LH2 Prevalve Close Commands
T ₀ + 9:02	20.00	1. Close "Intr'cn" in for E1, E2, E3 2. Terminate Sequence

*The countdown clock is reset to 0 at SRM ignition. Clock at SRM ignition is T₀ + ≈ 3.28 seconds in launch sequence.

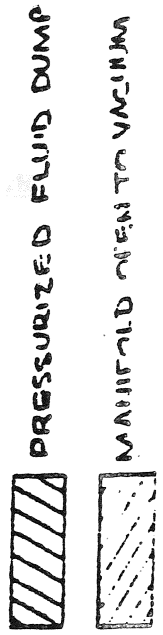
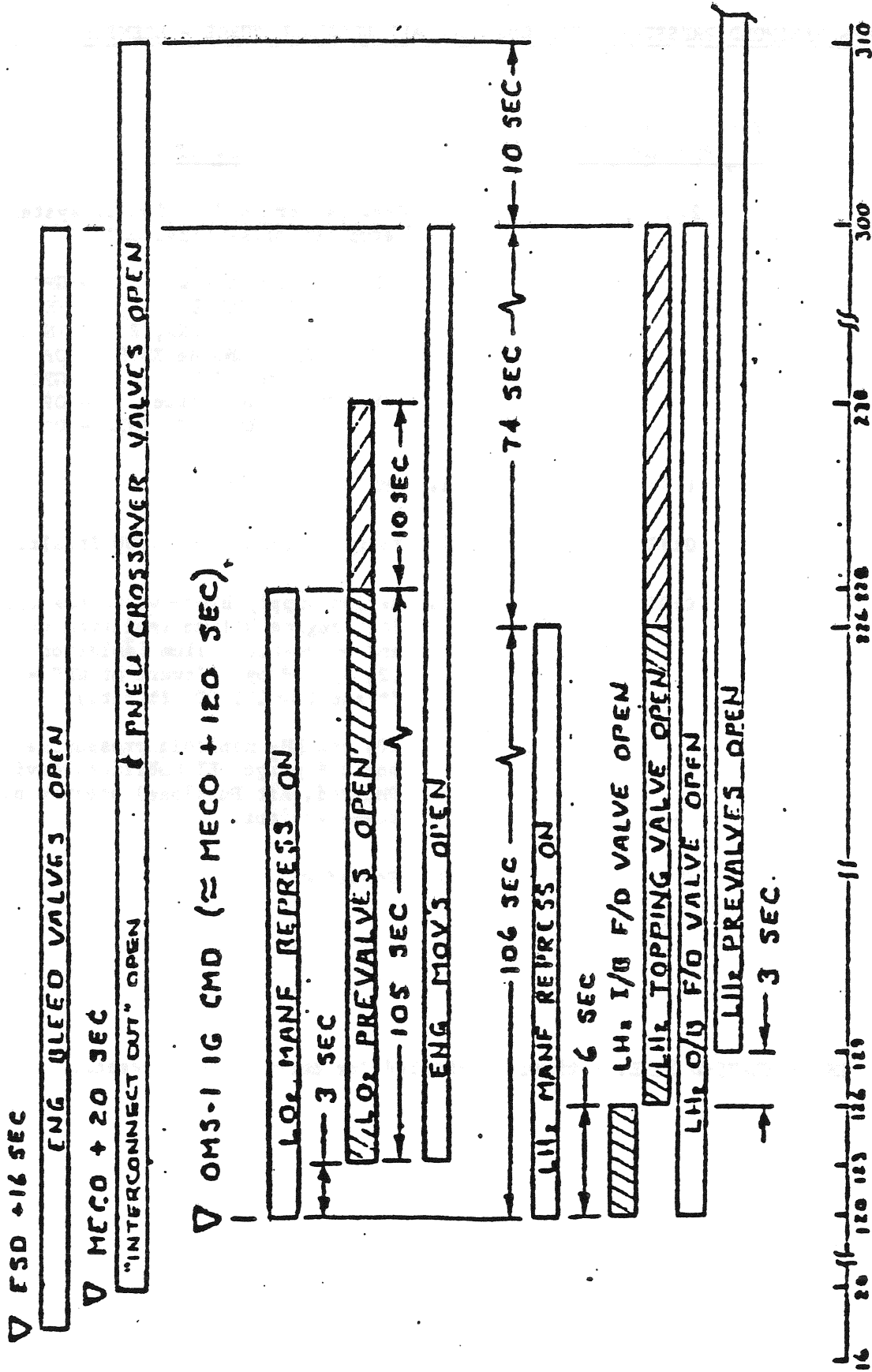
**1. Time after GPC receives message that engine is in shutdown phase.
2. This time is 4.9 seconds for an engine that is shut down prior to MECO.

***1. If an engine is shut down prior to MECO, this action occurs 5.9 seconds after that engine is shut down.

EXTERNAL TANK SEPARATION SEQUENCE

<u>NOMINAL MISSION TIME (MINS:SECS)</u>	<u>SEQUENCE TIME (SECS)</u>	<u>EVENT</u>
T ₀ +8:47.9	0	<ol style="list-style-type: none">1. Open LO2 and LH2 Feedline Relief Shutoff Valves2. Verify all Prevalves Commanded Closed
T ₀ +8:48.9	1	<ol style="list-style-type: none">1. Close LO2 and LH2 Feedline Disconnect Valves
T ₀ +8:51.9	4	<ol style="list-style-type: none">1. Fire ET/Umbilical Unlatch (1st Pass)2. ET/Umbilical Retract (2nd Pass)3. Open RILS Inbd/Outb'd Dump Valves (2nd Pass)
T ₀ +8:57.4	9.5	<ol style="list-style-type: none">1. Arm STR SEP PIC2. Verify feedline disc. vlvs. closed
T ₀ +8:58.9	11	<ol style="list-style-type: none">1. External Tank Separation
T _c +9:31.9	34	<ol style="list-style-type: none">1. Close RILS Inbd/Outboard Dump Valves2. End of Sequence

MPS DUMP SEQUENCE



MPS MANIFOLD PRESSURIZATION/OMS POD, AFT FUSELAGE PURGE - REENTRY

<u>EET*</u> <u>Hrs:Min</u>	<u>Time to Landing,</u> <u>Hrs:Min</u>	<u>Event</u>
8:43	2:17	1. Crew performed function of system setup for pressurization: MPS He ISOL L (two) - GPC I'CONNECT L - IN OP CTR, R - IN CL MPS PNEU L ENG He XOVR - OP He ISOL - GPC MPS MANF PRESS (two) - OP FILL/DRAIN LH ₂ INBD - OP
10:00	1:00	1. OMS deorbit burn
10:30	0:30	1. Entry interface (400,000 ft.alt.)
10:53	0:07	1. Helium supply blowdown valves (2), left engine helium isolation valve B, and pneumatic helium isolation valves (2) opened by software at GRV = 4500 ft/sec (\approx 110,000 ft.alt.). LO ₂ and LH ₂ manifold pressurized and MPS purge (ET Umbilical Cavity, OMS Pod, Aft Fuselage) started by these actions.
11:00	0	1. Touchdown

*EET: ENTRY ELAPSED TIME: A timeline created for entry related events.