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AIRCRAFT ENGINE INSTALLATION SUBSYSTEM SPECIFICATION

SST

BOEING MODEL 2707

COMMERCIAL SUPERSONIC TRANSPORT PROGRAM

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PHASE II-C REPORT

D6A10113-1

THE BOEING COMPANY
SUPERSONIC TRANSPORT DIVISION

NOTICES

AIRCRAFT ENGINE INSTALLATION SUBSYSTEM SPECIFICATION

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PHASE II-C REPORT
CONTRACT FA-SS-66-5

JUNE 30, 1966

Prepared For
FEDERAL AVIATION AGENCY
Supersonic Transport Development Program

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D6A10113-1

THE BOEING COMPANY
SUPERSONIC TRANSPORT DIVISION

ISSUE NO. 2

SUBSYSTEM SPECIFICATION

PERFORMANCE/DESIGN
AND PRODUCT CONFIRMATION REQUIREMENTS

AIRCRAFT ENGINE INSTALLATION
SUBSYSTEM SPECIFICATION
SUPERSONIC TRANSPORT AIRCRAFT
BOEING MODEL 2707

JUNE 30, 1966

REVISION RECORD

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1.0 SCOPE

1.1 PERFORMANCE. This specification establishes the requirements for performance, design, test and qualification for the Aircraft Engine Installation Subsystem. The subsystem is used to provide the total propulsive power required by the airplane for accomplishing its intended functions. The subsystem is also used to provide mechanical and pneumatic power for supporting airframe accessory, environmental and air inlet subsystems. The subsystem requires fuel, air flow, electrical and airframe support and control inputs for its operation. These are provided by the airframe fuel, air inlet, air inlet control, electrical, flight control, and airframe structure subsystems.

2.0 APPLICABLE DOCUMENTS

2.1 FEDERAL AND MILITARY. The following documents of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detailed content of Sections 3 and 4, the detailed requirements of Sections 3 and 4 shall supersede.

SPECIFICATIONS

Federal

FAR 25	1 February 1965	Federal Aviation Regulations, Part 25, Airworthiness Standards: Transport Category Airplanes

Military

MIL-STD-210A		Military Standard - Climatic Extremes for Military Equipment
MIL-E-5272C	2 January 1960	Environmental Testing, Aeronautical and Associated Equipment, General Specification, Amendment 1

2.2 OTHER PUBLICATIONS. The following documents form a part of this specification to the extent specified herein. In the event of conflict between documents referenced herein and other detailed content of Sections 3 and 4, the detailed requirements of 3 and 4 shall supersede.

Boeing Documents

D6A10107-1	Airframe Subsystem Specification
D6A10109-1	Flight Deck Subsystem Specification
D6A10089-1	Accessory Drive Subsystem Specification
D6A10111-1	Propulsion Performance Subsystem Specification (GE)
D6A10112-1	Propulsion Performance Subsystem Specification (P&WA)
D6A10114-1	Air Induction Subsystem Specification
D6A10115-1	Fire Detection - Extinguishing Subsystem Specification

SPECIFICATIONS (Cont.)

Boeing Documents (Cont.)

D6A10116-1	Fuel Subsystem Specification
D6A10118-1	Air Induction Control Subsystem Specification
D6A10117-1	Inlet Anti-Icing Subsystem Specification
D6A10121-1	Environmental Control Subsystem Specification
D6A10178-1	Starting Subsystem Specification
D6A10198-1	Engine-Airframe Technical Agreement (GE)
D6A10199-1	Engine-Airframe Technical Agreement (P&WA)
D6A10119-1	Electrical Power Subsystem Specification
D6A10120-1	Flight Control and Hydraulic Subsystem Specification

3.0 REQUIREMENTS

3.1 CHARACTERISTICS. The Engine Installation Subsystem performance shall be obtained by meeting functional and performance design characteristics as follows:

3.1.1 Functional Characteristics. The Engine Installation Subsystem shall generate, control and translate thrust to the airplane. In addition, the subsystem shall provide for:

a. Reversing thrust to decelerate the airplane.

b. Transmitting engine generated mechanical power to the airplane accessory drive and air inlet hydraulic control subsystems.

c. Transmitting engine generated pneumatic power to the airplane environmental control, air inlet anti-icing and engine cross starting systems.

d. Provide mounting support for the engine assembly including the exhaust nozzle and thrust reverser, the exterior fairings and the air inlet.

e. Provide for integration with the airframe fuel and air inlet subsystems to support power generation.

3.1.1.1 Subsystem Performance Characteristics. The Engine Installation Subsystem shall be designed to generate power from four independently mounted, operated and controlled engine installations. Each of the independent installations shall be designed to:

a. Transmit flight deck control commands to the engine.

b. Transmit indication of subsystem operation to the flight deck.

c. Support and enclose the basic engine nozzle to provide essentially zero internal losses and only external skin, wetted area, drag while the airplane is in flight.

d. Contribute a favorable position pressure at M=2.7 to the Horizontal Stabilizer lower surface.

e. Support the inlet below the wing boundary layer air and point the air inlet directly into the incoming flow field within 1/2°.

f. Insure protection and isolation to prevent an inlet unstart in one pod causing unstart in the adjacent pod.

g. Provide for safe and reliable performance.

3.1.1.1.1 For Boeing Model 2707 (GE). The subsystem component elements and performance characteristics which meet the subsystem functions shall be as follows:

3.1.1.1.1.1 Engine. The Engine Installation Subsystem shall incorporate at each of the four engine locations, a turbojet engine in accordance with Boeing Document D6A10198-1, Engine-Airframe Technical Agreement. The subsystem shall be capable of satisfying the following power requirements:

a. Propulsive. The subsystem shall provide propulsive thrust to satisfy aircraft flight performance as defined in D6A10111-1, Propulsion Performance Subsystem Specification.

b. Mechanical. Each of the individual engine installations shall provide mechanical power which satisfies the requirements as defined in D6A10198-1, Engine-Airframe Technical Agreement, for driving an aircraft accessory drive subsystem (Ref. D6A10089-1), and hydraulic pumps for the air inlet control subsystem (Ref. D6A10118-1).

c. Engine Bleed Air. Each of the individual engine installations shall provide pneumatic power to satisfy requirements as specified in D6A10198-1, Engine-Airframe Technical Agreement, for support of aircraft environmental control (Ref. D6A10121-1), engine inlet anti-icing (Ref. D6A10117-1) and engine starting (Ref. D6A10078-1).

3.1.1.1.2 For Boeing Model 2707 (P&WA). The subsystem component elements and performance characteristics shall be as follows:

3.1.1.1.2.1 Engine. The Engine Installation Subsystem shall incorporate a turbofan engine as defined in Boeing Document D6A10199-1. The subsystem shall be capable of satisfying the following power requirements:

a. Propulsive. The subsystem shall provide propulsive thrust to satisfy aircraft flight performance as defined in D6A10112-1, Propulsion Performance Subsystem Specification.

b. Mechanical. Each of the individual engine installations shall provide mechanical power which satisfies the requirements as defined in D6A10199-1, Engine-Airframe Technical Agreement, for driving an aircraft accessory drive system (Ref. D6A10089-1), and hydraulic pumps for the air inlet control system (Ref. D6A10118-1).

c. Engine Bleed Air. Each of the individual engine installations shall provide pneumatic power to satisfy requirements as specified in D6A10199-1, Engine-Airframe Technical Agreement, for support of aircraft environmental control (Ref. D6A10121-1), engine air inlet anti-icing (Ref. D6A10117-1), and engine starting (Ref. D6A10078-1).

3.1.1.1.3 Controls. Engine controls shall include thrust control and windmill brake control as follows:

3.1.1.1.3.1 Thrust Control. The Engine Installation shall provide for control of engine control units in response to power setting and reverse positioning signals transmitted from the flight deck, as defined in D6A10109-1, Flight Deck Subsystem Specification and in D6A10120-1, Flight Controls and Hydraulic Subsystem Specification.

3.1.1.1.3.2 Windmill Brake. Means shall be provided to break the rotor speed of an engine shutdown in flight to rpm below free windmilling speed.

3.1.1.1.4 Exhaust Nozzle-Thrust Reverser. The Exhaust Nozzle-Thrust Reverser shall be provided with the engine as defined in D6A10198-1 (GE), and D6A10199-1 (P&WA) Engine-Airframe Technical Agreements. Design of the system shall provide for exhaust gases to be discharged in a pattern to minimize impingement on airplane structure and control surfaces. Ingestion of reverse exhaust gases into an engine inlet shall not cause engine surge or stall above an airplane speed of 60 knots TAS at maximum reverse power and with 90° crosswind velocities of 30 knots. The net effective reverse thrust, discounting ram drag, shall be at least 50 percent maximum forward dry thrust, per the Engine-Airframe Technical Agreement.

3.1.1.1.5 Engine Mounts and Fittings. The engine mounting system shall provide support for the entire pod, consisting of the air inlet, the engine cowling and the complete engine assembly, including the exhaust nozzle-thrust reverser. The mounting system shall provide for transfer of engine thrust and engine loads to the airframe. It shall:

a. React to all engine thrust loads in either forward or reverse directions, and also react to pod vertical and side loads.

b. Permit expansion caused by thermal changes.

c. React to seizure loads caused by sudden engine stoppage, as defined in FAR 25, Par. 25.361.

3.1.1.1.5.1 For Boeing Model 2707 (GE). The engine mounting system shall be designed to withstand the loads as specified in D6A10198-1, Engine-Airframe Technical Agreement.

3.1.1.1.5.2 For Boeing Model 2707 (P&WA). The engine mounting system shall be designed to withstand the loads as specified in D6A10199-1, Engine-Airframe Technical Agreement.

3.1.1.1.6 Cowling. The cowling shall provide an aerodynamic fairing which encloses the engine and the engine installation components. The cowl panels enclosing the engine shall withstand a working differential pressure of 3 psi. Cowl latches shall be capable of supporting the maximum cowl loads occurring during flight.

3.1.1.1.7 Engine Bleed Air. The engine shall provide for extraction of bleed air to support the pneumatic requirements of the aircraft environmental control and air inlet anti-icing subsystems. The bleed air equipment shall be capable of supplying the pneumatic requirements over the entire operating range of the airplane. The engine bleed air system will prevent a backflow of bleed air from operating engines to a non-operating engine or from engines operating at higher power settings to engines at lower power settings.

3.1.1.1.8 Instrumentation. Instruments and sensors shall be provided to allow monitoring the Engine Installation operation throughout the airplane flight mission. The instrumentation system shall meet the requirements of Far, Par. 25.1305, and the Flight Deck Subsystem Specification D6A10109-1.

3.1.1.1.9 Fire Protection. Fire protection features shall be provided to isolate combustible material from ignition sources and to confine fires within the engine pod. The subsystem shall provide means for detecting fire and for extinguishing engine fires. Bromotrifluomethane fire extinguishing agent shall be supplied and controlled by the fire extinguishing subsystem, Ref. D6A10115-1.

3.1.1.1.10 Engine Starting. Engine ground starting shall be furnished by the starting subsystem as defined in D6A10078-1. Inflight starting shall normally be accomplished without using starter assist.

3.1.2 Operability. The reliability and maintainability allocations of the operability requirements defined below have been accomplished by analysis and experience and may be revised as long as the overall aircraft requirements as specified in Par. 3.1.2 of D6A10107-1 are satisfied. For definition of terms used, refer to 3.1.2 of D6A10107-1.

3.1.2.1 Reliability The aircraft engine installation subsystem shall be designed to achieve the following:

The maximum number of inflight turnbacks or deviations from the intended destination as a result of malfunction in the aircraft engine installation subsystem shall not exceed 35 per 100,000 flights. (See the engine contractor specification for engine reliability values).

For reliability purposes, the term "flight" is interpreted to mean a nominal SST supersonic flight of 1.75 hours duration. Normal maintenance of the system is assumed.

3.1.2.2 Maintainability. The design of the engine installation shall:

a. Minimize the need for maintenance.

b. Facilitate the accomplishment of essential maintenance.

c. Reduce the cost of maintenance and support.

3.1.2.2 (Cont.)

d. Require no more than a mean expenditure of 1,620 direct maintenance manhours per 1,000 flight hours on and off the airplane, not including servicing of consumables, based on an average flight length of 1.75 hours. (See the engine contractor specification for engine maintenance manhour requirements.)

3.1.2.2.1 Maintenance Repair Cycle. The scheduled checks and the time goals for these checks are as follows: (All servicing and scheduled inspection will be fitted within one of these cycles.)

Scheduled Checks	Time Intervals	Elapsed Time
Transit	As required	1/2 hour
Turnaround	As required	1-1/2 hours
Daily Check	50 flight hours	1 hour
Intermediate Check	300 flight hours	4 hours
Periodic Check	1,700 flight hours	16 hours
Basic Check	8,400 flight hours	5 days

3.1.2.2.1.1 Component Removal. There shall be no scheduled removal of engine installation components except for the basic engine. Components will be removed only for wear-out or failure that cannot be corrected by minor adjustment.

3.1.2.2.2 Servicing and Access. The following features shall be provided in the Engine Installation Design:

a. Subsystem and component assemblies shall be readily accessible to the maintenance technician for the purpose of fault isolation, calibration, adjustment, servicing, and replacement. In all cases, accessibility provisions shall allow for efficient maintenance under the expected climactic extremes.

b. Servicing shall be accomplished without removing structural access doors or panels.

c. All servicing points shall be accessible from the underside of the aircraft.

d. Designs shall emphasize minimum requirements for ground equipment.

3.1.2.2.2 (Cont.)

e. Maintenance shall be within the skill levels of maintenance personnel trained for subsonic jet aircraft.

f. Access to engine accessory systems and components shall be provided for by cowl panels which can be opened or removed. Access doors in the cowl panels shall provide for access to those components requiring periodic servicing or inspection, such as fuel and oil filters, oil tanks, fuel control adjustment, etc. Provisions which allow for quick opening of access doors and panels will be incorporated.

3.1.2.3 Useful Life. The installation shall be designed to have a useful life of 10,000 hours with normal maintenance and inspection.

3.1.2.4 Environmental. The Engine Installation Subsystem shall function reliably and safely in all natural and induced environments associated with the operational requirements as defined in D6A10107-1. Equipments installed within the engine accessory compartments shall be capable of satisfactory operation within the temperature range of -50°F to 600°F.

3.1.2.5 Human Performance. Controls and instruments located in the flight deck shall provide remote control and monitoring for the Engine Installation during engine operation and checkout.

3.1.2.6 Safety. The subsystem shall be designed to include safety features which will minimize potentially hazardous conditions to the airplane and personnel in flight and on the ground.

3.1.2.6.1 Flight Safety. As a design objective, isolation of engine installations and arrangement of component systems, including engine controls, shall be such as to prevent any one mechanical, electrical, pneumatic, or hydraulic failure of any one engine installation from affecting any other engine adversely. The arrangement shall provide maximum protection for the airplane from subsystem malfunctions, breakdowns, fires or engine stoppage. The following safety features and design considerations will be included in the design of the Engine Installation Subsystem:

a. Warning devices and procedures shall provide timely indications so that failures will be detected and corrective action taken before conditions become hazardous.

b. Mechanical position feedback and safety interlocks shall be provided to prevent unsafe operation of the thrust reverser system (Ref. FAR 25, Par. 25.1155). Means shall be provided to reduce engine thrust to the interlock limit if the reverser moves from the flight deck thrust level command position.

c. The mount system shall be adequate to prevent separation of an engine from the airplane under all probable conditions of engine failure, extreme flight maneuvers, or engine fires. In the unlikely event of an engine separating from the airplane, the separation shall not cause structural damage to the primary structure or rupture a fuel tank.

3.1.2.6.1 (Cont.)

d. Isolation of the engines from the airplane shall be complete so that airplane safety will not be jeopardized by an engine pod fire.

e. An isolation firewall shall be installed between the engine pod and the horizontal stabilizer capable of withstanding flame at 2000°F for 15 minutes. Service penetrations through the firewall shall be sealed to maintain firewall integrity.

f. Provisions shall be made (Ref. FAR 25) for detecting fire conditions and for extinguishing engine fires.

g. The engine installation design shall prevent any contained failure conditions more adverse to the airplane than complete power loss in one engine.

h. Relief panels shall be provided in the cowling to protect against cowl overpressure and overtemperature.

i. The main fuel components of the engines shall be located as high as possible on the side of the engine, for safety in an emergency, wheels up, landing.

3.1.2.6.2 Ground Safety. Means shall be provided to assure adequate protection of the Engine Installation Subsystem during maintenance and other ground operations. Subsystem design shall allow for use of existing ground support fire extinguishing equipment. The cowling shall be designed to allow insertion of a ground fire extinguisher nozzle to discharge a fire extinguisher agent into the engine fire zone. Suitable external markings on each pod shall define the turbine wheel plane area of avoidance while the engine is operating. In addition, the requirements of Par. 3.1.2.6.1 are applicable to ground safety.

3.1.2.6.3 Personnel Safety. The Engine Installation Subsystem shall include provisions to reduce potential danger to personnel working on or in the vicinity of the engine installation. Protection of persomnel is provided through use of adequate supports for open cowl panels and suitable markings to warn personnel of the hazardous areas or conditions.

3.2 SUBSYSTEM DEFINITION

3.2.1 Interface Requirements. The engine installation subsystem interface requirements occur between the engine manufacturer's engine and the airframe manufacturer's subsystems. Adjoining subsystems of the airframe manufacturer also have interface requirements. The engine manufacturer shall be responsible for dimensional accuracy and quality control in manufacture of the engine and all engine furnished components up to the point of attachment to the airplane supplied equipment. Interface requirements shall be coordinated and firmly established to insure interface compatibility.

3.2.1.1 Schematic Arrangement. The engine installation interfaces with airframe subsystems as shown in Fig. 1.

3.2.1.2 Detailed Interface Definition. Table I provides individual interfaces existing for the engine, and engine installation subsystems.

3.2.2 Component Identification. Subsystem components shall be designated Government Furnished or Contractor Furnished.

3.2.2.1 Government Furnished Property. The following are listed as GFP:

3.2.2.1.1 Engine and Engine Accessories. The basic engine consists of the compressor, combustor, turbine, augmentor, and the variable area exhaust nozzle and thrust reverser. The engine assembly includes the basic engine and component system as defined in Ref. D6A10198-1 (GE) and D6A10199-1 (P&WA) Engine-Airframe Technical Agreements, including the following:

a. Engine exhaust nozzle-thrust reverser.

b. Engine windmill brake.

c. Secondary air nozzle cooling system.

d. Engine lubrication system.

e. Engine fuel system.

f. Engine ignition system.

g. Engine controls.

h. Engine power take-off.

i. Engine drain system.

3.2.2.1.1.1 Exhaust Nozzle-Thrust Reverser. The exhaust-nozzle thrust reverser subassembly consists of the augmentor case, the variable nozzle, the thrust reverser and the exterior cowling to continue the aerodynamic pod shape from the aft end of the engine cowl panels to the nozzle exit.

3.2.2.2 Contractor Furnished Property. The following installations are listed as CFP:

a. Engine mounts and fittings.

b. Cowling.

c. Bleed air equipment.

d. Anti-icing ducting.

e. Instrumentation.

f. Fire protection.

3.2.2.2 (Cont.)

g. Plumbing.

h. Wiring system.

i. Pod drain system.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Subsystem Design Features. The Aircraft Engine Installation Subsystem consists of four separate propulsion pods, two on each side of the airplane and mounted on the lower horizontal stabilizer surface. The subsystem design allows for independent operation and control of each of the propulsion pods. Each pod installation (see Figs. 3 and 4) contains a complete engine build-up assembly having components which serve the engine, airframe and the air inlet system. When these are installed and integrated with the air inlet subsystem and structure, they form a complete propulsion pod.

3.3.1.1 Exhaust Nozzle-Thrust Reverser. The engine exhaust nozzle-thrust reverser is a separate assembly provided as part of the basic engine. Design of the assembly will allow its installation or removal with the engine in place on the airplane. Engine supplied hydraulic power is used to actuate the exhaust/thrust reverser positioning equipment. Provisions for reverser position indication to the flight deck are included in the reverser system. For further control design features of the exhaust/thrust reverser, see D6A10109-1, Flight Deck Subsystem Specification, and D6A10120-1, Flight Control and Hydraulic Subsystem Specification.

3.3.1.2 Windmill Brake. The windmill brake reduces the speed of the engine rotor in case of an engine shutdown in flight. A pneumatic actuator using air pressure from the airplane crossover manifold drives a row of compressor stators to a closed position which reduces air flow through the engine. The actuator incorporates a brake to hold it in the committed position if actuation air pressure is lost. An air valve, mechanically actuated from the flight deck, is used to control brake actuation. Provisions are incorporated to allow flight deck indication of the brake position.

3.3.1.3 Secondary Air Nozzle Cooling System. The secondary cooling air is introduced into the pod at the engine compressor inlet and flows aft to the nozzle system. Normal operating control of the secondary air system is provided by the engine. The system may be shut off for fire protection isolation, and for engine trim operation, by flight deck signals (Ref. D6A10109-1).

3.3.1.4 Engine Lubrication System. The engine lubrication system is part of the engine assembly. The oil tank incorporates provisions to allow either gravity filling or pressure filling. Oil coolers use engine fuel flow as the heat exchange medium for cooling the lubrication system during engine operation. Flight deck instruments receive signals from engine transmitters to indicate:

a. Engine Oil Inlet Temperature.

b. Engine Oil Pressure.

3.3.1.4 (Cont.)

c. Engine Oil Quantity.

d. Low Oil Level Warning.

3.3.1.5 Engine Fuel System. The engine fuel system shall include the following design features:

a. Fuel flow shutoff provisions.

b. Fuel by-pass, which allows for returning fuel to the airplane fuel tanks.

c. Provisions which allow for monitoring system fuel flow and temperature.

3.3.1.6 Engine Ignition System. The ignition system is coupled with a flameout detection system which provides for automatic relight if engine flameout occurs at engine IDLE RPM and above. The flameout provisions are incorporated for both the main burner and augmentor burner. The flameout detection system is deactivated below engine IDLE RPM through a signal from the tachometer generator. Electrical power to the ignition system is provided by the airplane electrical subsystem. The system meets the provisions of Par. 33.69 of FAR 33.

3.3.1.7 Engine Controls. The engine control has provisions for mechanical linkage to the airplane control system which responds to power-setting signals from the flight deck control levers. The system also transmits positioning signals to the thrust reverser. The control system is described in D6A10109-1, Flight Deck Subsystem Specification and D6A101120-1, Flight Controls and Hydraulic Subsystem Specification.

3.3.1.8 Engine Power Take-off. The engine provides a power take-off which drives a remotely located aircraft accessory drive system. A disconnect is provided to permit engine installation or removal without requiring removal of the accessory drive system. Mounting pads are provided for two hydraulic pumps which power the engine air inlet actuation system.

3.3.1.9 Engine Mounting. The engine mount system supports and orients the propulsion pod which includes the air inlet, engine assembly, exhaust nozzle-thrust reverser and the cowl panels. The air inlet is attached to the engine at its face. It will be possible to remove the engine from the airplane without having to remove the air inlet, per D6A10114-1. The engine mount system is a three-point support system designed to withstand engine-thrust loading and all loads resulting from flight maneuvers or sudden engine stoppage. Structural linkages attach to the engine mount rings and terminate in self-aligning cone bolts for attachment to the airplane. For engine installation, the engine-provided cone bolts are seated into airframe mating cone provisions and nuts are torqued on the bolts. The cone bolts are used to facilitate engine installation or removal. The mount system design permits radial and longitudinal expansion of the engine resulting from thermal changes (refer to Figs. 3 and 4).

3.3.1.10 Cowling. The engine cowling is part of the propulsion pod exterior aerodynamic fairing between the engine inlet and the aft fairing for the exhaust system. The cowling consists of three longitudinally hinged cowl panels and incorporates the following features:

a. Quick release type latches.

b. Removal of cowl panels from the airplane using only standard tools.

c. Retaining cowl panels in the open position for normal maintenance.

d. Cowl panel sizes which allow one man to open, store open, or close any single cowl panel.

e. Any single panel can be handled, installed or removed by two men.

f. Access doors are provided in the cowl panels for access to components which require routine servicing or inspection such as: fuel and oil filters, oil tank fill and drain, fuel control adjustments, instrumentation, drains, etc.

g. Small panels are provided in the cowling to protect against cowl overpressure or overtemperature conditions.

h. Seals are provided for maintaining cowl pressure requirements. The seals are designed to allow for thermal expansion and deflection of the engine installation. Seal design takes advantage, wherever possible, of on-side pressure for achieving satisfactory sealing.

3.3.1.11 Compressor Bleed Air. Bleed air from the engine compressor supports the aircraft environmental control system, the engine starting system and the anti-icing system for the air inlet subsystem. A check valve will be used in the duct to prevent air backflow into the engine from the cross manifold. The bleed air system is designed to withstand pressures up to 190 psia and temperatures as high as 1100°F. Proof factors of 1.5 for proof and 2.5 for burst pressure will be used for duct design.

3.3.1.12 Anti-Icing Ducting for Boeing Model 2707 (GE). The anti-icing ducting provides a connection between the engine anti-icing duct and the air inlet anti-icing system as defined in D6A10117-1.

3.3.1.13 Anti-Icing Ducting for Boeing Model 2707 (P&WA). The anti-icing ducting connects between an engine bleed port and the air inlet anti-icing system as defined in D6A10117-1.

3.3.1.14 Engine Instrumentation. Engine instrumentation is provided to monitor engine operation and to transmit the information to the flight deck. Table II provides a list of the various transmitters supporting the engine installation. The instrumentation system meets the requirements of FAR 25, Par. 25.1305. The instrument lines meet the requirements of FAR 25, Par. 25.1337.

3.3.1.15 Fire Protection. The fire protection system includes continuous type sensing elements for detection of fire conditions. A high rate discharge nozzle is provided in designated fire zones for discharging a fire extinguishing agent as described in D6A10115-1, Fire Detection-Extinguishing Subsystem Specification. An engine pod/horizontal stabilizer isolating compartment firewall is provided which is capable of withstanding a 2000°F flame for 15 minutes without failure. All services entering the compartment from the horizontal stabilizer or leaving the compartment from the engine, are sealed at the point of entry, or exit, to maintain firewall integrity. The fire protection provisions comply with the requirements of FAR 25, Par. 25.1191.

3.3.1.16 Plumbing. Fuel lines are provided from the engine to the pod/airframe interface to supply fuel to the engine and return fuel from engine to the airframe tanks. Hydraulic lines are provided to connect the inlet hydraulic pumps, mounted on the engine, to the air inlet hydraulic actuating system. The hydraulic plumbing includes the hydraulic fluid supply, pressure, and return flow lines. All plumbing is corrosion resistant steel and complies with FAR 25, Par. 25.1183 for fire zone requirements. Design of the plumbing system utilizes conventional plumbing and avoids traps wherever possible. Flexible lines are provided as required for interface tolerances and flexibility.

3.3.1.17 Engine Wiring System. The electrical wiring serving the various engine functions is collected into bundles that terminate in fireproof connectors at the engine/horizontal stabilizer interface. For systems requiring more than one type of instrument reading, the wires are run in separate bundles wherever practicable, to prevent complete loss of instrumentation if a bundle is damaged. Electrical wiring is isolated from, or installed above fluid carrying lines, where possible.

3.3.1.18 Drain System. The engine is provided with a drain system which includes a drain tank for collecting drainage from the engine accessory drain pads and the fuel manifold and combustion chamber. The drain tank has the capacity to accept fuel manifold and combustion chamber drainage from one normal engine shutdown plus two unsuccessful starts. Pod drainage is provided through design of the cowl structure and the drain lines for draining the areas and pockets where fluid accumulations might occur. Pod drainage is collected at the low point of the pod. An ejection system provides for automatic disposal of the collected drainage during engine operation. Flame arrestors in the ejector system are provided to minimize fire hazards. Vent lines are routed separately from drain lines. Vent ports are located to prevent their being closed by icing and the consequent contribution to fire hazard.

3.3.2 Selection of Specifications. See Airframe Subsystem Specification D6A10107-1, Par. 3.3.2.

3.3.3 Materials, Parts, and Processes. See Airframe Subsystem Specification D6A10107-1, Par. 3.3.3.

3.3.4 Standard and Commercial Parts. See Airframe Subsystem Specification D6A10107-1, Par. 3.3.4.

3.3.5 Moisture and Fungus Resistance. See Airframe Subsystem Specification D6A10107-1, Par. 3.3.5.

3.3.6 Corrosion of Metal Parts. See Airframe Subsystem Specification D6A10107-1, Par. 3.3.6.

3.3.7 Interchangeability and Replaceability. Common parts and assemblies subject to removal from the engine and engine installation for routine maintenance, shall be made interchangeable or replaceable-interchangeable. Each engine installation shall be interchangeable between pod positions and airplanes. The built-up engine assemblies are interchangeable between any pod location as defined below:

a. Complete interchangeability of engine and accessories.

b. Adding left-hand or right-hand mount fittings to suit location on airplane is possible without making changes to accessory configurations.

c. Pod-wing intersection fairing assemblies to suit specific pod locations, are controlled replaceable.

d. The No. 1 and No. 4 engine positions are opposite to each other.

e. The No. 2 and No. 3 engine positions are opposite to each other.

f. Cowl panels and access doors shall be interchangeable between engines.

3.3.8 Workmanship. Workmanship, materials, and methods used in the construction of the subsystem shall be in accordance with requirements of the Airframe Subsystem Specification D6A10107-1, Par. 3.3.8.

3.3.9 Electromagnetic Interference. See Airframe Subsystem Specification D6A10107-1, Par. 3.3.9.

3.3.10 Identification and Marking. See Airframe Subsystem Specification D6A10107-7, Par. 3.3.10.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 TESTING. A test program shall be conducted to demonstrate Engine Installation Subsystem compliance with the requirements of Section 3 to determine the level of subsystem capability. The tests will include:

a. Engineering tests and evaluations.

b. Preliminary qualification tests.

c. Formal qualification tests which will encompass the inspection, demonstration, and ground tests made on a static ground rig and the tests made on the prototype airplane.

d. Analysis based on logic evaluation of test data, failures, etc.

4.2 ENGINEERING TEST AND EVALUATION. Engineering tests and evaluations shall be conducted, as required, to establish a high degree of confidence that the equipment design will be capable of performing its functions when subjected to formal qualification and when integrated into the airplane subsystems. Equipment and equipment designs which have not been previously approved or proven through other program usage and which cannot be fully tested on the ground test rig or prototype airplane, will be subject to engineering test and evaluation. Data from such engineering development testing shall be evaluated to determine equipment capability to meet requirements and to provide assurance that this capability will be maintained when the equipment is integrated with the airplane subsystems.

a. Engine Mounts & Fittings. Refer to Par. (3.1.1.1.5). Structural tests shall be conducted to insure that the engine mounting system is capable of withstanding the load requirements.

b. Cowling. Refer to Pars. (3.1.1.1.6 and 3.3.1.10). Pressure load tests shall be performed to verify cowl panel design ability to withstand pressure and pressure seal requirements.

c. Engine Bleed Air. Refer to Par. (3.3.1.11). Proof pressure tests shall be conducted on the bleed air ducts to verify the adequacy of duct design for the pressure load requirements.

4.3 PRELIMINARY QUALIFICATION TESTS. Design features shall be tested for adequacy by preliminary qualification tests.

4.4 FORMAL QUALIFICATION. Formal qualifications shall verify that the Engine Installation Subsystem and its component systems meet all assigned requirements when integrated with the airplane subsystems. Formal qualification shall be conducted using approved test equipment, test methods and procedures. The test program shall include inspections, demonstrations, analyses and tests.

4.4.1 Inspection. Inspection shall include visual examination and dimensional measurement to verify that the subsystem components, equipment and

4.4.1 (Cont.)

design features, have been provided and that they have been fabricated, assembled, and installed in accordance with the applicable drawings and specifications. The inspection shall verify that the physical interfaces of the subsystems meet the requirements and are compatible with those subsystems or equipments with which they interface. Functional performance of installed equipment will be verified during ground test programs. Verification of the following requirements will be accomplished by inspection:

a. Engine. Refer to Par. (3.1.1.1). An inspection shall be made of the engines and documentation from the engine manufacturer at the time of receiving the first qualification test engines, to verify that the engines satisfy the requirements of the engine model specification, including components, proper assembly, physical dimensions and interfaces.

b. Cowling. Refer to Pars. (3.1.1.1.6 and 3.3.1.10). An inspection shall be conducted during formal qualification to verify that the cowling complies with the envelope, fit and clearance requirements for engine pod mounted accessories.

c. Fire Protection System. Refer to Par. (3.1.1.1.9). Inspection shall be made to verify that the isolation provisions for fire confinement have been installed per applicable drawings.

d. Inspections shall be conducted to verify that the safety features have been provided and installed in accordance with applicable control drawings and specifications for compliance with the following requirement: Pars.:

(3.1.2.6) Safety
(3.1.2.6.1) Flight Safety
(3.1.2.6.2) Ground Safety
(3.1.2.6.3) Personnel Safety

e. Inspections shall be made to verify that the requirements for the following component systems, equipments and design features have been provided and installed per applicable control drawings and specifications: Pars.:

(3.3.1) Design Features
(3.3.1.1) Exhaust Nozzle-Thrust Reverser
(3.3.1.2) Windmill Brake
(3.3.1.3) Secondary Air Nozzle Cooling System
(3.3.1.4) Engine Lubrication System
(3.3.1.5) Engine Fuel System
(3.3.1.6) Engine Ignition System
(3.3.1.7) Engine Controls
(3.3.1.8) Engine Power Takeoff
(3.2.2.1) GFP
(3.2.2.2) CFP

4.4.1 (Cont.)

f. Engine Mounting. Refer to Par. (3.3.1.9). An inspection shall be conducted to verify that structural support provisions are in accordance with requirements for supporting complete EBU and that installation compatibility exists at all interfaces.

g. Compressor Bleed Air. Refer to Par. (3.3.1.11). Inspection shall be made to verify that the bleed air duct includes the check valve and that the physical interfaces have been accomplished per applicable control drawings.

h. Inspections shall be conducted to provide verification that equipments have been provided, and installed, in accordance with applicable control drawings and specifications for the following pars.:

(3.3.1.12) & (3.3.1.13) Anti-Icing Ducting
(3.3.1.14) Engine Instrumentation
(3.3.1.15) Fire Protection
(3.3.1.16) Plumbing
(3.3.1.17) Engine Wiring
(3.3.1.18) Drain System

4.4.2 Analyses. Analysis of all data relating to the Engine Installation Subsystem shall be conducted. The analysis shall establish the reliability of the subsystem to perform its functions and will determine the effects of the subsystem on airplane performance, when it is integrated with airplane subsystems.

a. Flight Safety. Refer to Par. (3.1.2.6.1). Analytical demonstration of Engine Installation Subsystem design shall be used to verify the adequacy of safety provisions.

b. Interfaces. Refer to Par. (3.2.1). There shall be a review of analytical data to verify that the engine to pod-interfaces and integration of controls, thrust reverser, operational, and safety features, provide the required efficiency and reliability.

c. Useful Life. Refer to Par. (3.1.2.3). Data accumulated during qualification testing of the vehicle will be analyzed to substantiate that the useful life is as specified.

4.4.3 Demonstrations. The following demonstrations shall be conducted to verify the maintenance, handling and servicing requirements:

a. Servicing and Access. Refer to Par. (3.1.2.2.2). The requirements shall be considered satisfied when the airplane system maintainability requirements are satisfactorily demonstrated.

b. Cowling. Refer to Par. (3.3.1.10). A demonstration shall be conducted on the airplane to verify that one man can open and close the cowl panel.

4.4.3 (Cont.)

c. Maintenance and Repair Cycles and Engine Mounting. Refer to Pars. (3.1.2.2.1 and 3.3.1.9). A demonstration shall be made to verify engine removal time.

4.4.4 Tests. The testing program shall be as follows:

4.4.4.1 Ground Test. Testing will be conducted on an engine ground test rig or during prototype airplane testing, for verification of performance compatibility between the engine installation components, propulsion pod, and other subsystems. The complete pod including the engine with inlet, nozzle, thrust reverser, cowling, accessories, controls, instrumentation, accessory drive system, and engine mounts will be tested to verify the following:

a. Engine. Refer to Par. (3.1.1.1). Tests shall verify engine capability to meet the thrust and the mechanical drive power installation requirements for the airplane accessory drive and air inlet hydraulic pumps. The tests shall verify compatibility of accessory power drive with engine drive shaft power takeoff (PTO) under various loads and power settings.

b. Thrust Control. Refer to Par. (3.1.1.1.3.1). Tests shall verify the adequacy of controls to the engine.

c. Exhaust Nozzle-Thrust Reverser. Refer to Par. (3.1.1.1.4). Exhaust nozzle-thrust reverser operation and response shall be verified.

d. Windmill Brake. Refer to Par. (3.1.1.1.3.2). Windmill brake actuation shall be verified.

e. Instrumentation. Refer to Par. (3.1.1.1.8). Engine instrumentation performance shall be verified during operational testing of the propulsion system.

f. Engine Bleed Air. Refer to Par. (3.1.1.1.7). Tests shall verify engine capability to provide bleed air requirements for support of the airplane subsystems and to verify bleed duct check valve capability of preventing bleed air back flow into engines.

g. Fire Protection. Refer to Par. (3.1.1.1.9). The integrity of the engine fire detection provisions shall be demonstrated through testing the fire detection and extinguishing subsystem per D6A10115-1.

h. Engine Starting. Refer to Par. (3.1.1.1.10). Tests shall be conducted to verify the capability of starting an engine using ground start equipment and starting the remaining engines from an operating engine.

i. Environmental. Refer to Par. (3.1.2.4). The temperature environment within the engine compartments shall be determined to verify that maximum temperature limits are not exceeded.

4.4.4.2 Flight Tests. Flight testing shall verify engine installation performance and engine control over the airplane operating envelope, during the airplane flight test program.

4.5 RELIABILITY TEST AND ANALYSIS. The reliability requirements of Par. 3.1.2.1 represent the mature system operated in representative scheduled airline revenue service. Inasmuch as the tests and data specified in Par. 4.4.4 are limited and the hardware may be of a prototype nature, compliance with the requirements of Par. 3.1.2.1 will be accomplished as follows:

4.5.1 Reliability Tests. Tests specifically designed to verify the reliability of the subsystem shall not be conducted. Data obtained from tests conducted under Par. 4.4.4 shall be applied to the reliability analysis specified in Par. 4.5.2, extrapolated to anticipated airline operational conditions.

4.5.2 Reliability Analysis. A reliability analysis shall be performed to demonstrate that the requirements of Par. 3.1.2.1 can be achieved. This shall be accomplished as follows:

a. A growth curve shall be established to base the target reliability levels projected by the end of Phase III.

b. Design data and test results will be applied to a reliability analysis model incorporating:

   1. Block diagrams summarizing the logical relationships between components success/failure and system success/failure.

   2. A mathematical reliability model derived from 1. and incorporating minimum equipment requirements for continued flight.

   3. A mathematical reliability model simulating typical airline operations and routes.

c. Comparison shall be provided with the Phase III targets and the results extrapolated to determine expectation of achieving the requirements of Par. 3.1.2.1, in airlines operation.

APPENDIX A

PERFORMANCE AND CONFIGURATION/ QUALITY VERIFICATION CROSS REFERENCE

TITLE	PARAGRAPH NO.	PARAGRAPH NO.
Engine	3.1.1.1	4.4.1.a & 4.4.4.1.a
Controls	3.1.1.1.3	4.4.4.1.b and 4.4.4.2
Exhaust Nozzle Thrust Reverser	3.1.1.1.4	4.4.4.1.c
Engine Mounts & Fittings	3.1.1.1.5	4.2.a, 4.4.1.f
Cowling	3.1.1.1.6	4.2.b, 4.4.1.b
Engine Bleed Air	3.1.1.1.7	4.2.c, 4.4.4.1.f
Instrumentation	3.1.1.1.8	4.4.4.1.e, 4.4.4.2
Fire Protection	3.1.1.1.9	4.4.1.c, 4.4.4.1.g
Engine Starting	3.1.1.1.10	4.4.4.1.h
Reliability	3.1.2.1	4.5
Maintainability	3.1.2.2	4.5 & 4.4.3
Useful Life	3.1.2.3	4.4.2.c
Environmental	3.1.2.4	4.4.4.1.i
Human Performance	3.1.2.5	N.A.
Safety	3.1.2.6	4.4.2.a & 4.4.1.d
Subsystem Definition	3.2	N.A.
Interface Requirements	3.2.1	N.A.
Component Identification	3.2.2	4.4.1.e
Design and Construction	3.3	4.4.1
Subsystem Design Features	3.3.1	4.4.1.e
Exhaust Nozzle Thrust Reverser	3.3.1.1	4.4.1.e

APPENDIX A (Cont.)

TITLE	PARAGRAPH NO.	PARAGRAPH NO.
Windmill Brake	3.3.1.2	4.4.1.e, 4.4.4.1
Secondary Air Nozzle Cooling System	3.3.1.3	4.4.1.e, 4.4.4.1
Engine Lubrication System	3.3.1.4	4.4.4.1 & 4.4.1.e
Engine Fuel System	3.3.1.5	4.4.1.e, 4.4.4.1
Engine Ignition	3.3.1.6	4.4.1.e, 4.4.4.1
Engine Controls	3.3.1.7	4.4.1.e, 4.4.4.1
Engine Power Takeoff	3.3.1.8	4.4.1.e, 4.4.4.1
Engine Mounting	3.3.1.9	4.4.1.f, 4.4.3.c
Cowling	3.3.1.10	4.4.1.b, 4.4.3.c
Compressor Air Bleed	3.3.1.11	4.4.1.g
Anti-Icing Ducting	3.3.1.12 & 3.3.1.13	4.4.1.h
Engine Instrumentation	3.3.1.14	4.4.1.h
Fire Protection	3.3.1.15	4.4.1.h
Plumbing	3.3.1.16	4.4.1.h, 4.4.4.1
Engine Wiring System	3.3.1.17	4.4.1.h, 4.4.4.1
Drain System	3.3.1.18	4.4.1.h, 4.4.4.1

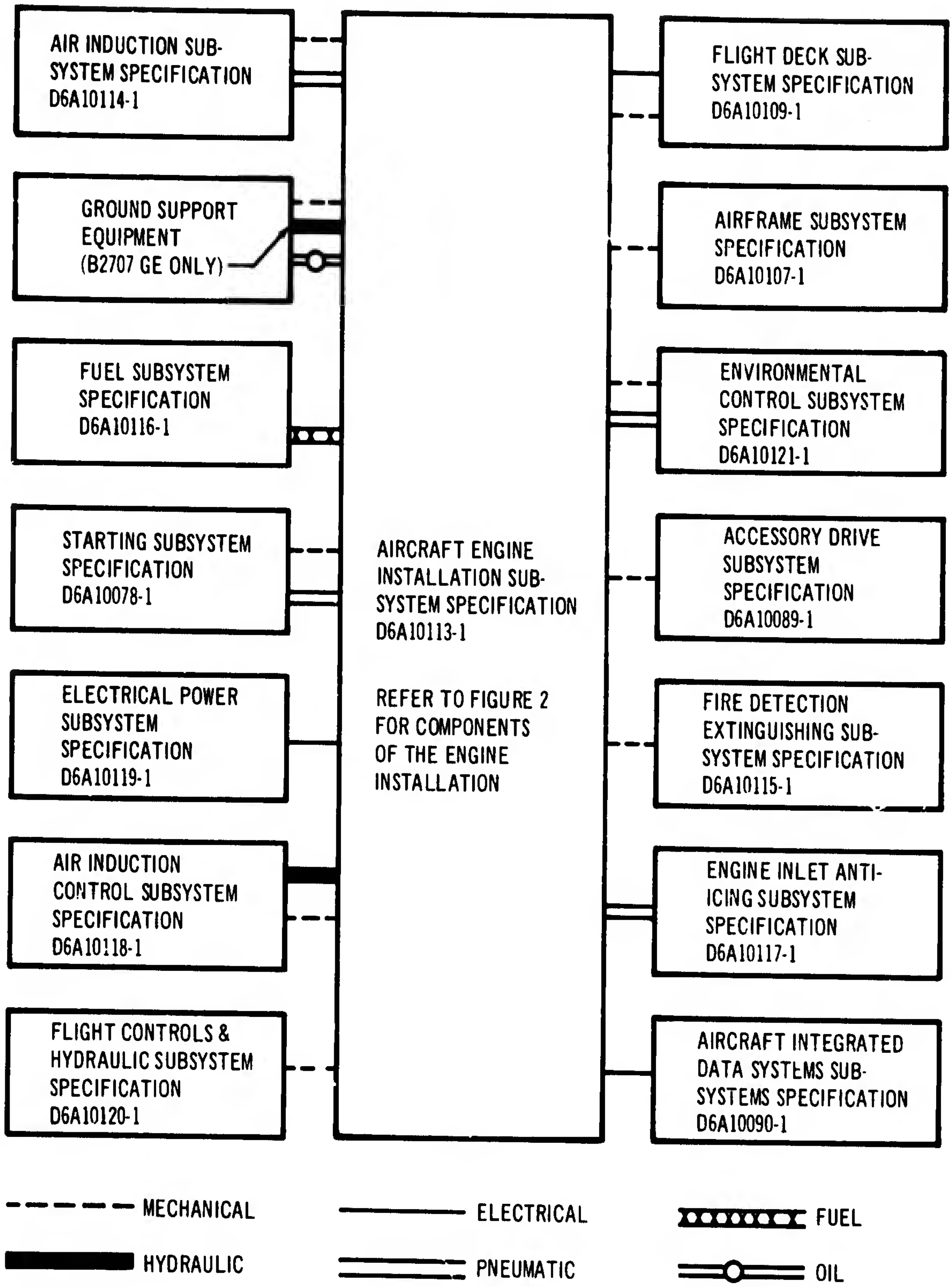

Figure 1. Interface Diagram

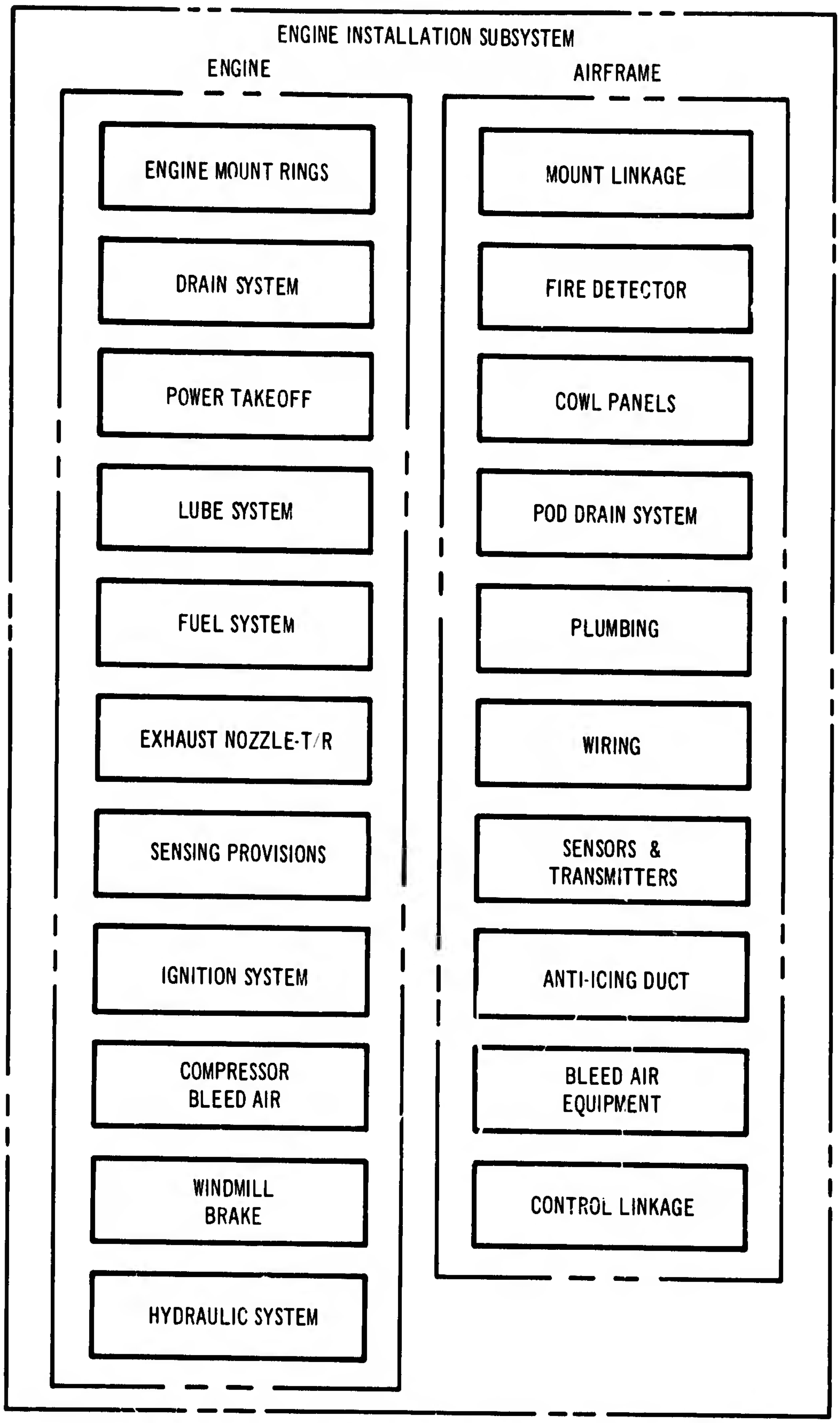

Figure 2. Engine Installation Subsystem Engine/Airframe Components

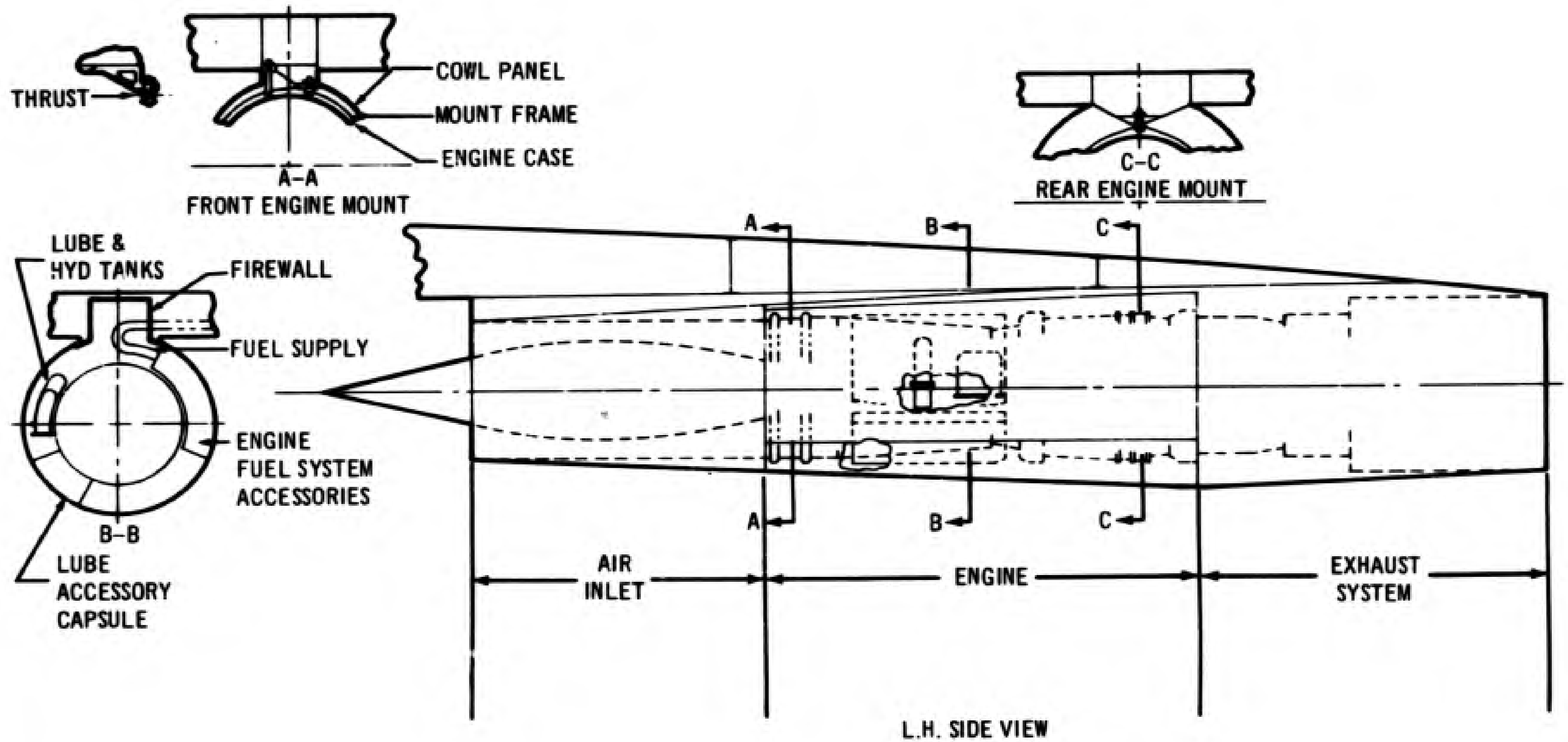

Figure 3. Propulsion Pod Installation (GE)

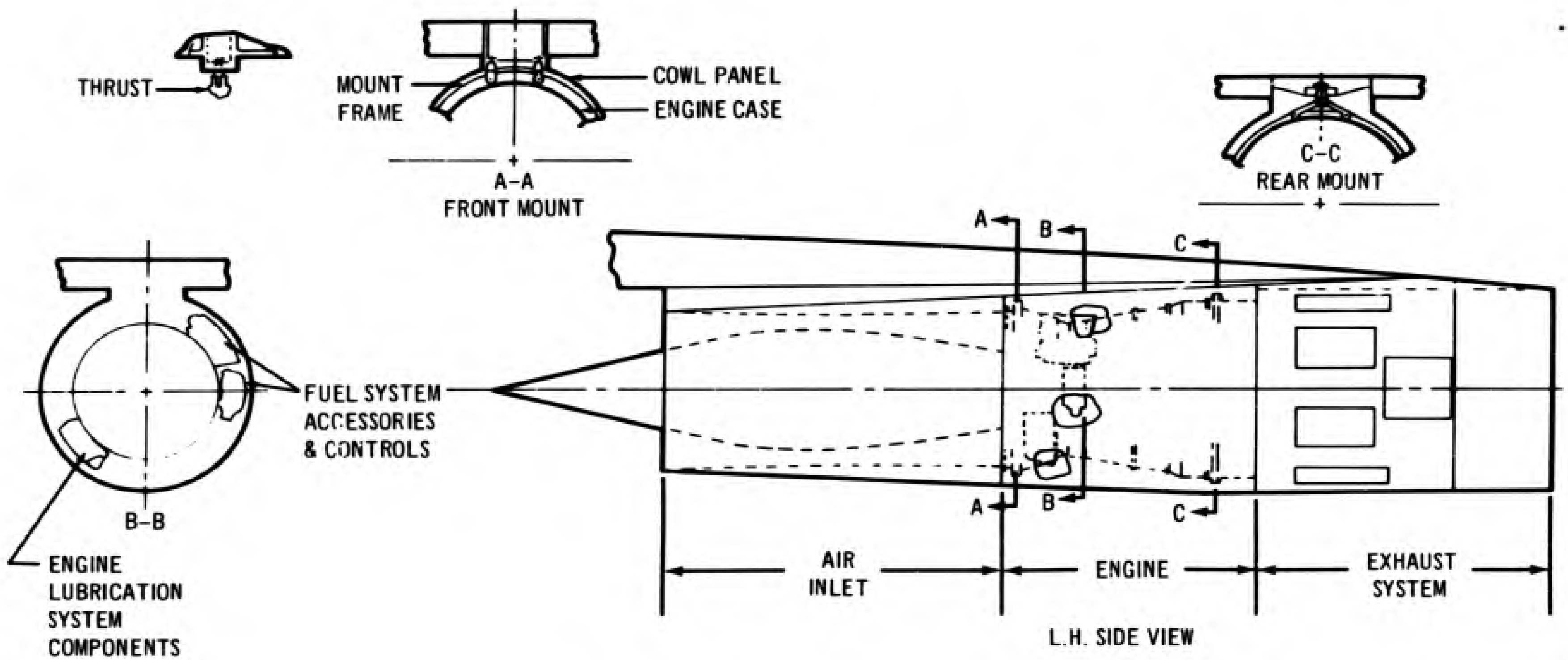

Figure 4. Propulsion Pod Installation (P&WA)

Table I. Interface List

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Flight Deck	Elect. Signal-Input	Electrical Connectors	Mach. Sense Signal to Secondary Air Control	
Flight Deck	Elect. Power-Input	Electrical Connectors	Manual Trim Power to Secondary Air Control	
Flight Deck	Elect. Power-Input	Electrical Connectors	Fire Shut Down Power to Secondary Air Control	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Secondary Air Actuator Position Indication	
Flight Deck	Elect. Power-Input	Electrical Connectors	Anti-Ice Pilot Valve	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Anti-Ice Temp. Sensor	
Flight Deck	Elect. Power-Input	Electrical Connectors	Manual Trim Power to Main Fuel Control	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Interlock Signal for: T/R in Reverse/Transit and Cover in Reverse/Transit	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Wind Mill Brake	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Turbine Cooling Valve	
Flight Deck	Elect. Power-Input	Electrical Connectors	Ignition Unit	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Tach. Generator (RPM)	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Flight Deck	Elect. Signal-Output	Electrical Connectors	Nozzle Inlet Fuel Temp.	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Turbine Disch. Temp. (T_{t5})	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Nozzle Control (AREA)	
Flight Deck	Elect. Power-Input	Electrical Connectors	Nozzle Control (Noise Abatement)	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Main Fuel Flow	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Augment Fuel Flow B2707 GE	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Duct Heater Fuel Flow - B2707 P&WA	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Jet Nozzle Cooling Valve	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Fwd. Stator Act. Position	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Aft. Stator Act. Position	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Lube. Tank-Oil Level	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Flight Deck	Elect. Signal-Output	Electrical Connectors	Hydraulic Tank Level B2707 GE	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Engine Oil Pressure	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Fuel Supply Temp.	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Engine Oil Temp.	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Engine Oil Filter ΔP Warning	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Engine Oil Low Pressure Warning	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Turbine Vibration	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Compressor Vibration	
Flight Deck	Elect. Signal-Output	Electrical Connectors	Turbine Disch. Pressure	
Flight Deck	Elect. Signal-Output	Responder & Tail Connector	Continuous Element Fire Detector	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Fire Detection Extinguishing	Struct. Support-Input	Mech. Fastener	Continuous Element Fire Detector	
Fire Detection Extinguishing	Gas	Mech. (Location)	Ext. Nozzle	
Airframe	Struct. Support-Output	3 Cone Bolts	Engine Mount	
Airframe	Aerodynamic Seal-Output	Mech. Seal	Cowl Fairing	
Airframe	Aero. Smooth-Output	Mech-Faying Surface	Cowl Fairing	
Engine	Elect. Power-Output	Electrical Connectors	Manual Trim Pwr. to Main Fuel Control	
Engine	Elect. Signal-Input	Electrical Connectors	Interlock Signal for: T/R in Reverse/Transit and Cover in Reverse/Transit	
Engine	Elect. Signal-Input	Electrical Connectors	Wind Mill Brake	
Engine	Elect. Signal-Input	Electrical Connectors	Turbine Cooling Valve	
Engine	Elect. Power-Output	Electrical Connectors	Ignition Unit	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Engine	Elect. Signal-Input	Electrical Connectors	Tach Generator (RPM) B2707 GE	
Engine	Elect. Signal-Input	Electrical Connectors	Nozzle Inlet Fuel Temp.	
Engine	Elect. Signal-Input	Electrical Connectors	Turbine Disch. Temp. (T_{t5})	
Engine	Elect. Signal-Input	Electrical Connectors	Nozzle Control (AREA)	
Engine	Elect. Power-Output	Electrical Connectors	Nozzle Control (Noise Abatement)	
Engine	Mech. Pwr.	Pad-Pwr. Takeoff	Tach Generator N_1 B2707 P&W	
Engine	Mech. Pwr.	Pad-Pwr. Takeoff	Tach Generator N_2 B2707 P&W	
Air Induction Control	Hydraulic-Output	3 Lines per Pump	Inlet Control Hydraulic Pump (2/Engine)	
Accessory Drive	Mech. Power-Output	Rotating Shaft	Power Takeoff	
Fuel Subsystem	Fuel Lines-Input	Fuel Line	Fuel Control System	
Airframe	T/R Gas Flow Path-Output	Structure	T/R Air Flow System	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Ground Support Equipment	Pneumatic-Input	Ground Start Receptacle	Engine Bleed Duct No. 4 Only	
Starting Subsystem	Pneumatic-Output	Mech. Support	Starting	
Engine	Elect. Signal-Output	Electrical Connectors	Mach. Sense Signal to Secondary Air Control	
Engine	Elect. Power-Output	Electrical Connectors	Manual Trim Pwr. to Secondary Air Control	
Engine	Elect. Power-Output	Electrical Connectors	Fire Shut Down Pwr. to Secondary Air Control	
Engine	Elect. Signal-Input	Electrical Connectors	Secondary Air Actuator Position	
Engine	Elect. Power-Output	Electrical Connectors	Anti-Ice Pilot Valve B2707 GE	
Engine	Elect. Signal-Input	Electrical Connectors	Anti-Ice Temp. Sensor B2707 GE	
Airframe	Pneumatic Seal-Output	Mechanical	Pressurized Cowl	
Ground Support Equipment	Ground Servicing	Mech.-Filler Neck & Cap	Hydraulic Tank B2707 GE	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Ground Support Equipment	Ground Servicing	Mech. -Press. Neck, Cap & Dipstick	Lubrication Tank	
Ground Support Equipment	Ground Servicing	Mech. -Filler Fill Port	Lubrication System	
Ground Support	Ground Servicing	Struct. -Bolt	Ground Handling Provisions	
Engine Inlet Anti-Icing	Pneumatic Supply-Output	Flanged Connector	Engine Anti-Icing	
Air Induction	Air Supply-Input	Mechanical	Engine Air	
Environmental Control	Pneumatic Supply-Output	Flanged Connector	High Pressure Bleed	
Environmental Control	Pneumatic Press.-Input	Flanged Connector	Wind Mill Brake	
Flight Deck	Mechan. Bias-Input	Mech.-Bolted	Wind Mill Brake and Combination Valve	
Flight Deck	Mechan. Bias-Input	Mech. -Bolted	Thrust Control	
Engine	Meter Input/Output	Mechanical	Main Fuel Flow	
Engine	Pneumatic-Input	Mech. -Bleed Port	Anti-Ice B2707 P&W	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Engine	Meter-Input/Output	Mechanical	Augment Fuel Flow	
Engine	Elect. Signal-Input	Electrical Connectors	Jet Nozzle Cooling Valve	
Engine	Elect. Signal-Input	Electrical Connectors	Fwd. Stator Act. Position	
Engine	Elect. Signal-Input	Electrical Connectors	Aft. Stator Act. Position	
Engine	Elect. Signal-Input	Electrical Connectors	Lube Tank Oil Level	
Engine	Elect. Signal-Input	Electrical Connectors	Hydraulic Tank Level B2707 GE	
Engine	Mechanical-Input	Press. Transmitter	Engine Oil Pressure	
Engine	Mechanical-Input	Temp. Sensor	Fuel Supply Temp.	
Engine	Mechanical-Input	Temp. Sensor	Engine Oil Temp.	
Engine	Mechanical-Input	Press. Transmitter	Engine Oil Filter ΔP Warning	
Engine	Mechanical-Input	Press. Transmitter	Engine Oil Low Press. Warning	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Engine	Mechanical-Input	Vibration Pickup Unit	Turbine Vibration	
Engine	Mechanical-Input	Vibration Pickup Unit	Compressor Vibration	
Engine	Mechanical-Input	Press. Transmitter	Turbine Disch. Press.	
Engine	Structure Support-Input	3 Bolts	Engine Mount	
Engine	Mechanical-Input	Support	Cowl Fairing	
Engine	Aero. Smooth-Input	Mech.-Faying Surface	Cowl Fairing	
Engine	Pneumatic Seal-Input	Mechanical	Pressurized Cowl	
Engine	Pneumatic Seal-Input	Mechanical	Accessory Capsule B2707 GE	
Engine	Drain	Struct. (Location)	Ejector Drain System	
Engine	Overboard Vent-Input	Tubing	Lubrication System	
Engine	Pneumatic-Input	Flanged Connector	Engine Anti-Icing	

Table I. Interface List (Cont.)

Adjoining Equipment or Subsystem	Functional Nature with Aircraft Engine Subsystem	Physical Nature	To Provide For	Quantitative Values and Tolerances
Engine	Pneumatic-Input	Mech. -Bolted	High Pressure Bleed	
Engine	Pneumatic Press.-Output	Flanged Connector	Wind Mill Brake	
Engine	Mech. Bias-Output	Mech. -Bolted	Wind Mill Brake and Combination Valve	
Engine	Mech. Bias-Output	Mech. -Bolted	Thrust Control	
Engine	Mech. Power-Input	Mech. -QAD	Inlet Control Hydraulic Pump (2/Engine)	
Engine	Fuel-Output	Fuel Line	Fuel Control System	
Engine	T/R Gas Flow Path-Input	Structural	T/R Air Flow System	
Engine	Pneumatic-Output	Mech. Ground Start Receptacle	Engine Bleed Duct	

Table II. Engine Instrumentation Provisions

Function	Range	Transmitter
Vibration	0-10DA	Mass Acceleration
Exhaust Gas Temp. (EGT)	0-2500°C	Thermocouple
Engine Rotor (RPM)	0-110%	Tach. Generator
Fuel Flow (Main & Aug.)		Mass Flow
Thrust. Engine Pressure Area Ratio (EPAR)	0.6-5.0 EPAR Units	
Nozzle Area	500-2000 sq. in.	Linear Variable Differential Transformer
Lube Oil Quantity	0-6.0	Probe Magnetic Switching
Lube Oil Temperature	0 to +500°F	Resistance Bulb
Lube Oil Pressure	0-100 psi	Variable Reluctance
Lube Oil Low Press. Warning	To be determined	Press. Switch
Lube Oil Filter P Warning	To be determined	Press. Switch
Fuel Supply Temp. to Engine Pump	0 to +400°F	Resistance Bulb
*Engine Fuel to Manifold Temp.	0 to +400°F	Resistance Bulb
*Nozzle and Reverser Hydraulic Oil Quantity	To be determined	Probe Magnetic Switching
Reverser Position	In transit In reverse	Switch Switch
*Engine Anti-Icing		Temp-Activated Switch
Fire Detector		Continuous Element
Windmill Brake Position		Switch
Secondary Valve Position		

*Used on Model B2707 (GE) only.