Rocketdyne
North American Rockwell

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ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC

F-1 ENGINE FAMILIARIZATION

TRAINING MANUAL

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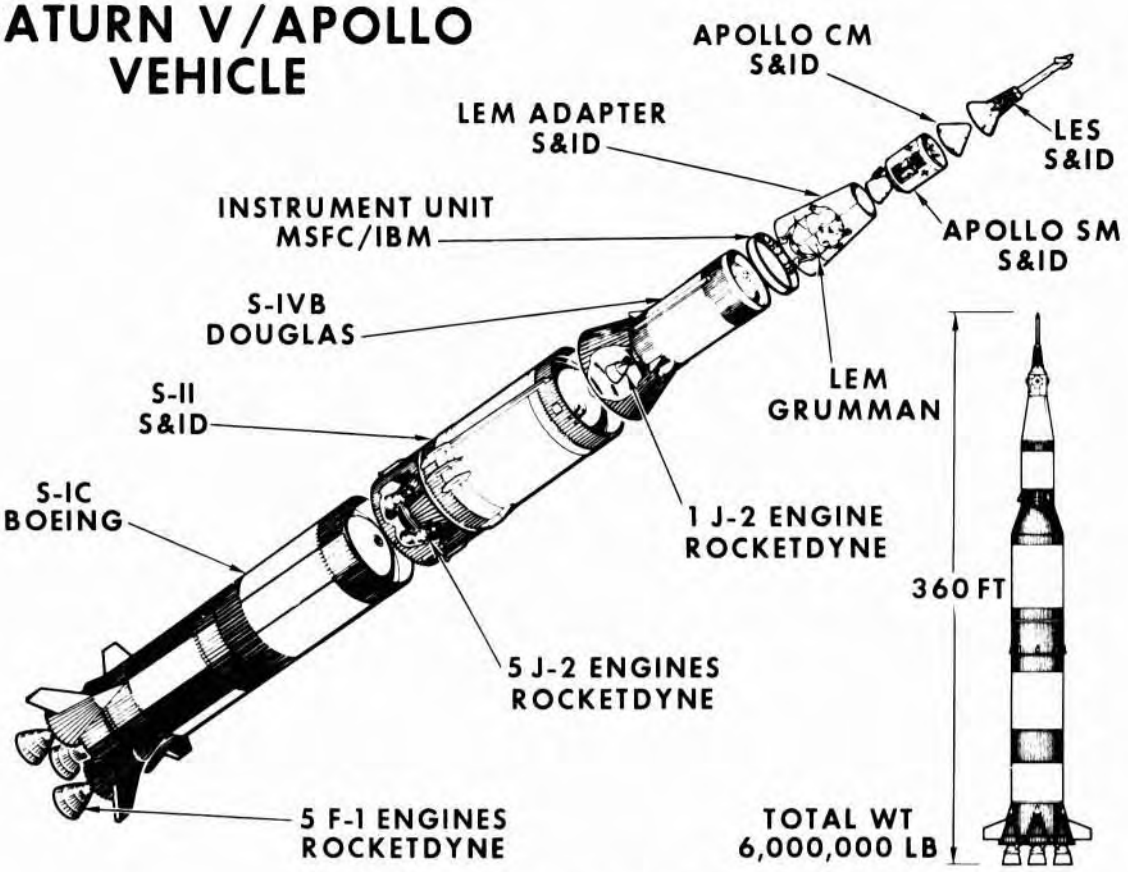
Dept. 580-722

USE THIS DATA FOR
TRAINING PURPOSES ONLY

FORM R 18-G-4

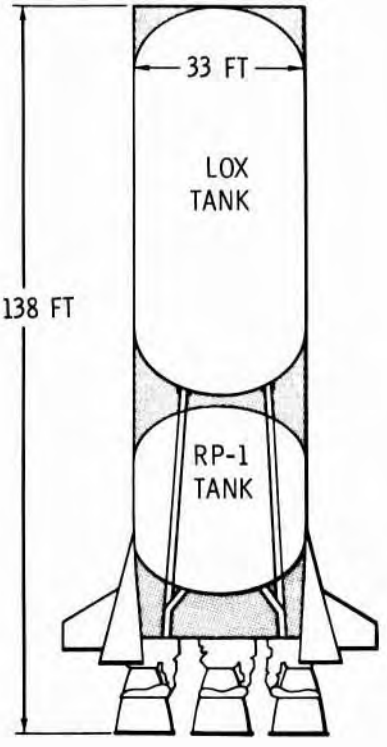
SATURN V/APOLLO VEHICLE

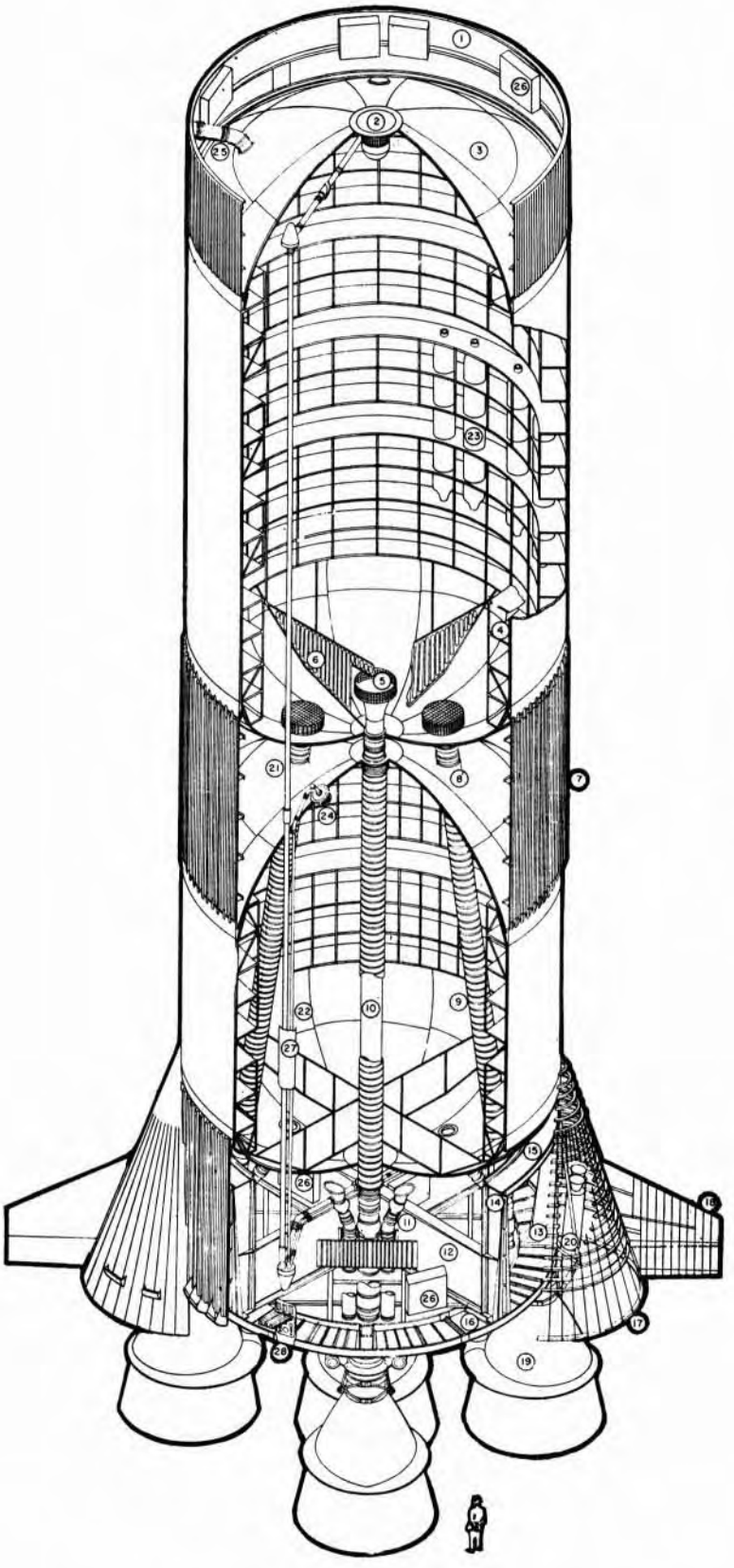


S-IC STAGE

SATURN V, 1ST STAGE

- PRIME CONTRACTOR: BOEING
  ASSEMBLED AT MICHOUD, LA.
- ENGINES: 5 ROCKETDYNE F-1
- THRUST: 7,500,000 LB
  EACH ENGINE: 1.5 MILLION LBS
- BURNING TIME: 150 SEC (2.5 MIN)
- PROPELLANT: 4,400,000 LB
  RP-1 - 206,000 GALS
  LOX - 340,000 GALS
- GROSS WT: 4,800,000 LB
- BURNOUT WT: 425,000 LB
- ALTITUDE: 0-200,000 FT (38 MILES)
- VELOCITY: 0-7,700 FT/SEC (5,460 MPH)





MAJOR COMPONENTS

1. FORWARD SKIRT STRUCTURE
2. GOX DISTRIBUTOR
3. LOX TANK
4. ANTI-SLOSH BAFFLES
5. ANTI-VORTEX DEVICE
6. CRUCIFORM BAFFLE
7. INTERTANK STRUCTURE
8. FUEL TANK
9. SUCTION LINE TUNNELS
10. LOX SUCTION LINES
11. FUEL SUCTION LINES
12. CENTER ENGINE SUPPORT
13. THRUST COLUMN
14. HOLD DOWN POST
15. UPPER THRUST RING
16. LOWER THRUST RING
17. ENGINE FAIRING
18. FIN
19. F-1 ENGINE
20. RETRO ROCKETS
21. GOX LINE
22. HELIUM LINE
23. HELIUM BOTTLES
24. HELIUM DISTRIBUTOR
25. LOX VENT LINE
26. INSTRUMENTATION PANELS
27. CABLE TUNNEL
28. UMBILICAL PANEL

SATURN C-5, S-IC STAGE

SECTION I

DESCRIPTION AND OPERATION

1-1. SCOPE. This section contains a general description of the F-1 propulsion system and a detailed description of each subsystem and component. Engine operation from the preparation phase through and including the engine cutoff phase is defined. Also included, are external inputs necessary for engine operation, typical engine operating parameters, and a description of the flow the engine follows from the time it is accepted by the Customer through Apollo/Saturn V launch.

1-2. F-1 ROCKET ENGINE.

1-3. The F-1 propulsion system was developed to provide the power for the booster flight phase of the Saturn V vehicle. Five engines are clustered in the S-IC stage of the Saturn V to obtain the necessary 7,610,000 pounds thrust.

1-4. The engine features a two-piece thrust chamber that is tubular-walled and regeneratively cooled to the 10:1 expansion ratio plane, and double-walled and turbine gas cooled to the 16:1 expansion ratio plane; a thrust chamber mounted turbopump that has two centrifugal pumps spline-connected on a single shaft driven by a two-stage, direct-driven turbine; one-piece rigid propellant ducts that are used in pairs to direct the fuel and oxidizer to the thrust chamber; and a hypergolic fluid cartridge that is used for thrust chamber ignition.

1-5. The engine is within an envelope 12 feet in diameter and 16 feet long and weighs approximately 18,500 pounds dry. Thrust vector changes are achieved by gimbaling the entire engine. The gimbal block is located on the thrust chamber dome, and actuator attach points are provided by two outriggers on the thrust chamber body.

1-6. Component locations on the engine in the horizontal position are basically referenced to No. 1 (left) (figure 1-1) or No. 2 (right) (figure 1-2) sides of the engine as viewed from the exit end of the thrust chamber with the turbopump at 12 o'clock (top) and the hypergol manifold assembly at 6 o'clock (bottom). Component locations on the engine in the vertical position are referenced to the principal component on the four sides of the engine (eg, gas generator side (No. 1), engine control valve side (No. 2), turbopump side, and hypergol manifold side). A view of the forward end of the engine is shown in figure 1-3.

1-7. ENGINE PHYSICAL DESCRIPTION.

1-8. The F-1 engine is a single-start, fixed-thrust, liquid bipropellant engine, calibrated to develop a sea-level-rated thrust of 1,522,000 pounds with a specific impulse (I_{sp}) of 265.3 seconds. Engine propellants are liquid oxygen and RP-1 fuel at a mixture ratio of 2.27:1. The RP-1 fuel is used as the working fluid for the gimbal actuators and for the engine control system and is also used as the turbopump bearing lubricant. The F-1 engine is comprised of seven operational systems:

(1) A propellant feed system, which supplies pressurized propellants for combustion and hydraulic pressure for the engine control system.

(2) An ignition system, which initiates combustion in the gas generator and the thrust chamber.

(3) A gas generating system, which produces the energy to drive the turbopump and condition propellant tank pressurants.

(4) An engine control system, which regulates the start, operating level, and shutdown of the engine.

(5) A flight instrumentation system, which measures selected engine parameters for monitoring and evaluating the operational characteristics of the engine.

(6) An environmental conditioning system, which protects the engine from extreme temperature environment caused by plume radiation and backflow during flight.

(7) A purge and drain system, which inhibits contamination and facilitates the overboard disposition of expended fluids. Detailed informa- of the engine system and its components are in the following paragraphs. An engine schematic (figure 1-4) and engine parameters (figure 1-5) are included to support the text. Detailed information on engine operation is presented in paragraphs 1-121 through 1-133.

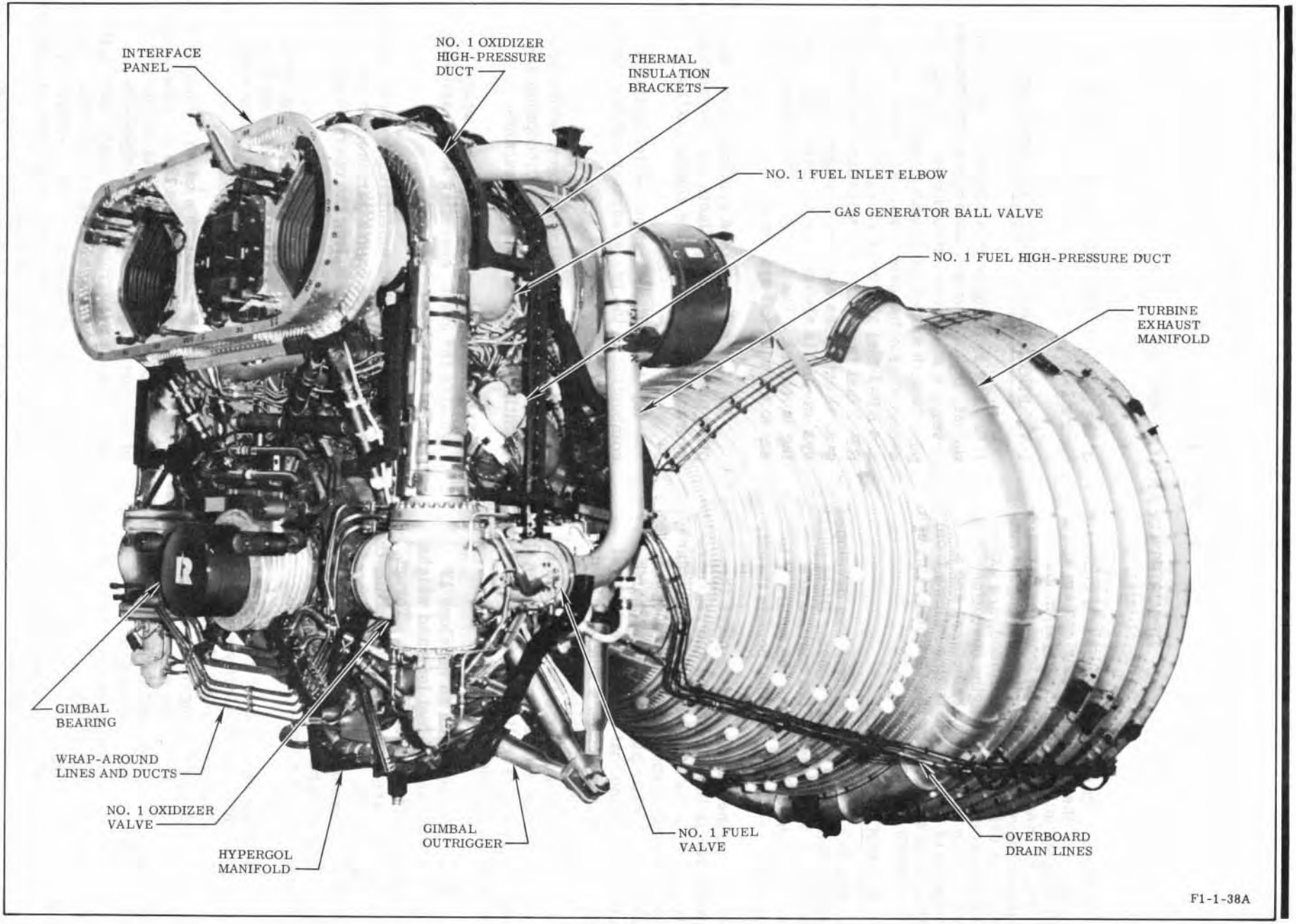


Figure 1-1. F-1 Rocket Engine, Number One Side

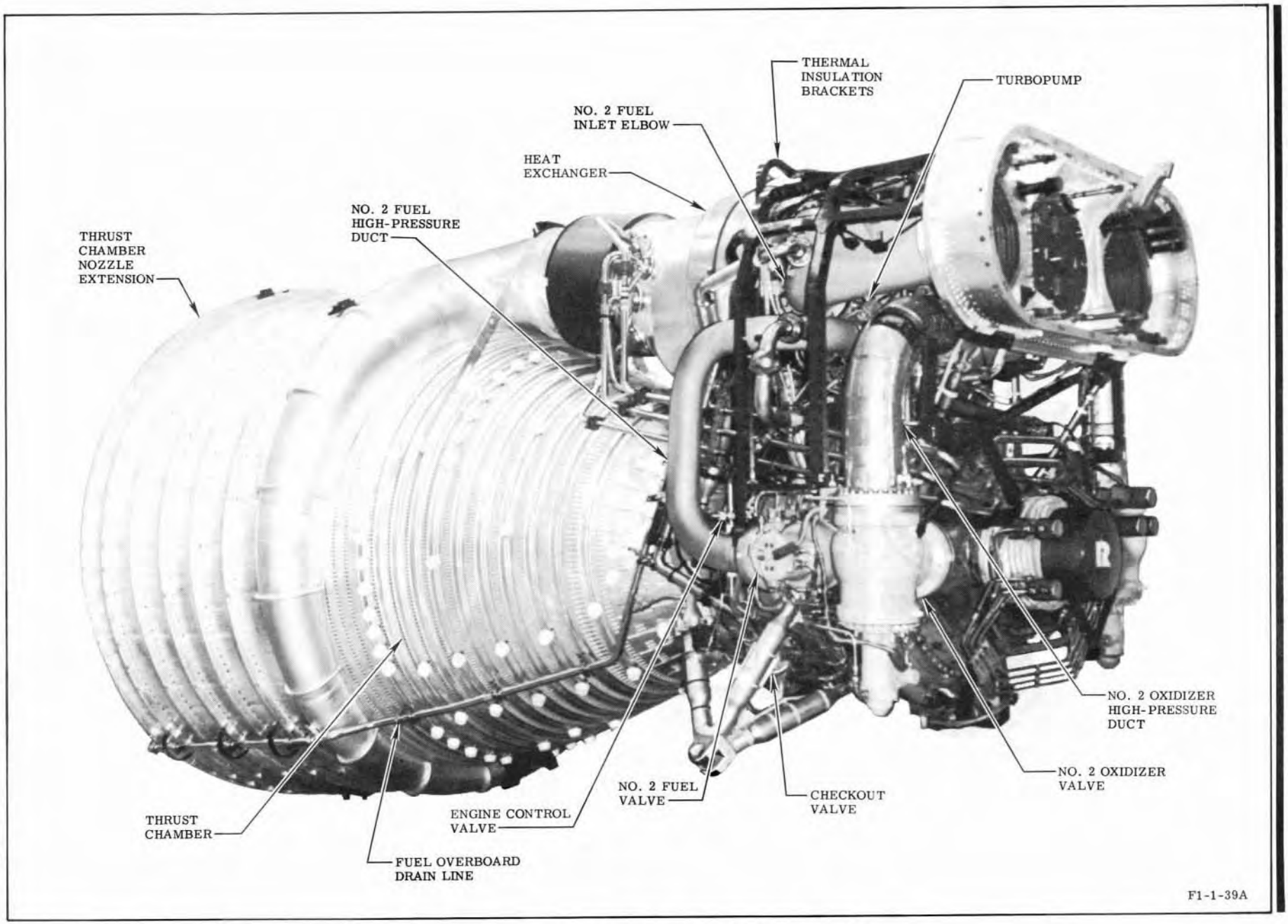


Figure 1-2. F-1 Rocket Engine, Number Two Side