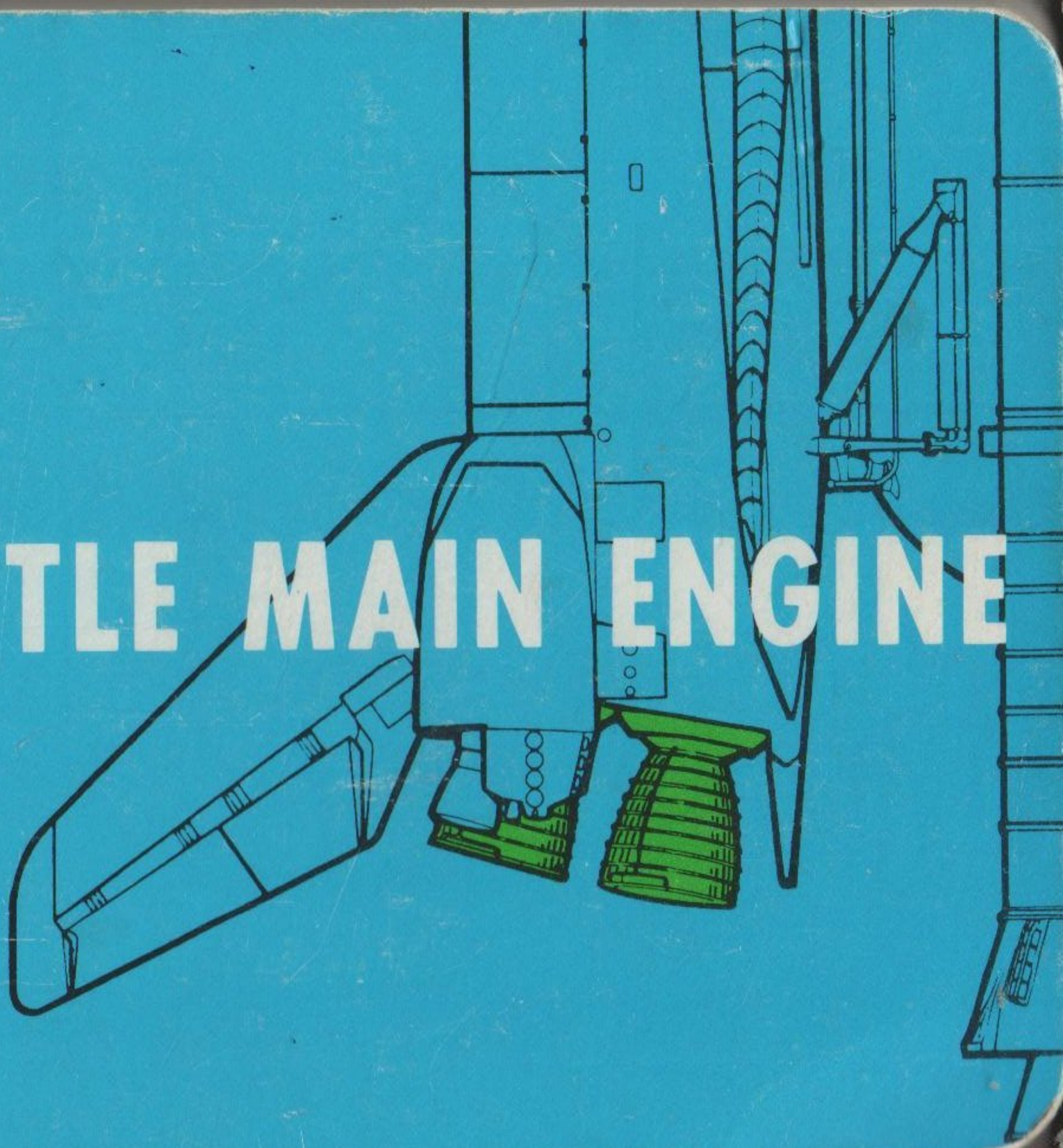
POCKET DATA
RI/RD87-142

SPACE SHUTTLE MAIN ENGINE



Rockwell International
Rocketdyne Division

RI/RD87-142

POCKET DATA

SPACE SHUTTLE MAIN ENGINE

PART NUMBER RS007001

PREPARED BY
ROCKWELL INTERNATIONAL,
ROCKETDYNE DIVISION

23 MARCH 1989

INTRODUCTION

THIS POCKET DATA PROVIDES FINGERTIP INFORMATION FOR PERSONNEL ASSOCIATED WITH THE SPACE SHUTTLE MAIN ENGINE. THE DATA IS TECHNICAL IN NATURE AND ACCURATE AS OF THE DATE OF PUBLICATION. THIS POCKET DATA SHOULD BE USED FOR REFERENCE ONLY.

THIS POCKET DATA IS DIVIDED INTO 5 SECTIONS AS FOLLOWS:

SECTION I.	SPACE SHUTTLE VEHICLE/SSME SYSTEMS AND OPERATION
SECTION II.	SPACE SHUTTLE MAIN ENGINE (SSME) DESCRIPTION
SECTION III.	GROUND TURNAROUND OPERATIONS AND MAINTENANCE
SECTION IV.	SSME GROUND SUPPORT EQUIPMENT
SECTION V.	SHUTTLE FRF/STS LAUNCH HISTORICAL DATA

REVISIONS TO THIS POCKET DATA WILL BE MADE AS NECESSARY AND AS FURTHER INFORMATION BECOMES AVAILABLE. DESTROY OUTDATED POCKET DATA PUBLICATIONS UPON RECEIPT OF REVISED COPY.

COMMENTS AND SUGGESTIONS REGARDING INFORMATION CONTAINED IN THIS PUBLICATION SHOULD BE DIRECTED TO THE ROCKETDYNE FIELD ENGINEERING & LOGISTICS DIRECTOR, DEPARTMENT 579, CANOGA PARK, CALIFORNIA.

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ABBREVIATIONS AND ACRONYMS

AFV	ANTI-FLOOD VALVE
ASI	AUGMENTED SPARK IGNITER
CCV	CHAMBER COOLANT VALVE
CCVA	CHAMBER COOLANT VALVE ACTUATOR
FASCOS	FLIGHT ACCELERATION SAFETY CUTOFF SYSTEM
FBV	FUEL BLEED VALVE
FPB	FUEL PREBURNER
FPL	FULL POWER LEVEL
FPOV	FUEL PREBURNER OXIDIZER VALVE
HEX	HEAT EXCHANGER
GCV	GASEOUS OXYGEN CONTROL VALVE
HGM	HOT-GAS MANIFOLD
HPFTP	HIGH-PRESSURE FUEL TURBOPUMP
HPOTP	HIGH-PRESSURE OXIDIZER TURBOPUMP
HPV	HELIUM PRECHARGE VALVE
LPFTP	LOW-PRESSURE FUEL TURBOPUMP
LPOTP	LOW-PRESSURE OXIDIZER TURBOPUMP
LRU	LINE REPLACEABLE UNIT
LVDT	LINEAR VARIABLE DIFFERENTIAL TRANSFORMER
MCC	MAIN COMBUSTION CHAMBER
MFV	MAIN FUEL VALVE
MOV	MAIN OXIDIZER VALVE
MPL	MINIMUM POWER LEVEL
MR	MIXTURE RATIO
MVA	MAIN VALVE ACTUATOR
OBV	OXIDIZER BLEED VALVE
OPB	OXIDIZER PREBURNER
OPOV	OXIDIZER PREBURNER OXIDIZER VALVE
PB	PREBURNER
PCA	PNEUMATIC CONTROL ASSEMBLY
PBVA	PREBURNER VALVE ACTUATOR
RIV	RECIRCULATION ISOLATION VALVE
RPL	RATED POWER LEVEL
RVDT	ROTARY VARIABLE DIFFERENTIAL TRANSFORMER
SRB	SOLID ROCKET BOOSTER
SSME	SPACE SHUTTLE MAIN ENGINE
VEEI	VEHICLE ENGINE ELECTRONICS INTERFACE

SECTION 1

SPACE SHUTTLE VEHICLE/SSME SYSTEMS AND OPERATION

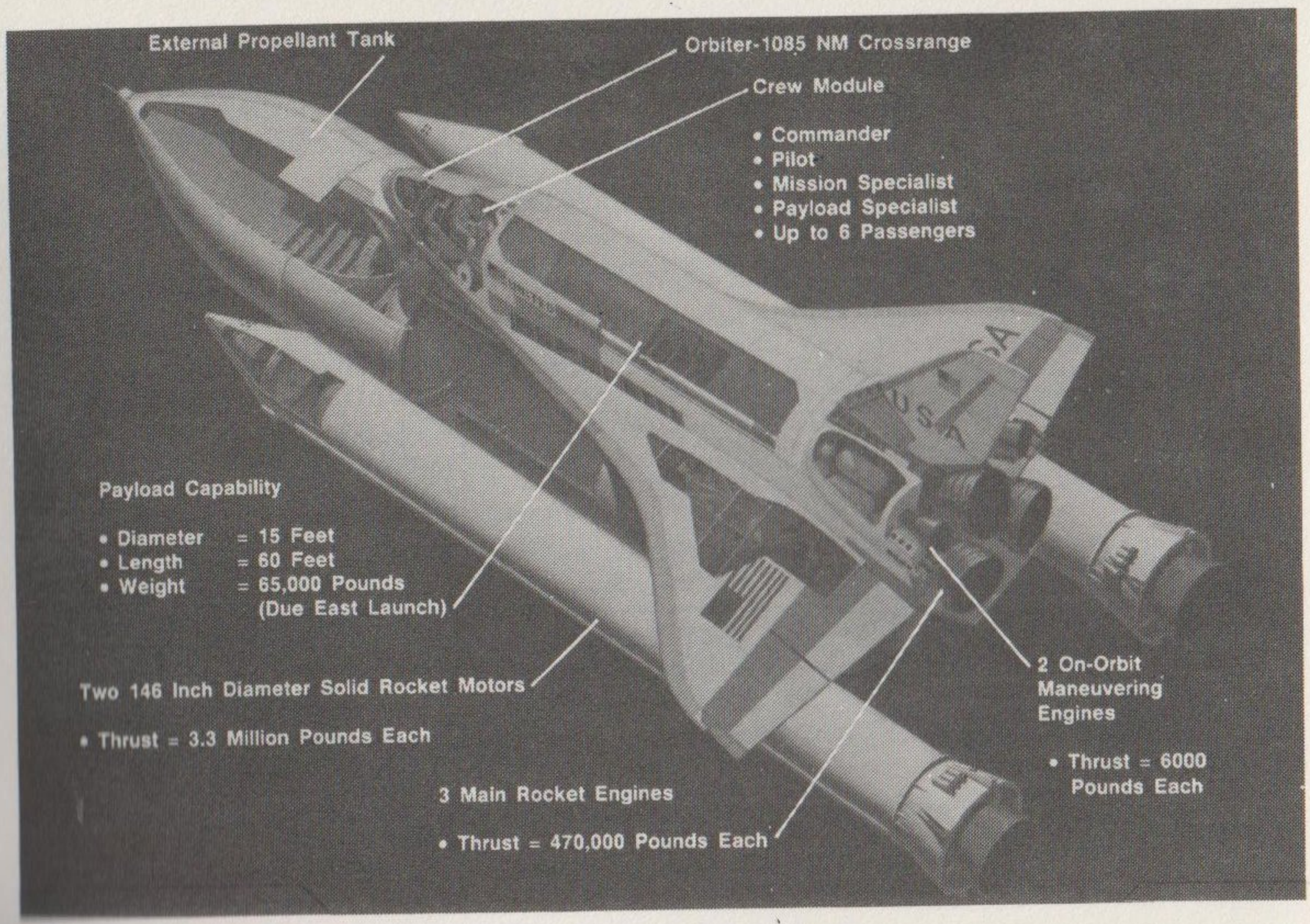
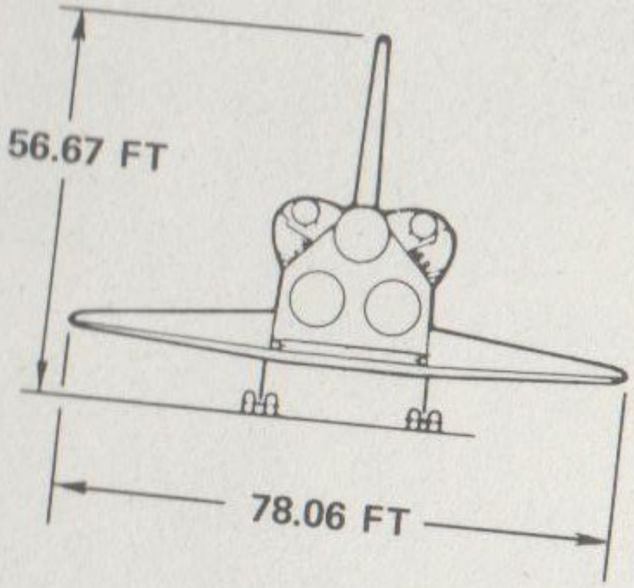


FIGURE 1-1. SPACE SHUTTLE VEHICLE



ORBITER	150,000 LB DRY*
SRB (2)	1,292,000 LB EA
ET	1,655,600 LB

*PLUS PAYLOAD AND CONSUMABLES

WEIGHTS APPROXIMATE

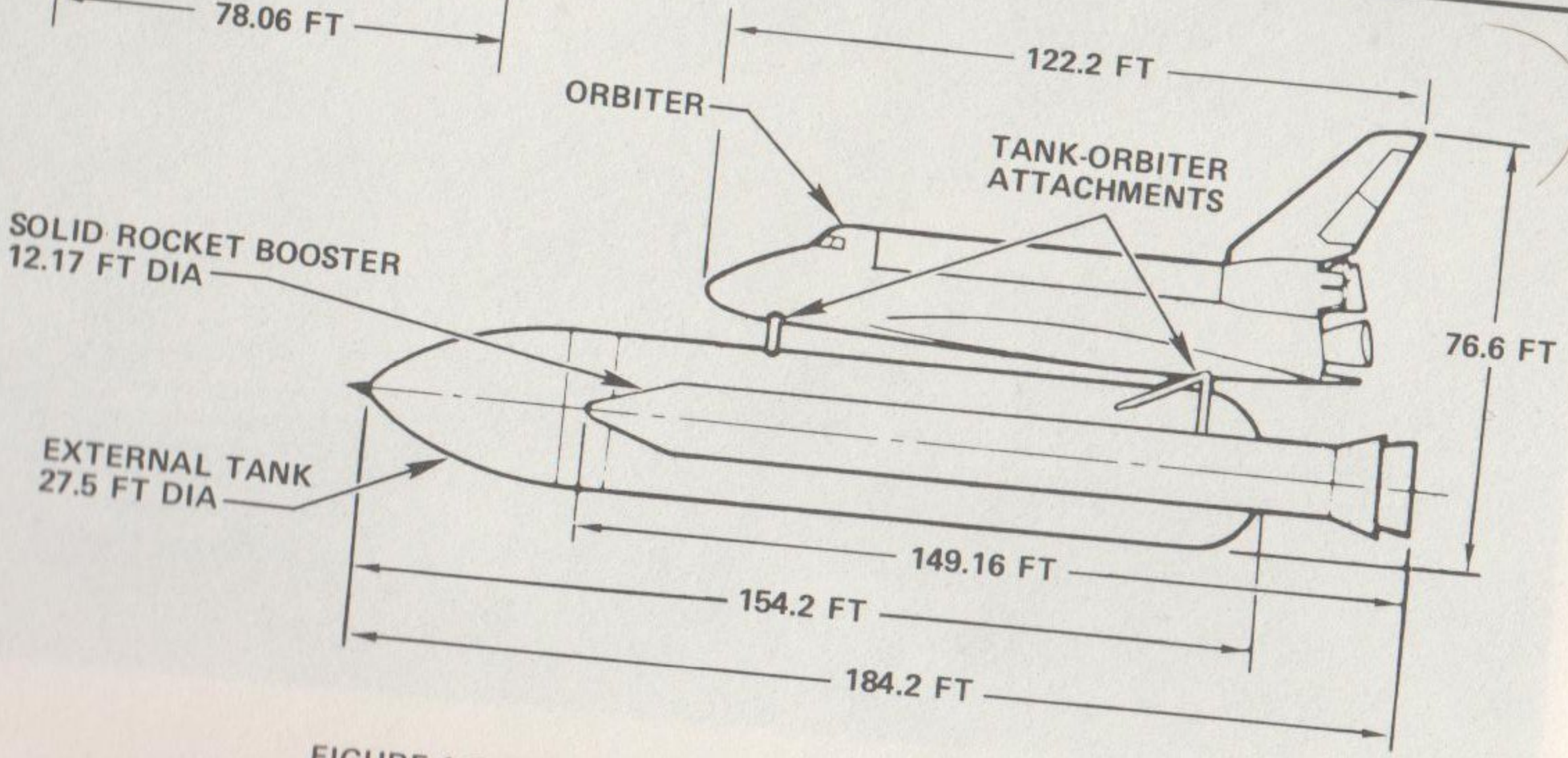


FIGURE 1-2. SPACE SHUTTLE STATISTICS (SHEET 1 OF 2)

WEIGHT

GROSS LIFTOFF:

4.5 MILLION LBS

ORBITER LANDING:

VARIES DEPENDENT UPON MISSION

THRUST

SOLID ROCKET BOOSTERS (SRB) (2):

3.3 MILLION LBS OF THRUST EACH AT SEA LEVEL

ORBITER MAIN ENGINES (3):

375,000 LBS OF THRUST EACH AT SEA LEVEL
(100% OF RATED POWER LEVEL)

TOTAL SYSTEM:

7.7 MILLION LBS OF THRUST AT SEA LEVEL

CARGO BAY

DIMENSIONS:

60 FT LONG, 15 FT IN DIAMETER

PAYLOADS:

UNMANNED SPACECRAFT TO FULLY EQUIPPED
SCIENTIFIC LABORATORIES

FIGURE 1-2. SPACE SHUTTLE STATISTICS (SHEET 2 OF 2)

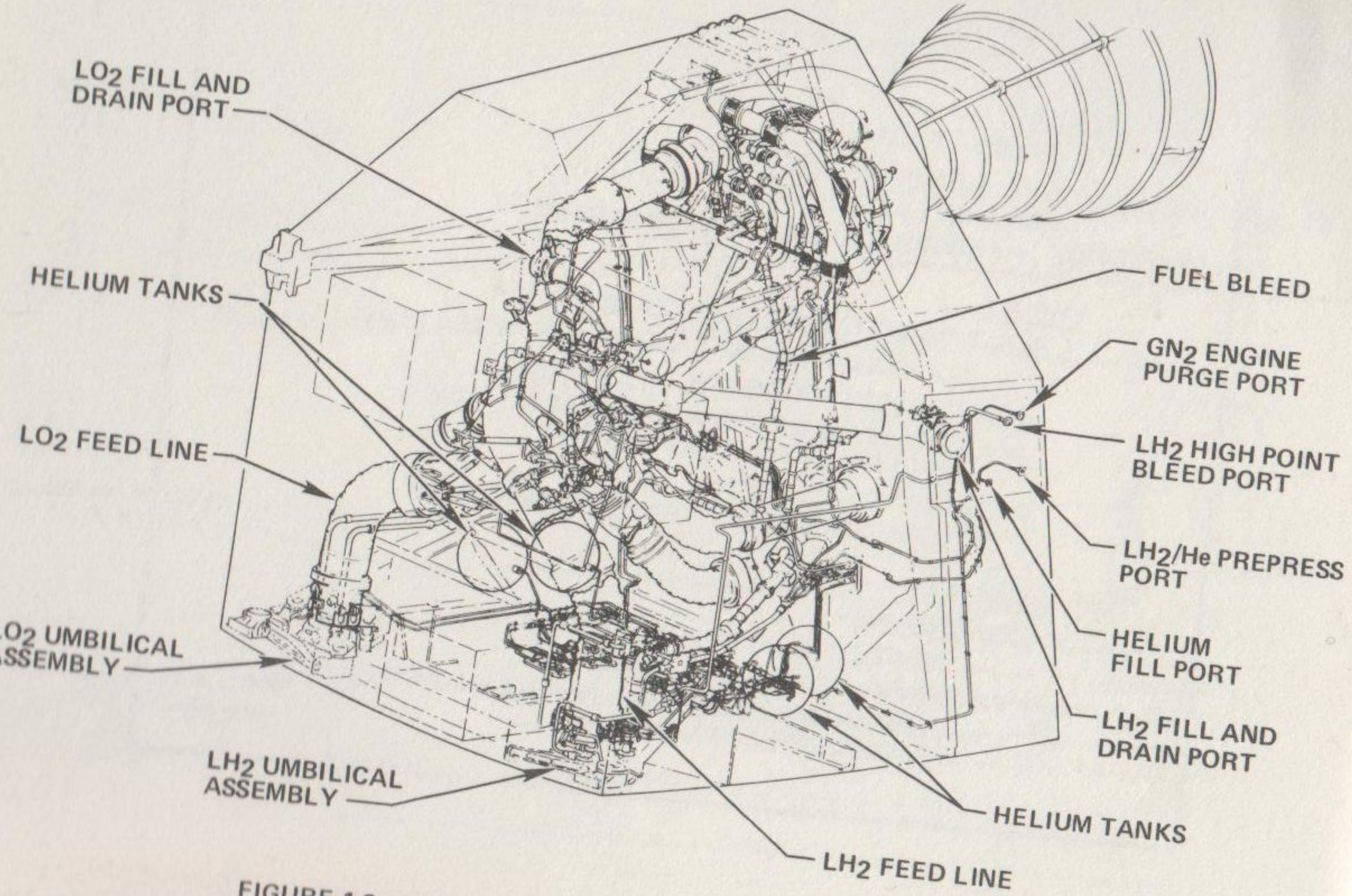


FIGURE 1-3. PROPULSION SYSTEM COMPONENT/LINE LOCATOR

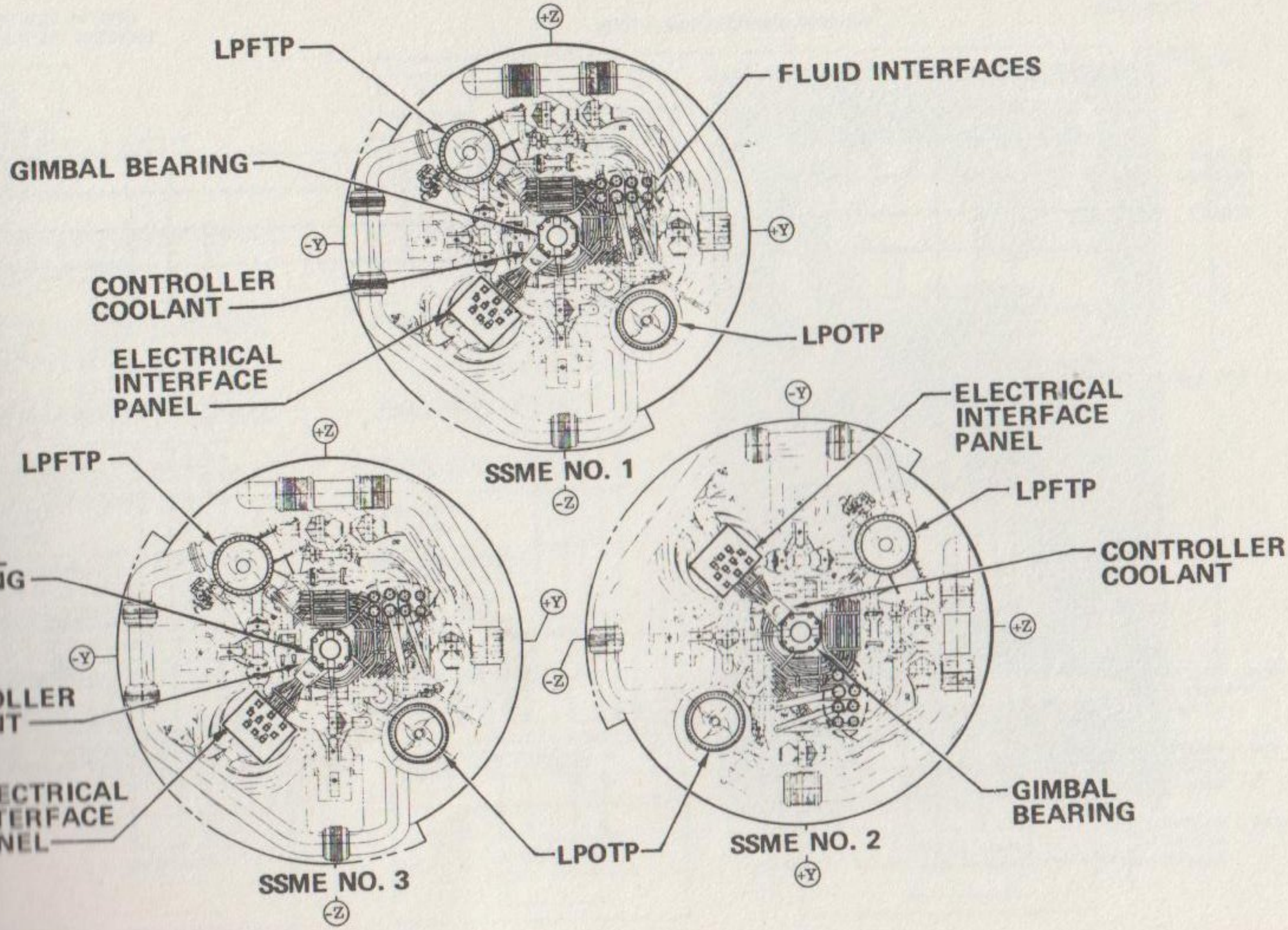


FIGURE 1-4. SSME INSTALLATION ORIENTATION AND INTERFACES (VIEW LOOKING AFT)

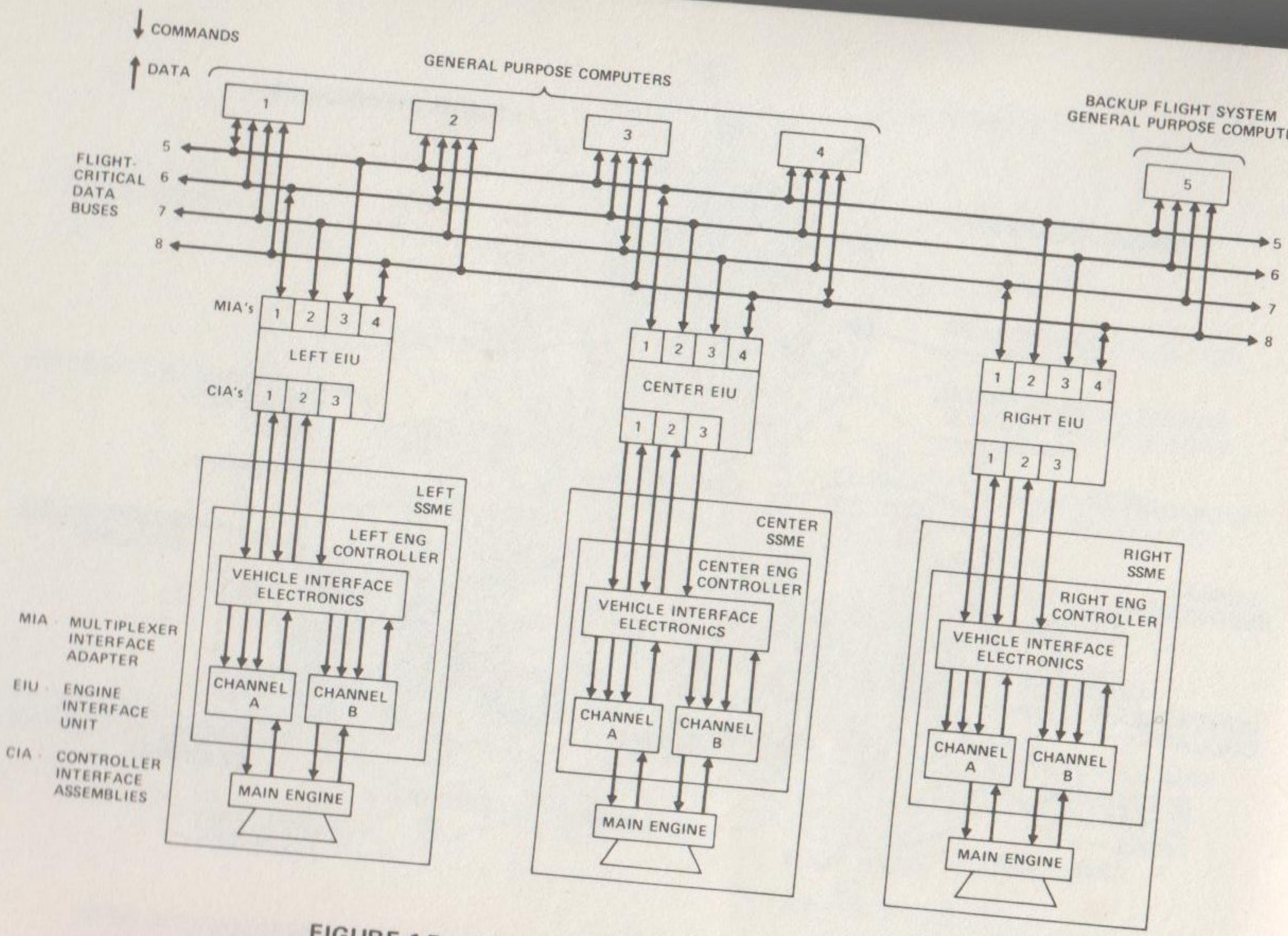


FIGURE 1-5. ORBITER/SSME AVIONICS INTERFACE

■ PROPELLANTS	OXYGEN/ HYDROGEN
■ RATED POWER LEVEL (RPL) 100%	470,000 LBS
■ FULL POWER LEVEL (FPL) 109%	512,300 LBS
■ CHAMBER PRESSURE	3280 PSIA @ FPL
■ SPECIFIC IMPULSE AT ALTITUDE	453.5 SECONDS
■ THROTTLE RANGE	65 TO 109%
■ WEIGHT	7000 LBS
■ DESIGN LIFE	27,000 SECONDS 55 STARTS
■ FULL POWER LEVEL	14,000 SECONDS

FIGURE 1-6. SPACE SHUTTLE MAIN ENGINE CHARACTERISTICS

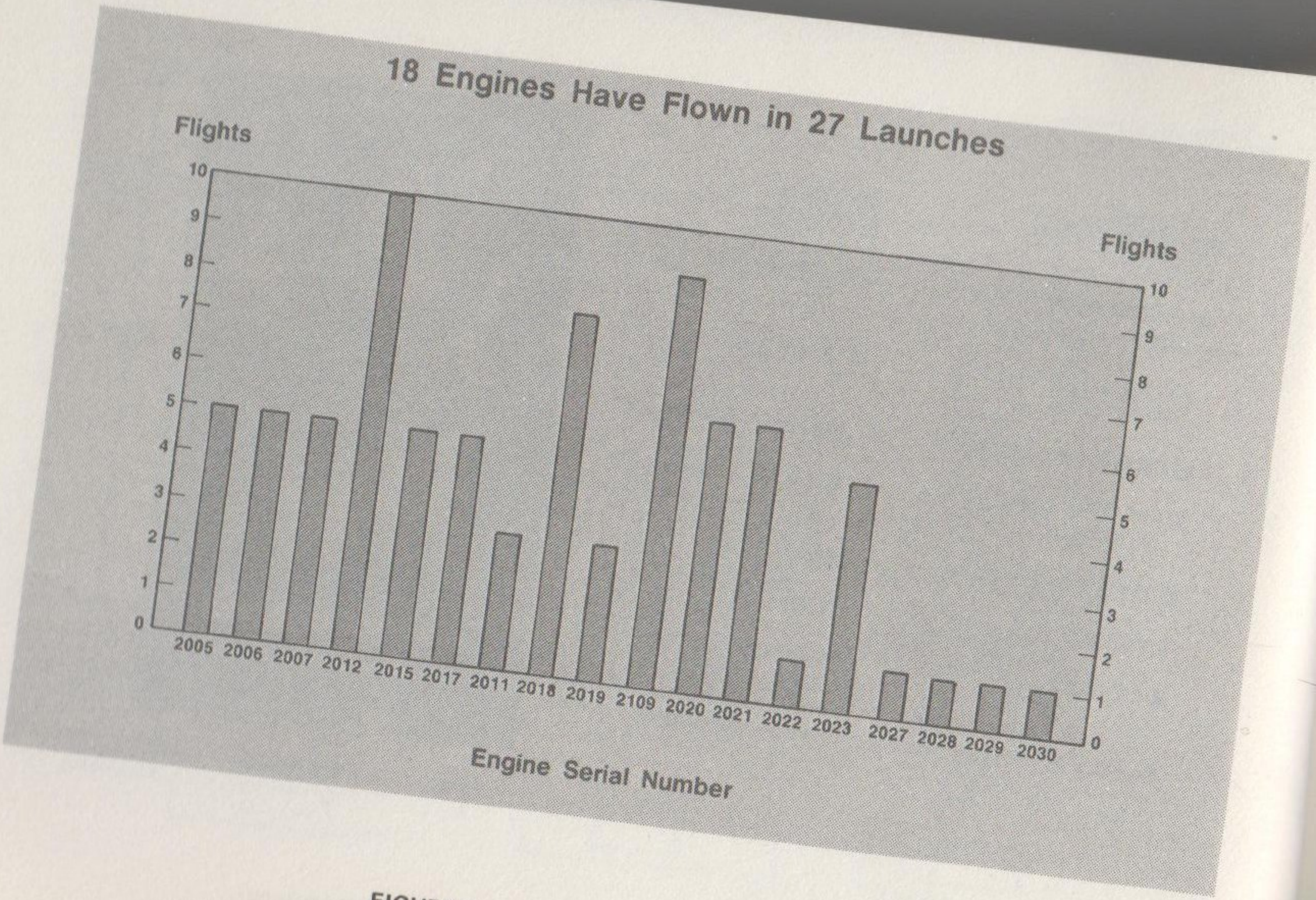


FIGURE 1-7. SSME FLIGHT EXPERIENCE

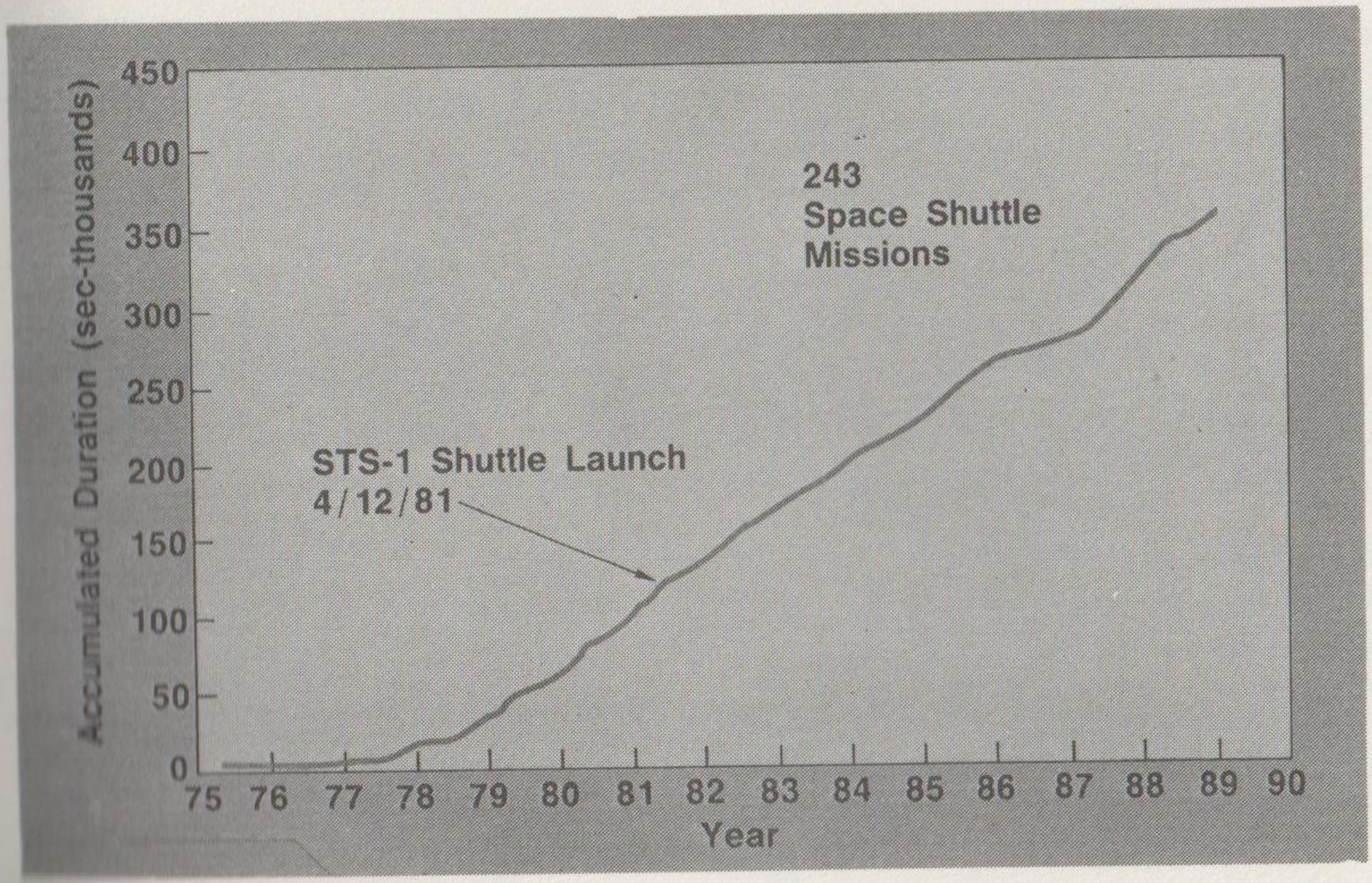


FIGURE 1-8. SSME HOT-FIRE SUMMARY

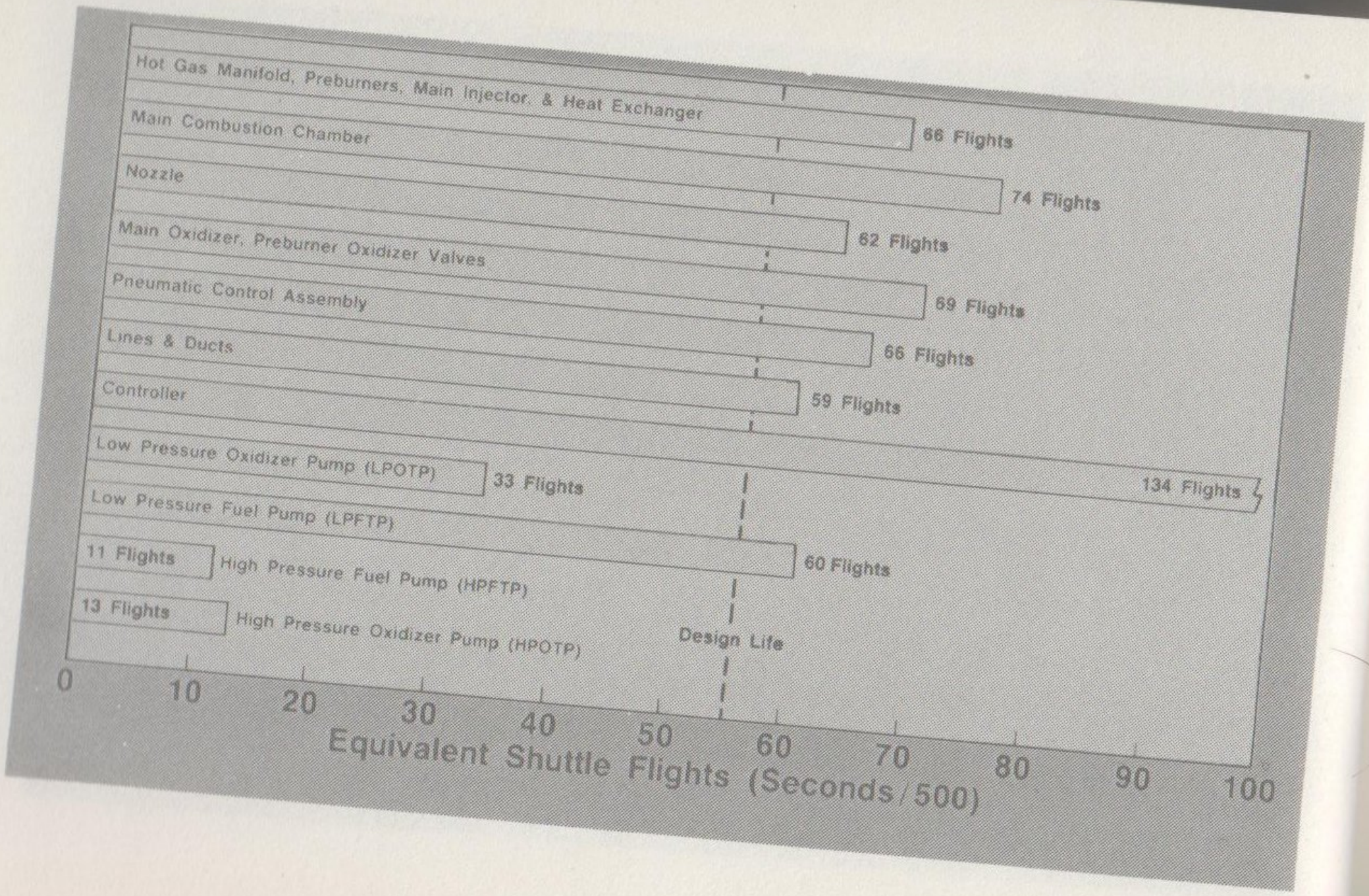


FIGURE 1-9. DEMONSTRATED SSME CAPABILITY

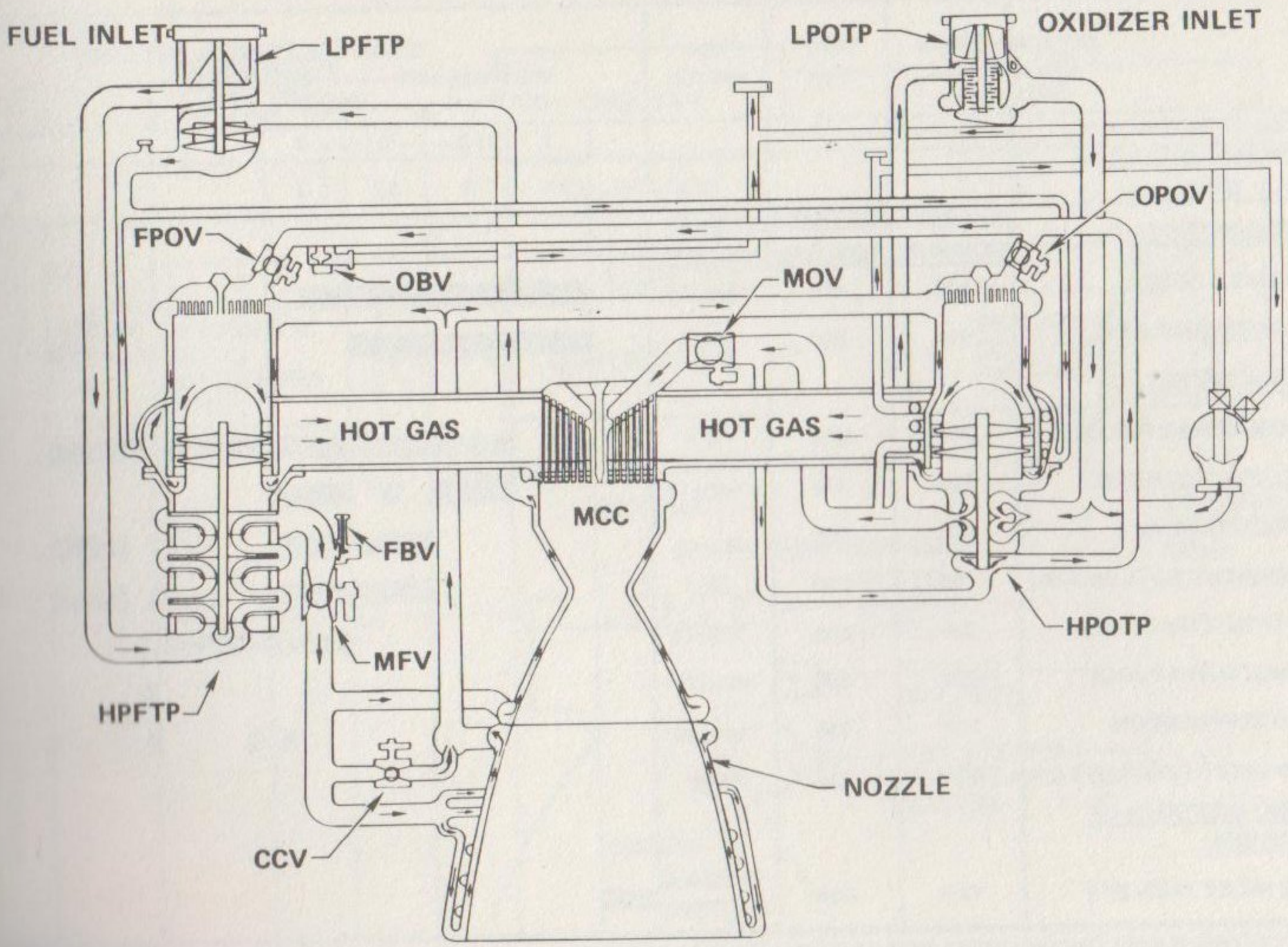
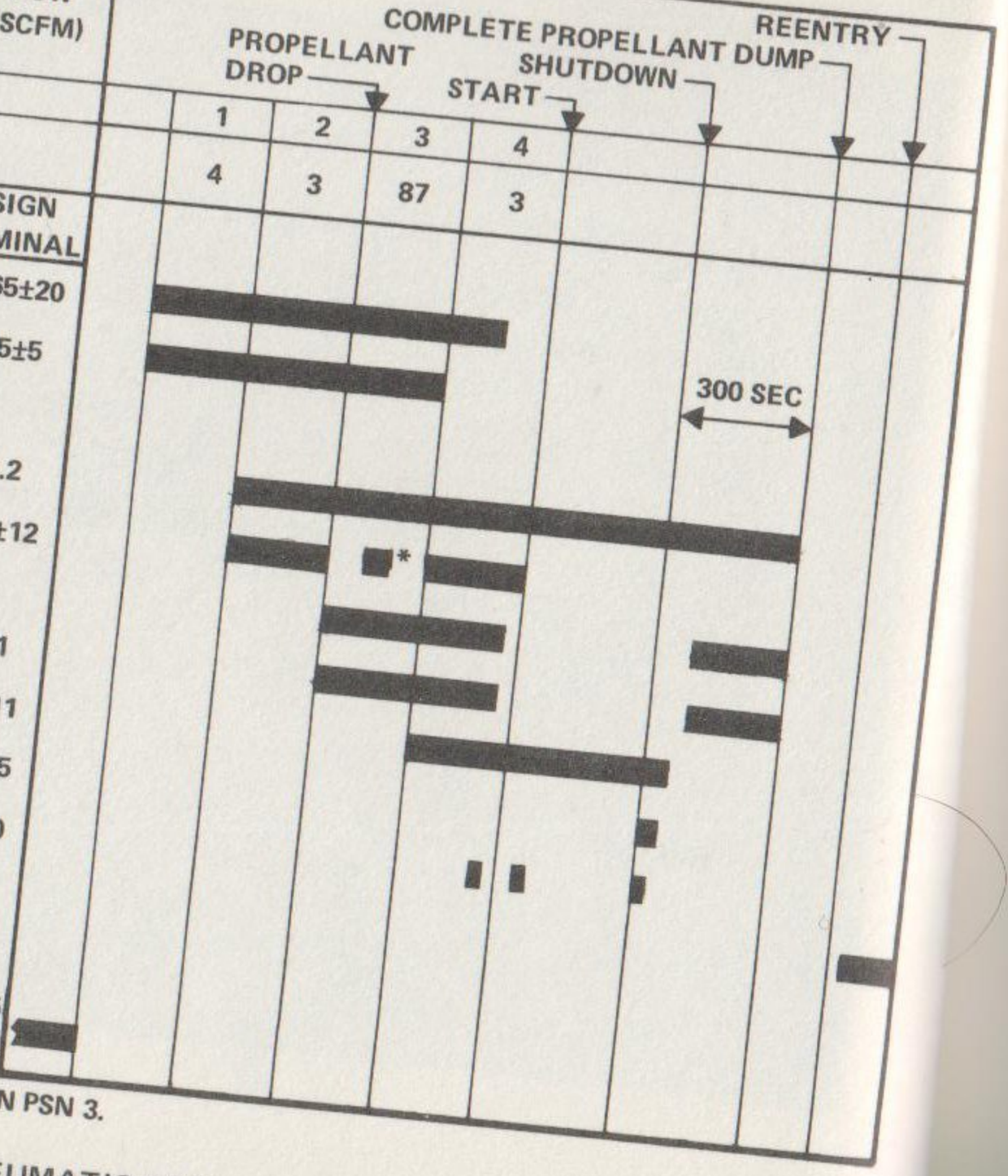


FIGURE 1-10. SSME PROPELLANT FLOW SCHEMATIC

	PRESS (PSIA)	TEMP (^{o}R)	FLOW (SCFM)
PURGE SEQUENCE NO.			
MIN PURGE DURATION (MIN.)			
GND NITROGEN	DESIGN NOMINAL	DESIGN NOMINAL	DESIGN NOMINAL
OXIDIZER DOME	600	590	265±20
HPOTP INTERM SEAL	600	590	65±5
VEHICLE HELIUM			
LPFD BARRIER PURGE	750	530	1.2
FUEL SYSTEM PURGE	750	530	125±12
BLEED VALVE ACT	750	530	
COMPONENT FUEL DRAIN	750	530	2±1
HPOTP INTERM SEAL	750	530	260±11
PB SHUTDOWN PURGE	750	530	1050±75
POGO SUPPRESSION	750	530	460±40
OXID INLET FEED SYS	17.7	530	20±5
GND NITROGEN OR HELIUM			
OXID INLET FEED SYS	17.7	530	(He)20±5 (GN_2)7.5±2



*FUEL SYSTEM PURGE ON 3 MINUTES FOR EACH 60 MINUTES IN PSN 3.

FIGURE 1-11. SSME PNEUMATIC REQUIREMENTS

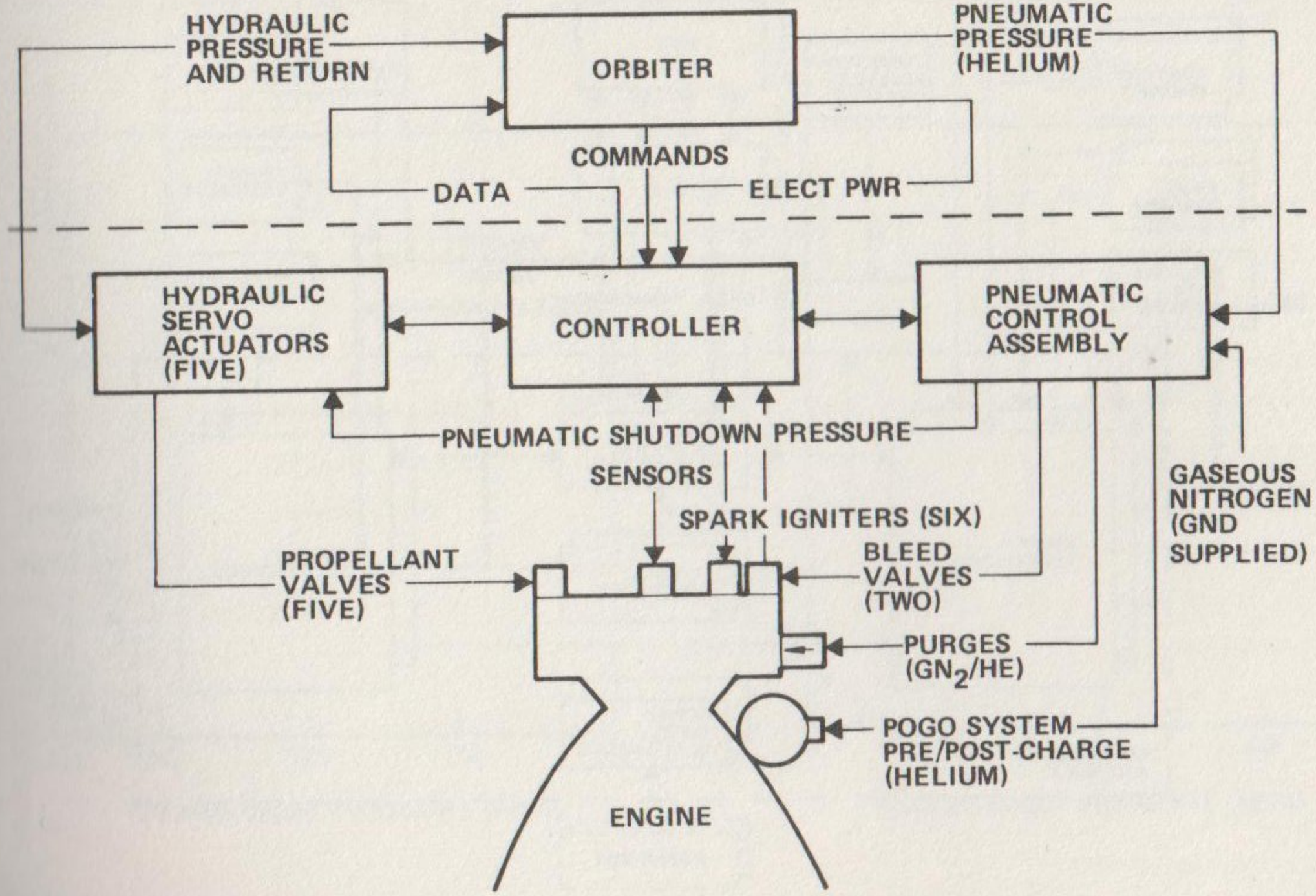


FIGURE 1-12. SSME CONTROL SYSTEM

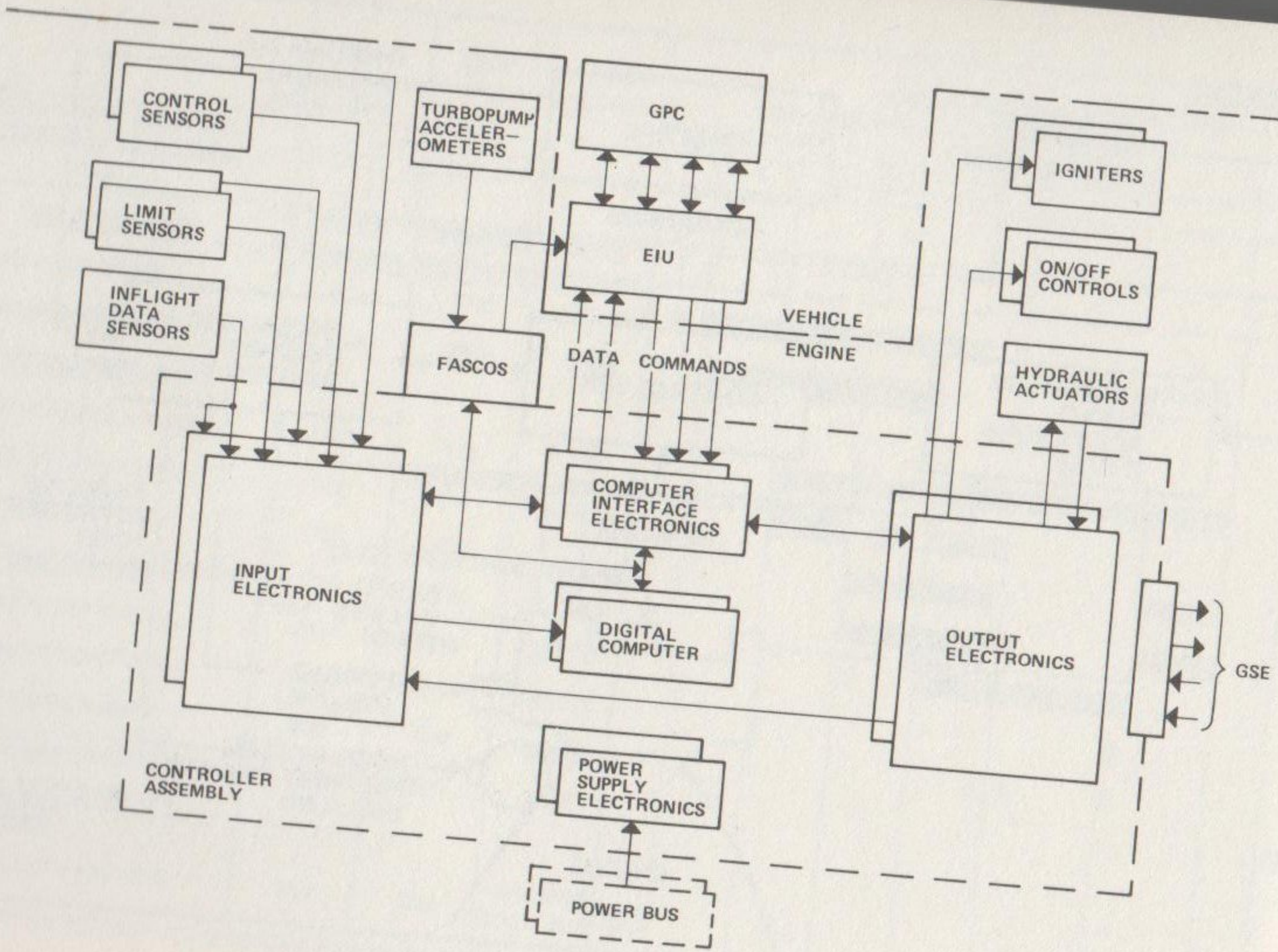
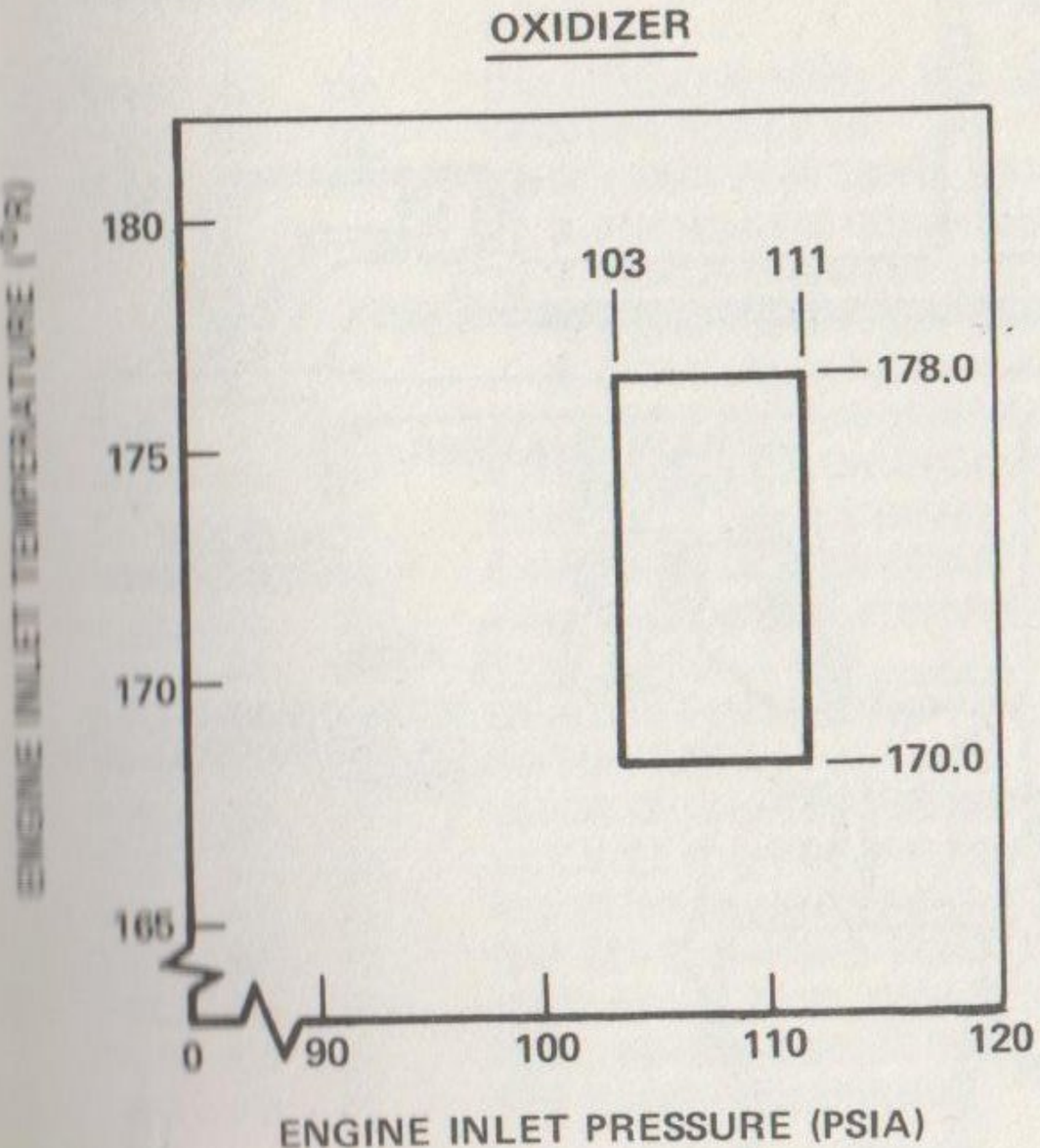


FIGURE 1-13. CONTROLLER ORGANIZATION



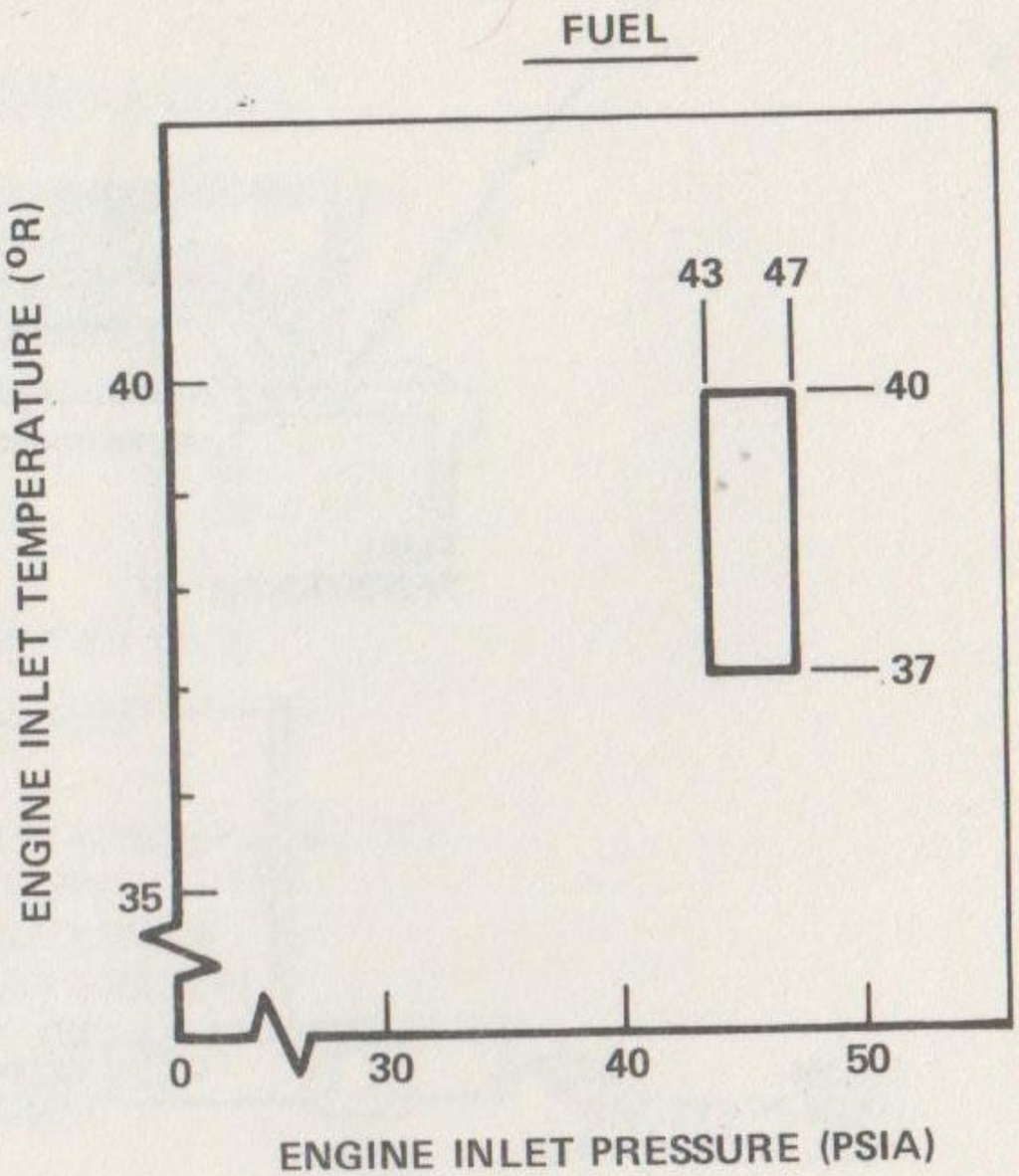


FIGURE 1-14. PRESTART PROPELLANT CONDITIONS

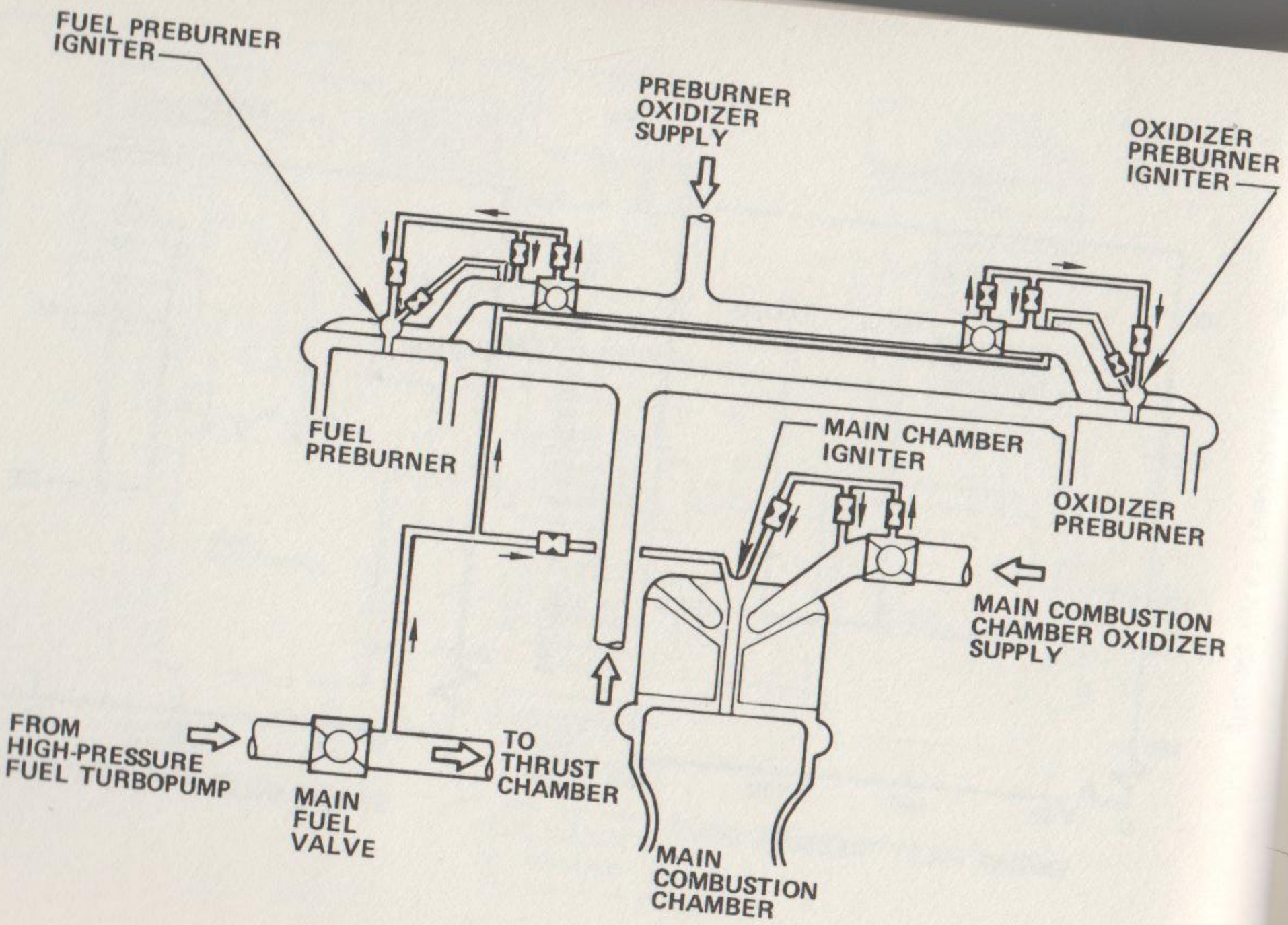


FIGURE 1-15. IGNITION SYSTEM SCHEMATIC

HR	MIN	SEC	
T-46:	00:	00	CALL TO STATIONS – SET COUNTDOWN CLOCK
T-45:	30:	00	ORBITER POWER UP
T-27:	00:	00	SSME PREPS FOR CRYO-LOAD (OMRSD SOOFAO.210) ● PNEUMATIC COMPONENT CHECKOUT ● SENSOR/IGNITER CALIBRATION/CHECKOUT ● LOAD FLIGHT SOFTWARE ● PURGE SEQ. NO. 3 CHECKOUT (5 SECS MIN)
T-06:	30:	00	INITIATE SSME PURGING (PSN 1, 2, AND 3)
T-06:	00:	00	START LH_2/LOX CHILLDOWN
T-03:	15:	00	COMPLETE LH_2 TANKING
T-03:	05:	00	COMPLETE LOX TANKING
T-00:	09:	00	START GROUND LAUNCH SEQUENCER (GLS)
T-00:	05:	00	START APU
T-00:	04:	30	DEACTIVATE SSME MFV HEATERS
T-00:	04:	00	INITIATE PSN 4
T-00:	02:	55	INITIATE LO_2 PRE-PRESSURIZATION/GN_2 PURGE OFF
T-00:	01:	57	INITIATE LH_2 PRE-PRESSURIZATION
T-00:	00:	31	START REDUNDANT SET AUTO SEQUENCE
T-00:	00:	10	GLS GO-FOR-SSME-START (START ENABLE)
T-00:	00:	06.6	SSME START CMD (ENGINES 3, 2, 1 AT 120 MS INTERVALS)
T-00:	00:	03	SSME MAINSTAGE ($\geq$ 90% THRUST)
T-00:	00:	00	SRB IGNITION/LIFTOFF

FIGURE 1-16. SSME LAUNCH COUNTDOWN HIGHLIGHTS (TYPICAL)

SSME OPERATIONAL PHASES/MODES

- CHECKOUT PHASE
  - STANDBY MODE
  - COMPONENT CHECKOUT MODE
- START PREPARATION PHASE
  - PURGE SEQUENCE NO. 1 MODE
  - PURGE SEQUENCE NO. 2 MODE
  - PURGE SEQUENCE NO. 3 MODE
  - PURGE SEQUENCE NO. 4 MODE
  - ENGINE READY MODE
- START PHASE
  - START INITIATION MODE
  - THRUST BUILDUP MODE
  - ELECTRICAL LOCKUP
  - HYDRAULIC LOCKUP
  - FIXED DENSITY
- MAINSTAGE PHASE
  - NORMAL CONTROL MODE
  - ELECTRICAL LOCKUP MODE
  - HYDRAULIC LOCKUP MODE
  - THRUST LIMITING
  - FIXED DENSITY
- SHUTDOWN PHASE
  - THROTTLE TO ZERO THRUST MODE
  - PROPELLANT VALVES CLOSED MODE
  - FAIL-SAFE PNEUMATIC MODE
- POST-SHUTDOWN PHASE
  - STANDBY MODE
  - TERMINATE SEQUENCE MODE
  - OXIDIZER DUMP MODE

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 1 OF 20)

SSME CHECKOUT PHASE MODES

- CHECKOUT PHASE: CONTROLLER OPERATIONAL PROGRAM IS INITIATED TO BEGIN ACTIVE CONTROL, MONITORING, OR CHECKOUT.

  - STANDBY MODE: A WAITING MODE DURING WHICH ACTIVE CONTROL SEQUENCE OPERATIONS ARE NOT IN PROGRESS. MONITORING FUNCTIONS THAT DO NOT AFFECT ENGINE HARDWARE COMPONENT STATUS ARE CONTINUALLY ACTIVE. SUCH FUNCTIONS INCLUDE PROCESSING OF VEHICLE COMMANDS, STATUS UPDATE, AND CONTROLLER SELF-TEST. DURING CHECKOUT PHASE, DATA AND INSTRUCTIONS CAN BE LOADED INTO COMPUTER MEMORY. THIS PERMITS UPDATING OF SOFTWARE PROGRAM AND DATA AS NECESSARY TO PROCEED WITH ENGINE FIRING OPERATIONS OR CHECKOUT OPERATIONS.

  - COMPONENT CHECKOUT MODE: A CHECKOUT OR ENGINE LEAK TEST IS BEING PERFORMED ON AN INDIVIDUAL ENGINE SYSTEM COMPONENT USING OVERLAY MODULES.

    - SENSOR CALIBRATION AND CHECKOUT
    - PNEUMATIC CHECKOUT
    - HYDRAULIC ACTUATOR CHECKOUT
    - REDUNDANCY VERIFICATION I & II
    - FLIGHT READINESS TEST (FRT AND FRT-2)

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 2 OF 20)

SSME START PREPARATION PHASE MODES

- START PREPARATION PHASE: SYSTEM PURGES AND PROPELLANT CONDITIONING ARE PERFORMED IN PREPARATION FOR ENGINE START.
  - PURGE SEQUENCE NO. 1 MODE: FIRST PURGE SEQUENCE OF START PREPARATION PHASE IS IN PROGRESS. FUNCTIONS INCLUDE COMMANDING PROPELLANT VALVES CLOSED. DURING THIS SEQUENCE, FACILITY INITIATES OXIDIZER SYSTEM AND HPOTP INTERMEDIATE SEAL GASEOUS NITROGEN PURGES.
  - PURGE SEQUENCE NO. 2 MODE: SECOND PURGE SEQUENCE OF START PREPARATION IS IN PROGRESS. FUNCTIONS INCLUDE FUEL SYSTEM PURGE OPERATION AND CONTINUATION OF PURGES INITIATED IN PURGE SEQUENCE NO. 1.
  - PURGE SEQUENCE NO. 3 MODE: THIRD PURGE SEQUENCE OF START PREPARATION IS IN PROGRESS. FUNCTIONS INCLUDE PROPELLANT RECIRCULATION (BLEED VALVE OPERATION), ACTUATOR EXERCISE SEQUENCE, AND DISCONTINUANCE OF FUEL SYSTEM PURGE. (NOTE: DURING PURGE SEQUENCE NO. 3, FUEL SYSTEM PURGE WILL BE REINSTATED FOR 3 MINUTES EACH 60-MINUTE PERIOD.)
  - PURGE SEQUENCE NO. 4 MODE: FOURTH PURGE SEQUENCE OF START PREPARATION IS IN PROGRESS. FUNCTIONS INCLUDE FUEL SYSTEM AND HPOTP INTERMEDIATE SEAL HELIUM PURGES. ALL FAIL-SAFE SERVO-SWITCHES ARE ENERGIZED.
  - ENGINE READY MODE: READY STAGE OF START PREPARATION IN WHICH PROPER ENGINE CONDITIONS FOR START HAVE BEEN ATTAINED AND OTHER CRITERIA FOR START HAVE BEEN SATISFIED. FUNCTIONS INCLUDE A CONTINUATION OF PURGE SEQUENCE NO. 4 FUNCTION.

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 3 OF 20)

PURGE SEQUENCE NO. 1 (NOMINAL DURATION: 4 MINUTES)

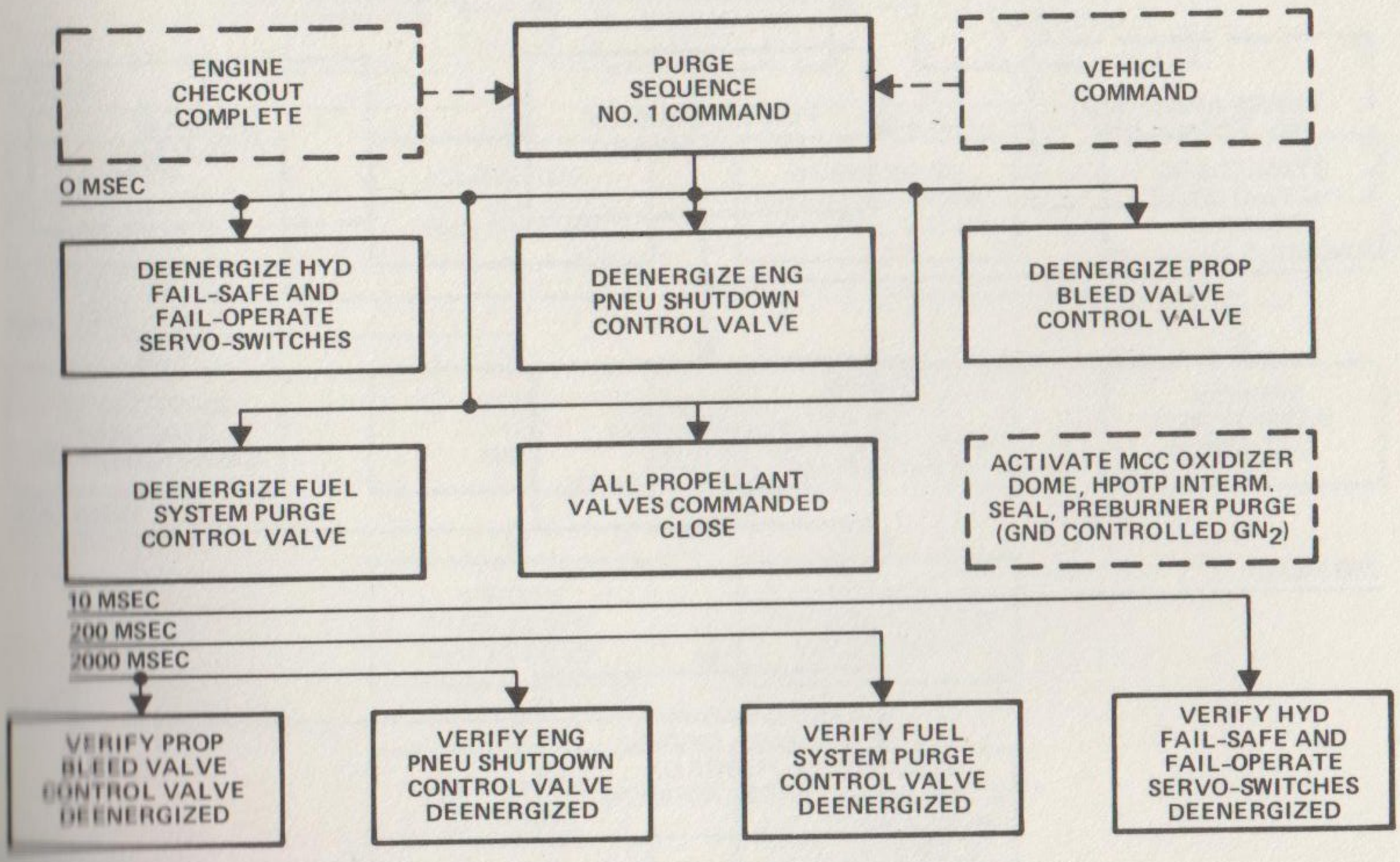


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 4 OF 20)

PURGE SEQUENCE NO. 2 (NOMINAL DURATION: 3 MINUTES)

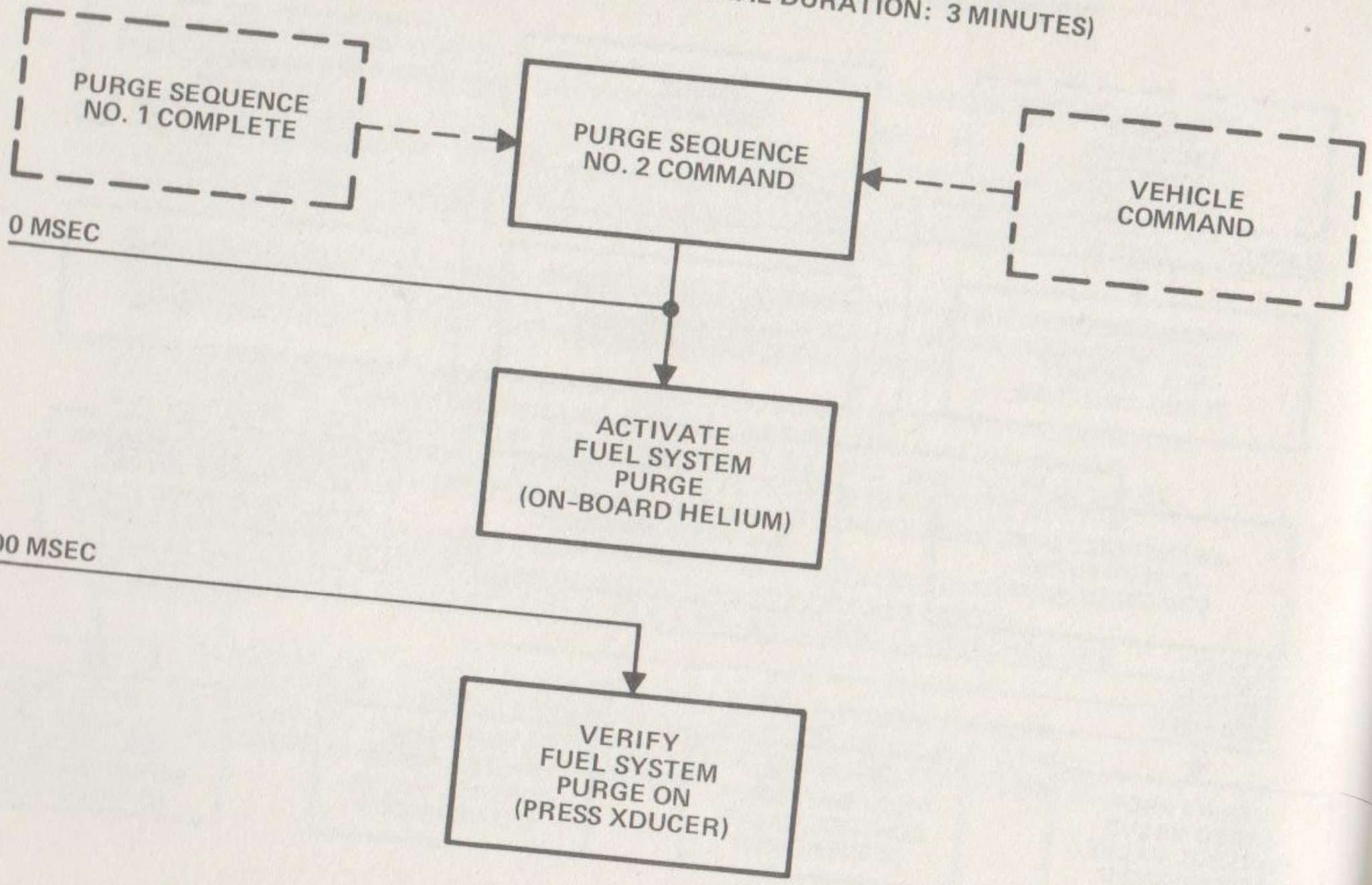


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 5 OF 20)

PURGE SEQUENCE NO. 3 (NOMINAL DURATION: 6–8 HOURS)

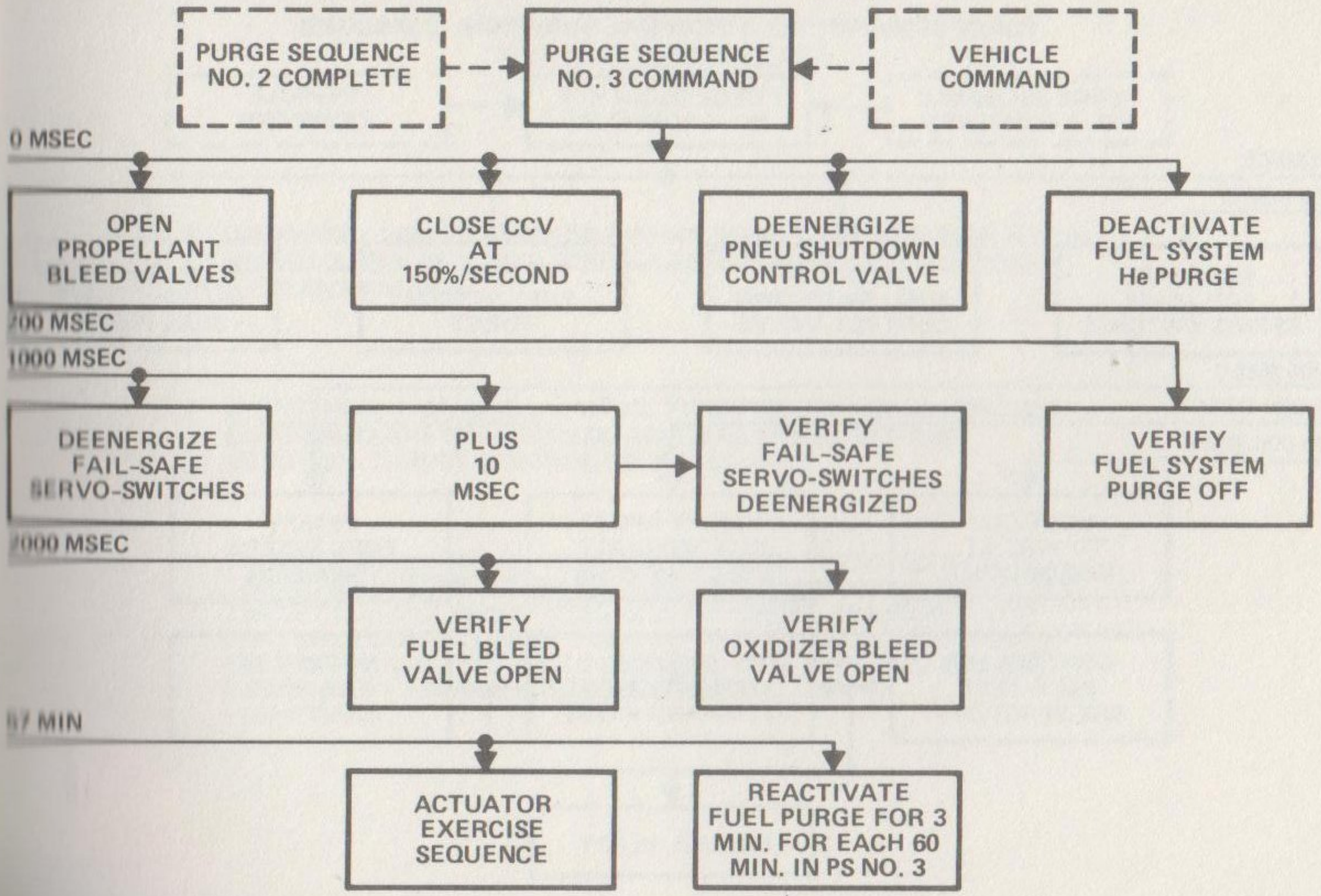


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 6 OF 20)

PURGE SEQUENCE NO. 4 (NOMINAL DURATION: 3 MINUTES)

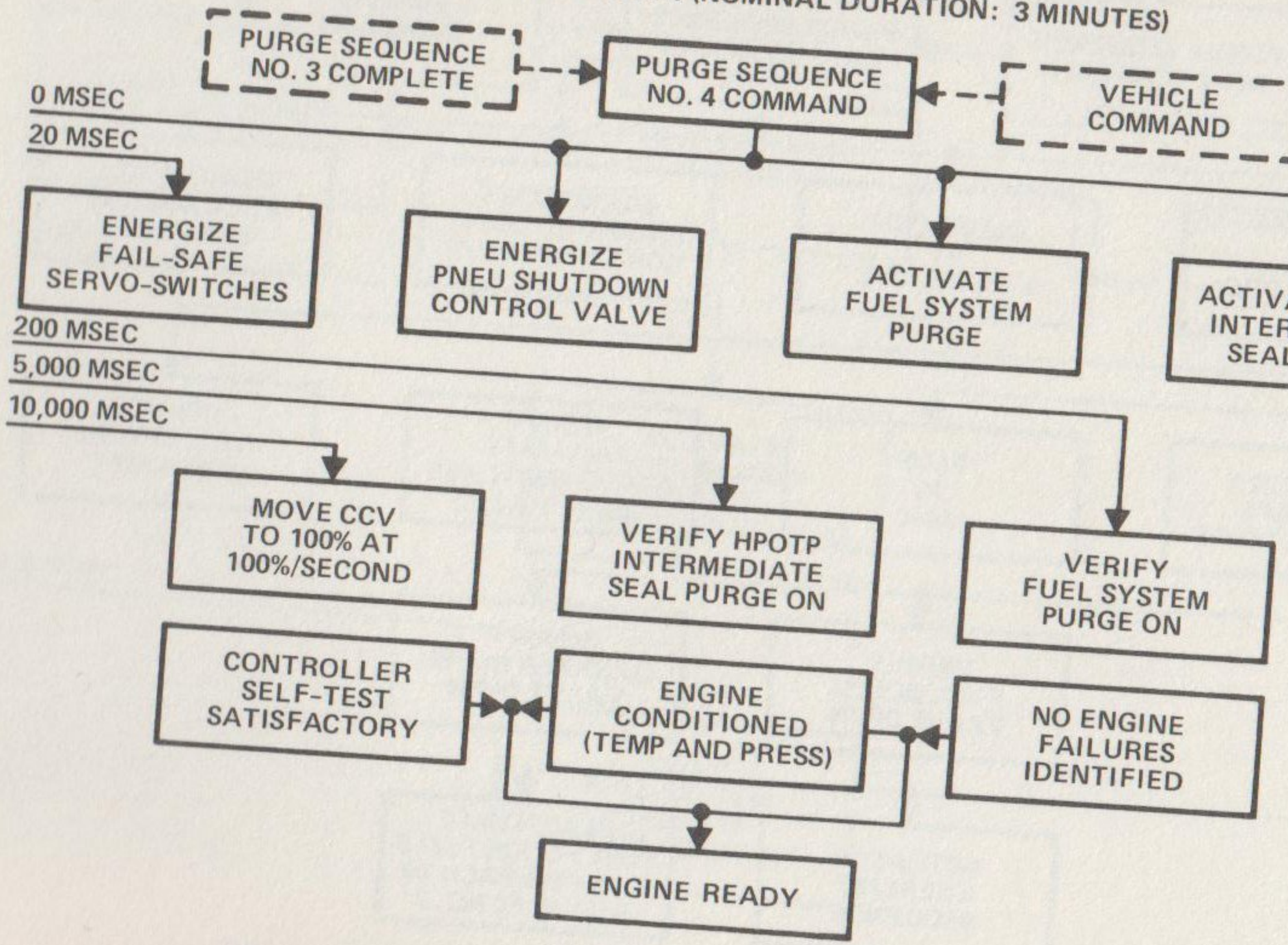


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 7 OF 20)

SSME START PHASE MODES

- START PHASE: OPERATIONS FOR ENGINE STARTING AND FIRING ARE IN PROGRESS, BEGINNING WITH SCHEDULED (OPEN-LOOP) OPERATION OF PROPELLANT VALVES.

  - START INITIATION MODE: INITIAL FUNCTIONS PRIOR TO IGNITION CONFIRMED ARE IN PROGRESS. IGNITERS ENERGIZED AND VERIFIED. THRUST CONTROL LOOP IS CLOSED.

  - THRUST BUILDUP MODE: IGNITION HAS BEEN DETECTED BY MONITORING MAIN COMBUSTION CHAMBER PRESSURE AND CLOSED-LOOP THRUST BUILDUP SEQUENCING IS IN PROGRESS. MIXTURE RATIO CONTROL LOOP IS CLOSED. POGO SUPPRESSION ACCUMULATOR IS HELIUM PRE-CHARGED FOR 2 SECONDS. MFV, MOV, AND CCV ARE SCHEDULED I/A/W MCC PRESSURE (THRUST).

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 8 OF 20)

GROUND LAUNCH SEQUENCER GO FOR SSME START (NOMINAL DURATION: 3.3 SECONDS)

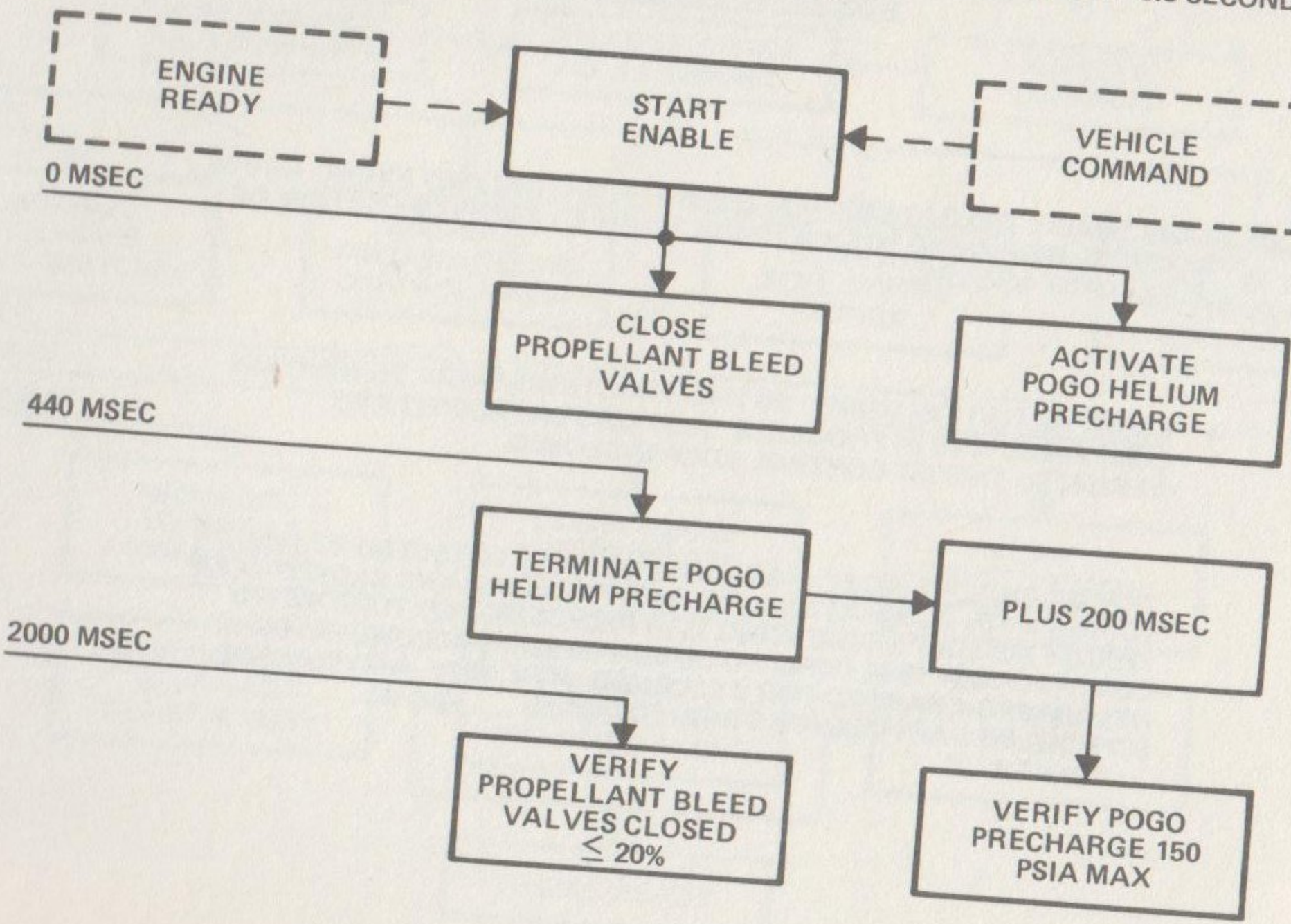


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 9 OF 20)

START INITIATION MODE-FIRST HALF (NOMINAL DURATION: 750 MSEC)

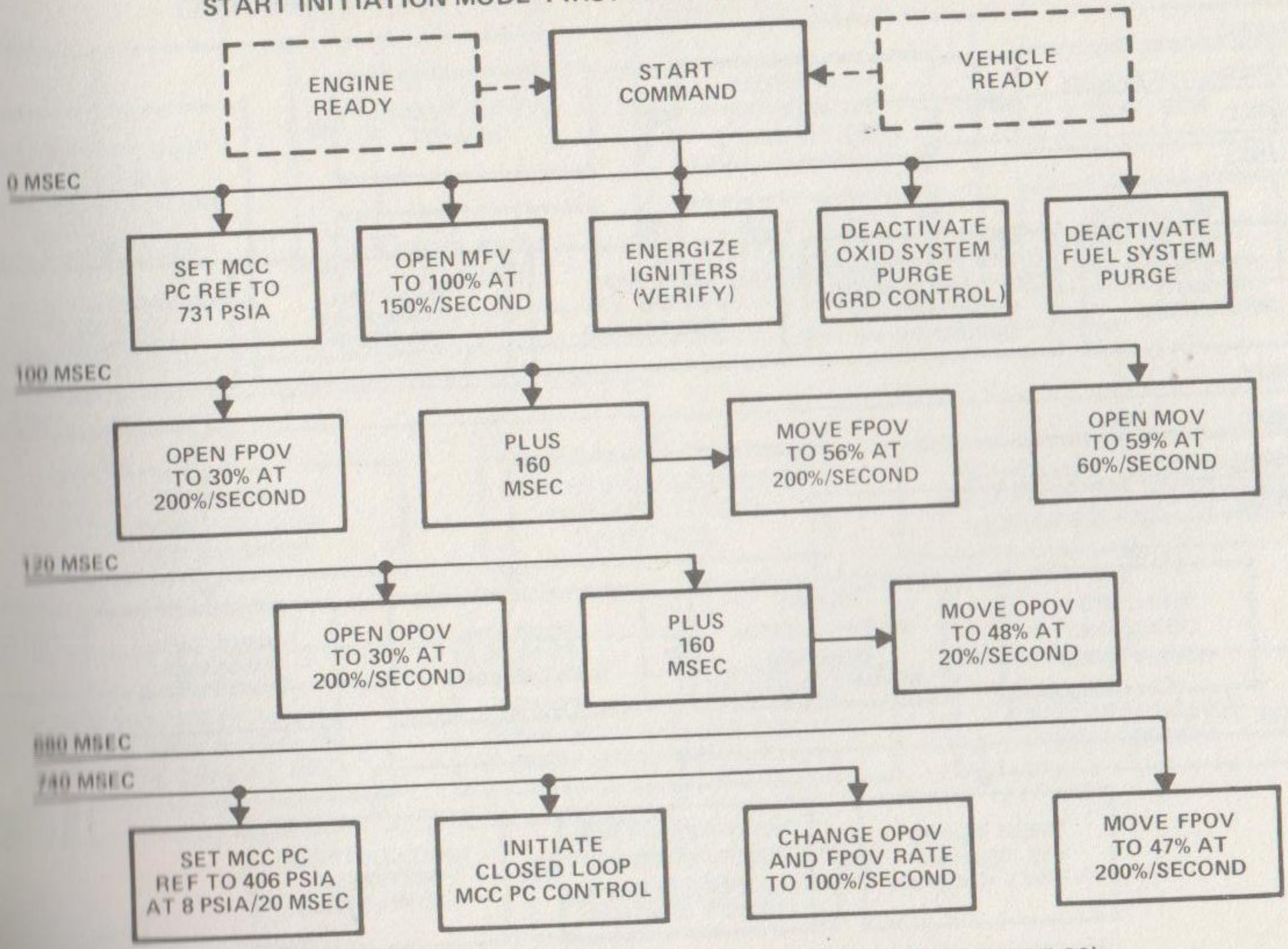


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 10 OF 20)

START INITIATION MODE–LAST HALF (NOMINAL DURATION: 1400 MSEC)

880 MSEC

1100 MSEC

1160 MSEC

1240 MSEC

1460 MSEC

- MOVE CCV TO 70% AT 100%/SECOND
- CHECK HPFTP SHAFT SPEED FOR IGNITION CONFIRMATION (4600 RPM MIN)
- MOVE FPOV TO 49% AT 200%/SECOND
- MOVE OPOV TO 38.5% AT 200%/SECOND
- MOVE FPOV TO 51.5% AT 200%/SECOND

1500 MSEC

1680 MSEC

1700 MSEC

2100 MSEC

- MOVE OPOV TO 48.5% AT 200%/SECOND
- VERIFY MCC PC 290 PSIA MINIMUM (VERIFY IGNITION)
- MOVE FPOV TO 54.6% AT 200%/SECOND
- MOVE OPOV TO 38.5% AT 200%/SECOND

2300 MSEC

- CHECK MCC PC 610 –1000 PSIA (VERIFY IGNITION)
- CHECK ANTI–FLOOD VALVE 80% OPEN MINIMUM (VERIFY IGNITION)
- LIMIT CONTROLS ACTIVATED (VEHICLE CMD)

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 11 OF 20)

(THRUST BUILDUP PHASE - NOMINAL DURATION: 2.6 SECONDS)

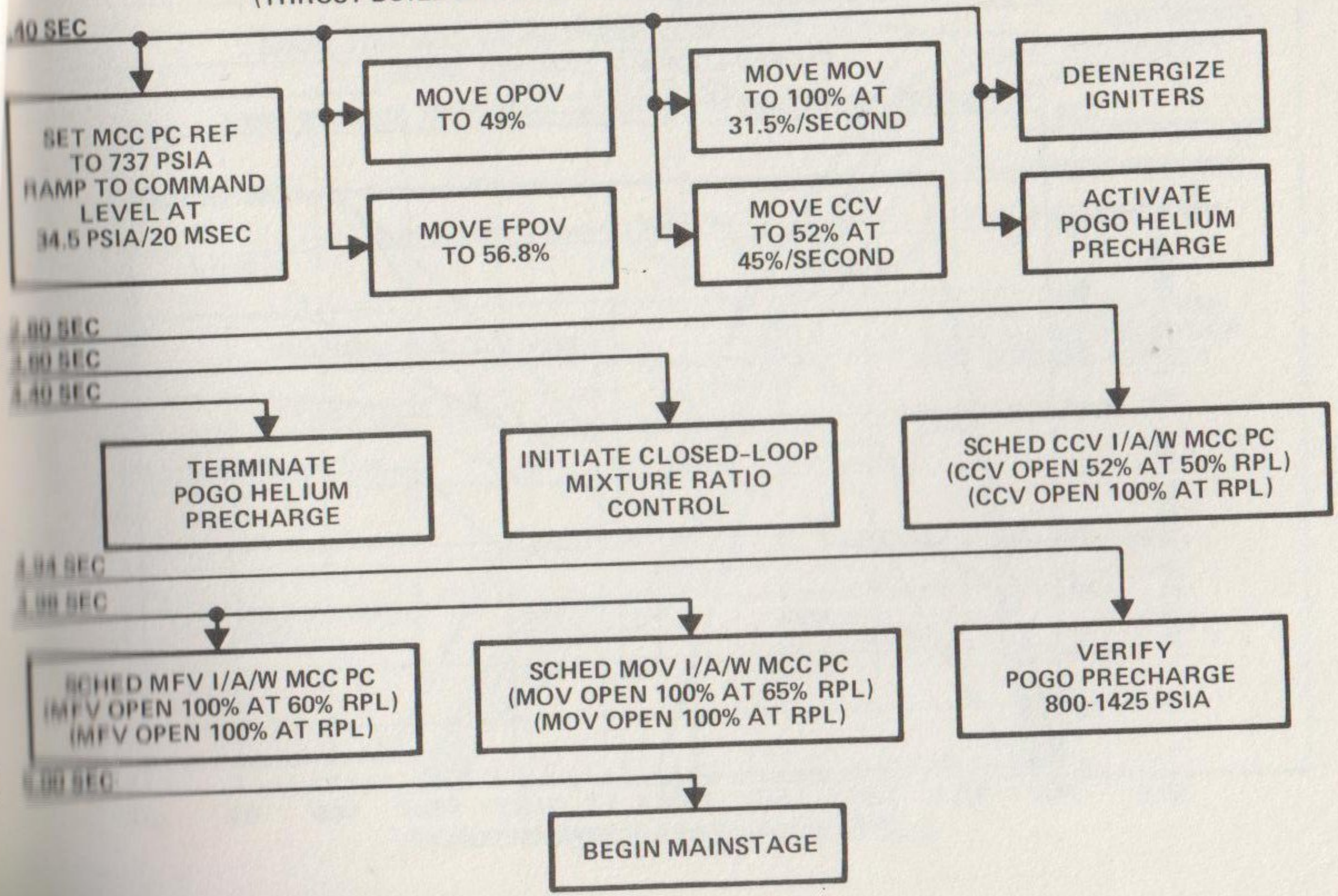


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 12 OF 20)

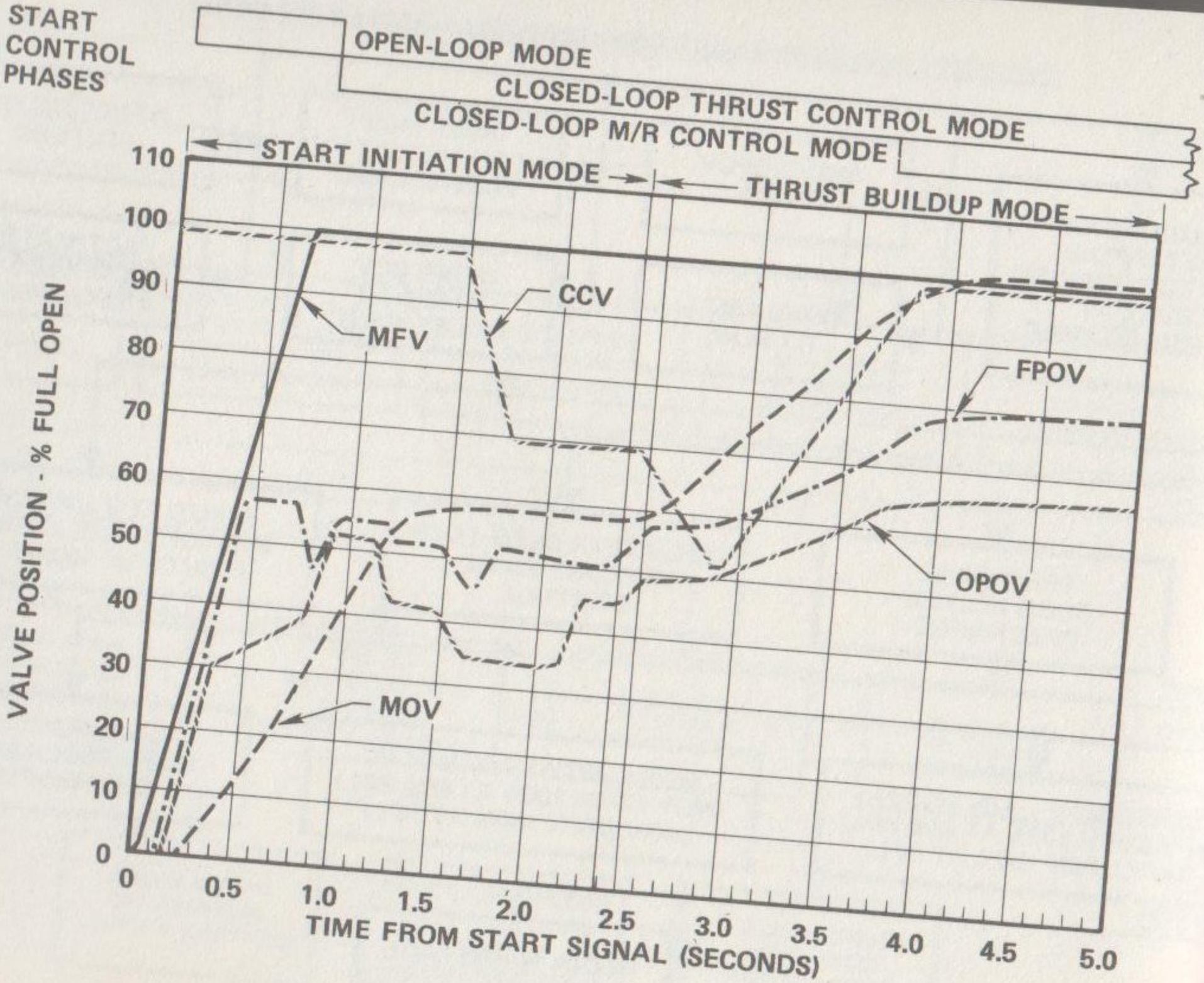


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 13 OF 20)

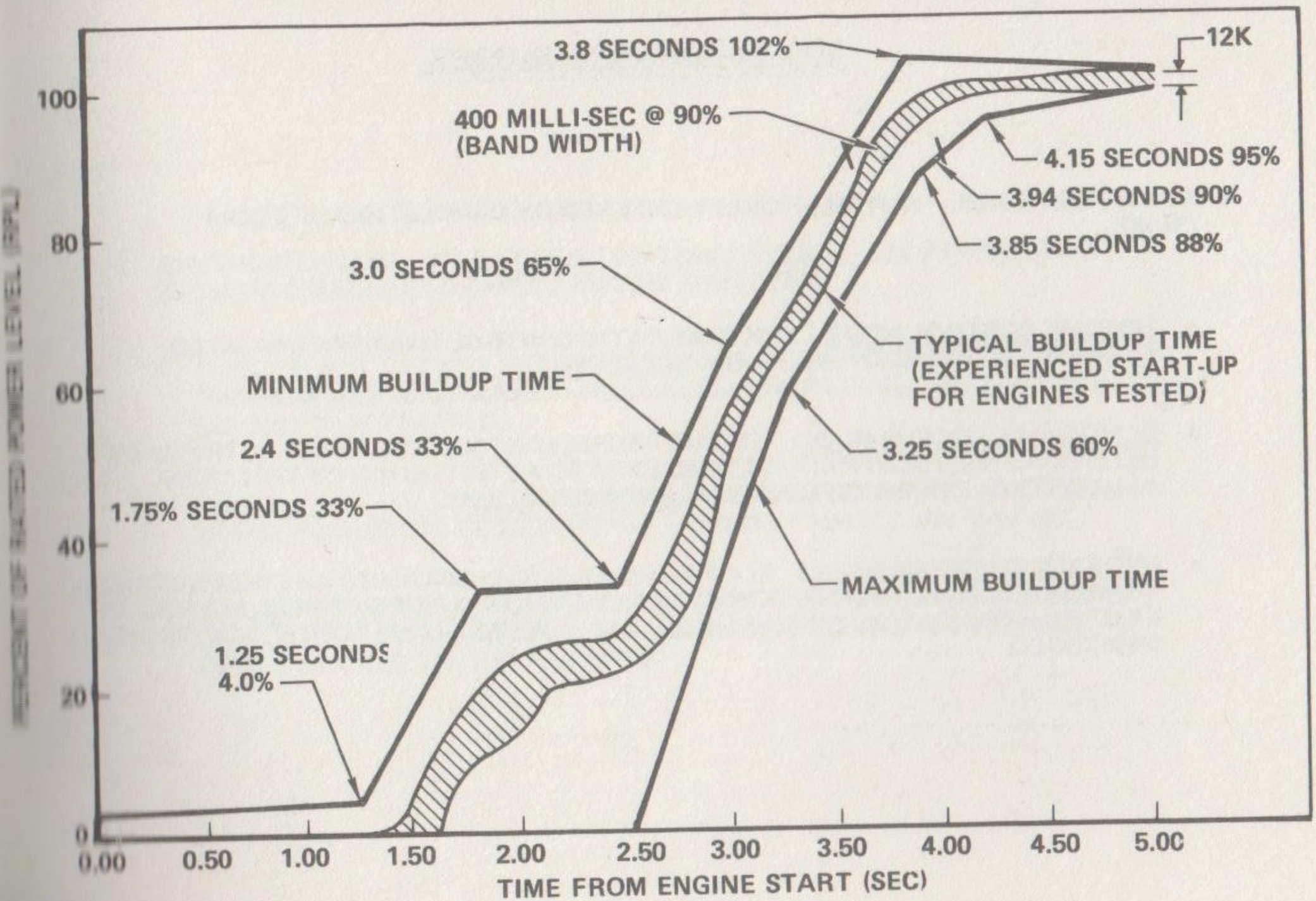


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 14 OF 20)

SSME MAINSTAGE PHASE MODES

- MAINSTAGE PHASE: AUTOMATICALLY ENTERED ON COMPLETION OF START PHASE.

  - NORMAL CONTROL MODE: MIXTURE RATIO CONTROL HAS BEEN INITIATED; THRUST CONTROL IS OPERATING NORMALLY.

  - ELECTRICAL LOCKUP MODE: ENGINE PROPELLANT VALVES ARE ELECTRICALLY HELD IN A FIXED CONFIGURATION AS EXISTED AT INITIATION OF THIS MODE. ALL CONTROL LOOP COMPUTATIONS ARE SUSPENDED.

  - HYDRAULIC LOCKUP MODE: ALL FAIL-SAFE SERVO-SWITCHES ARE DE-ENERGIZED TO HYDRAULICALLY HOLD PROPELLANT VALVES IN A FIXED CONFIGURATION AS EXISTED AT INITIATION OF THIS MODE. ALL CONTROL LOOP COMPUTATIONS ARE SUSPENDED.

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 15 OF 20)

SSME SHUTDOWN PHASE MODES

- SHUTDOWN PHASE: OPERATIONS TO REDUCE ENGINE MCC PRESSURE AND DRIVE ALL VALVES TO EFFECT ENGINE SHUTDOWN.

  - THROTTLING TO ZERO THRUST MODE: SHUTDOWN IS IN PROGRESS AT A PROGRAMMED SHUTDOWN THRUST REFERENCE LEVEL. HELIUM POST-CHARGE IS ACTIVATED.

  - PROPELLANT VALVES CLOSED MODE: THE SHUTDOWN SEQUENCE IS IN STAGE FOLLOWING CLOSURE OF ALL LIQUID PROPELLANT VALVES.

  - FAILSAFE PNEUMATIC MODE: THE ENGINE IS IN PNEUMATIC SHUTDOWN MODE DUE TO THE EXISTENCE OF HYDRAULIC LOCKUP OR VARIOUS OTHER SERIOUS ENGINE FAILURES.

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 16 OF 20)

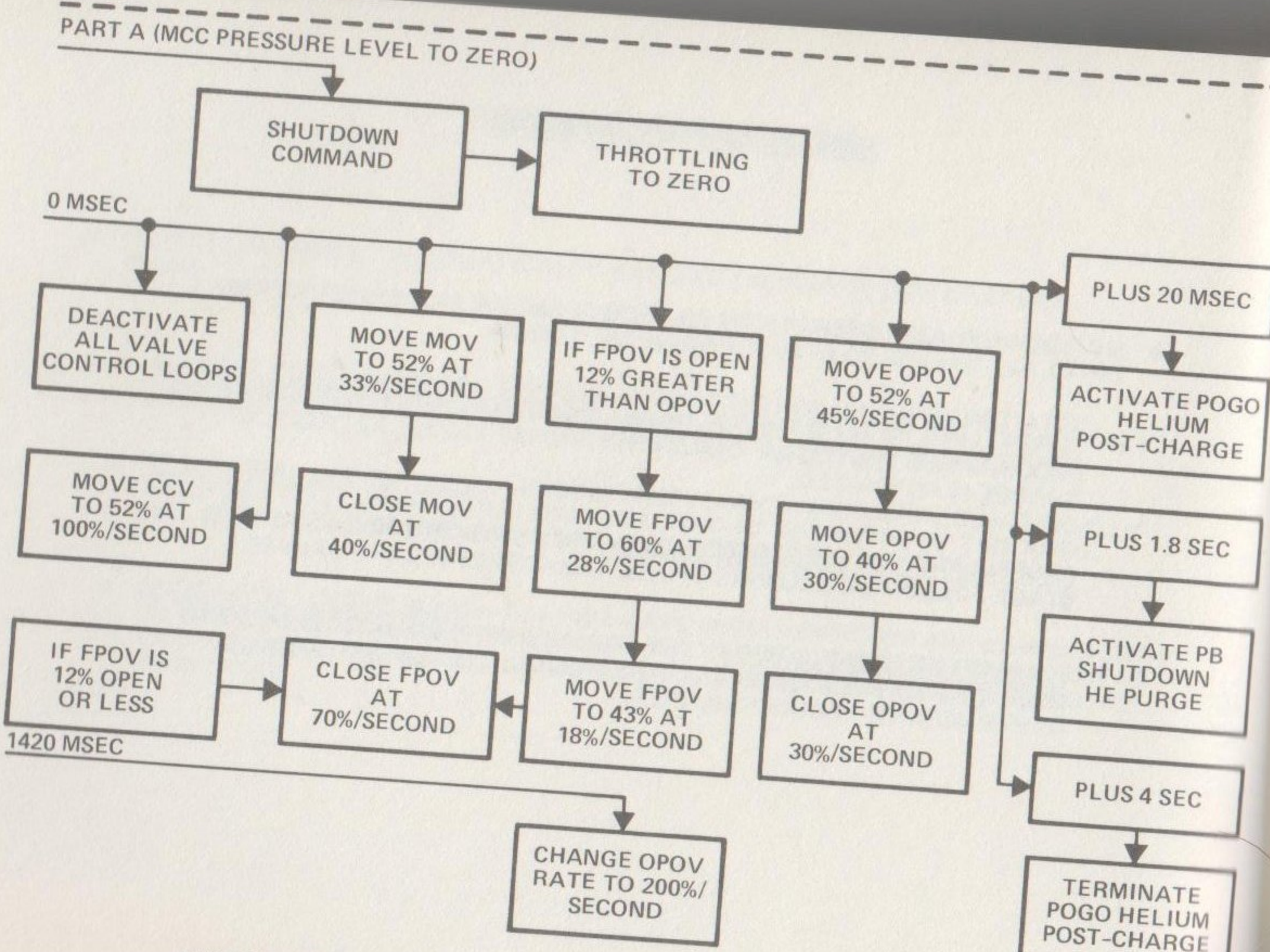
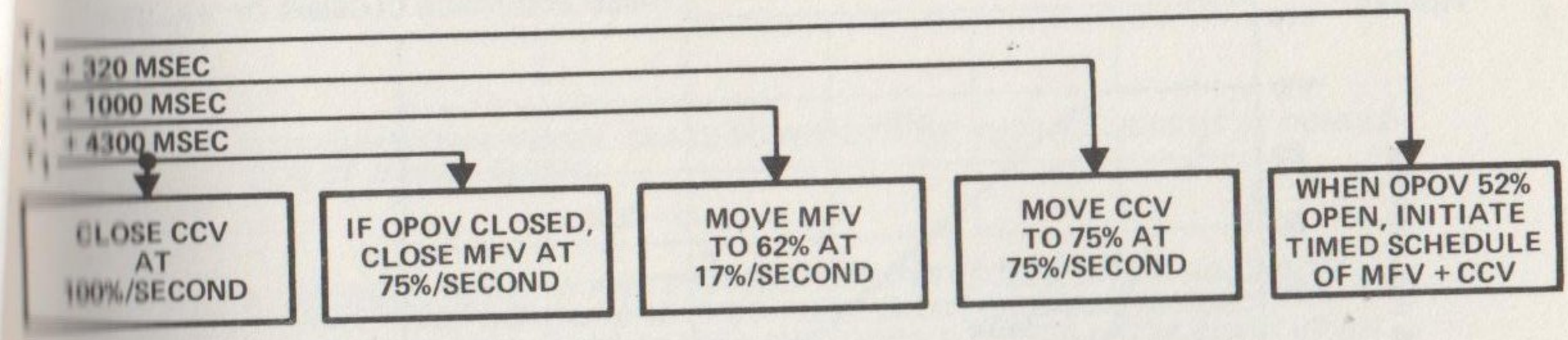


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 17 OF 20)

PART A (MCC PRESSURE LEVEL TO ZERO) (CONTINUED)



PART B (SEQUENCE AFTER PROP VALVES ARE CLOSED)

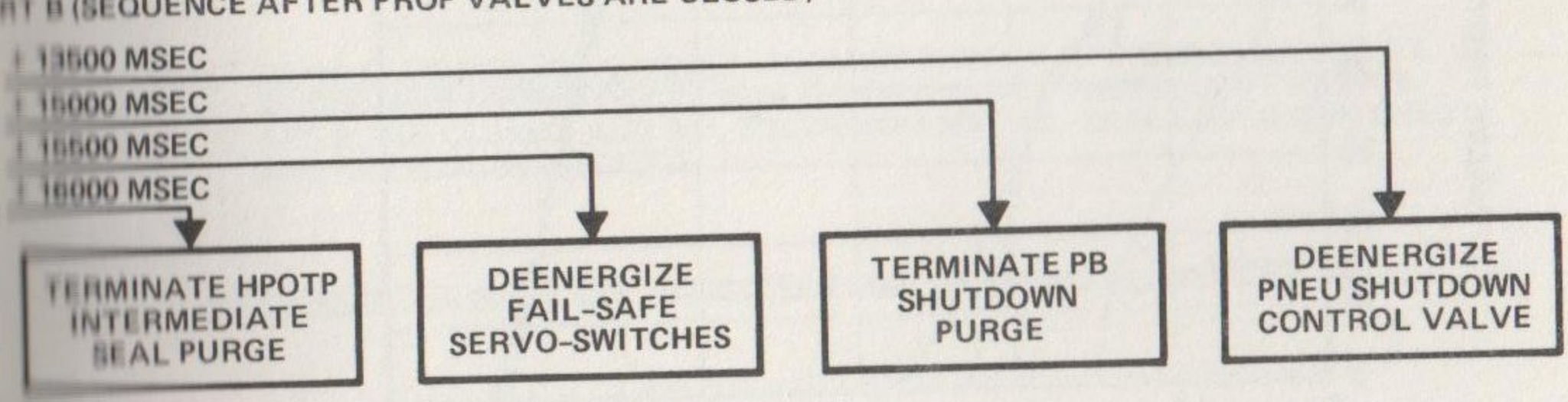


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 18 OF 20)

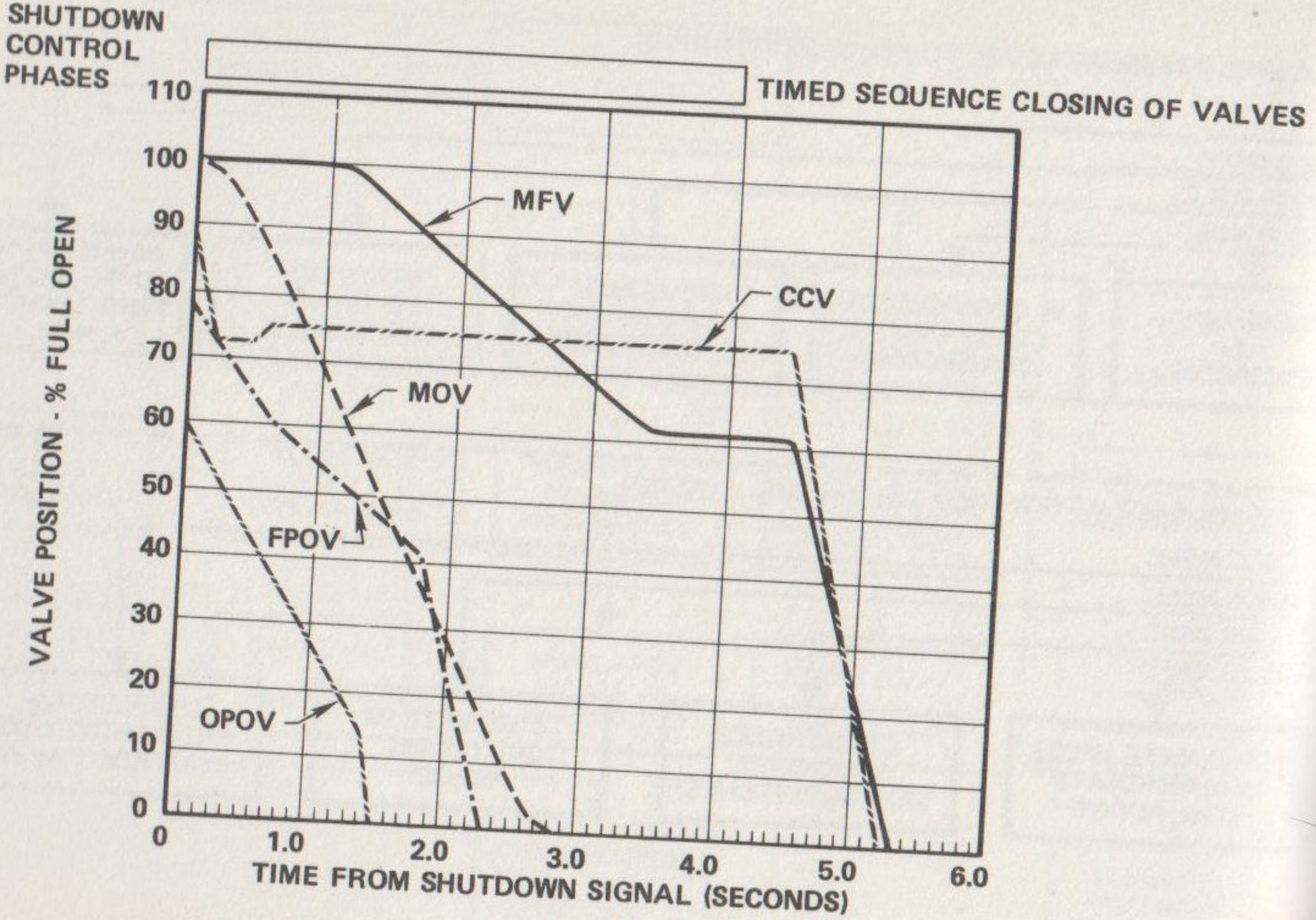


FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 19 OF 20)

SSME POST-SHUTDOWN PHASE MODES

- POST-SHUTDOWN PHASE: STATE TO WHICH SSME AND MEC REVERT AT COMPLETION OF ENGINE FIRING.

  - STANDBY MODE: A WAITING MODE OF CONTROLLER OPERATIONS WITH FUNCTIONS IDENTICAL TO THOSE OF STANDBY DURING CHECKOUT. THIS IS NORMAL MODE OF POST-SHUTDOWN ENTERED AFTER COMPLETION OF SHUTDOWN PHASE.

  - TERMINATE SEQUENCE MODE: TERMINATION OF A PURGE SEQUENCE BY A COMMAND FROM VEHICLE IS IN PROGRESS. ALL PROPELLANT VALVES ARE BEING CLOSED, AND ALL SOLENOID AND FAIL-SAFE SERVO-SWITCHES ARE BEING DE-ENERGIZED.

  - OXIDIZER DUMP MODE: OXIDIZER DUMP SEQUENCE BEING PERFORMED.

FIGURE 1-17. SSME OPERATIONAL PHASE/MODES (SHEET 20 OF 20)

SECTION II

SPACE SHUTTLE MAIN ENGINE (SSME)

DESCRIPTION

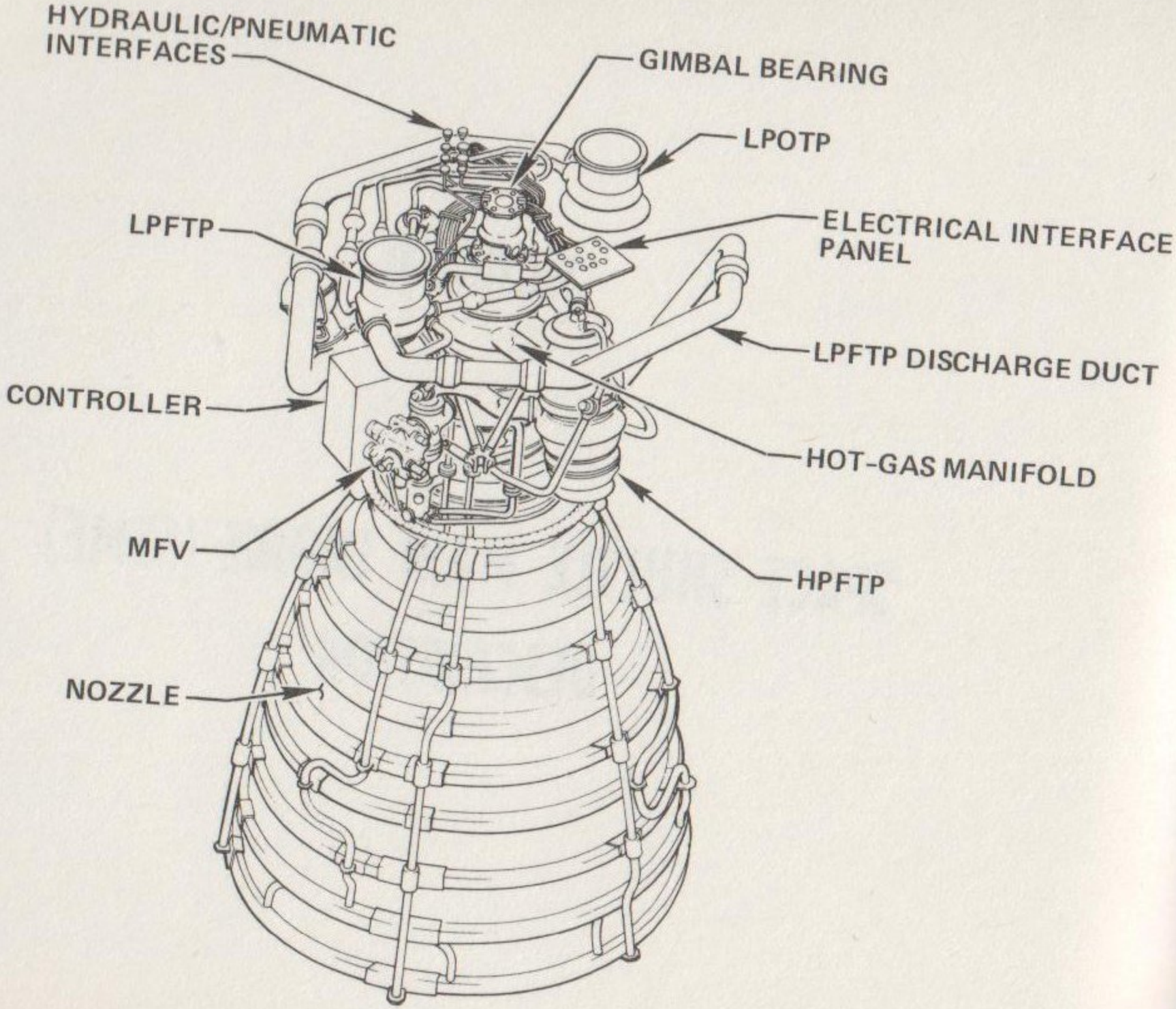


FIGURE 2-1. SPACE SHUTTLE MAIN ENGINE (SHEET 1 OF 2)

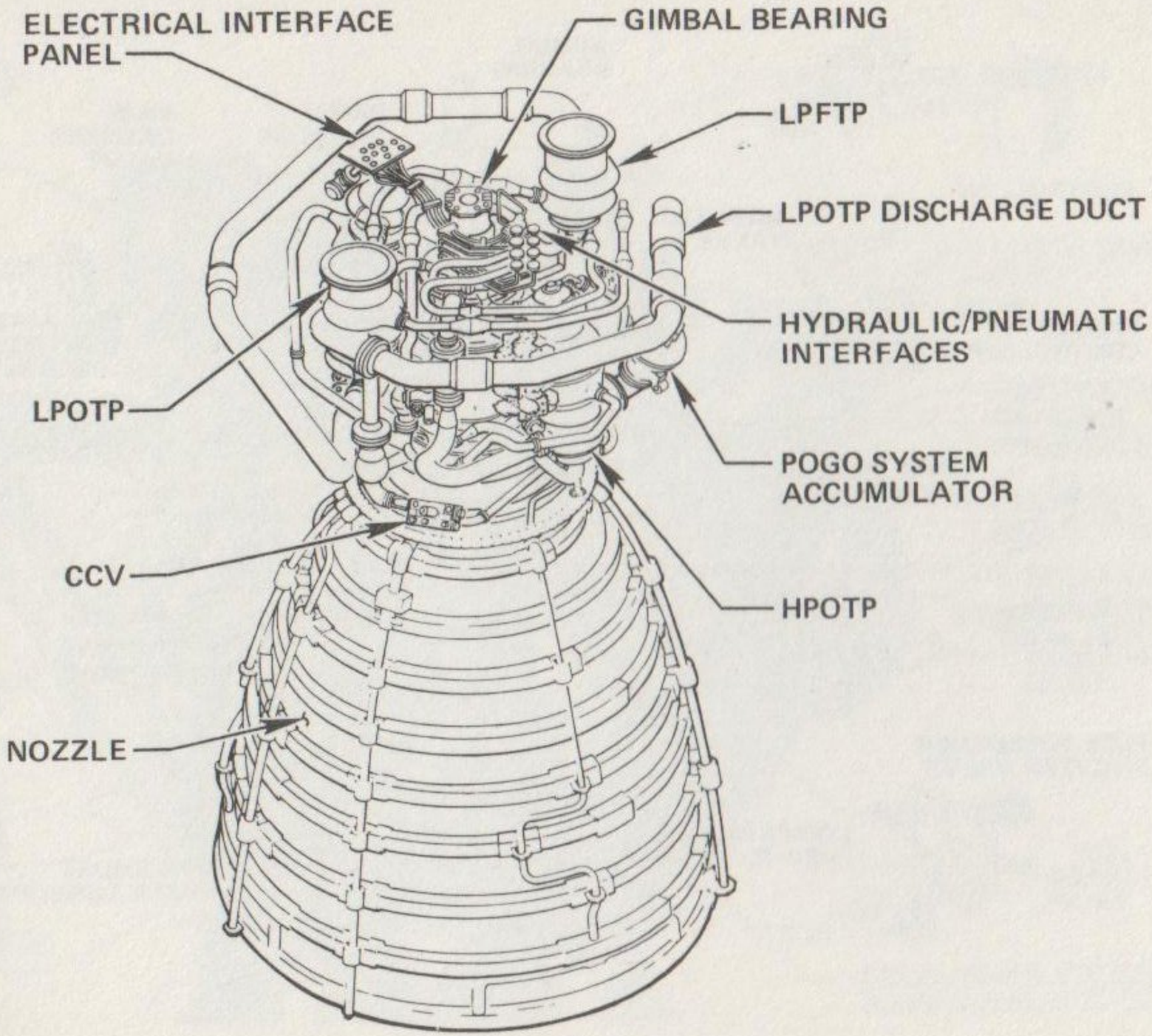


FIGURE 2-1. SPACE SHUTTLE MAIN ENGINE (SHEET 2 OF 2)

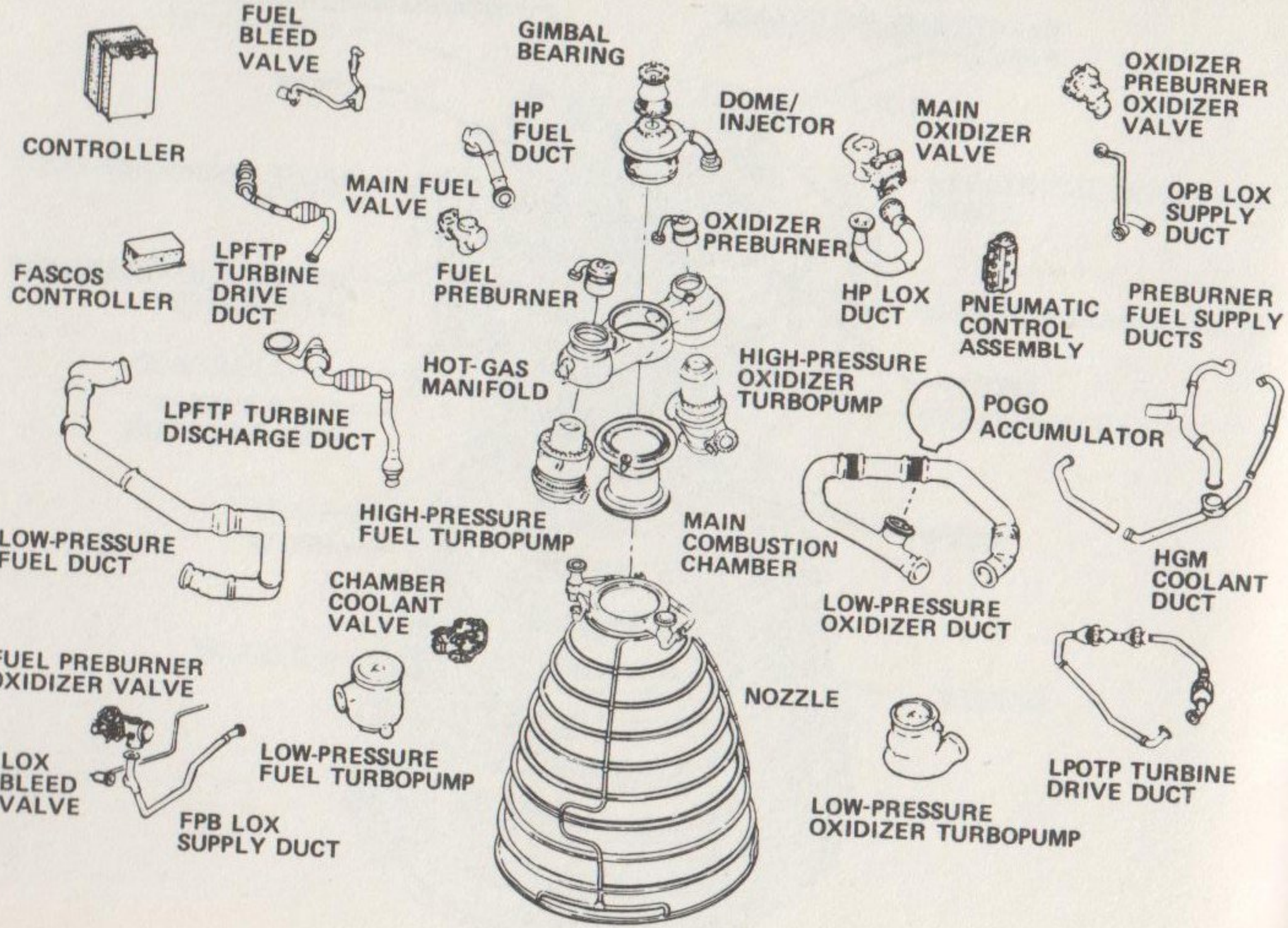


FIGURE 2-2. SSME MAJOR COMPONENTS

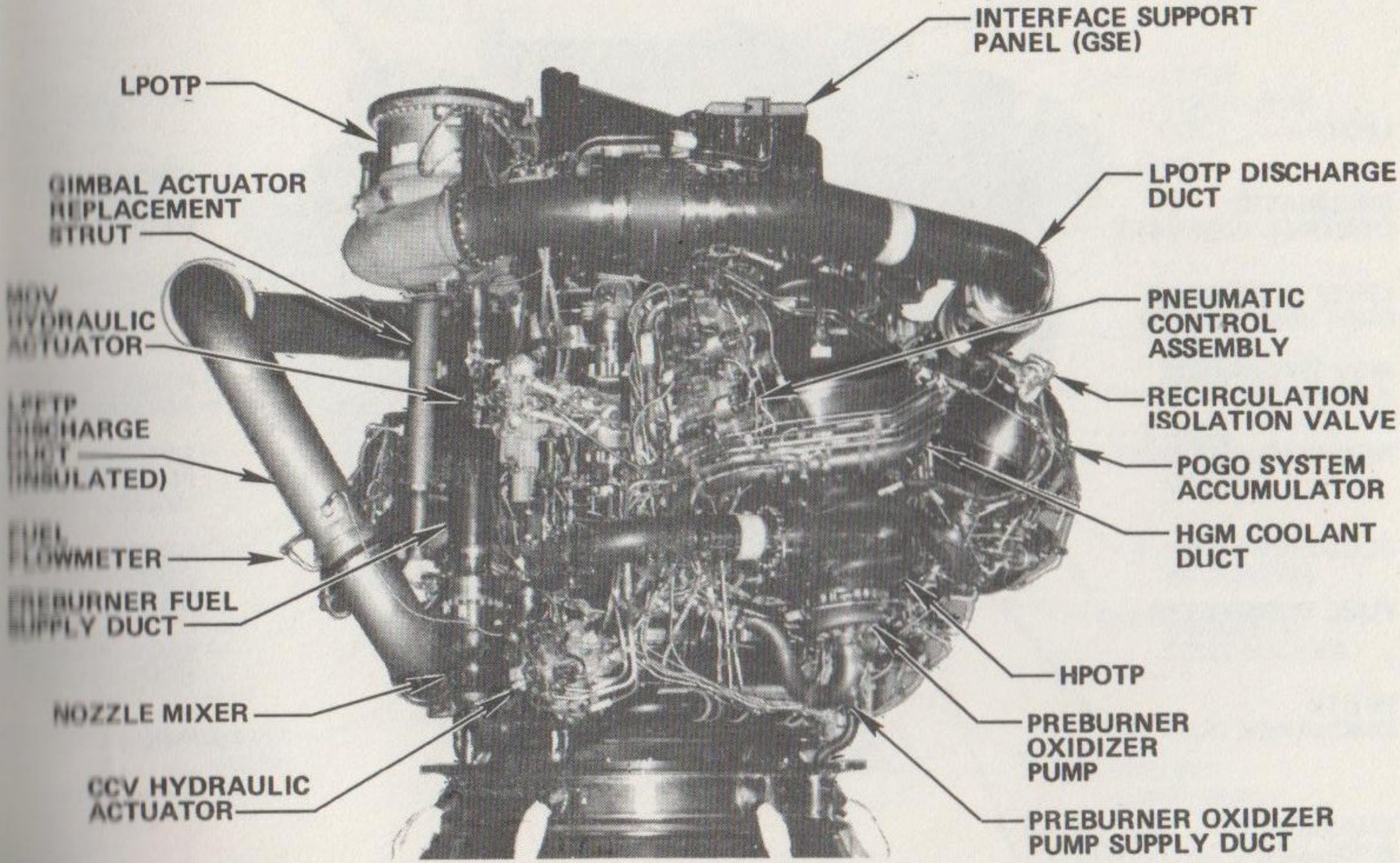


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 1) (SHEET 1 OF 8)

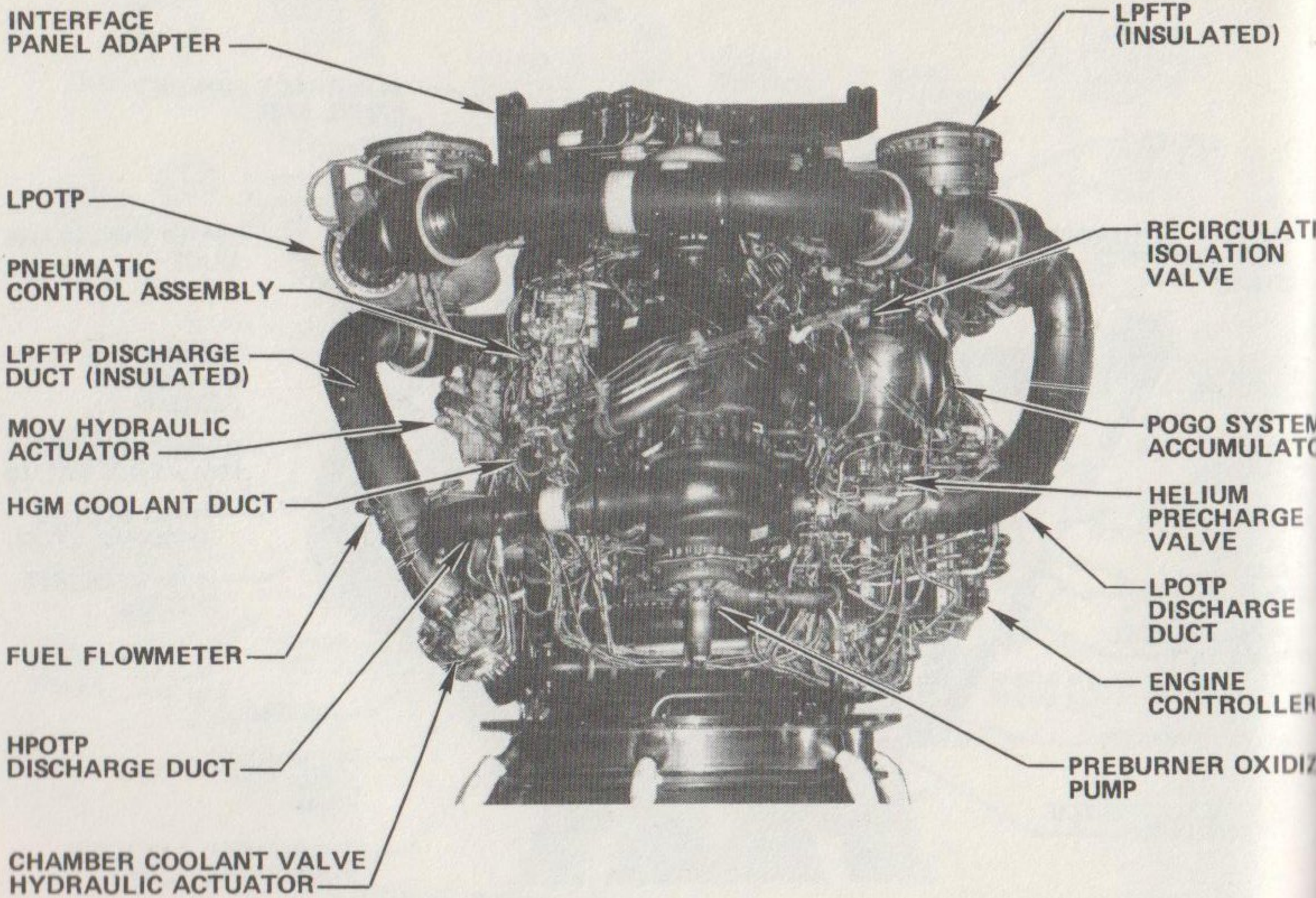


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 2) (SHEET 2 OF 8)

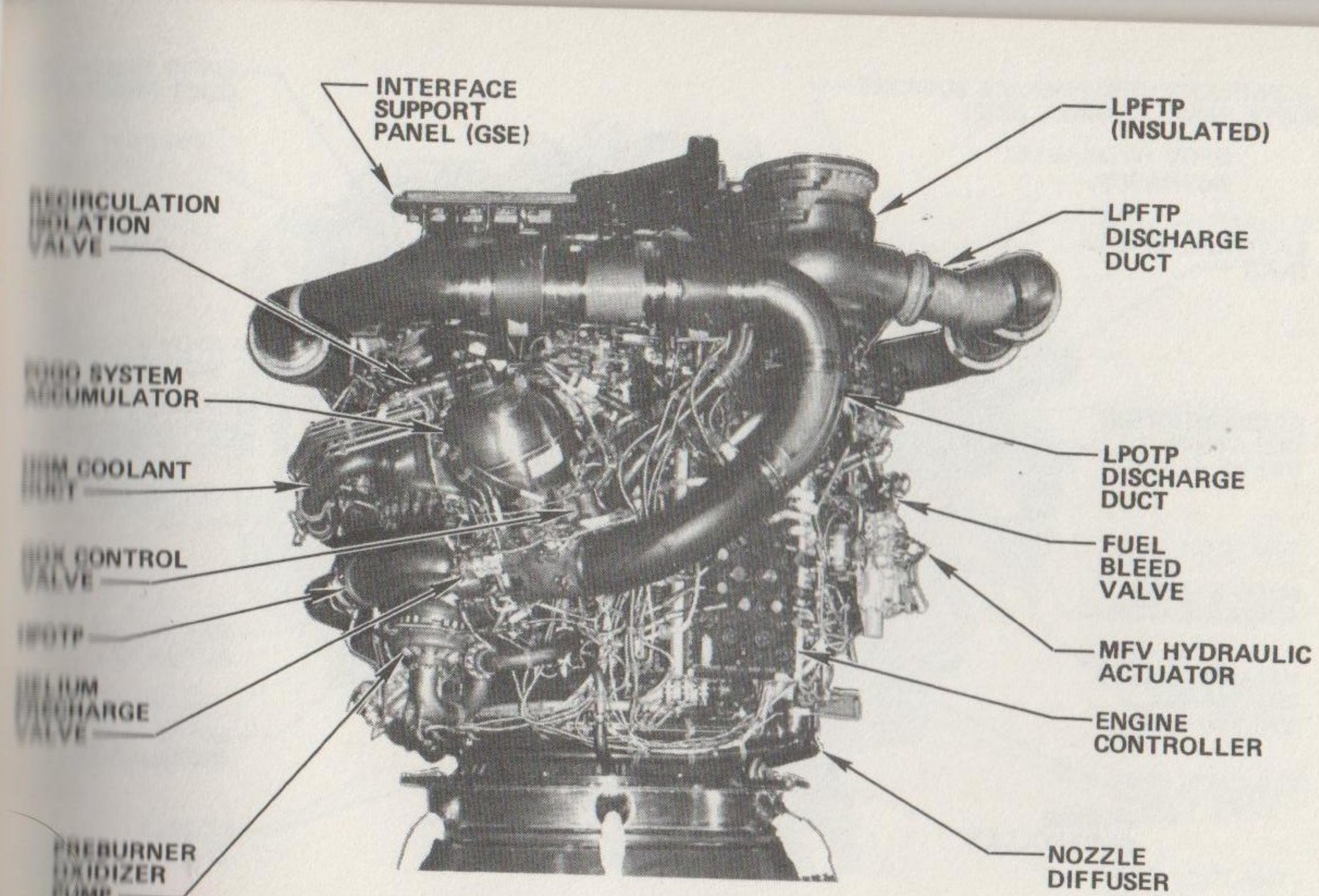


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 3) (SHEET 3 OF 8)

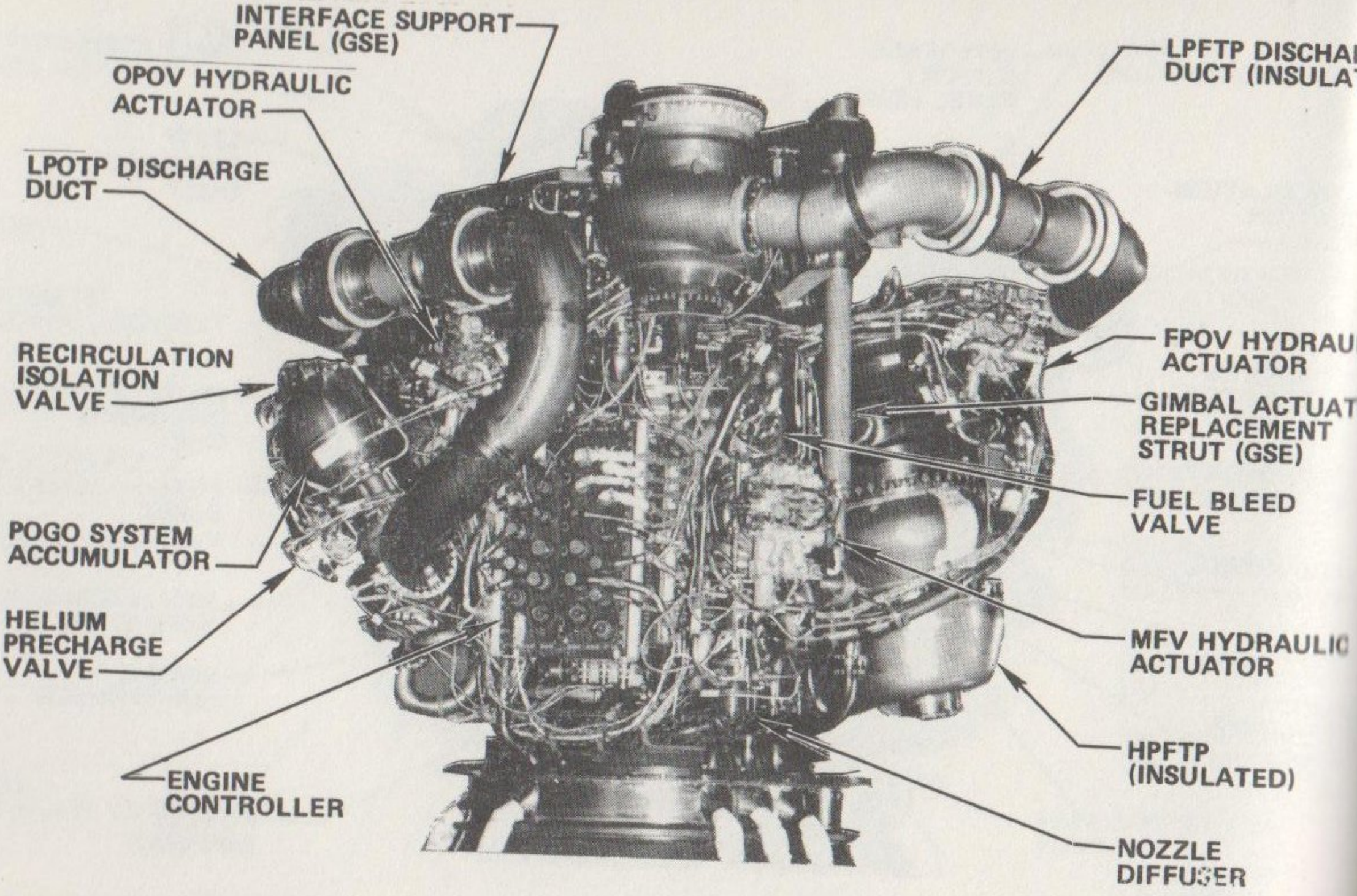


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 4) (SHEET 4 OF 8)

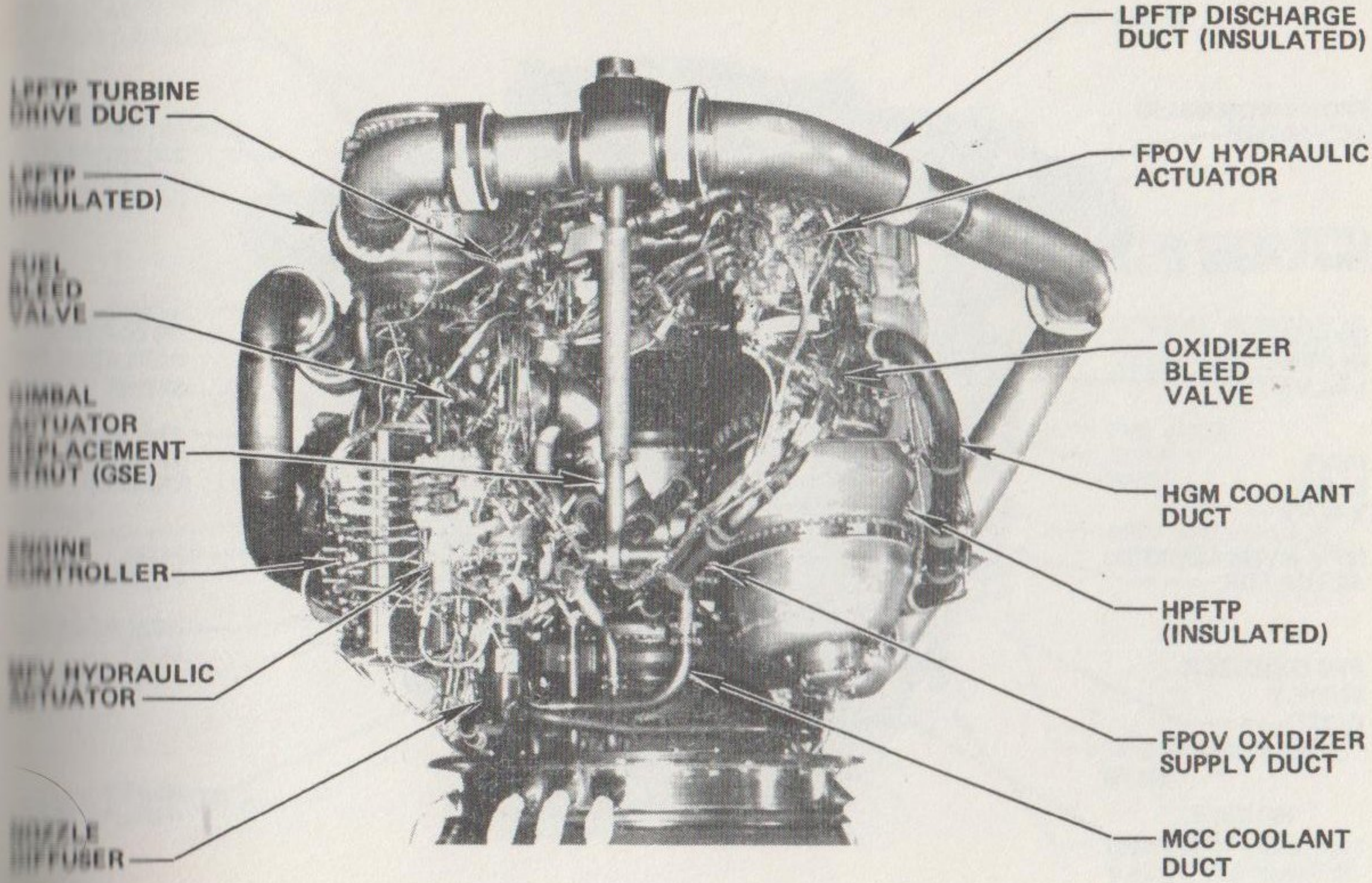


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 5) (SHEET 5 OF 8)

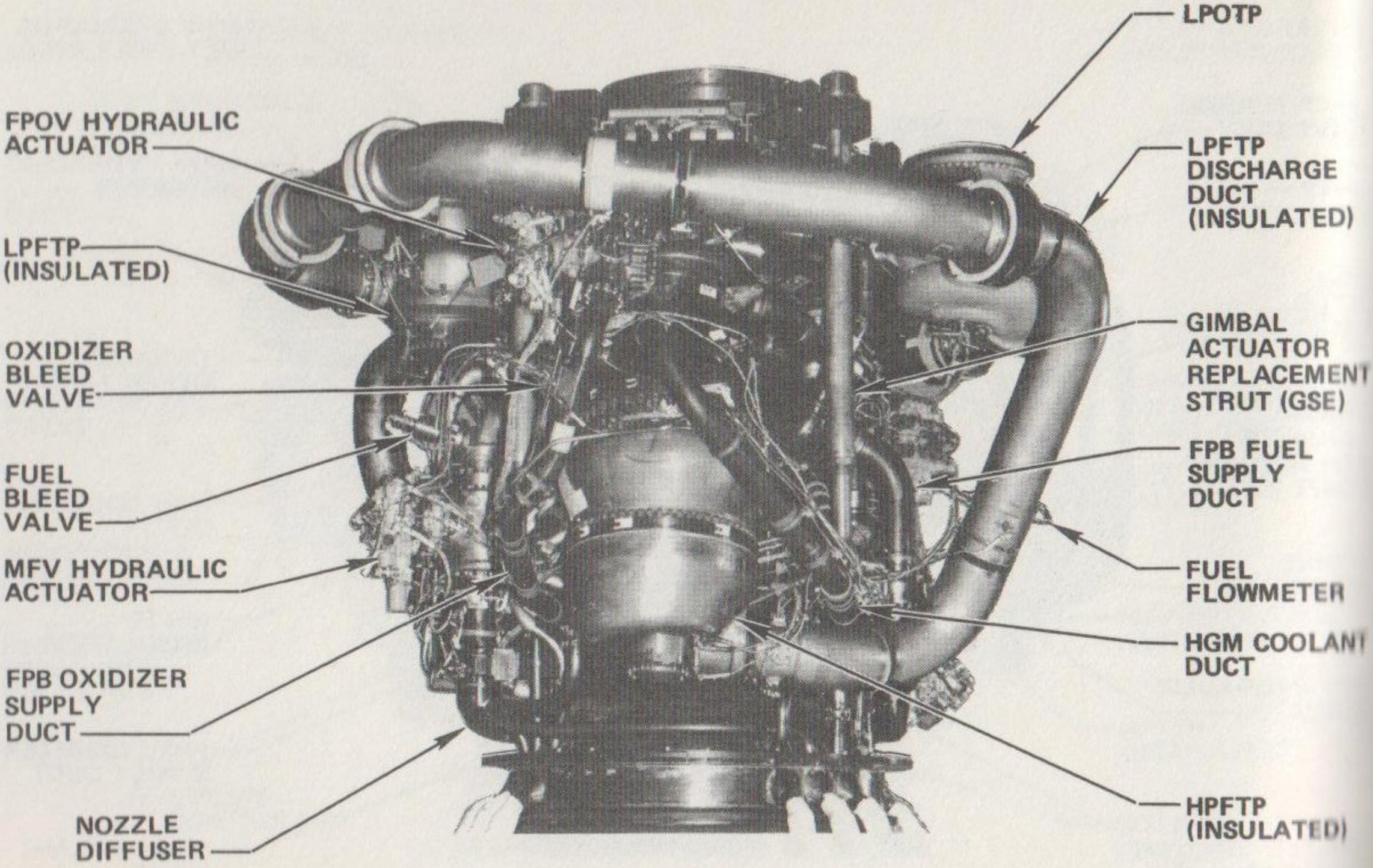


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 6) (SHEET 6 OF 8)

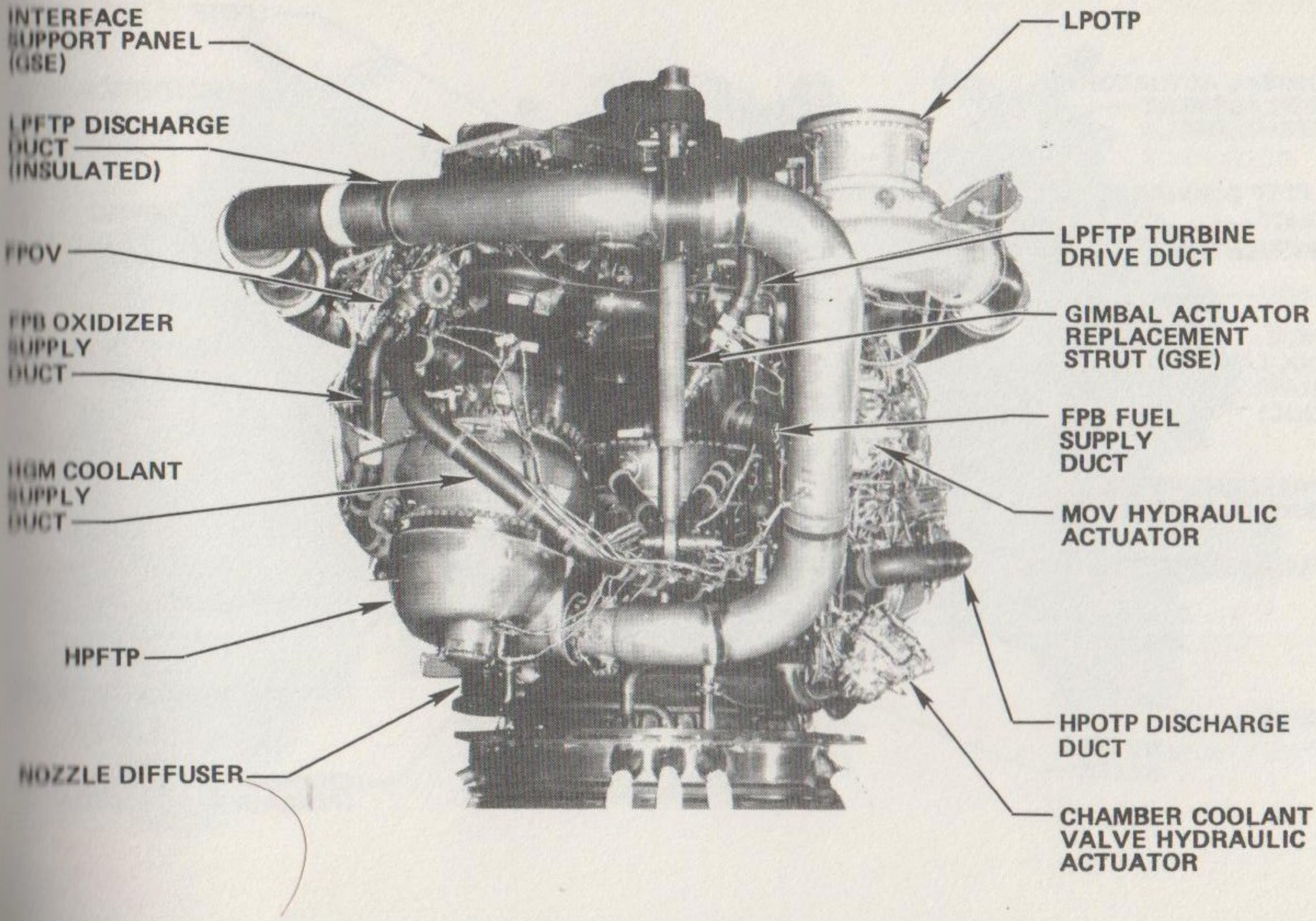


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 7) (SHEET 7 OF 8)

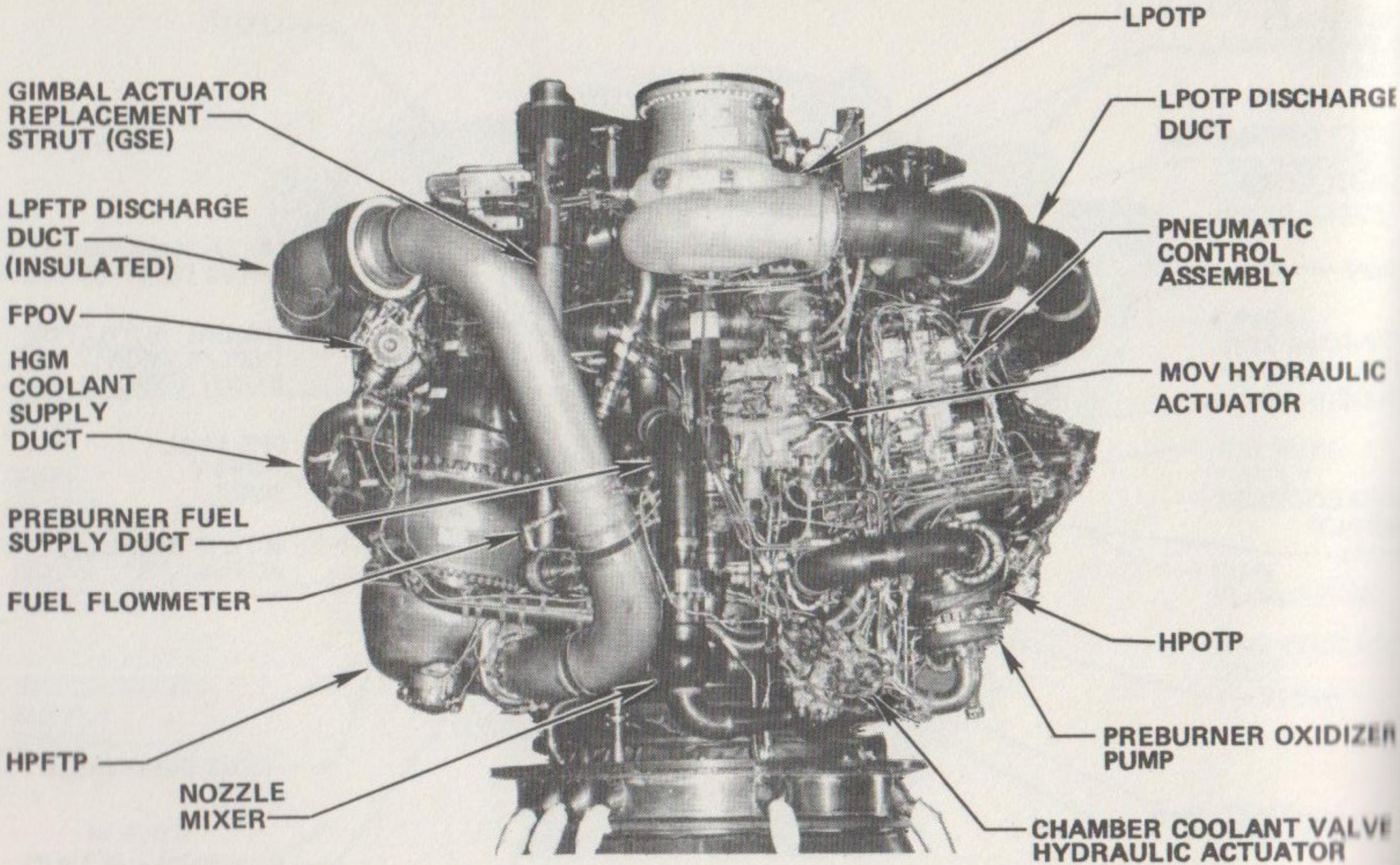


FIGURE 2-3. SSME TYPICAL VIEWS (VIEW 8) (SHEET 8 OF 8)

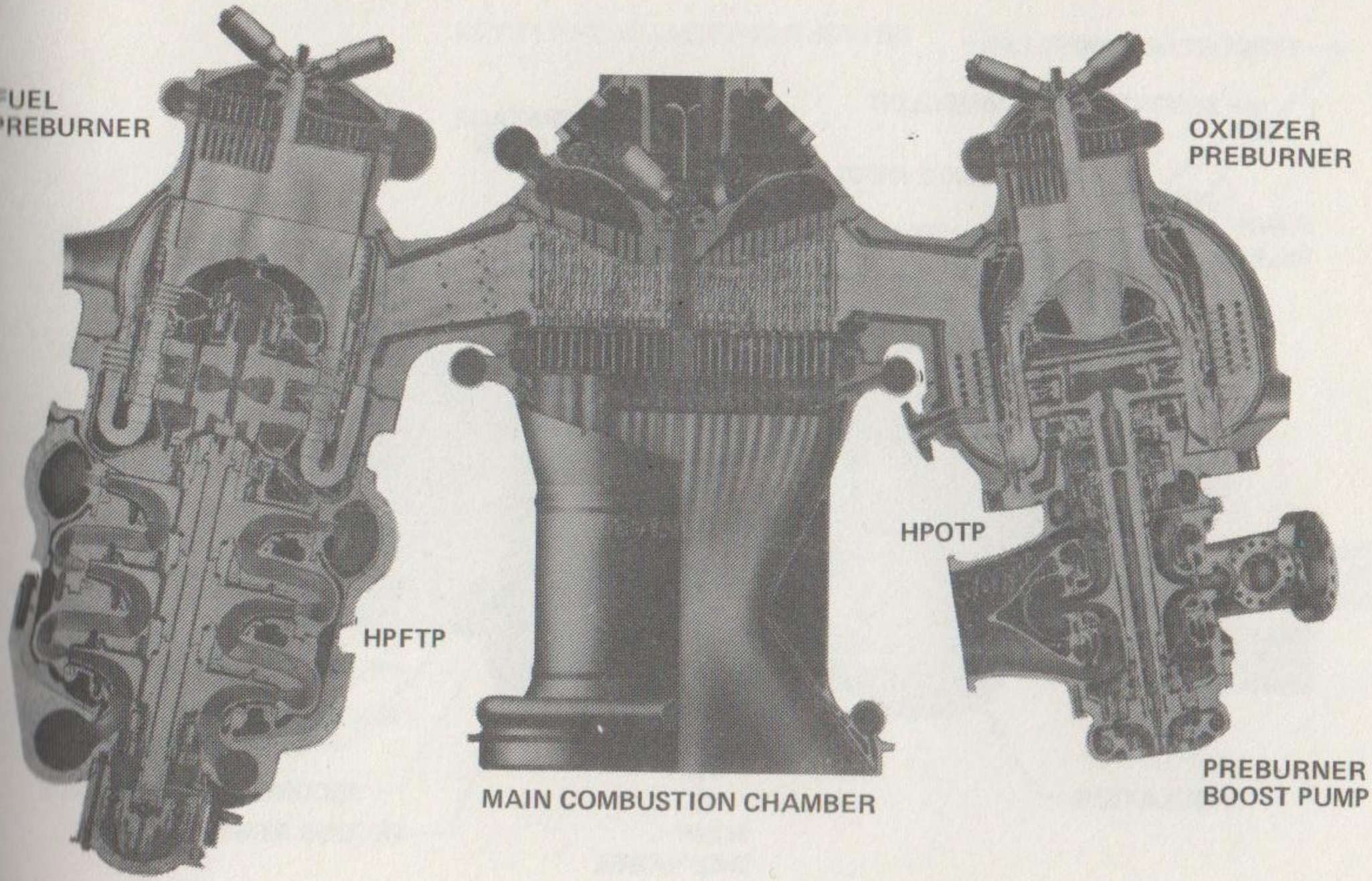


FIGURE 2-4. SSME POWERHEAD COMPONENT ARRANGEMENT

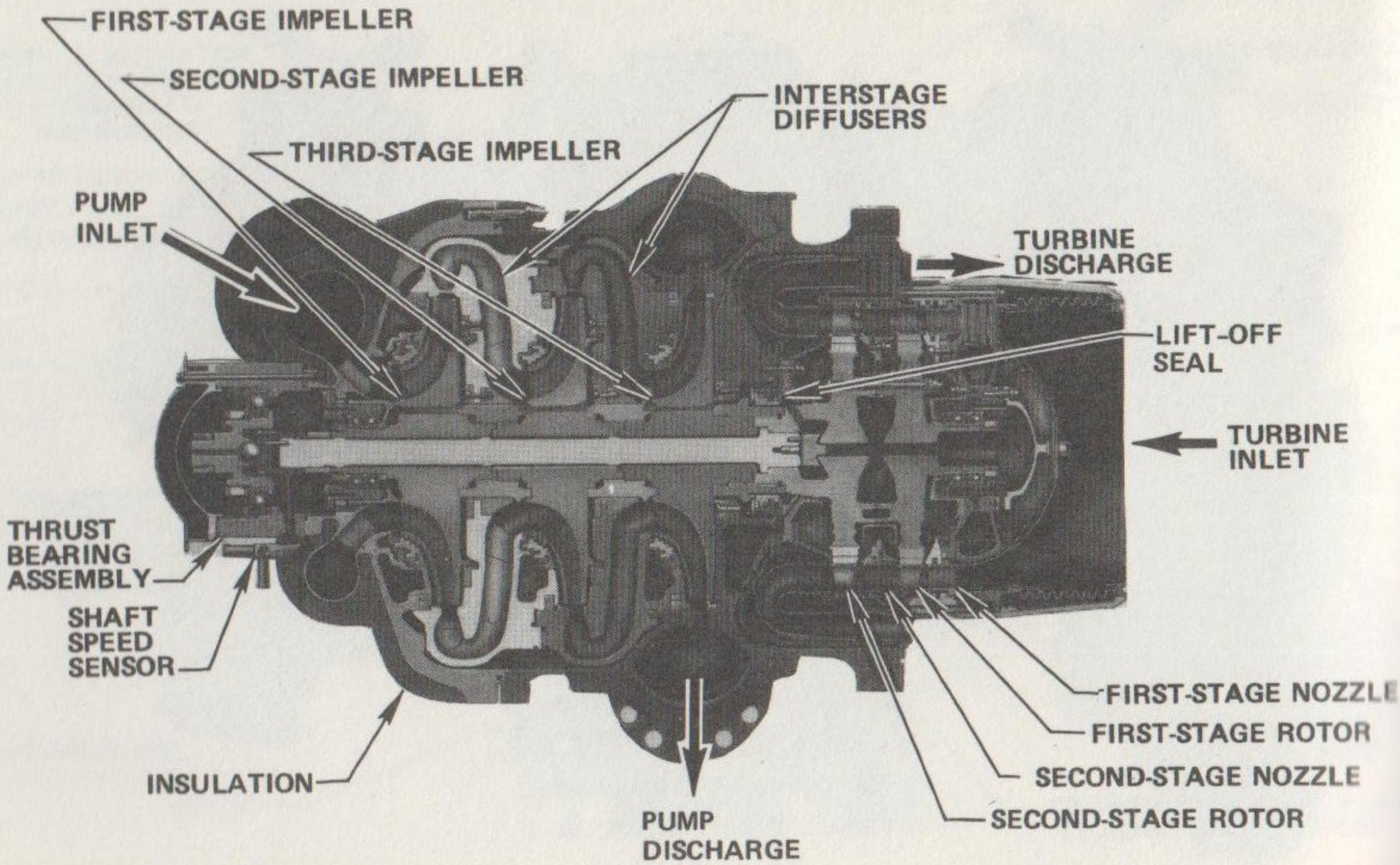


FIGURE 2-5. HIGH-PRESSURE FUEL TURBOPUMP (SHEET 1 OF 2)

KEY PERFORMANCE PARAMETERS

	100%	109%
PUMP INLET FLOWRATE (LB/SEC)	149.1	162.5
PUMP INLET PRESSURE (PSIA)	222.4	237.5
PUMP DISCHARGE PRESSURE (PSIA)	6110.4	6871.7
PUMP EFFICIENCY	.763	.760
TURBINE FLOWRATE (LB/SEC)	158.6	177.6
TURBINE INLET TEMP (^{o}R)	1794.5	1903.7
TURBINE PRESSURE RATIO	1.411	1.440
TURBINE EFFICIENCY	.839	.842
TURBINE SPEED (RPM)	34,386	36,595
TURBINE HORSEPOWER	61,402	74,928

FIGURE 2-5. HIGH-PRESSURE FUEL TURBOPUMP (SHEET 2 OF 2)

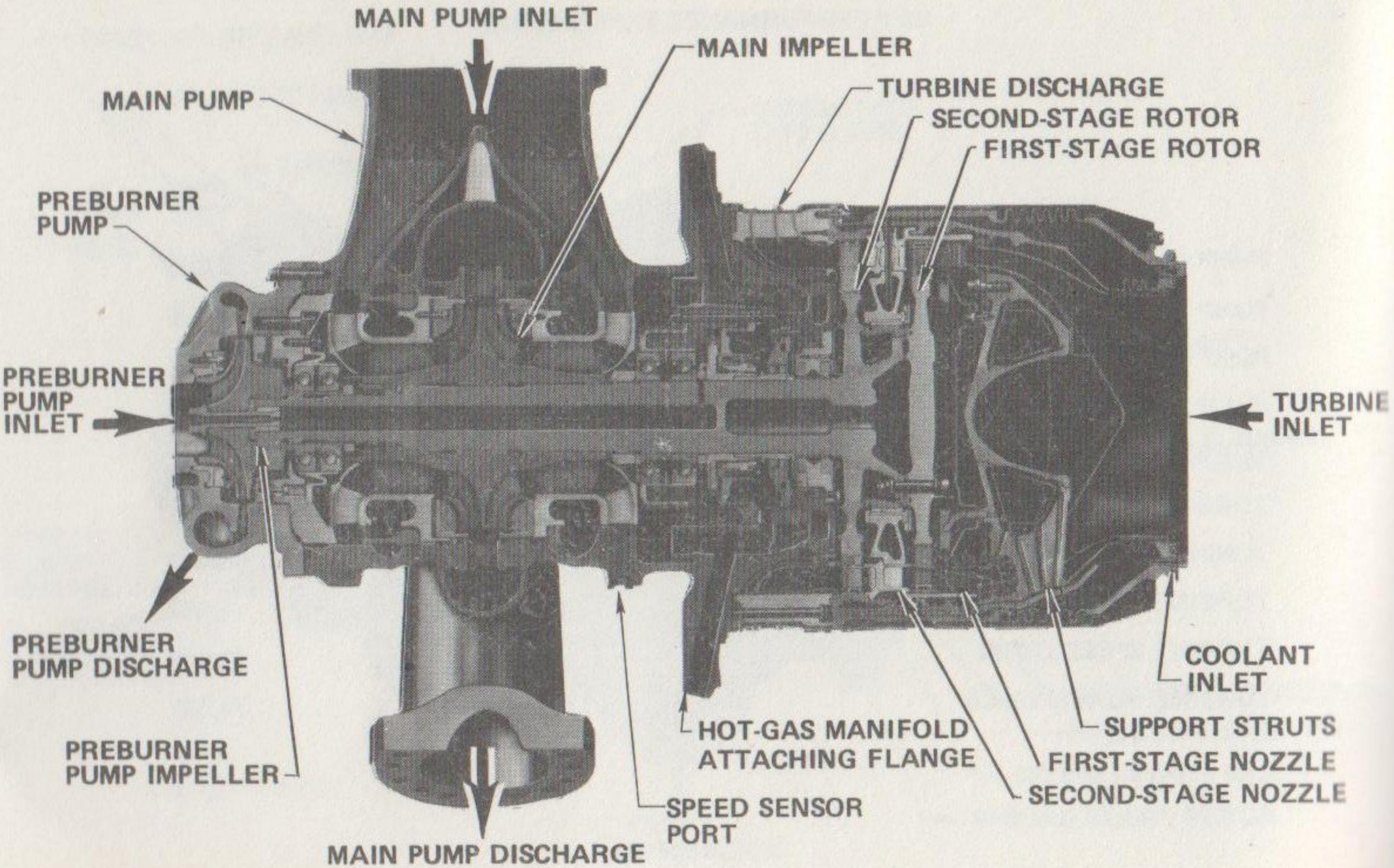


FIGURE 2-6. HIGH-PRESSURE OXIDIZER TURBOPUMP (SHEET 1 OF 2)

KEY PERFORMANCE PARAMETERS

	100%		109%	
	MAIN	BOOST	MAIN	BOOST
PUMP INLET FLOWRATE (LB/SEC)	1072.1	109.1	1162.5	125.8
PUMP INLET PRESSURE (PSIA)	379.9	3992.2	392.3	4428.7
PUMP DISCHARGE PRESSURE (PSIA)	4118.4	7210.9	4578.2	7935.9
PUMP EFFICIENCY	.686	.808	.681	.805
TURBINE FLOWRATE (LB/SEC)	58.8		65.49	
TURBINE INLET PRESSURE (PSIA)	5020.0		5631.6	
TURBINE INLET TEMP (^{o}R)	1522.5		1625.4	
TURBINE PRESSURE RATIO	1.513		1.547	
TURBINE EFFICIENCY	.759		.769	
TURBINE SPEED (RPM)	27,263		29,194	
TURBINE HORSEPOWER	23,068		28,229	

FIGURE 2-6. HIGH-PRESSURE OXIDIZER TURBOPUMP (SHEET 2 OF 2)

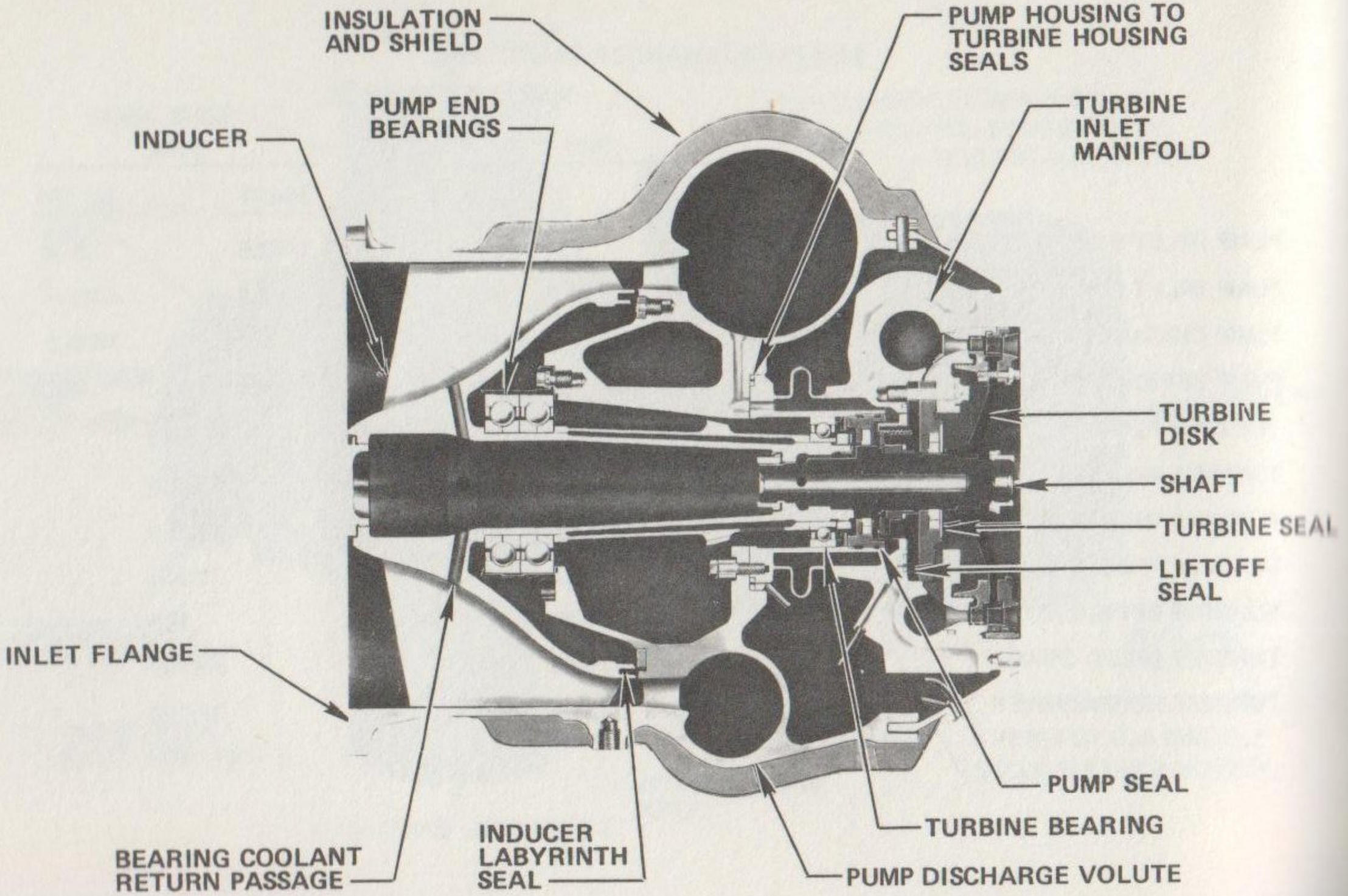


FIGURE 2-7. LOW-PRESSURE FUEL TURBOPUMP (SHEET 1 OF 2)

KEY PERFORMANCE PARAMETERS

	100%	109%
PUMP INLET FLOWRATE (LB/SEC)	148.6	161.9
PUMP INLET PRESSURE (PSIA)	30.0	30.0
PUMP DISCHARGE PRESSURE (PSIA)	280.5	306.3
PUMP EFFICIENCY	.774	.749
TURBINE FLOWRATE (LB/SEC)	26.1	29.5
TURBINE INLET TEMP (^{o}R)	493.4	479
TURBINE PRESSURE RATIO	1.32	1.34
TURBINE EFFICIENCY	.519	.523
TURBINE SPEED (RPM)	15765	16722
TURBINE HORSEPOWER	2950	3518

FIGURE 2-7. LOW-PRESSURE FUEL TURBOPUMP (SHEET 2 OF 2)

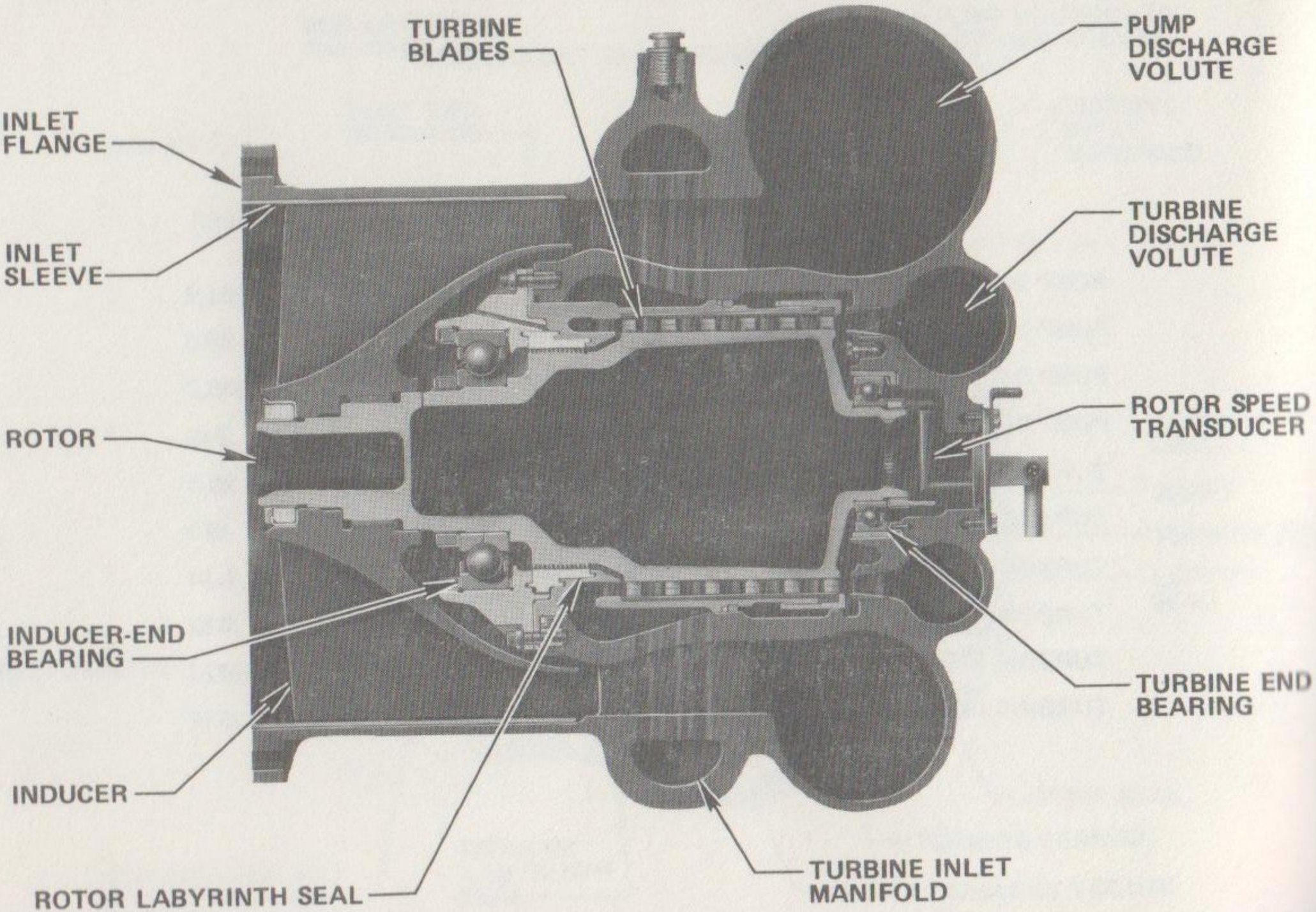


FIGURE 2-8. LOW-PRESSURE OXIDIZER TURBOPUMP (SHEET 1 OF 2)

KEY PERFORMANCE PARAMETERS

	100%	109%
PUMP INLET FLOWRATE (LB/SEC)	895.8	975.1
PUMP INLET PRESSURE (PSIA)	100.0	100.0
PUMP DISCHARGE PRESSURE (PSIA)	414.2	432.7
PUMP EFFICIENCY	.689	.671
TURBINE FLOWRATE (LB/SEC)	176.3	186.4
TURBINE INLET PRESSURE (PSIA)	3951.1	4390.9
TURBINE INLET TEMP (^{o}R)	190.2	193.5
TURBINE PRESSURE RATIO	-	-
TURBINE EFFICIENCY	.649	.649
TURBINE SPEED (RPM)	5042.1	5814.6
TURBINE HORSEPOWER	1504.8	1782.0

FIGURE 2-8. LOW-PRESSURE OXIDIZER TURBOPUMP (SHEET 2 OF 2)

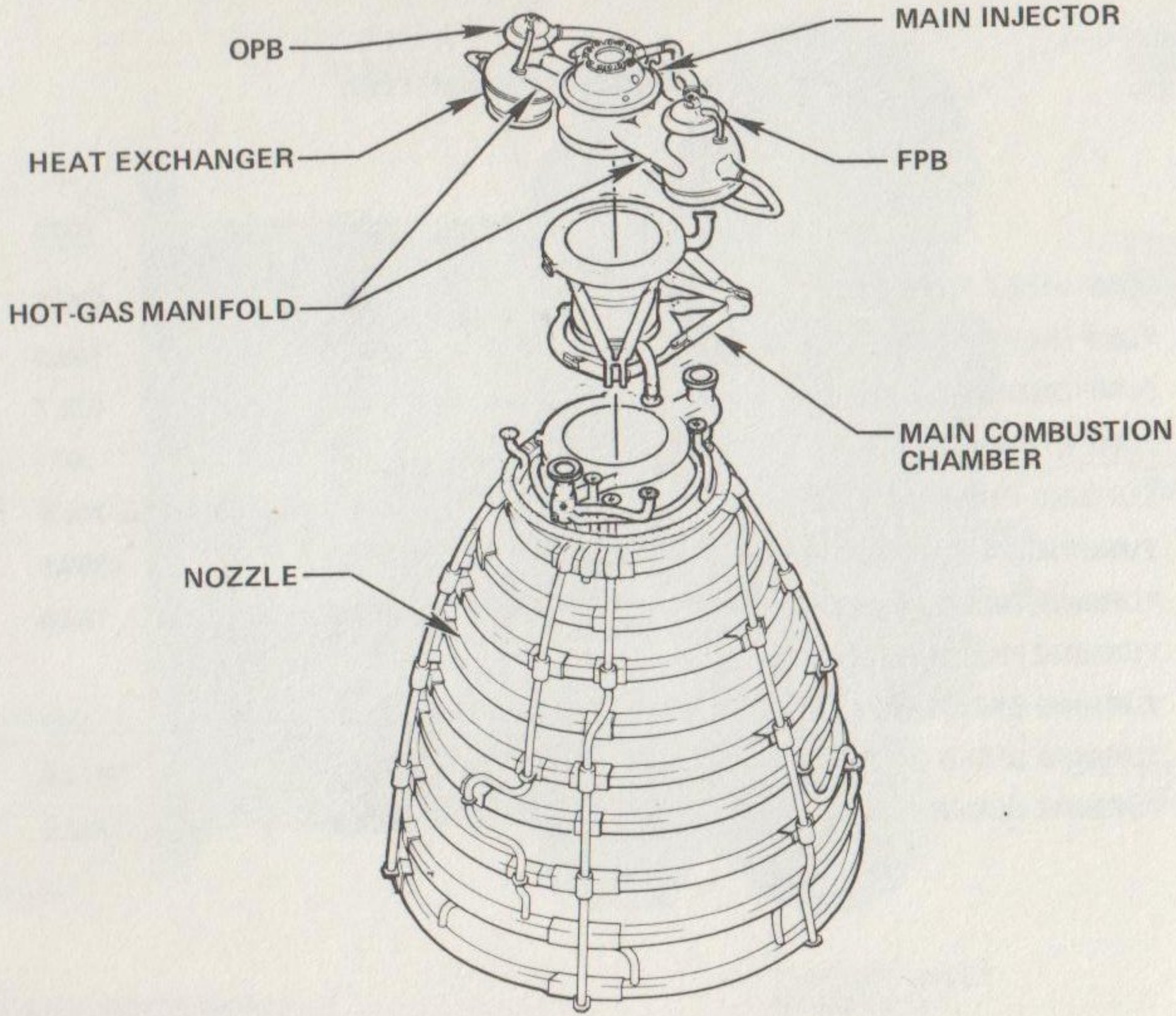


FIGURE 2-9. SSME COMBUSTION DEVICES

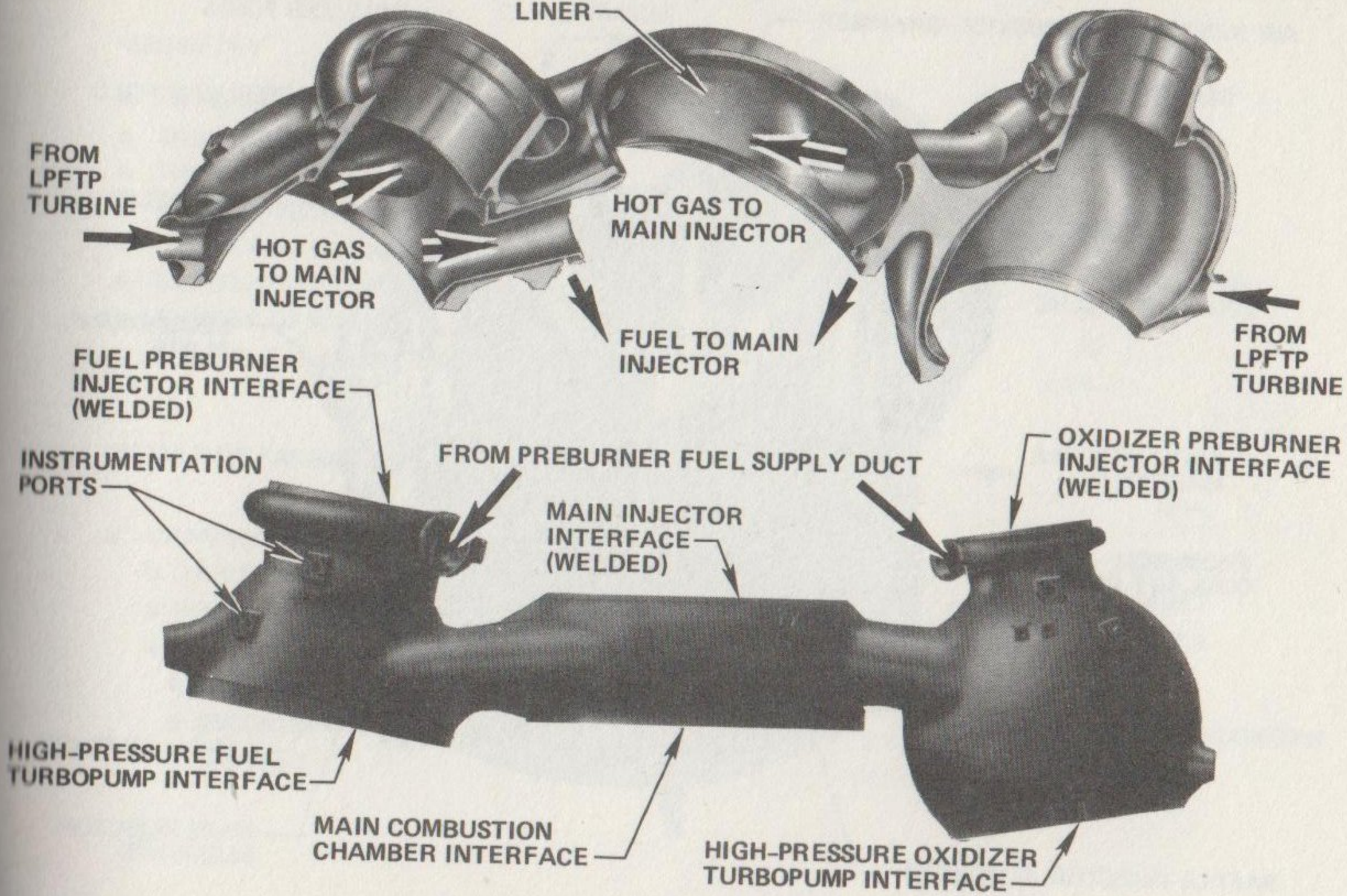


FIGURE 2-10. HOT-GAS MANIFOLD

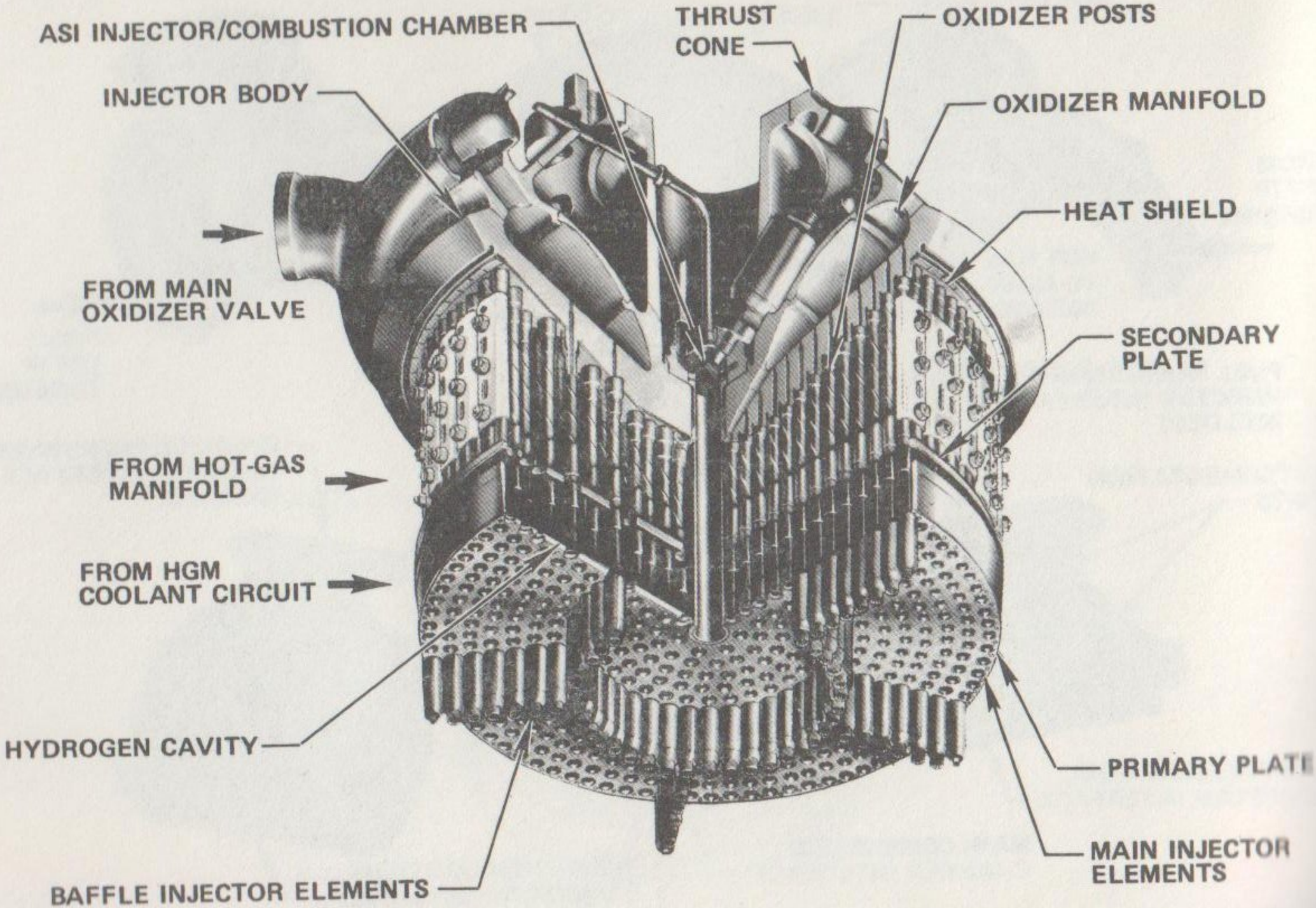


FIGURE 2-11. MAIN INJECTOR (SHEET 1 OF 2)

GEOMETRY

● 347 CRES RIGIMESH FACEPLATES	
● DUAL SPARK IGNITER	
● FACE DIAMETER	17.74 IN.
● INJECTOR CONFIGURATION	CONCENTRIC ORIFICE
● NUMBER OF ELEMENTS	525
● NUMBER OF FLOW SHIELDS	42
● NUMBER OF BAFFLE ELEMENTS	75
● BAFFLE ELEMENT LENGTH	2 IN.

OPERATING PARAMETERS (RPL, MR-6.026)

	100%	109%
● CHAMBER PRESSURE (PSIA)	3006	3277
● OXIDIZER FLOWRATE (LB/SEC)	792.4	856.1
● HOT GAS FLOWRATE (LB/SEC)	225.8	252.4
● COOLANT FLOWRATE (LB/SEC)		
● PRIMARY FACEPLATE	4.3	5.0
● SECONDARY FACEPLATE	2.9	3.4
● BAFFLES	16.5	18.5

FIGURE 2-11. MAIN INJECTOR (SHEET 2 OF 2)

MAIN INJECTOR ELEMENT

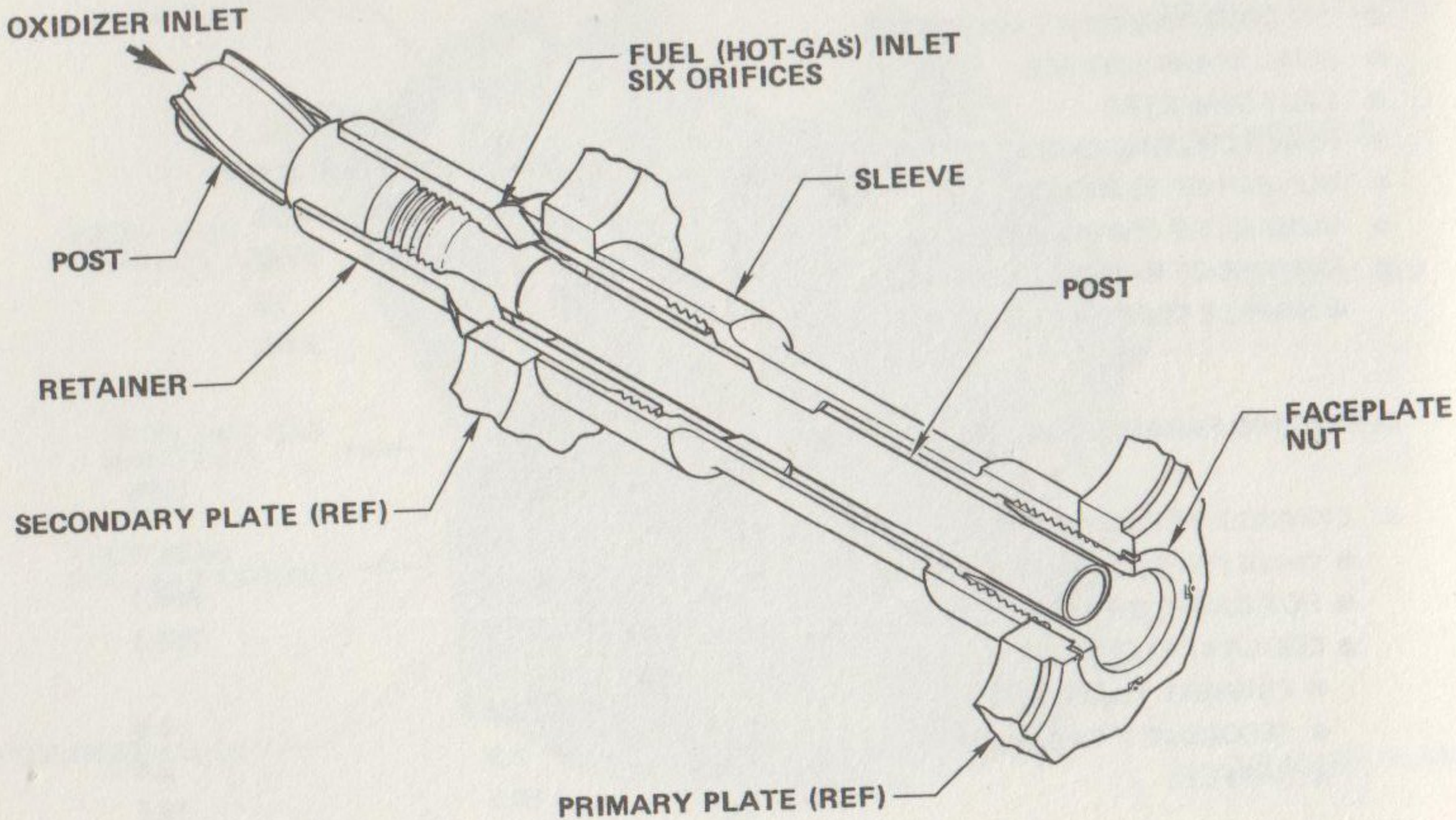


FIGURE 2-12. MAIN INJECTOR ELEMENTS (SHEET 1 OF 2)

MAIN INJECTOR BAFFLE ELEMENT

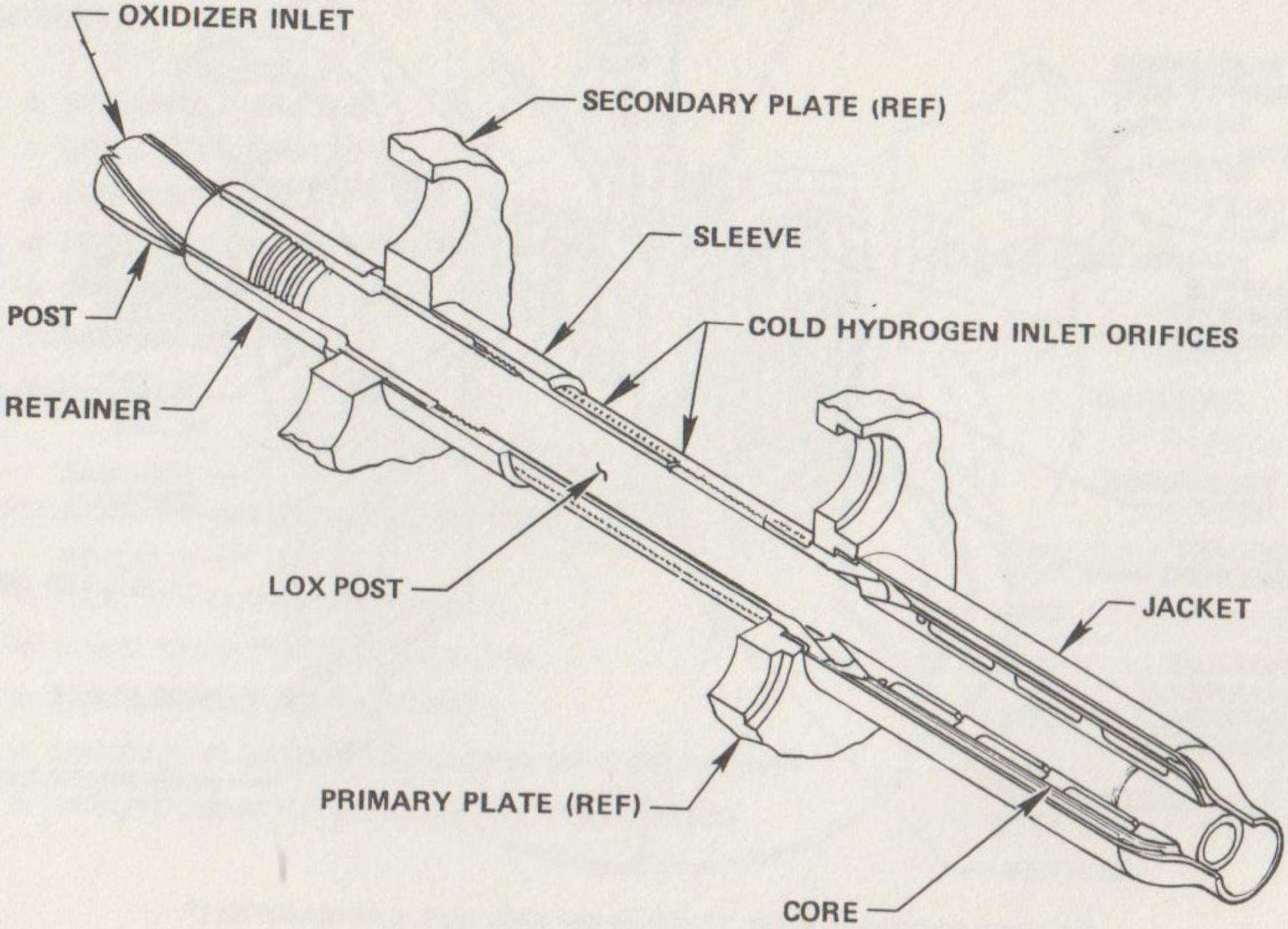


FIGURE 2-12. MAIN INJECTOR ELEMENTS (SHEET 2 OF 2)

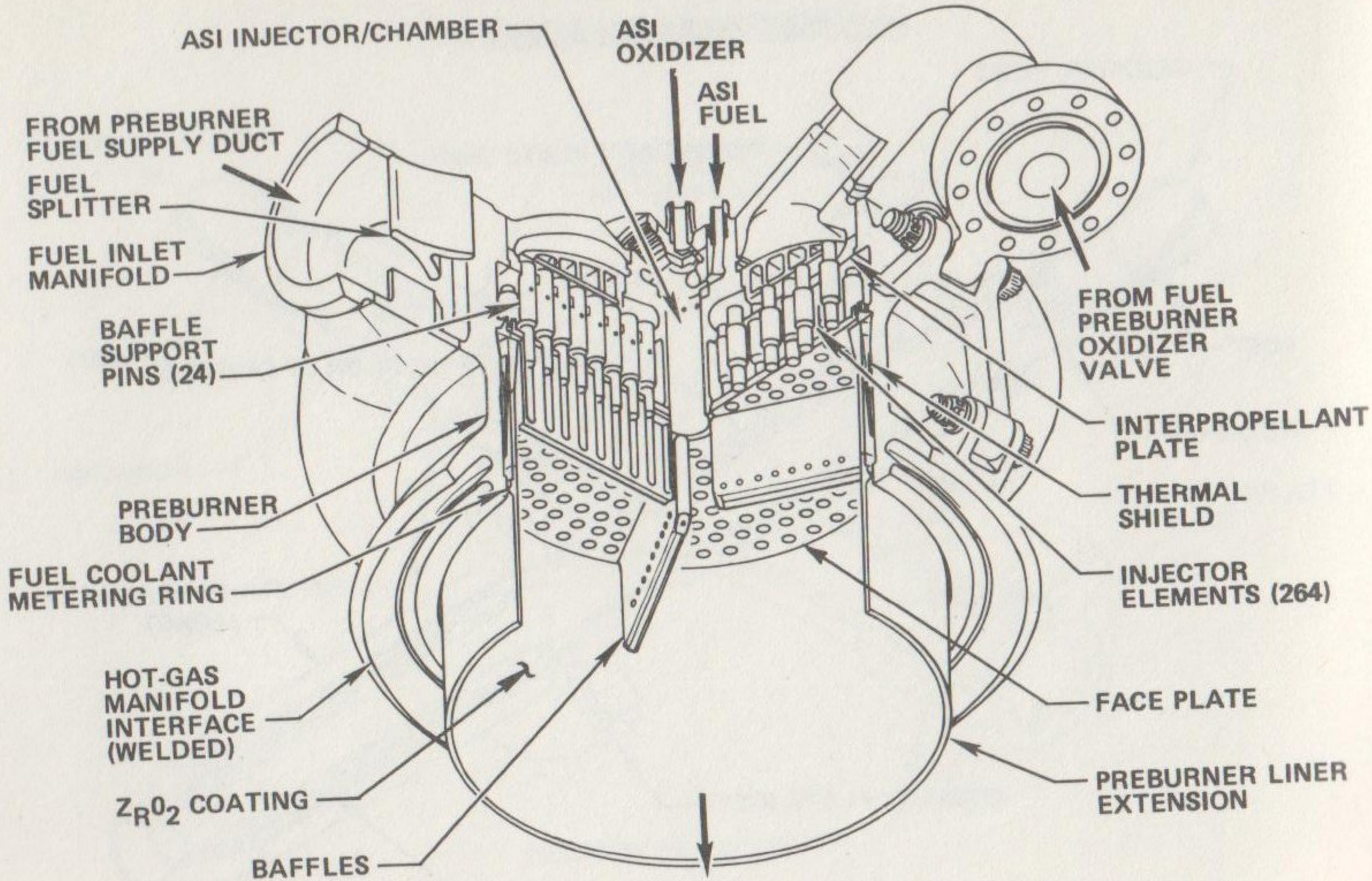


FIGURE 2-13. FUEL PREBURNER (SHEET 1 OF 2)

GEOMETRY

● INTERNAL DIAMETER	10.43 IN.
● COMBUSTOR LENGTH	4.37 IN.
● INCO 625 FACEPLATE	
● INJECTOR CONFIGURATION	CONCENTRIC ORIFICE
● NUMBER OF ELEMENTS	264
● BAFFLE LENGTH	2.25 IN.
● MATERIAL	NARLOY-A

OPERATING PARAMETERS (RPL, MR-6.026)

	100%	109%
● INJECTOR END PRESSURE (PSIA)	4868	5462
● COMBUSTION TEMPERATURE (^{o}R)	1794	1904
● HOT GAS MIXTURE RATIO (O/F)	0.9152	0.9813
● OXIDIZER FLOWRATE (INCLUDING IGNITER) (LB/SEC)	75.80	87.97
● FUEL FLOWRATE (INCLUDING IGNITER) (LB/SEC)	82.83	89.64

FIGURE 2-13. FUEL PREBURNER (SHEET 2 OF 2)

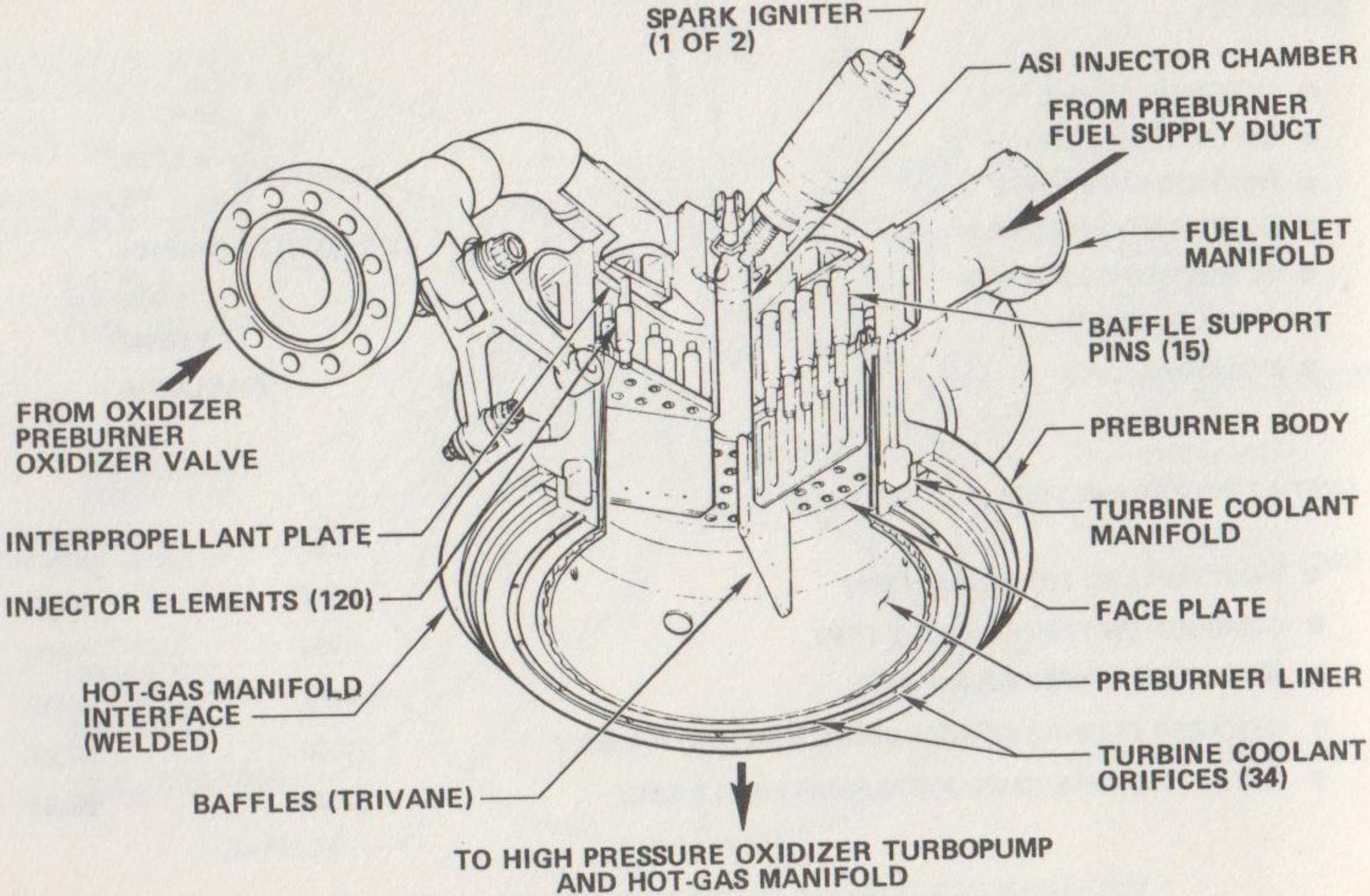


FIGURE 2-14. OXIDIZER PREBURNER (SHEET 1 OF 2)

GEOMETRY

● INTERNAL DIAMETER	7.43 IN.
● COMBUSTOR LENGTH	4.25 IN.
● INCO 625 FACEPLATE	
● INJECTOR CONFIGURATION	CONCENTRIC ORIFICE
● NUMBER OF ELEMENTS	120
● BAFFLE LENGTH	2.25 IN.
● MATERIAL	NARLOY-A

OPERATING PARAMETERS (RPL, MR-6.0)

	100%	109%
● CHAMBER PRESSURE (PSIA)	5039	5654
● COMBUSTION TEMPERATURE (^{o}R)	1522	1625
● HOT GAS MIXTURE RATIO (O/F)	0.7453	0.8051
● OXIDIZER FLOWRATE (INCLUDING IGNITER) (LB/SEC)	25.11	29.21
● FUEL FLOWRATE (INCLUDING IGNITER) (LB/SEC)	35.16	37.92

FIGURE 2-14. OXIDIZER PREBURNER (SHEET 2 OF 2)

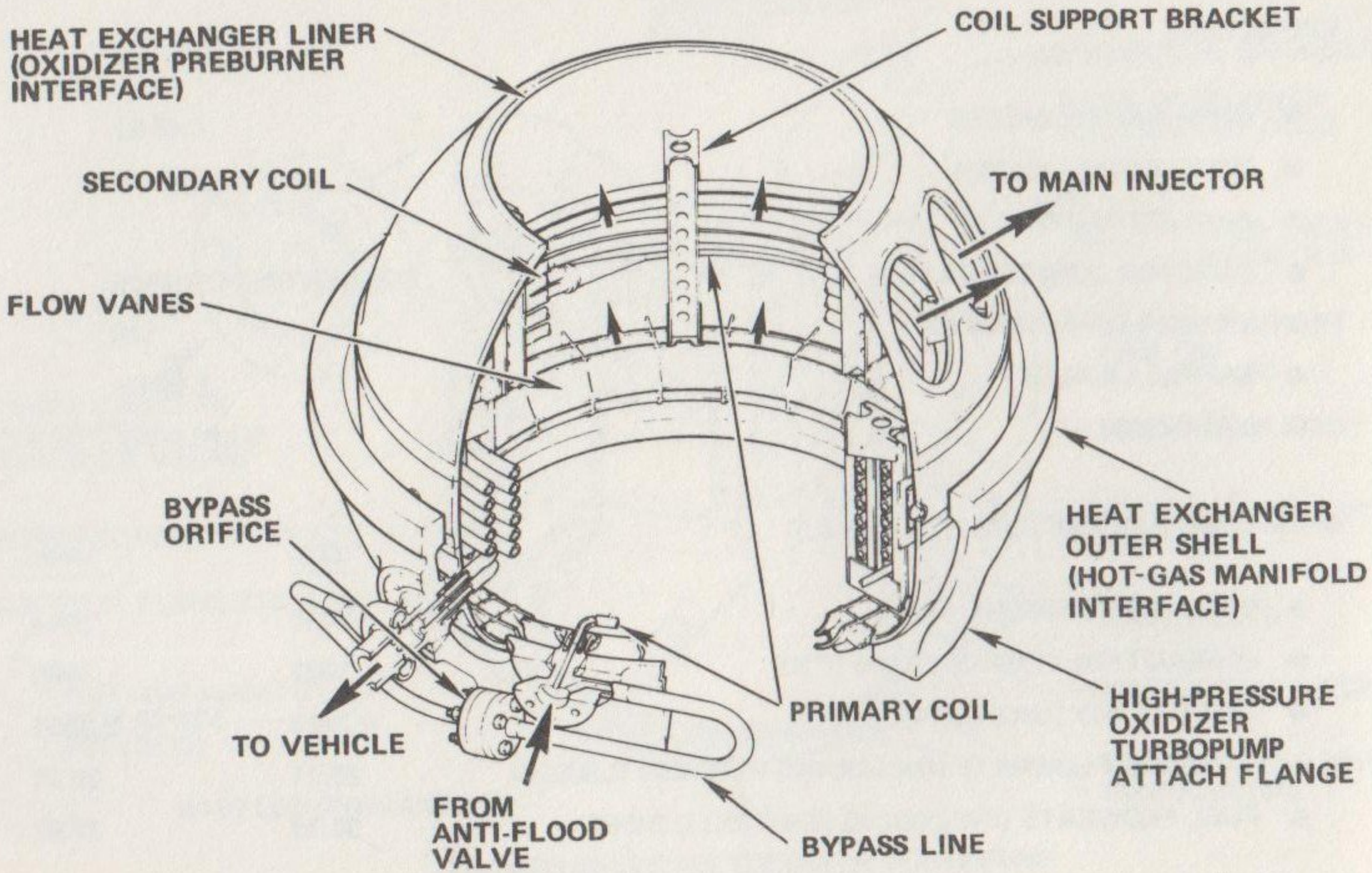


FIGURE 2-15. HEAT EXCHANGER (SHEET 1 OF 2)

- SUPPLIES HOT OXYGEN FOR EXTERNAL TANK AND POGO ACCUMULATOR PRESSURIZATION
- $850^{o}R$, 1.1–2.2 LB_M/SEC @ RPL TO VEHICLE PER ENGINE
- BYPASS SYSTEM, RESULTS IN SMALL $\frac{\partial T}{\partial W}$
- HEATED BY HPOTP TURBINE EXHAUST GASES ($1370^{o}R$ @ RPL)
- HEAT LOAD = 1.08 1.91 X 10^{6} BTU/HR @ RPL
- 316L CRES TUBING

  PRIMARY – .215 O.D. X .0125 W. X 2.6 FT
  SECONDARY – .382 O.D. X .0265 W. X 26.4 FT (2 EA)
- TUBES SUPPORTED BY 8 BRACKETS
- ASSEMBLY WELDED TO HGM

FIGURE 2-15. HEAT EXCHANGER (SHEET 2 OF 2)

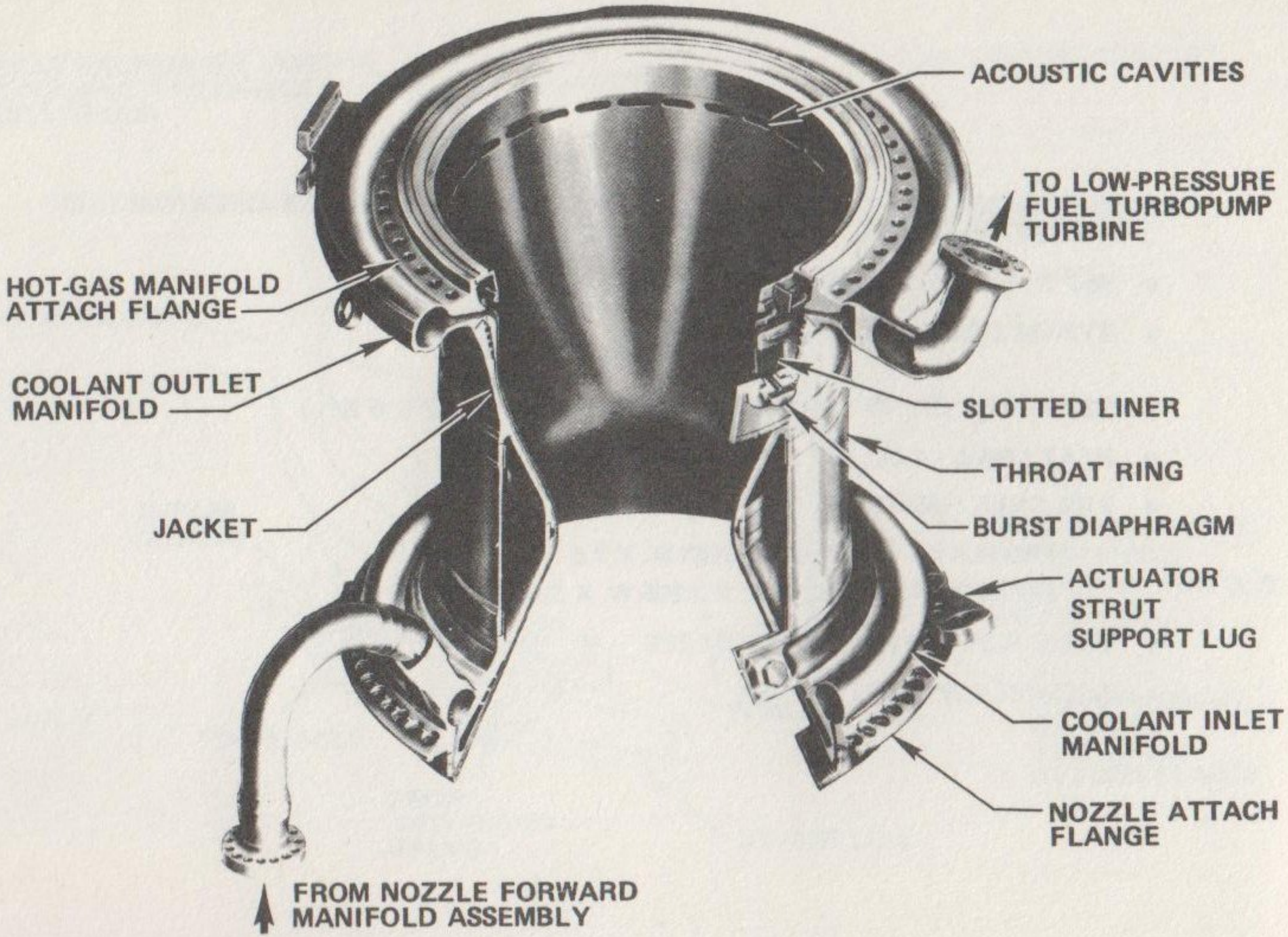


FIGURE 2-16. MAIN COMBUSTION CHAMBER (SHEET 1 OF 2)

GEOMETRY

- NARLOY Z LINER + EDCu BARRIER + EDNi CLOSE-OUT + INCO 718 STRUCTURE SHELL
- NUMBER OF SLOTS 390
- NUMBER OF ACOUSTIC CAVITIES 30
- INJECTOR END DIAMETER 17.74 IN.
- THROAT AREA 83.41 IN.^{2}
- INJECTOR END TO THROAT LENGTH 14.00 IN.
- CONTRACTION RATIO 2.96:1
- EXPANSION RATIO 5.0:1

OPERATING PARAMETERS (RPL, MR-6.0)

	100%	109%
THROAT STAGNATION PRESSURE (PSIA)	3010	3282
COOLANT INLET PRESSURE (PSIA)	5978	6718
COOLANT INLET TEMPERATURE (^{o}R)	95	101
COOLANT EXIT PRESSURE (PSIA)	4756	5315
COOLANT EXIT TEMPERATURE (^{o}R)	493	479
COOLANT FLOWRATE (LB/SEC)	26.09	29.46
HOT-GAS WALL TEMPERATURE AT THROAT (^{o}F)	1000	1000

FIGURE 2-16. MAIN COMBUSTION CHAMBER (SHEET 2 OF 2)

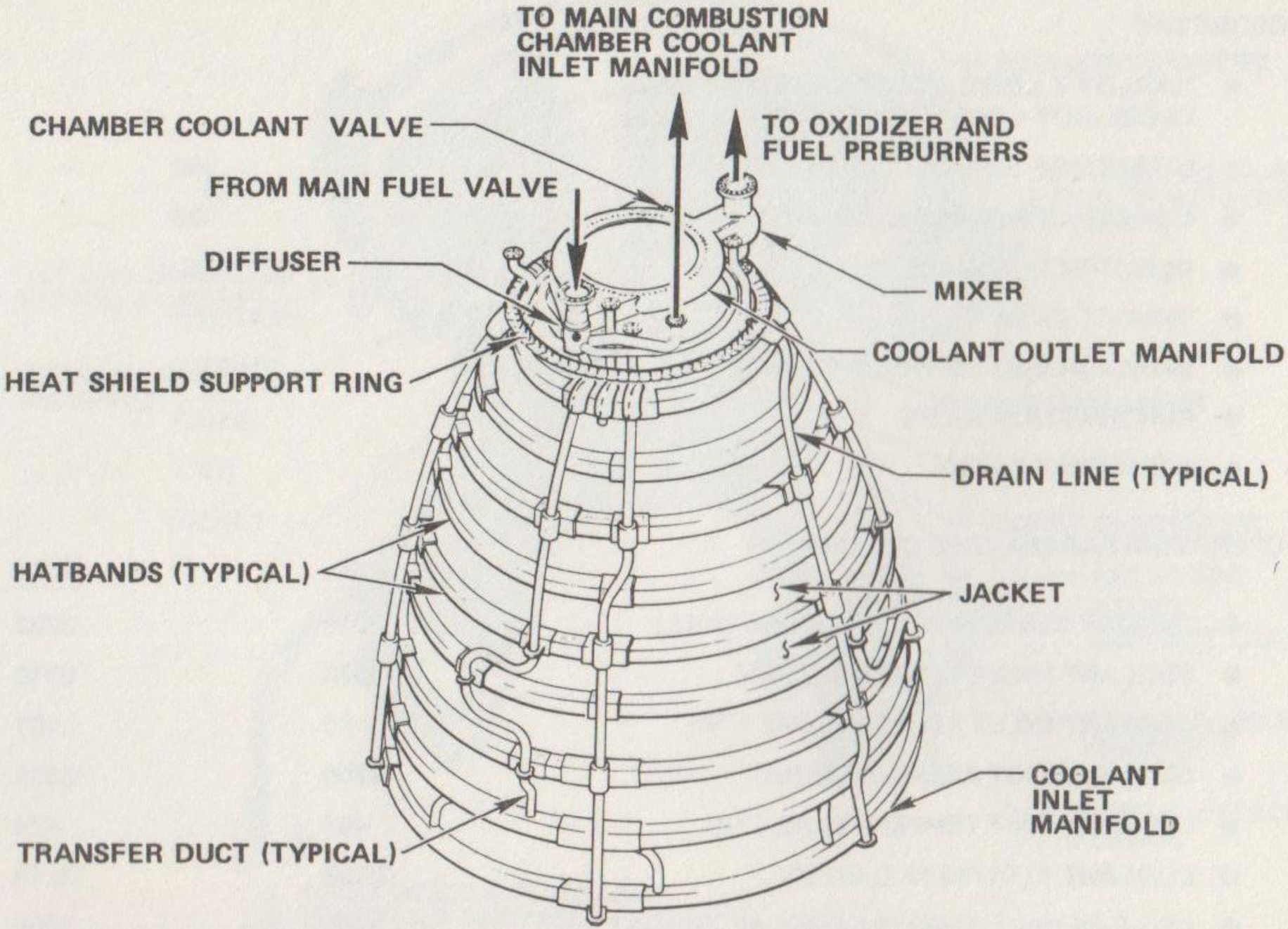


FIGURE 2-17. NOZZLE (SHEET 1 OF 2)

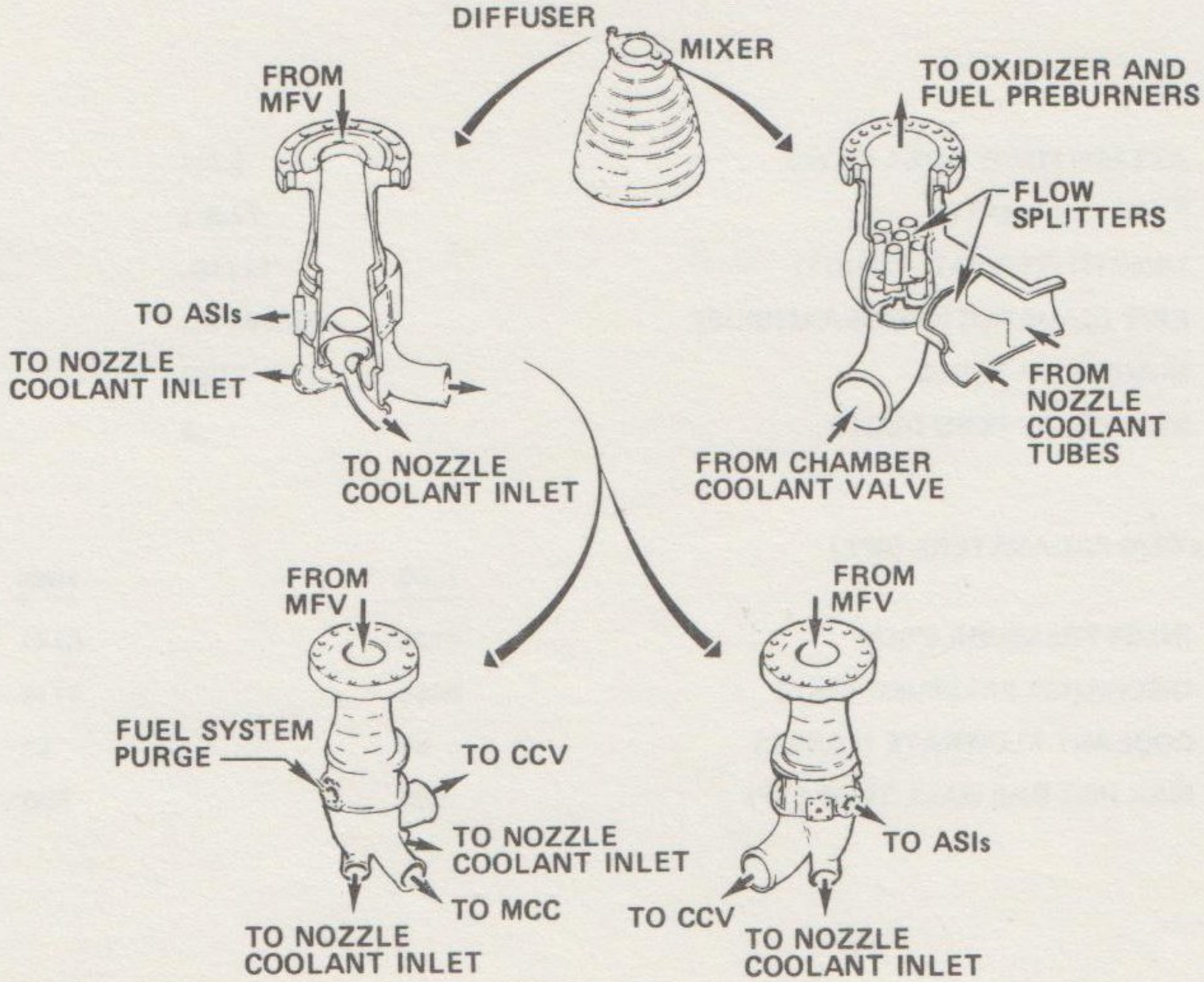


FIGURE 2-17. NOZZLE (SHEET 2 OF 2)

GEOMETRY

● ATTACH POINT AREA RATIO	5.0:1
● EXIT AREA RATIO	77.5:1
● LENGTH (THROAT TO EXIT)	121 IN.
● EXIT DIAMETER (INSIDE/OUTSIDE)	90.7/94 IN.
● NUMBER OF TUBES	1,080
● NUMBER OF FEED DUCTS	3

OPERATING PARAMETERS (RPL)

	100%	109%
● INLET PRESSURE (PSIA)	5999	6741
● DISCHARGE PRESSURE (PSIA)	5460	6110
● COOLANT FLOWRATE (LB/SEC)	54	63
● MAX HOT-GAS WALL TEMP (^{o}F)	880	880

FIGURE 2-18. NOZZLE DIFFUSER AND MIXER

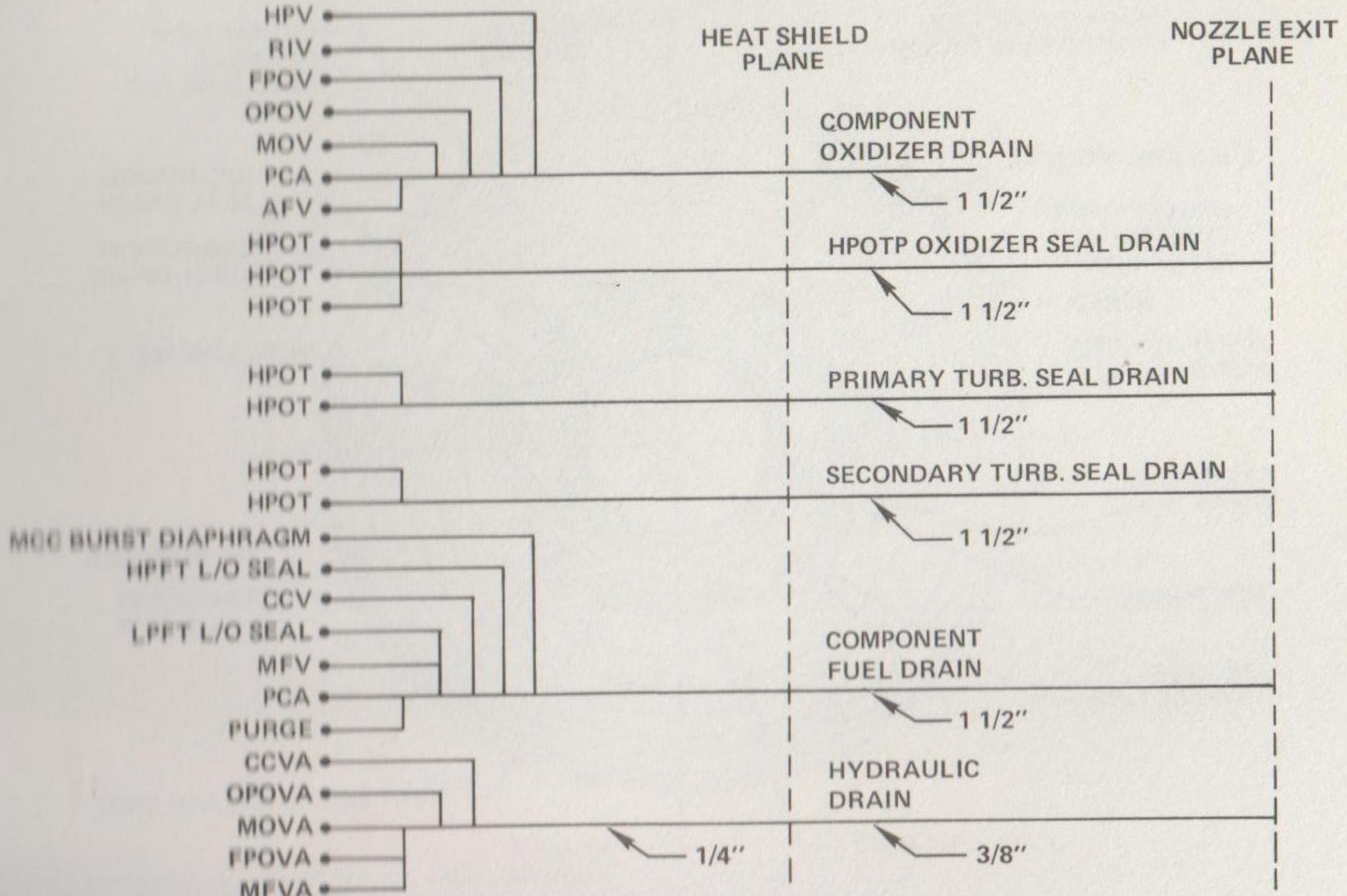


FIGURE 2-19. SSME DRAIN LINE SCHEMATIC

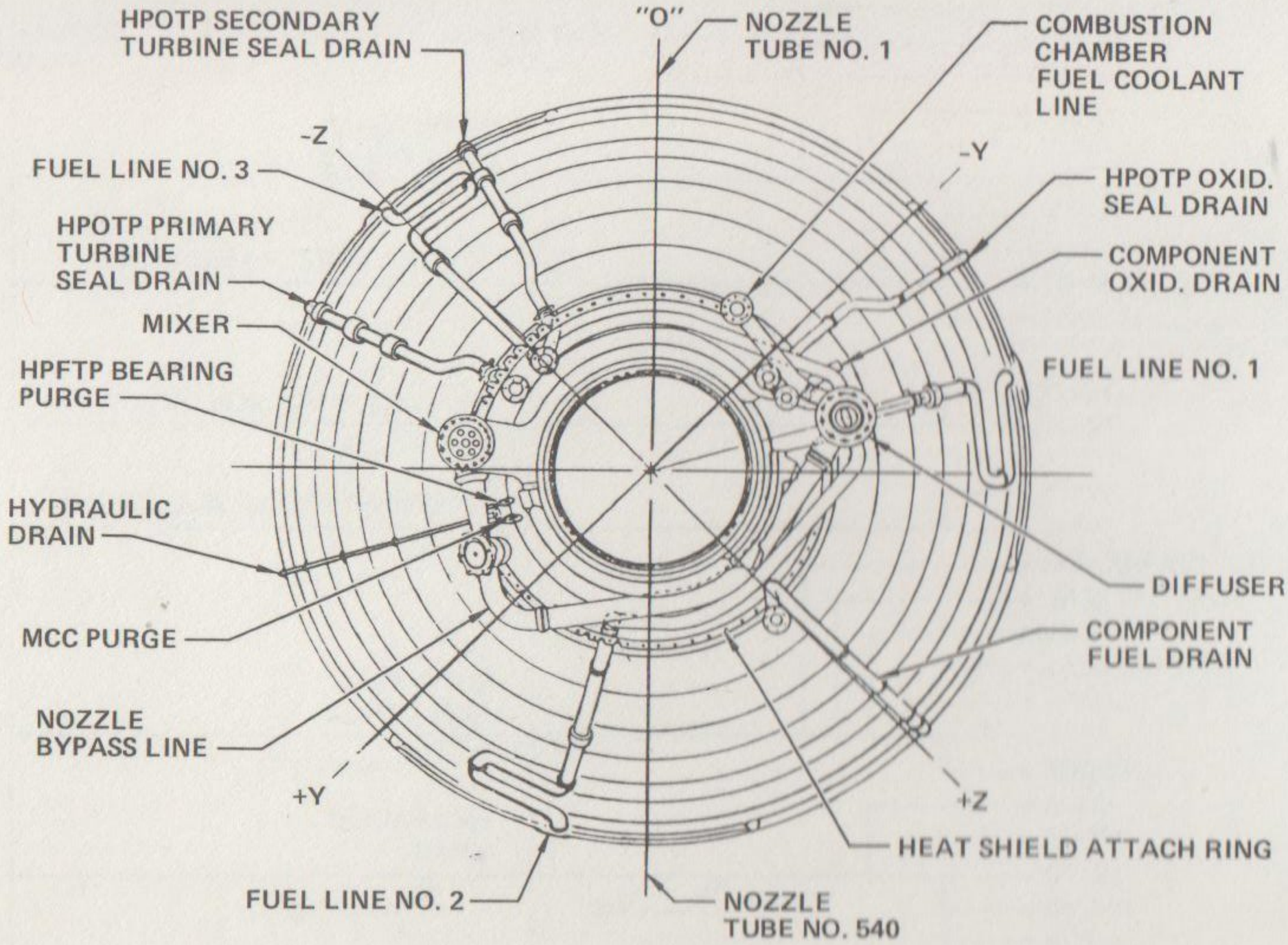


FIGURE 2-20. FLIGHT NOZZLE FEATURES

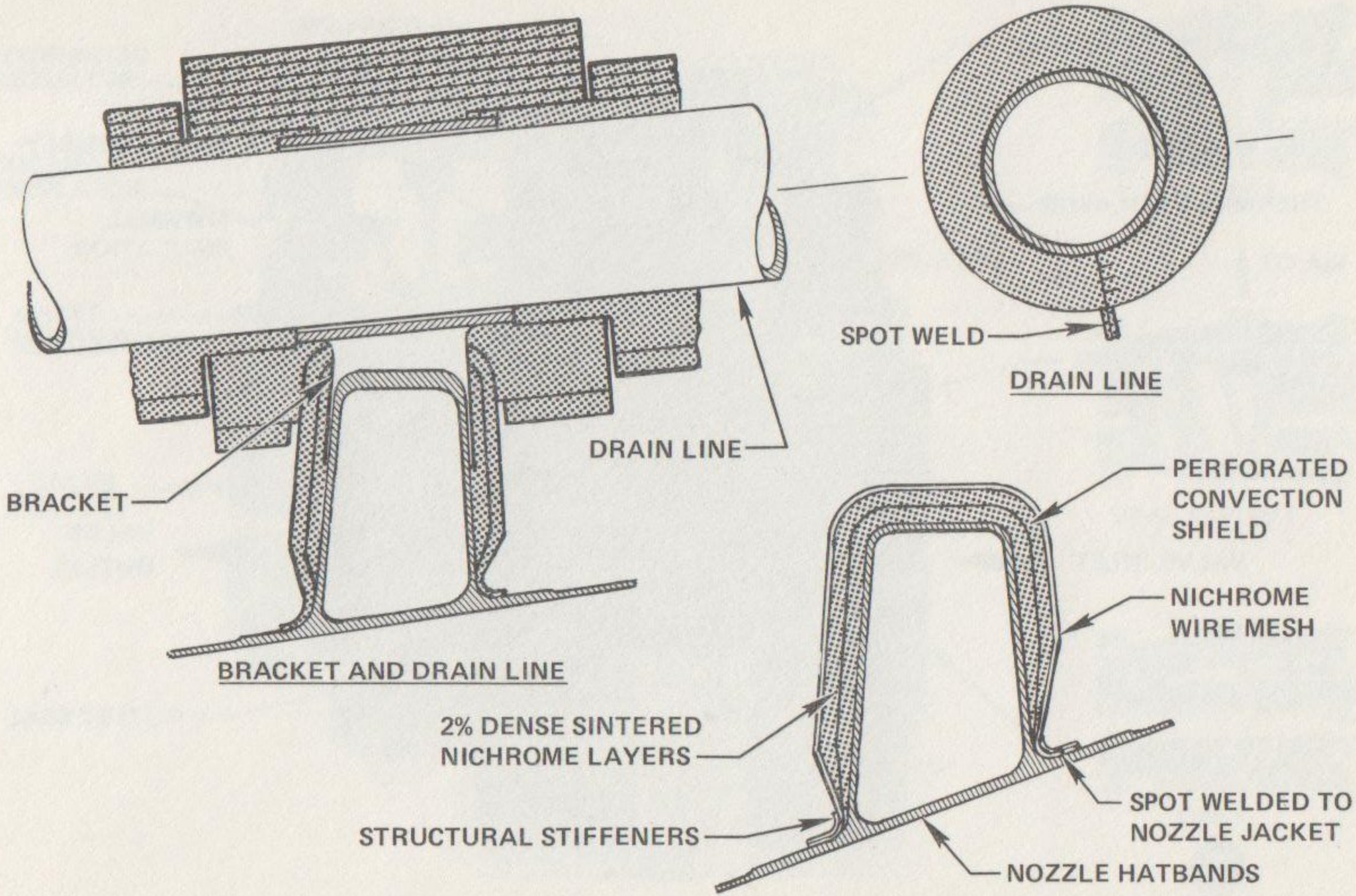


FIGURE 2-21. NOZZLE THERMAL PROTECTION INSULATION CONFIGURATION

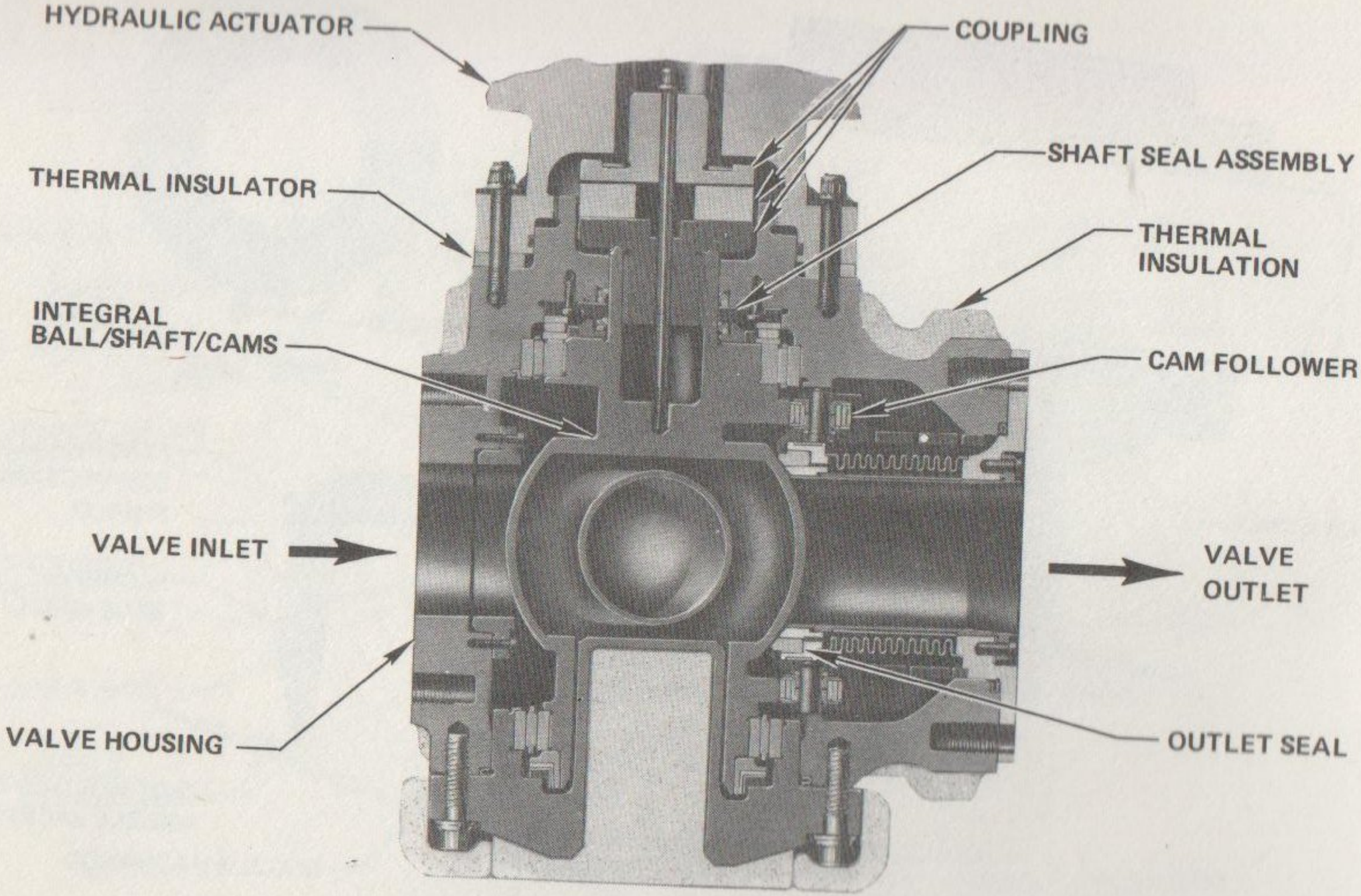


FIGURE 2-22. MAIN FUEL VALVE

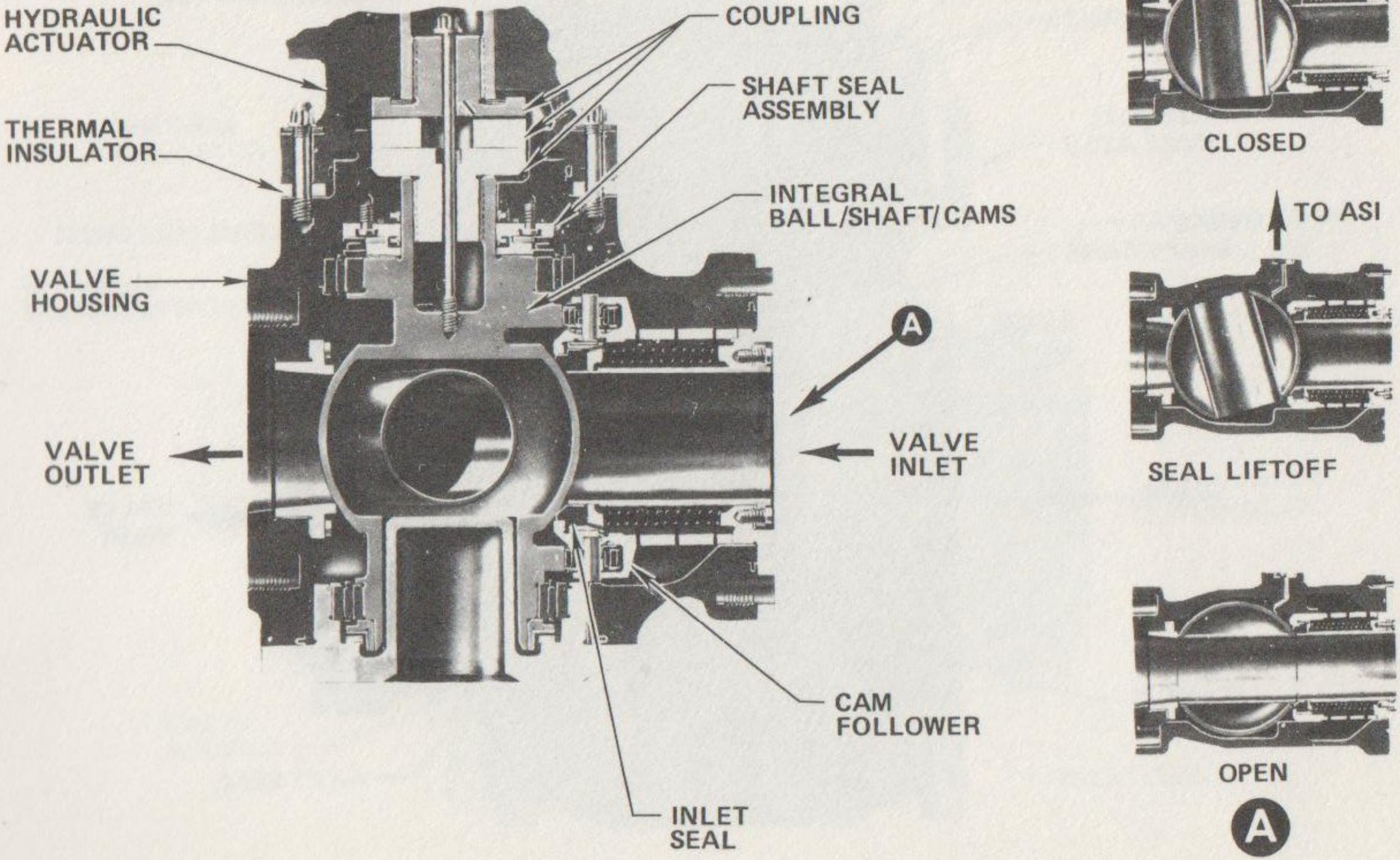


FIGURE 2-23. MAIN OXIDIZER VALVE

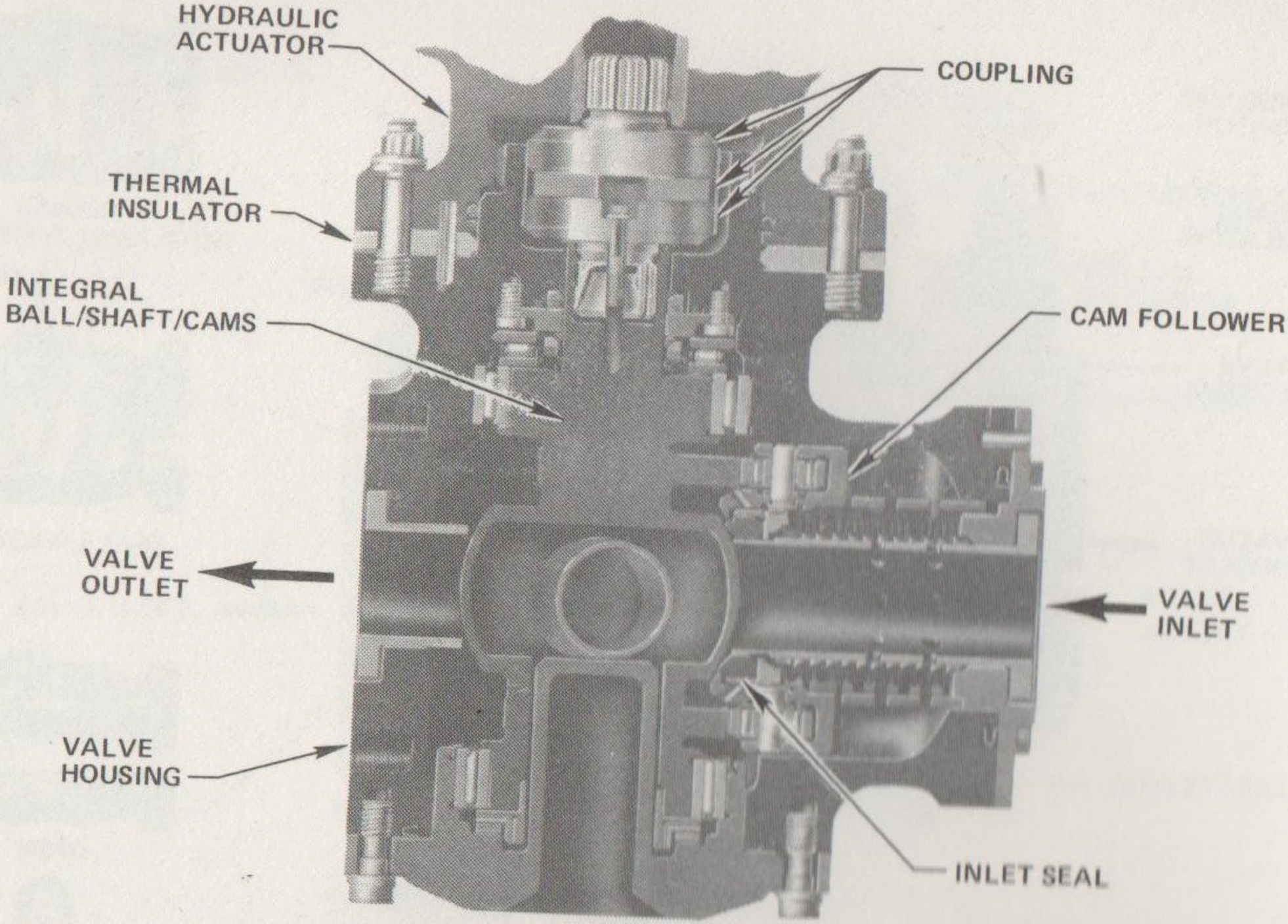


FIGURE 2-24. FUEL PREBURNER OXIDIZER VALVE

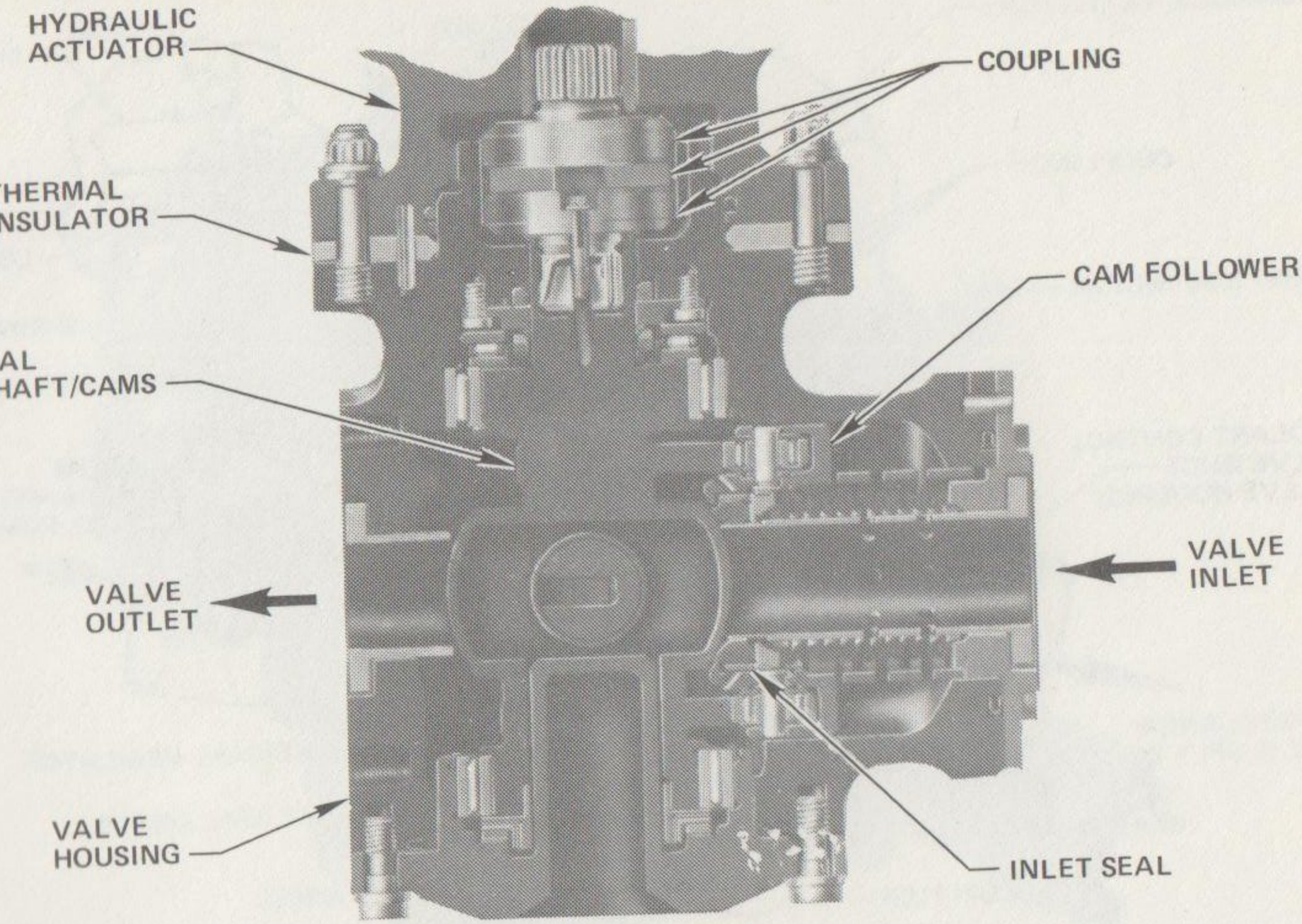


FIGURE 2-25. OXIDIZER PREBURNER OXIDIZER VALVE

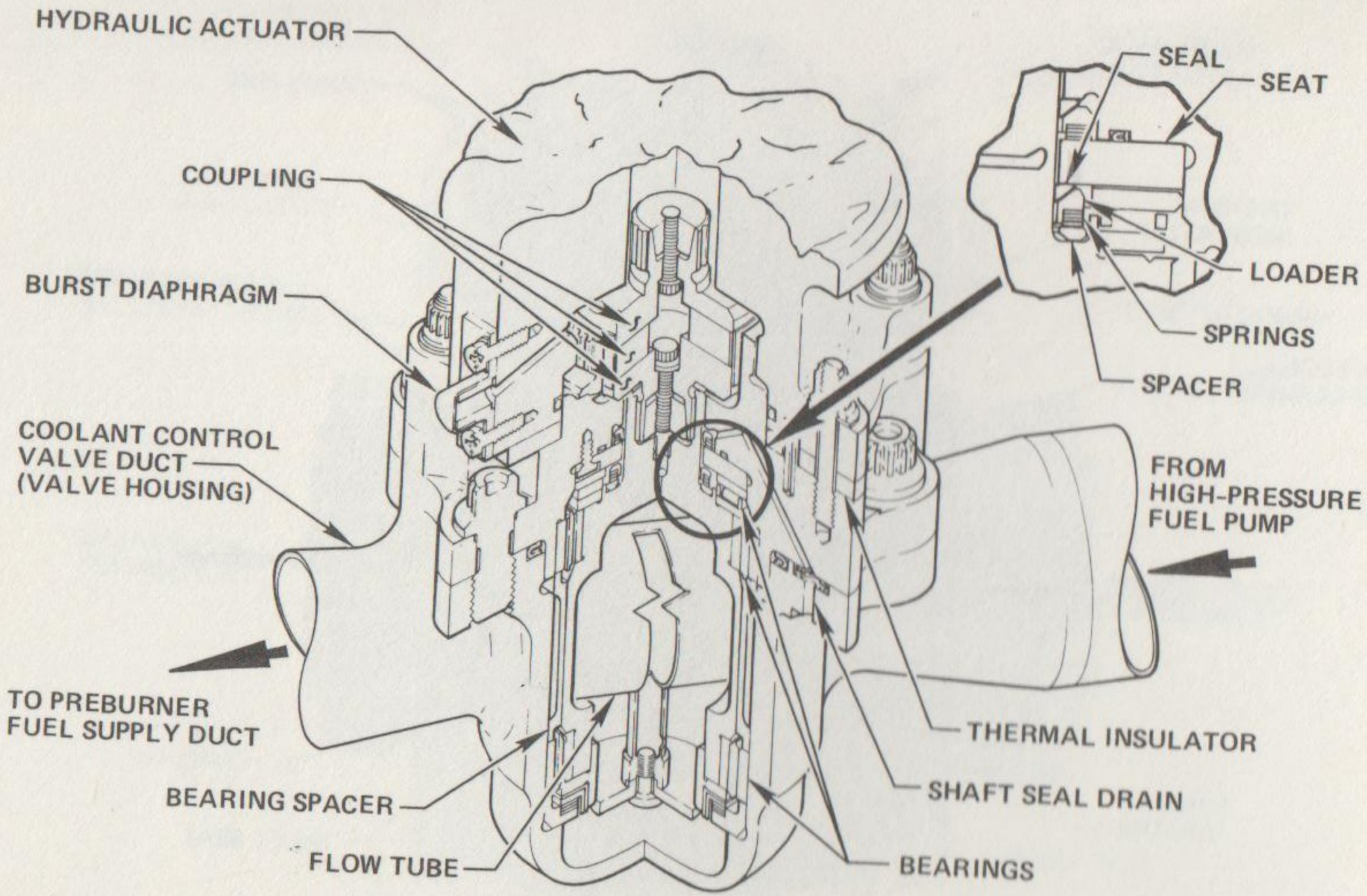


FIGURE 2-26. CHAMBER COOLANT VALVE

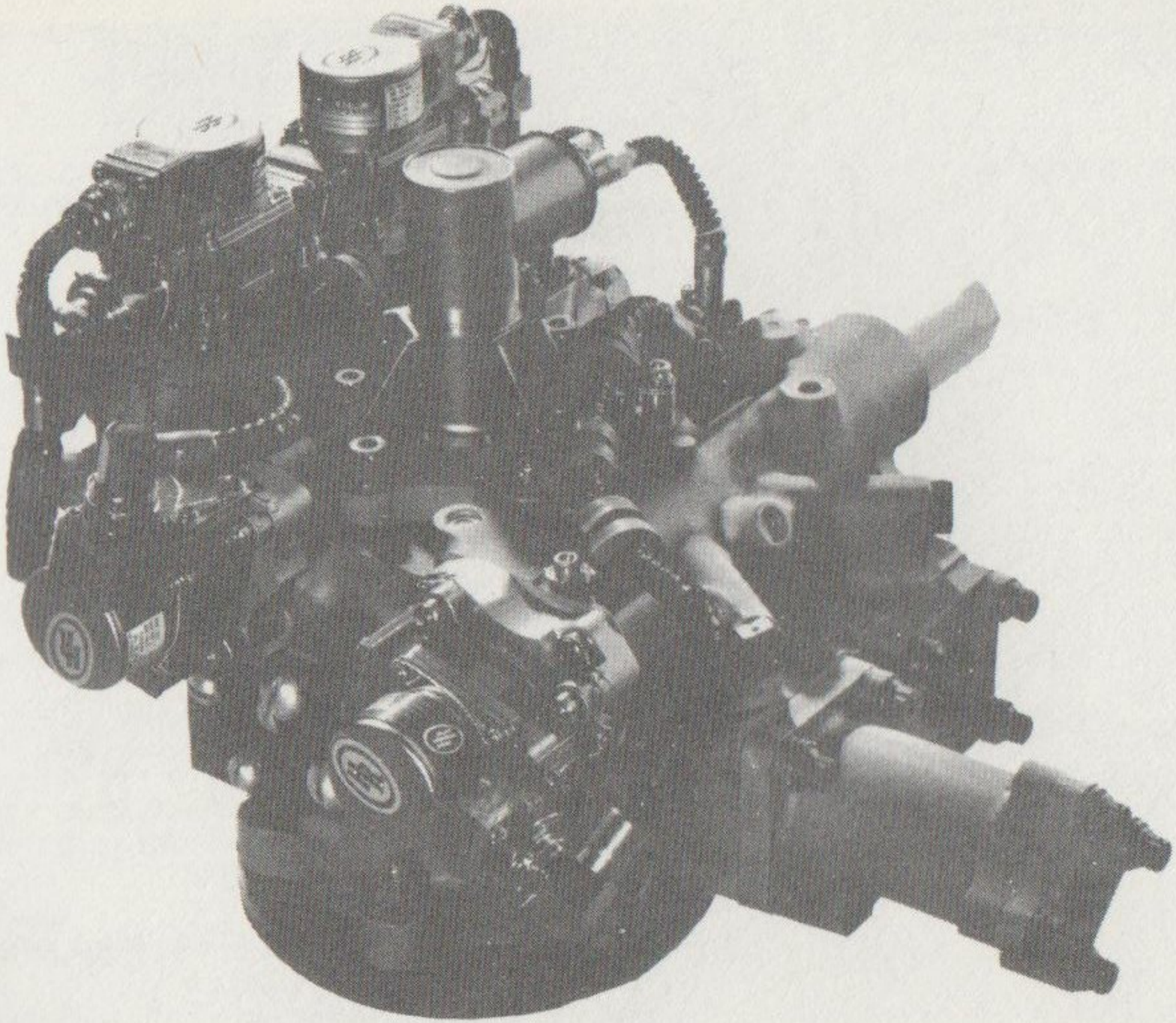
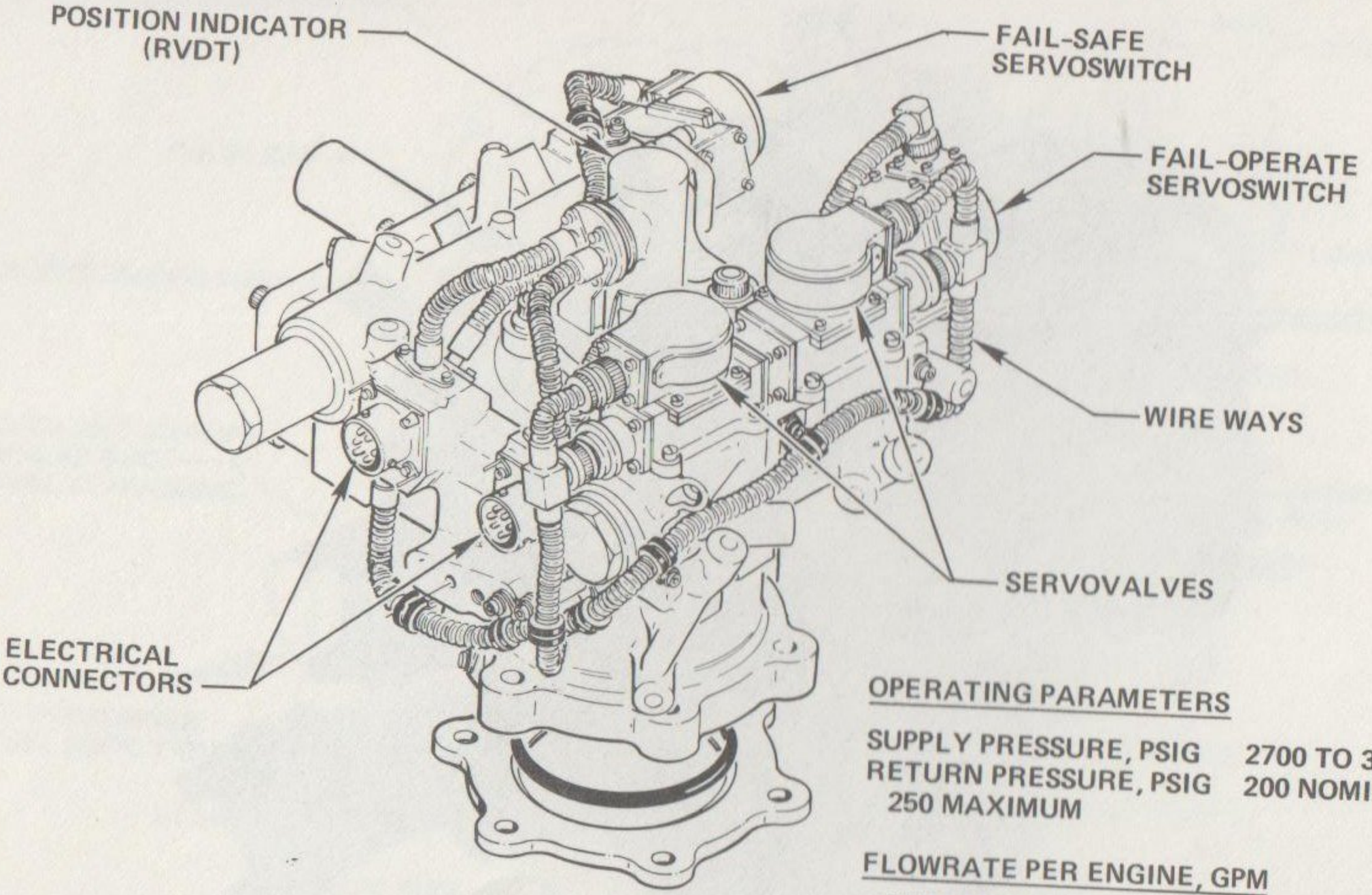


FIGURE 2-27. PROPELLANT VALVE HYDRAULIC ACTUATOR (TYPICAL) (SHEET 1 OF 2)



OPERATING PARAMETERS

SUPPLY PRESSURE, PSIG	2700 TO 3100
RETURN PRESSURE, PSIG	200 NOMINAL,
250 MAXIMUM	

FLOWRATE PER ENGINE, GPM

STEADY STATE	2 MINIMUM
TRANSIENT	12

FIGURE 2-27. PROPELLANT VALVE HYDRAULIC ACTUATOR (TYPICAL) (SHEET 2 OF 2)

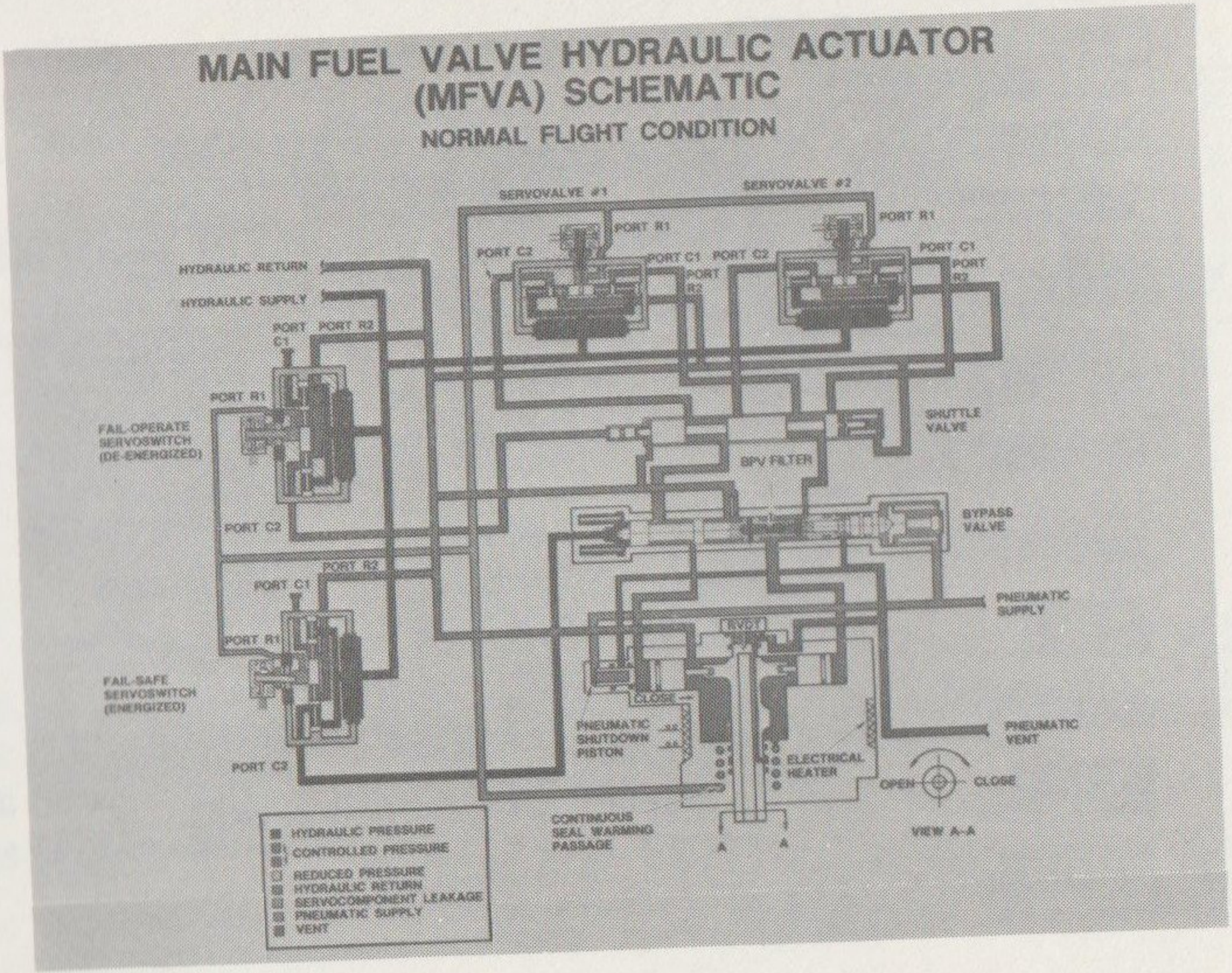


FIGURE 2-28. SSME HYDRAULIC SCHEMATIC

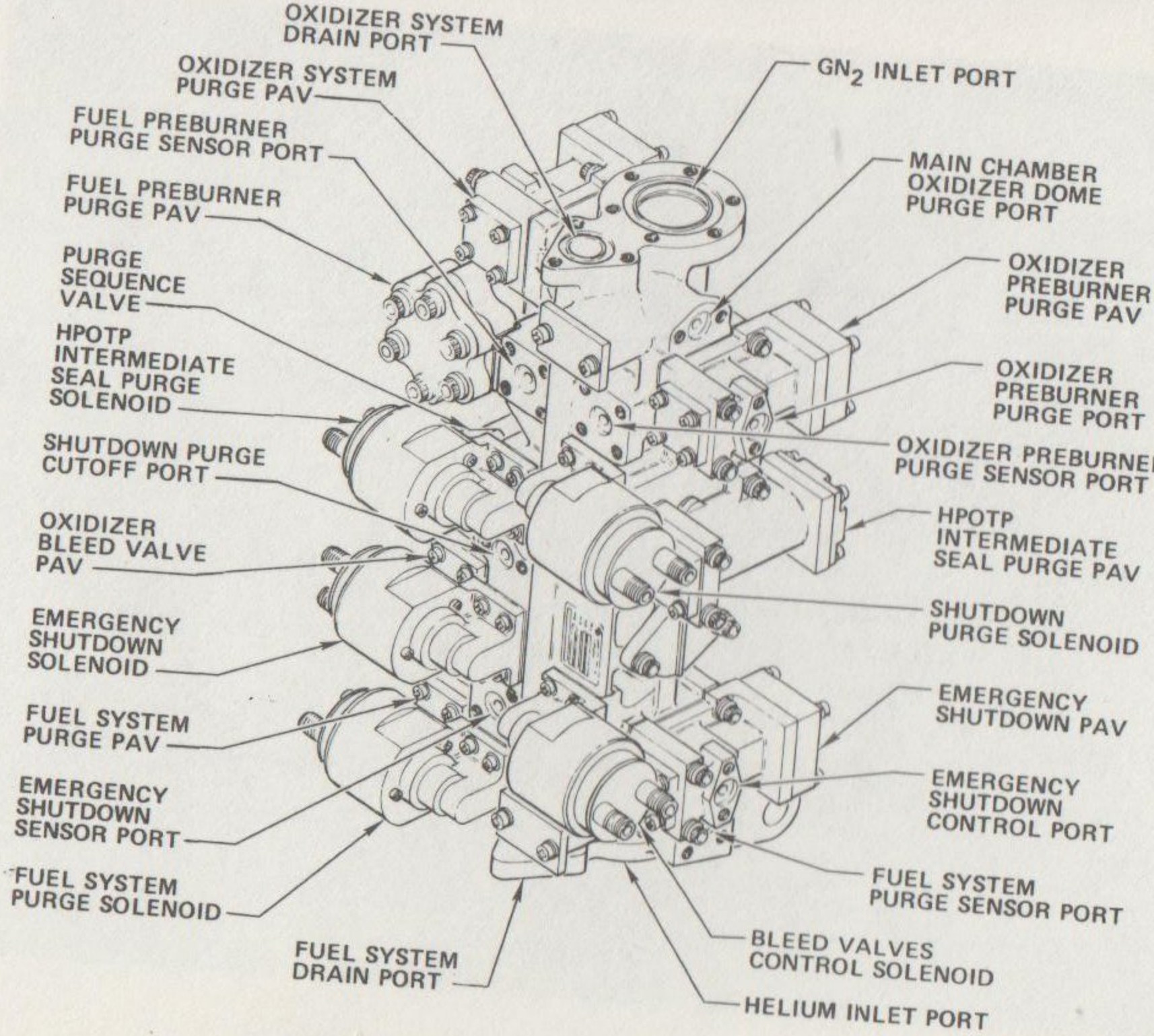


FIGURE 2-29. PNEUMATIC CONTROL ASSEMBLY

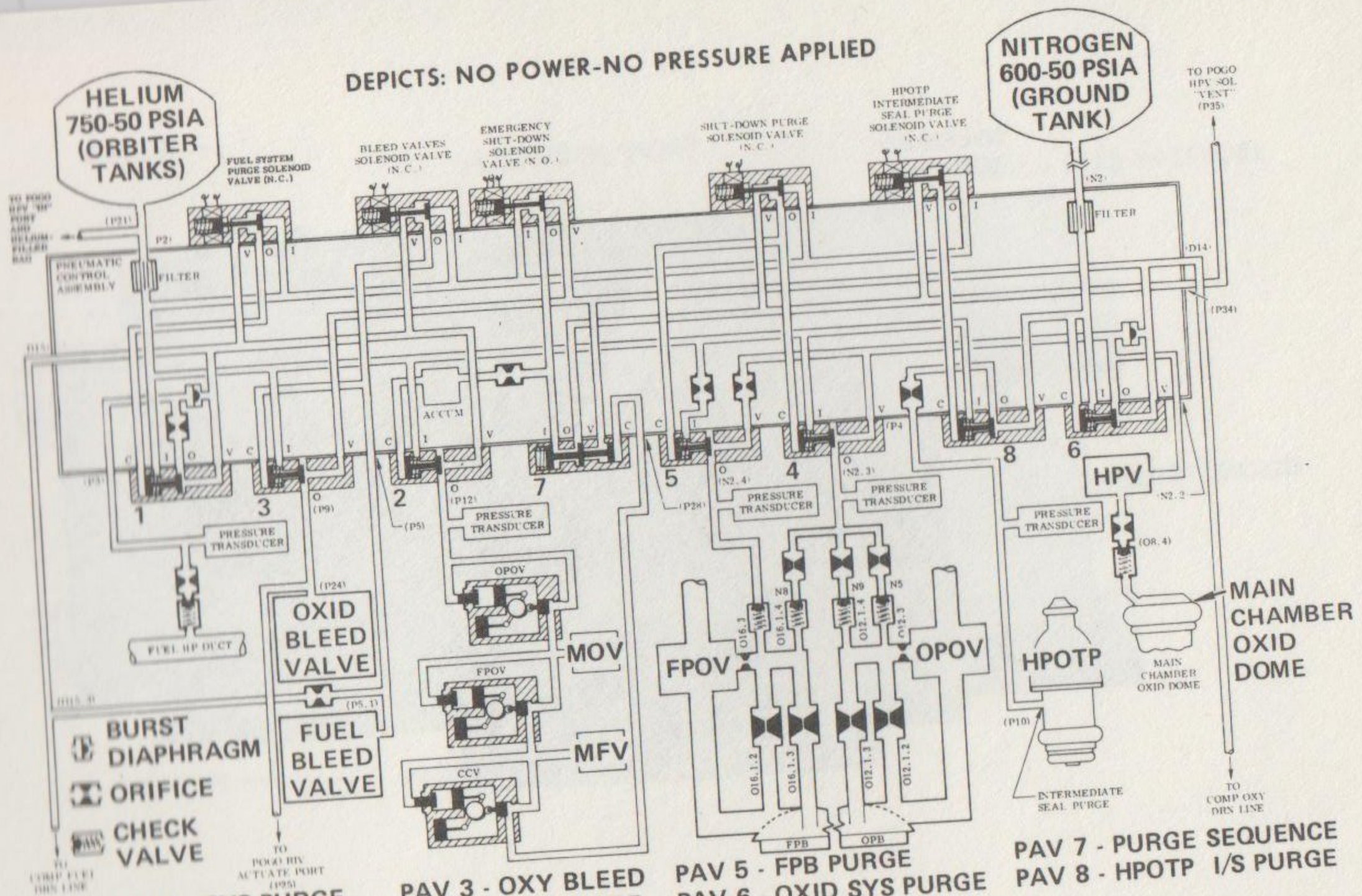


FIGURE 2-30. SSME PNEUMATIC SCHEMATIC

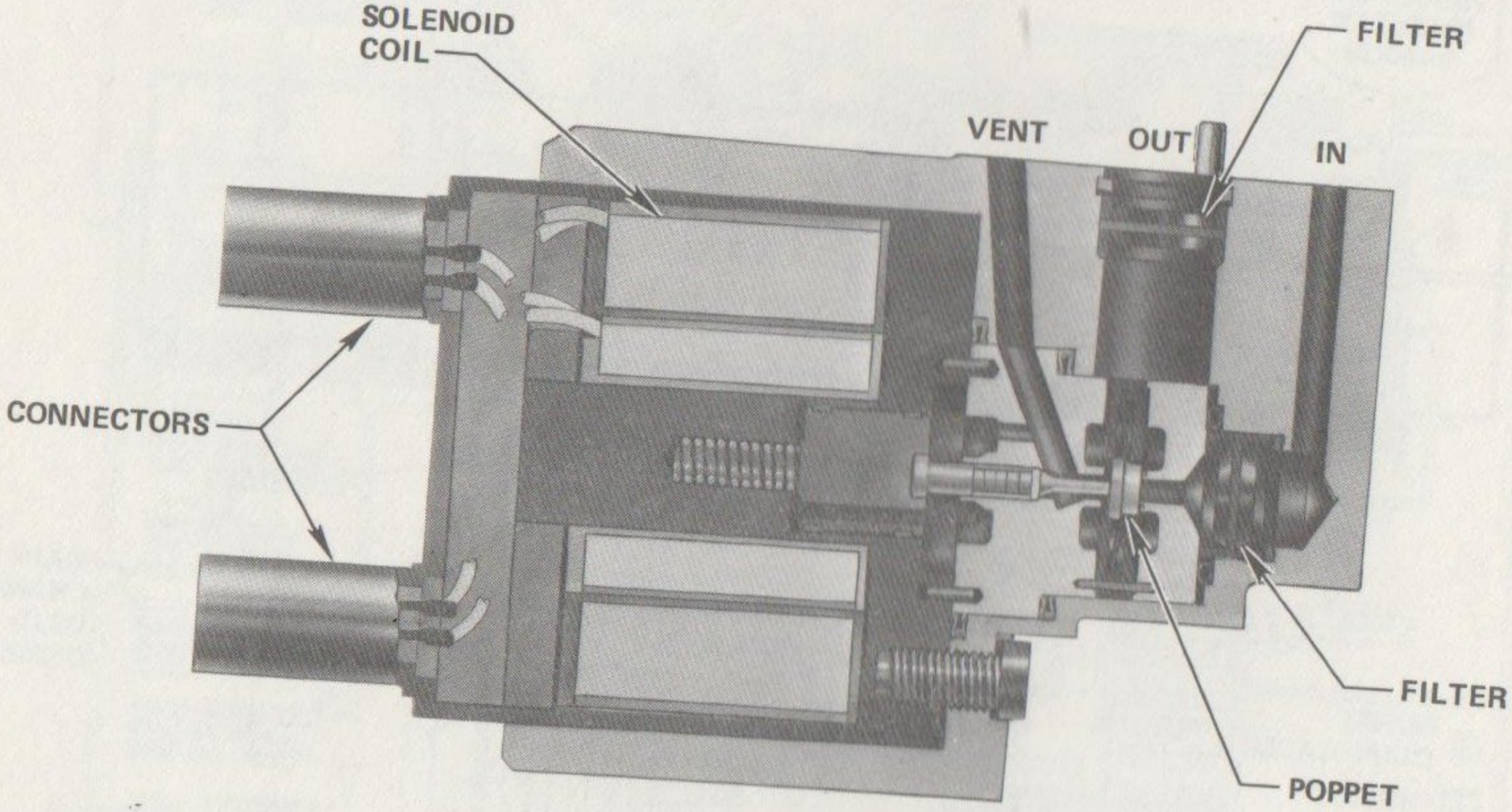


FIGURE 2-31. NORMALLY CLOSED DUAL COIL SOLENOID VALVE

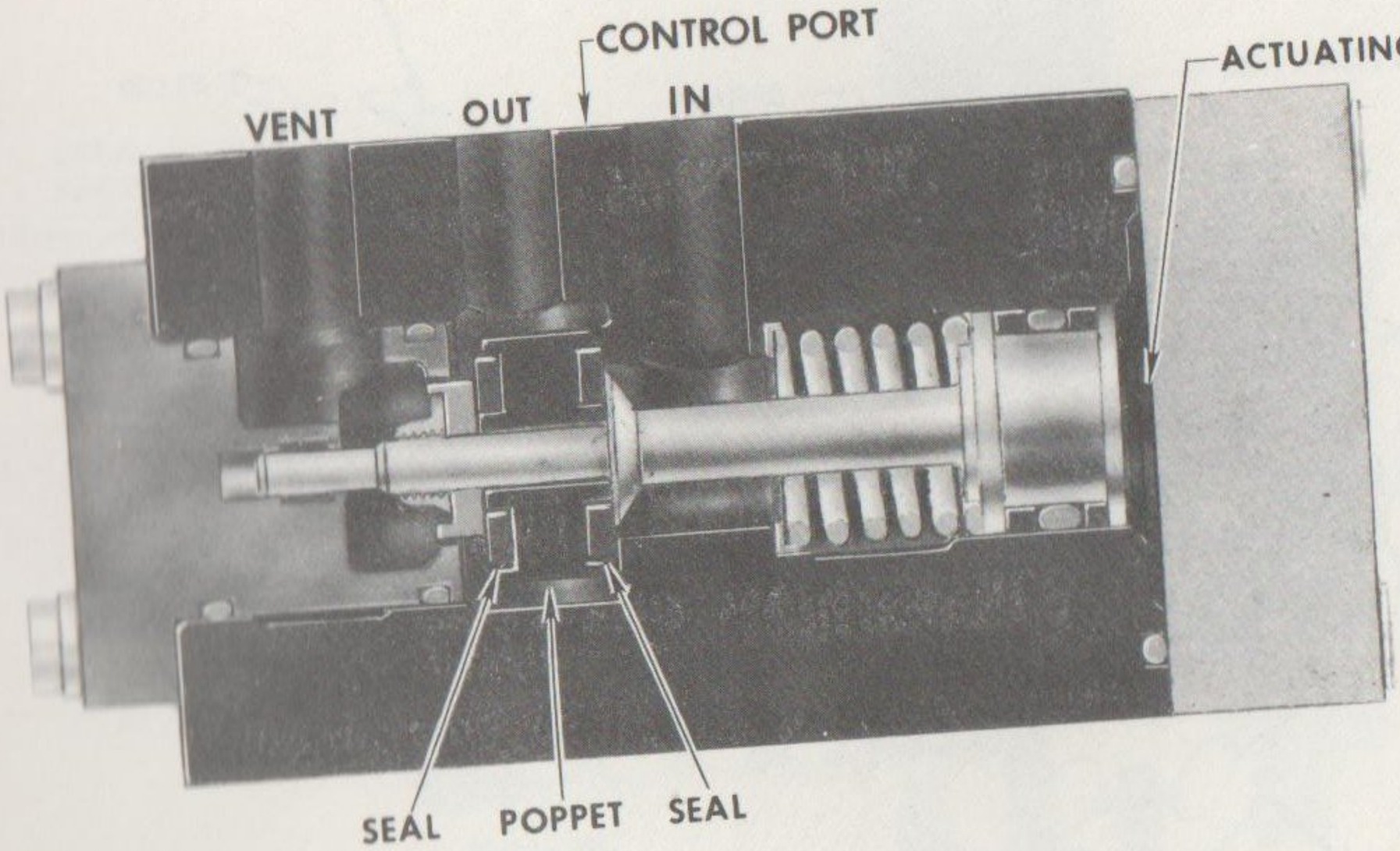


FIGURE 2-32. PRESSURE ACTUATED VALVE

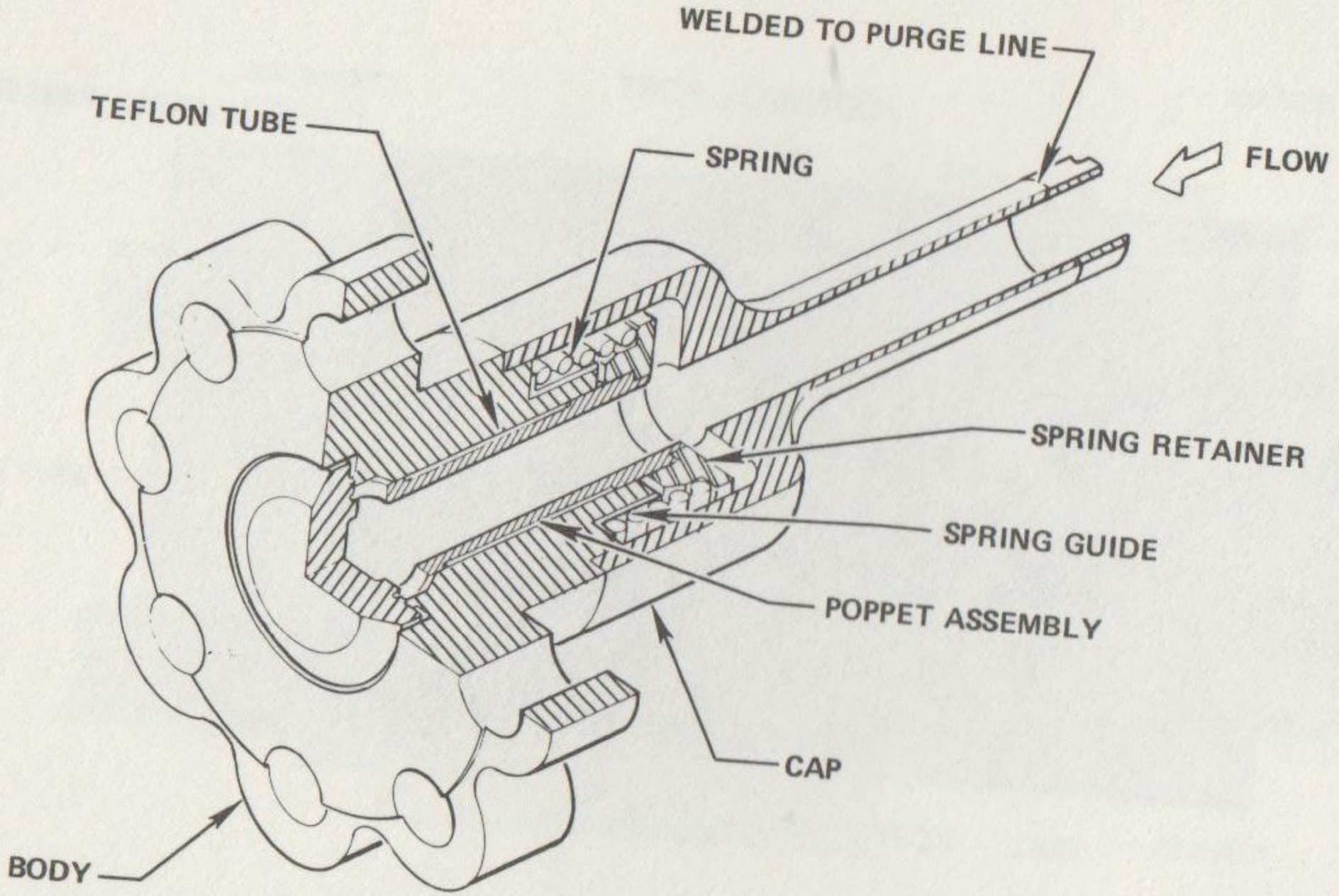


FIGURE 2-33. PURGE CHECK VALVES

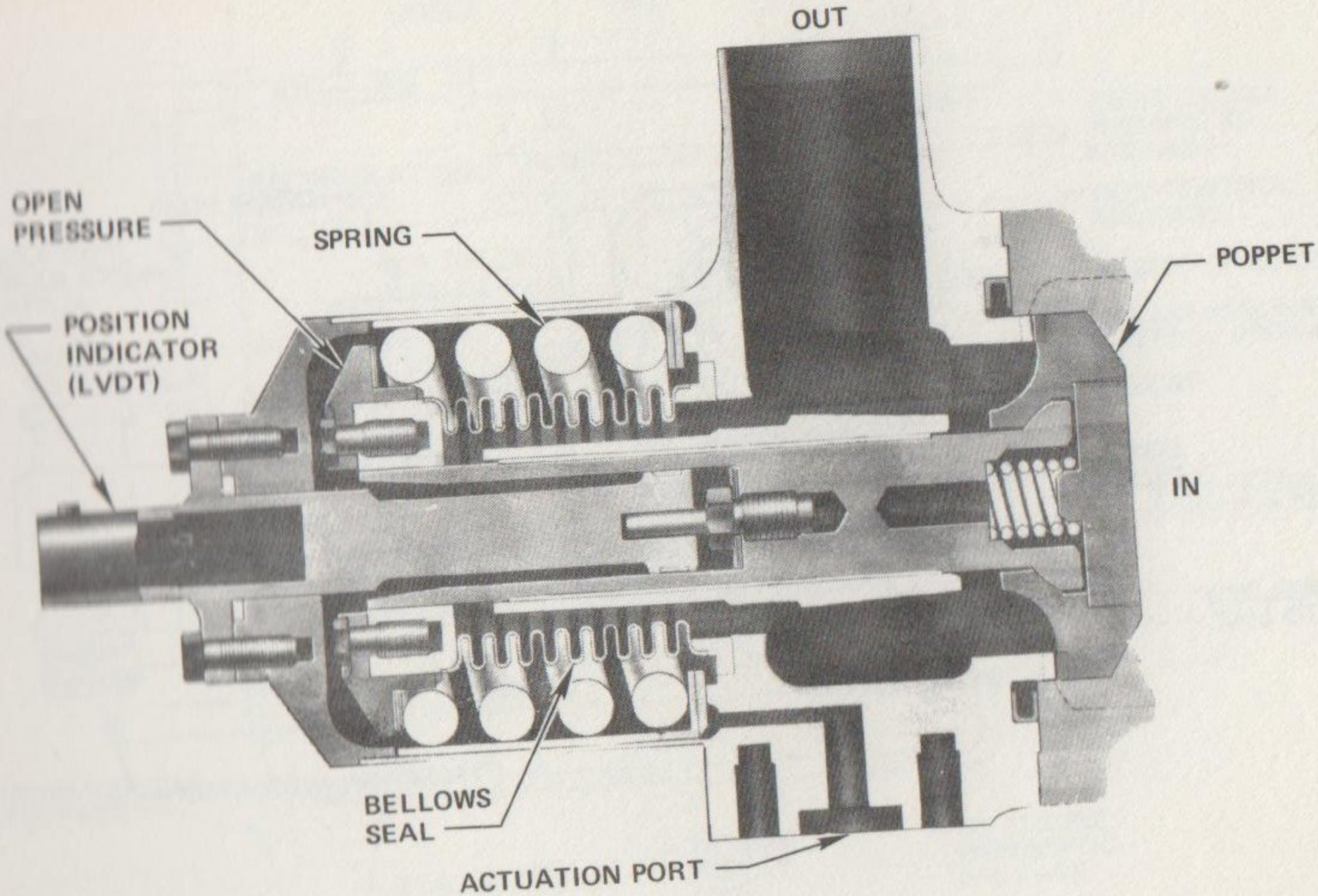


FIGURE 2-34. PROPELLANT BLEED VALVE

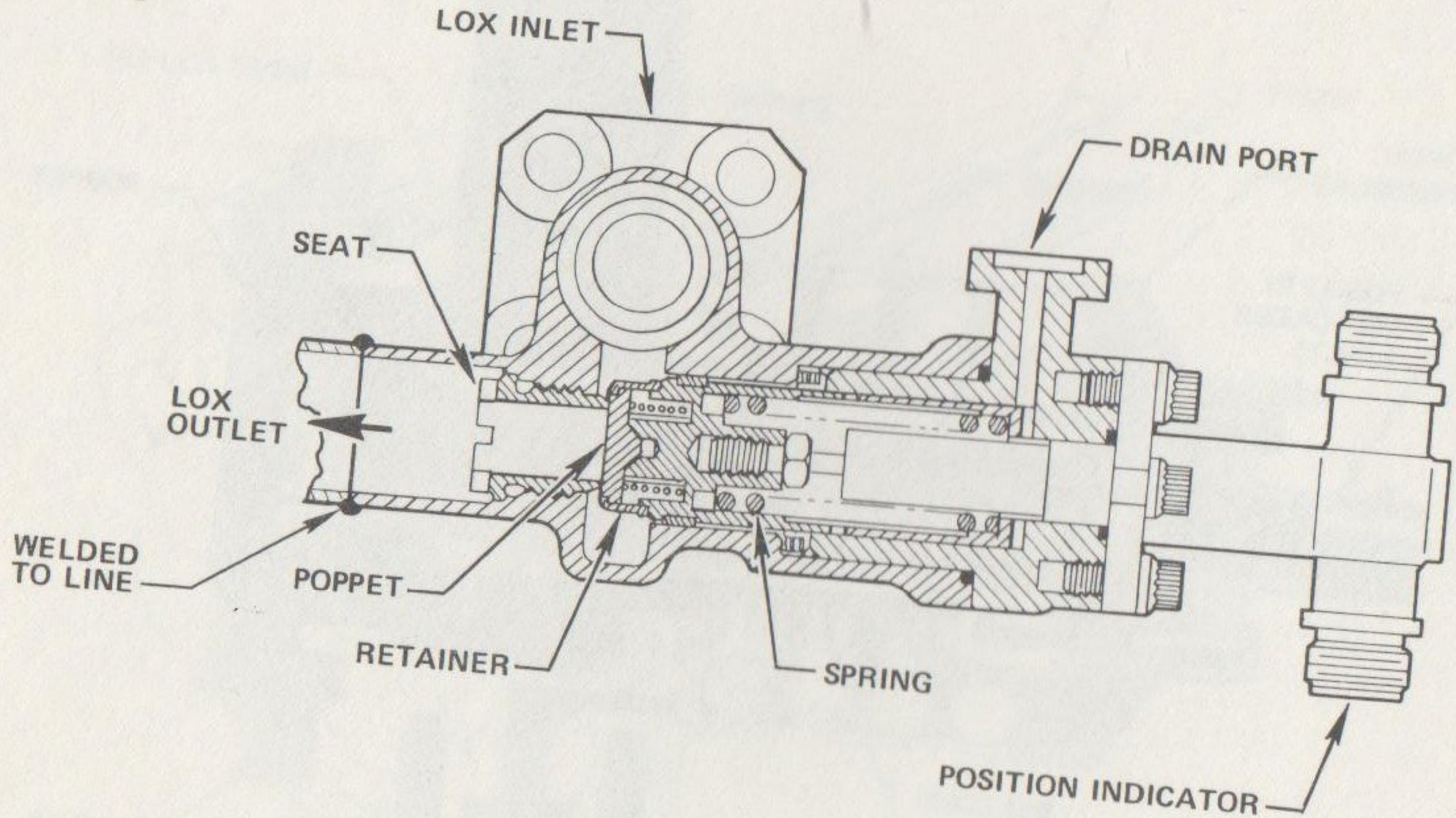


FIGURE 2-35. ANTI-FLOOD VALVE

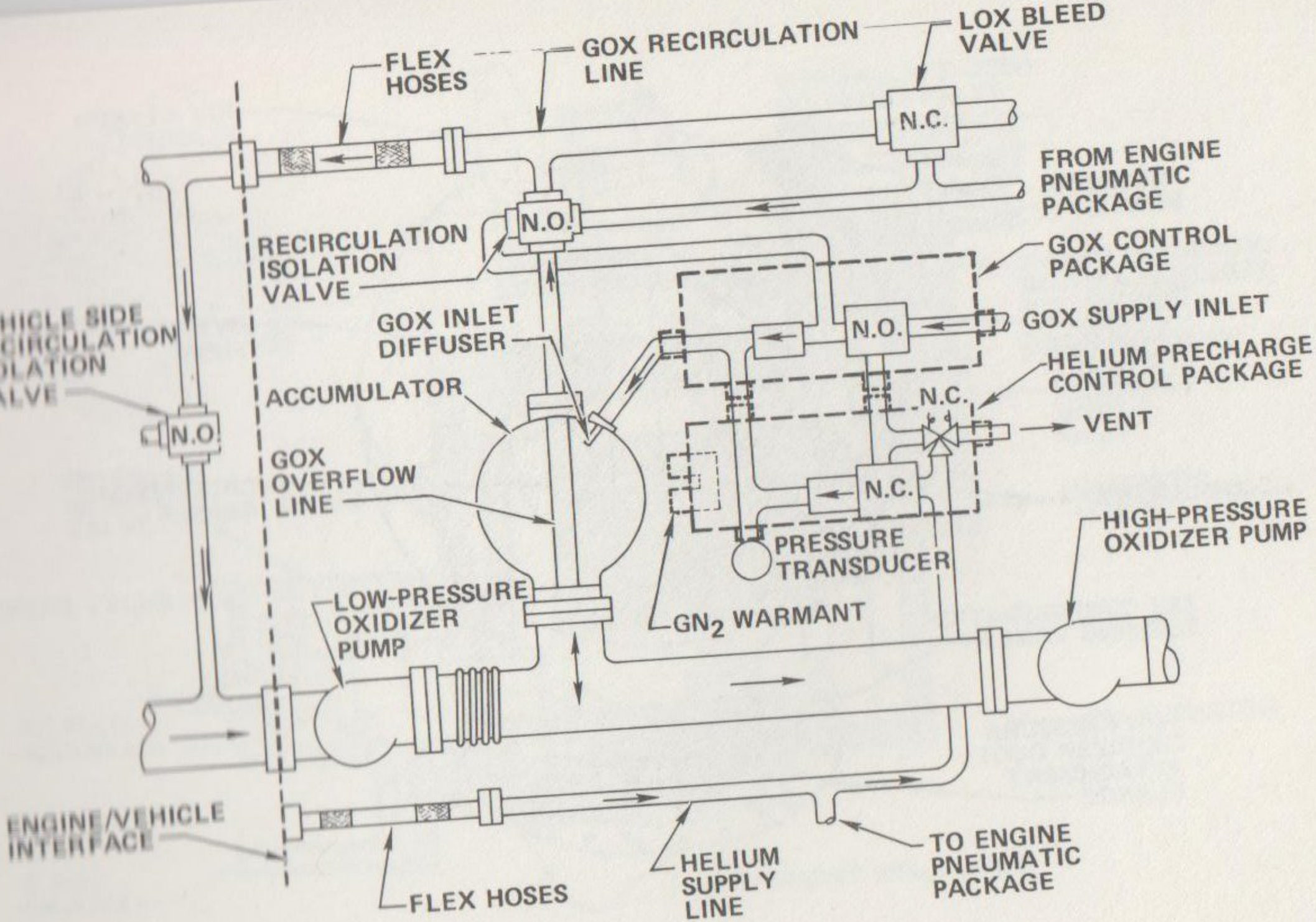


FIGURE 2-36. POGO SUPPRESSION SYSTEM SCHEMATIC

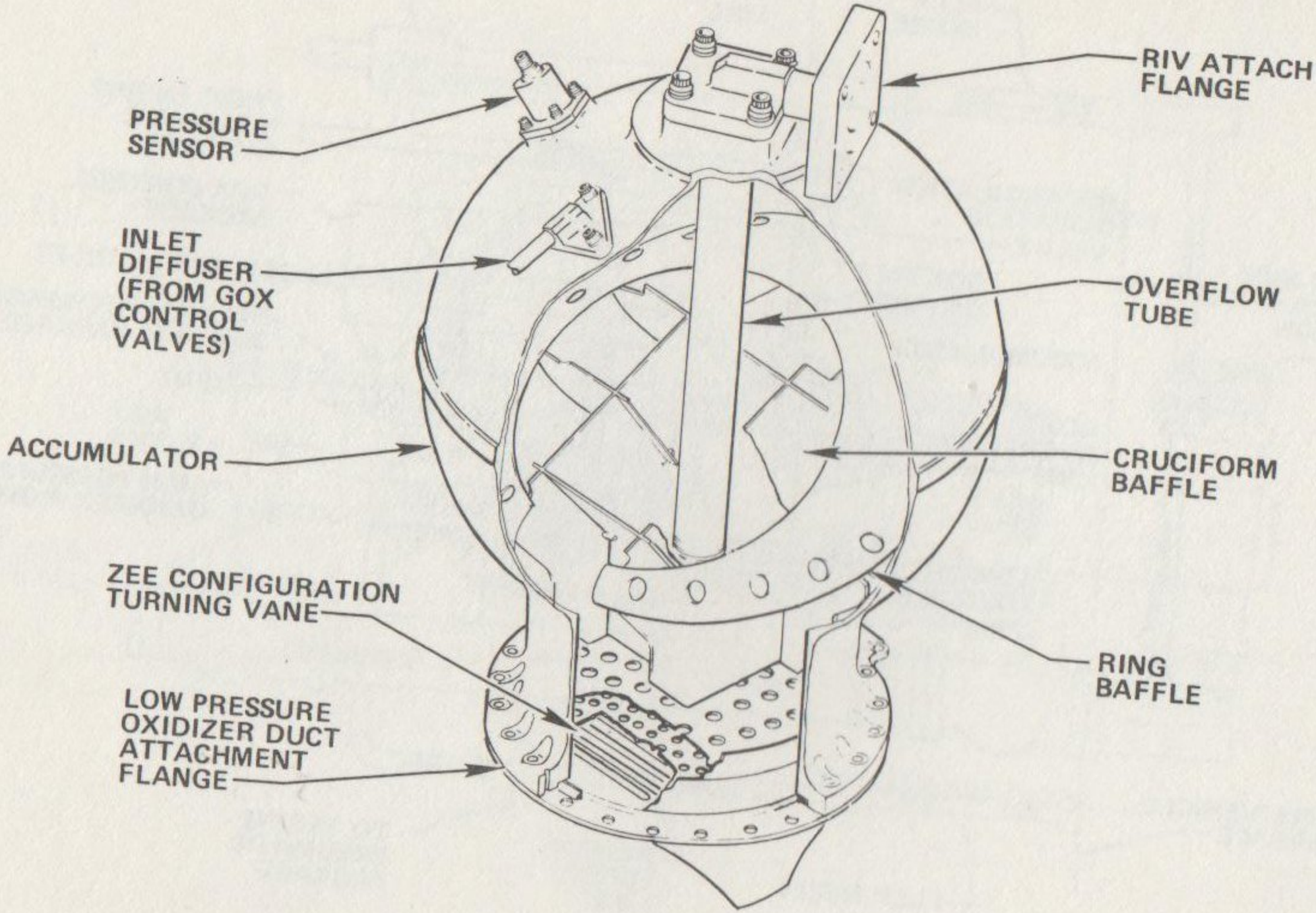


FIGURE 2-37. POGO SUPPRESSOR ACCUMULATOR

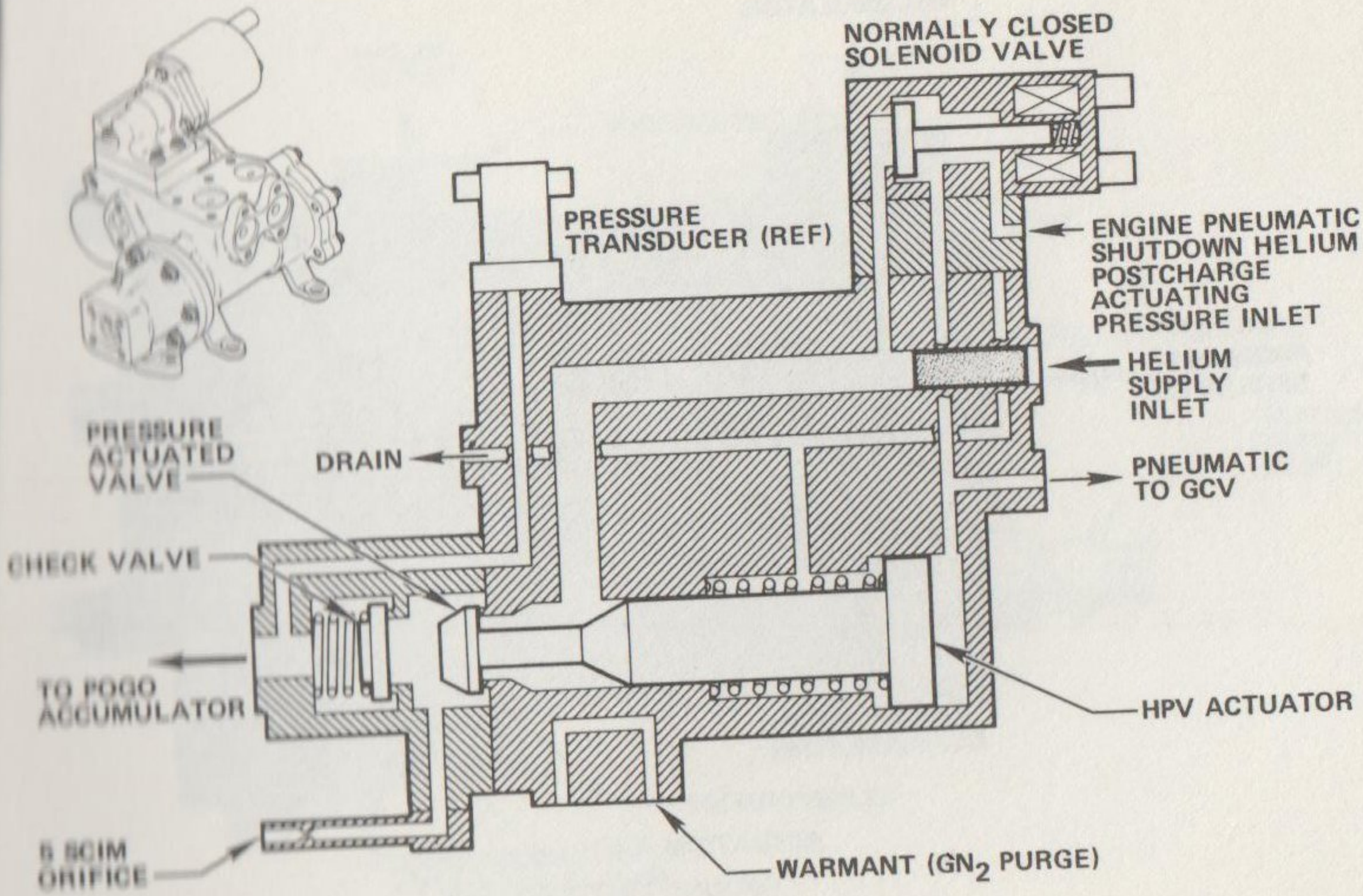


FIGURE 2-38. HELIUM PRECHARGE VALVE

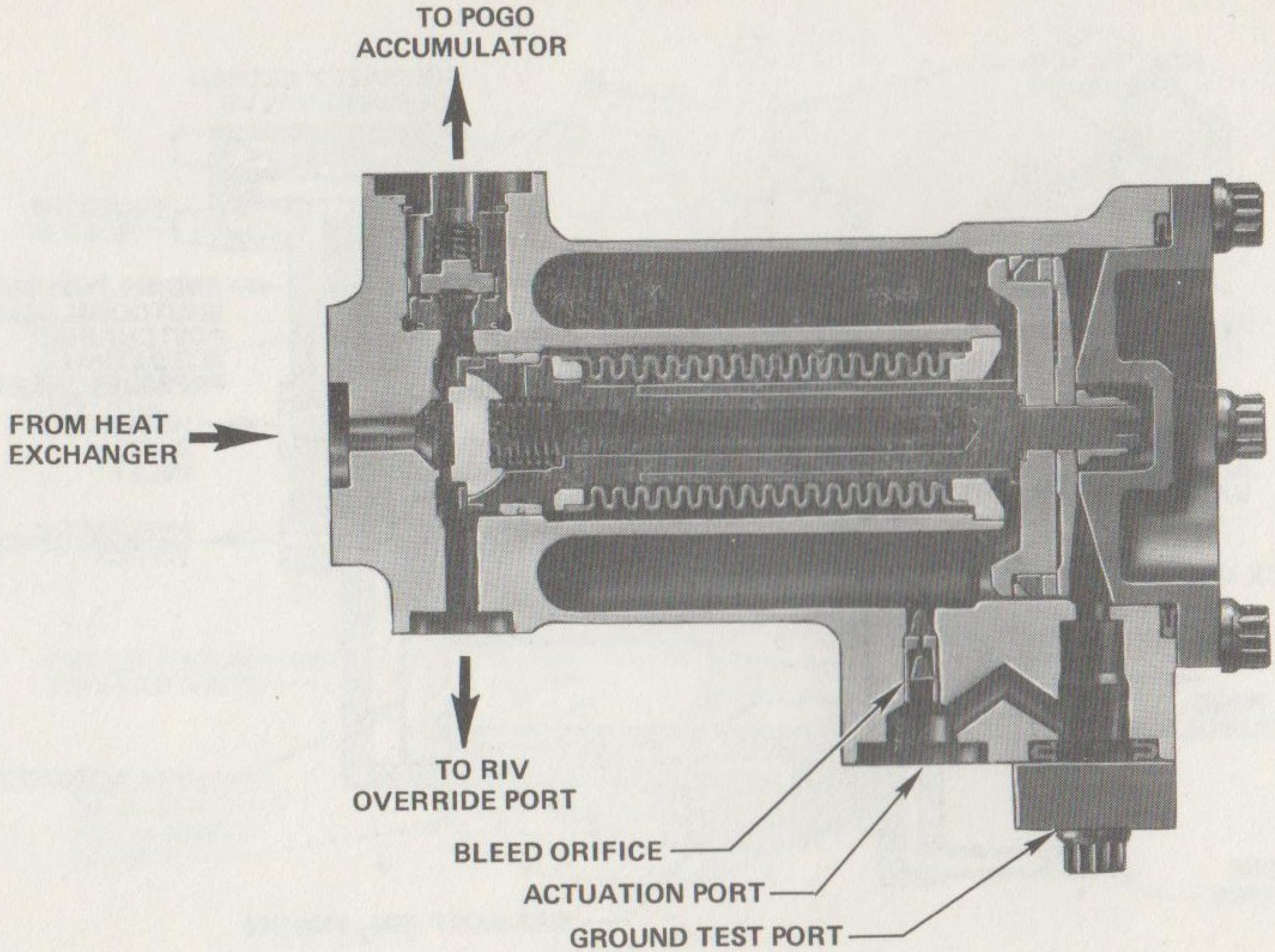


FIGURE 2-39. GASEOUS OXYGEN CONTROL VALVE

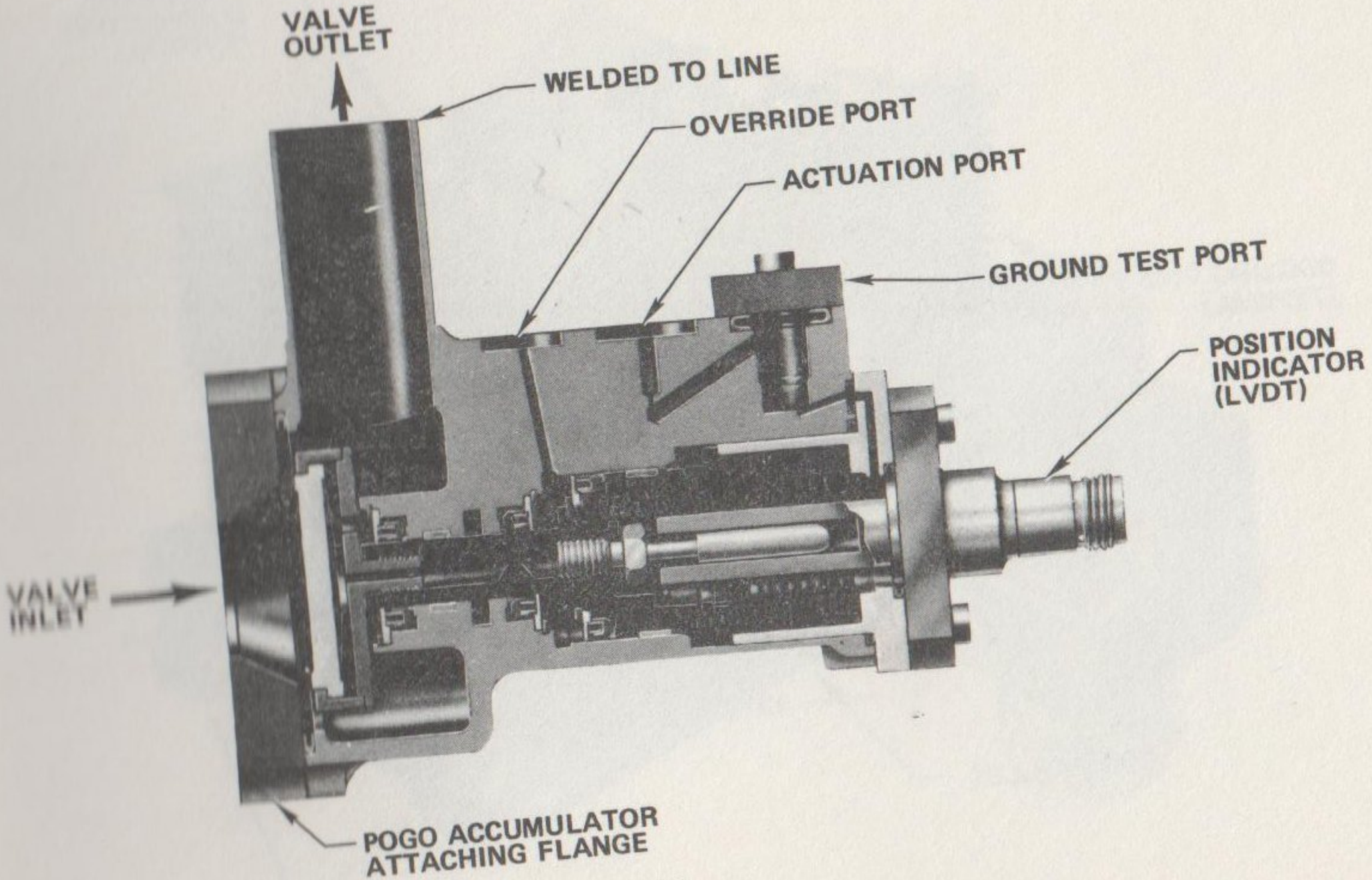


FIGURE 2-40. RECIRCULATION ISOLATION VALVE

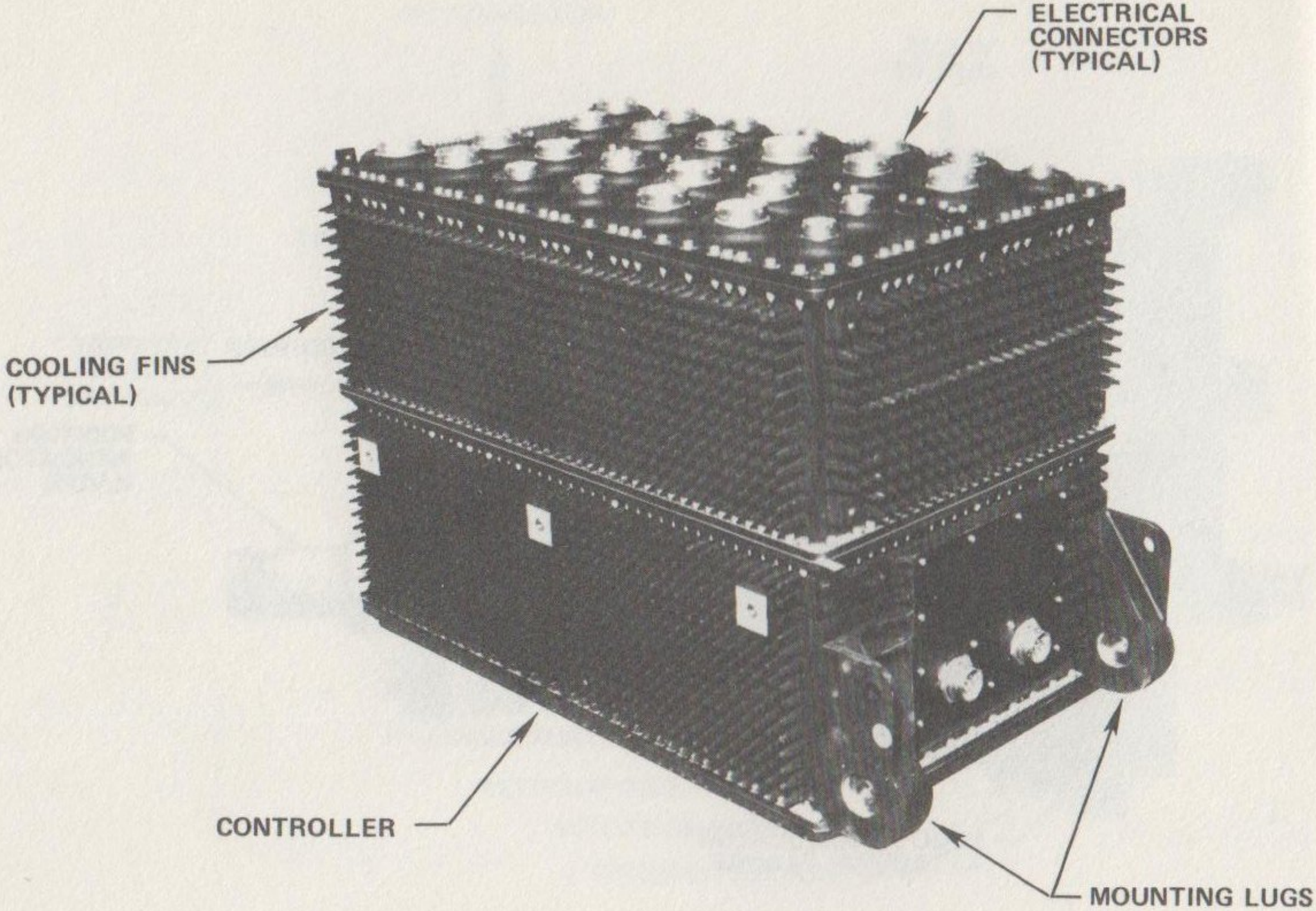


FIGURE 2-41. CONTROLLER

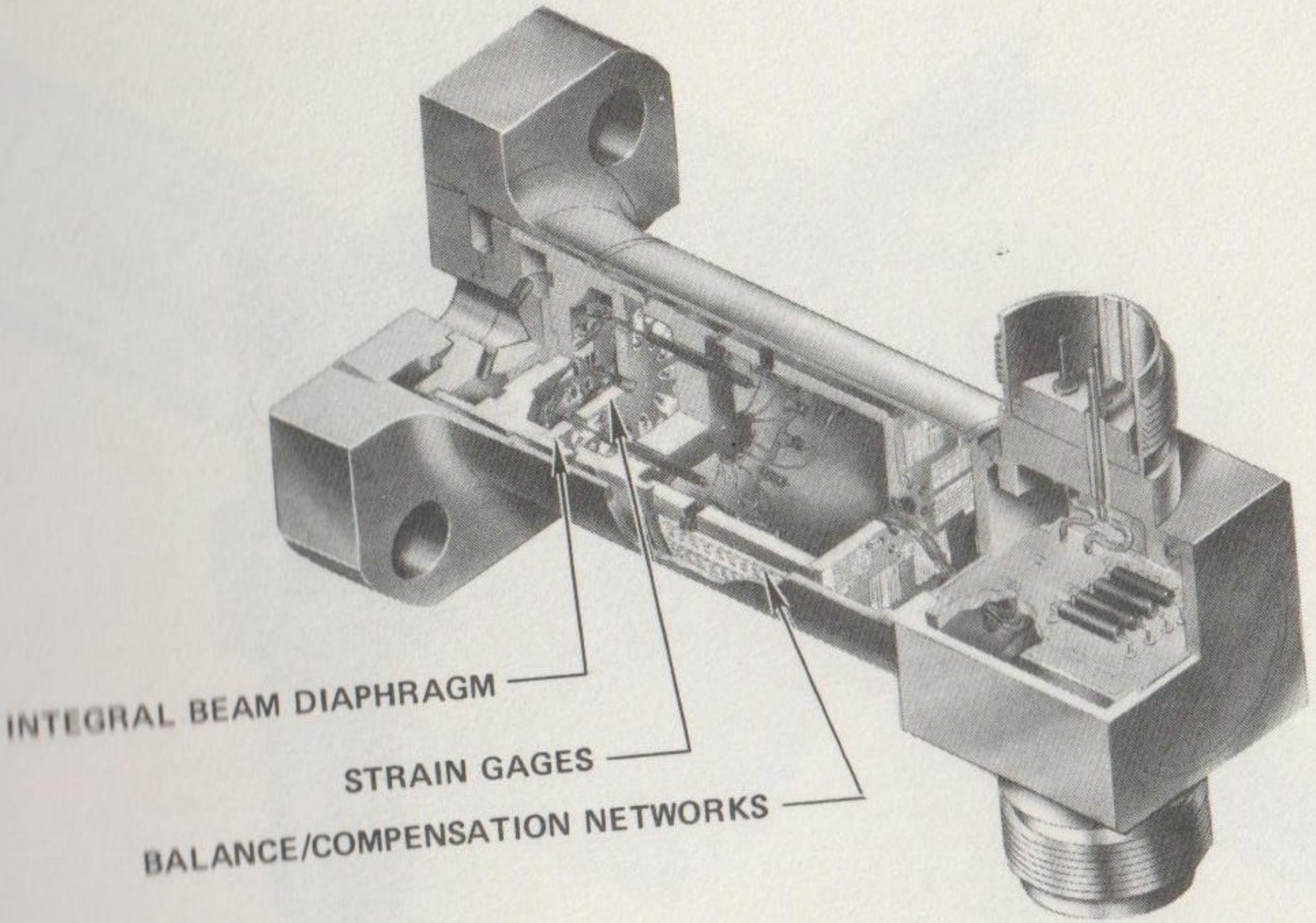


FIGURE 2-42. SSME PRESSURE TRANSDUCER

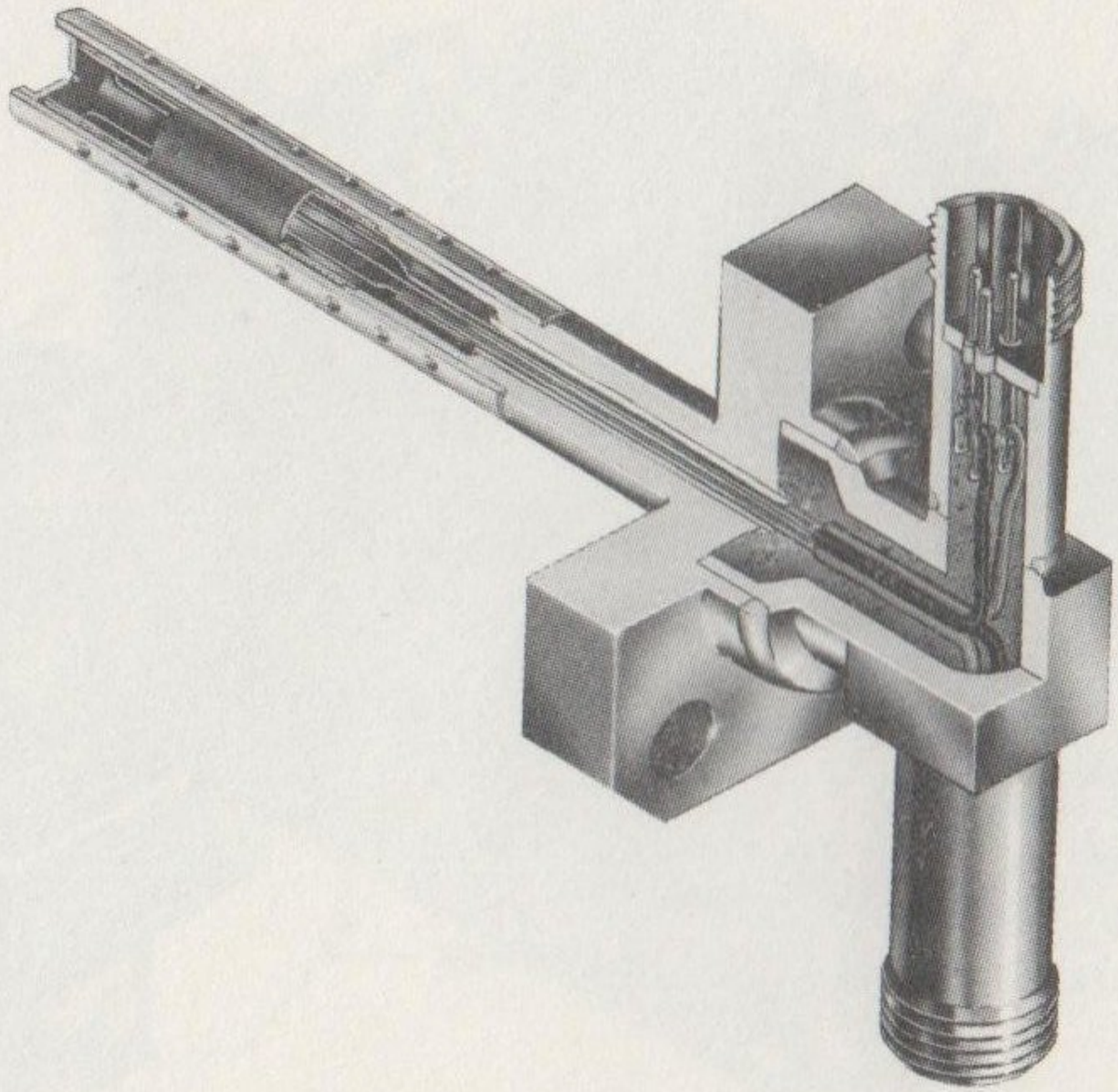


FIGURE 2-43. CRYOGENIC TEMPERATURE SENSOR

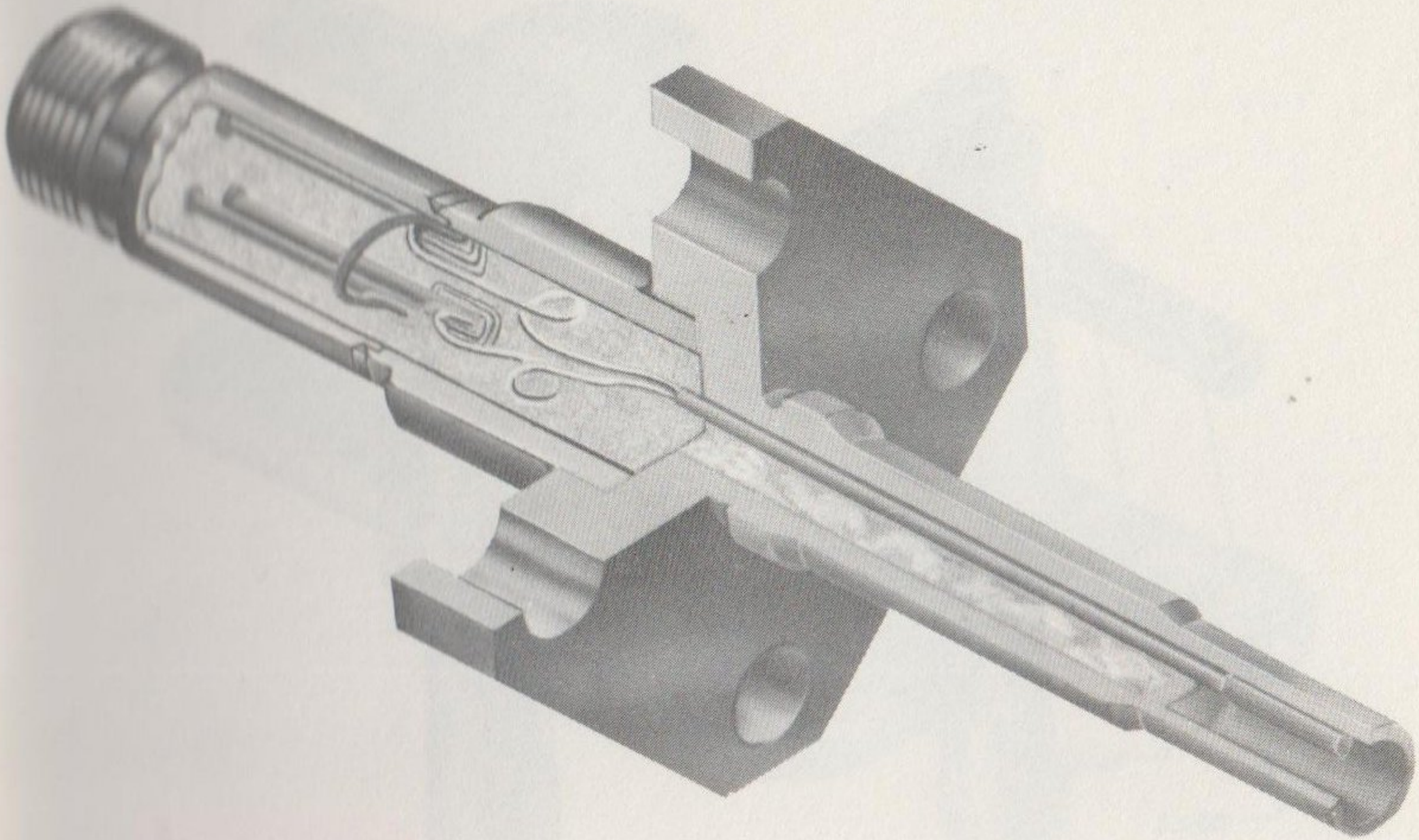


FIGURE 2-44. HOT-GAS TEMPERATURE SENSOR

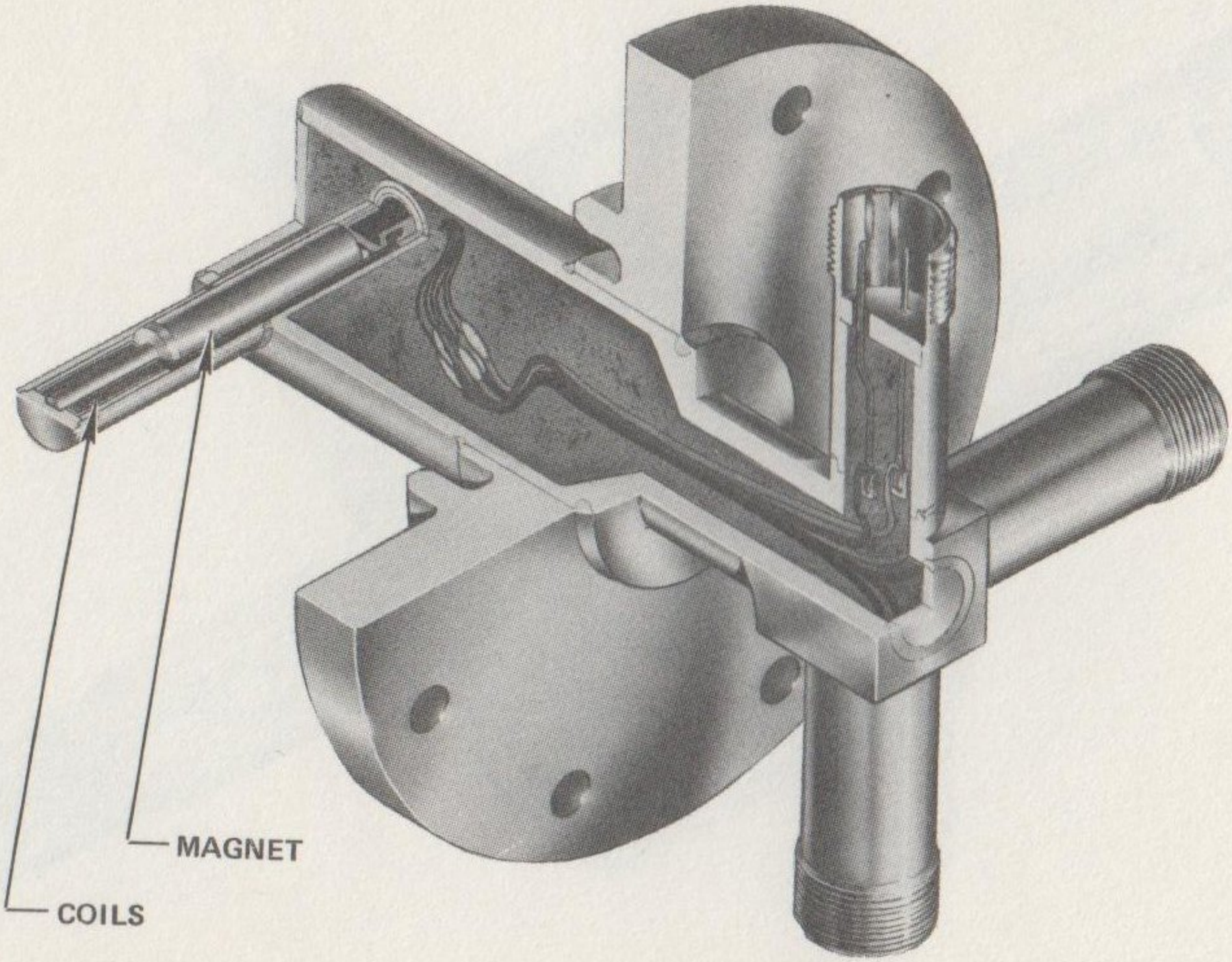


FIGURE 2-45. LPOTP SPEED SENSOR

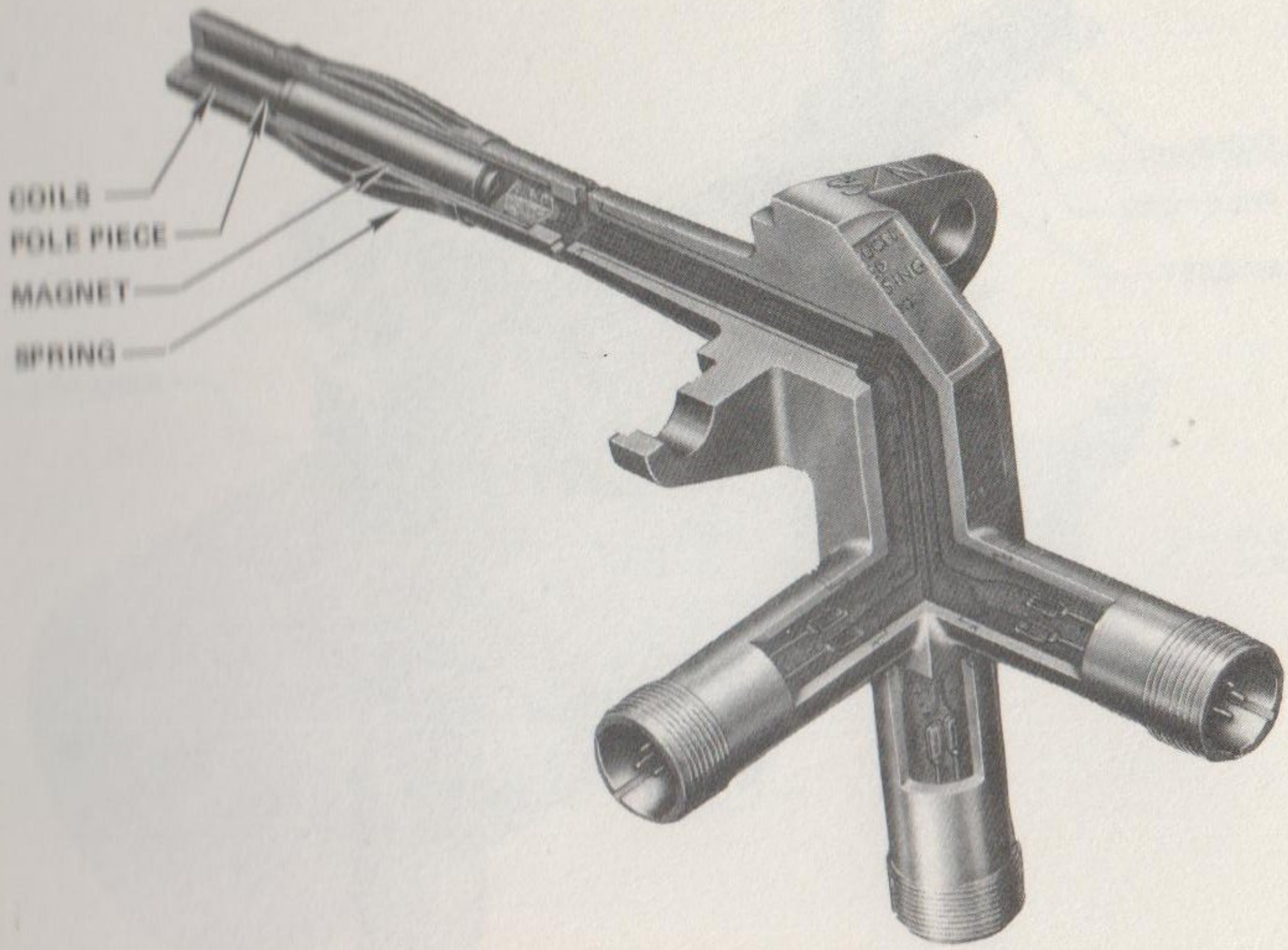


FIGURE 2-46. LPFTP SPEED SENSOR

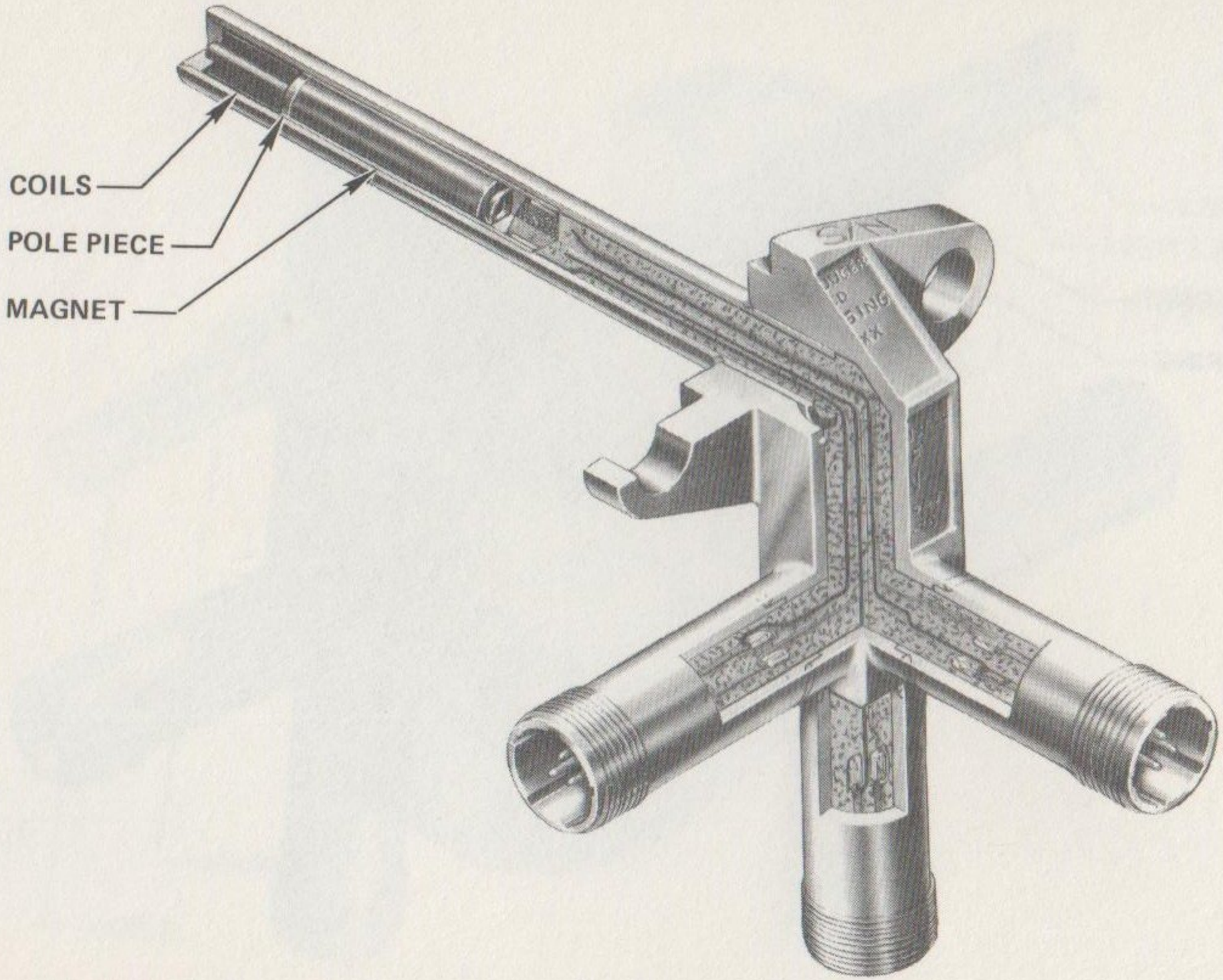


FIGURE 2-47. HPFTP SPEED SENSOR

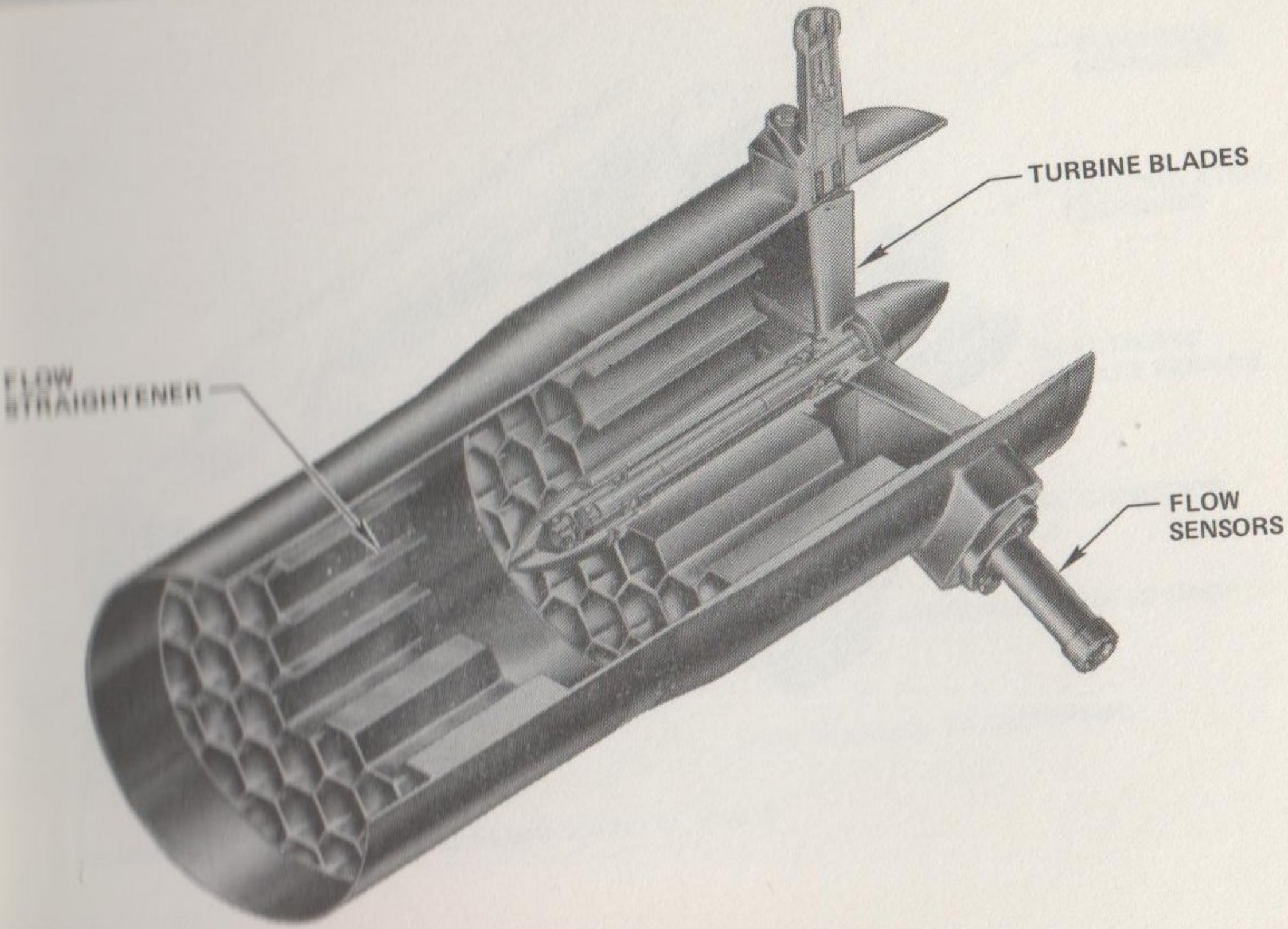


FIGURE 2-48. SSME FUEL FLOWMETER

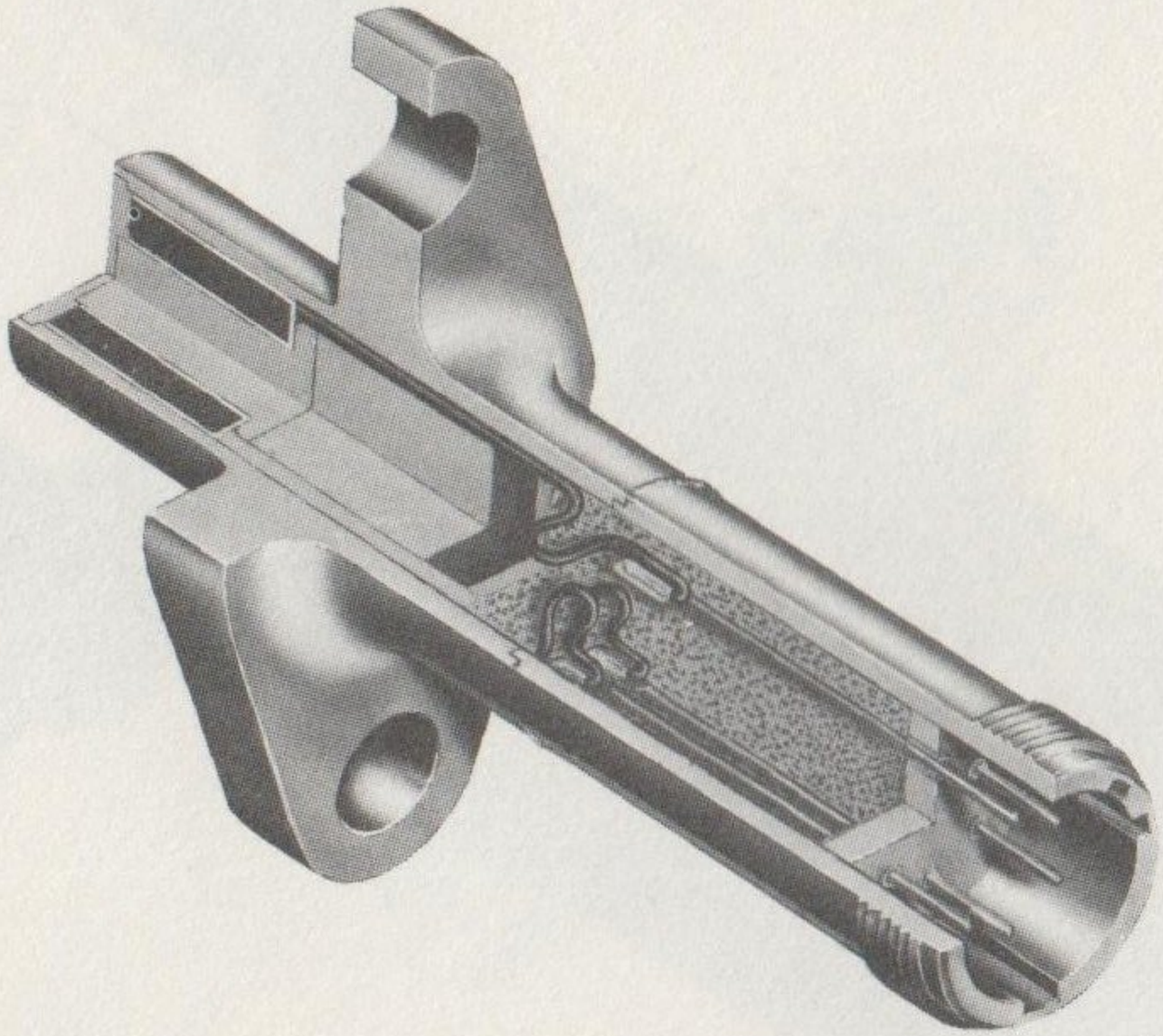


FIGURE 2-49. FLOW SENSOR

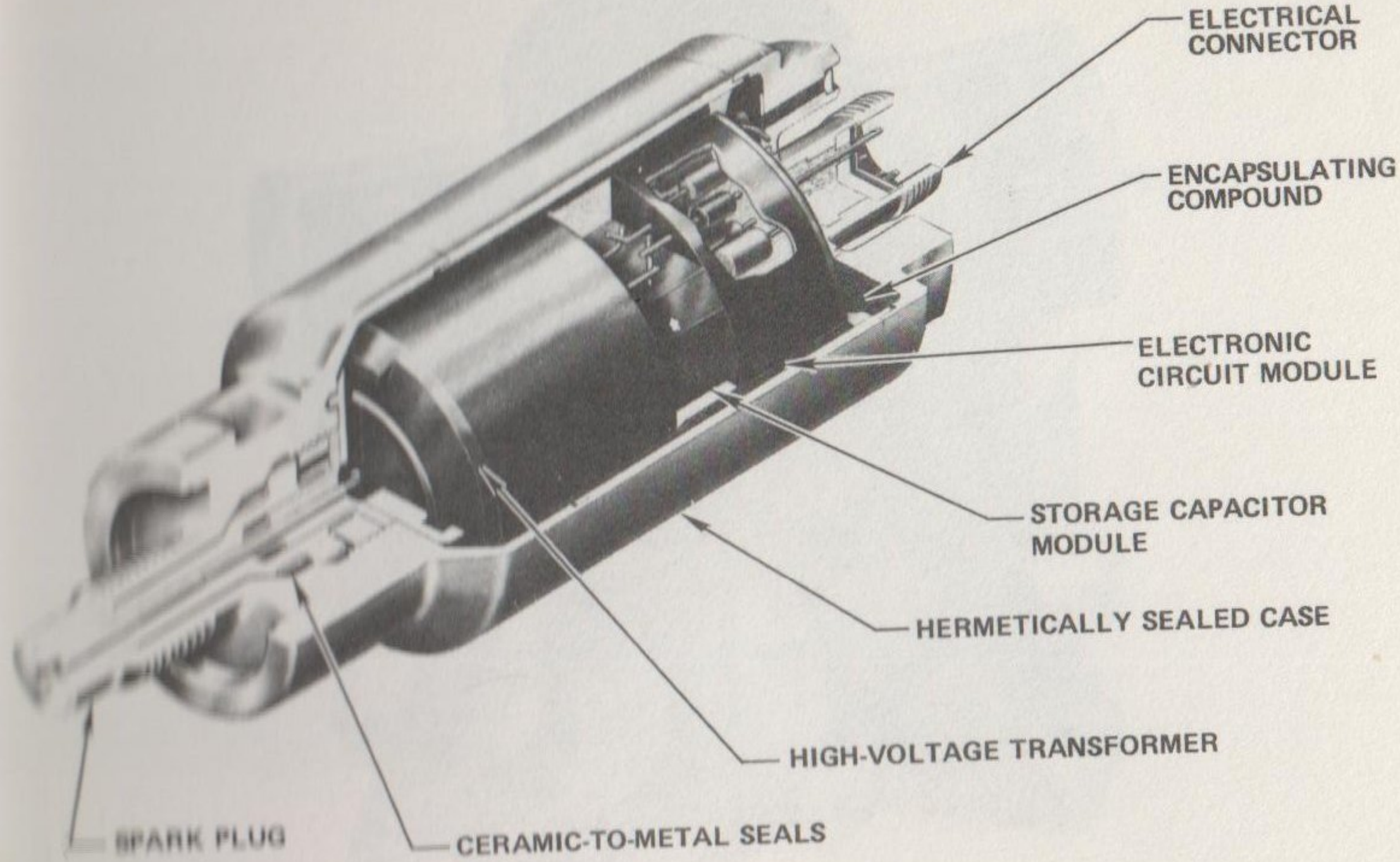


FIGURE 2-50. SPARK IGNITER

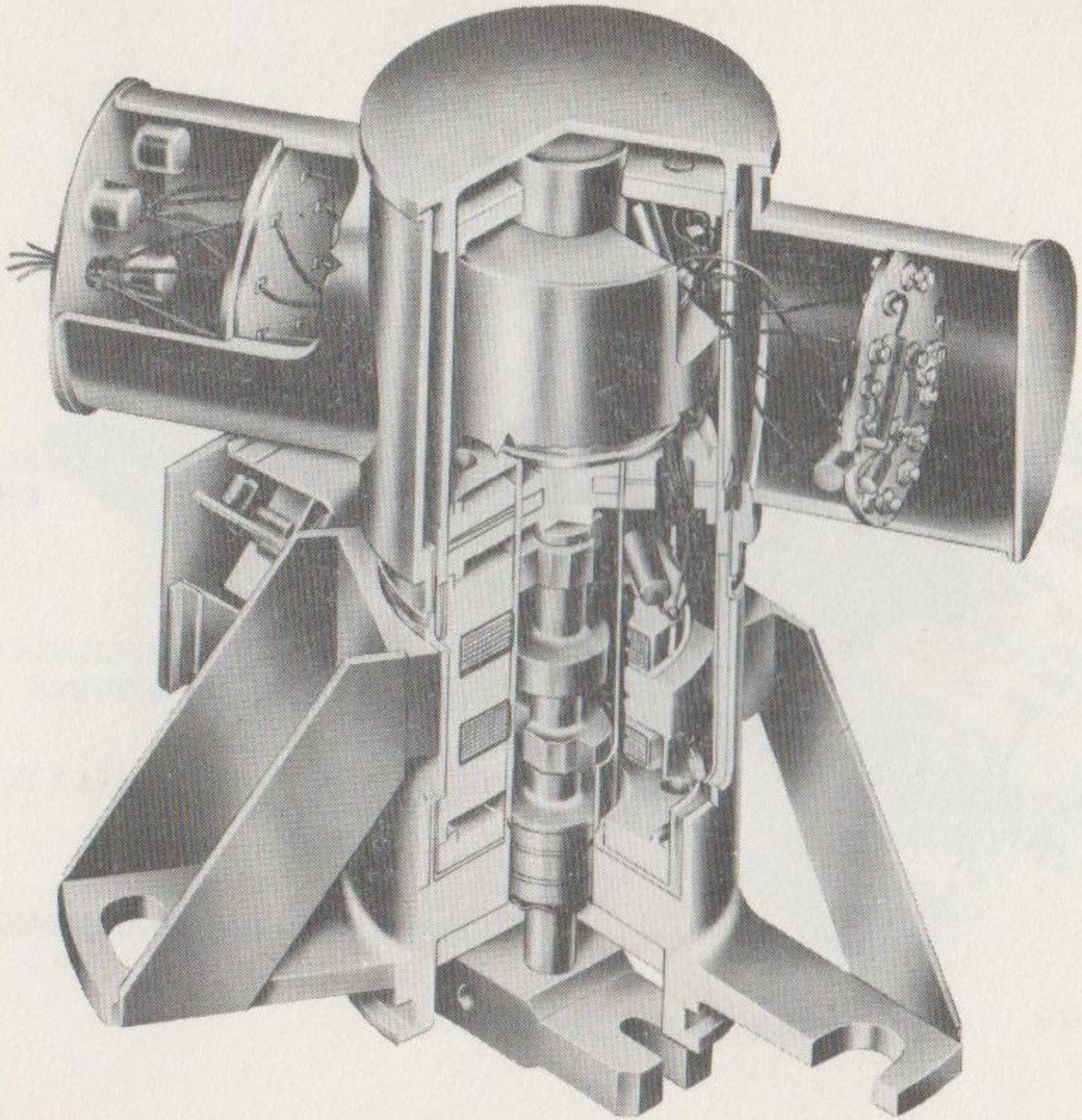


FIGURE 2-51. ROTARY VARIABLE DIFFERENTIAL TRANSFORMER (RVDT)

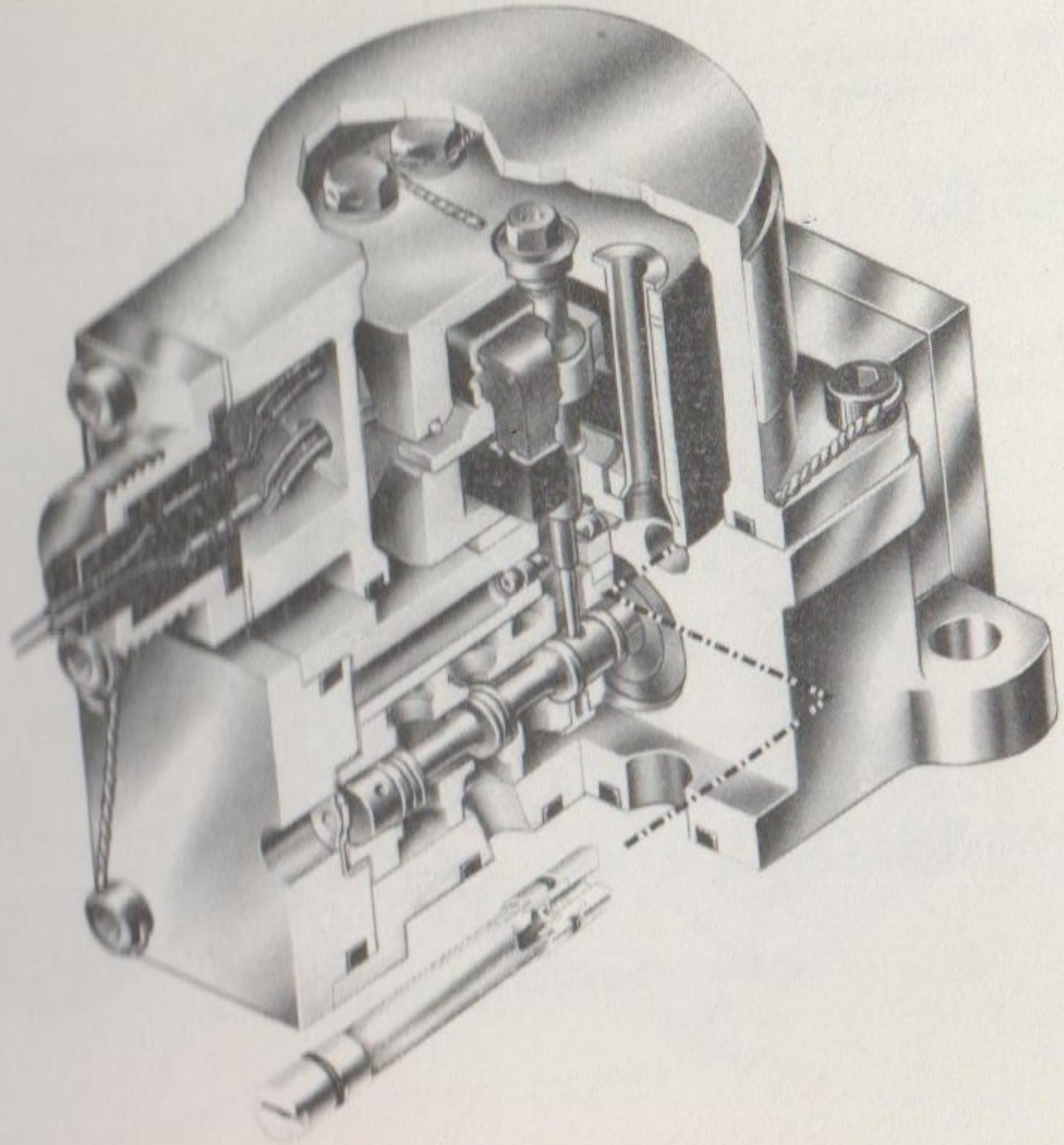


FIGURE 2-52. SERVOVALVE ASSEMBLY

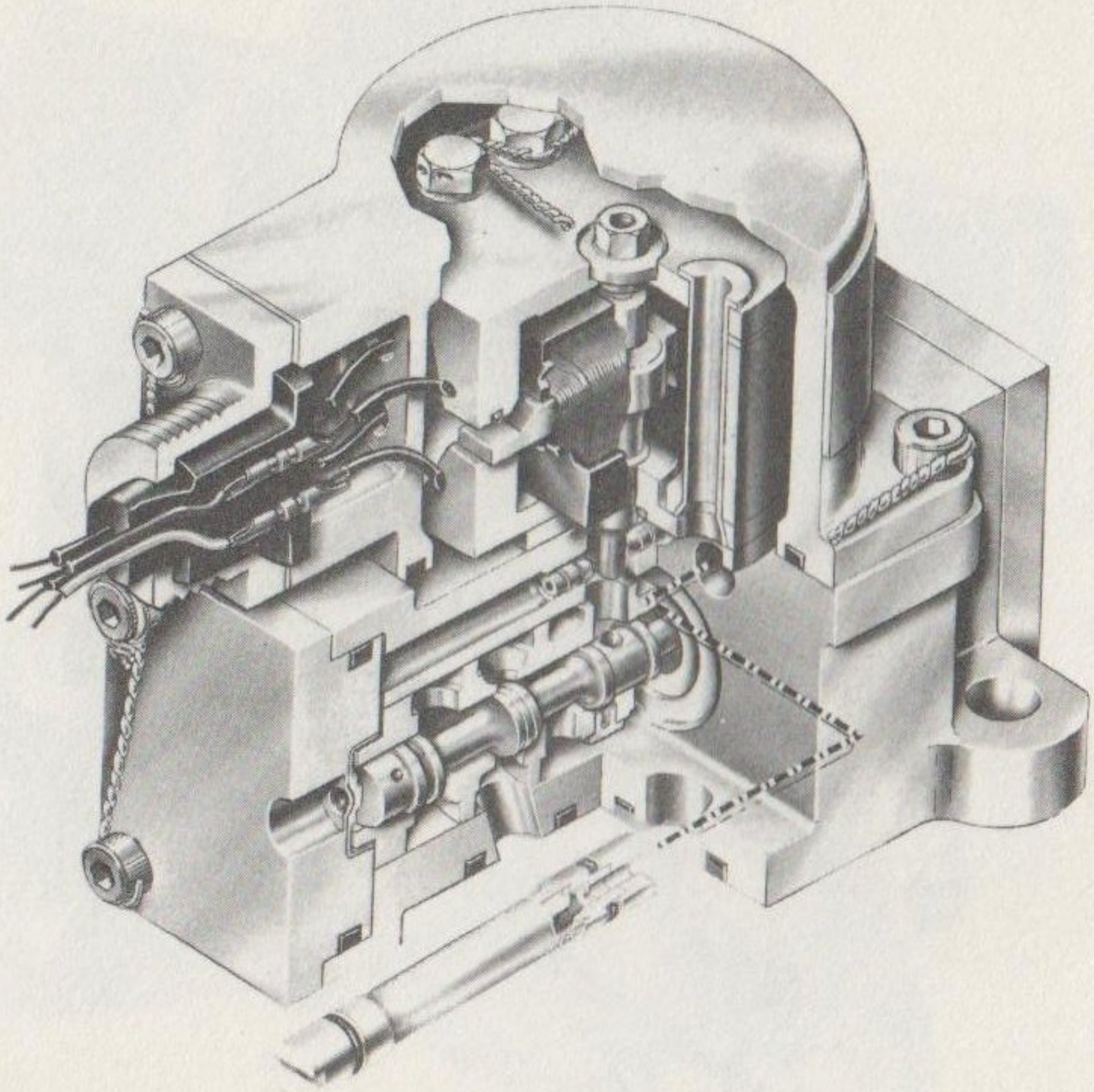


FIGURE 2-53. SERVOSWITCH ASSEMBLY

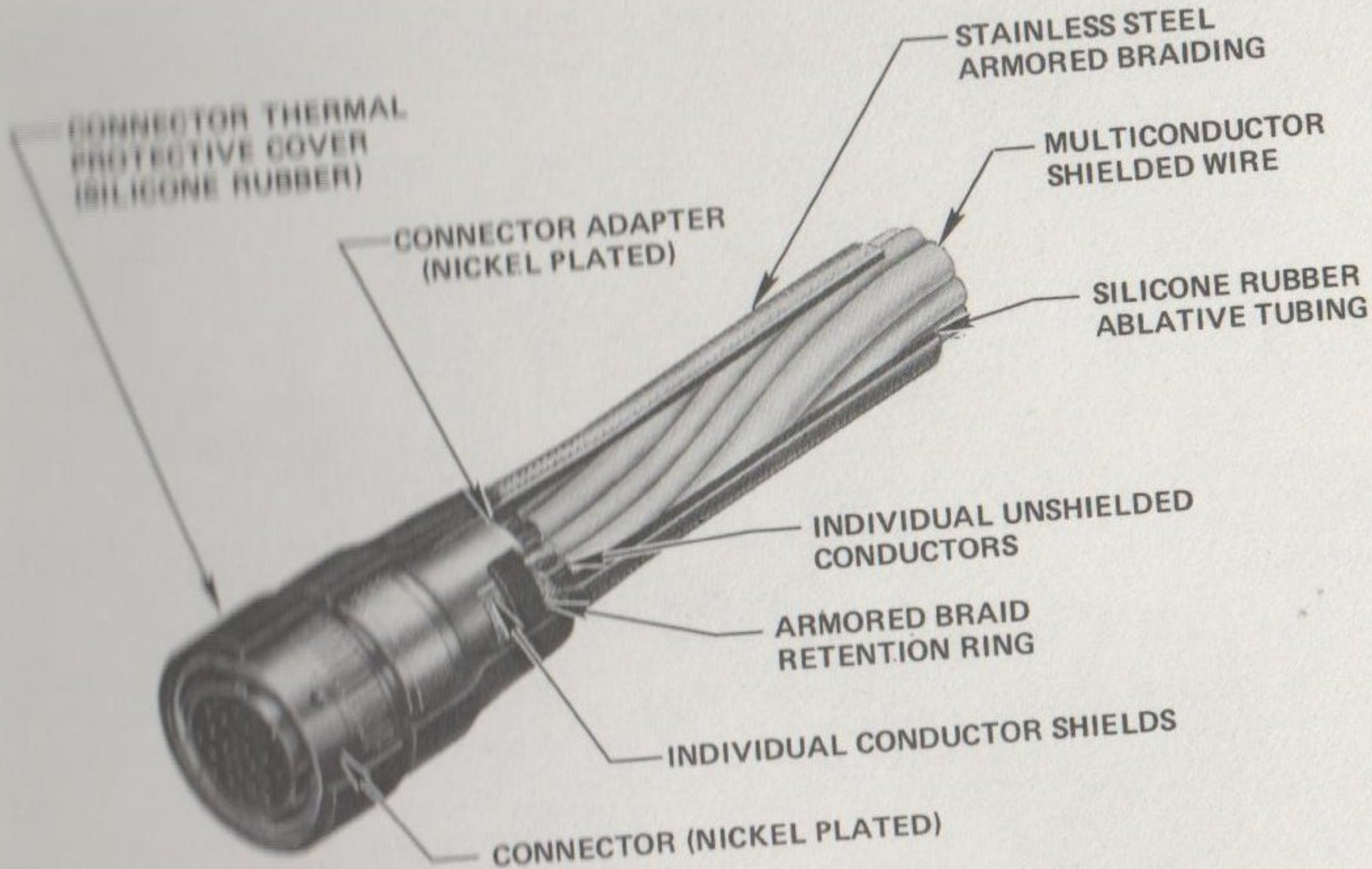


FIGURE 2-54. FLEXIBLE ARMORED HARNESS

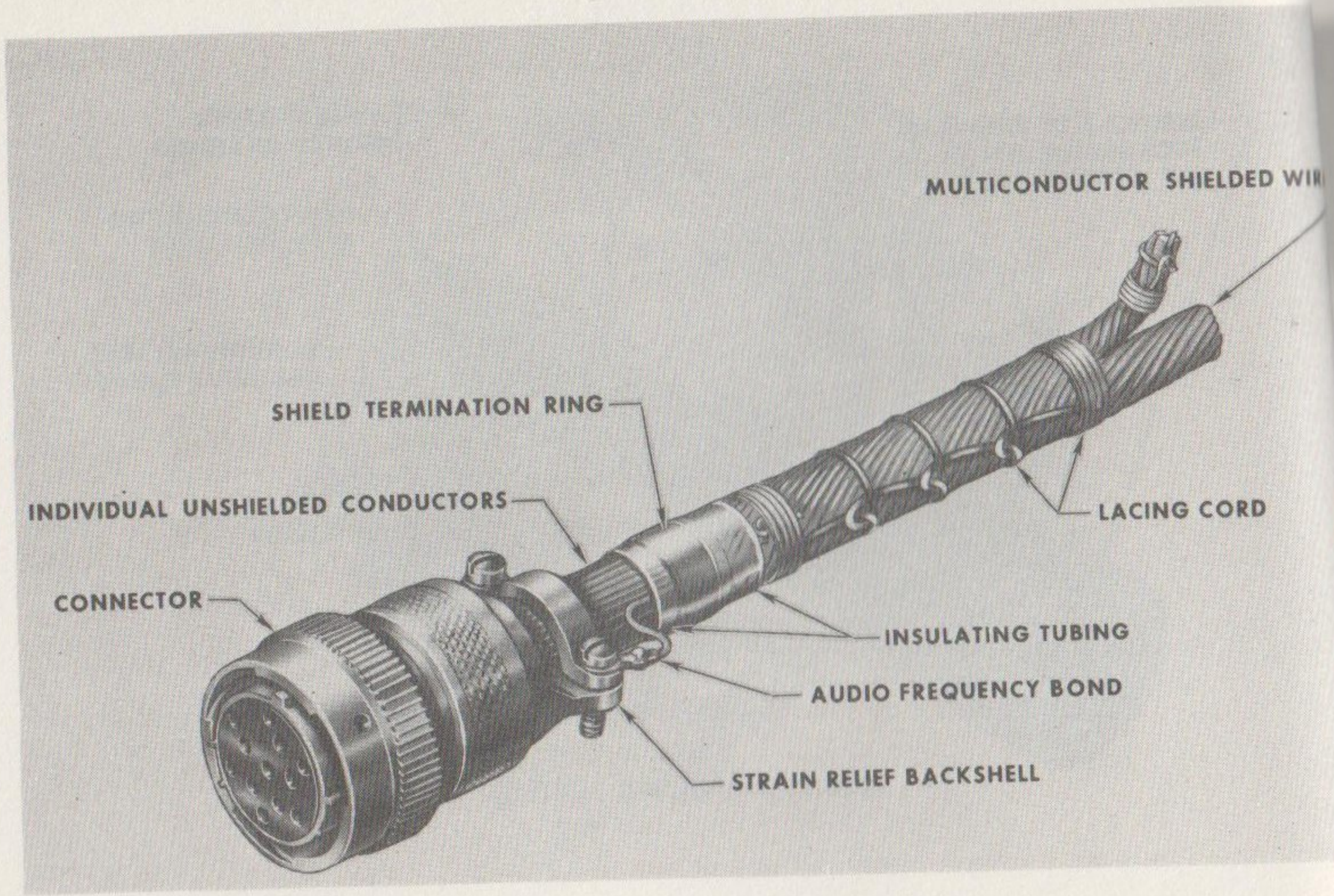


FIGURE 2-55. CONVENTIONAL HARNESS

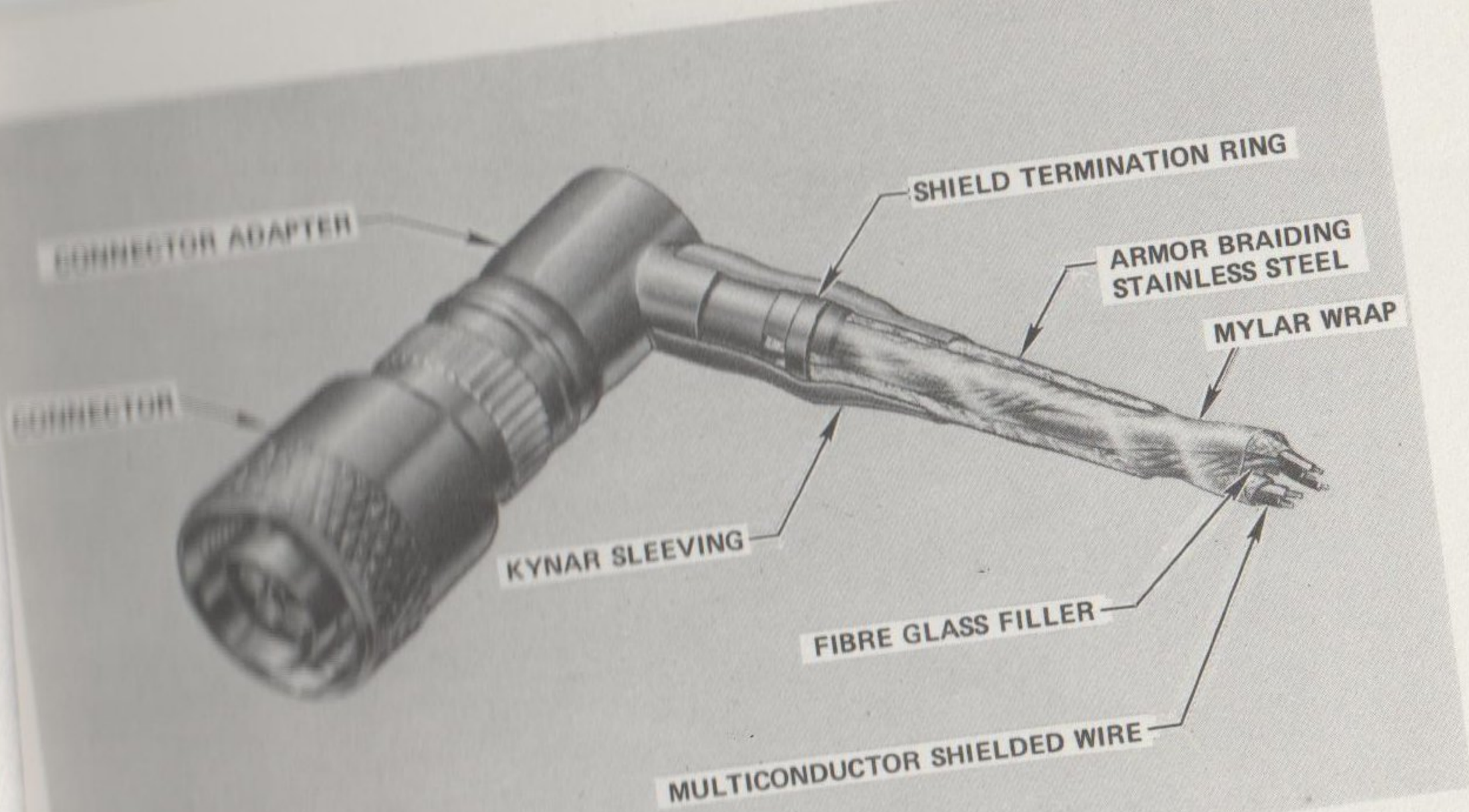


FIGURE 2-56. LIGHTNING BRAIDED HARNESS

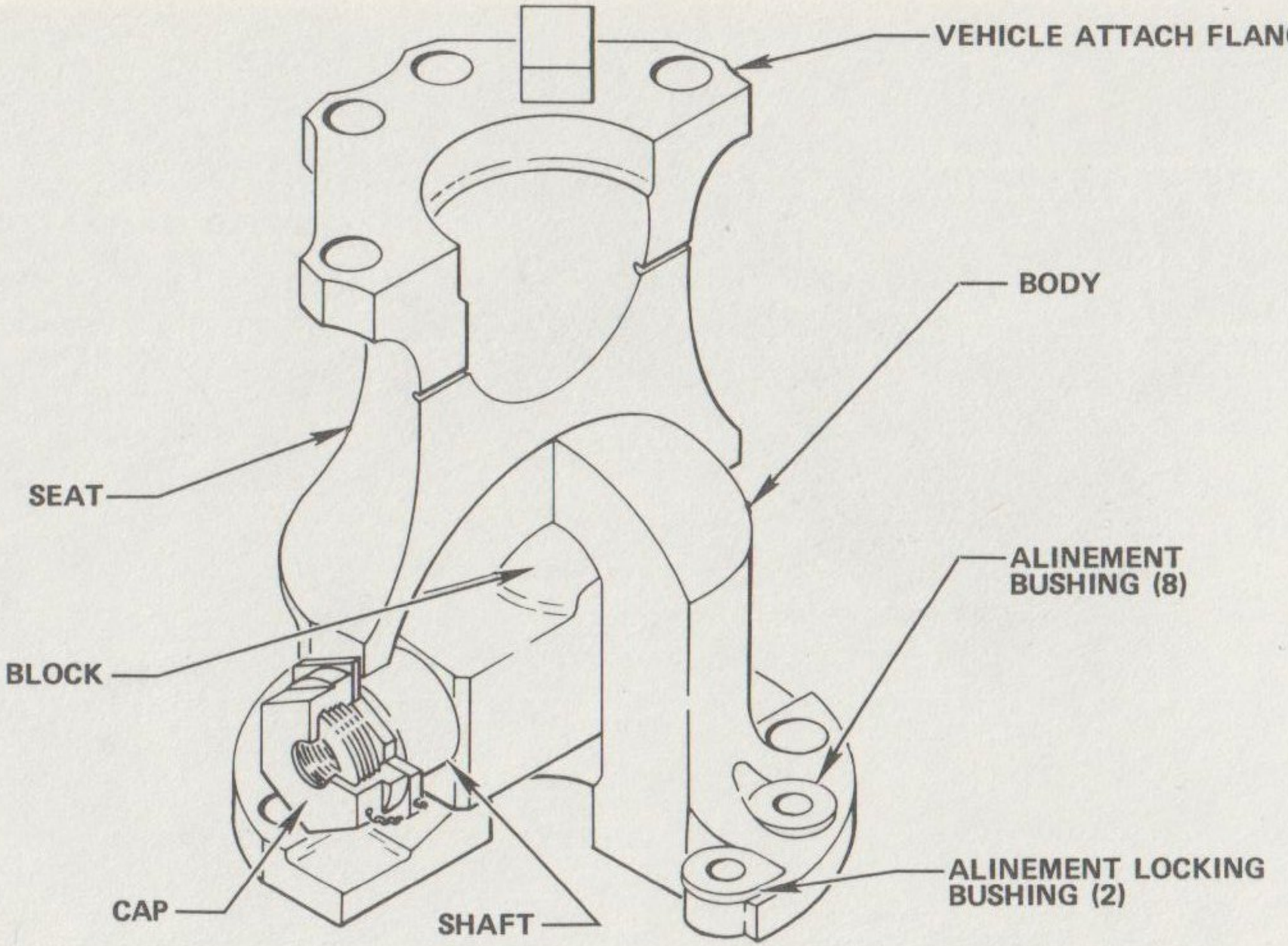


FIGURE 2-57. GIMBAL BEARING (SHEET 1 OF 2)

- ANGULATION CAPABILITY ± 12.5 DEGREES ABOUT EACH OF TWO AXES. THIS INCLUDES:
  - 0.5 DEGREE FOR SNUBBING
  - 0.5 DEGREE FOR ANGULAR ALIGNMENT
  - 6 MINUTES OVER-TRAVEL VECTOR ADJUSTMENT
  - 0.7 DEGREE FOR GIMBAL ATTACH POINT TOLERANCE
- ACCELERATION = 30 RAD/SEC^2 MAXIMUM
- ANGULAR VELOCITY - 20 DEGREES/SEC MAXIMUM
- LATERAL ADJUSTMENT - ±.25 INCH MAXIMUM
- COEFFICIENT OF FRICTION - 0.01 TO 0.20 OVER TEMPERATURE RANGE OF 160 TO 610^{o}R

FIGURE 2-57. GIMBAL BEARING (SHEET 2 OF 2)

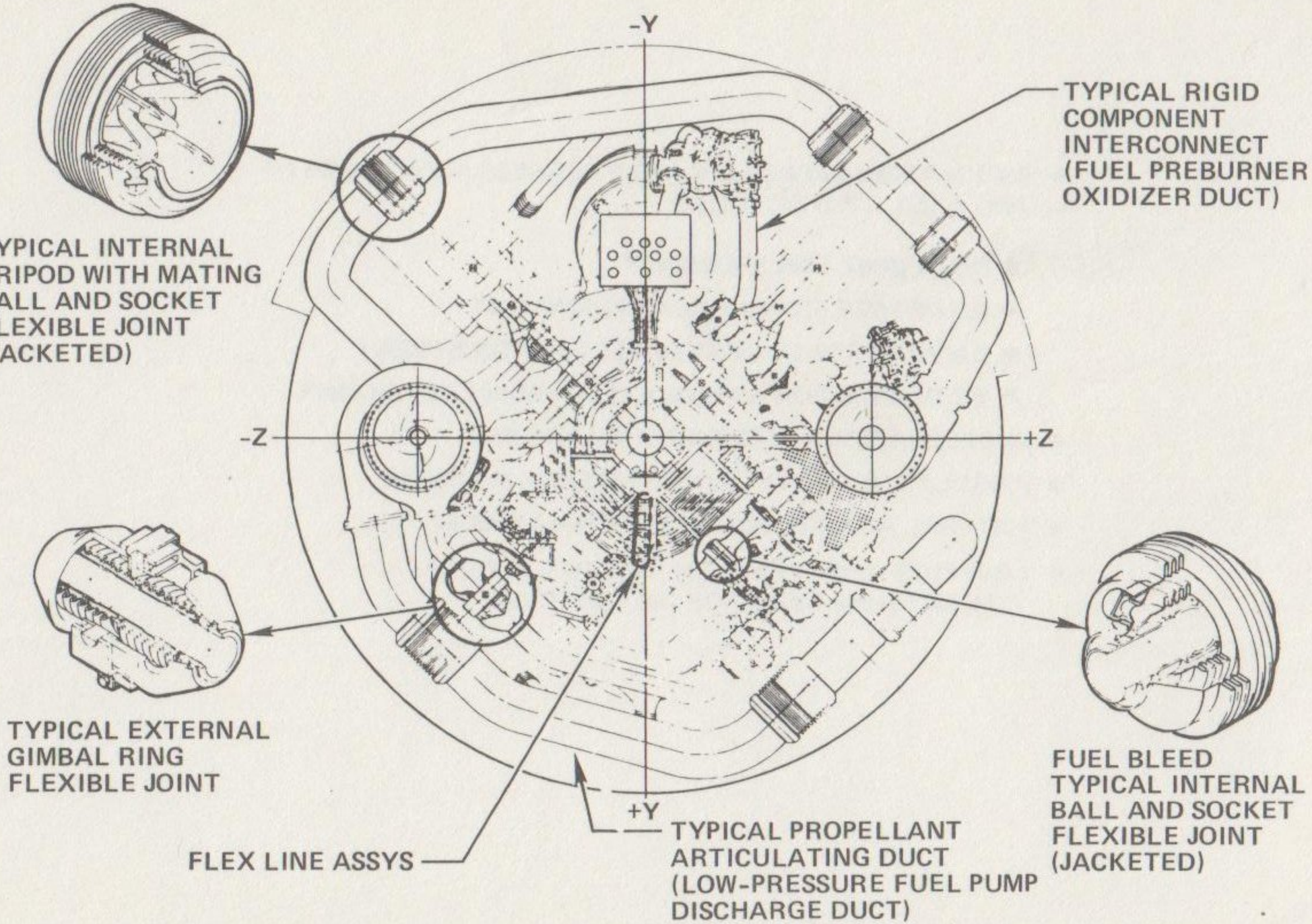
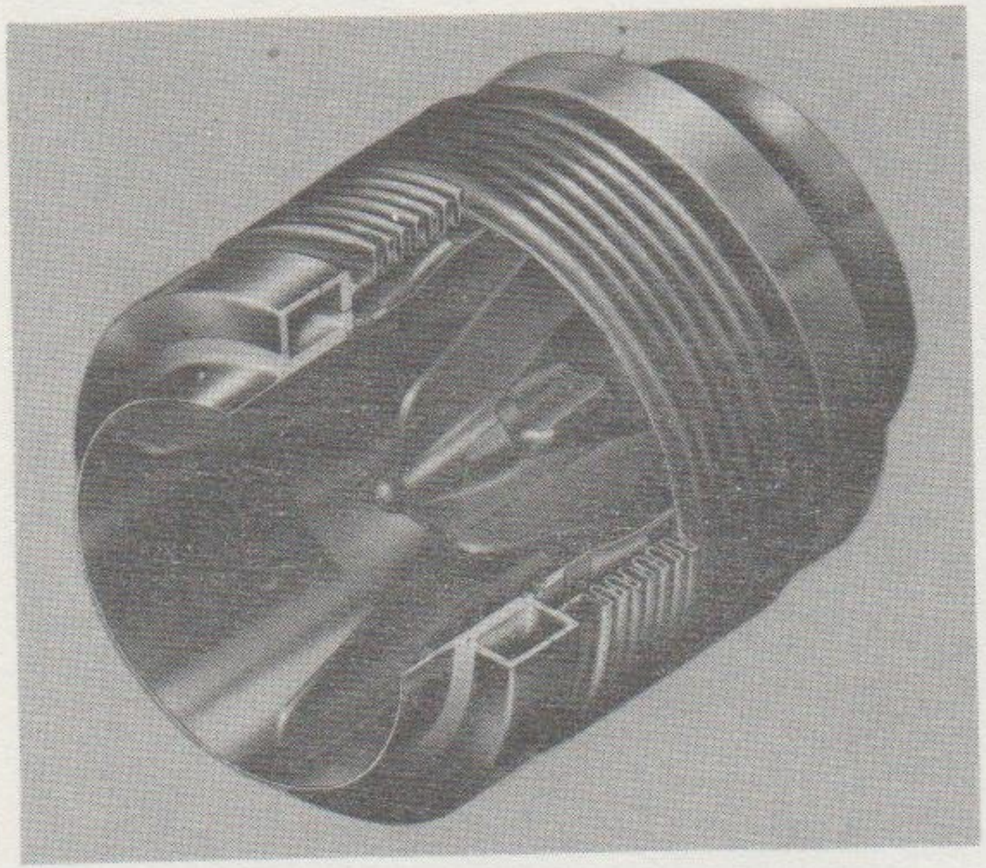


FIGURE 2-58. TYPICAL FLEX BELLOWS APPLICATIONS



OPERATING PRESSURE..... 300 TO 600 PSIA

TEMP..... -290F

I.D..... 6.3 INCH LINER

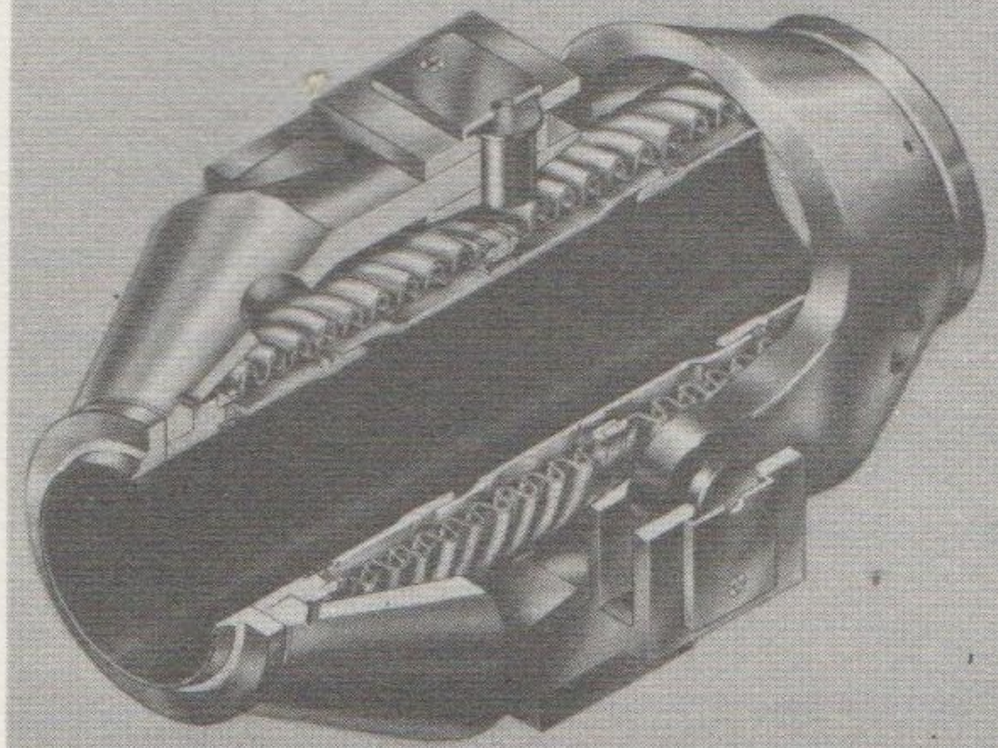
ANGULAR DISPLACEMENT.....$\pm 13^{o}$

LIFE.....200 OPERATIONAL
1400 NON-OPERATIONAL
FULL DEFLECTION CYCLES

MATERIAL.....LPOP DISCH: INCONEL 718
LPFP DISCH: ARMCO 21-6-9

PICTURE IS TYPICAL OF..... LPOP DISCH

FIGURE 2-59. INTERNALLY TIED FLEX JOINTS



OPERATING PRESSURE.....4000 TO 6000 PSIA

TEMP RANGE..... AMB. TO 670F

I.D. ..... .75 TO 2.70 INCH LINER

ANGULAR DISPLACEMENT..... ±13.25°

LIFE..... 200 OPERATIONAL
1400 NON-OPERATIONAL
FULL DEFLECTION CYCLES

MATERIAL..... INCONEL 718
INCONEL 903
TITANIUM

TYPICAL OF

LPOP TURBINE DRIVE

OXID TANK PRESSURANT

LPFP TURBINE DRIVE

LPFP TURBINE DISCH.

FIGURE 2-60. EXTERNAL GIMBAL RING (LONG) FLEX JOINT

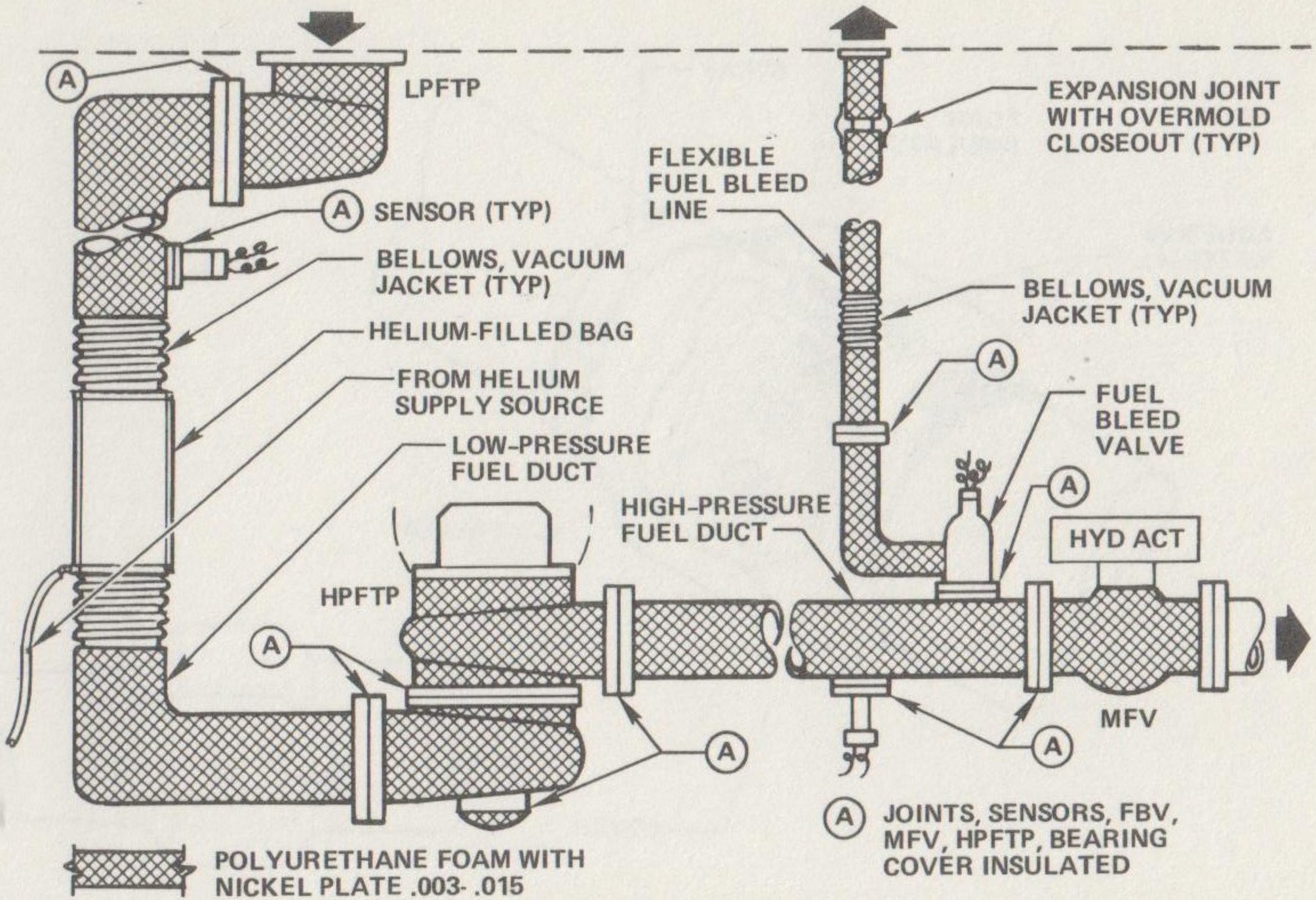


FIGURE 2-61. FUEL SYSTEM INSULATION

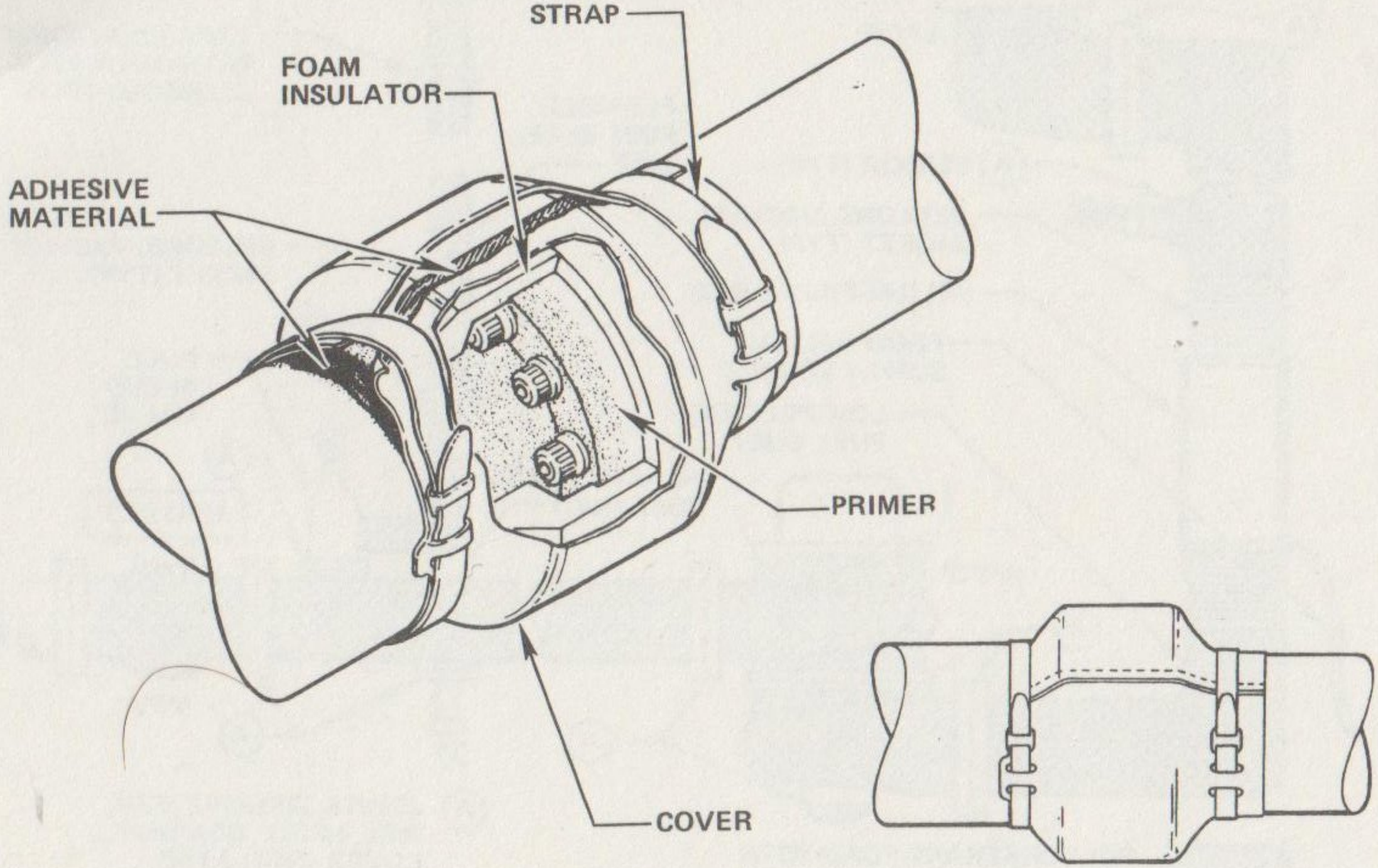


FIGURE 2-62. TYPICAL JOINT INSULATION

SECTION III

GROUND TURNAROUND OPERATIONS AND MAINTENANCE

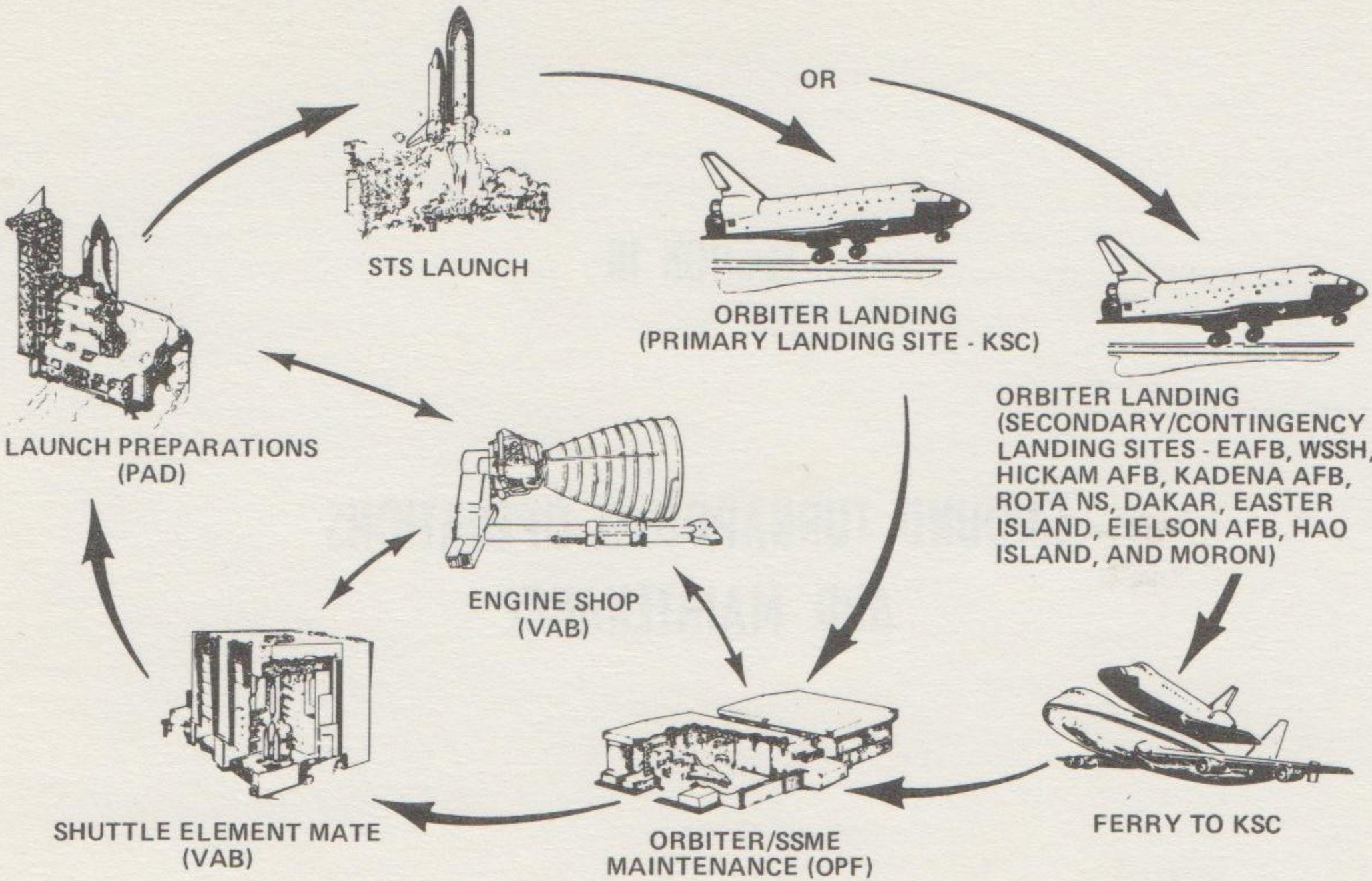


FIGURE 3-1. KSC STS/SSME TURNAROUND FLOW

SPACE SHUTTLE MAIN ENGINE GROUND
TURNAROUND OPERATIONS AND MAINTENANCE

- SCHEDULED TURNAROUND MAINTENANCE
  - ROUTINE TASKS
    - HIGH-PRESSURE FUEL TURBO-PUMP TURBINE BEARING DRYING
    - EXTERNAL INSPECTIONS
    - TURBOPUMP TORQUE/SHAFT POSITION CHECKS
    - INTERNAL INSPECTIONS
    - ENGINE SERVICING
    - LEAK TESTS
    - AUTOMATIC/ELECTRICAL CHECKOUTS
    - PRELAUNCH CONFIDENCE CHECK
    - PRELAUNCH CLOSEOUT INSPECTION
    - LAUNCH SITE LANDING OPERATIONS
  - PERIODIC TASKS
    - LEAK TESTS
    - INSPECTIONS
- UNSCHEDULED MAINTENANCE
  - AS REQUIRED
- REMOTE SITE LANDING REQUIREMENTS
  - SCHEDULED OPERATIONS AND MAINTENANCE
    - ENVIRONMENTAL PROTECTION SET INSTALLATION
    - HPFTP DRYING
    - FERRY FLIGHT SET INSTALLATION
    - LEAK CHECKS
    - TVC LOCK INSTALLATION
  - UNSCHEDULED MAINTENANCE
    - AS REQUIRED

FIGURE 3-2. SSME GROUND TURNAROUND OPERATIONS AND MAINTENANCE

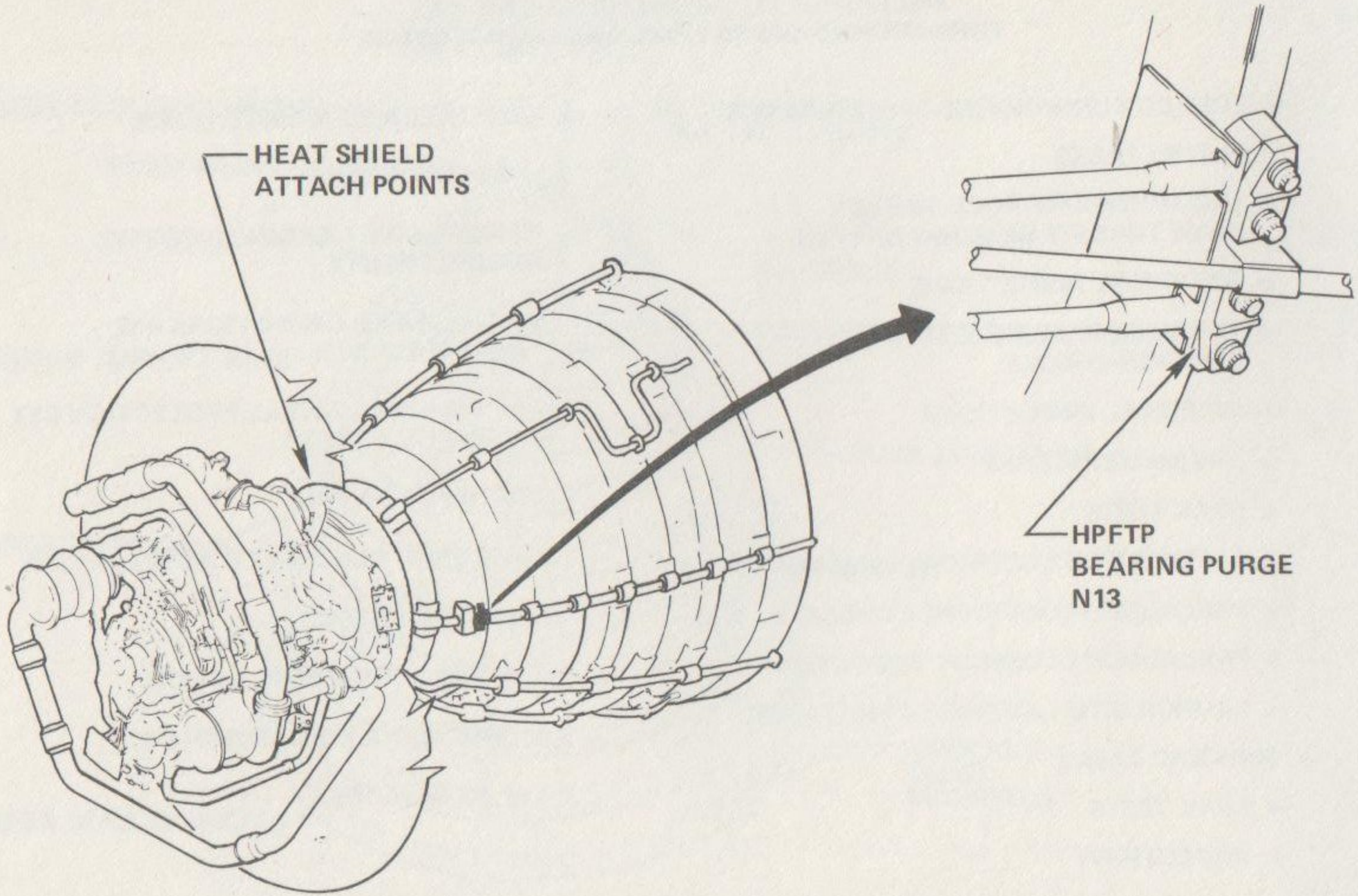
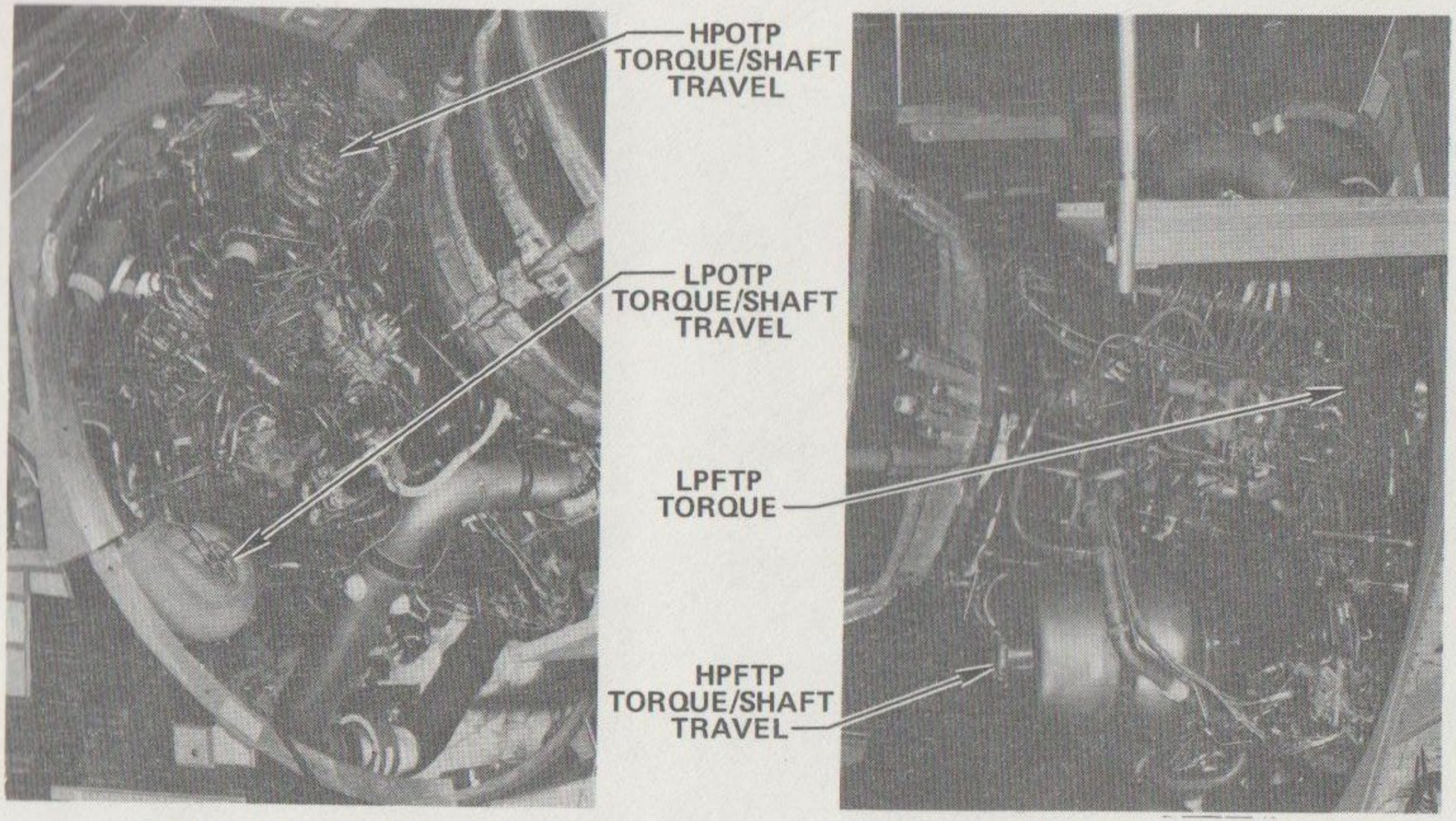


FIGURE 3-3. HPFTP TURBINE BEARING DRYING PURGE INTERFACE



ENGINE POSITION NO. 1

ENGINE POSITION NO. 1

FIGURE 3-4. SSME TURBOPUMP TORQUE/SHAFT TRAVEL

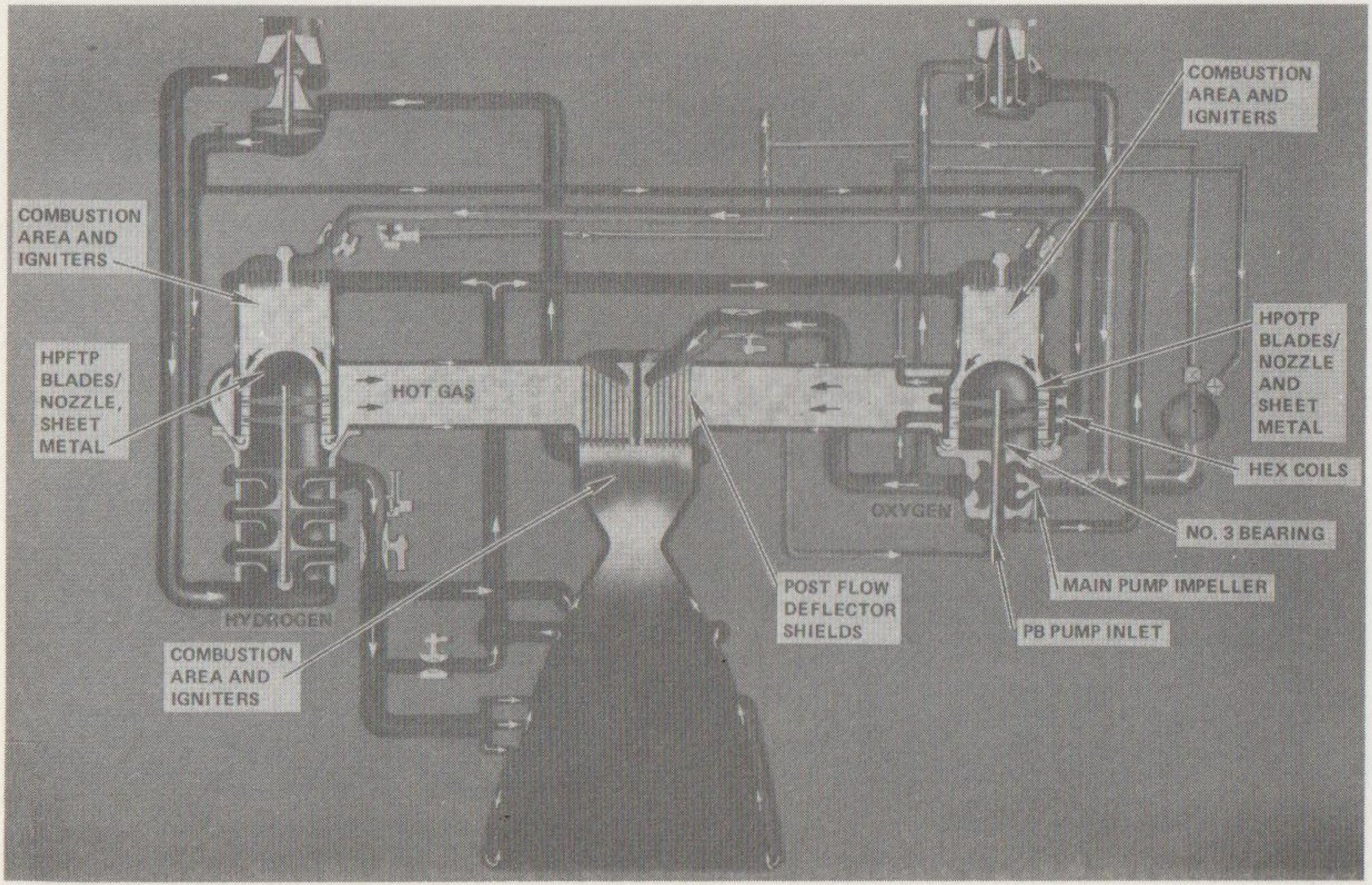


FIGURE 3-5. SSME INTERNAL INSPECTION AREAS

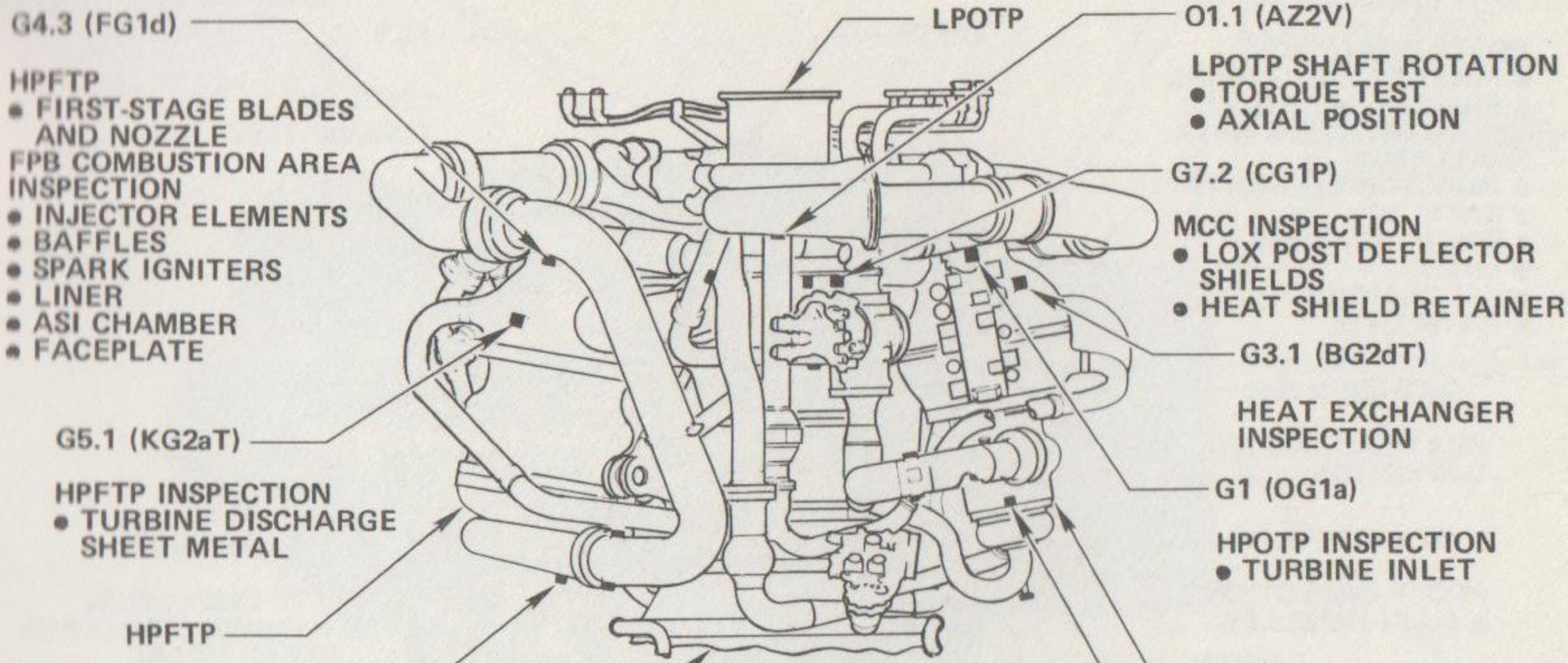


FIGURE 3-6. INTERNAL INSPECTION AND SHAFT ROTATION ACCESS - LPOTP SIDE OF ENGINE

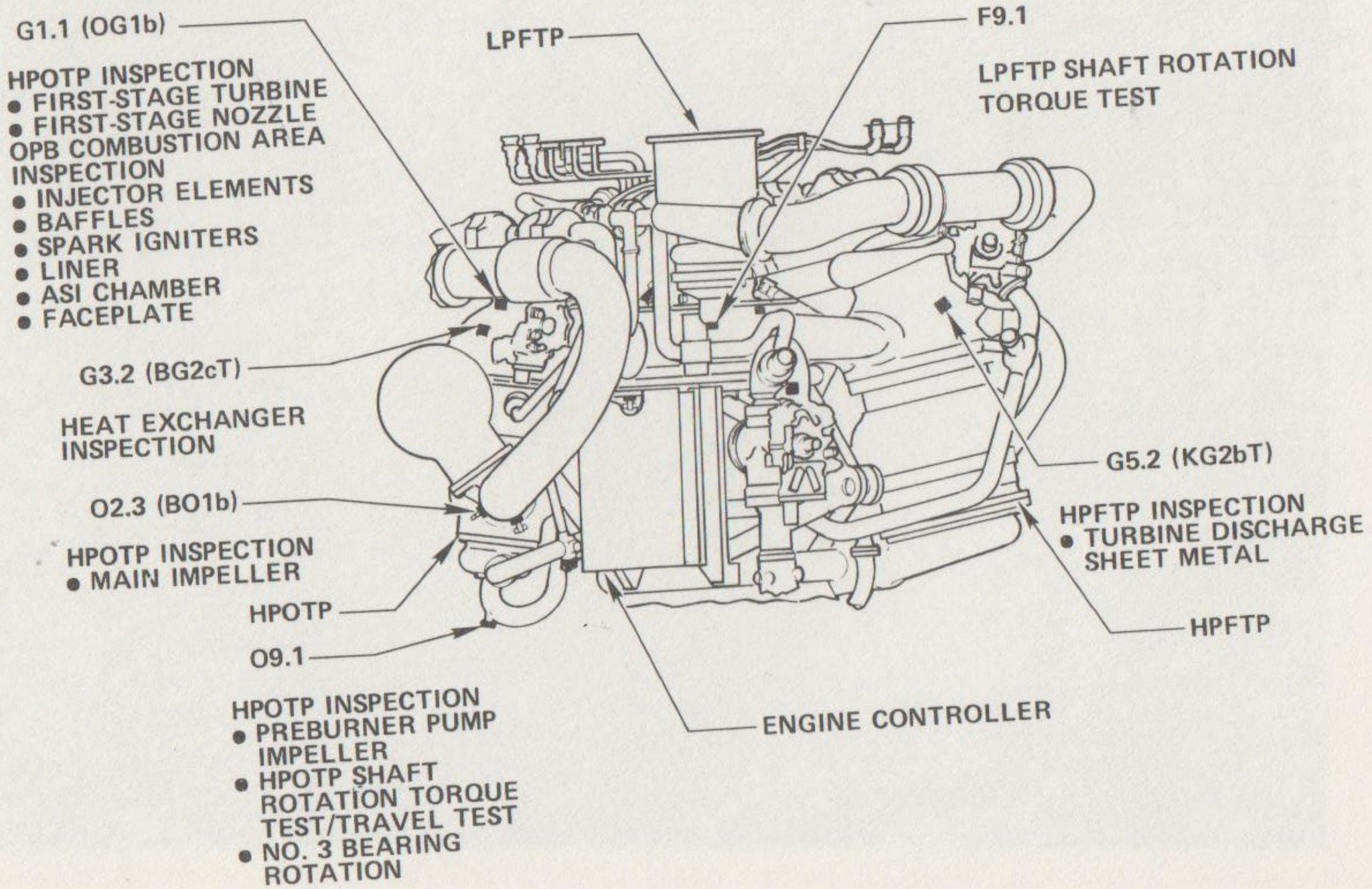


FIGURE 3-7. INTERNAL INSPECTION AND SHAFT ROTATION ACCESS - LPFTP SIDE OF ENGINE

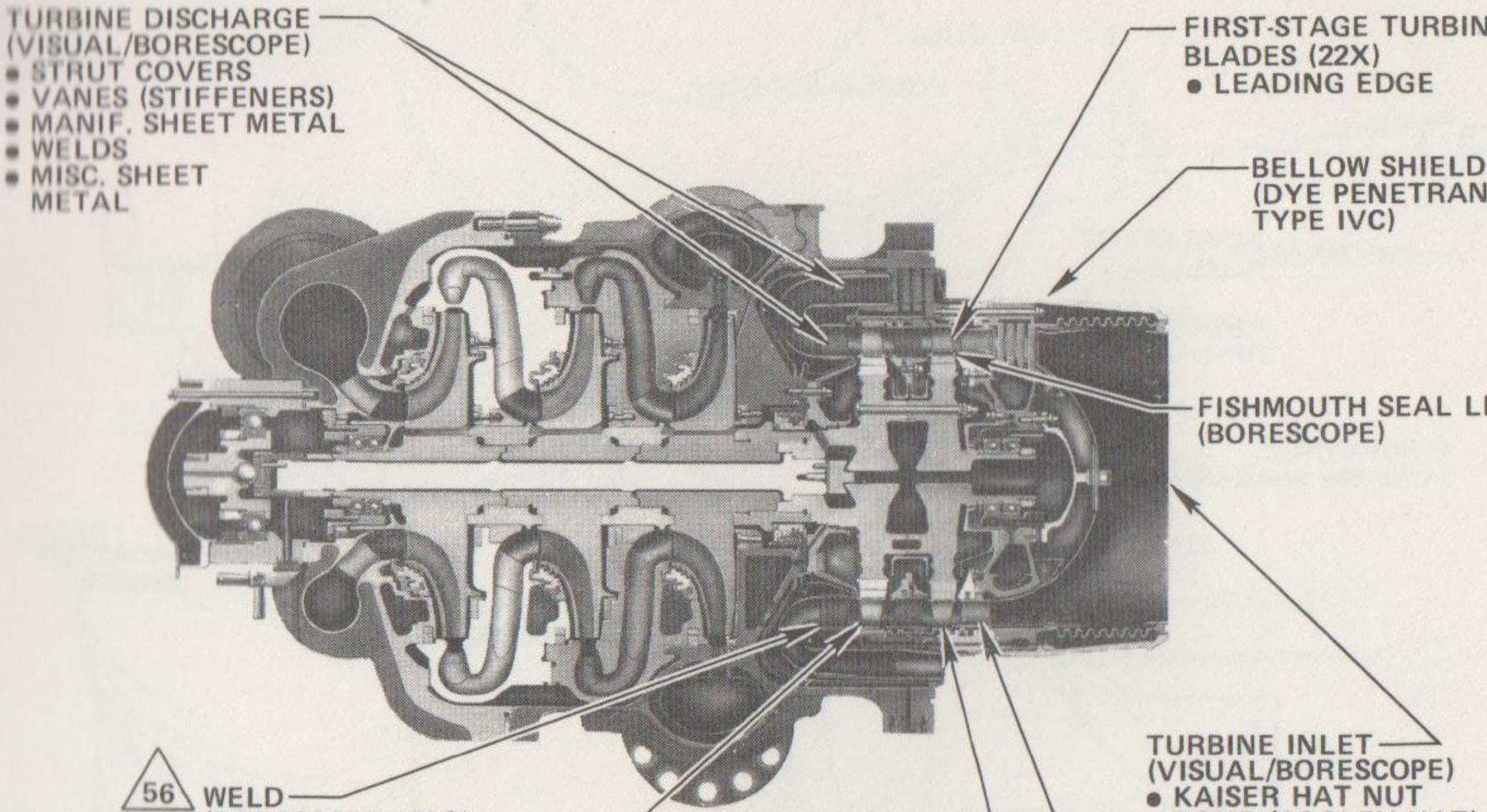


FIGURE 3-8. HPFTP TURBINE INSPECTION REQUIREMENTS

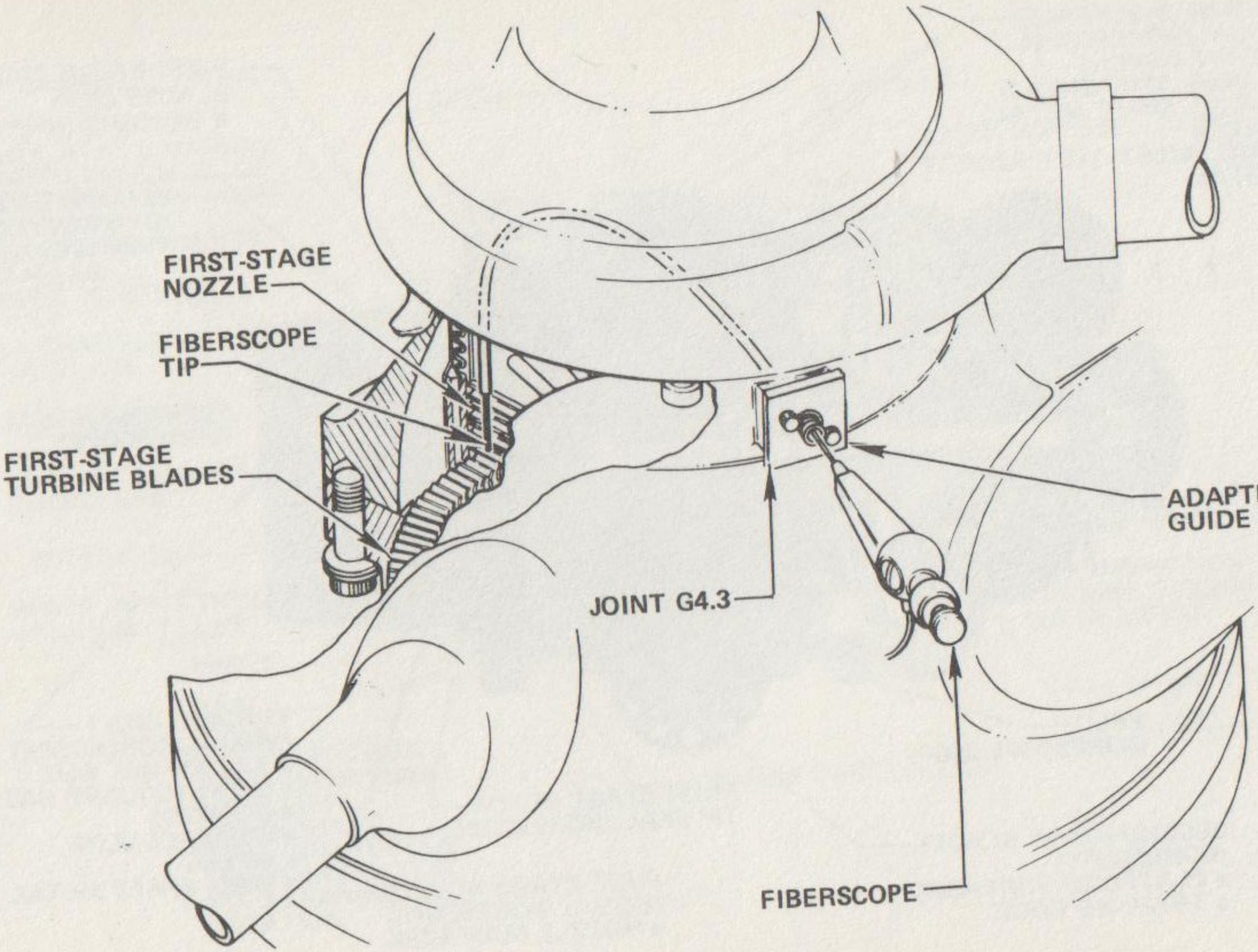


FIGURE 3-9. HPFTP FIRST-STAGE TURBINE BLADES/NOZZLE INSPECTION

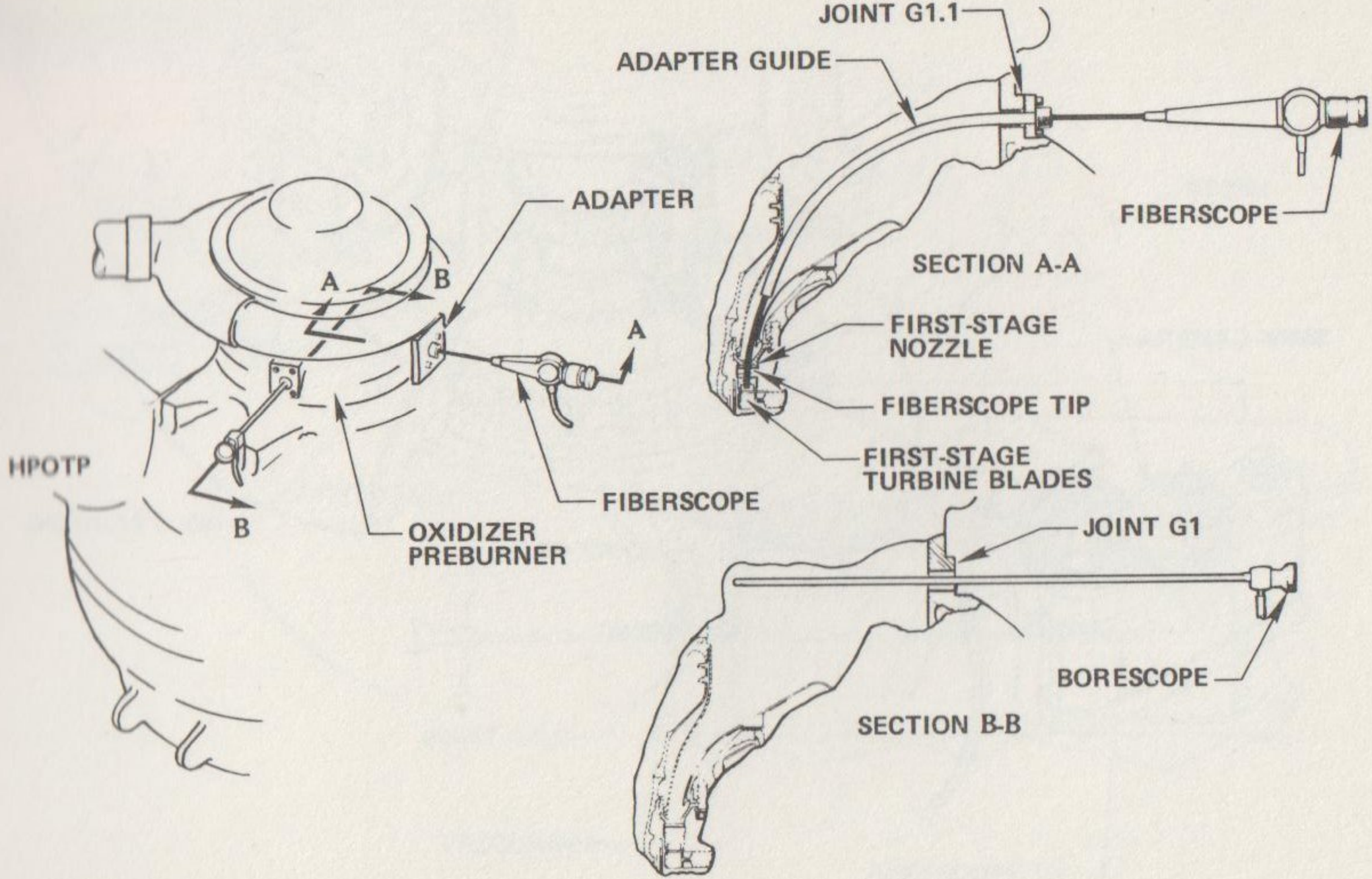


FIGURE 3-10. HPOTP FIRST-STAGE TURBINE BLADES/NOZZLE INSPECTION

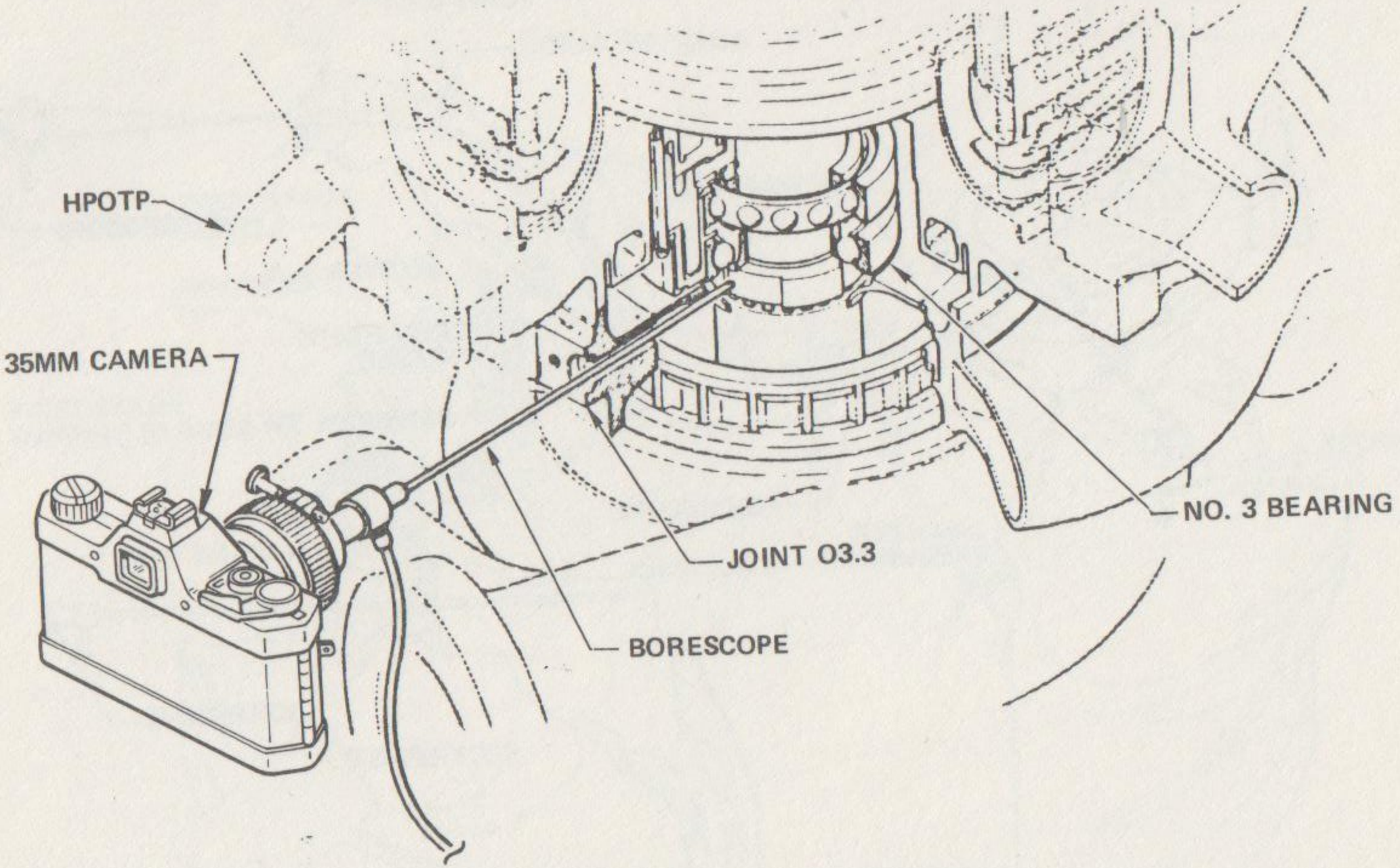


FIGURE 3-11. HPOTP NO. 3 BEARING INSPECTION

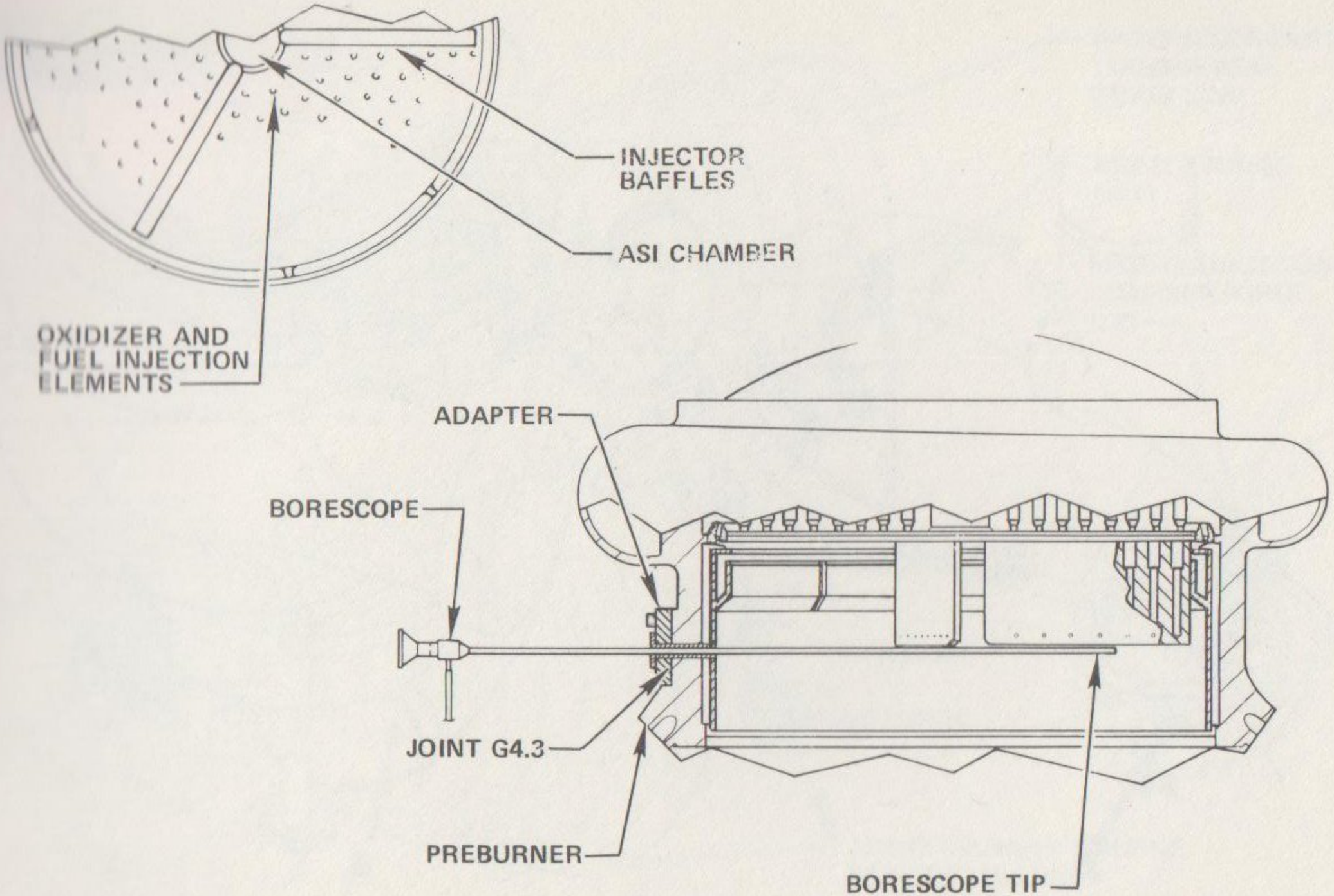


FIGURE 3-12. PREBURNER COMBUSTION AREA INSPECTION

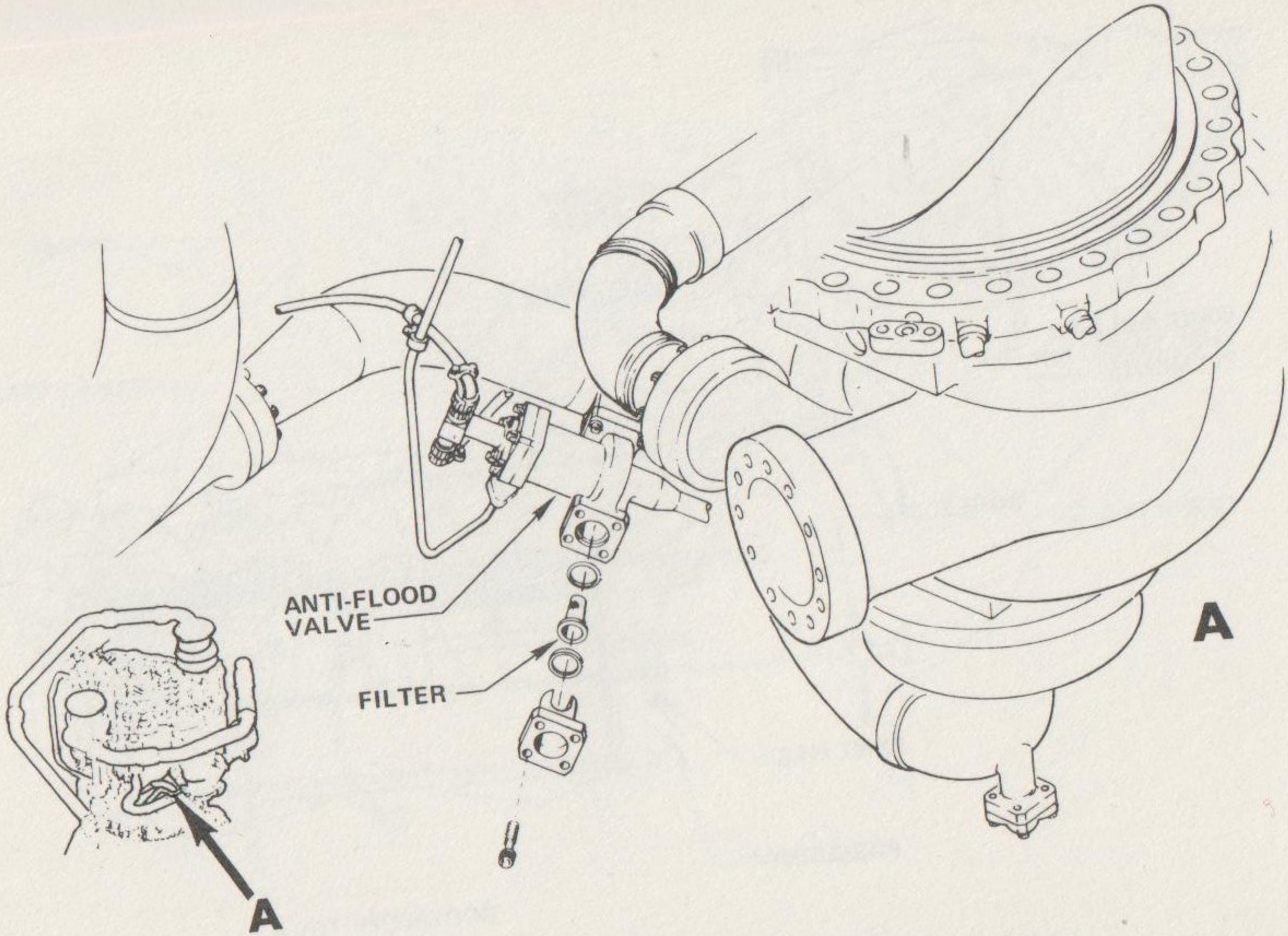


FIGURE 3-13. ANTI-FLOOD VALVE (AFV) FILTER REPLACEMENT

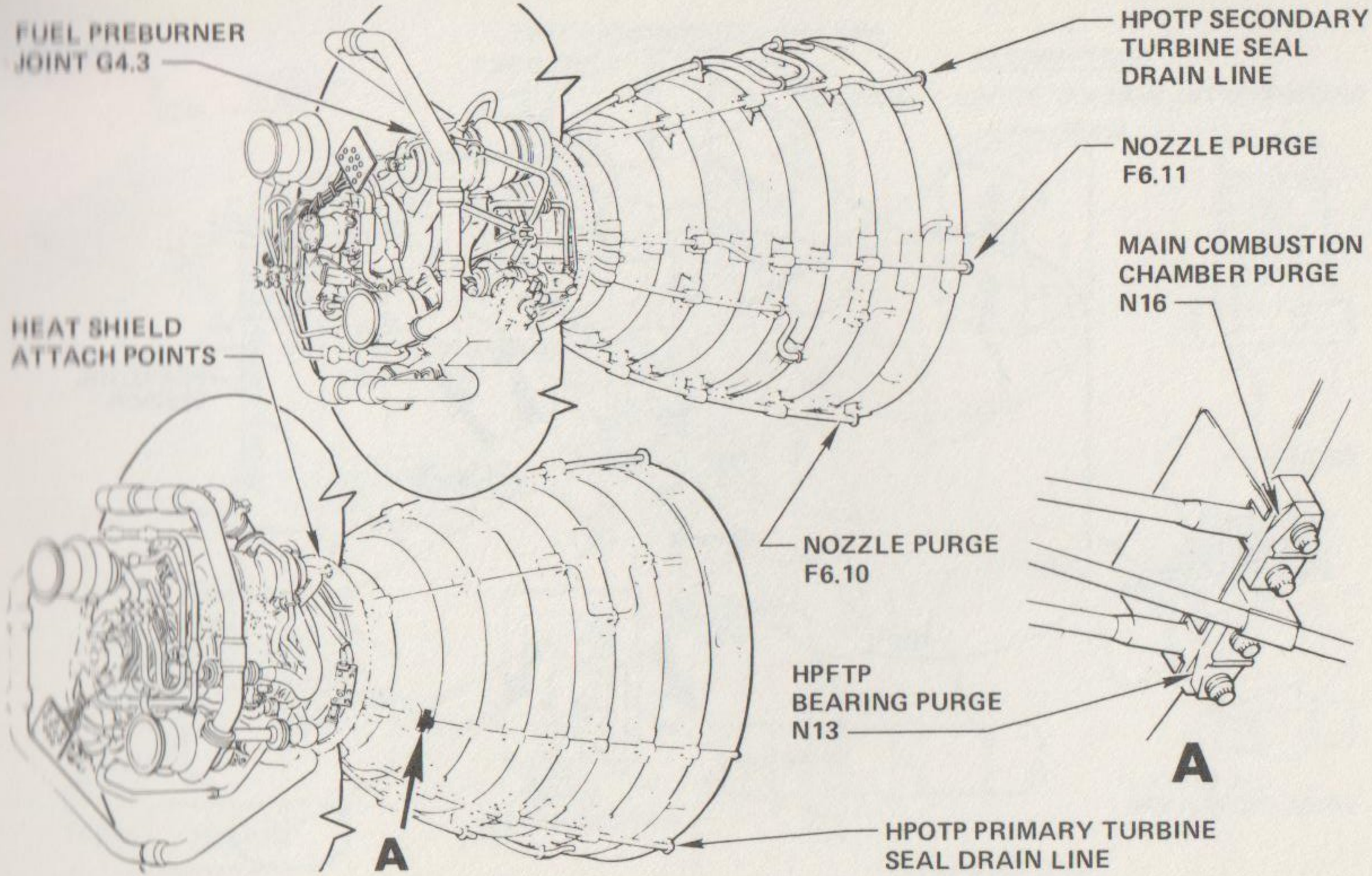


FIGURE 3-14. ENGINE DRYING INTERFACES

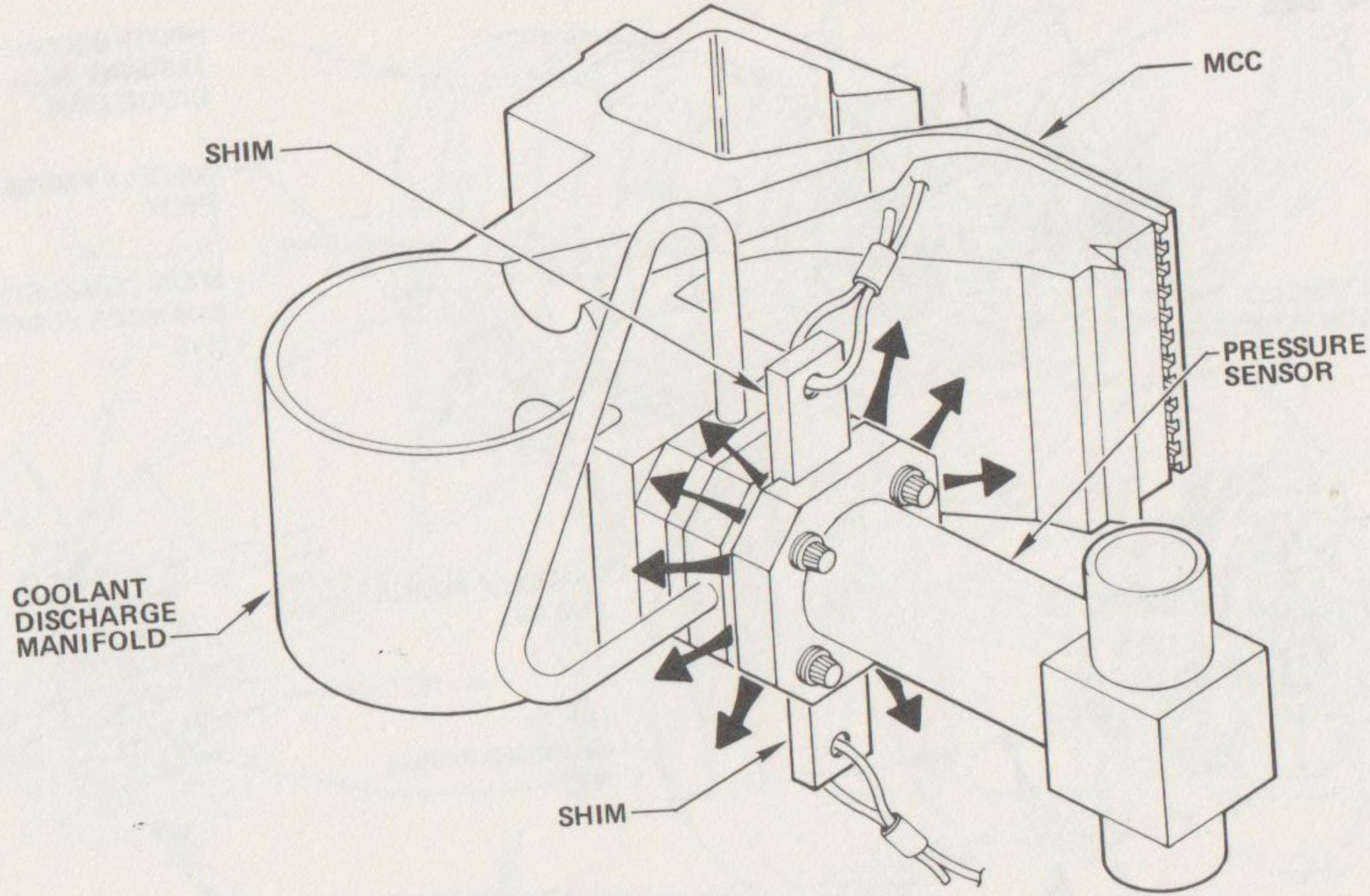


FIGURE 3-15. MCC COMBUSTION PRESSURE SENSOR DRYING USING SHIMS

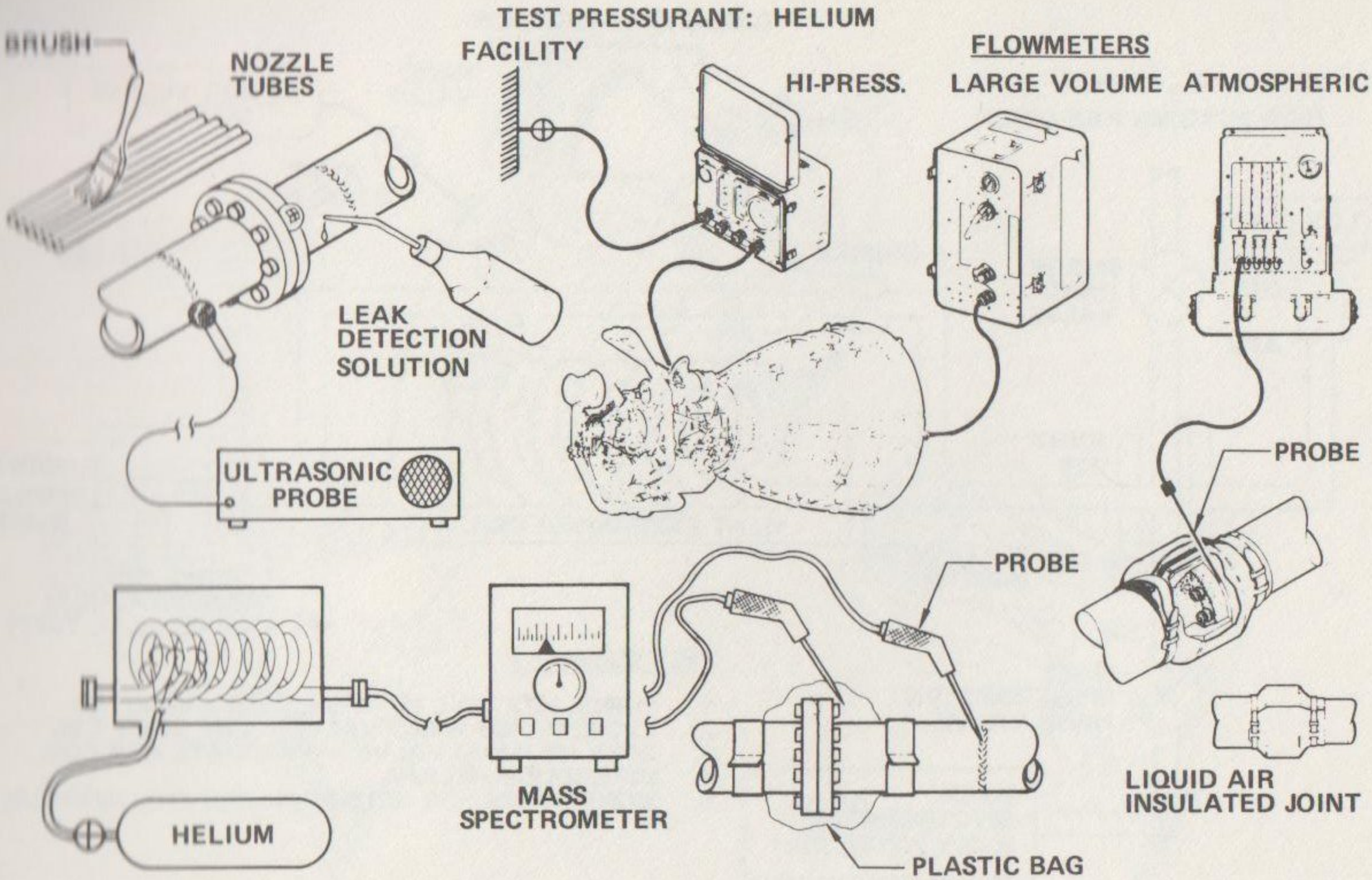
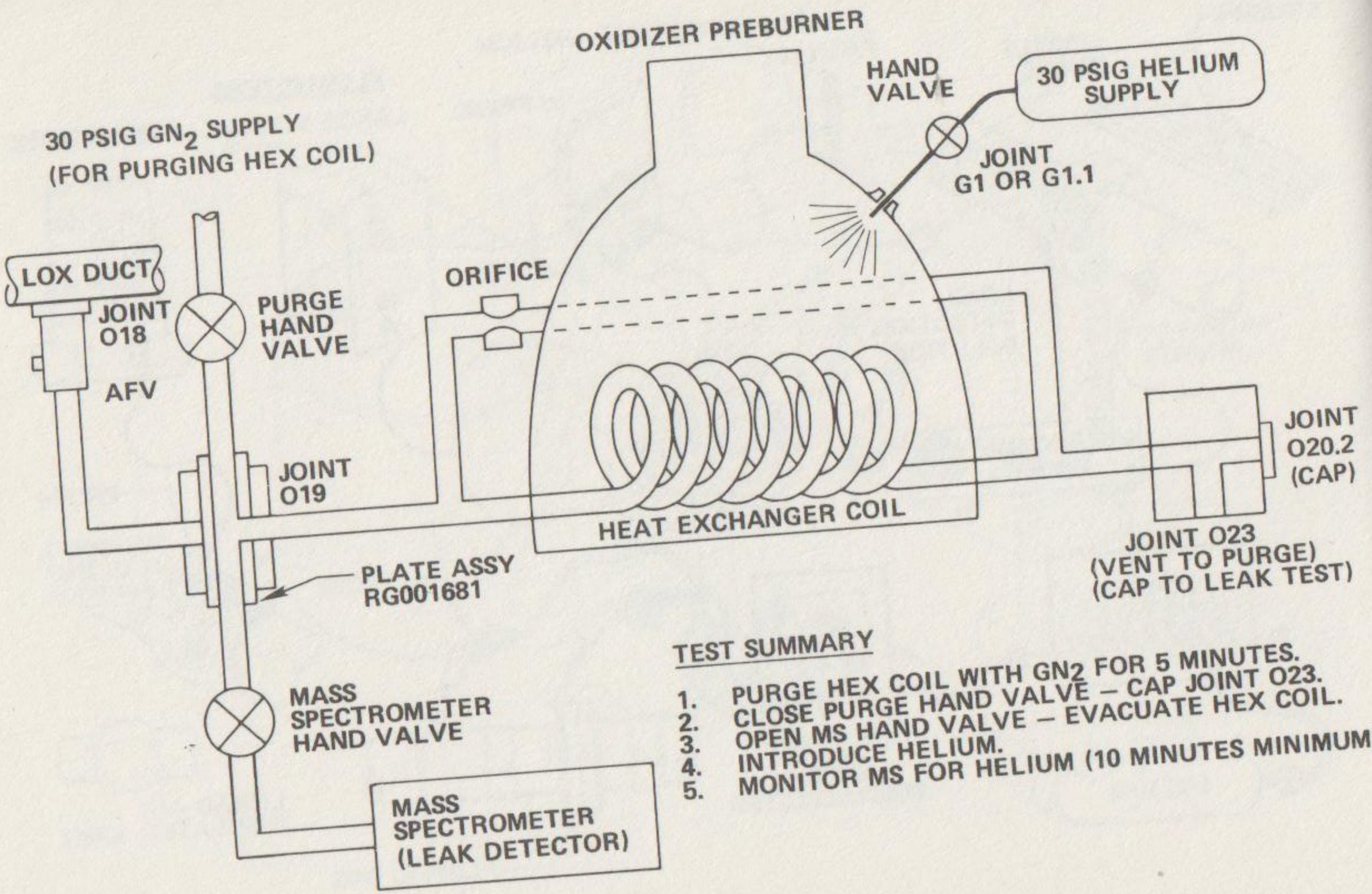


FIGURE 3-16. ENGINE LEAK TEST METHODS



TEST SUMMARY

1. PURGE HEX COIL WITH GN_2 FOR 5 MINUTES.
2. CLOSE PURGE HAND VALVE – CAP JOINT O23.
3. OPEN MS HAND VALVE – EVACUATE HEX COIL.
4. INTRODUCE HELIUM.
5. MONITOR MS FOR HELIUM (10 MINUTES MINIMUM).

FIGURE 3-17. HEAT EXCHANGER COIL LEAK TEST

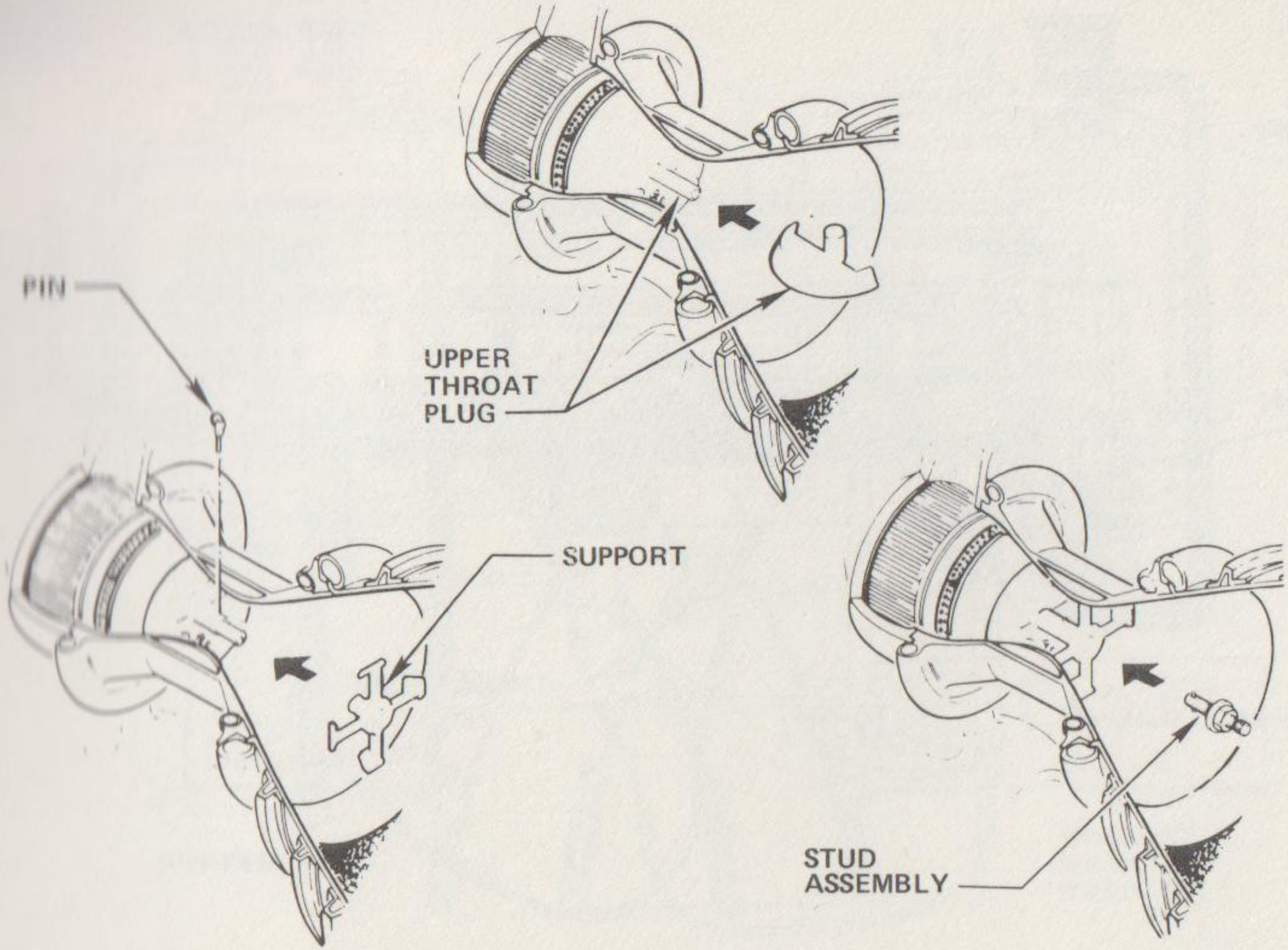


FIGURE 3-18. UPPER THROAT PLUG INSTALLATION

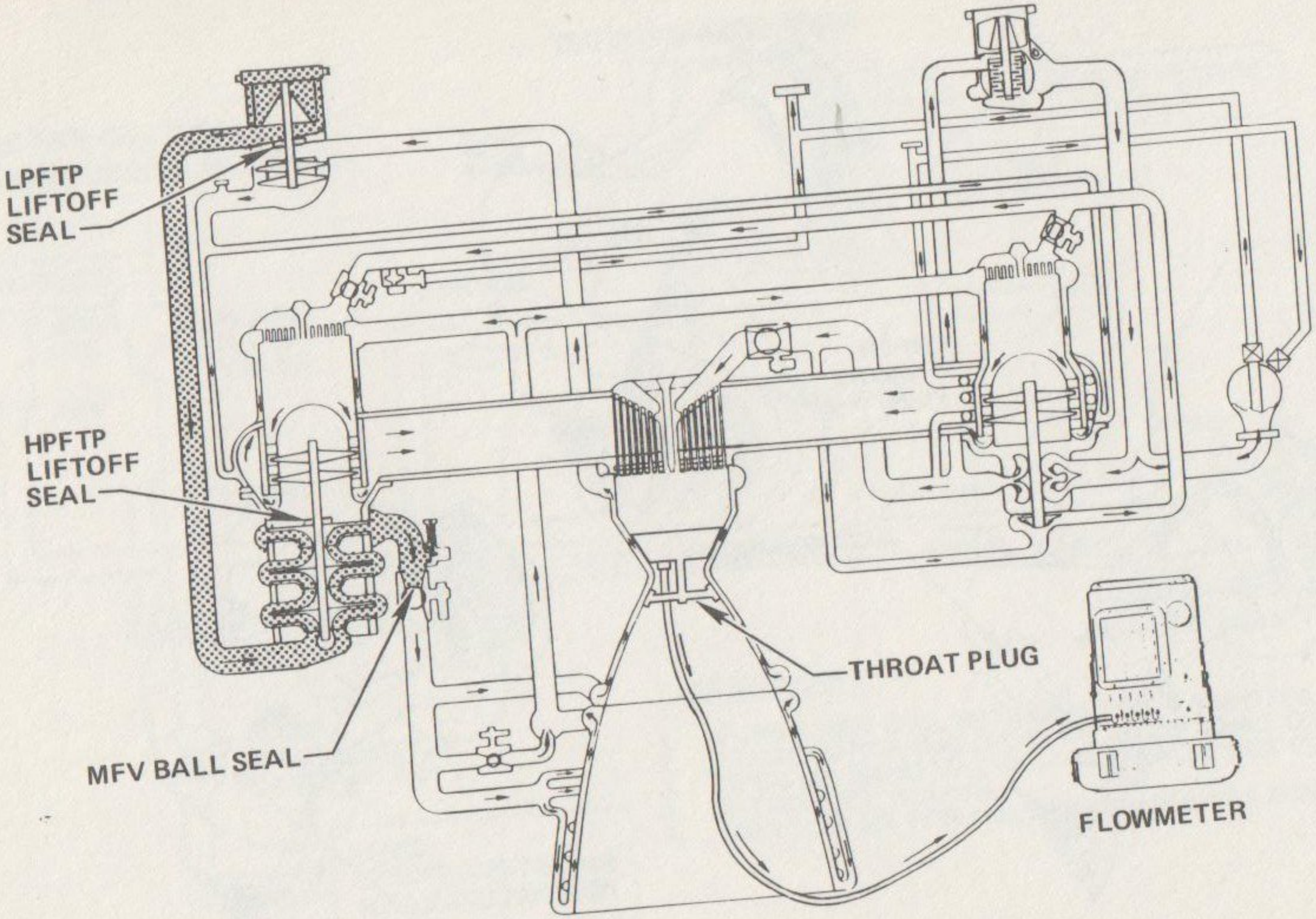


FIGURE 3-19. COMBINED LEAK TEST LPFTP AND HPFTP LIFTOFF SEALS AND MFV BALL SEAL

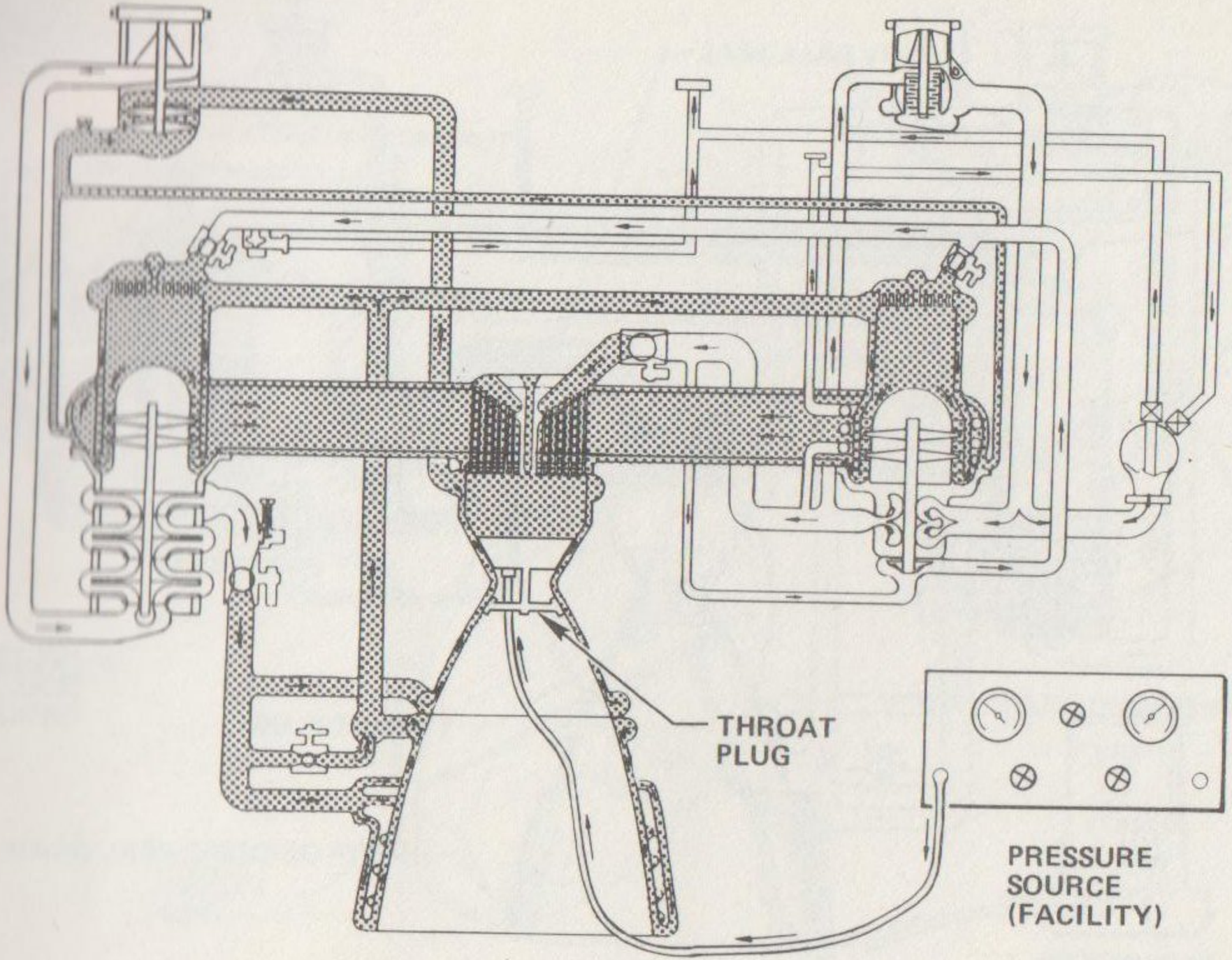


FIGURE 3-20. THRUST CHAMBER AND HOT-GAS SYSTEM LEAK TESTS

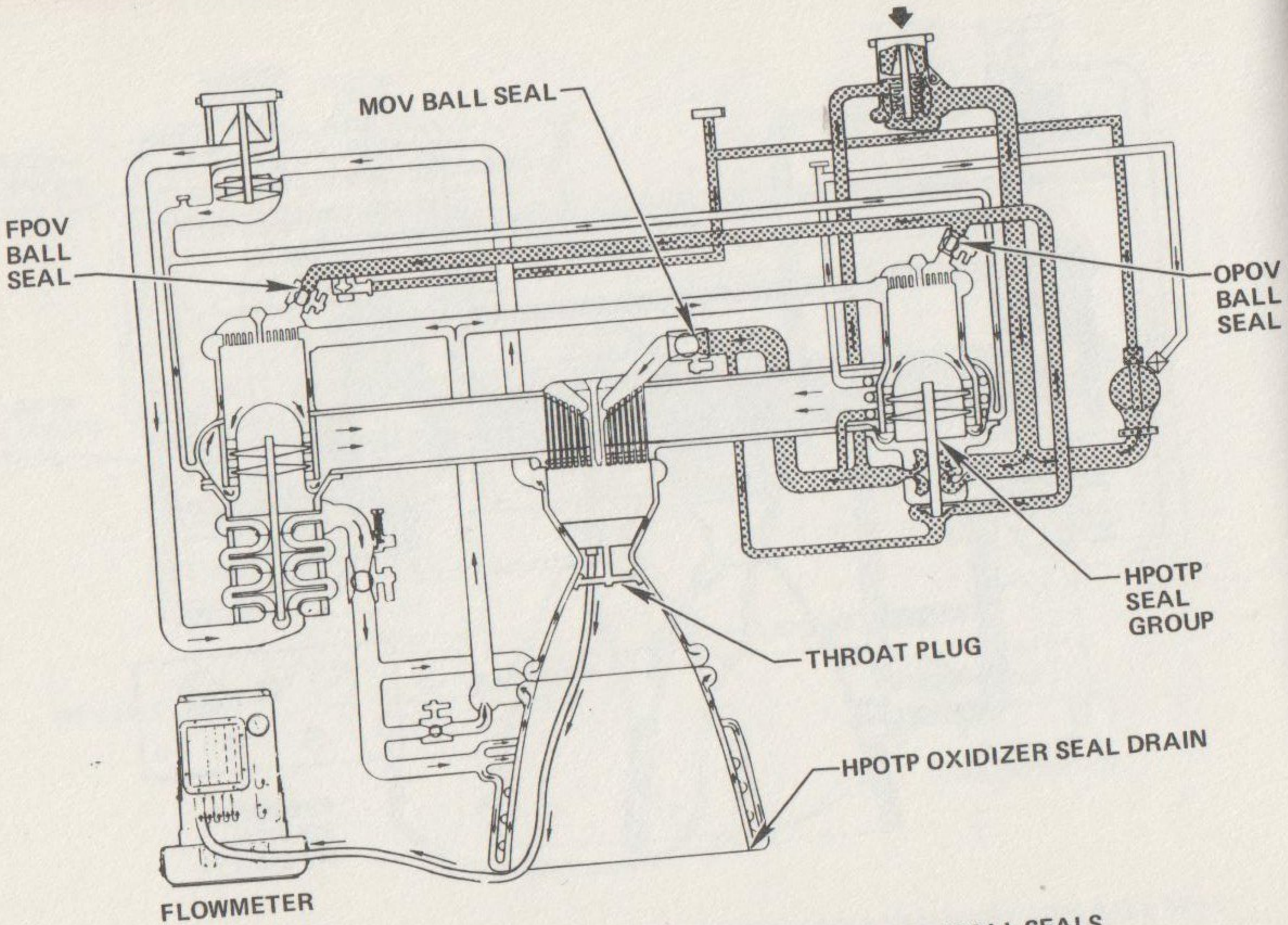
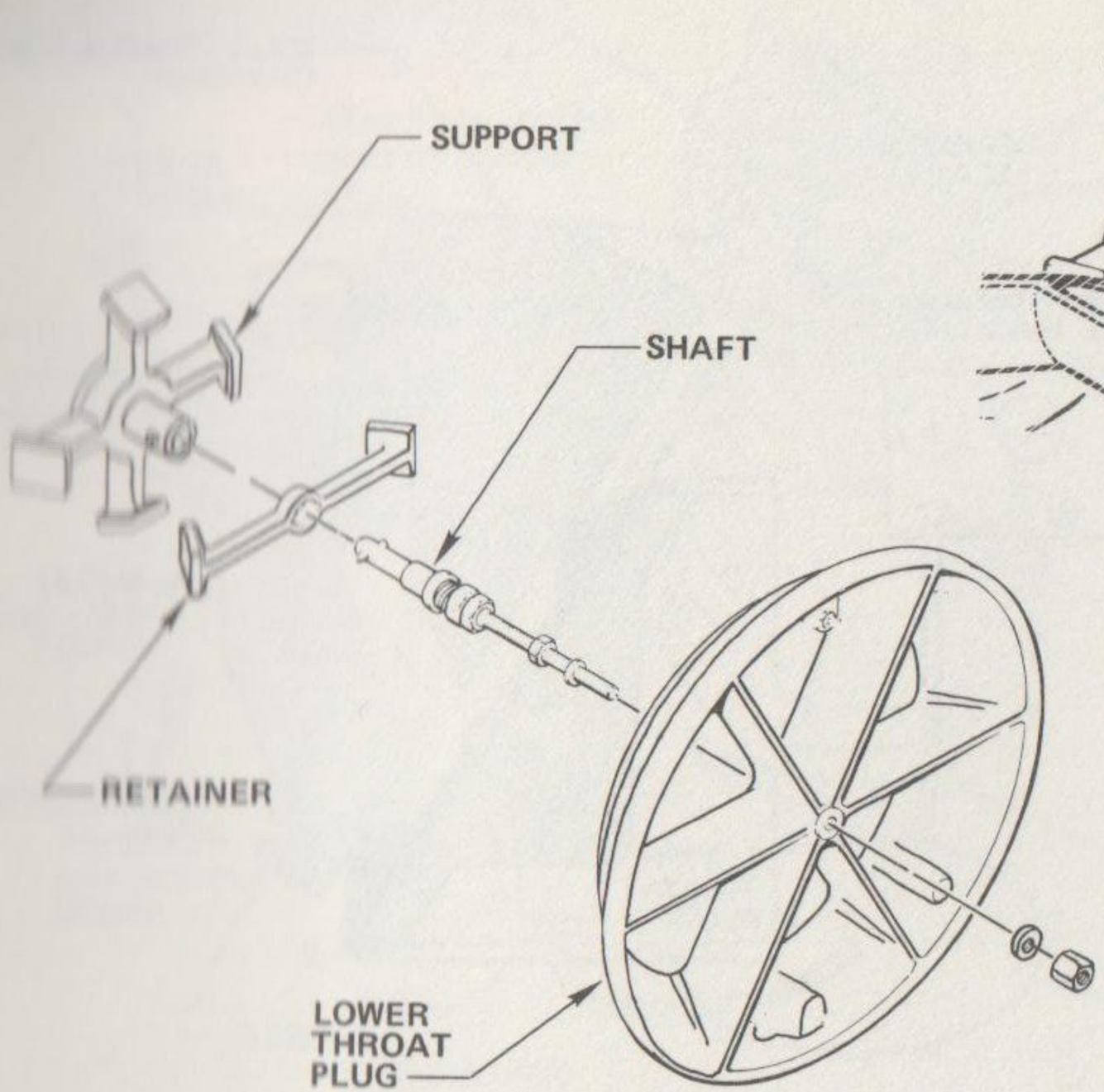
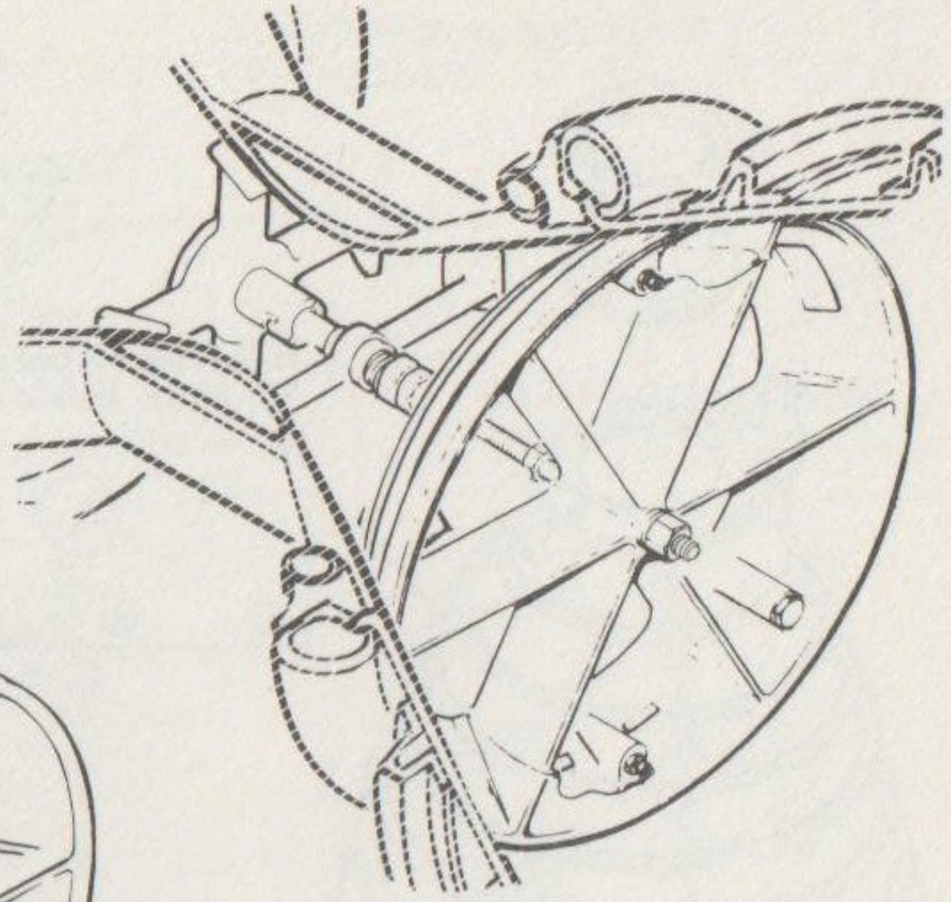


FIGURE 3-21. COMBINED LEAK TEST MOV, FPOV, OPOV BALL SEALS





INSTALLED CONFIGURATION

FIGURE 3-22. LOWER THROAT PLUG INSTALLATION

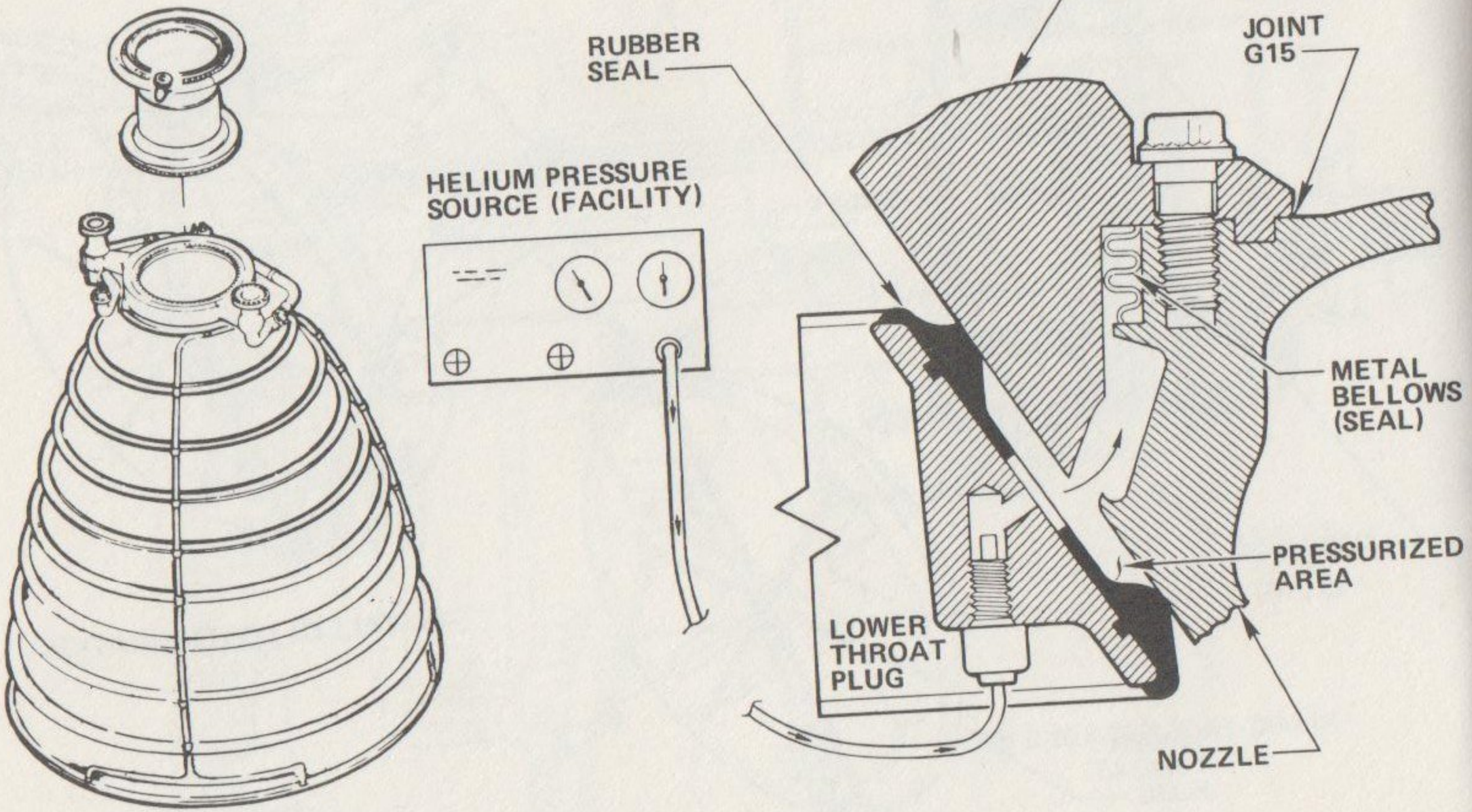


FIGURE 3-23. MCC - NOZZLE JOINT LEAK TEST

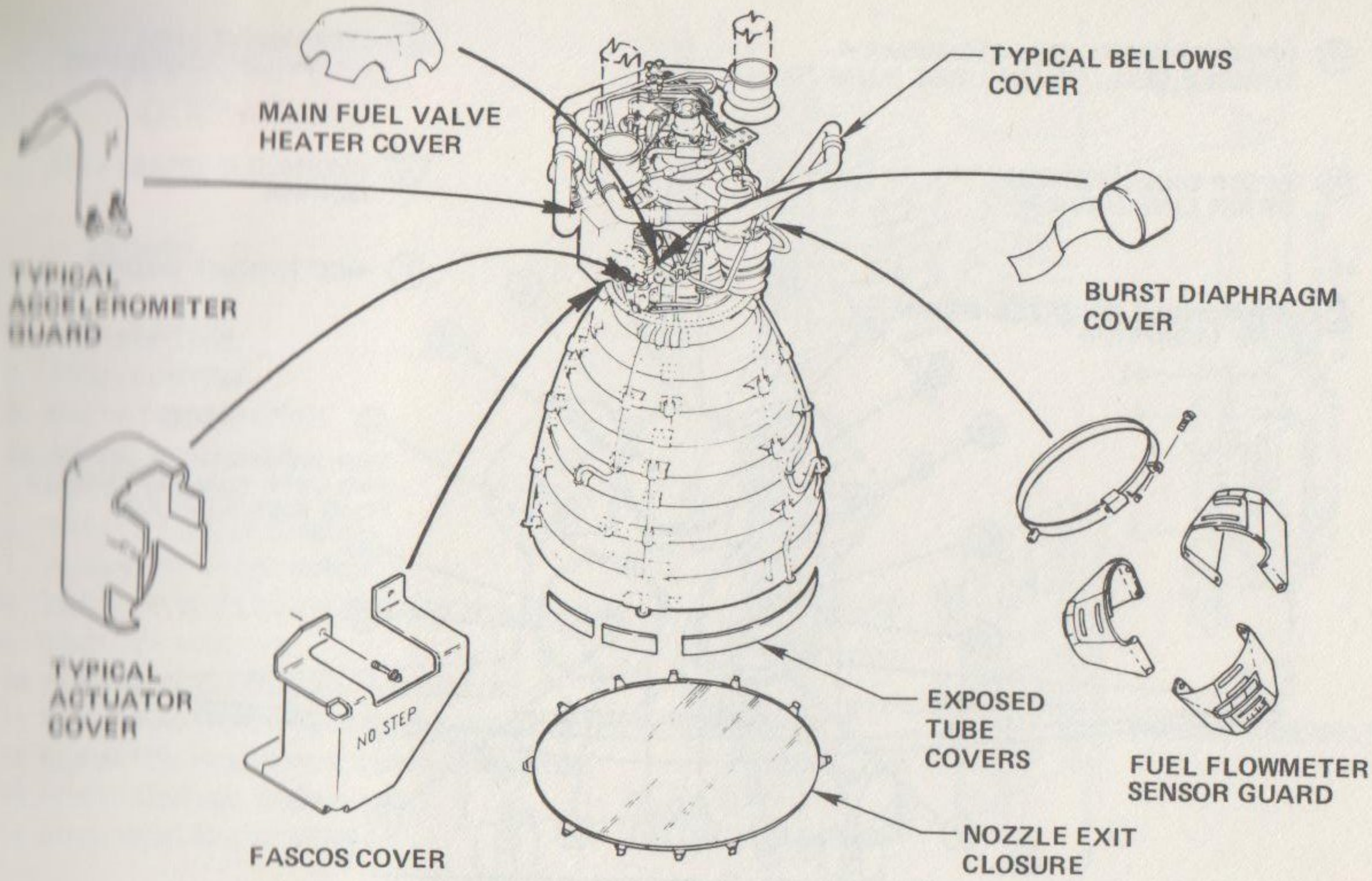


FIGURE 3-24. TYPICAL PROTECTIVE COVERS DURING MAINTENANCE

Ⓐ HPOTP PRIMARY AND SECONDARY TURBINE SEAL, DRAIN LINES (ADAPTERS)

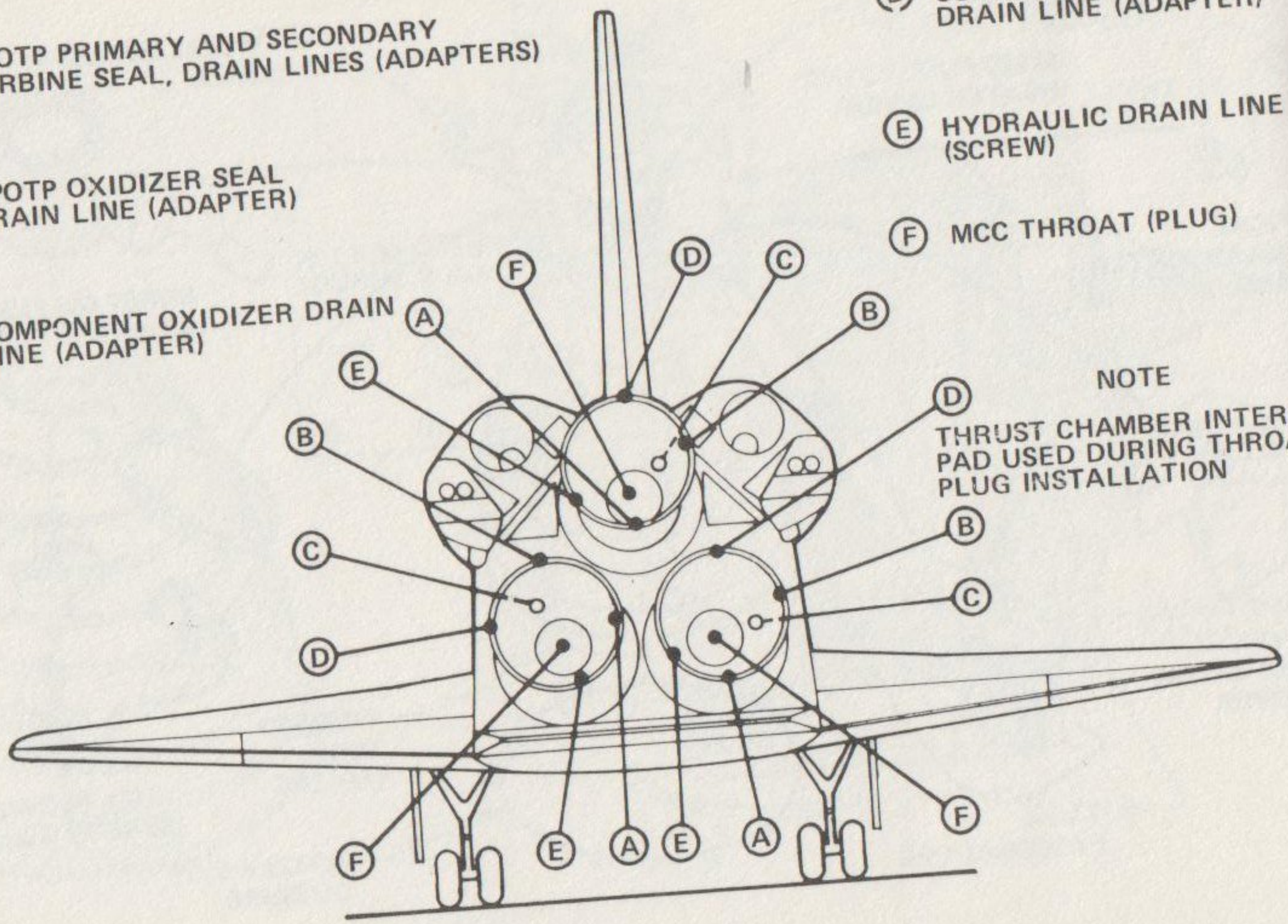
Ⓑ HPOTP OXIDIZER SEAL DRAIN LINE (ADAPTER)

Ⓒ COMPONENT OXIDIZER DRAIN LINE (ADAPTER)

Ⓓ COMPONENT FUEL DRAIN LINE (ADAPTER)

Ⓔ HYDRAULIC DRAIN LINE (SCREW)

Ⓕ MCC THROAT (PLUG)



NOTE

THRUST CHAMBER INTERIOR PAD USED DURING THROAT PLUG INSTALLATION

FIGURE 3-25. FERRY FLIGHT SET INSTALLATION POINTS

VERTICAL RAIL OPERATION

LEGEND

1 YAW CONTROL
2 PITCH CONTROL
3 ELEVATION CONTROL
4 AZIMUTH CONTROL
5 ROLL CONTROL
6 TROLLEY DRIVE WINCH
7 ELEVATOR TRACK WINCH
8 TROLLEY TO ELEVATOR TRACK ROLLERS (8)
9 TROLLEY RAILS (2)
10 ELEVATOR STANCHION CASTORS (4)
11 ELEVATOR TRACK SLEW DRIVE CONTROL
12 ELEVATOR TRACK PITCH DRIVE CONTROL
13 PITCH CONTROL COVERS (2)
14 ROLL CONTROL COVERS (2)

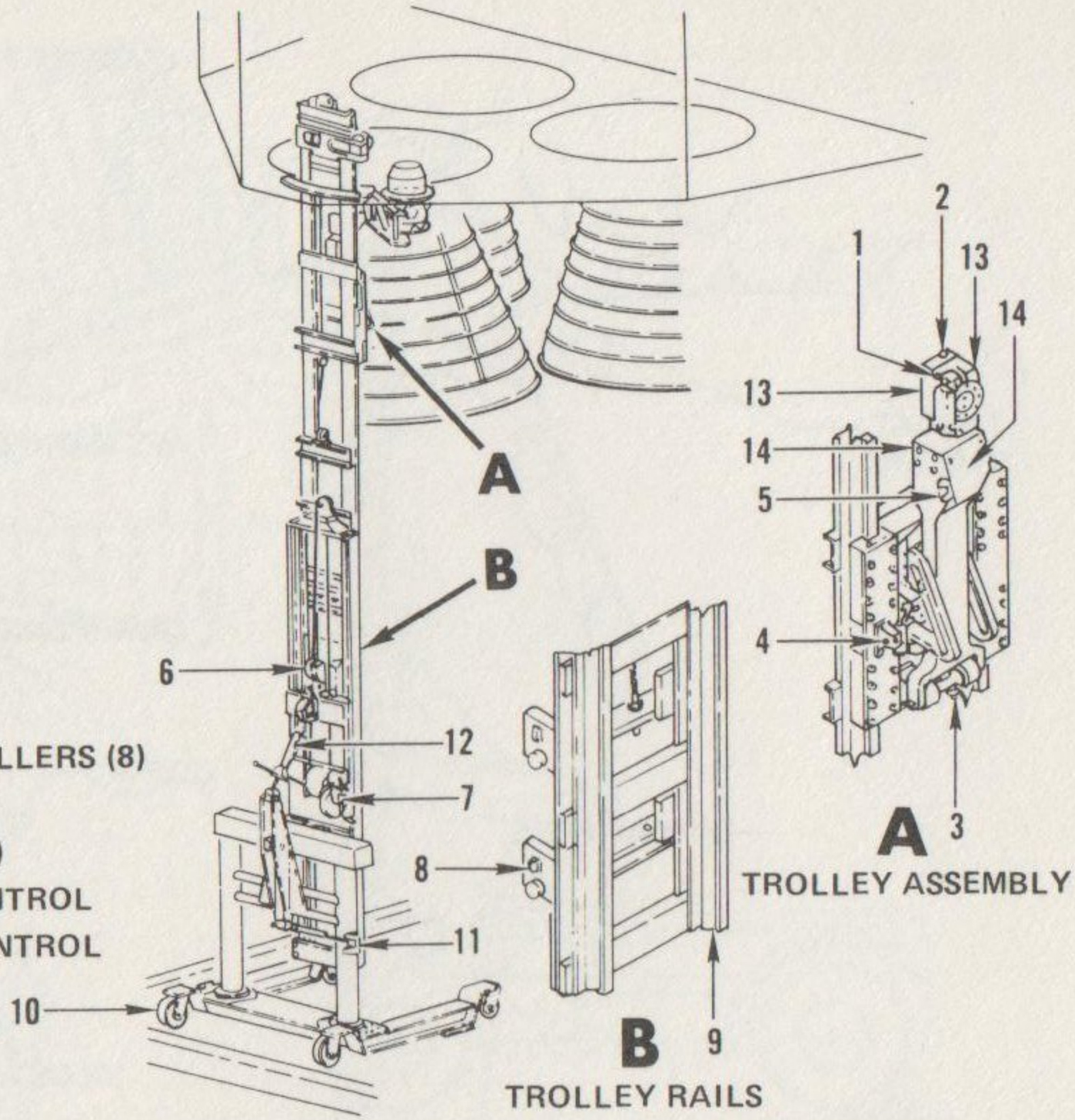


FIGURE 3-26. VERTICAL RAIL OPERATION

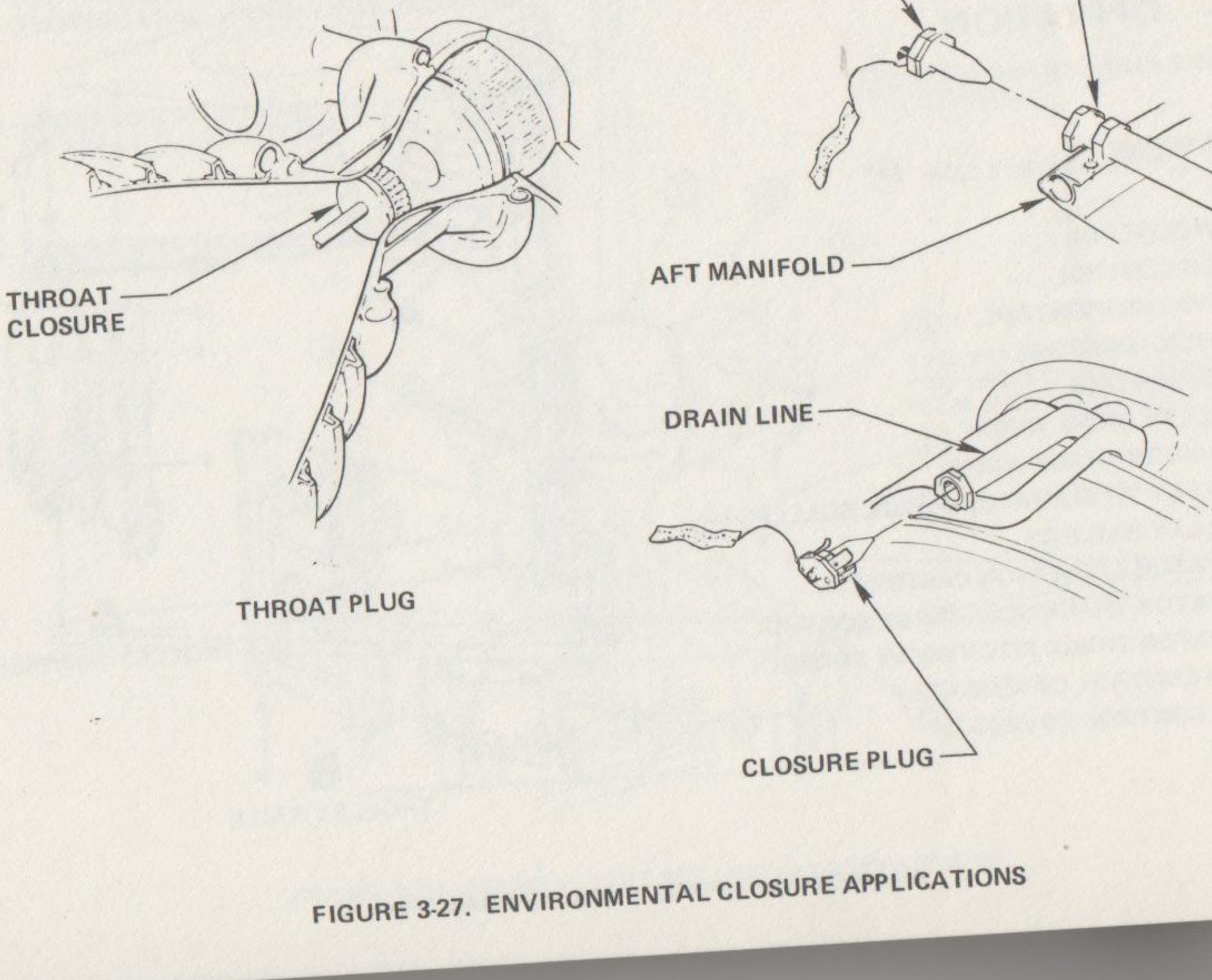


FIGURE 3-27. ENVIRONMENTAL CLOSURE APPLICATIONS

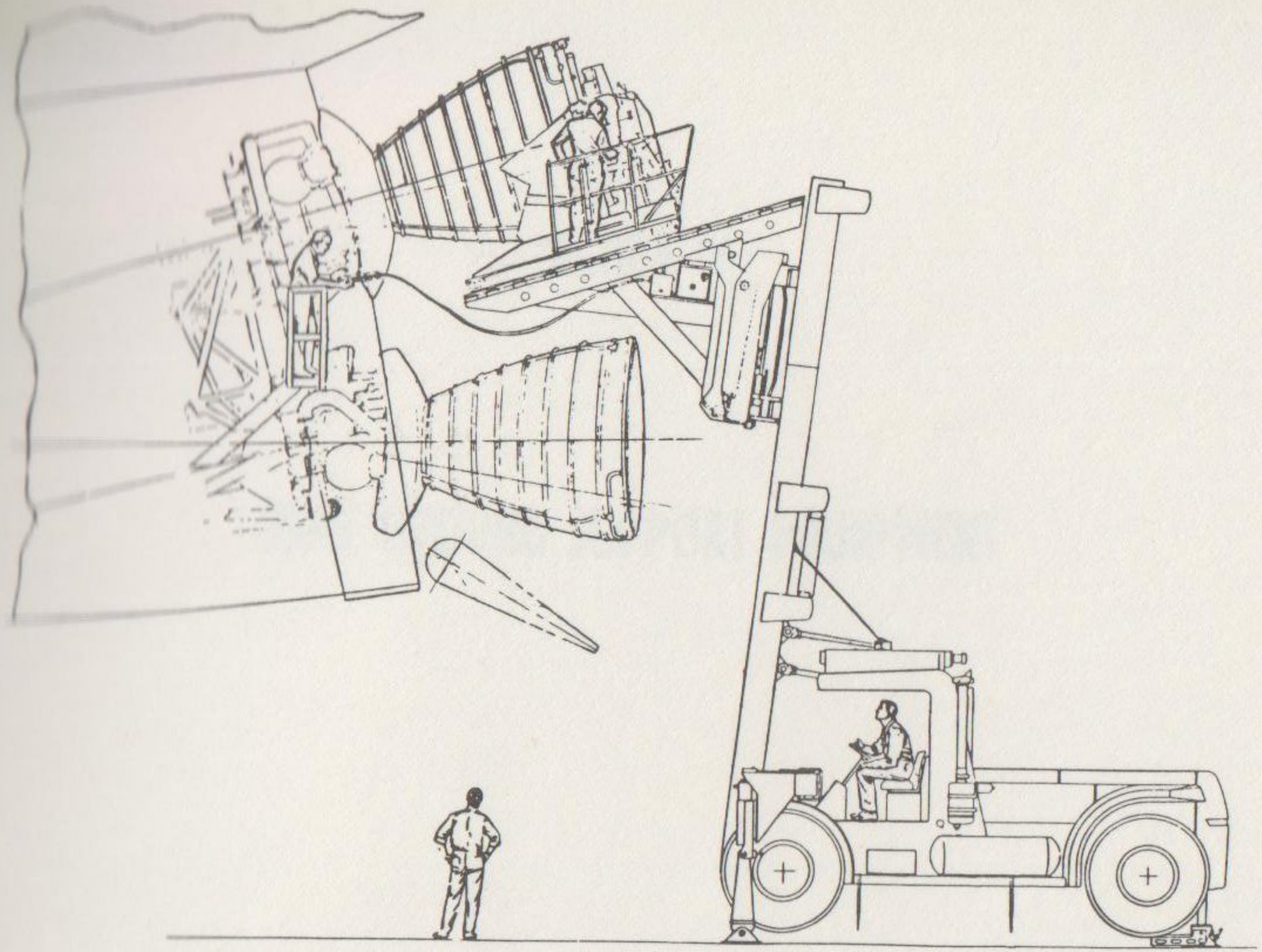


FIGURE 3-28. HORIZONTAL ENGINE REMOVAL

SECTION IV

SSME GROUND SUPPORT EQUIPMENT

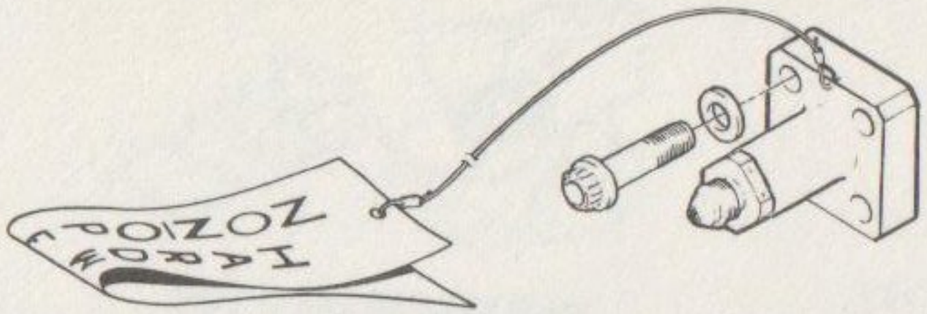
NOMENCLATURE	PROGRAM CODE
TEST EQUIPMENT	
SCHEDULED ENGINE LEAK TEST SET RG2527A, RG000013	C70-0914
UNSCHEDULED ENGINE LEAK TEST SET RG2526A, RG000012	C70-0915
ENGINE INTERFACE TEST PLATE SET RG2576A, RG000400	C70-0916
PNEUMATIC (ATMOSPHERIC) FLOW TESTER RG2528A, RG000014	C70-0903
LARGE VOLUME FLOW TESTER RG2536A, RG003046	C70-0908
HIGH-PRESSURE PNEUMATIC FLOW TESTER RG2529A, RG000015	C70-0904
DCU MEMORY LOADER RG2553A UG8629A2	C70-0910
ELECTRICAL CHECKOUT AND MAINTENANCE SET RG2538A, RG000018	C70-0912
ENGINE SIMULATOR WEIGHT RG2581A, RG003010	S70-0911
MULTIPLE GAS ANALYZER ASSEMBLY RG2577A, RG000480	C70-0917
COMMAND AND DATA SIMULATOR II RG2584A, RG000521	C70-0906
INSPECTION EQUIPMENT	
INTERNAL INSPECTION SET RG2575A, RG000020	C70-0907
MAINTENANCE EQUIPMENT	
SPECIAL TOOL SET RG2531A, RG000017	S70-0905
MAINTENANCE AND REPAIR SET RG2539A, RG000024	S70-0908
INTERFACE SEAL REMOVAL/ INSTALLATION SET RG2517A, RG000199	S70-0909
PROTECTION EQUIPMENT	
THRUST CHAMBER PROTECTIVE PAD RG2515A, RG000010	S70-0903
ENVIRONMENTAL PROTECTION COVER SET RG2513A, RG000008	S70-0902
FERRY FLIGHT SET RG2537A, RG000023	C70-0909
NOZZLE BUMPER SET RG2578A, RG000463	S70-0910
HANDLING EQUIPMENT	
ENGINE HANDLER RG2502A, RG000001	H70-0901
ENGINE HANDLER SLING RG2505A, RG000003	H70-0902
COMPONENT HANDLER SLING SET RG2514A, RG000009	H70-0905
VERTICAL ENGINE INSTALLER SET RG2507A, RG000327	H70-0774-1
ENGINE ROTATING SLING RG2506A, RG000004	H70-0903
INTERFACE PANEL AND STRUT SET RG2518A, RG000350	H70-0911
HIGH-PRESSURE FUEL TURBOPUMP SHIPPING CONTAINER ASSEMBLY RG2591A, RG000438	H70-0906
HIGH-PRESSURE OXIDIZER TURBOPUMP SHIPPING CONTAINER ASSEMBLY RG2592A, RG000441	H70-0907
LOW-PRESSURE TURBOPUMP SHIPPING CONTAINER ASSEMBLY RG2593A, RG000442	H70-0908

FIGURE 4-1. GROUND SUPPORT EQUIPMENT LIST

(C70-0914) (RG2527A) (RG000013)

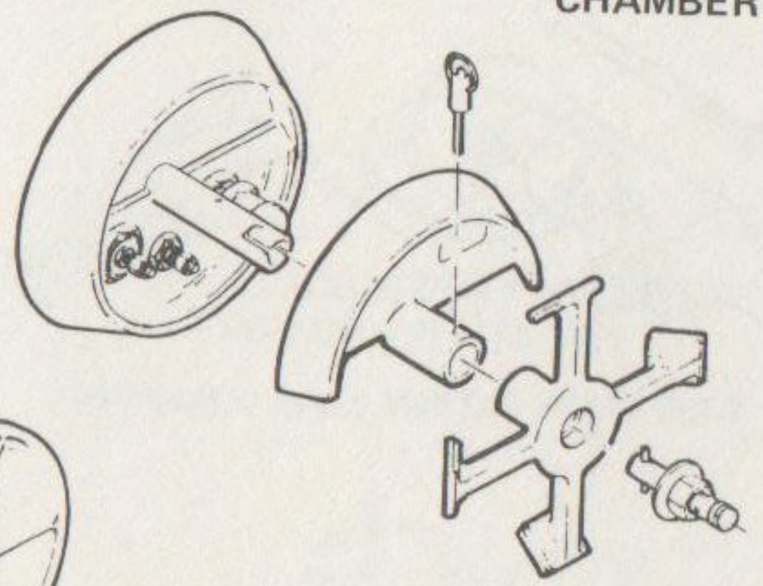
SANDWICH-TYPE TEST PLATE

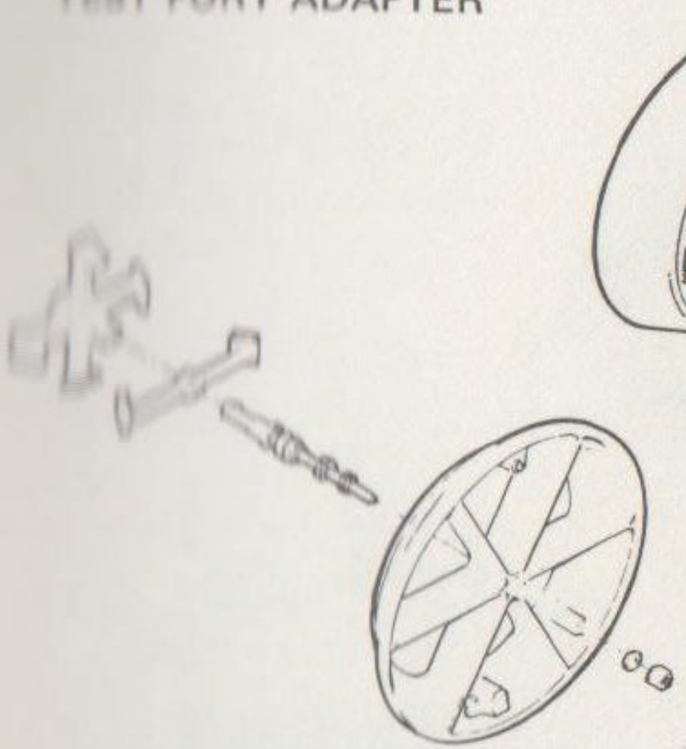
TEST PORT ADAPTER



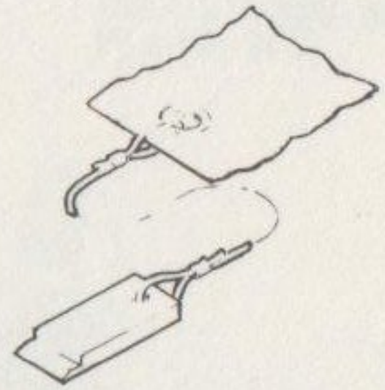
FPB COMBUSTION CHAMBER ADAPTER

OBV SEAT LEAKAGE TEST PLATE





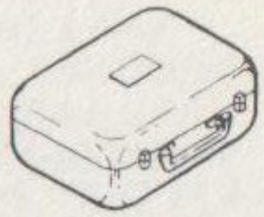
ENGINE THROAT PLUG SET



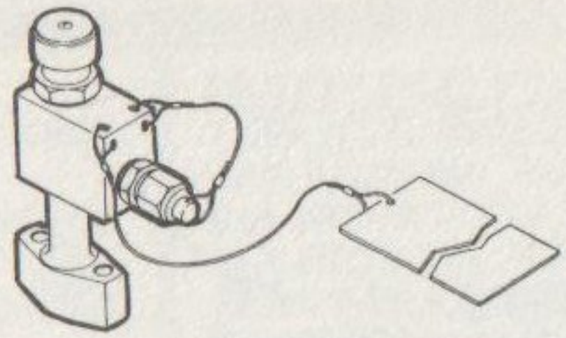
TRANSDUCER PURGE SEAL RETAINER TOOL

PURPOSE: PROVIDE AN INTERFACE FOR GSE AND CONTAIN PNEUMATIC PRESSURES IN ENGINE SYSTEMS DURING LEAK AND FUNCTION TESTS OF INSTALLED ENGINES.

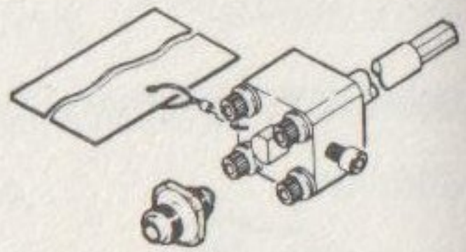
FIGURE 4-2. SCHEDULED ENGINE LEAK TEST SET (SHEET 1 OF 2)



CONTAINER (TYP)

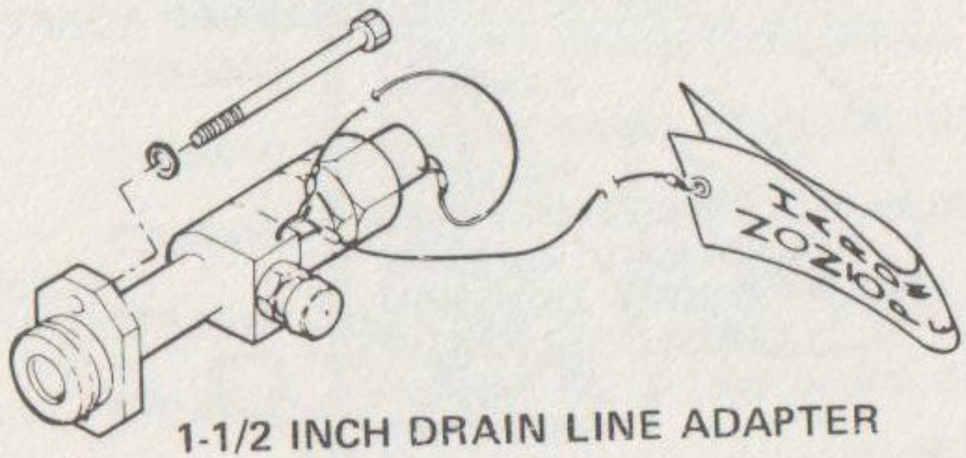


RIV ADAPTER

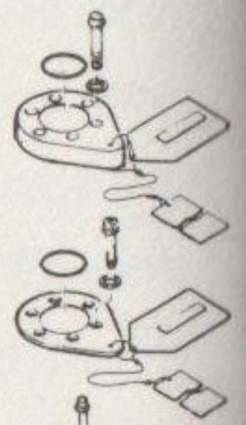


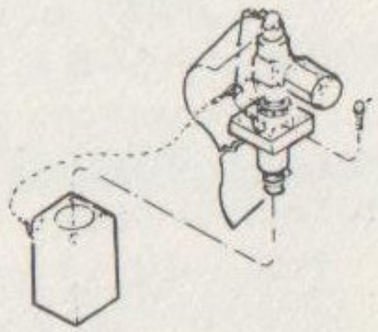
MCC AND NOZZLE PURGE SET

HOSE SET

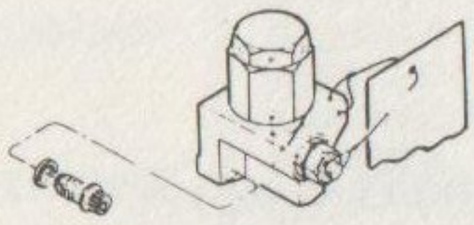


1-1/2 INCH DRAIN LINE ADAPTER





ANTIFLOOD VALVE
TEST SET



HPOTP AND HPFTP
PURGE ADAPTERS
(TYP)

HEAT EXCHANGER
PLATE SET

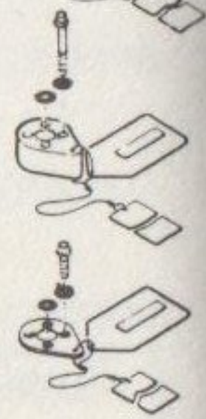
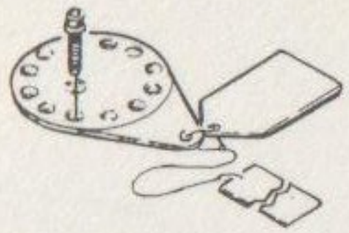


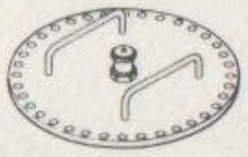
FIGURE 4-2. SCHEDULED ENGINE LEAK TEST SET (SHEET 2 OF 2)

(C70-0915) (RG2526A) (RG000012)

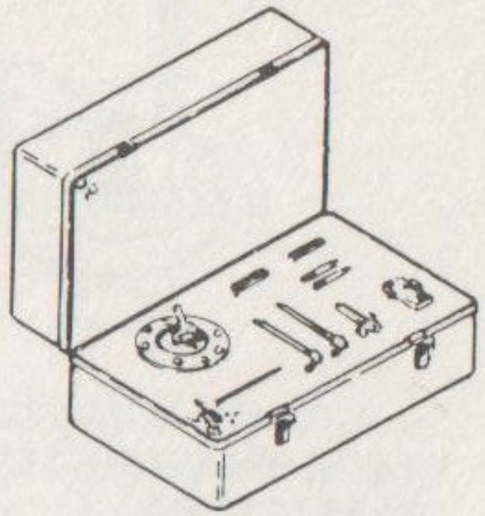
COMMON PREBURNER PURGE PLATE (2)



PREBURNER PUMP DISCHARGE PLATE

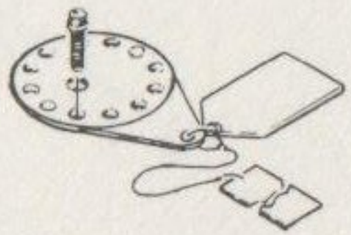


G3 OXIDIZER PLATE SET
G6 FUEL PLATE SET

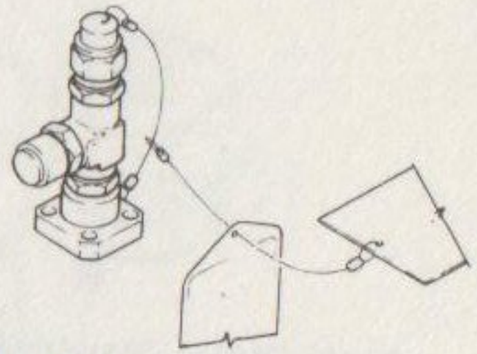


INLET DUCT MFV PLATE SET

LPFTP DISCHARGE TEST PLATE



FPOV SUPPLY TEST PLATE

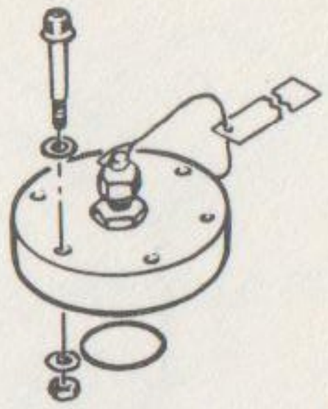


PREBURNER VALVES DOWNSTREAM LEAK TEST ADAPTER

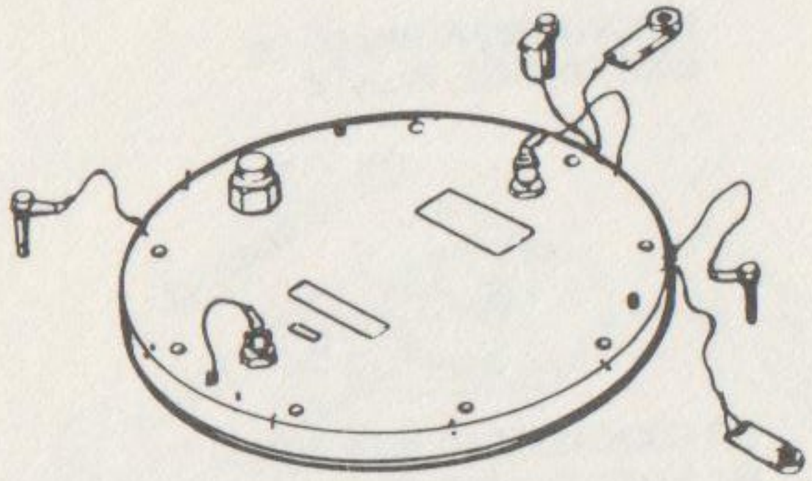
PURPOSE: PROVIDE AN INTERFACE FOR GSE AND CONTAIN PNEUMATIC PRESSURES IN ENGINE SYSTEMS DURING PERIODIC OR ISOLATION LEAK AND FUNCTION TESTS.

FIGURE 4-3. UNSCHEDULED ENGINE LEAK TEST SET

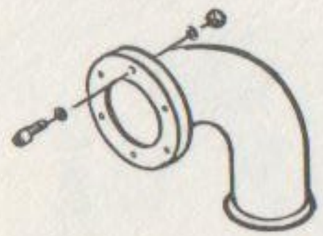
(C70-0916) (RG2576A) (RG000400)



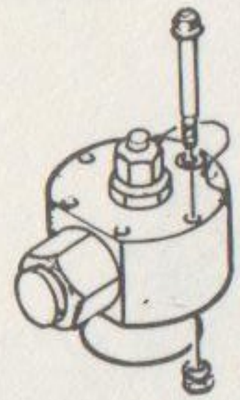
CUSTOMER CONNECT FUEL TANK PRESSURE TEST PLATES (TYP)



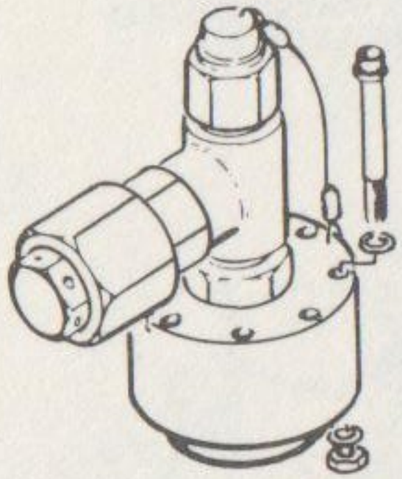
FUEL AND OXIDIZER TEST PLATES (TYP)



CONTROLLER COOLANT PLATE



CUSTOMER CONNECT TEST PLATES (TYP) (FUEL BLEED, OXIDIZER BLEED)

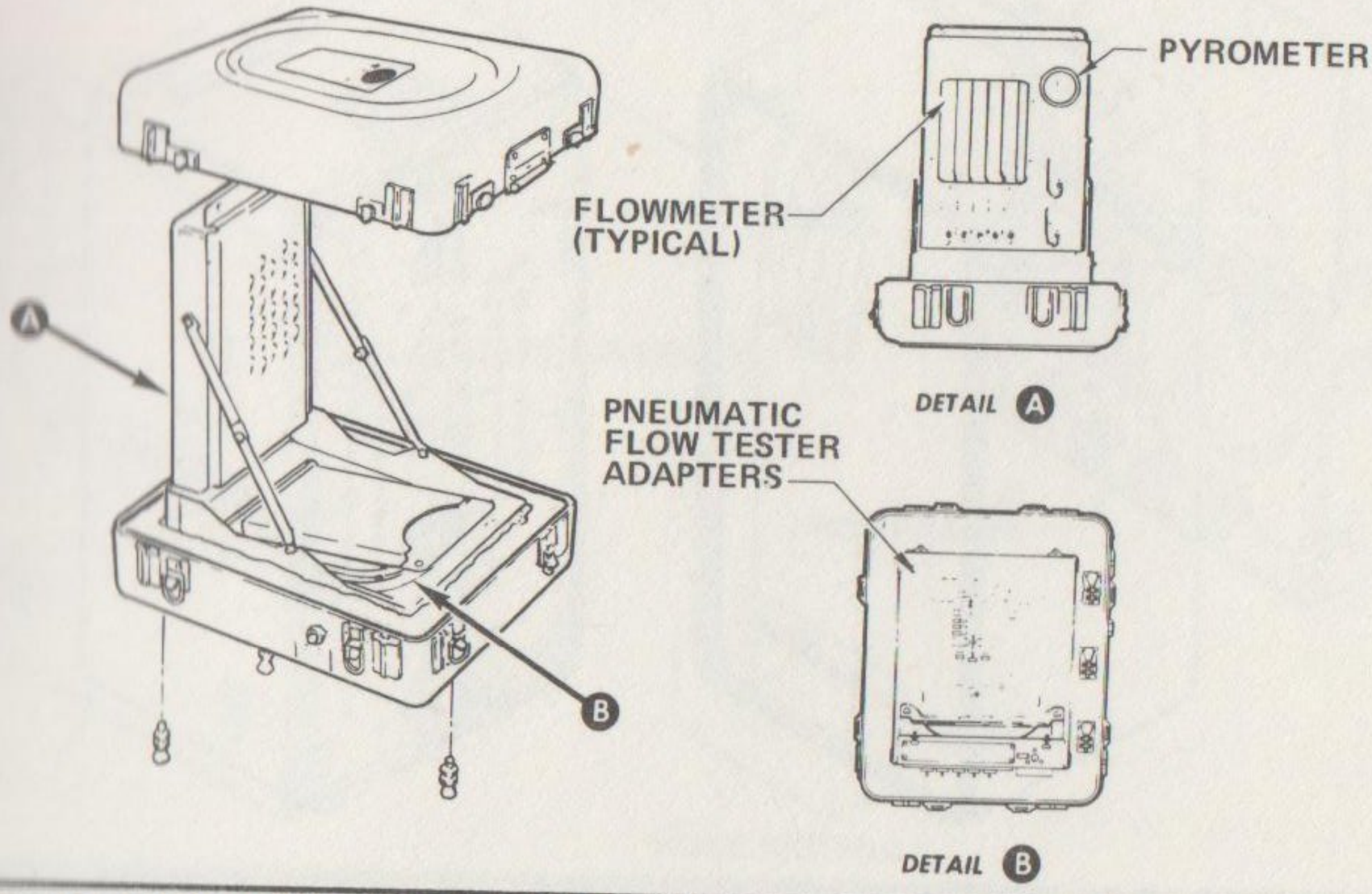


CUSTOMER CONNECT TEST PLATES (TYP) (GN_2, He, OXID TANK PRESSURE)

PURPOSE: PROVIDE AN INTERFACE FOR GSE AND CONTAIN PNEUMATIC PRESSURE IN ENGINE SYSTEMS DURING LEAK AND FUNCTION TESTS OF UNINSTALLED ENGINES.

FIGURE 4-4. ENGINE INTERFACE TEST PLATE SET

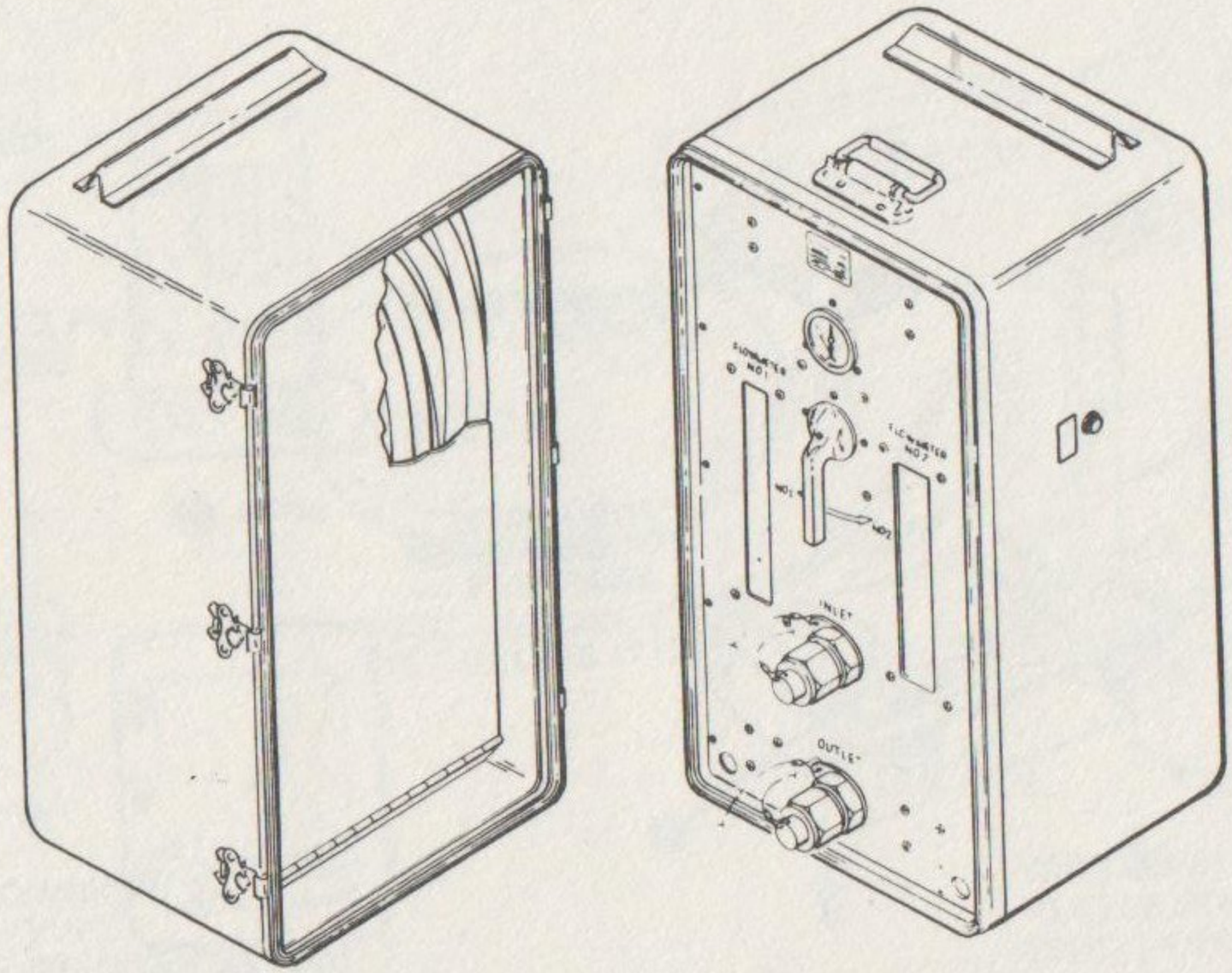
(C70-0903) (RG2528A) (RG000014)



PURPOSE: MEASURE PNEUMATIC LEAKAGE FROM COMPONENTS AND SYSTEMS DURING LEAK TESTS (VENTS TO ATMOSPHERE).

FIGURE 4-5. PNEUMATIC (ATMOSPHERIC) FLOW TESTER

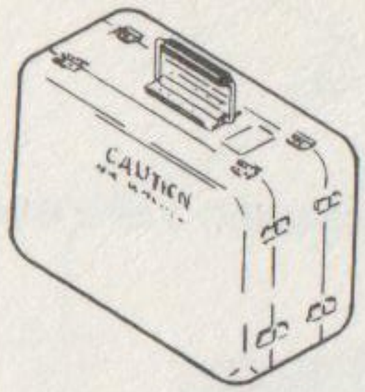
(C70-0908) (RG2536A) (RG003046)



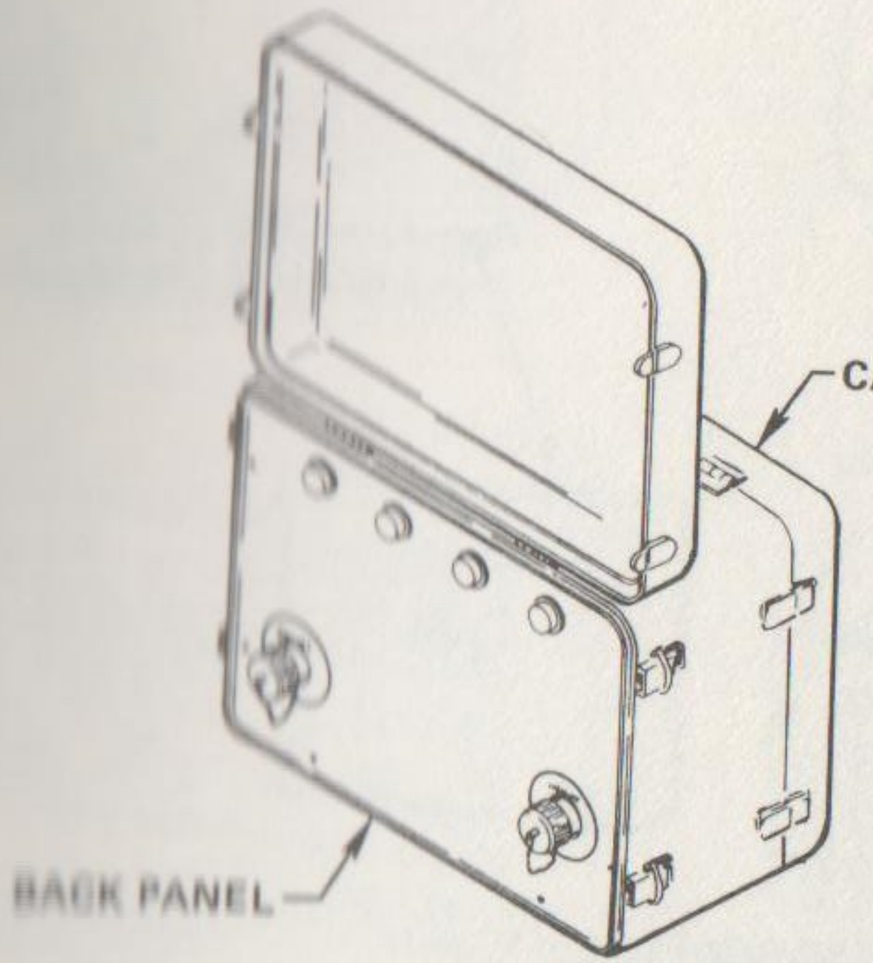
PURPOSE: MEASURE PNEUMATIC FLOWS PAST HIGH-PRESSURE OXIDIZER TURBOPUMP SEALS DURING LEAK TESTS.

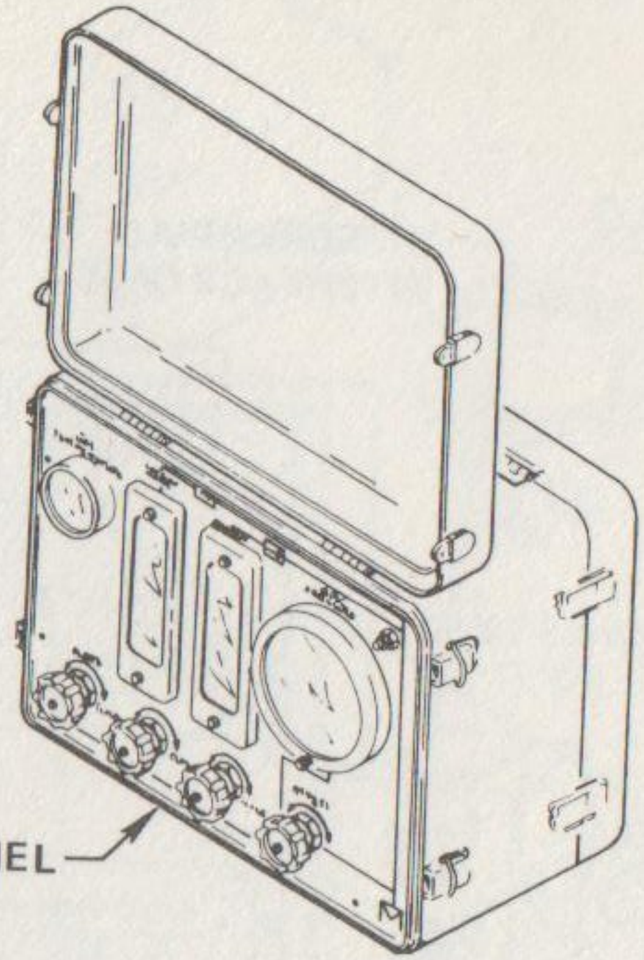
FIGURE 4-6. LARGE VOLUME FLOW TESTER

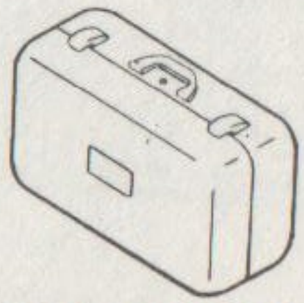
(C70-0904) (RG2529A) (RG000015)



PNEUMATIC TESTER





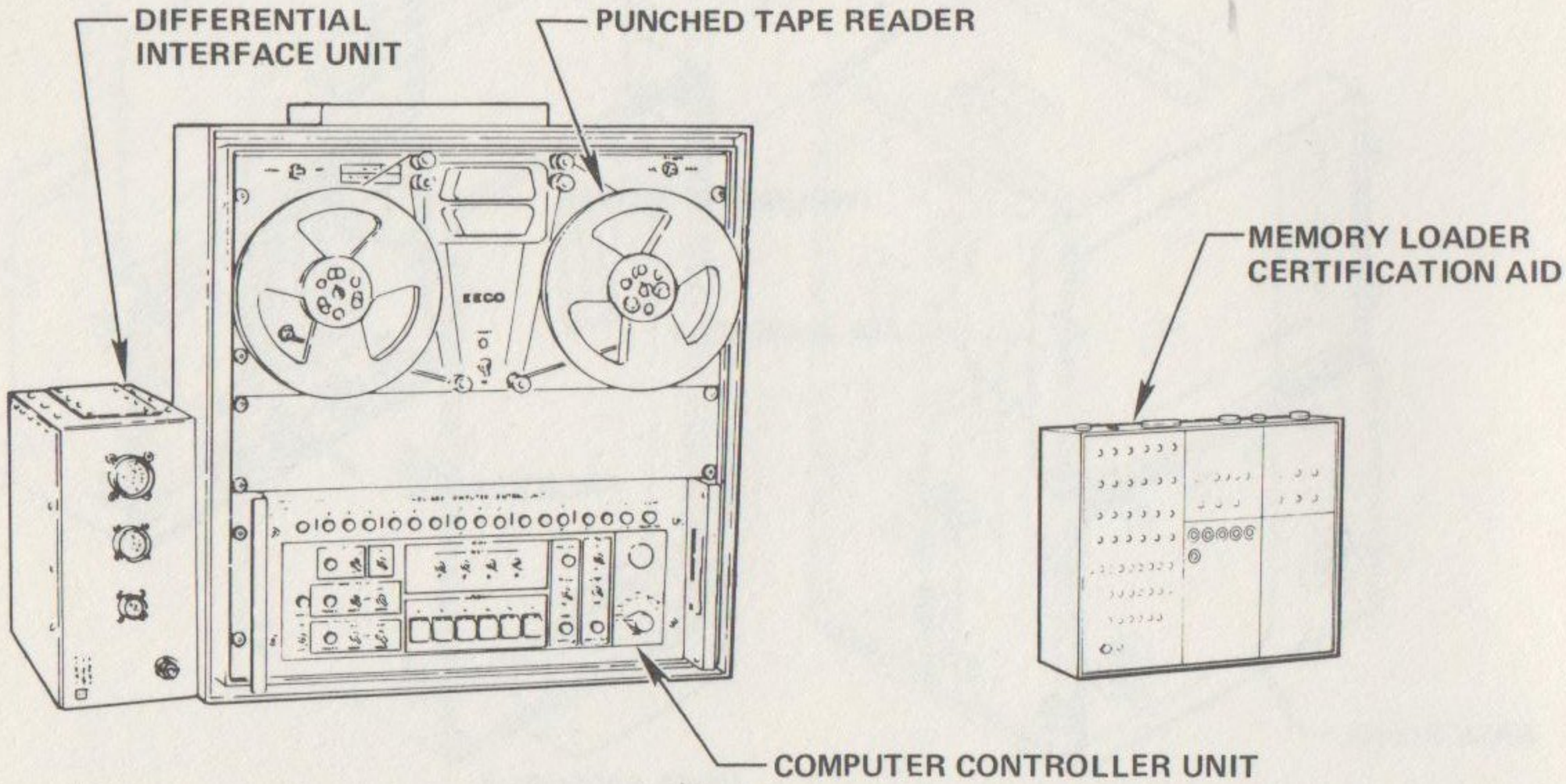


HOSE ASSEMBLY

PURPOSE: MEASURE PNEUMATIC LEAKAGE PAST SSME ANTIFLOOD VALVE SEAT (IN-LINE SYSTEM FLOWMETER).

FIGURE 4-7. HIGH-PRESSURE PNEUMATIC FLOW TESTER

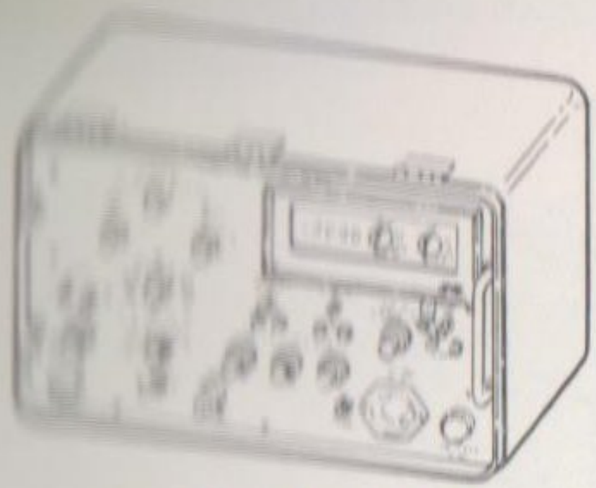
(C70-0910) (RG2553A) (RES1198)



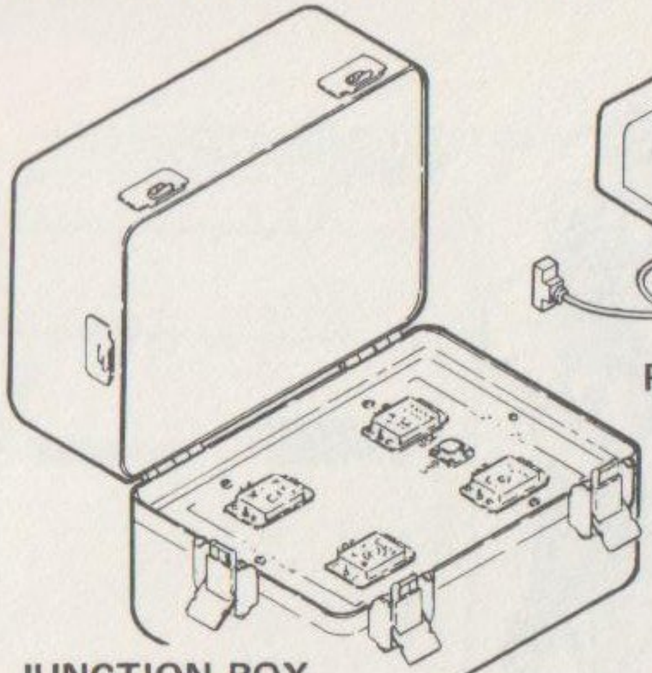
PURPOSE: PROVIDE A CAPABILITY TO LOAD AND READ MEMORY AND REGISTERS OF MAIN ENGINE CONTROLLER.

FIGURE 4-8. MAIN ENGINE CONTROLLER DCU MEMORY LOADER

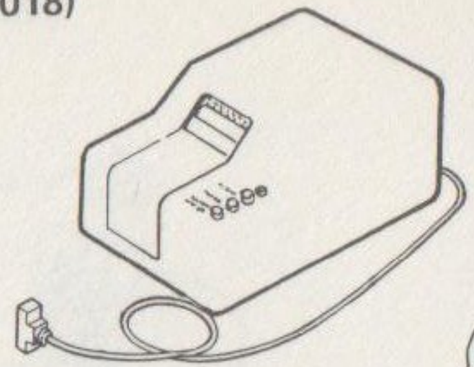
(C70-0912) (RG2538A) (RG000018)



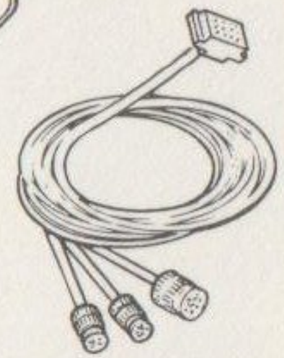
SENSOR SIMULATOR



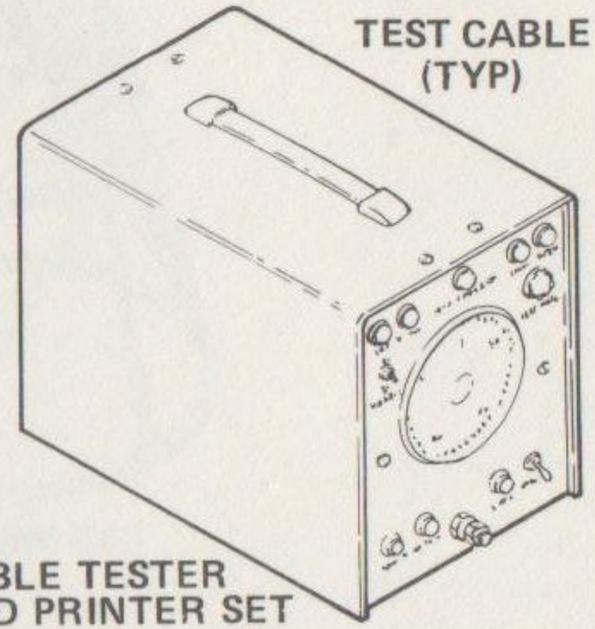
JUNCTION BOX



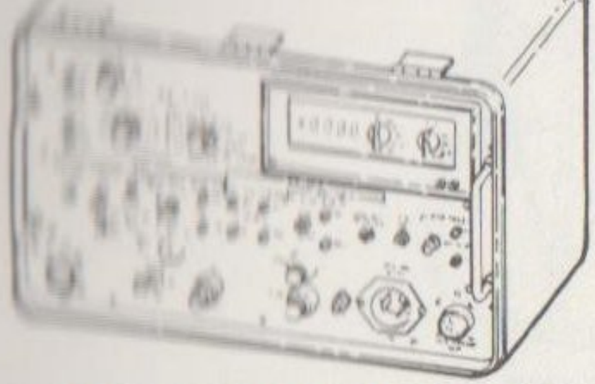
PRINTER



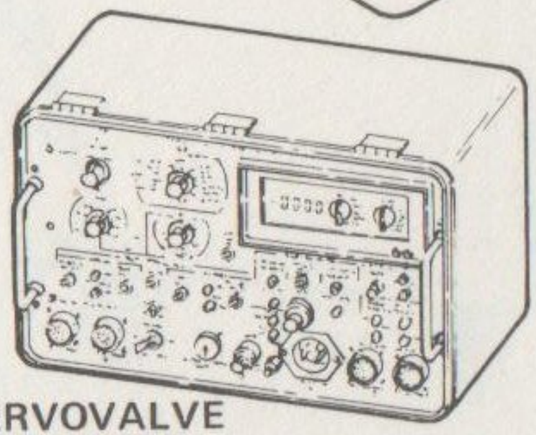
TEST CABLE (TYP)



CABLE TESTER AND PRINTER SET



IGNITER/PNEUMATIC VALVE SIMULATOR

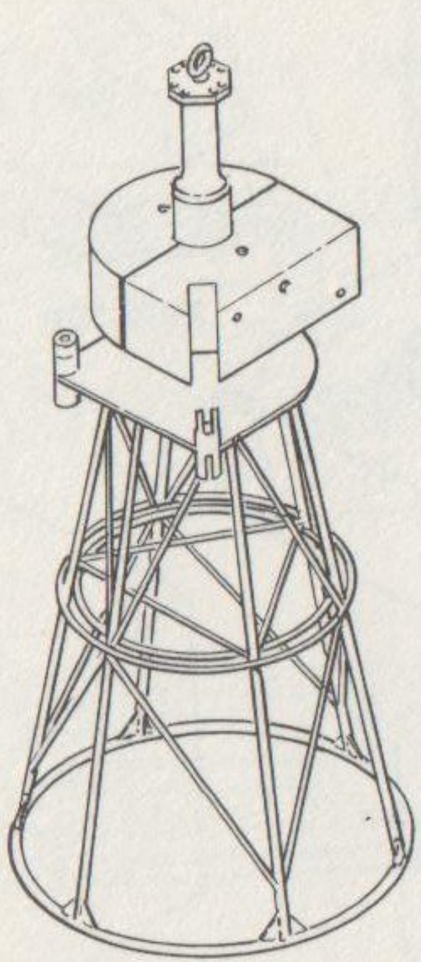


SERVOVALVE SIMULATOR

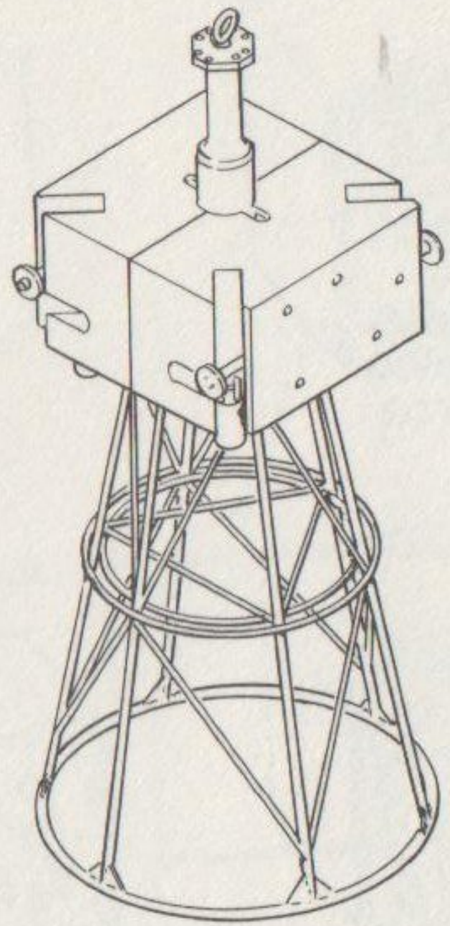
PURPOSE: TROUBLESHOOT SERVOVALVES, SENSORS, IGNITERS, PNEUMATIC VALVES, AND CHECK ELECTRICAL HARNESS FOR CONTINUITY AND INSULATION BREAKDOWN.

FIGURE 4-9. ELECTRICAL CHECKOUT AND MAINTENANCE SET

(S70-0911) (RG2581A) (RG003010)



1G WEIGHT

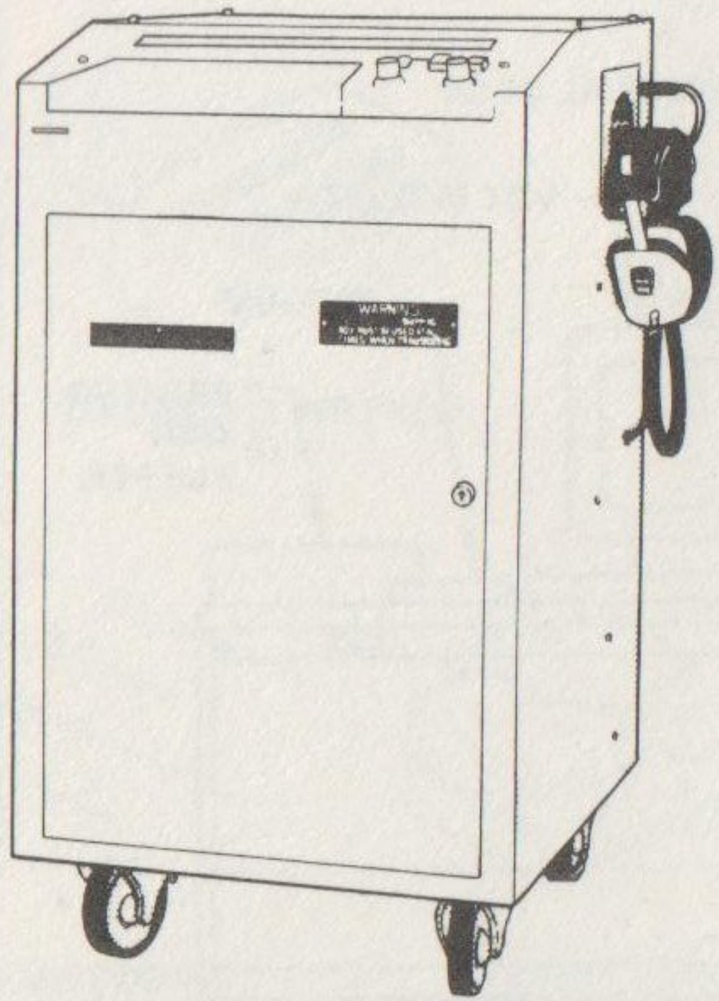


3G WEIGHT

PURPOSE: REPRESENTS SSME ENVELOPE; CONFIGURED TO 3G WEIGHT FOR PROOF TEST; CONFIGURED TO 1G WEIGHT FOR CRITICAL LIFTS; USED TO VALIDATE EQUIPMENT AND PERSONNEL.

FIGURE 4-10. ENGINE SIMULATOR WEIGHT

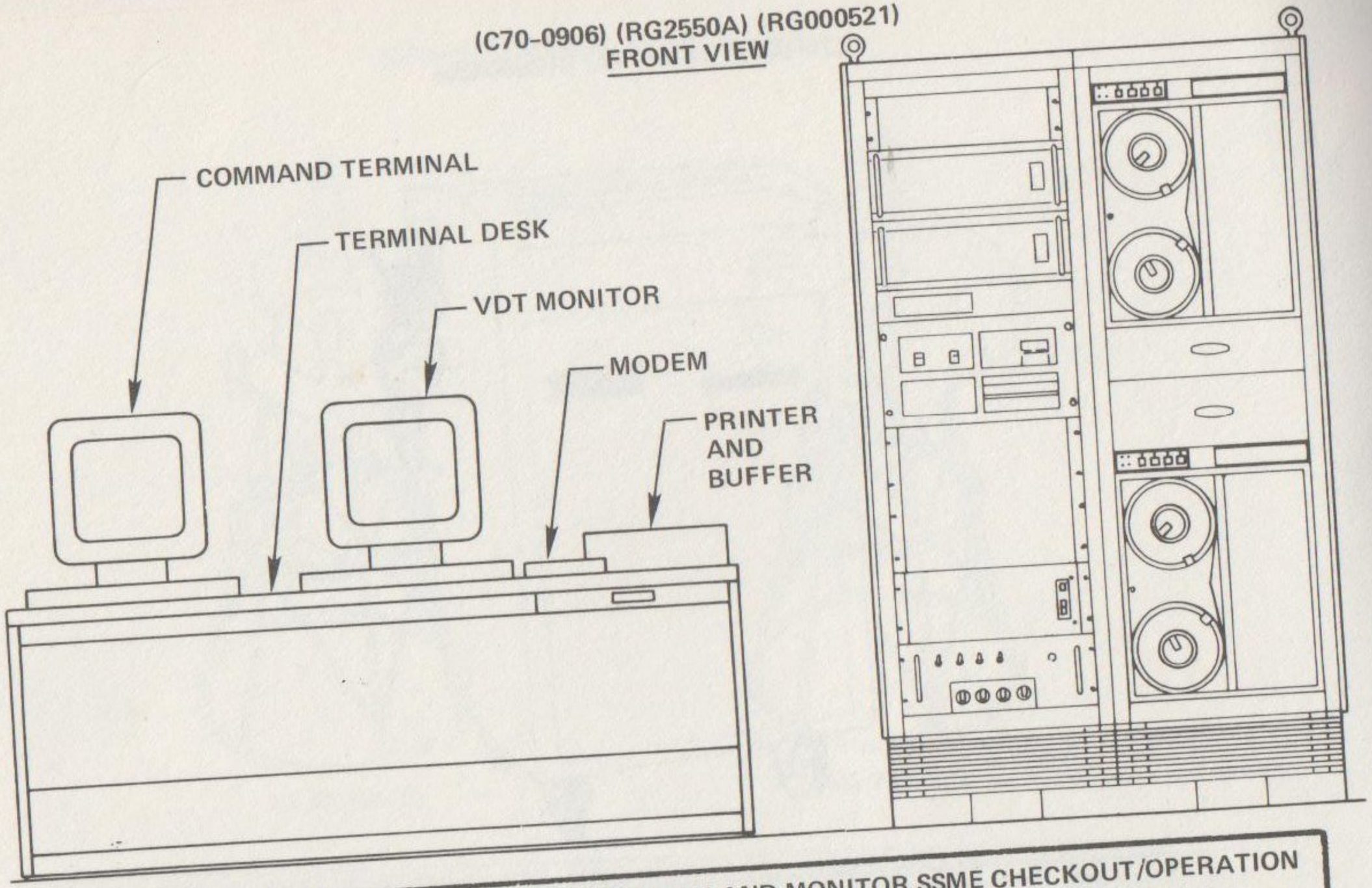
(C70-0917) (RG2577A) (RG000480)



PURPOSE: PROVIDE FAST, SENSITIVE MONITOR OF GASES DURING STATIC BAG AND VIOLATED JOINT LEAK CHECKS.

FIGURE 4-11. MULTIPLE GAS ANALYZER ASSEMBLY

(C70-0906) (RG2550A) (RG000521)
FRONT VIEW

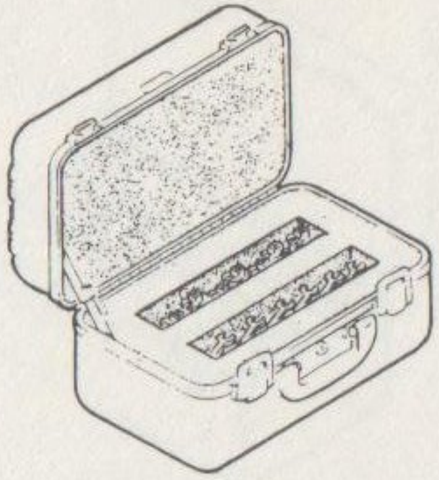


PURPOSE: PROVIDE A CAPABILITY TO PERFORM AND MONITOR SSME CHECKOUT/OPERATION IN SSME SHOP.

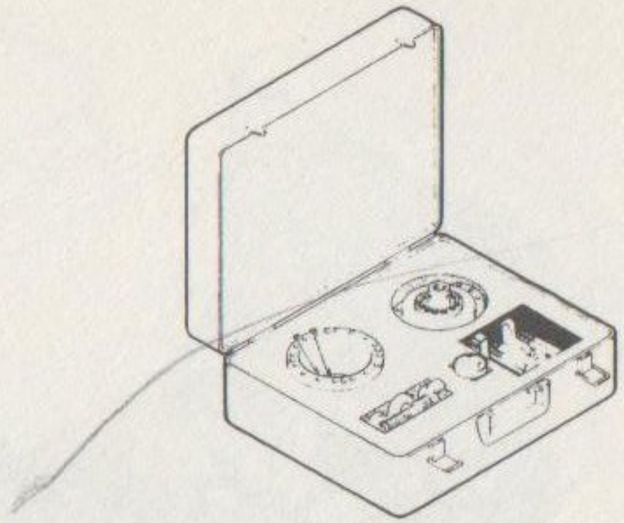
FIGURE 4-12. COMMAND AND DATA SIMULATOR

(C70-0907) (RG2575A) (RG000020)

LPOTP SHAFT TRAVEL SET

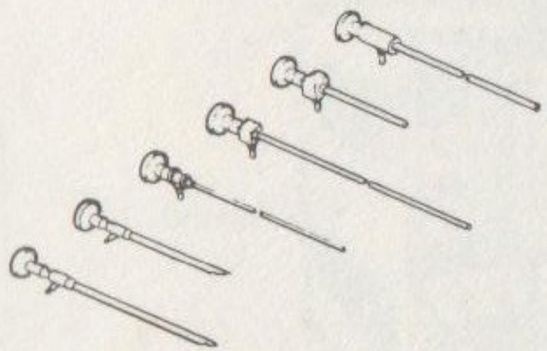


CROWFOOT WRENCH SET

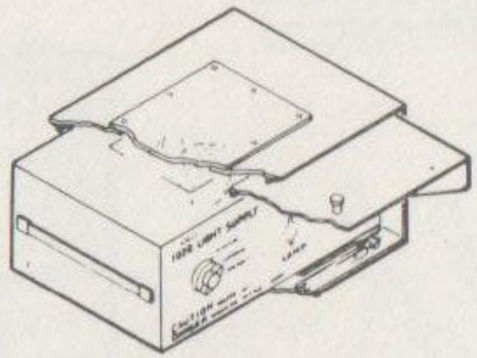


HPFTP TORQUE TOOL SET

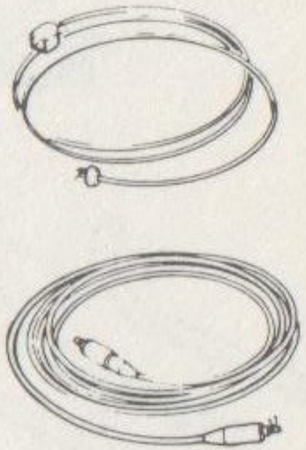
FLEXIBLE BORESCOPE (TYP)



RIGID BORESCOPES



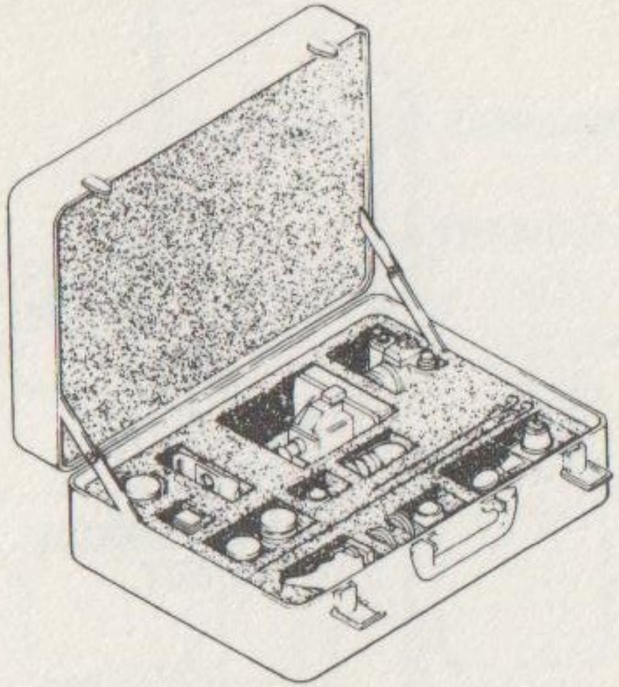
LIGHT SUPPLY



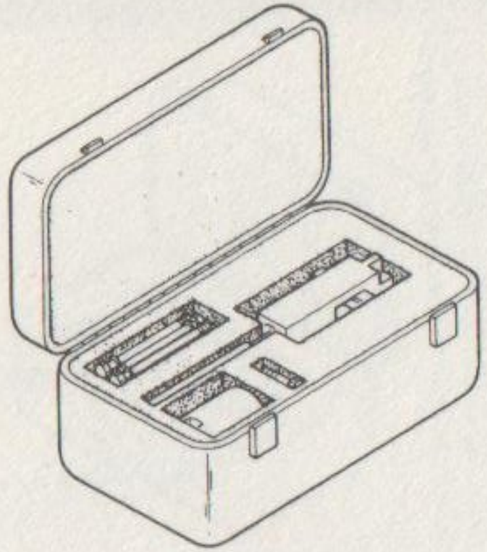
LIGHT CARRIERS

PURPOSE: PROVIDE ABILITY TO VISUALLY INSPECT AND RECORD RESULTS OF OTHERWISE INACCESSIBLE AREAS OF ENGINE AND CONDUCT TORQUE CHECKS OF TURBOPUMPS.

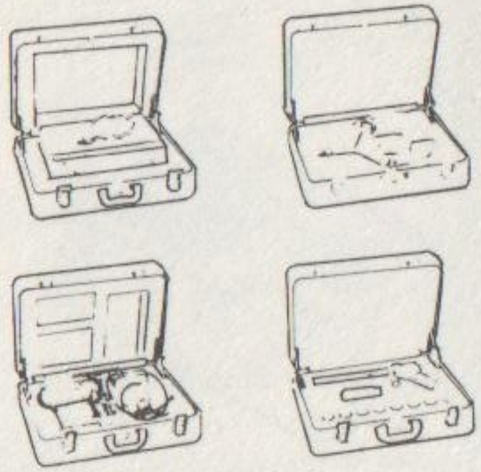
FIGURE 4-13. INTERNAL INSPECTION SET (SHEET 1 OF 3)



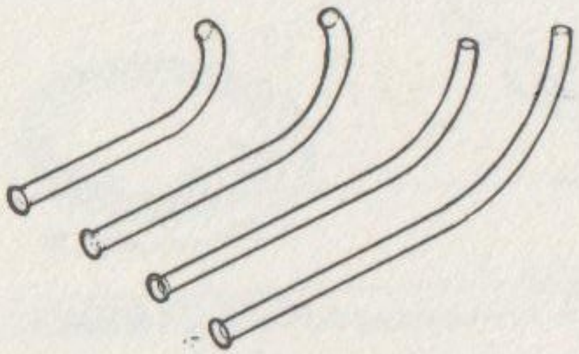
CAMERA SET



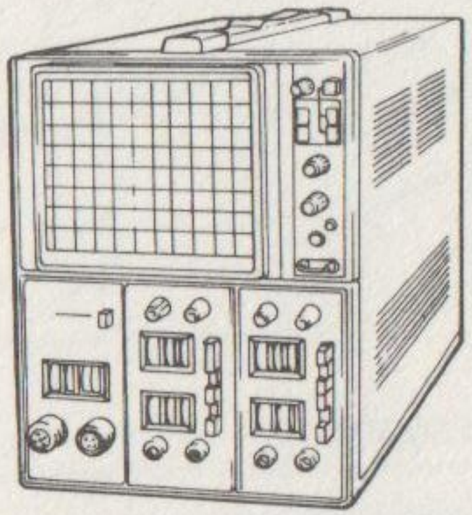
HPOTP SHAFT TRAVEL SET



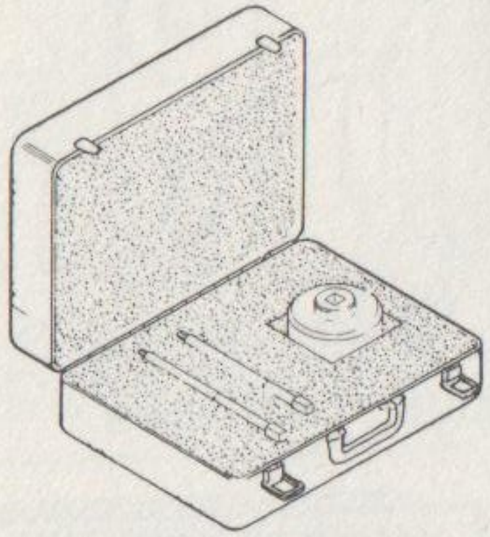
MICROSCOPE SET



POSITIONING
ADAPTER SET

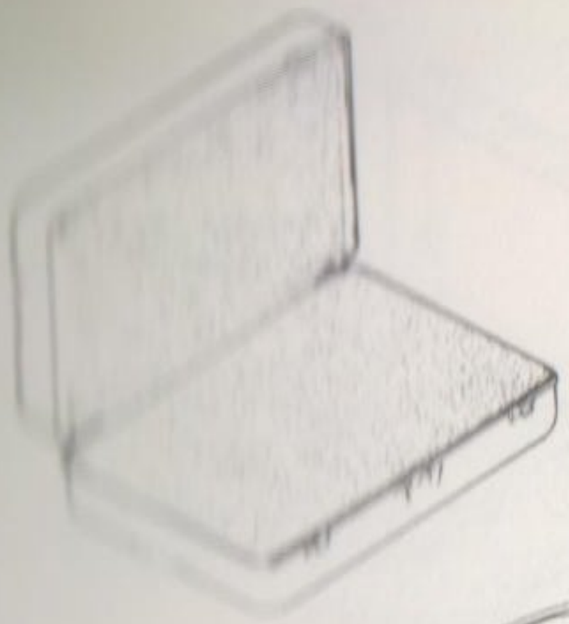


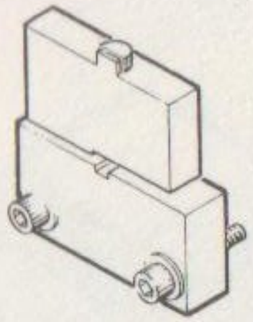
COMPONENT EDDY
CURRENT MEASUREMENT SET

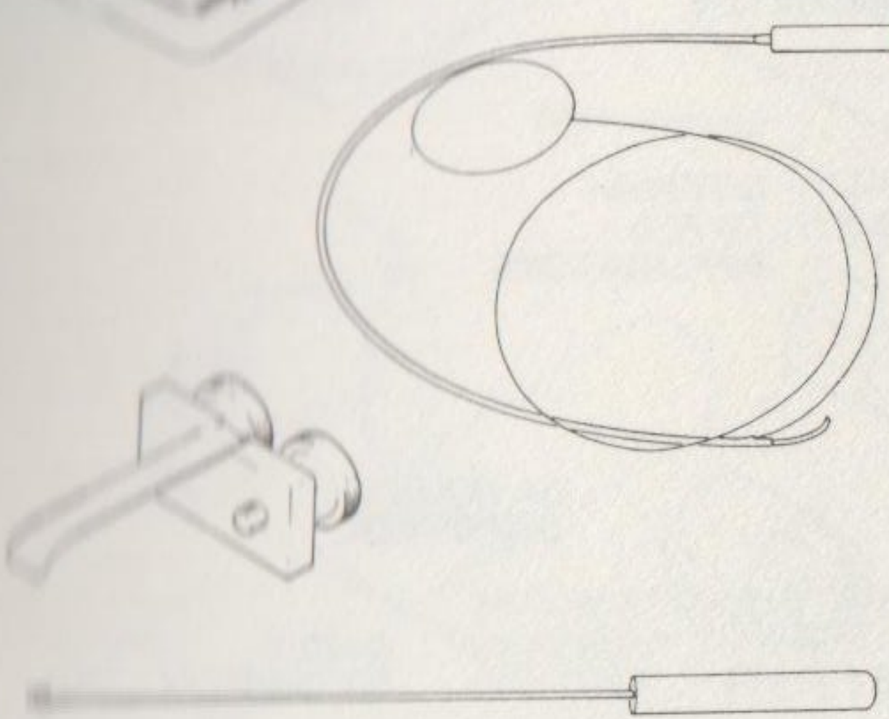


TURBOPUMP ROTATING
TOOL SET

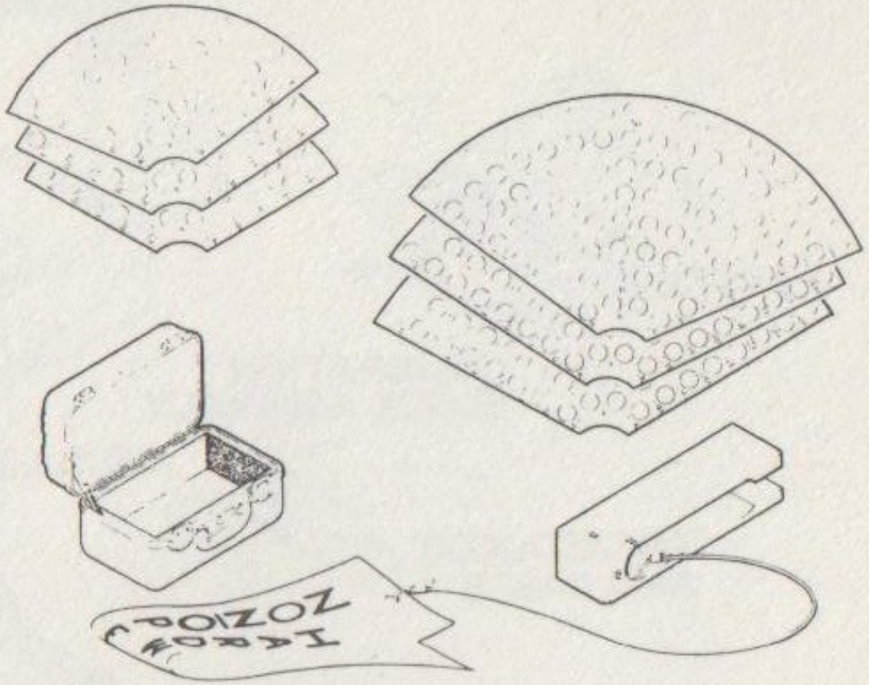
FIGURE 4-13. INTERNAL INSPECTION SET (SHEET 2 OF 3)



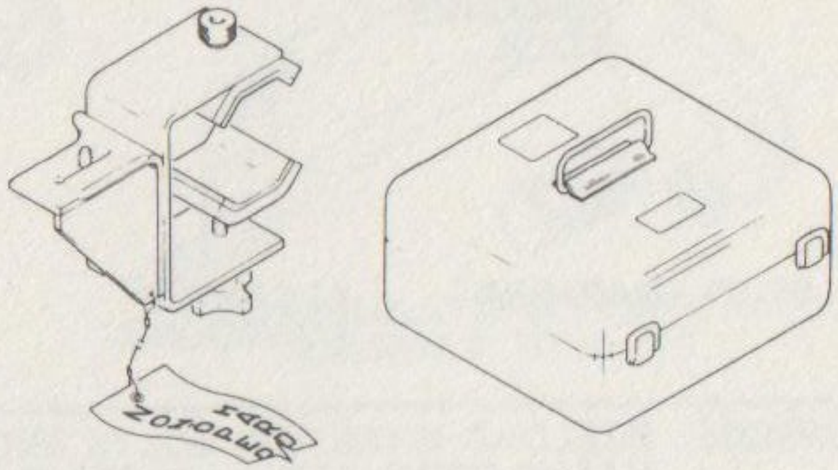




GUIDE TUBE SET



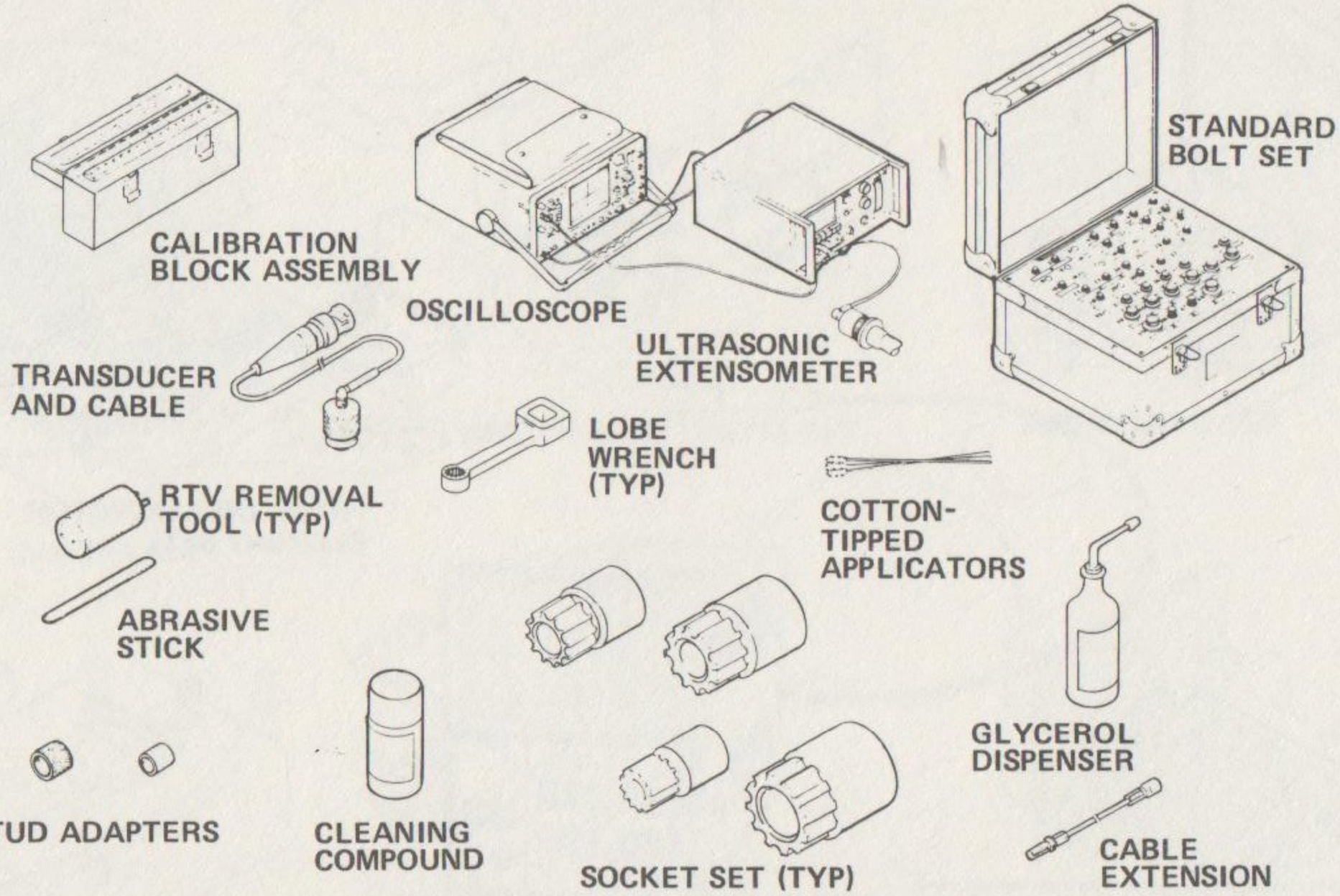
PREBURNER INJECTOR
ELEMENT SET



CAMERA MOUNT SET

FIGURE 4-13. INTERNAL INSPECTION SET (SHEET 3 OF 3)

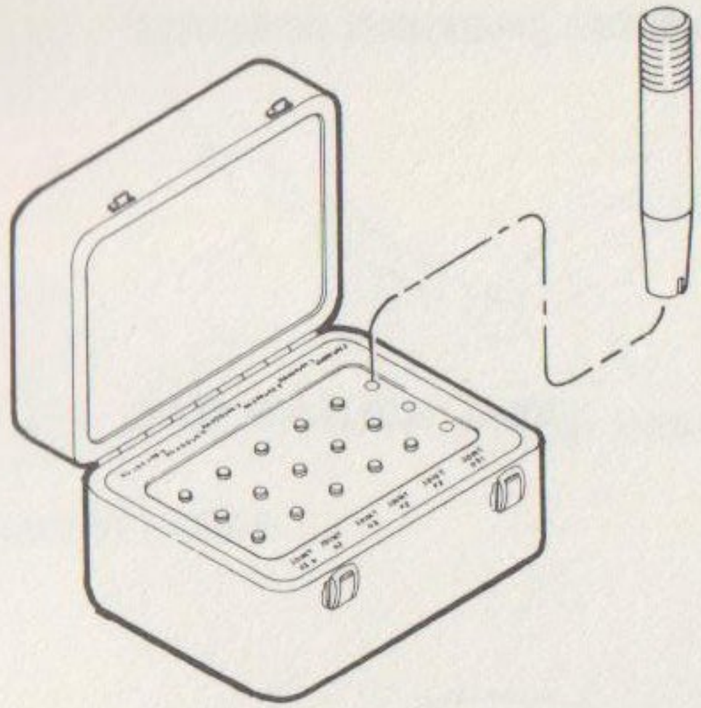
(S70-0905) (RG2531A) (RG000017)



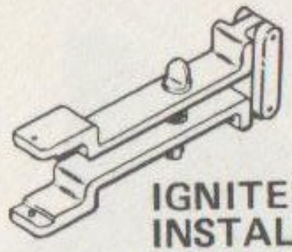
PURPOSE: PRELOAD (STRETCH) BOLTS AND STUDS; ALINE PROPELLANT VALVE ACTUATOR TO VALVE BODY; AND FACILITATE REPLACEMENT OF VARIOUS LRUs.

FIGURE 4-14. SPECIAL TOOL SET (SHEET 1 OF 3)

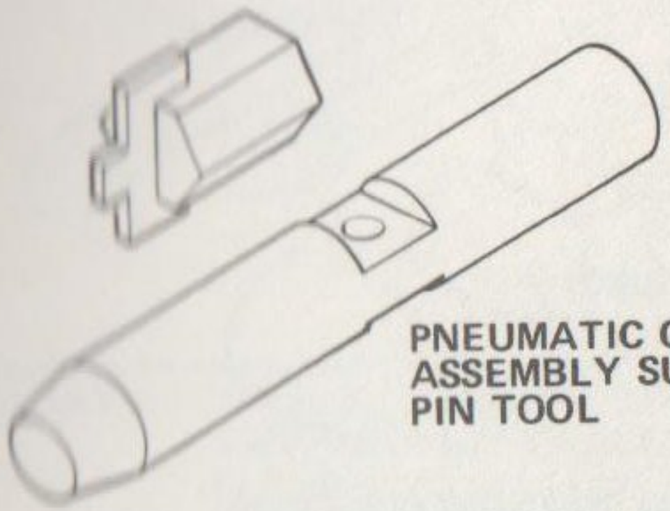
CONTROLLER MOUNT
SPANNER WRENCH



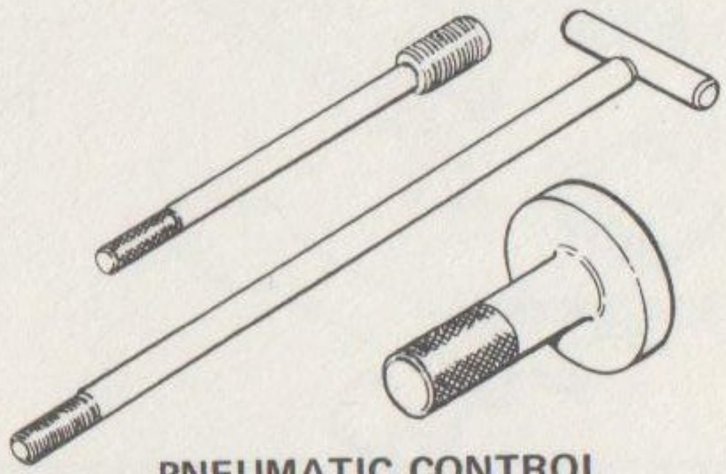
ALINEMENT/GUIDE
PIN SET



IGNITER
INSTALLATION
TOOL

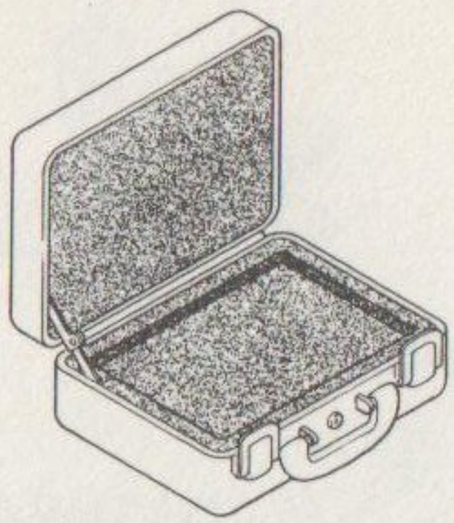


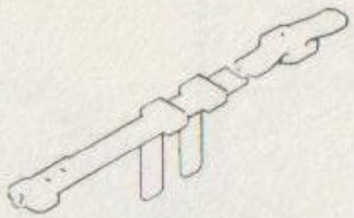
PNEUMATIC CONTROL
ASSEMBLY SUPPORT
PIN TOOL



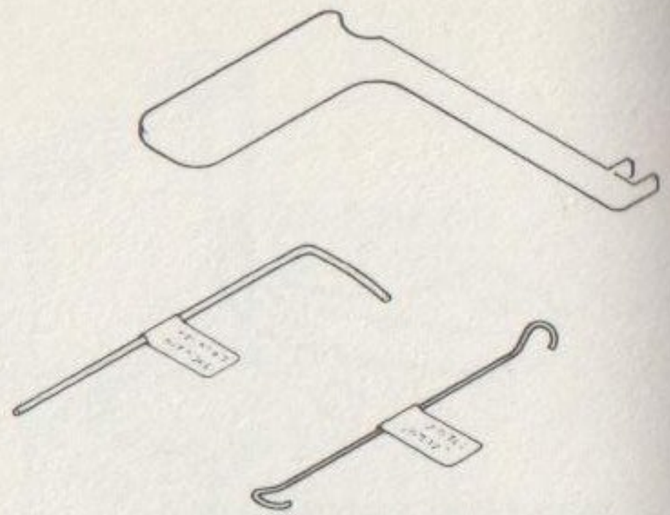
PNEUMATIC CONTROL
ASSEMBLY TOOL SET

FIGURE 4-14. SPECIAL TOOL SET (SHEET 2 OF 3)

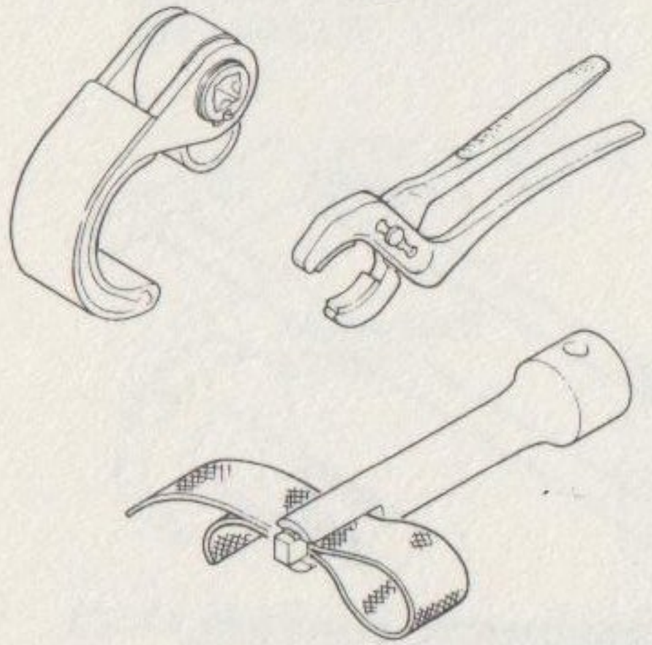




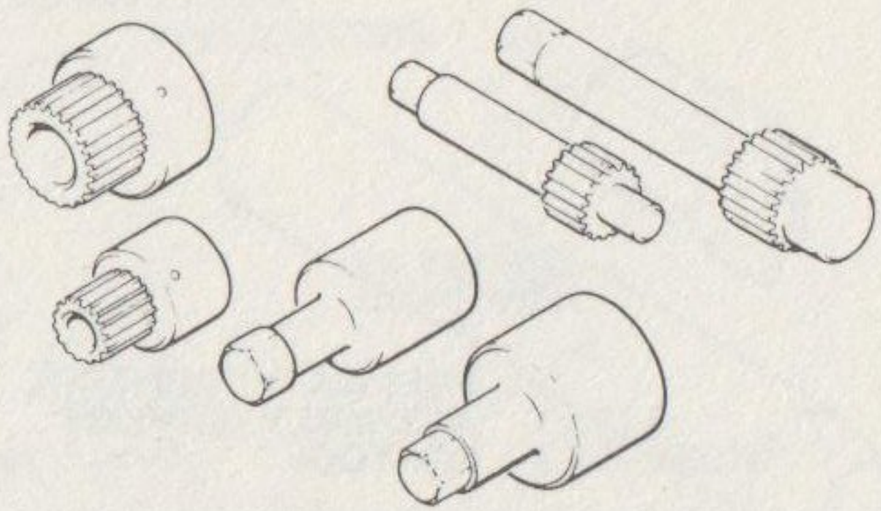
SEAL HOLDING TOOL



HEAT EXCHANGER COIL TUBING INSPECTION TOOL SET



ELECTRICAL CONNECTOR WRENCH SETS

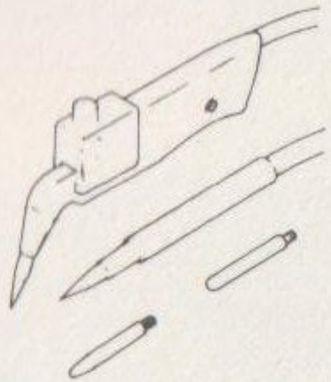


ACTUATOR INSTALLATION TOOL SET

FIGURE 4-14. SPECIAL TOOL SET (SHEET 3 OF 3)

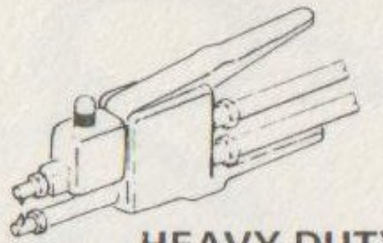
(S70-0908) (RG2539A) (RG000024)

SPOT WELDER

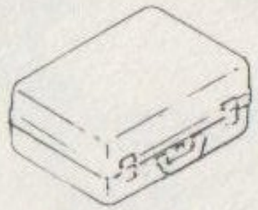


WELDING PROBE

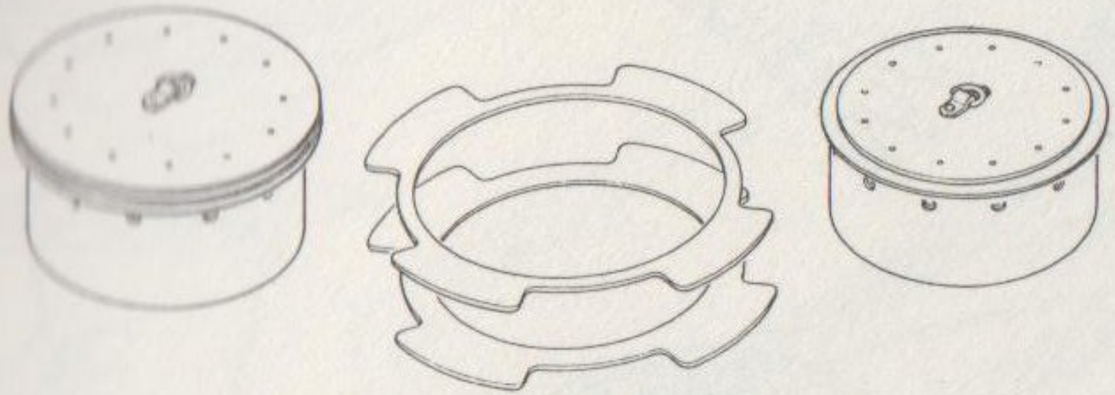
PUSH HAND GUN



HEAVY-DUTY TWEEZER



ACCESSORY CONTAINER (TYP)

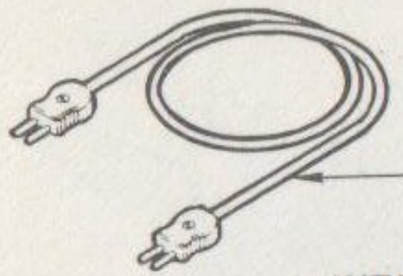


HPFTP COVER SET

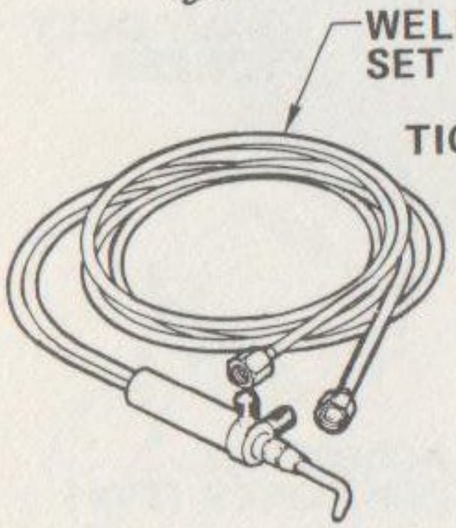
FORCE GAGE

PURPOSE: SPOT-WELD THRUST CHAMBER NOZZLE INSULATION, WELD-REPAIR NOZZLE TUBES; REPRESSURIZE MAIN ENGINE CONTROLLERS; REMOVE HIGH-PRESSURE FUEL TURBOPUMP BELLOWS SHIELD; REPAIR ELECTRICAL CONNECTORS; AND TEST AND REPAIR INJECTOR ELEMENTS.

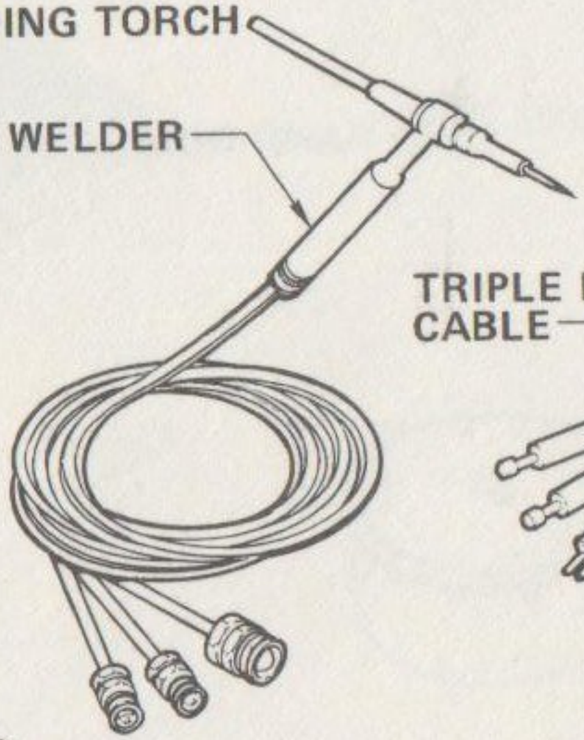
FIGURE 4-15. MAINTENANCE AND REPAIR SET (SHEET 1 OF 3)



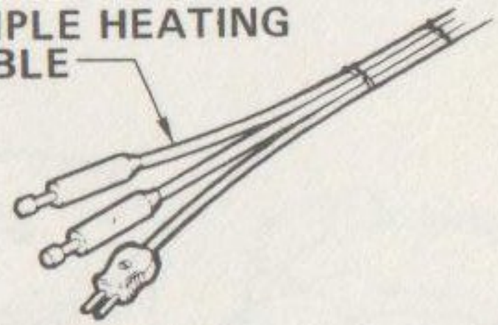
JUMPER CABLES



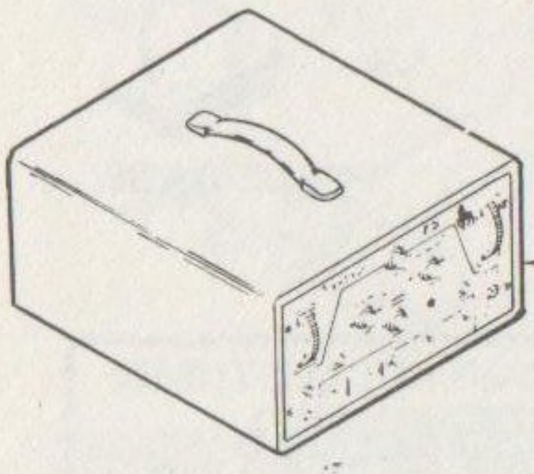
WELDING TORCH SET



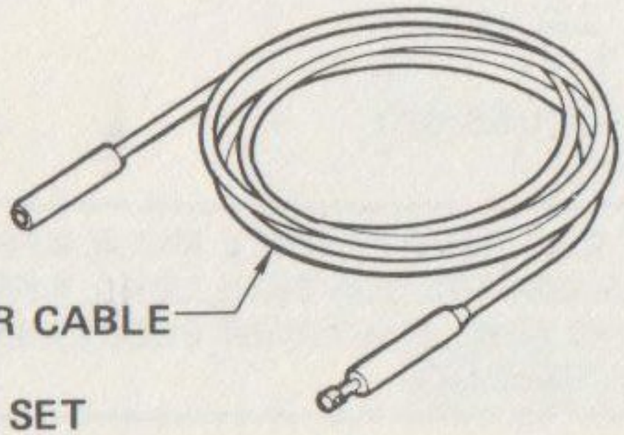
TIG WELDER



TRIPLE HEATING CABLE

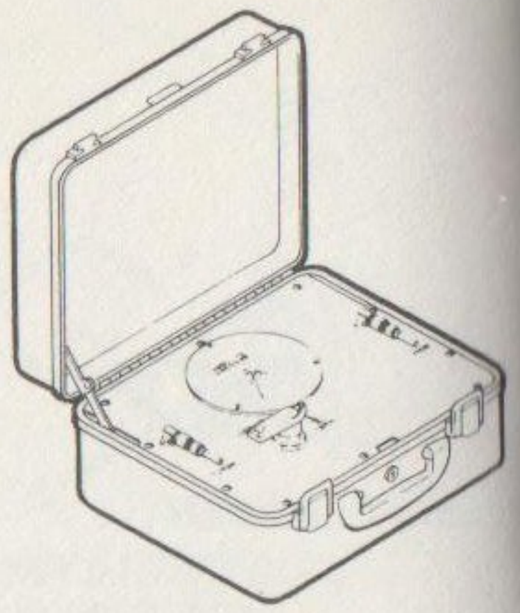


CENTAUR WELDER

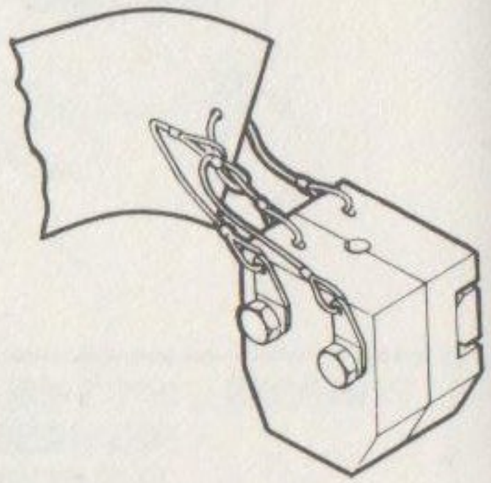


POWER CABLE

NOZZLE REPAIR TOOL SET

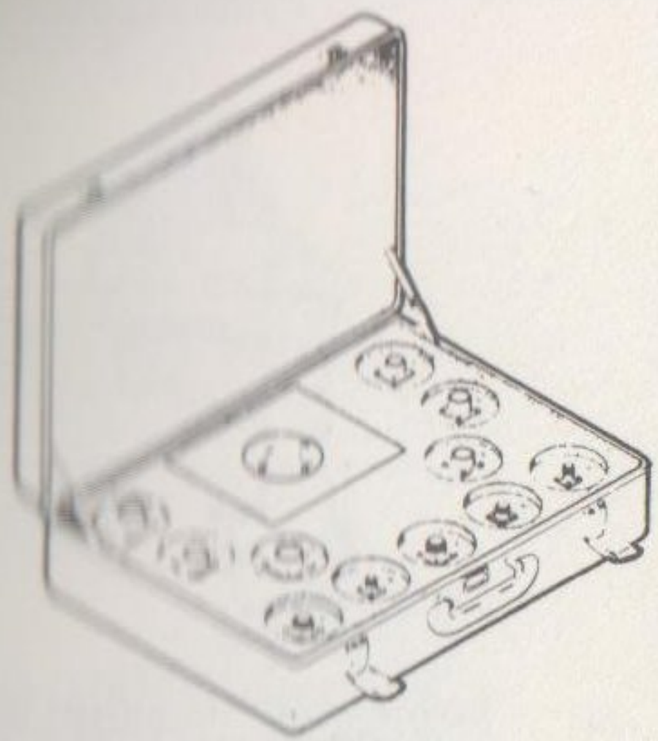


VACUUM GAGE PANEL ASSEMBLY

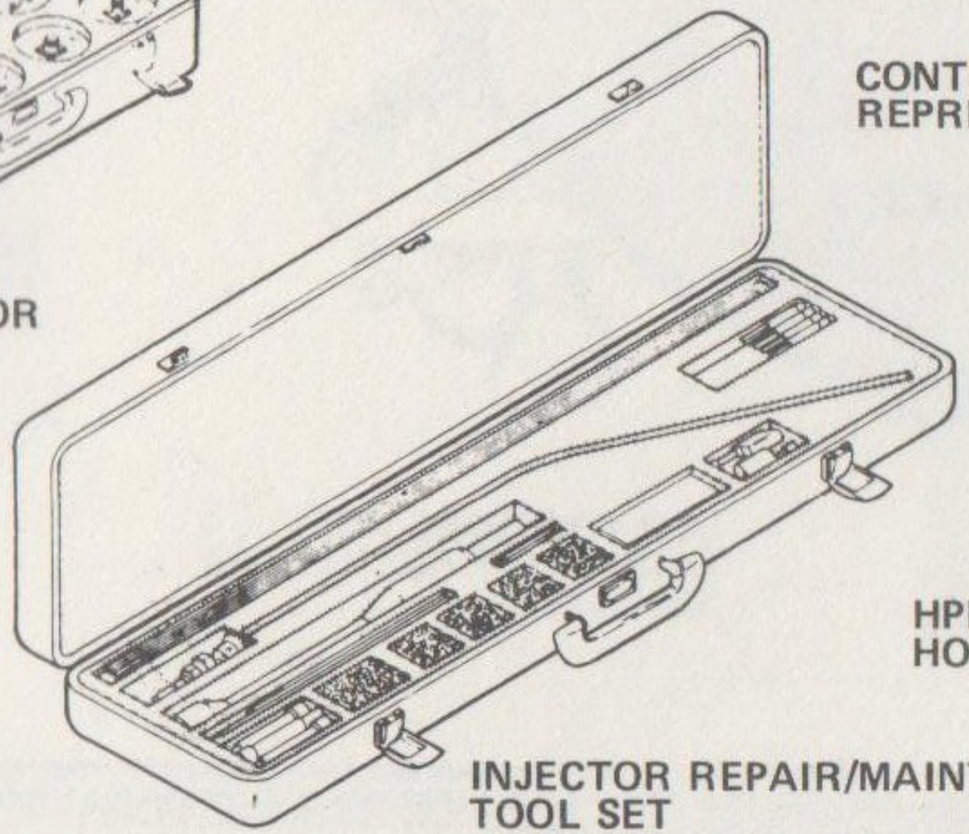


POTTING MOLD

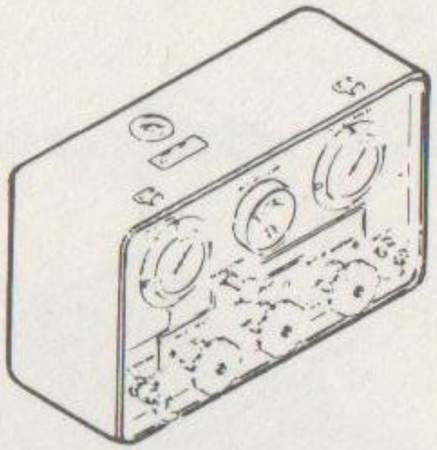
FIGURE 4-15. MAINTENANCE AND REPAIR SET (SHEET 2 OF 3)



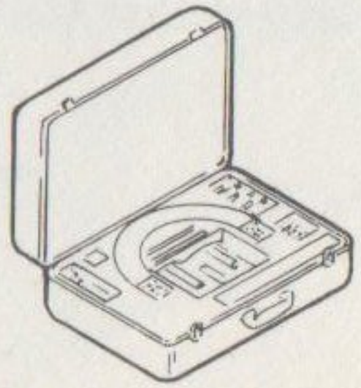
ELECTRICAL CONNECTOR
TORQUING TOOL SET



INJECTOR REPAIR/MAINTENANCE
TOOL SET



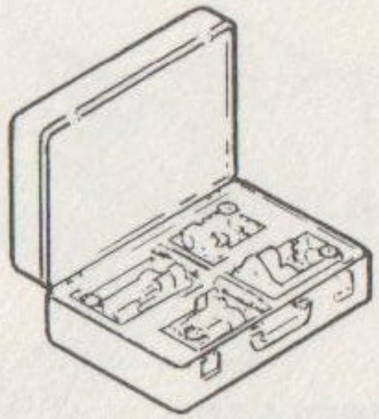
CONTROLLER
REPRESSURIZATION SET



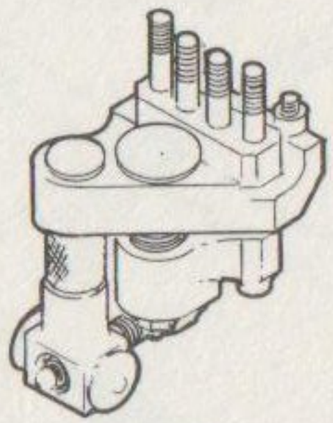
HPFTP BELLOWS SHIELD AND
HOUSING STUD TOOL SET

FIGURE 4-15. MAINTENANCE AND REPAIR SET (SHEET 3 OF 3)

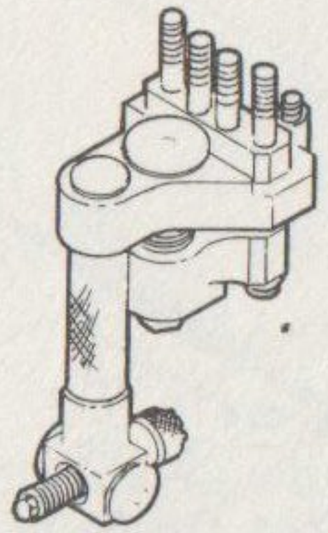
(S70-0909) (RG2517A) (RG000199)



INTERFACE SEAL
REMOVAL/INSTALLATION SET



LOW-PRESSURE FUEL
TURBOPUMP RETRACTOR
ASSEMBLY



LOW-PRESSURE OXIDIZER
TURBOPUMP RETRACTOR
ASSEMBLY

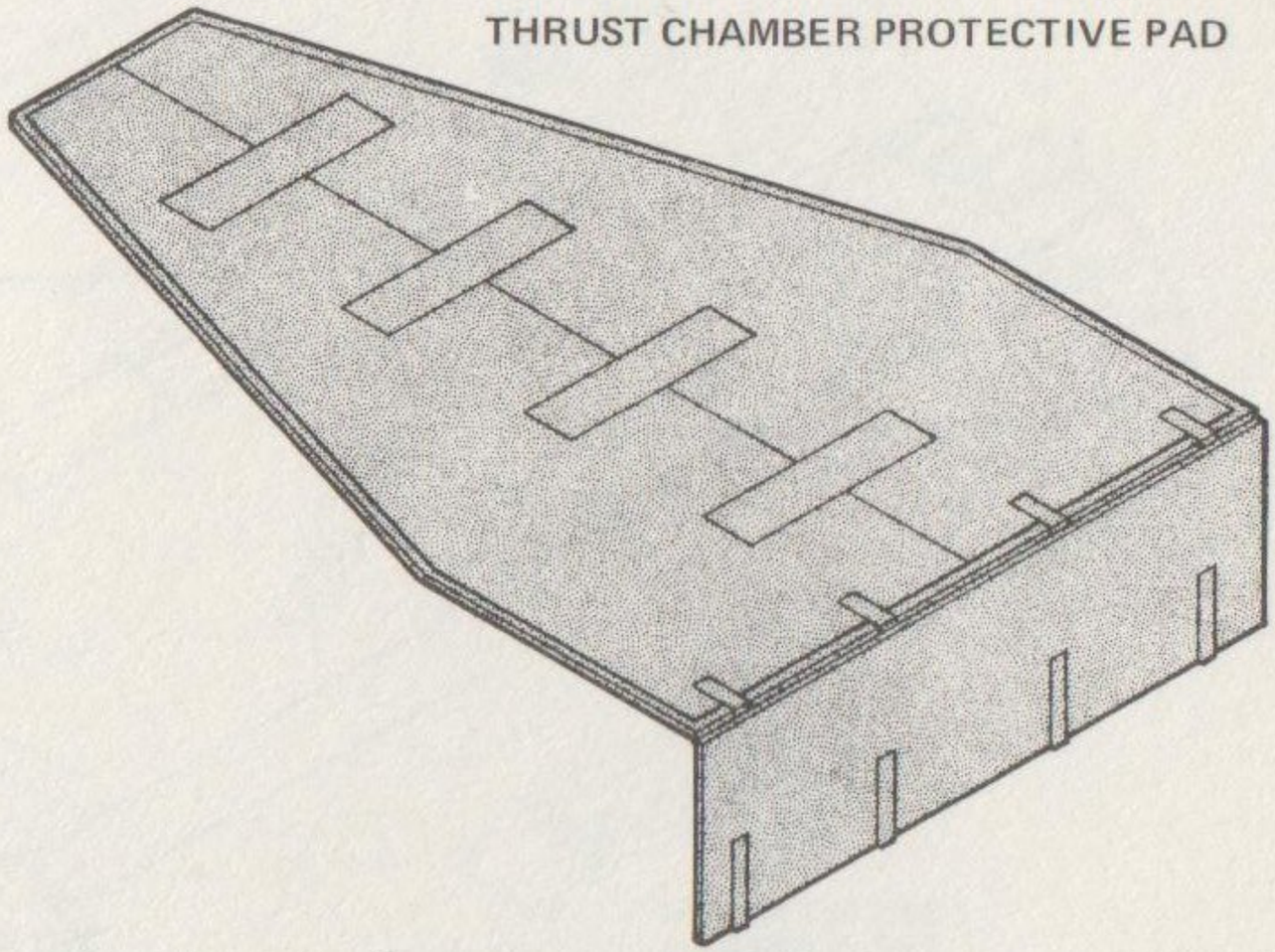
PURPOSE: SUPPORT LOW-PRESSURE TURBOPUMPS WHILE SEPARATING TURBOPUMPS FROM ORBITER FOR SEAL REPLACEMENT.

FIGURE 4-16. INTERFACE SEAL REMOVAL/INSTALLATION SET

(S70-0903) (RG2515A) (RG000010)

MCC PROTECTIVE PAD

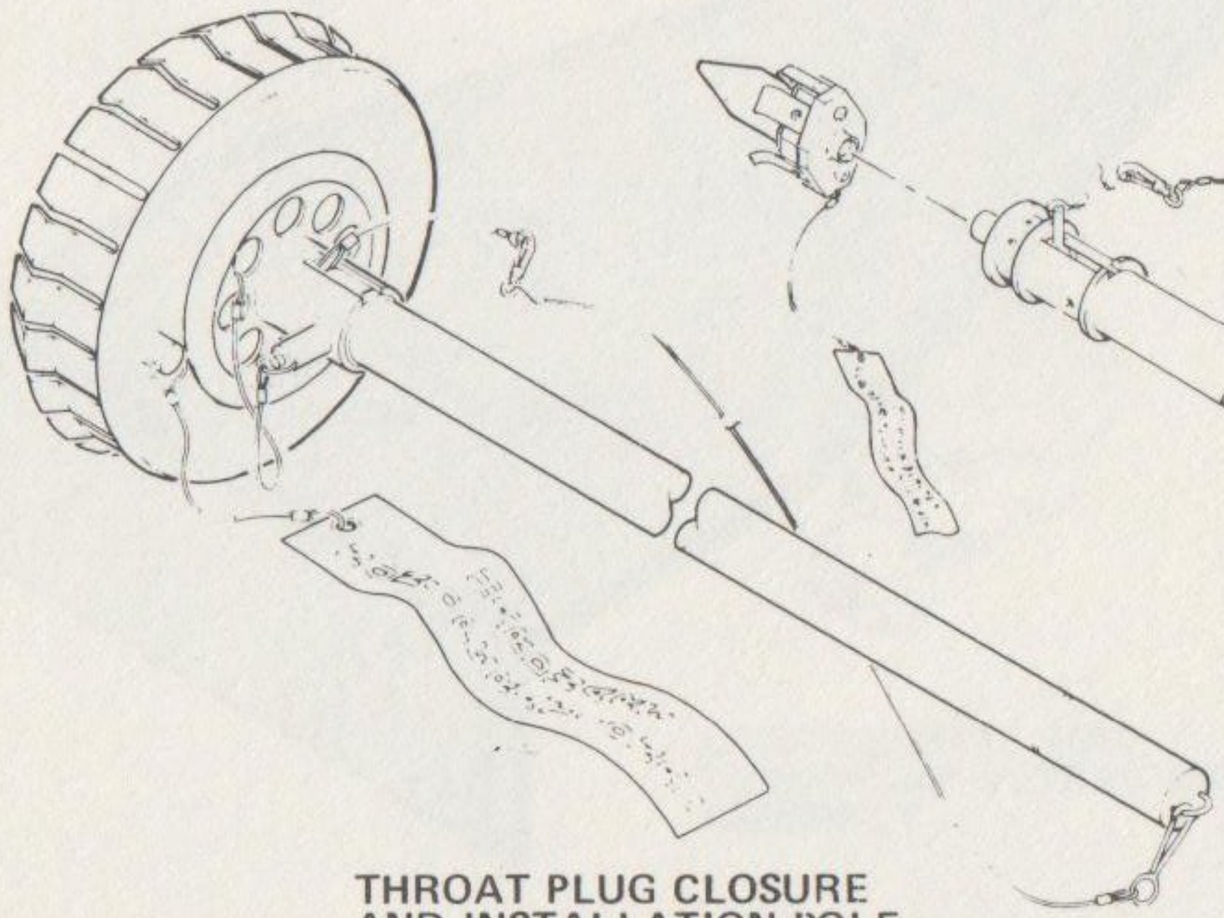
THRUST CHAMBER PROTECTIVE PAD



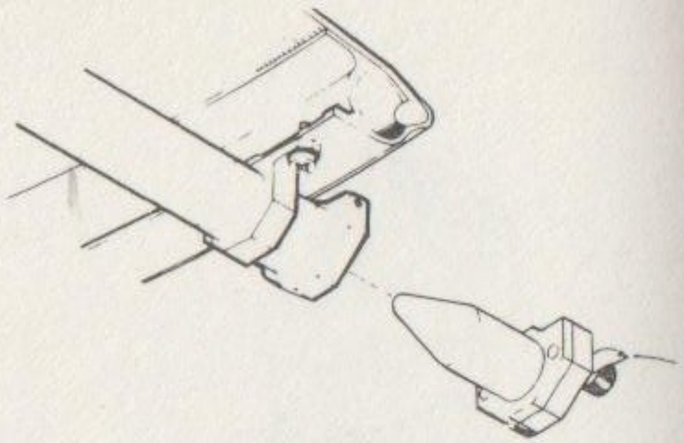
PURPOSE: PROTECT MAIN COMBUSTION CHAMBER AND THRUST CHAMBER NOZZLE TUBES DURING PERSONNEL ENTRY INTO NOZZLE FOR INSPECTIONS AND MAINTENANCE.

FIGURE 4-17. THRUST CHAMBER PROTECTIVE PAD

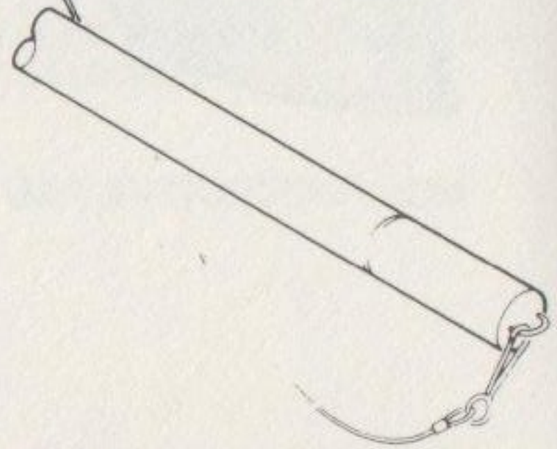
(S70-0902) (RG2513A) (RG000008)



THROAT PLUG CLOSURE
AND INSTALLATION POLE



AFT MANIFOLD DRAIN
LINE ADAPTER

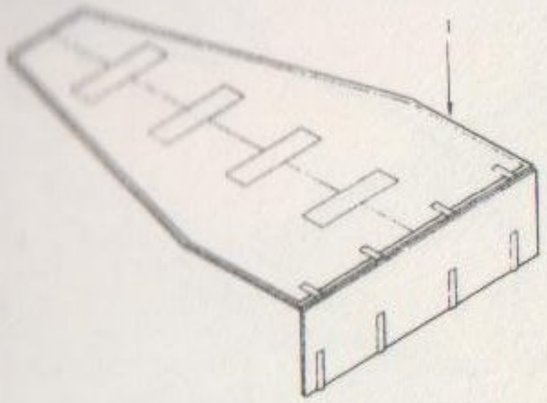


DRAIN LINE CLOSURE
AND INSTALLATION POLE

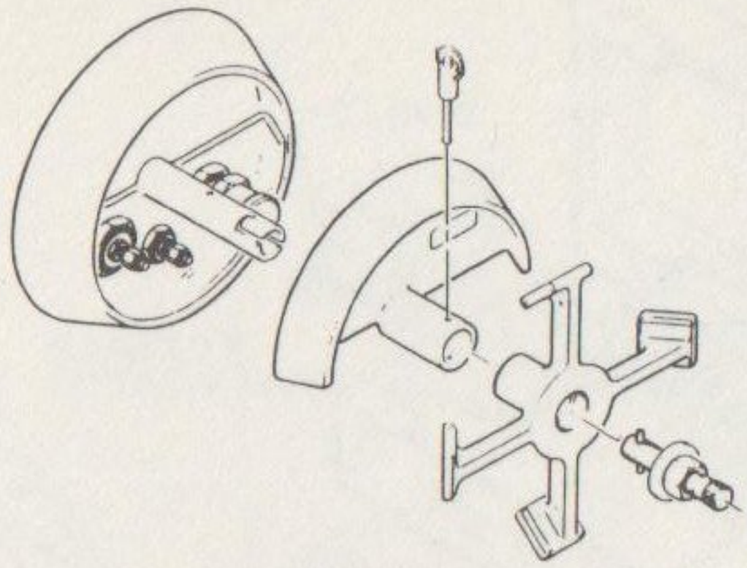
PURPOSE: PROVIDE PROTECTION FROM DUST, SAND, AND RAIN DURING LANDING OPERATIONS.

FIGURE 4-18. ENVIRONMENTAL PROTECTION COVER SET

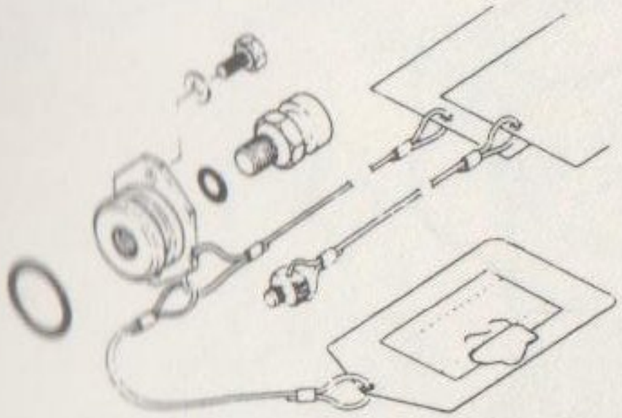
(C70-0909) (RG2537A) (RG000023)



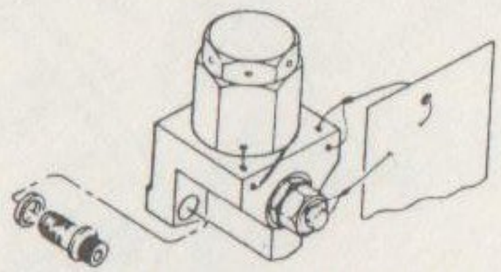
THRUST CHAMBER
PROTECTIVE PAD



THROAT PLUG SET



DRAIN LINE CLOSURE SET

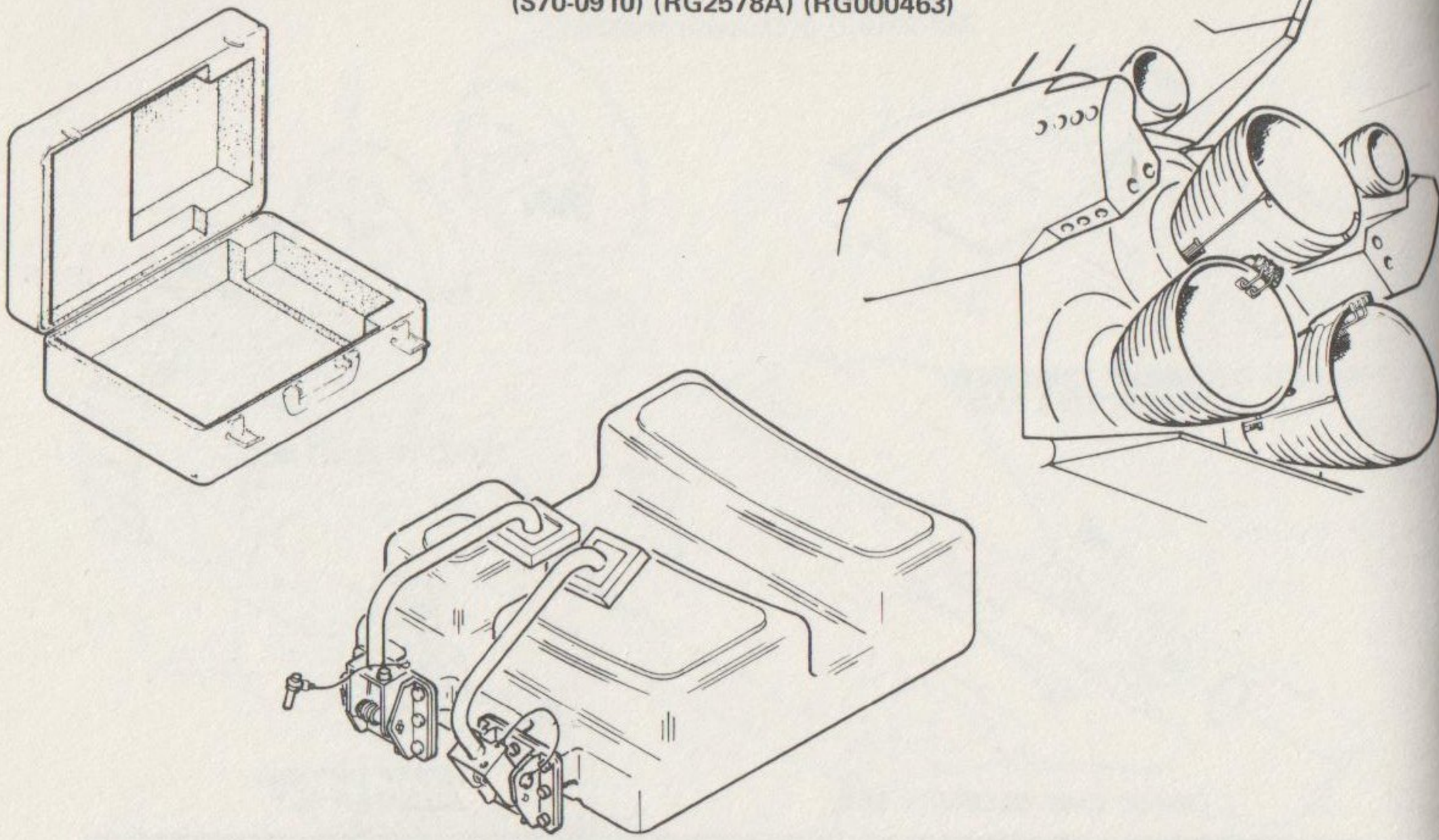


HPFTP DRYING
ADAPTER SET

PURPOSE: CONTAIN PNEUMATIC PRESSURE IN SSME SYSTEMS TO PRECLUDE MOISTURE/ CONTAMINANT ENTRY DURING ALTITUDE CHANGES WHEN IN FERRY FLIGHT AND ADAPT HPFTP FOR TURBINE BEARING DRYING.

FIGURE 4-19. FERRY FLIGHT SET

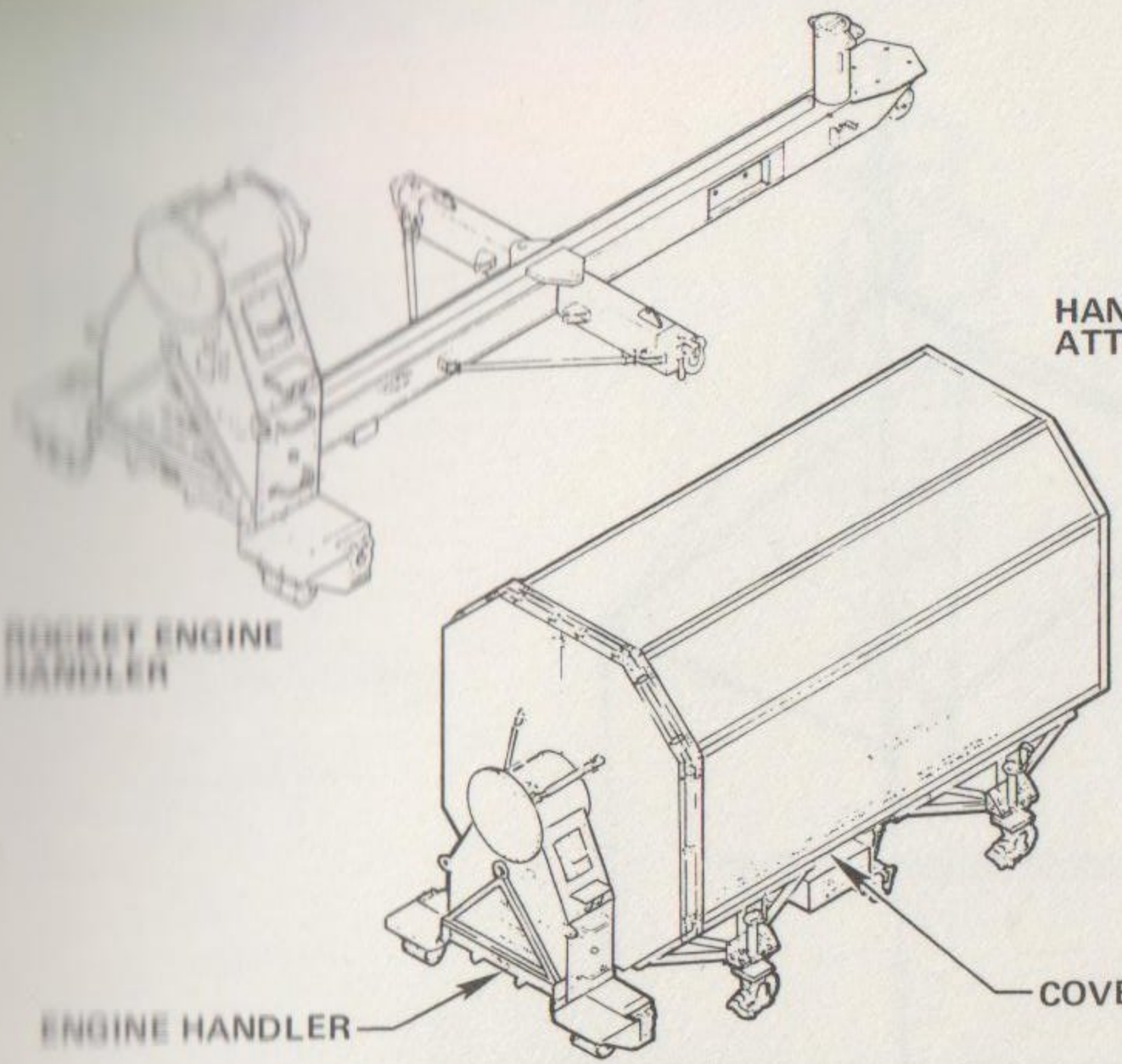
(S70-0910) (RG2578A) (RG000463)

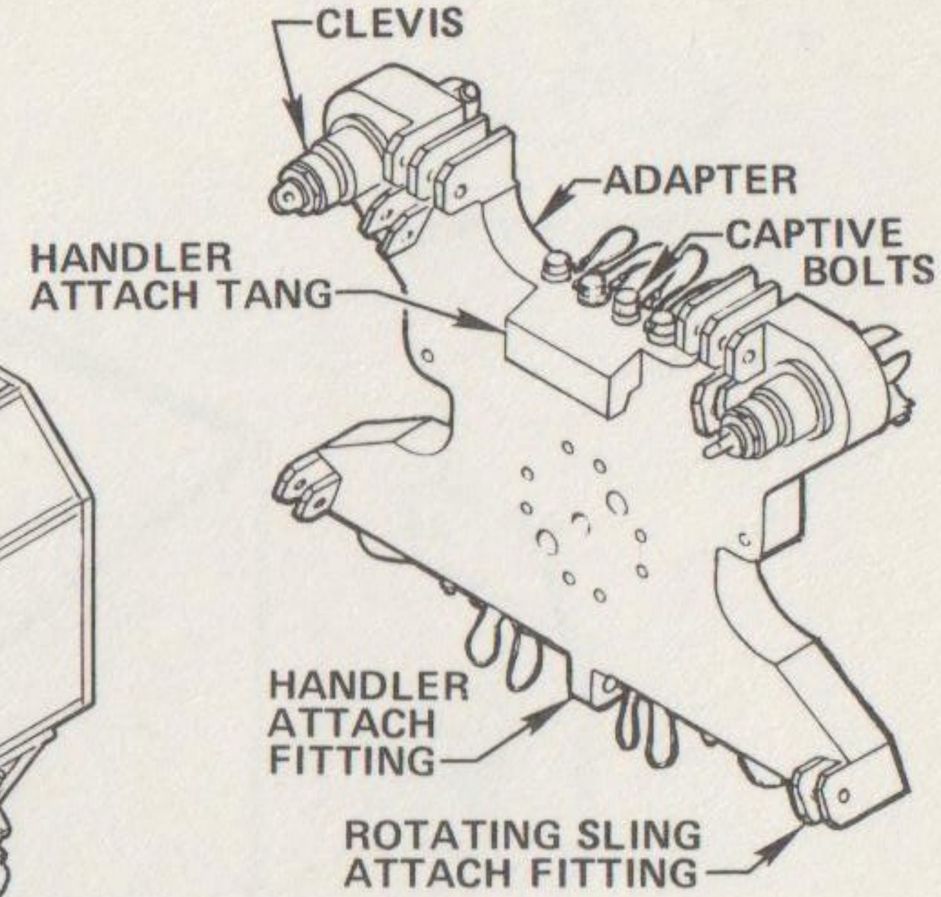


PURPOSE:	TO PREVENT CONTACT OF DRIFTING NOZZLES IN THE EVENT THAT HYDRAULICS ARE SHUT DOWN AND GIMBAL LOCKS ARE NOT INSTALLED.

FIGURE 4-20. NOZZLE BUMPER SET

(H70-0901) (RG2502A) (RG000001)

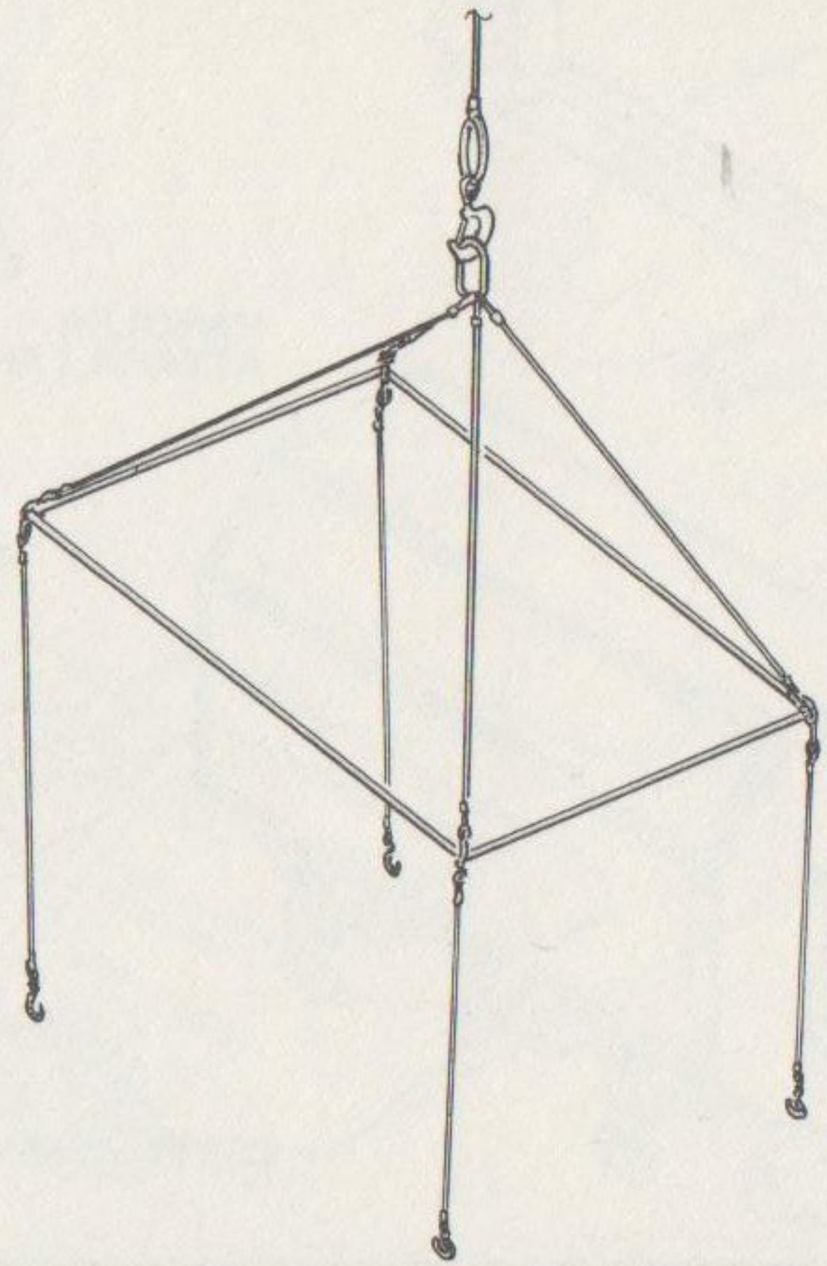




PURPOSE: SHIP AND STORE SSMEs IN HORIZONTAL POSITION AND ROTATE ENGINES FOR MAINTENANCE.

FIGURE 4-21. ENGINE HANDLER

(H70-0902) (RG2505A) (RG000003)



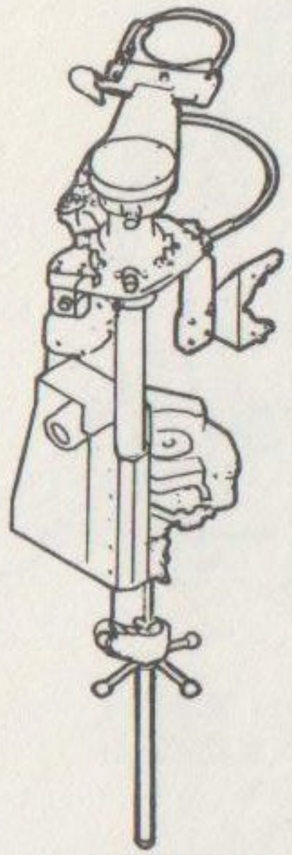
PURPOSE: LIFT ROCKET ENGINE HANDLER WITH OR WITHOUT SSME INSTALLED.

FIGURE 4-22. ENGINE HANDLER SLING

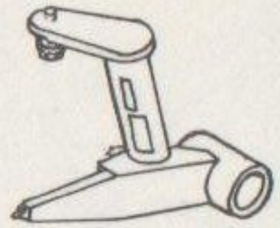
(H70-0905) (RG2514A) (RG000009)

HPFTP HANDLER SLING

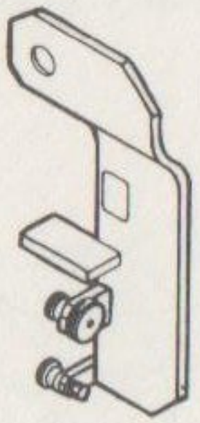
LPOTP HANDLER SLING



HPOTP HANDLER SLING



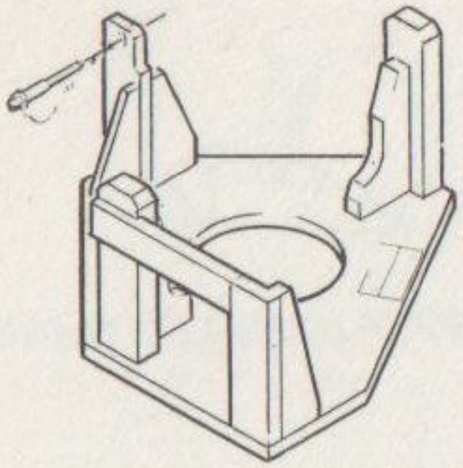
LPFTP HANDLER SLING



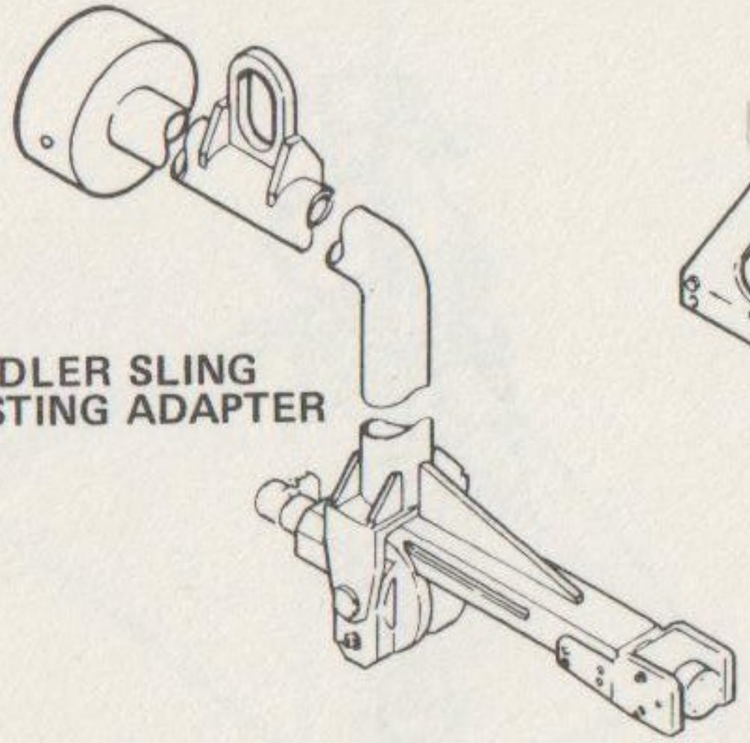
MAINTENANCE AREA
MFV/MOV SLING

PURPOSE: SUPPORT, LIFT, GUIDE, AND MOVE SELECTED LRUs DURING LRU REMOVAL AND INSTALLATION IN SSME OR SHIPPING CONTAINERS.

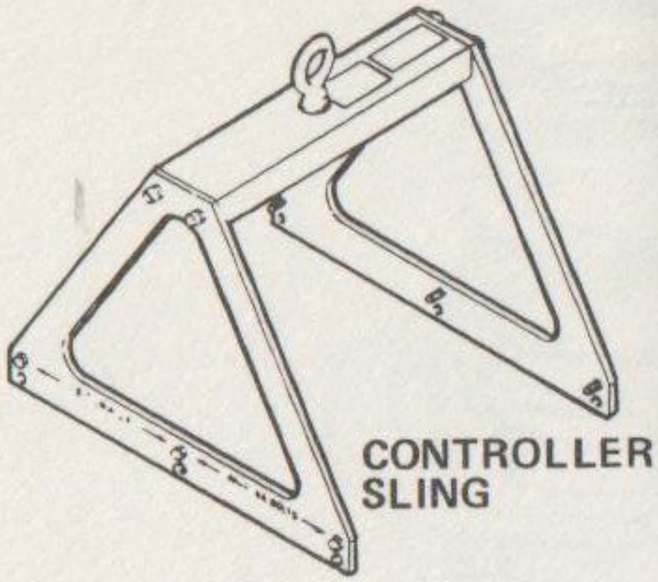
FIGURE 4-23. COMPONENT HANDLER SLING SET (SHEET 1 OF 3)



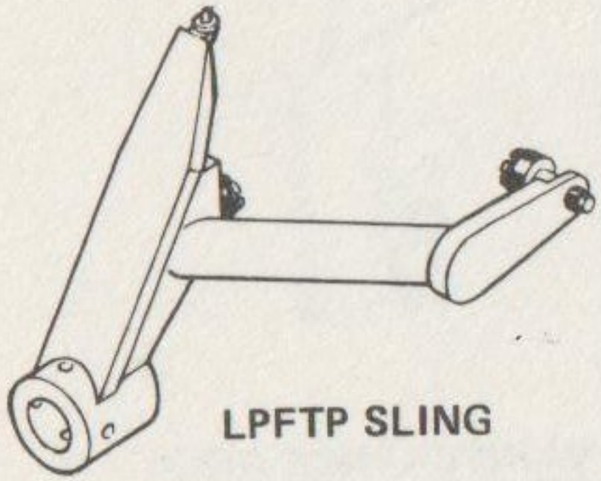
HPFTP SUPPORT STAND



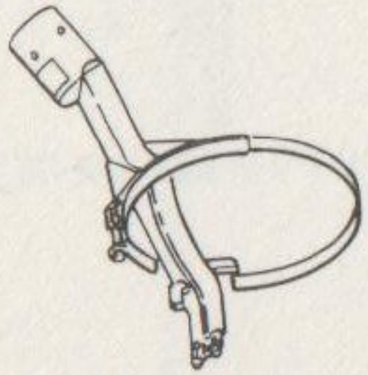
HANDLER SLING
HOISTING ADAPTER



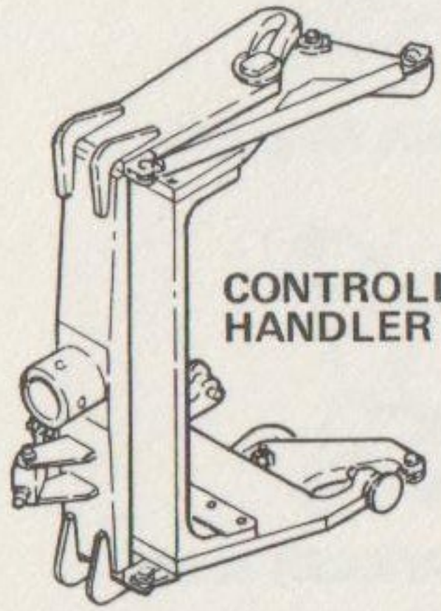
CONTROLLER
SLING



LPFTP SLING

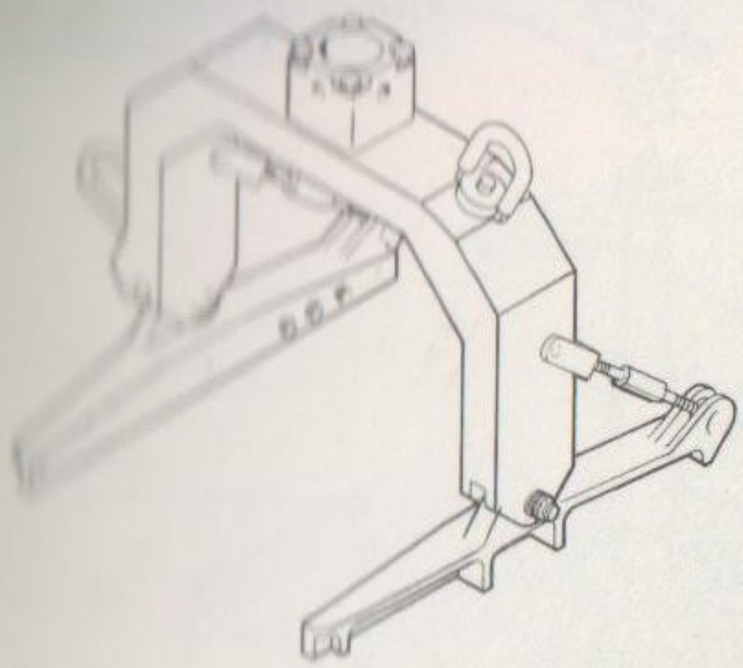


POGO ACCUMULATOR AND
SYSTEM HANDLER SLING

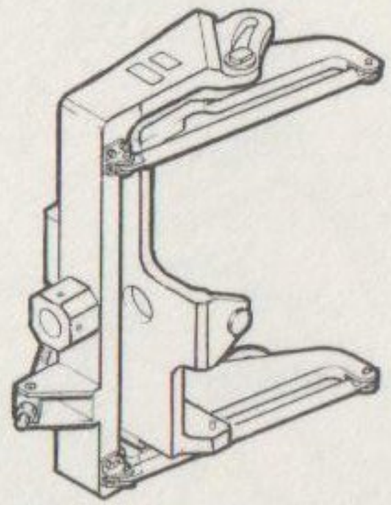


CONTROLLER
HANDLER SLING

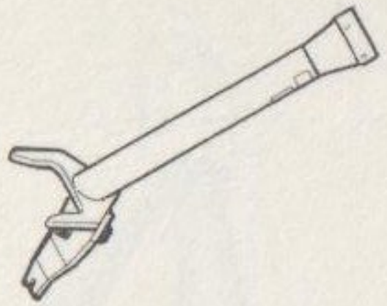
FIGURE 4-23. COMPONENT HANDLER SLING SET (SHEET 2 OF 3)



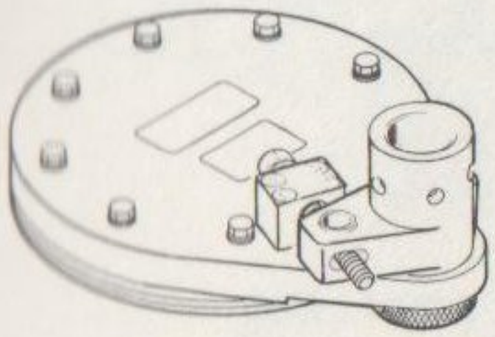
LIGHTWEIGHT CONTROLLER HANDLER



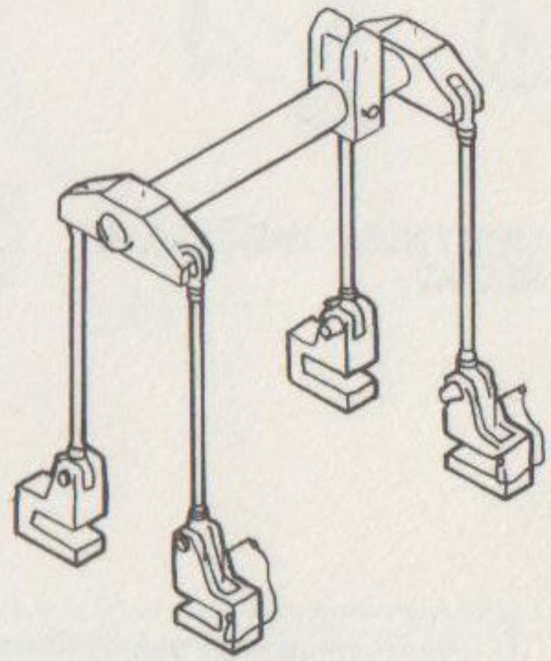
BLOCK II CONTROLLER HANDLER



MFV/MOV HANDLER SLING



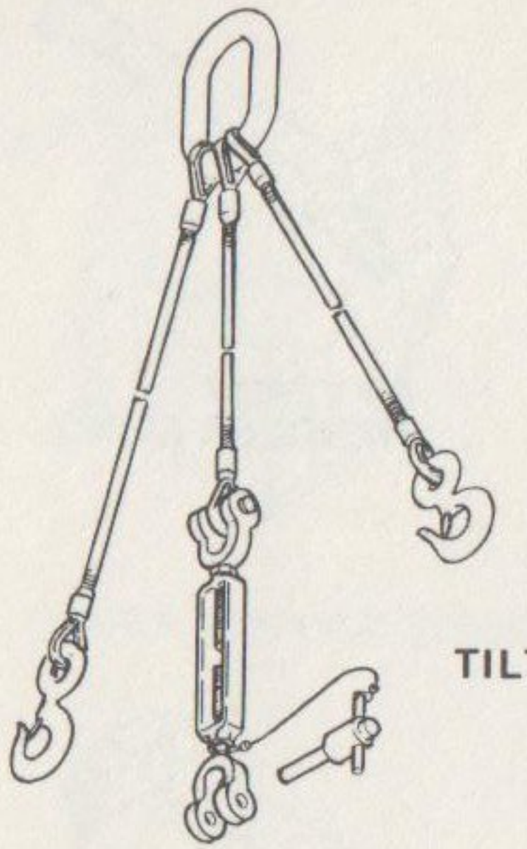
LPFTP HANDLER ADAPTER



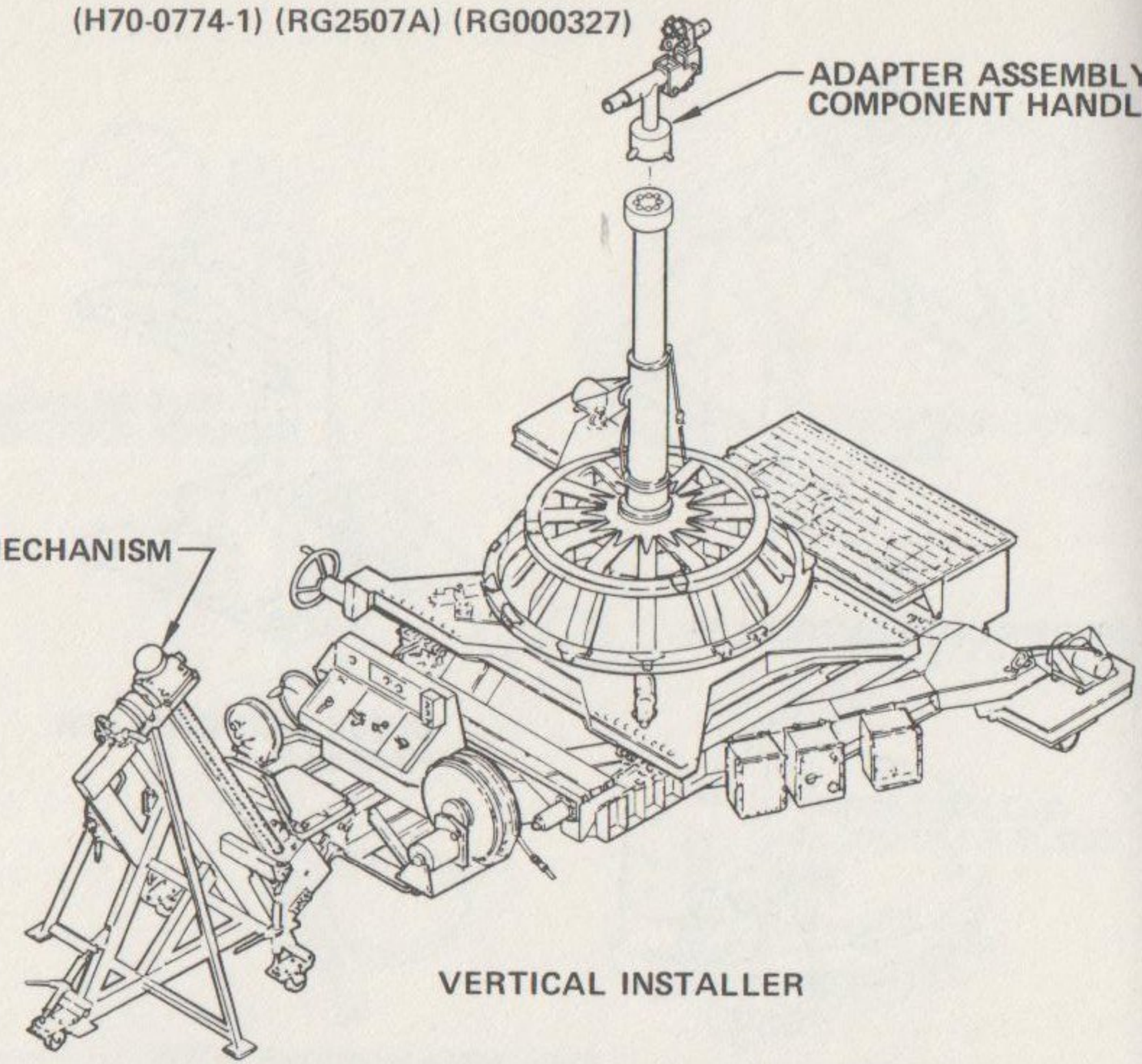
HPTP HANDLER SLING

FIGURE 4-23. COMPONENT HANDLER SLING SET (SHEET 3 OF 3)

(H70-0774-1) (RG2507A) (RG000327)



VERTICAL INSTALLER SLING

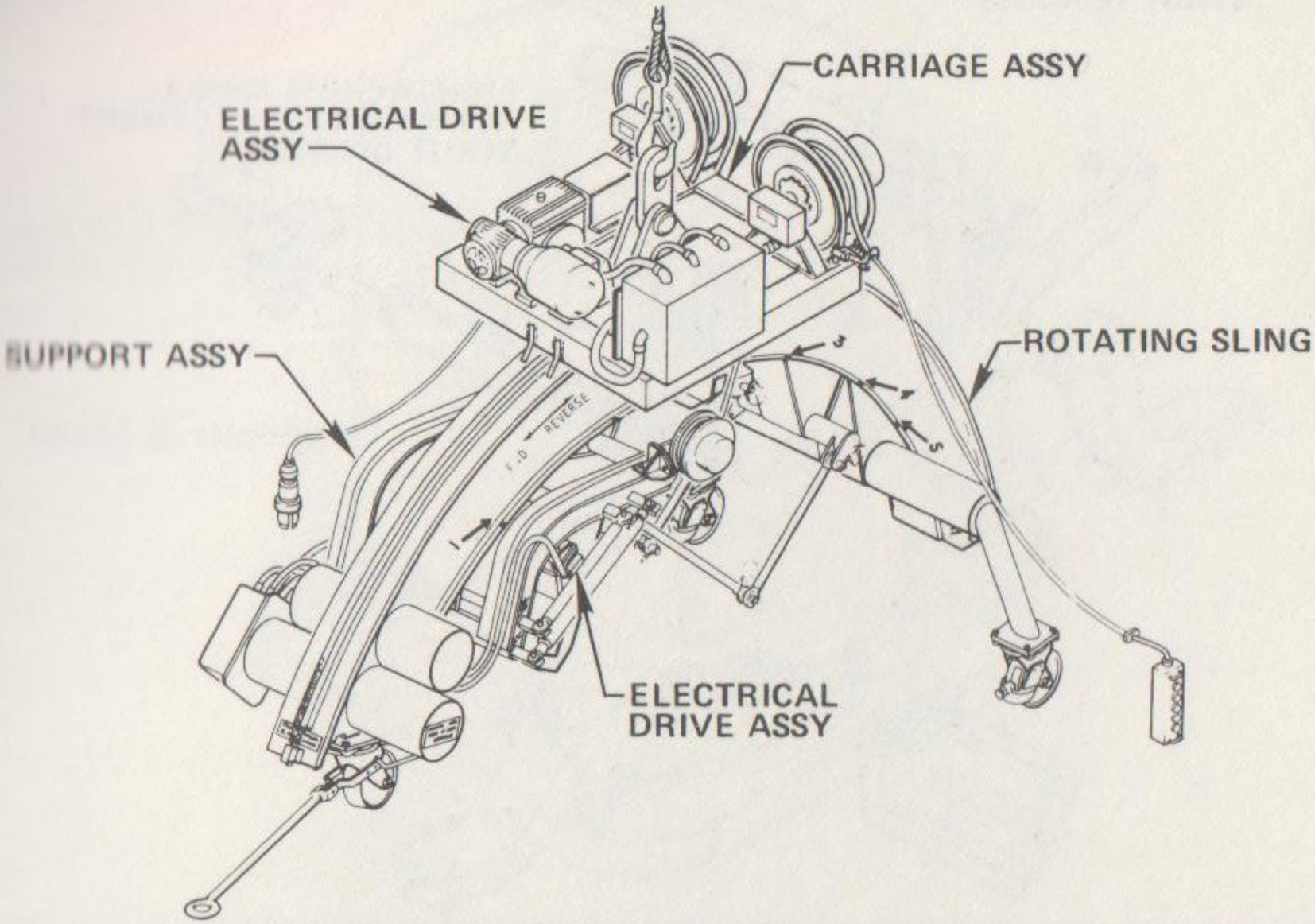


VERTICAL INSTALLER

PURPOSE: INSTALL SSME VERTICALLY INTO ORBITER OR TEST STAND.

FIGURE 4-24. ENGINE INSTALLER SET

(H70-0903) (RG2506A) (RG000004)

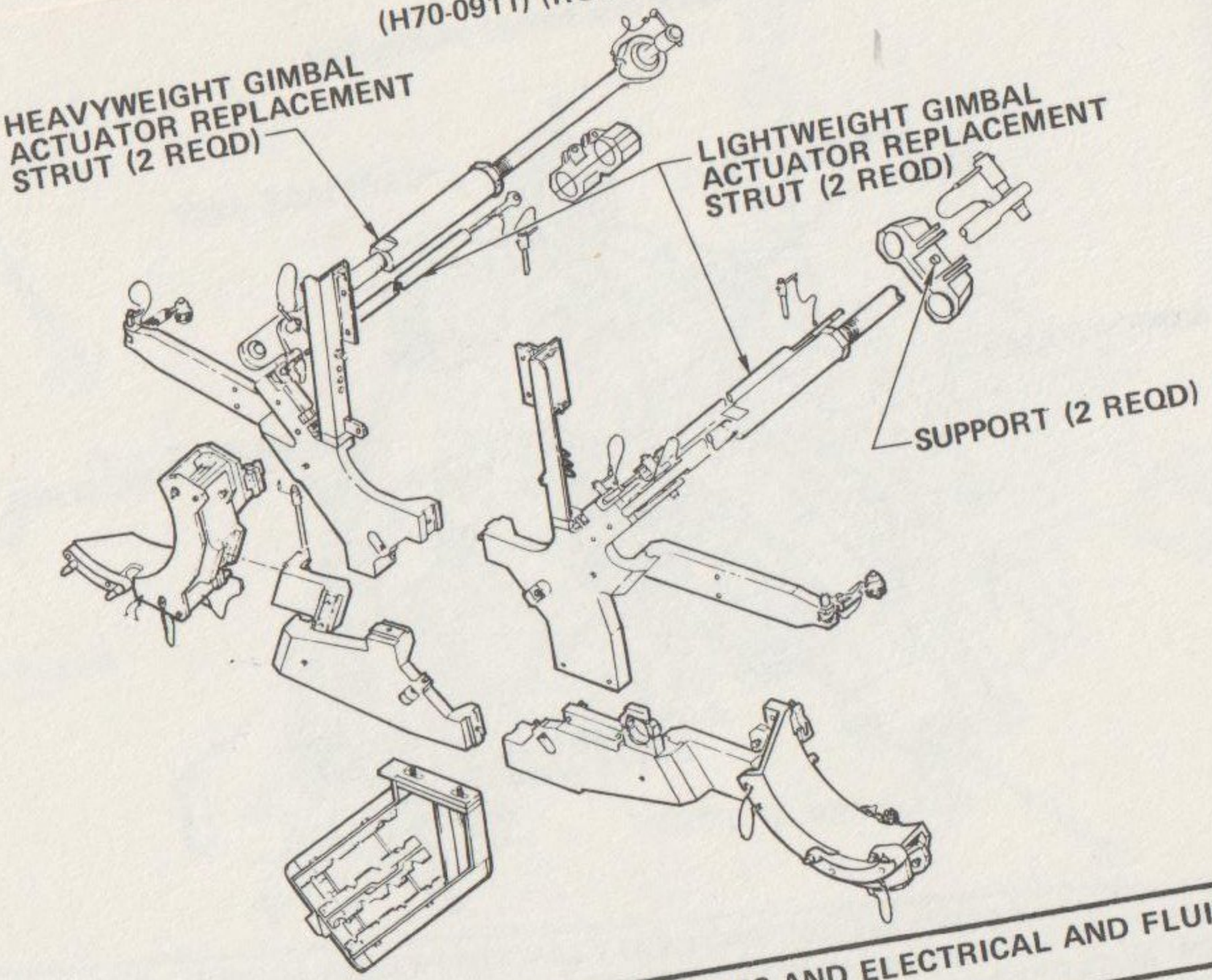


PURPOSE: SUPPORT, LIFT, GUIDE, AND ROTATE SSME DURING INSTALLATION AND REMOVAL FROM ROCKET ENGINE HANDLER AND VERTICAL ENGINE INSTALLER.

FIGURE 4-25. ENGINE ROTATING SLING

(H70-0774-1) (RG2507A1)

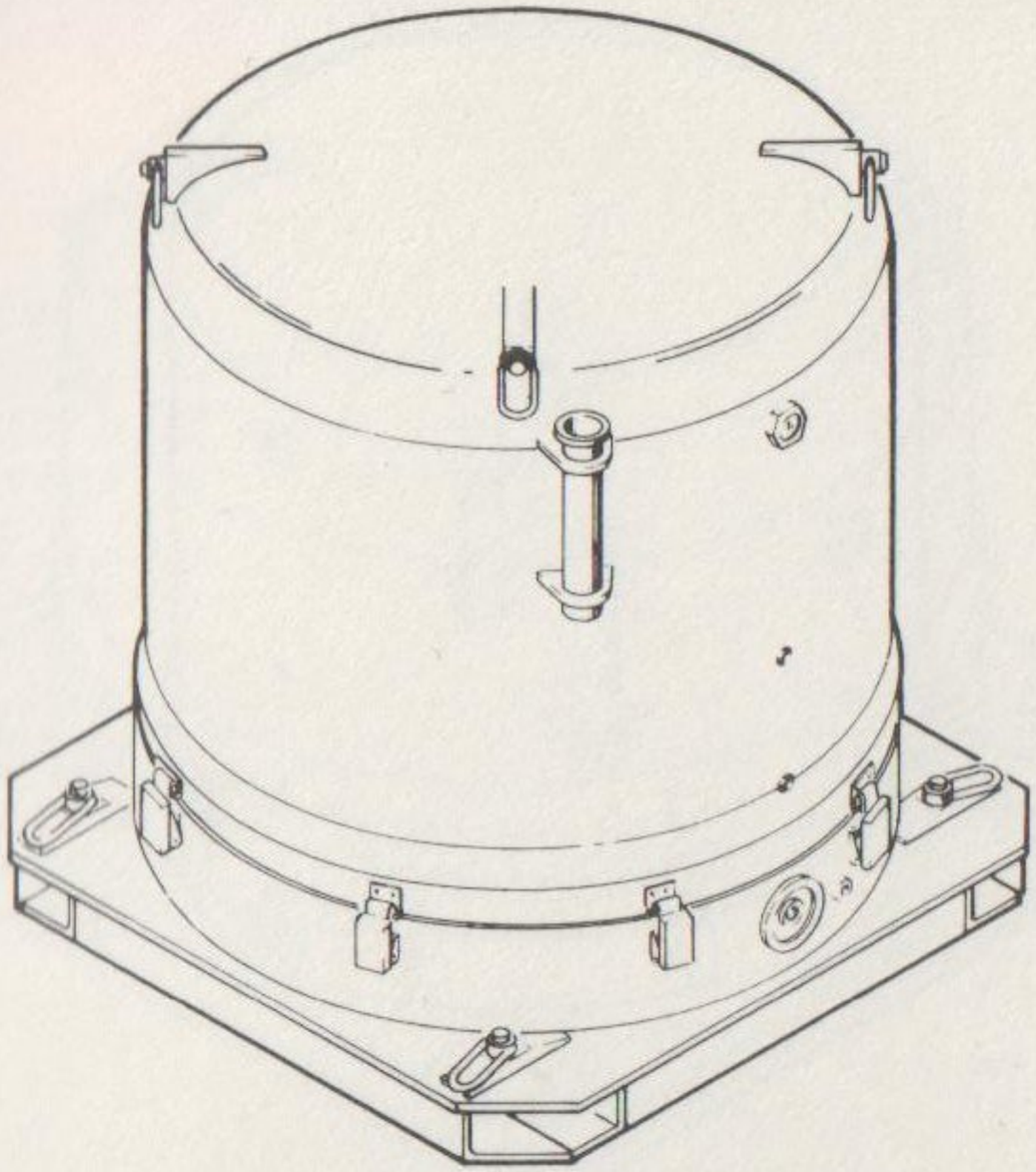
(H70-0911) (RG2518A) (RG000350)



PURPOSE: SUPPORT LOW-PRESSURE TURBOPUMPS AND ELECTRICAL AND FLUID INTERFACE PANELS OF UNINSTALLED ENGINES.

FIGURE 4-26. INTERFACE PANEL AND STRUT SET

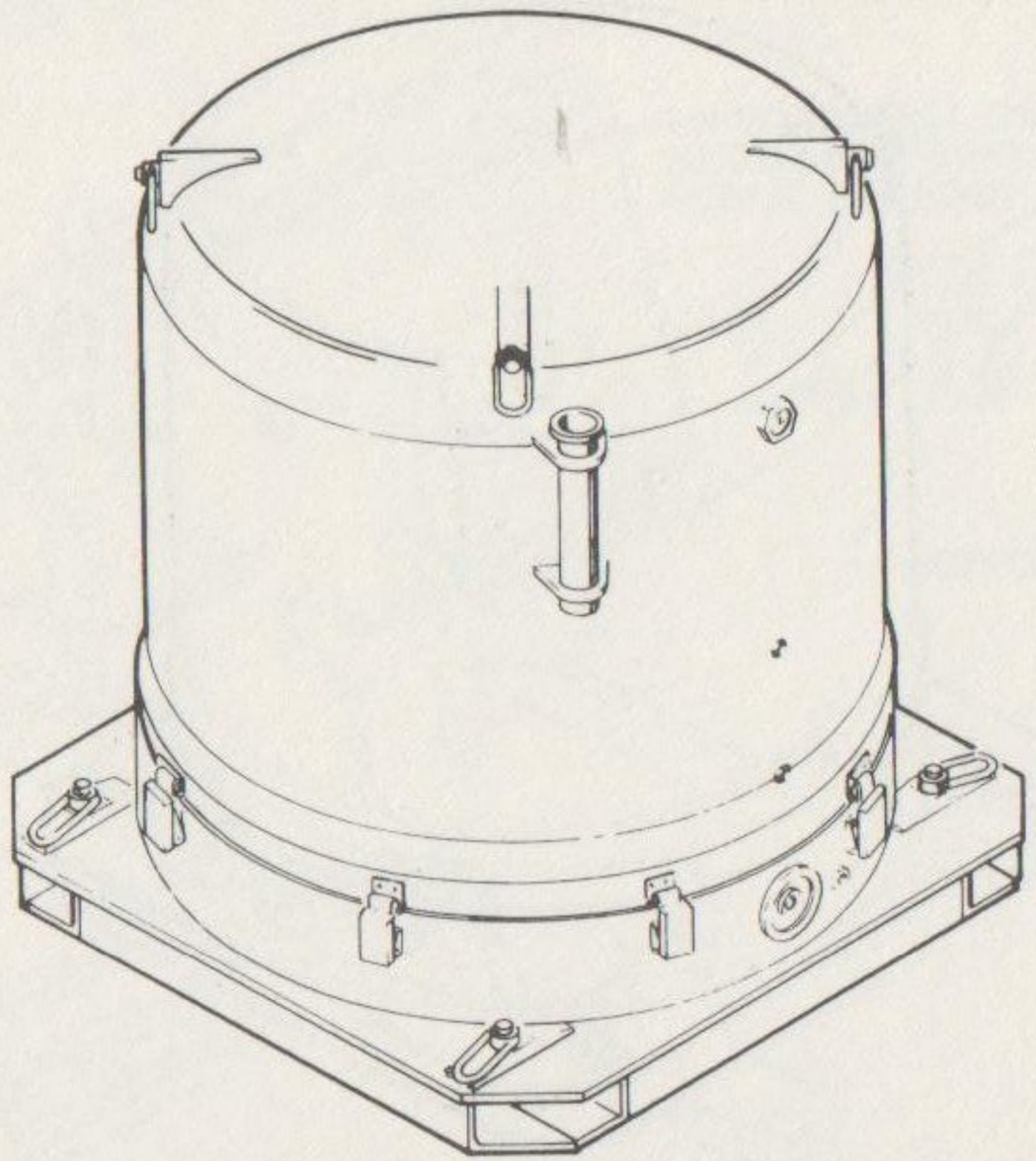
(H70-0906) (RG2591A) (RG000438)



PURPOSE: PROVIDE AN ENVIRONMENTALLY PROTECTED IMPACT-O-GRAPH MONITORED, DESICCANT-SHIELDED CONTAINER FOR THE TRANSPORT AND STORAGE OF THE HIGH-PRESSURE FUEL TURBOPUMP.

FIGURE 4-27. HIGH-PRESSURE FUEL TURBOPUMP SHIPPING CONTAINER ASSEMBLY

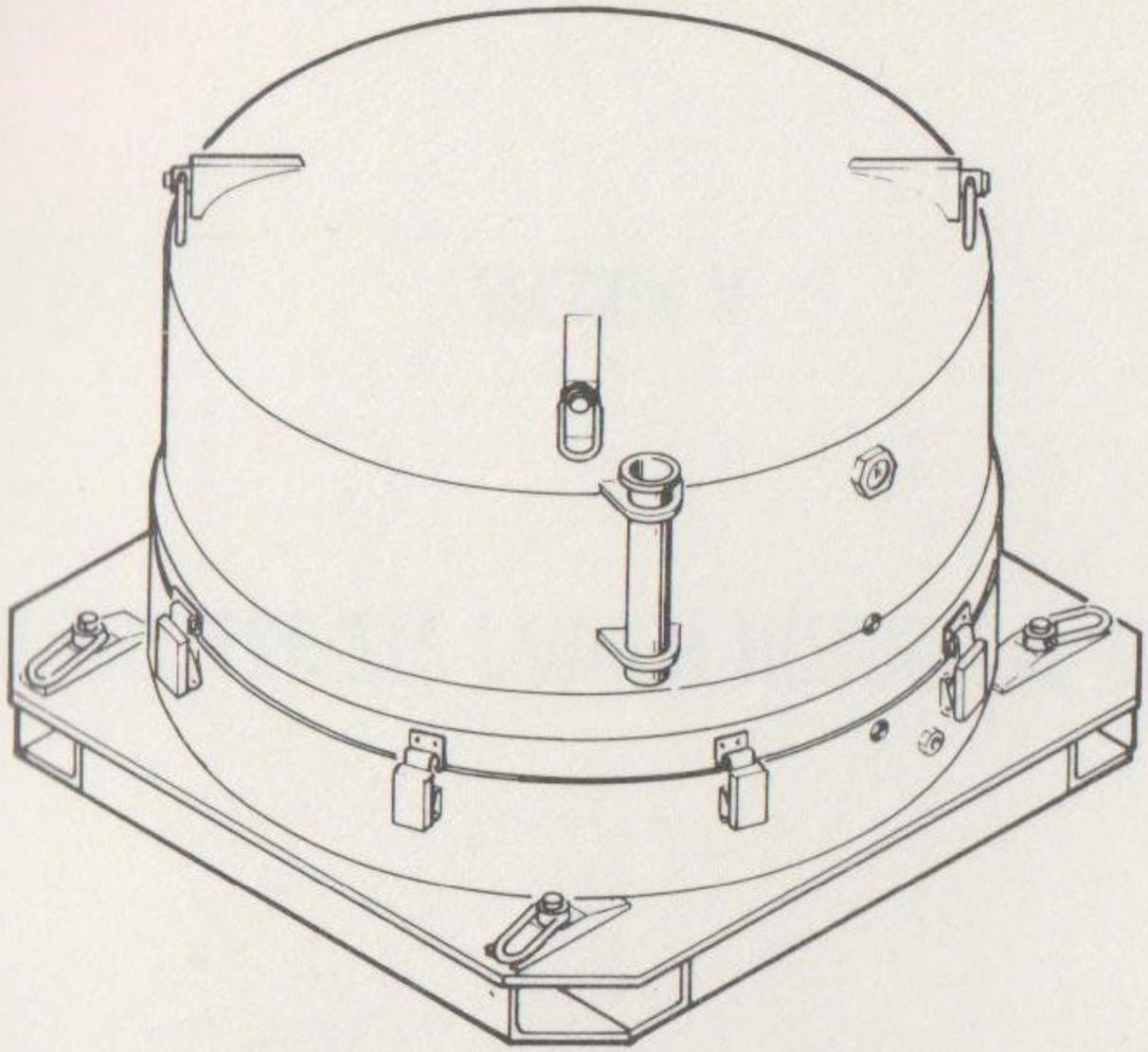
(H70-0907) (RG2592A) (RG000441)



PURPOSE: PROVIDE AN ENVIRONMENTALLY PROTECTED IMPACT-O-GRAPH MONITORED, DESICCANT-SHIELDED CONTAINER FOR THE TRANSPORT AND STORAGE OF THE HIGH-PRESSURE OXIDIZER TURBOPUMP.

FIGURE 4-28. HIGH-PRESSURE OXIDIZER TURBOPUMP SHIPPING CONTAINER ASSEMBLY

(H70-0908) (RG2593A) (RG000442)



PURPOSE: PROVIDE AN ENVIRONMENTALLY PROTECTED IMPACT-O-GRAPH MONITORED, DESICCANT-SHIELDED CONTAINER FOR THE TRANSPORT AND STORAGE OF THE LOW-PRESSURE TURBOPUMPS.

FIGURE 4-29. LOW-PRESSURE TURBOPUMP SHIPPING CONTAINER ASSEMBLY

SECTION V

SHUTTLE FRF/STS LAUNCH HISTORICAL DATA

FRF/ Mission	Date	Challenger 099	Columbia 102	Discovery 103	Atlantis 104	Power Level %	Engine Serial No. Position No. 1	Position No. 2	Position No. 3	Launch/ Land Sites
FRF-01	02-28-81		X			100	2007	2006	2005	DNA
STS-1	04-12-81		X			100	2007	2006	2005	KSC/EAFB
STS-2	11-12-81		X			100	2007	2006	2005	KSC/EAFB
STS-3	03-22-82		X			100	2007	2006	2005	KSC/WSSH
STS-4	06-27-82		X			100	2007	2006	2005	KSC/EAFB
STS-5	11-11-82		X			100	2007	2006	2005	KSC/EAFB
FRF-02	12-18-82	X				104	2011	2015	2012	DNA
FRF-03	01-25-83	X				104	2011	2015	2012	DNA
STS-6	04-04-83	X				104	2017	2015	2012	KSC/EAFB
STS-7	06-18-83	X				104	2017	2015	2012	KSC/EAFB
STS-8	08-30-83	X				100	2017	2015	2012	KSC/EAFB
STS-9	11-28-83		X			104	2011	2018	2019	KSC/EAFB
STS-11	02-03-84	X				100	2109	2015	2012	KSC/KSC
STS-13	04-06-84	X				104	2109	2020	2012	KSC/EAFB
FRF-04	06-02-84			X		100	2021	2018	2017	DNA
STS-14 ABORT	06-26-84			X		100	2109	2018	2017	DNA
STS-14	08-30-84			X		104	2109	2018	2021	KSC/EAFB
STS-17	10-05-84	X				100	2023	2020	2021	KSC/KSC
STS-19	11-08-84			X		104	2109	2018	2012	KSC/KSC
STS-20	01-24-85			X		104	2109	2018	2012	KSC/KSC

FIGURE 5-1. SHUTTLE FRF/STS LAUNCH SUMMARY (SHEET 1 OF 2)

FRF/ Mission	Date	Challenger 099	Columbia 102	Discovery 103	Atlantis 104	Power Level %	Engine Serial No. Position No. 1	Position No. 2	Position No. 3	Launch/ Land Sites
STS-23	04-12-85			X		100	2109	2018	2012	KSC/KSC
STS-24	04-29-85	X				104	2023	2020	2021	KSC/EAFB
STS-25	06-17-85			X		104	2109	2018	2012	KSC/EAFB
STS-26 ABORT	07-12-85	X				104	2023	2020	2021	DNA
STS-26	07-29-85	X				104	2023	2020	2021	KSC/EAFB
STS-27	08-27-85			X		104	2109	2018	2012	KSC/EAFB
FRF-05	09-12-85				X	100	2011	2019	2017	DNA
STS-28	10-03-85				X		2011	2019	2017	KSC/EAFB
STS-30	10-30-85	X				104	2023	2020	2021	KSC/EAFB
STS-31	11-26-85				X	104	2011	2019	2017	KSC/EAFB
STS-32	01-12-86		X			104	2015	2018	2109	KSC/EAFB
STS-33	01-28-86	X				104	2023	2020	2021	KSC/
FRF-06	08-10-88			X		100	2019	2022	2028	DNA
STS-26R	09-29-88			X		104	2019	2022	2028	KSC/EAFB
STS-27R	12-02-88				X	104	2027	2030	2029	KSC/EAFB
STS-29R	03-13-89			X		104	2031	2022	2028	KSC/EAFB

FIGURE 5-1. SHUTTLE FRF/STS LAUNCH SUMMARY (SHEET 2 OF 2)

FRF-01

ORBITER: COLUMBIA (OV-102)

SSME INITIAL ORBITER INSTALLATION: 07-15-79, 07-18-79, AND 08-04-79

SSME REMOVALS FOR NOZZLE STEERHORN/HPOTP MODS: 12-21-79, 01-03-80, AND 01-04-80

SSME NSTL REACCEPTANCE COMPLETE: 06-23-80, 07-14-80, AND 07-21-80

SSME ORBITER REINSTALLATION: 07-20-80, 07-21-80, AND 08-04-80

SSME REMOVALS FOR FPB LINER MODS: 10-10-80

SSME ORBITER REINSTALLATION: 11-08-80

ROLLOUTS: OPF 11-25-80 VAB 12-29-80

FRF-01: 02-28-81

SSME'S: 2007(1), 2006(2), AND 2005(3)

SSME POWER LEVEL: 100%

SSME FRF-01 SOFTWARE: 81-SSME-0021R1

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 1 OF 33)

STS-1

ORBITER: COLUMBIA (OV-102)

ERF-01 CONDUCTED: 02-28-81

• LAUNCH: KSC 04-12-81 07:00 EST

SSME'S: 2007(1), 2006(2), AND 2005(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 81-SSME-0024

PAYLOAD: PRIMARY — DFI, ACIP; SECONDARY — NONE

ASTRONAUTS: COMMANDER: JOHN YOUNG PILOT: ROBERT CRIPPEN

• LANDING: EAFB 04-14-81 10:21 PST
EAFB - PRIMARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 75 HOURS
DFRF PROCESSING TIME - 11 DAYS

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 2 OF 33)

STS-2

ORBITER: COLUMBIA (OV-102)

OPF FLOW INITIATION: 04-29-81

OPF SSME PROCESSING TIME: 144 SHIFTS

ROLLOUTS: OPF 08-10-81 VAB 08-31-81

● LAUNCH: KSC 11-12-81 10:10 EST

SSME'S: 2007(1), 2006(2), AND 2005(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 81-SSME-0031

PAYLOAD:

PRIMARY	SECONDARY
OSTA-1, PDRS	NONE
OEX	

ASTRONAUTS: COMMANDER: JOE ENGLE PILOT: RICHARD TRULY

● LANDING: EAFB 11-14-81 01:23 PST
EAFB - PRIMARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 28 HOURS
DFRF PROCESSING TIME - 9 DAYS

COLUMBIA PREVIOUS MISSIONS: STS-1 (04-12-81)

STS-1 SSME'S: 2007(1), 2006(2), AND 2005(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 3 OF 33)

STS-3

ORBITER: COLUMBIA (OV-102)

OPF FLOW INITIATION: 11-25-81

OPF SSME PROCESSING TIME: 57 SHIFTS

ROLLOUTS: OPF 02-03-82 VAB 02-16-82

• LAUNCH: KSC 03-22-82 11:00 EST

SSME'S: 2007(1), 2006(2), AND 2005(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 81-SSME-0031

PAYLOAD:	PRIMARY OSS-1, OEX	SECONDARY NONE
ASTRONAUTS:	COMMANDER: JACK LOUSMA	PILOT: C. GORDON FULLERTON

• LANDING: WSSH 03-30-82 09:05 MST
EAFB PRIMARY - SWITCH TO WSSH LAUNCH - 4 DAYS
HPFTP BEARING PURGES INITIATED - LANDING PLUS 24 HOURS
WSSH PROCESSING TIME - 5 DAYS

COLUMBIA PREVIOUS MISSIONS: STS-1 AND STS-2 (08-10-81)

STS-2 SSME'S: 2007(1), 2006(2), AND 2005(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 4 OF 33)

STS-4

ORBITER: COLUMBIA (OV-102)

OPF FLOW INITIATION: 03-08-82

OPF SSME PROCESSING TIME: 66 SHIFTS

ROLLOUTS: OPF 05-19-82 VAB 05-26-82

● LAUNCH: KSC 06-27-82

SSME'S: 2007(1), 2006(2), AND 2005(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 82-SSME-0033R2

PAYLOAD:	PRIMARY	SECONDARY
	DOD 82-1	MBR, DFI, GAS, ACIP

ASTRONAUTS: COMMANDER: THOMAS MATTINGLY II PILOT: HENRY HARTSFIELD JR.

● LANDING: EAFB 07-04-82 09:09 PST
EAFB - PRIMARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 34 HOURS
DFRF PROCESSING TIME - 9 DAYS

COLUMBIA PREVIOUS MISSIONS: STS-1, STS-2, AND STS-3 (03-22-82)

STS-3 SSME'S: 2007(1), 2006(2), AND 2005(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 5 OF 33)

STS-5

ORBITER: COLUMBIA (OV-102)

OPF FLOW INITIATION: 07-16-82

OPF SSME PROCESSING TIME: 63 SHIFTS

ROLLOUTS: OPF 09-09-82 VAB 09-21-82

• LAUNCH: KSC 11-11-82 07:19 EST

SSME'S: 2007(1), 2006(2), AND 2005(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 82-SSME-0035R4

PAYLOAD:	PRIMARY SBS-C, TELESAT-E	SECONDARY GLOW, SSIP (3), GAS (1)
ASTRONAUTS:	COMMANDER: VANCE BRAND	PILOT: ROBERT OVERMYER
	MISSION SPECIALISTS: JOSEPH ALLEN, WILLIAM LENOIR	

• LANDING: EAFB 11-16-82 06:33 PST
EAFB - PRIMARY LANDING SITE
HPFTP BEARINGS PURGES INITIATED - LANDING PLUS 27 HOURS
DFRF PROCESSING TIME - 4 DAYS

COLUMBIA PREVIOUS MISSIONS: STS-1, STS-2, STS-3, AND STS-4 (06-27-82)

STS-4 SSME'S: 2007(1), 2006(2), AND 2005(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 6 OF 33)

FRF-02

ORBITER: CHALLENGER (OV-099)

SSME INSTALLATION: 10-21-82, 10-25-82, AND 11-10-82

ROLLOUTS: OPF 11-23-82 VAB 11-30-82

FRF-02: 12-18-82

SSME'S: 2011(1), 2015(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FRF-02 SOFTWARE: 83-SSME-0043R2

FRF-03 (PRE STS-6)

ORBITER: CHALLENGER (OV-099)

FRF-03: CONDUCTED TO EVALUATE HYDROGEN AFT FUSELAGE CONTENT

FRF-03: 01-25-83

SSME'S: 2011(1), 2015(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME SOFTWARE: 83-SSME-0047R1

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 7 OF 33)

STS-6

ORBITER: CHALLENGER (OV-099)

OPF FLOW INITIATION:

OPF SSME PROCESSING TIME: DNA - FRF TURNAROUND

ROLLOUTS: OPF 11-23-83 VAB 11-30-83

• LAUNCH: KSC 04-04-83 13:30 EST

SSME'S: 2017(1), 2015(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 83-SSME-0048

PAYLOAD: PRIMARY
TDRS-1

SECONDARY
CFES, MLR, NOSL, AND GAS (3)

ASTRONAUTS: COMMANDER: PAUL WEITZ PILOT: KAROL BOBKO
MISSION SPECIALISTS: DONALD PETERSON, STORY MUSGRAVE

• LANDING: EAFB 04-09-83 10:49 PDT
EAFB - PRIMARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 17 HOURS
DFRF PROCESSING TIME - 4 DAYS

CHALLENGER PREVIOUS MISSIONS: NONE

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 8 OF 33)

STS-7

ORBITER: CHALLENGER (OV-099)

OPF FLOW INITIATION: 04-18-84

OPF SSME PROCESSING TIME: 52 SHIFTS

ROLLOUTS: OPF 05-21-83 VAB 05-26-83

● LAUNCH: KSC 06-18-83 07:33 EDT

SSME'S: 2017(1), 2015(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 83-SSME-0049R1

PAYLOAD:

PRIMARY	SECONDARY
SPAS-01, OSTA-2 TELESAT-F, PALAPA-B1	CFES, MLR, GAS (7)

ASTRONAUTS: COMMANDER: ROBERT CRIPPEN PILOT: FREDERICK HAUCK
MISSION SPECIALISTS: JOHN FABIAN, SALLY RIDE, NORMAN THAGARD

● LANDING: EAFB 06-24-83 06:57 PDT
EAFB - SECONDARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 40 HOURS 18 MINUTES
DFRF PROCESSING TIME - 5 DAYS

CHALLENGER PREVIOUS MISSIONS: STS-6 (04-04-83)

STS-6 SSME'S: 2017(1), 2015(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 9 OF 33)

ORBITER: CHALLENGER (OV-099)

OFF FLOW INITIATION: 06-30-83

OFF SSME PROCESSING TIME: 24 SHIFTS

ROLLOUTS: OPF 07-26-83 VAB 08-01-83

*LAUNCH: KSC 08-30-83 02:32 EST

SSME'S: 2017(1), 2015(2), AND 2012(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 83-SSME-0051

PAYLOAD:

PRIMARY	SECONDARY
PDRS/PFTA, OIM INSAT I-B	CFES, RME, GAS(4), SSIP (1)

ASTRONAUTS: COMMANDER: RICHARD TRULY PILOT: DANIEL BRANDENSTEIN

MISSION SPECIALISTS: DALE GARDNER, GUION BLUFORD, WILLIAM THORNTON

*LANDING: EAFB 09-05-83 00:41 PDT
EAFB - PRIMARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 18 HOURS 20 MINUTES
DFRF PROCESSING TIME - 4 DAYS

CHALLENGER PREVIOUS MISSIONS: STS-6 AND STS-7 (06-18-83)

STS-7 SSME'S: 2017(1), 2015(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 10 OF 33)

STS-9 (MISSION 41-A)

ORBITER: COLUMBIA (OV-102)

SSME ENGINE INSTALLATION: 06-02-83, 07-18-83, AND 07-19-83

OPF SSME PROCESSING TIME: DNA - NEW ENGINES

ROLLOUTS: OPF 11-03-83 VAB 11-08-83

● LAUNCH: KSC 11-28-83 11:00 EST

SSME'S: 2011(1), 2018(2), AND 2019(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 83-SSME-0052R4

PAYLOAD: PRIMARY — SPACELAB 1; SECONDARY — NONE

ASTRONAUTS: COMMANDER: JOHN YOUNG PILOT: BREWSTER SHAW
MISSION SPECIALISTS: OWEN GARRIOTT, ROBERT PARKER
PAYLOAD SPECIALISTS: BYRON LICHTENBERG, ULF MERBOLD (W. GERMANY)

● LANDING: EAFB 12-08-83 15:47 PST
EAFB - PRIMARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 19 HOURS 32 MINUTES
DFRF PROCESSING TIME - 6 DAYS

COLUMBIA PREVIOUS MISSIONS: STS-1, STS-2, STS-3, STS-4, AND STS-5 (11-11-82)

STS-5 SSME'S: 2007(1), 2006(2), AND 2005(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 11 OF 33)

STS-11 (MISSION 41-B)

ORBITER: CHALLENGER (OV-099) (STS-10 DELETED)

OPF FLOW INITIATION: 09-11-83

OPF SSME PROCESSING TIME: 43.5 SHIFTS

ROLLOUTS: OPF 01-06-84 VAB 01-12-84

• LAUNCH: KSC 02-03-84

SSME'S: 2109(1), 2015(2), AND 2012(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 83-SSME-0054R3

PAYLOAD:	PRIMARY	SECONDARY
	SPAS-01A, PALAPA B-2 WESTAR VI	ACES, IEF, C-360c+b RME, MLR, GAS(5), SSIP(1), IRT

ASTRONAUTS: COMMANDER: VANCE BRAND PILOT: ROBERT GIBSON

MISSION SPECIALISTS: BRUCE MCCANDLESS, ROBERT STEWART, RONALD MCNAIR

• LANDING: KSC 02-11-84 07:16 EST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 21 HOURS 14 MINUTES

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, AND STS-8 (08-30-83)

STS-8 SSME'S: 2017(1), 2015(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 12 OF 33)

STS-13 (MISSION 41-C)

ORBITER: CHALLENGER (OV-099) (STS-12 DELETED)

OPF FLOW INITIATION: 02-12-84

OPF SSME PROCESSING TIME: 30.5 SHIFTS

ROLLOUTS: OPF 03-14-84 VAB 03-19-84

● LAUNCH: KSC 04-06-84 08:58 EST

SSME'S: 2109(1), 2020(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 84-SSME-0059R3

PAYLOAD:	PRIMARY	SECONDARY
	LDEF-1, SMM REPAIR	RME, IMAX, C-360b SSIP(1)

ASTRONAUTS: COMMANDER: ROBERT CRIPPEN PILOT: FRANCIS SCOBEE

MISSION SPECIALISTS: GEORGE NELSON, TERRY HART, JAMES VAN HOFTEN

● LANDING: EAFB 04-13-84 05:38 PST
EAFB - SECONDARY LANDING SITE
HPFTP BEARING PURGES INITIATED - LANDING PLUS 41.5 HOURS
DFRF PROCESSING TIME - 4 DAYS

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, STS-8, AND STS-11 (02-03-84)

STS-11 SSME'S: 2109(1), 2015(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 13 OF 33)

FRF-04

ORBITER: DISCOVERY (OV-103)

SSME INSTALLATIONS: 01-10-84, 02-07-84, AND 04-12-84 (SSME 2020 INSTALLED 01-12-84, BUT REMOVED 02-17-84 FOR INSTALLATION IN CHALLENGER).

ROLLOUTS: OPF 05-12-84 VAB 05-19-84

FRF-04: 06-02-84

SSME'S: 2021(1), 2018(2), AND 2017(3)

SSME POWER LEVEL: 100%

SSME FRF-04 SOFTWARE: 83-SSME-0055R6

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 14 OF 33)

STS-14 (MISSION 41-D)

ORBITER: DISCOVERY (OV-103)
OPF FLOW INITIATION: DNA
OPF SSME PROCESSING TIME: DNA - FRF TURNAROUND
ROLLOUTS: OPF 05-12-84 VAB 05-19-84
● ABORT: KSC 06-26-84 08:43 EDT SSME'S 2109(1), 2018(2), AND 2017(3)
POWER LEVEL: 100% SSME FLIGHT SOFTWARE: 84-SSME-00635

PAYLOAD:	PRIMARY	SECONDARY
	OSTA-1, LFC TELESAT-1, SYNCOM IV-1	CFES III, IMAX, RME, C-360b, SSIP (1)

ROLLBACK: PAD 07-14-84 VAB 07-16-84
ROLLOUT: OPF 08-02-84 PAD 08-09-84
● LAUNCH: KSC 08-30-84 08:42 EDT
SSME'S: 2109(1), 2018(2), AND 2021(3)
SSME POWER LEVEL: 104%
SSME FLIGHT SOFTWARE: 84-SSME-0063R8

PAYLOAD:	PRIMARY	SECONDARY
	OSTA-1, SBS-D TELSTAR 3-C, SYNCOM IV-2	CFES III, IMAX, RME, SSIP (1), CLOUDS

ASTRONAUTS: COMMANDER: HENRY HARTSFIELD PILOT: MICHAEL COATS
MISSION SPECIALISTS: JUDITH RESNIK, STEVEN HAWLEY, RICHARD MULLANE
PAYLOAD SPECIALIST: CHARLES WALKER
● LANDING: EAFB 09-05-84 06:37 PST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 20 HOURS 27 MINUTES
DFRF PROCESSING TIME - 4 DAYS
DISCOVERY PREVIOUS MISSIONS: NONE

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 15 OF 33)

STS-17 (MISSION 41-G)

ORBITER: CHALLENGER (OV-099)

SSME INSTALLATION: 07-20-84 (SSME'S 2020 AND 2023)

ROLLOUTS: OPF 04-23-84 VAB 09-09-84

• LAUNCH: KSC 10-05-84 07:03 EDT

SSME'S: 2023(1), 2020(2), AND 2021(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 84-SSME-0065R5

PAYLOAD:

PRIMARY	SECONDARY
ERBS, OSTA-3 LFC, ORS	IMAX, RME, GAS (8), TLD, APE, CANEX

ASTRONAUTS: COMMANDER: ROBERT CRIPPEN PILOT: JON MCBRIDE
MISSION SPECIALISTS: KATHRYN SULLIVAN, SALLY RIDE, DAVID LEESTMA
PAYLOAD SPECIALISTS: MARC GARNEAU (CANADA) PAUL SCULLY-POWER

• LANDING: KSC 10-13-84 12:26 EDT
HPFTP BEARING PURGES INITIATED - LANDING PLUS 50 HOURS 44 MINUTES

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, STS-8, STS-11, AND STS-13 (04-06-84)

STS-13 SSME'S: 2109(1), 2020(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 16 OF 33)

STS-19 (MISSION 51-A)

ORBITER: DISCOVERY (OV-103)

OPF FLOW INITIATION: 09-14-84

OPF SSME PROCESSING TIME: 38 SHIFTS

ROLLOUTS: OPF 10-18-84 VAB 10-23-84

● LAUNCH: SCRUB 11-07-84 KSC 11-08-84

SSME'S: 2109(1), 2018(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 84-SSME-0067R5

PAYLOAD:

PRIMARY
TELESAT-H, SYNCOM IV-1,
PALAPA B-2 RETRIEVAL HARDWARE
WESTAR VI RETRIEVAL HARDWARE

SECONDARY
MFR, MMU (2), DMOS, RME

ASTRONAUTS: COMMANDER: FREDERICK HAUCK PILOT: DAVID WALKER
MISSION SPECIALISTS: JOSEPH ALLEN, ANNA FISHER,
DALE GARDNER

● LANDING: KSC 11-16-84 07:00 EST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 23 HOURS 45 MINUTES

DISCOVERY PREVIOUS MISSIONS: STS-14 (08-30-84)

STS-14 SSME'S: 2109(1), 2018(2), AND 2021(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 17 OF 33)

STS-20 (MISSION 51-C)

ORBITER: DISCOVERY (OV-103)

OPF FLOW INITIATION: 11-16-84

OPF SSME PROCESSING TIME: 51 SHIFTS

ROLLOUTS: OPF 12-21-84 VAB 01-05-85

● LAUNCH: KSC 01-24-85 14:50 EST

SSME'S: 2109(1), 2018(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 84-SSME-0072R

PAYLOAD: DOD

ASTRONAUTS: COMMANDER: THOMAS MATTINGLY II PILOT: LOREN SHRIVER
MISSION SPECIALISTS: ELLISON ONIZUKA, JAMES BUCHLI
PAYLOAD SPECIALIST: GARY PAYTON

● LANDING: KSC 01-27-85 16:23 EST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 44 HOURS 7 MINUTES

DISCOVERY PREVIOUS MISSIONS: STS-14 AND STS-19 (11-08-84)

STS-19 SSME'S: 2109(1), 2018(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 18 OF 33)

STS-23 (MISSION 51-D)

ORBITER: DISCOVERY (OV-103)

OPF FLOW INITIATION: 01-28-85

OPF SSME PROCESSING TIME: 97 SHIFTS

ROLLOUTS: OPF 03-23-85 VAB 03-28-85

● LAUNCH: KSC 04-12-85 08:59 EST

SSME'S: 2109(1), 2018(2), AND 2012(3)

SSME POWER LEVEL: 100%

SSME FLIGHT SOFTWARE: 84-SSME-0068R3

PAYLOAD:

PRIMARY	SECONDARY
TELESAT I	CFES, AFE, PPE/SAS,
SYNCOM IV-3	SSIP (2), GAS (2)

ASTRONAUTS: COMMANDER: KAROL BOBKO PILOT: DONALD WILLIAMS
MISSION SPECIALISTS: MARGARET SEDDON, JEFFREY HOFFMAN, DAVID GRIGGS
PAYLOAD SPECIALISTS: CHARLES WALKER, JAKE GARN

● LANDING: KSC 04-19-85 08:54 EST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 40 HOURS 31 MINUTES

DISCOVERY PREVIOUS MISSIONS: STS-14, STS-19, AND STS-20 (01-24-85)

STS-20 SSME'S: 2109(1), 2018(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 19 OF 33)

STS-24 (MISSION 51-B)

ORBITER: CHALLENGER (OV-099)

OPF FLOW INITIATION: 10-13-84

OPF SSME PROCESSING TIME: 60 SHIFTS

ROLLOUTS: OPF 03-07-85 VAB 04-10-85

● LAUNCH: KSC 04-29-85 12:02 EDT

SSME'S: 2023(1), 2020(2), AND 2021(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0081

PAYLOAD:	PRIMARY	SECONDARY
	SPACELAB 3	GAS (2)

ASTRONAUTS: COMMANDER: ROBERT OVERMYER PILOT: FREDERICK GREGORY
MISSION SPECIALISTS: DON LIND, NORMAN THAGARD, WILLIAM THORNTON
PAYLOAD SPECIALISTS: LODWEIJK VAN DEN BERG, TAYLOR WANG

● LANDING: EAFB 05-06-85 09:11 PDT
HPFTP BEARING PURGES INITIATED - LANDING PLUS 38 HOURS 4 MINUTES

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, STS-8, STS-11, STS-13, AND STS-17 (10-05-84)

STS-17 SSME'S: 2023(1), 2020(2), AND 2021(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 20 OF 33)

STS-25 (MISSION 51-G)

ORBITER: DISCOVERY (OV-103)

OPF FLOW INITIATION: 04-19-85

OPF SSME PROCESSING TIME: 64 SHIFTS

ROLLOUTS: OPF 05-28-85 VAB 06-04-85

● LAUNCH: KSC 06-17-85 07:33 EDT

SSME'S: 2109(1), 2018(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0083

PAYLOAD:

PRIMARY	SECONDARY
SPARTAN-I	FPE
MORELOS-A	FEE
ARABSAT-IB	ADSF
TELSTAR 3-D	GAS (6)

ASTRONAUTS: COMMANDER: DANIEL BRANDENSTEIN PILOT: JOHN CREIGHTON
MISSION SPECIALISTS: SHANNON LUCID, STEVEN NAGEL, JOHN FABIAN
PAYLOAD SPECIALISTS: PATRICK BAUDRY (FRANCE), SULTAN SALMAN AL-SAUD (SAUDI ARABIA)

● LANDING: EAFB 06-24-85 06:14 PDT
HPFTP BEARING PURGES INITIATED - LANDING PLUS 20 HOURS 21 MINUTES

DISCOVERY PREVIOUS MISSIONS: STS-14, STS-19, AND STS-23 (04-12-85)

STS-23 SSME'S: 2109(1), 2018(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 21 OF 33)

STS-26 (MISSION 51-F)

ORBITER: CHALLENGER (OV-099)

OPF FLOW INITIATION: 05-11-85

OPF SSME PROCESSING TIME: 92 SHIFTS

ROLLOUTS: OPF 06-24-85 VAB 06-29-85

● ABORT: KSC 07-12-85 06:30 EDT

SSME'S: 2023(1), 2020(2), AND 2021(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0084R4

PAYLOAD: PRIMARY — SECONDARY
SPACELAB-2

ASTRONAUTS: COMMANDER: C. GORDON FULLERTON PILOT: ROY BRIDGES
MISSION SPECIALISTS: STORY MUSGRAVE, ANTHONY ENGLAND, KARL HENIZE
PAYLOAD SPECIALISTS: LOREN ACTON, JOHN-DAVID BARTOE

● LAUNCH: KSC 07-29-85

SSME'S: 2023(1), 2020(2), AND 2021(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0084R11

● LANDING: EAFB 08-06-85 12:45 PDT
HPFTP BEARING PURGES INITIATED - LANDING PLUS 23 HOURS 45 MINUTES
DFRF PROCESSING TIME - 4 DAYS

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, STS-8, STS-11, STS-13, STS-17, AND STS-24 (04-29-85)

STS-24 SSME'S: 2023(1), 2020(2), AND 2021(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 22 OF 33)

STS-27 (MISSION 51-I)

ORBITER: DISCOVERY (OV-103)

OPF FLOW INITIATION: 06-29-85

OPF SSME PROCESSING TIME: 70 SHIFTS

ROLLOUTS: OPF 07-30-85 VAB 08-06-85

● LAUNCH: KSC 08-27-85 06:58 EDT

SSME'S: 2109(1), 2018(2), AND 2012(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0088

PAYLOAD:

PRIMARY	SECONDARY
ASC-1	PVOTS
AUSAT-1	
LEASAT IV-F4	

ASTRONAUTS: COMMANDER: JOE ENGLE PILOT: RICHARD COVEY
MISSION SPECIALISTS: WILLIAM FISHER, JAMES VAN HOFTEN, MIKE LOUNGE

● LANDING: EAFB 09-03-85 06:16 PDT
HPFTP BEARING PURGES INITIATED - LANDING PLUS 19 HOURS 44 MINUTES

DISCOVERY PREVIOUS MISSIONS: STS-14, STS-19, STS-20, STS-23, AND STS-25 (06-17-85)

STS-25 SSME'S: 2109(1), 2018(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 23 OF 33)

FRF-05

ORBITER: ATLANTIS (OV-104)

SSME INSTALLATION: 06-11-85, 06-12-85, AND 06-13-85

ROLLOUTS: OPF 08-09-85 VAB 08-30-85

- FRF-05: 09-12-85

SSME'S: 2011(1), 2019(2), AND 2017(3)

SSME POWER LEVEL: 100%

SSME FRF-05 SOFTWARE: 85-SSME-0086R6

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 24 OF 33)

STS-28 (MISSION 51-J)

ORBITER: ATLANTIS (OV-104)

OPF FLOW INITIATION: DNA - FRF TURNAROUND

OPF SSME PROCESSING TIME: DNA - FRF TURNAROUND

ROLLOUTS: OPF 08-09-85 VAB 08-30-85

● LAUNCH: KSC 10-03-85 11:15 EDT

SSME'S: 2011(1), 2019(2), AND 2017(3)

SSME POWER LEVEL: CLASSIFIED

SSME FLIGHT SOFTWARE: 85-SSME-0087R4

PAYLOAD: PRIMARY — DOD (CLASSIFIED); SECONDARY

ASTRONAUTS: COMMANDER: KAROL BOBKO PILOT: RONALD GRABE
MISSION SPECIALISTS: ROBERT STEWART, DAVID HILMERS
PAYLOAD SPECIALIST: WILLIAM PAILES

● LANDING: EAFB 10-07-85 10:00 PDT
HPFTP BEARING PURGES INITIATED - LANDING PLUS 15 HOURS 30 MINUTES

ATLANTIS PREVIOUS MISSIONS: NONE

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 25 OF 33)

STS-30 (MISSION 61-A)

ORBITER: CHALLENGER (OV-099)

OPF FLOW INITIATION: 08-12-85

OPF SSME PROCESSING TIME: 102 SHIFTS

ROLLOUTS: OPF 10-12-85 VAB 10-16-85

● LAUNCH: KSC 10-30-85 12:00 EST

SSME'S: 2023(1), 2020(2), AND 2021(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0092R6

PAYLOAD: PRIMARY — SPACELAB D-1 — SECONDARY

ASTRONAUTS: COMMANDER: HENRY HARTSFIELD PILOT: STEVEN NAGEL
MISSION SPECIALISTS: JAMES BUCHLI, BONNIE DUNBAR, GUION BLUFORD
PAYLOAD SPECIALISTS: WUBBO OCKELS (NETHERLANDS), ERNST MESSERSCHMID (W. GERMANY), REINHARD FURRER (W. GERMANY)

● LANDING: EAFB 11-06-85 09:44 PST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 22 HOURS 16 MINUTES

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, STS-8, STS-11, STS-13, STS-17, STS-24, AND STS-26 (07-29-85)

STS-26 SSME'S: 2023(1), 2020(2), AND 2021(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 26 OF 33)

STS-31 (MISSION 61-B)

ORBITER: ATLANTIS (OV-104)

OPF FLOW INITIATION: 10-12-85

OPF SSME PROCESSING TIME: 58 SHIFTS

ROLLOUTS: OPF 11-08-85 VAB 11-12-85

● LAUNCH: KSC 11-26-85 19:30 EST

SSME'S: 2011(1), 2019(2), AND 2017(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 85-SSME-0094R3

PAYLOAD:

PRIMARY	SECONDARY
EASE/ACCESS	
MORELOS B	
SATCOM KU-2	
AUSSOT	

ASTRONAUTS: COMMANDER: BREWSTER SHAW PILOT: BRYAN O'CONNOR
MISSION SPECIALISTS: MARY CLEAVE, SHERWOOD SPRING.
JERRY ROSS
PAYLOAD SPECIALISTS: CHARLES WALKER, RODOLFO NERI VELA (MEXICO)

● LANDING: EAFB 12-03-85 13:34 PST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 23 HOURS 57 MINUTES

ATLANTIS PREVIOUS MISSIONS: STS-28 (10-03-85)

STS-28 SSME'S: 2011(1), 2019(2), AND 2017(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 27 OF 33)

STS-32 (MISSION 61-C)

ORBITER: COLUMBIA (OV-102)

OPF FLOW INITIATION: 10-28-85

OPF SSME PROCESSING TIME: 65 SHIFTS

ROLLOUTS: OPF 11-22-85 VAB 12-02-85

● LAUNCH: KSC 01-12-86 06:55 EST

SSME'S: 2015(1), 2018(2), AND 2109(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 84-SSME-0090R6

PAYLOAD:	PRIMARY	SECONDARY
	SATCOM KU-2	MSL-2 GAS BRIDGE

ASTRONAUTS: COMMANDER: ROBERT GIBSON PILOT: CHARLES BOLDEN
MISSION SPECIALISTS: FRANKLIN CHANG-DIAZ, STEVEN HAWLEY, GEORGE NELSON
PAYLOAD SPECIALISTS: ROBERT CENKER, BILL NELSON

● LANDING: EAFB 01-18-86 06:00 PST
HPFTP BEARING PURGES INITIATED - LANDING PLUS 32 HOURS

COLUMBIA PREVIOUS MISSIONS: STS-1, STS-2, STS-3, STS-4, STS-5, AND STS-9 (11-28-83)

STS-9 SSME'S: 2011(1), 2018(2), AND 2019(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 28 OF 33)

STS-33 (MISSION 51-L)

ORBITER: CHALLENGER (OV-099)

OPF FLOW INITIATION: 11-11-85

OPF SSME PROCESSING TIME: 71 SHIFTS

ROLLOUTS: OPF 12-16-85 VAB 12-21-85

● LAUNCH: KSC 01-28-86 11:38 EST

SSME'S: 2023(1), 2020(2), AND 2021(3)

SSME POWER LEVEL: 104%

SSME FLIGHT SOFTWARE: 86-SSME-0104

PAYLOAD:	PRIMARY	SECONDARY
	TDRS-B SPARTAN	

ASTRONAUTS: COMMANDER: FRANCIS SCOBEE PILOT: MICHAEL SMITH
MISSION SPECIALISTS: JUDITH RESNIK, ELLISON ONIZUKA, RONALD MCNAIR
PAYLOAD SPECIALISTS: GREGORY JARVIS, CHRISTA MCAULIFFE (TEACHER IN SPACE)

● LANDING: ORBITER LOST

CHALLENGER PREVIOUS MISSIONS: STS-6, STS-7, STS-8, STS-11, STS-13, STS-17, STS-24, STS-26, AND STS-30 (10-30-85)

STS-30 SSME'S: 2023(1), 2020(2), AND 2021(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 29 OF 33)

ORBITER: DISCOVERY (OV-103)

SSME INSTALLATION: 01-10-88, 01-24-88, AND 01-26-88

ROLLOUTS: OPF 06-21-88 VAB 07-04-88

- FRF-06: 08-10-88

SSME'S: 2019(1), 2022(2), AND 2028(3)

SSME POWER LEVEL: 100%

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 30 OF 33)

STS-26R

ORBITER: DISCOVERY (OV-103)

OPF SSME PROCESSING TIME: DNA (FRF TURNAROUND)

ROLLOUTS: OPF 06-21-88 VAB 07-04-88

- LAUNCH: KSC 09-29-88 11:37 EDT

SSME'S: 2019(1), 2022(2), AND 2028(3)

SSME POWER LEVEL: 104%

PAYLOAD: TDRS-C

ASTRONAUTS: COMMANDER: FREDRICK HAUCK PILOT: RICHARD COVEY
MISSION SPECIALISTS: GEORGE NELSON, JOHN LOUNGE, DAVID HILMERS

- LANDING: EAFB 10-03-88 09:37 PDT
  HPFTP BEARING PURGE INITIATED - LANDING PLUS 29 HOURS

DISCOVERY PREVIOUS MISSIONS: STS-14, STS-19, STS-20, STS-23, STS-25, AND STS-27

STS-27 SSME'S: 2109(1), 2018(2), AND 2012(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 31 OF 33)

ORBITER: ATLANTIS (OV-104)

OPF PROCESSING TIME: DNA (REFURBISHED ORBITER)

ROLLOUTS: OPF 10-22-88 VAB 11-02-88

● LAUNCH: KSC 12-02-88 09:30 EST

SSME'S: 2027(1), 2030(2), AND 2029(3)

SSME POWER LEVEL: 104%

PAYLOAD: DOD (CLASSIFIED)

ASTRONAUTS: COMMANDER: ROBERT L. GIBSON PILOT: GUY GARDNER
MISSION SPECIALISTS: WILLIAM SHEPHERD, JERRY L. ROSS, RICHARD M. MULLANE

● LANDING: EAFB 12-06-88 15:35 PST
HPFTP BEARING PURGE INITIATED - LANDING PLUS 30 HOURS 25 MINUTES

ATLANTIS PREVIOUS MISSIONS: STS-28 AND STS-31

STS-31 SSME'S: 2011(1), 2019(2), AND 2017(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 32 OF 33)

ORBITER: DISCOVERY (OV-103)

OPF FLOW INITIATION: 10-09-88

ROLLOUTS: OPF 01-23-89 VAB 02-03-89

● LAUNCH: KSC 03-13-89 09:57 EST

SSME'S: 2031(1), 2022(2), AND 2028(3)

SSME POWER LEVEL: 104%

PAYLOAD: TDRS

ASTRONAUTS: COMMANDER: MICHAEL L. COATS PILOT: JOHN E. BLAHA
MISSION SPECIALISTS: JAMES F. BUCHLI, ROBERT C. SPRINGER, JAMES P. BAGIAN

● LANDING: EAFB 03-18-89 06:36 PST
HPFTP BEARING PURGE INITIATED - LANDING PLUS 27 HOURS 44 MINUTES

DISCOVERY PREVIOUS MISSIONS: STS-14, STS-19, STS-20, STS-23, STS-25, STS-27 AND STS-26R

STS-26R SSME'S: 2019(1), 2022(2), AND 2028(3)

FIGURE 5-2. SHUTTLE FRF/STS LAUNCH GENERAL DATA (SHEET 33 OF 33)

NOTES