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Phase III
Supersonic Transport Development Program

BOEING MODEL 2707

MODEL
SPECIFICATION

D6-17850

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STATEMENT OF UNCLASSIFIED

Contract FA-SS-66-5

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Prepared for

FEDERAL AVIATION ADMINISTRATION
Office of Supersonic Transport Development Program

WASH. D. C.
26553

THE **BOEING** COMPANY
SUPERSONIC TRANSPORT DIVISION

FEB 29 1968

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REVISION RECORD

Document completely revised in response to Phase II-C requirements outlined in FAA letter of July 1, 1965, Gordon M. Bain to M. L. Pennell. Major changes as follows:

- a. D6-17850-1 Performance Guarantees, made into a separate document from Section 15 of original D6-17850 Specification.
- b. Supplement 1 of D6-17850 changed from describing the 733-363 Transcontinental to describing the Pratt & Whitney powered 733-373 Intercontinental.

Document completely revised to reflect the 733-390 configuration. (Reference Category I Change Number 1) November 15, 1965

Document revised to add Supplement 2 which describes the Model 733-394.

REVISED PAGES

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ADDED PAGES

Supplement 2 (Complete)
November 17, 1965

Document completely revised to reflect The 2707 configuration. (Reference Category I Change Number 2)

Document D6-17850-1, Performance Guarantees, has been cancelled. These data are now contained in Supplement 2 of this document.

June 30, 1966

Document completely revised to reflect the Phase III Proposal Configuration of the Model 2707.

September 6, 1966

Document completely revised to reflect the 2707-100 configuration and to incorporate revisions requested by the FAA as documented in D6A10490-1.

December 31, 1966

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INTRODUCTION

This specification defines the Bceing Model 2707-100 Intercontinental Supersonic Transport powered by four engines manufactured by General Electric or Pratt & Whitney Aircraft, and is designated 2707 (GE) or 2707 (P&W), respectively. Differences associated with the use of either type of engines are also noted herein.

This specification is submitted in compliance with Part IA of Exhibit 3B of the Federal Aviation Administration's Request For Proposal For Phase III of the Supersonic Transport Development Program.

The production configurations described herein are the basic intercontinental airline models. This specification has been arranged in a typical commercial format. Supplement 1 of this specification defines the discrete differences between the basic intercontinental production configurations of the Boeing Model 2707 airplane and the prototype. Supplement 2 defines the performance guarantees for the production versions of the aircraft.

This specification reflects extensive coordination with U.S. and non-U.S. airlines and the FAA. Those changes resulting from recent technical reviews with the airlines, the U.S. Airline SST Committee and Specialist Teams, and the FAA are shown in italics. Although many of the illustrations were either revised or added as a result of airline and FAA recommendations, these revisions or additions to the illustrations have not been specifically identified herein.

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SECTION 1
GENERAL AIRPLANE DESCRIPTION

1.1 DESCRIPTION

This Specification describes a supersonic transport monoplane having a variable-position wing.

For the 2707 (GE):

The general arrangement and inboard profile shall be substantially as shown in Figs. 1-1 and 1-3.

For the 2707 (P&W):

The general arrangement and inboard profile shall be substantially as shown in Figs. 1-2 and 1-4.

1.2 TYPE AND PURPOSE

A four-engine, land-based, *intercontinental*, supersonic airplane for commercial transportation of passengers and cargo.

1.3 SELLER'S NAME AND MODEL NUMBER

Boeing Model 2707 (GE) Intercontinental powered by General Electric engines or Boeing Model 2707 (P&W) Intercontinental powered by Pratt & Whitney Aircraft engines.

1.4 DESIGN WEIGHTS

Refer to Par. 2.15 for definitions

1.4.1 Structural Design Weights

For the 2707 (GE):

Maximum Design Taxi Weight	675,000 lb
Maximum Design Flight Weight (Flaps Up)	666,000 lb
Maximum Design Landing Weight	430,000 lb
Maximum Zero Fuel Weight	363,100 lb

For the 2707 (P&W):

Maximum Design Taxi Weight	675,000 lb
Maximum Design Flight Weight (Flaps Up)	666,000 lb
Maximum Design Landing Weight	420,000 lb
Maximum Zero Fuel Weight	361,220 lb

1.4.2 Allowable Payload

75,000 lb

1.5 CAPACITIES FOR CREW, PASSENGERS, AND CARGO

1.5.1

Crew
 Captain
 First officer
 Flight engineer
 Observers (2)
 Cabin attendants (10)

1.5.2

Passengers (Basic Intercontinental Arrangement)

28 First class passengers at 40-in. seat row pitch
 252 Tourist class passengers at 34-in. seat row pitch
 280 Total passengers

(Refer to Par. 11.2.2 for other interior arrangements)

1.5.3

Cargo

Approximate
 Bulk Volume
 Cu/Ft

Aft Compartment (Class D)	1,365
Forward Compartment (Class D)	1,775
TOTAL	3,140

1.6

DIMENSIONS AND AREAS (APPROXIMATE)

For The 2707 (GE):

See Fig. 1-1 for major external dimensions.

For The 2707 (P&W)

See Fig. 1-2 for major external dimensions.

Body Group

<i>Passenger Cabin Volume, Total</i>	18,000 cu ft
<i>Passenger Cabin Floor Area, Total</i>	2,240 sq ft

Wing Group

<i>Wing Area (Gross-Wings Aft, Incl. Horizontal Tail)</i>	9,000 sq ft
<i>Aspect Ratio (Wings Aft)</i>	1.24
<i>Dihedral</i>	0°

Leading Edge Sweep (Wing Forward)	20°
Leading Edge Sweep (Wings Aft)	72°
Wing Reference Chord (Wings Aft, L.E. at Body Sta. 1,470)	1,896.73 in.
Flap Area, Total	894 sq ft
Aileron Area, Outboard	120 sq ft
Horizontal Tail Area, Total	2,498 sq ft
Vertical Tail Area, Total	875 sq ft
Ventral Fin Area	201 sq ft

1.7 ENGINES

Four engines shall be installed. The engine type shall be:

For The 2707 (GE):

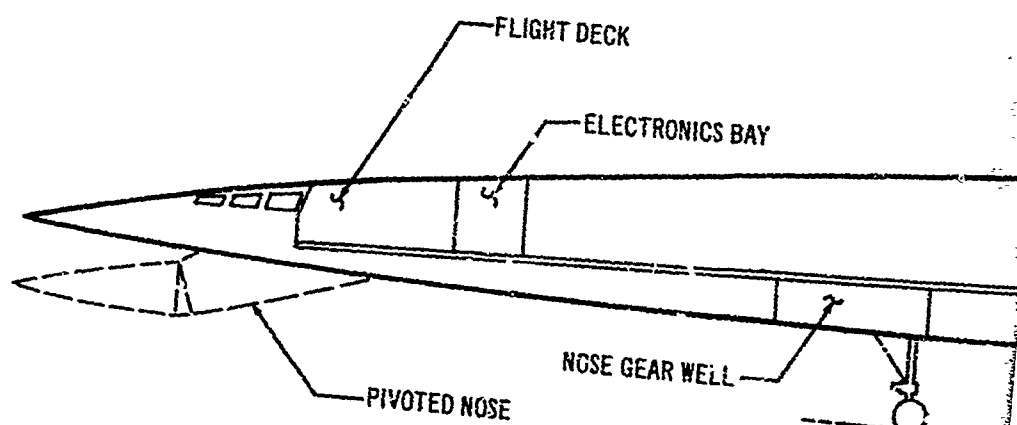
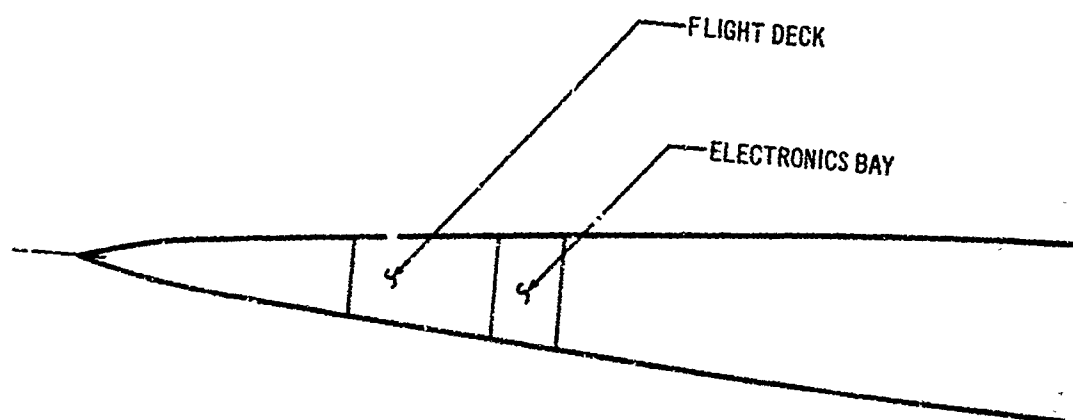
General Electric Engine Model GE 4/J5P (Oct. 7, 1966)

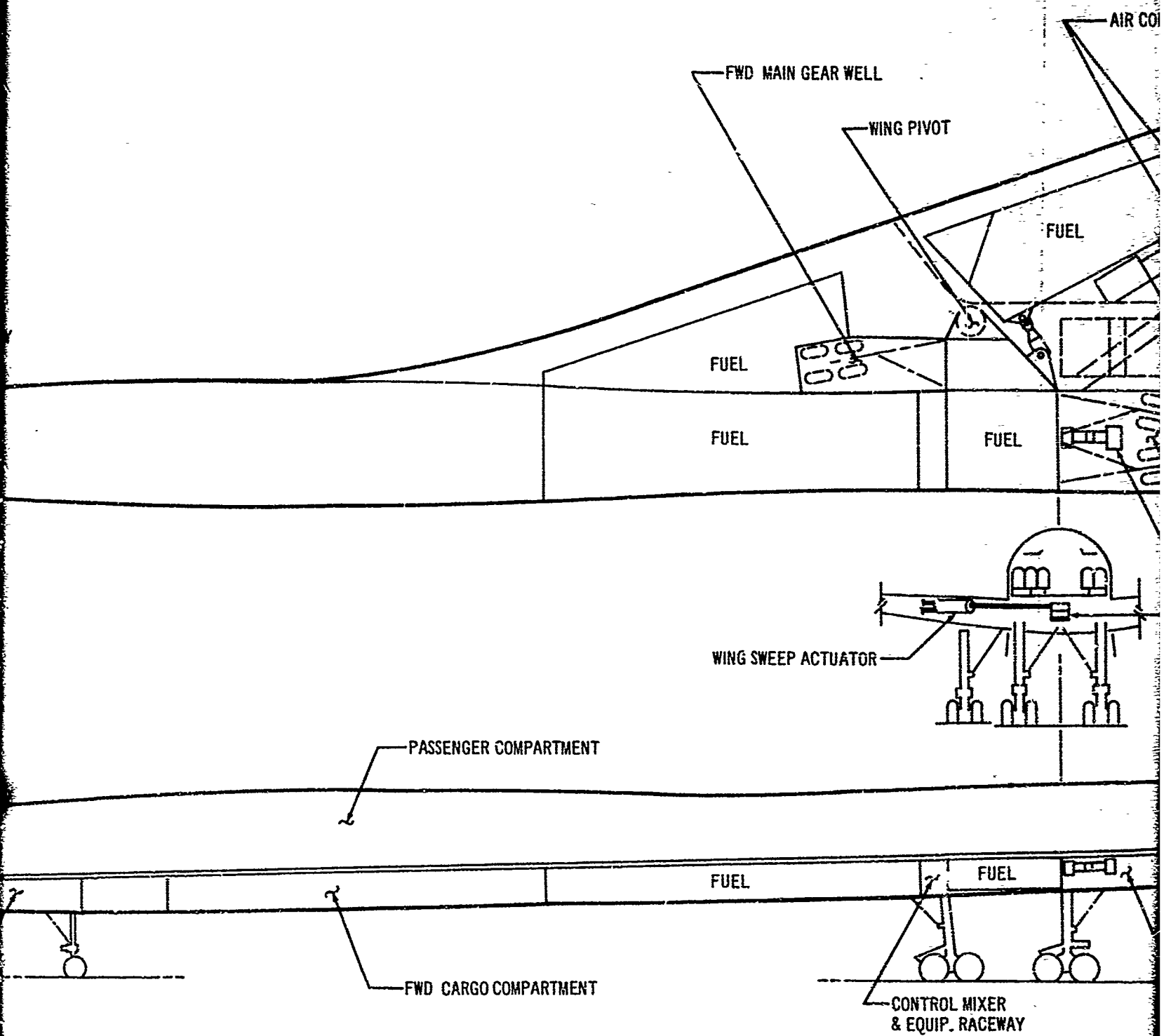
For The 2707 (P&W):

Pratt & Whitney Aircraft Engine Model JTF-17A-21B
(Aug. 5, 1966)

1.8 PERFORMANCE

Guaranteed performance data are contained in Supplement 2 of this specification.





Fig

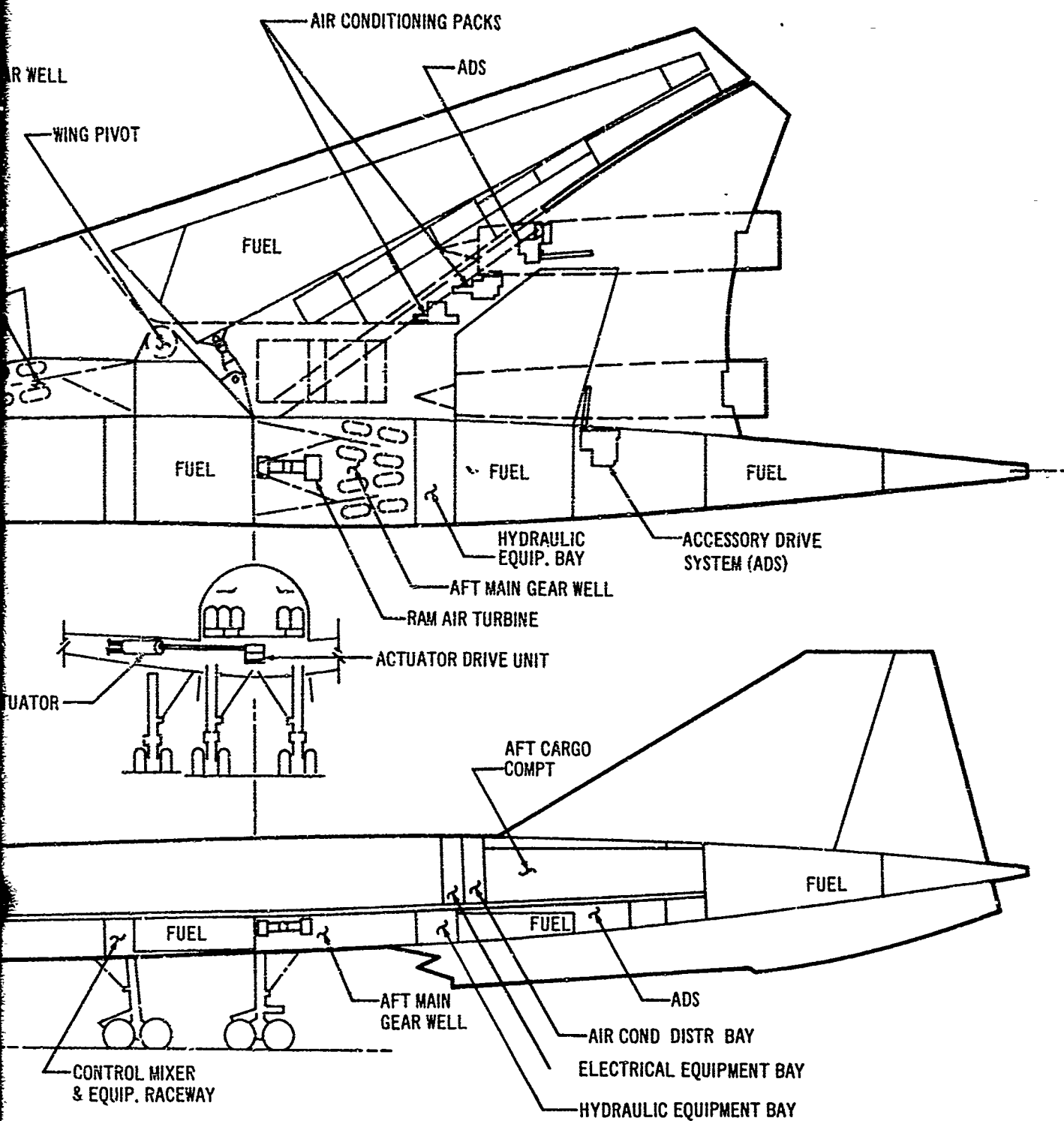
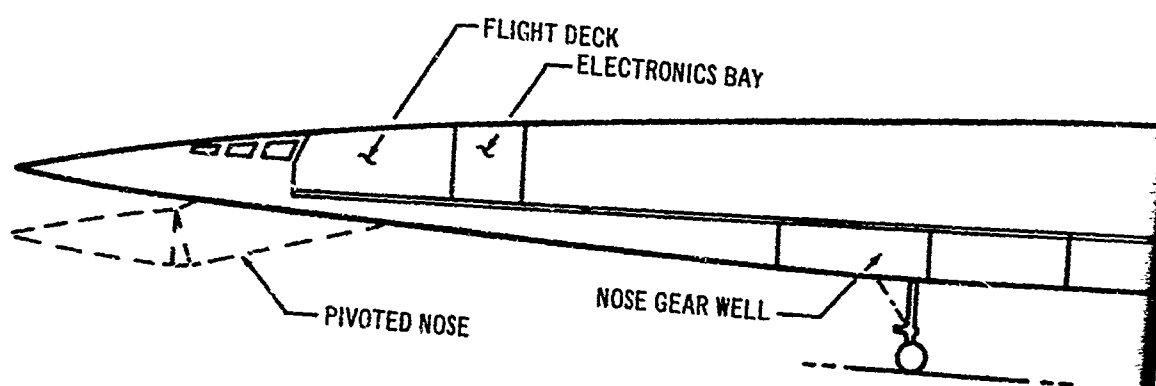
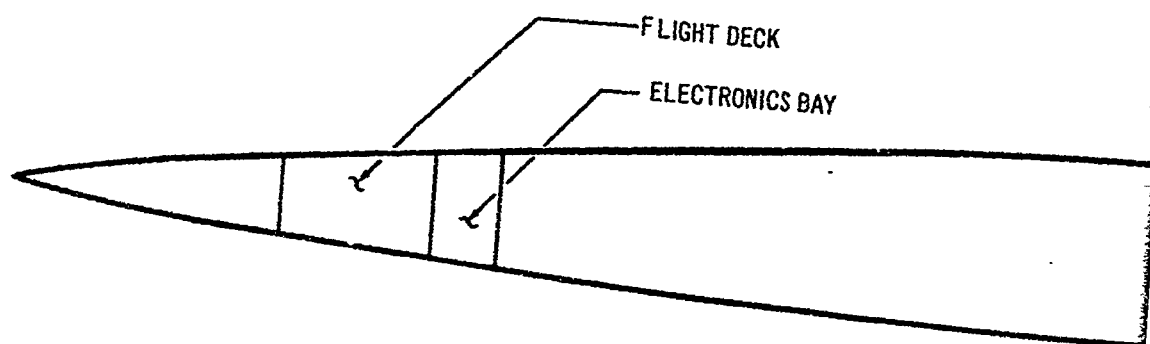


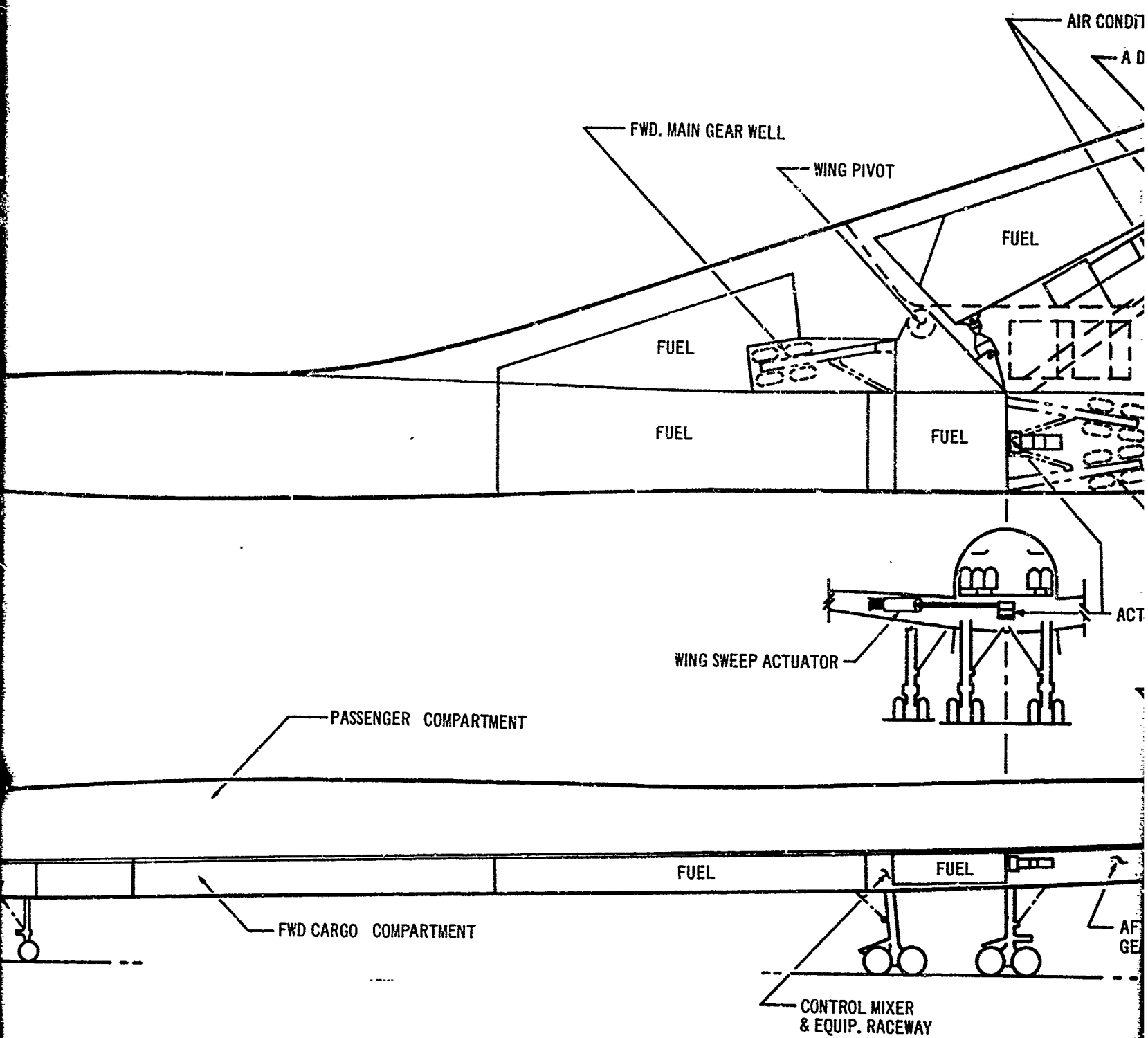
Figure 1-3. Inboard Profile Model B-2707-100 (GE)

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1-7
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Figure

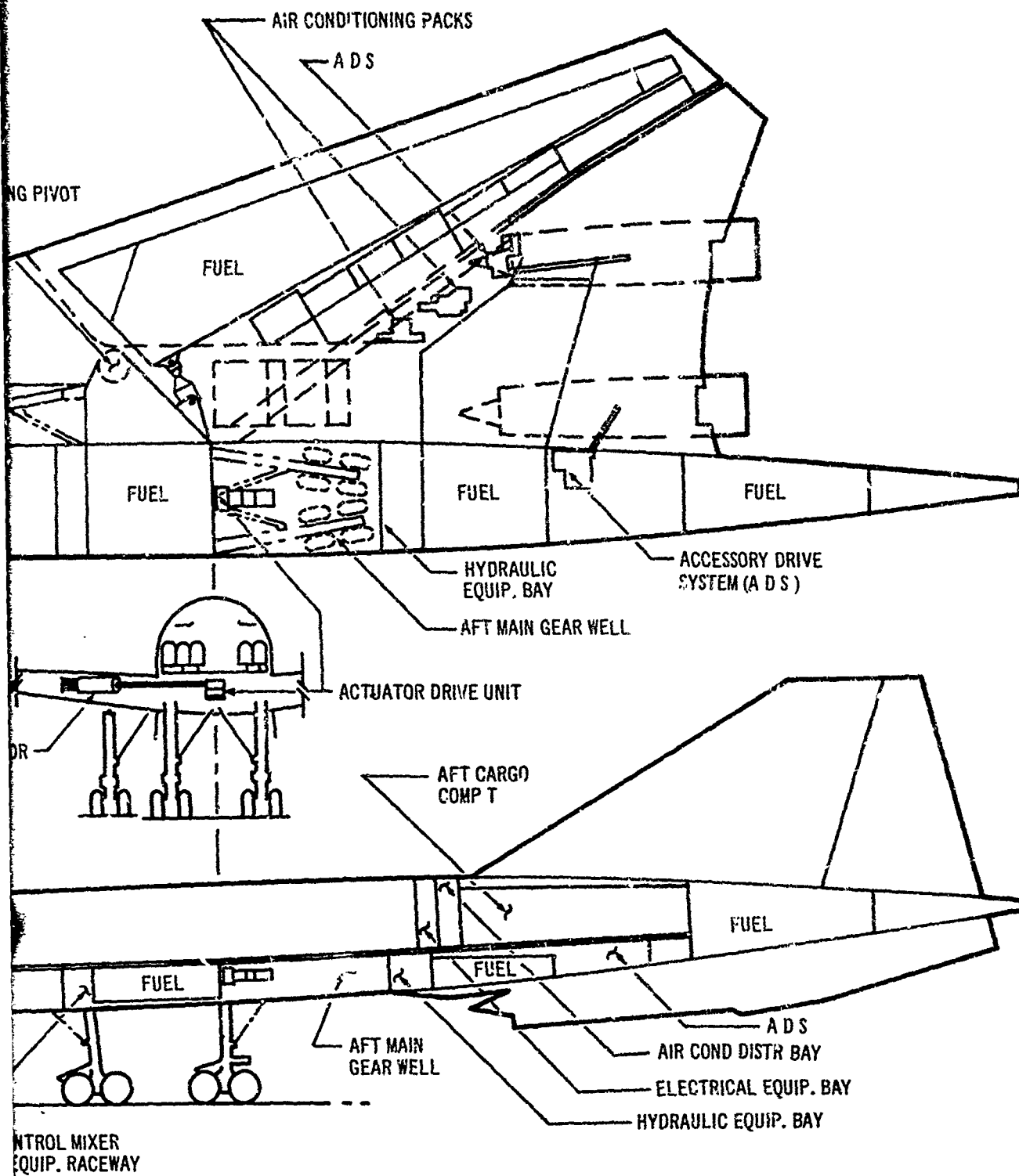


Figure 1-4, Inboard Profile Model B-2707-100 (P&W)

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SECTION 2 GENERAL REQUIREMENTS

2.1 PURCHASE AGREEMENT GOVERNS

In the event of any conflict or discrepancy between this Specification and the Purchase Agreement, the terms in the Purchase Agreement shall govern.

2.2 SPECIFICATION CONTROLLING

2.2.1 Specification Precedence

In the event of any conflict or discrepancy between this Specification and the supplemental specifications listed below, the terms in this Specification shall control.

2.2.2 Supplemental Specifications

- o Electrical Bonding and Grounding Design Requirements, D6A10236-1
- o SST Electromagnetic Interference Control Requirements, D6-16050-1
- o *Radio Technical Commission Aeronautics Paper 120-61/DO-108*
- o Electrical Requirements for Installed Equipment, D6-16328
- o Interior Colors and Materials, D6-6908
- o Galley Design and Installation Specification, D6-6954
- o Passenger Seat Design Criteria, D6-2556
- o Exterior Decorative Markings Specification D6-6956
- o Protective Finishes, D6A10072-1
- o *External Aerodynamic Smoothness Criteria Specification*

2.3 CERTIFICATION

2.3.1 General

Each airplane shall be certificated in accordance with the terms specified in the Purchase Agreement at weights of not less than the performance or structural limitations specified in Sections 1 and 3 of this Specification.

The airplane shall be certificated for ditching.

2.3.2 Dispatch Deviations

FAA-Approved Airplane Flight Manual data shall be provided to define airplane dispatch capabilities under the following conditions:

- o With one engine inoperative (nonrevenue ferry flight)
- o With one air conditioning pack inoperative

In the design of the airplane the ability to dispatch the airplane with certain other items of equipment inoperative will be a primary objective. Dispatch on revenue or non-revenue flights and at supersonic or subsonic speeds will be considered. Further, the Seller shall participate with airline Buyers and the FAA in determining a minimum equipment program for dispatch deviation purposes.

2.4 AIRPLANE SPECIFICATION CHANGES

2.4.1 General

Changes to the design of the airplane from the configuration described in this Specification shall be defined and handled as follows:

2.4.2 Negotiated Changes

This specification may be amended from time to time by change orders in writing to the Purchase Agreement as set forth in the Purchase Agreement. Such change orders will describe in detail the changes to be made to this Specification and the effect, if any, of such changes on design performance, weight, balance, time of delivery and purchase price of the aircraft.

2.4.3 Development Changes

This Specification also may be revised by Boeing without change order as set forth in the Purchase Agreement, to incorporate development changes where such changes do not adversely affect price, time of delivery, guaranteed weight or guaranteed performance of the aircraft or the interchangeability or replaceability requirements of this Specification. Development changes are those changes deemed necessary to correct defects, improve the aircraft, prevent delay of aircraft delivery or ensure compliance with the Purchase Agreement. Boeing shall notify the Buyer of all changes made in this Specification pursuant to this paragraph by furnishing the Buyer revision insert pages for this Specification.

2.4.4 Changes for Safety or Economics

Boeing reserves the right to make changes to the design specified herein if such changes are deemed necessary to improve the safety or economics of the airplane. Any such change shall not adversely affect price, guaranteed weight, or guaranteed performance. Boeing shall inform the buyer of such charges on a timely basis.

2.4.5 Changes Required to Obtain Certification

Changes required to obtain certification are those changes described in the Purchase Agreement under the article entitled "Federal Aviation Agency Approval". Any such change may require revision of the Purchase Agreement and Specification.

2.5 WORKMANSHIP, MATERIALS, AND METHODS

Workmanship, materials, and methods used in the construction of the airplane shall be in accordance with requirements of the FAA and consistent with the state-of-the-art for commercial airplanes of the supersonic transport category at the time the airplane is designed.

2.6 INSPECTION AND TESTS

An accurate and complete system of inspection covering all materials, fabrication methods, and finished parts shall be maintained. Inspection and testing of materials or parts shall be in accordance with procedures established by Boeing and, where appropriate, shall be subject to approval by the FAA.

2.7 PACKING AND MARKING

Each airplane shall be prepared by the Seller for flyaway delivery as set forth in the Purchase Agreement.

2.8 FINISHES, COLORS, AND FABRICS

Exterior and interior finishes shall be as specified in applicable documents listed in Par. 2.2.2. Reasonable deviations from the specified finishes shall be permissible, subject to the provisions of Par. 2.4. *The exterior decorative markings specification shall define the customer approved exterior design.*

2.9 MOCKUPS

Buyer-requested mockups, additional to those provided for the basic airplane, may be constructed by the Seller when

agreed to by Change Order to the Purchase Agreement or by separate written agreement between the Buyer and Seller.

2.10 BUYER-FURNISHED EQUIPMENT

The Purchase Agreement defines the obligations of Buyer and Seller concerning equipment to be furnished by the Buyer for installation in the airplane prior to delivery.

2.11 UNITS OF WEIGHTS AND MEASURES

All airplane manuals, charts, instrument dial markings, placards, signs, stencils, instructions, nameplates, and maintenance markings shall be in the following U. S. Standards Units of weights and measure unless stated otherwise in this Specification:

<u>Dimensions</u>	<u>Units</u>
Linear	inches, feet, nautical miles
Area	square inches, square feet
Volume	cubic inches, cubic feet
Liquid Measure	fluid ounces, U. S. gallons
Weight	ounces, pounds
Speed	knots, Mach number
*Temperature	degrees centigrade and/or Fahrenheit

**Takeoff and landing data shall be in degrees Fahrenheit and inflight data shall be in degrees centigrade in the flight manual. The cabin air conditioning system, landing gear, hydraulic system, and pneumatic system placards shall be given in degrees Fahrenheit.*

2.12 IDENTIFICATION

2.12.1 Seller's Name

The Seller's name and model number shall be displayed on the outside of the airplane so that they can be easily read by boarding passengers. Such display shall be consistent with the Buyer's decorative scheme and shall be approved by the Buyer.

2.12.2 Airplane Identification Numbers

The airplanes described by this Specification shall be assigned the following identification numbers:

<u>Airplane Number</u>	<u>Airplane Tabulation Number</u>	<u>Manufacturer's Serial Number</u>	<u>Registry Number</u>
1	*	*	*

*To be assigned.

2.13 CERTIFICATE OF SANITARY CONSTRUCTION

A U. S. Public Health Service certificate of sanitary construction shall be obtained and installed in a location that is visible to passengers, agreed to by the Buyer, and consistent with the interior decorative scheme.

2.14 DEFINITIONS

2.14.1 Terms and Abbreviations defined below shall have the meanings specified in this paragraph, wherever used in this Specification:

- "FAA" shall mean the United States Federal Aviation Administration.
- "FAR" shall mean the Federal Air Regulations promulgated by the United States Federal Aviation Administration.
- "NASA" shall mean the National Aeronautics and Space Administration.
- "Boeing" or "Seller" shall mean The Boeing Company, and "Buyer" shall mean the purchaser of the airplane(s) described in the Specification.
- "Purchase Agreement" shall mean the contract between Boeing and the Buyer relating to the sale and purchase of the airplane(s) described in this Specification.
- "Standard Day" shall mean U. S. Standard Atmosphere, 1962, *Geometric*.
- "ARINC" shall mean Aeronautical Radio, Inc.
- "SAE" shall mean Society of Automotive Engineers.
- "ATA" shall mean Air Transport Association.

- "AIA" shall mean Aerospace Industries Association of America, Inc.
- "ASTM" shall mean American Society for Testing Materials.

2.14.2 Provisions Terminology

The words "provisions for," "structural provisions for," and "space provisions for" shall have the following meanings wherever used in this Specification:

- "Provisions for" a specific item of equipment, or assembly or installation, shall mean that all supports, brackets, tubes and fittings, electrical wiring, hydraulic lines, etc., have been installed and adequate space allocated so that the equipment can be installed without alteration to the specified equipment or the airplane, and that no additional parts are required for installation other than the item itself. Standard stock items such as nuts, bolts, cotter pins, etc., need not be furnished by the Seller.
- "Structural provisions for" a specific installation shall mean that the primary structure will be structurally adequate for the installation but that brackets, bolt holes, electrical wiring, hydraulic lines, etc., will not be provided. Detailed engineering designs of tubing, wiring, parts, and installation will not be made. Attaching structure for a specific item shall be provided only when attaching structure is part of primary structure. The term "primary structure" includes all structural components that are essential to the safety and structural integrity of the airplane. Typical examples of primary structures are: wing spars, ribs, skin, and skin stiffeners; body bulkheads, frames, beams, and skin. The primary structure does not include items such as brackets, angles, channels, fittings, or similar parts that are provided only to attach equipment or accessories to the primary structure.
- "Space provisions for" a specific installation shall mean that the space required for that installation is unoccupied in the airplane. "Space provisions for" does not imply that adequate attaching structure is provided; that brackets, bolt holes, electrical wiring, hydraulic lines, etc., will be furnished, designed, or installed; or that the installation itself will be furnished.

2.15 STRUCTURAL TERMINOLOGY

The following terms are definitions of the basic strength criteria for design of the aircraft structure:

- "Maximum zero fuel weight" is the maximum gross weight with zero usable fuel.
- "Maximum design flight weight" is the maximum weight for flight as limited by airplane strength and airworthiness requirements. A flaps-up condition will be implied unless otherwise stated.
- "Maximum design landing weight" is the maximum weight for landing as limited by airplane strength and airworthiness requirements.
- "Maximum design taxi weight" is the maximum weight allowed for ground maneuver as limited by airplane strength and airworthiness requirements. This weight includes the weight of taxi and runup fuel.
- "Manufacturer's empty weight" is the weight of the structure, power plant, furnishings, systems, and other items of equipment that are an integral part of a particular airplane configuration. It is essentially a "dry" weight, including only those fluids contained in closed systems.
- "Standard items" are those system fluids or equipment which are not considered an integral part of a particular aircraft configuration and not included in the "Manufacturer's Empty Weight," but do not vary for aircraft of the same type.
- "Basic empty weight" is the "Manufacturer's Empty Weight" plus the "Standard Items."
- "Operational items" are those items of personnel, equipment and supplies that are necessary on a particular operation unless already included in the "Basic Empty Weight." These items may vary for a particular aircraft configuration according to the operator's allowances for the service intended.
- "Operational empty weight" is the "Basic Empty Weight" plus the "Operational Items."
- "Allowable payload" is the "Maximum Zero Fuel Weight" minus "Operational Empty Weight."

SECTION 3 GENERAL AIRPLANE CHARACTERISTICS

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SECTION 3 GENERAL AIRPLANE CHARACTERISTICS

3.1 GENERAL

The airplane shall be designed to meet *and show compliance with* the requirements of FAR 25, effective February, 1965, and Amendments 1 through 7, or the intent of the requirements of FAR 25 insofar as practicable for this particular design. *The FAA Tentative Airworthiness Standards for Supersonic Transports, dated November 1, 1965, shall be considered for study, trial application, and coordination with the FAA during the detail design phase of this airplane.* In addition, the design of the airplane shall be in accordance with the criteria defined in Par. 1.4 and this section of this Specification.

3.2 DESIGN STRUCTURAL CRITERIA

3.2.1 Limit Maneuver Load Factors (Flaps Up)

Positive: +2.50g
Negative: -1.00g

3.2.2 Limit Gust Load Criteria

The requirements of FAR 25.341 shall apply, except that rough air gusts at the design speed for maximum gust intensity (V_B) shall not be considered at speeds greater than Mach 1.0. The design gust velocities shall be modified as follows: For design cruising speed (V_C) values greater than Mach 1.0, positive and negative gusts of 60 fps shall be considered at altitudes between sea level and 20,000 ft. At altitudes above 20,000 ft, the gust velocity shall be reduced by the factor $(\sigma/\sigma_0)^{1/2}$, where σ is the density ratio at any altitude and σ_0 is the density at 20,000 ft.

For supersonic flight, a supersonic alleviation factor (K_g) shall be used in place of the standard subsonic gust alleviation factor. *The airplane shall be capable of withstanding continuous turbulence (within limits to be determined jointly by the FAA and Seller), taking into account the dynamic response of the configuration.*

3.2.3 Design and Operating Airspeed Limitations

3.2.3.1 Airspeed Designation

The design airspeeds in this Specification are listed as equivalent airspeed (EAS). The operating speeds placarded in the airplane shall be specified in calibrated airspeed (CAS).

3.2.3.2 Maximum Operating Limit Speed (V_{MO}/M_{MO})

For subsonic flight with wing-sweep positions of 42 and 72 deg, the maximum operating limit speeds shall be substantially as shown in Fig. 3-1. For supersonic flight, the airplane shall be designed for a maximum operating Mach number (M_{MO}) of 2.7, *but not to exceed a continuous maximum* stagnation temperature of 500°F, as shown in Fig. 3-1.

3.2.3.3 Design Limit Diving Speed (V_D/M_D)

For subsonic flight with wing-sweep positions of 42 and 72 deg, the design limit diving speeds shall be substantially as shown in Fig. 3-1. For supersonic flight, the airplane shall be designed for M_D equal to Mach 2.9 and a stagnation temperature of 585°F, as shown in Fig. 3-1, which allows for a 7.5-deg nose-down upset with cruise thrust for 20 seconds followed by a 1.5g pullout maneuver.

3.2.3.4 Design Flap Speeds (V_F)

The design flap speeds shall be a function of the extended position of the outboard main wing flap (20 and 30-deg wing-sweep positions only) as follows:

Outboard Main Wing Flap Extension Position (Reference)	Design Flap Speed V_F -Knots (EAS)
5 deg	290
20 deg	225
30 deg	195

3.2.3.5 Design Landing Gear Operating and Extended Speeds

The design landing gear operating and extended speeds shall be as follows:

Retract Speed	250 Knots (EAS) or Mach 0.83
Extend Speed	270 Knots (EAS) or Mach 0.90
Extended Speed (Doors Closed)	320 Knots (EAS) or Mach 0.90

3.2.3.6 Movable Nose Design Speed

Actuation of the movable forebody nose or flight with the nose in the down position shall be limited to Mach 0.90 or V_D , whichever is smaller.

3.3

DESIGN BALANCE LIMITS

The operational center-of-gravity limits (percent of the Wing Reference Chord specified in Par. 1.6) shall be substantially as shown in Fig. 3-2.

The aft center of gravity limit for all ground handling conditions shall be 63.7 percent of the wing reference chord specified in Par. 1.6 with manifold operating and 64.0 percent of the wing reference chord specified in Par. 1.6 with manifold closed.

A cg indicating system shall be provided to indicate to the flight crew the location of the cg as loaded for takeoff.

For the 2707 (GE):

The center-of-gravity position for the Operational Empty Weight shall be approximately 64.3 percent of the Wing Reference Chord specified in Par. 1.6 with the movable wing sections in the 20-deg sweep position, and the landing gear down.

For the 2707 (P&W):

The center-of-gravity position for the Operational Empty Weight shall be approximately 63.9 percent of the Wing Reference Chord specified in Par. 1.6, with the movable wing sections in the 20-deg sweep position, and the landing gear down.

3.4

DESIGN ENVIRONMENTAL CRITERIA

The airplane and all Seller-furnished equipment shall function satisfactorily under ground conditions in atmospheric ambient temperatures as follows:

Pressure Altitude (ft)	Cold Day	Hot Day
-1,000 to +2,500	-50°F	121°F*
8,000	-50°F	101°F*

* Linear variation of temperature with altitudes from 2,500 to 8,000 ft.

Engine oil and fuel system temperatures shall be an exception to this requirement. (Refer to Pars. 5.5, 5.12.1.1, and 8.1.1.)

The airplane and all Seller-furnished equipment shall function satisfactorily under flight conditions in atmospheric ambient temperatures defined by Fig. 12-3. The airplane and all Seller-furnished equipment shall function satisfactorily when operated on any combination of flights with the flight conditions defined by Fig. 12-3 and the most adverse ground ambient temperatures as defined above. Satisfaction of this requirement shall take into account adiabatic temperature rise during flight, solar heating, and the local environment of the installation.

3.5 DESIGN CERTIFICATION ALTITUDE

The design certification altitude of the airplane shall be 73,000 ft (pressure altitude).

3.6 DESIGN NOISE LEVEL CRITERIA

3.6.1 Design External Noise Level Criteria

Refer to Supplement 2, Par. S2-1.6 of this Specification.

3.6.2 Design Internal Noise Level Criteria

3.6.2.1 Flight Deck Sound Levels

The overall sound level and speech interference level, measured at head level for the pilots' and flight engineer's seats, shall not exceed the following values during the specified level-flight cruise conditions:

<i>Flight Condition</i>	<i>Overall Sound Level* (db)</i>	<i>Speech Interference Level** (db)</i>
<i>Mach 0.80</i>		
<i>24,000 ft Altitude</i>	<i>90</i>	<i>69</i>
<i>Body Nose, Down Position</i>		
<i>Mach 2.7</i>		
<i>65,000 ft Altitude</i>	<i>85</i>	<i>67</i>
<i>Body Nose, Fired Position</i>		

3.6.2.2 Passenger Cabin Sound Levels

The overall sound level * shall not exceed 86 db at any seat, head-level position, in the passenger cabin for either supersonic or subsonic cruise (with body

nose in either the faired or down position) conditions and a 50 percent passenger load.

The speech interference level ** shall not exceed 65 db for either supersonic or subsonic (with body nose in either the faired or down position) cruise at any seat, head-level position, in the passenger cabin.

The effect of Buyer-Furnished equipment or installations accomplished by the Buyer, are not considered a part of the sound levels specified herein.

*Sound pressure levels are in terms of 0.002 dyne/sq cm.

**Speech interference level is herein defined as the average sound pressure level in the following octave bands: 600 to 1,200, 1,200 to 2,400, and 2,400 to 4,800 cps.

3.6.3 Design Sonic Boom Overpressure Criteria

Refer to Supplement 2, Par. S2-4.8, of this Specification.

3.7 APPROACH AND LANDING CAPABILITY

The airplane shall possess characteristics in approach and landing configurations that will enable Instrument Landing System (ILS) approaches to be conducted by qualified airlines and flight crews to weather minimums of 2,600 feet Runway Visual Range (RVR), without assistance from an approach coupler, flight director, or other computing navigation devices.

The airplane shall incorporate computing/display-type equipment and/or automatic flight control equipment that will enable qualified airlines and flight crews to satisfactorily complete ILS approaches to touchdown under visibility conditions of 700-ft RVR on airports equipped with adequate approach and runway lighting facilities.

3.8 LANDING CAPABILITY, WINGS AFT

For the 2707 (GE):

The airplane shall be capable of being landed and brought to a full stop, with the wings fully aft, at a landing weight of 350,000 pounds, with all drag devices *which can be extended with wings fully aft*, with all wheel brakes and four engine thrust re-

versing systems operative, over a 50-ft obstacle, on a wet runway, in 6,900 ft or less, in still air, at sea level, on a standard day.

For the 2707 (P&W):

The airplane shall be capable of being landed and brought to a full stop, with the wings fully aft, at a landing weight of 350,000 pounds, with all drag devices *which can be extended with wings fully aft*, with all wheel brakes and four engine thrust reversing systems operative, over a 50-ft obstacle, on a wet runway, in 7,400 ft or less, in still air, at sea level, on a standard day.

3.9

FLIGHT DECK VISIBILITY

Flight deck visibility shall be equivalent to that provided in Model 707 subsonic jet transports during approach, landing and takeoff *and shall meet the objectives of SAE AS-580*. Further, it shall be an objective to provide flight deck visibility that will meet accepted industry standards for supersonic transports during en route climb, cruise, and descent conditions. It shall be an additional objective to verify that any diminution of flight deck visibility levels from that of the Model 707 during climb to altitude and cruise will not adversely affect safety of flight.

3.10

HANDLING QUALITIES

With stability augmentation functioning normally, airplane handling qualities shall be equal to or better *than those of the 707-120B and 727 aircraft*. It shall be a design objective that the airplane shall be designed for safe operation by the pilot with partial stability augmentation operative or without the aid of stability augmentation.

It shall be a design objective that the airplane shall have flight handling qualities such that at the most critical point in flight, with the most critical augmentation axis inoperative and the most critical engine inoperative, a descent and approach can be made manually on the flight director to a landing with weather minimums of 200 ft and 1/2 mi.

Pitch trim changes with configuration changes (flaps, speed brakes, thrust, gear and wing sweep) shall be kept to near zero. Automatic trim compensation shall be used if necessary.

SAE ARP 842 "Design Objectives for Flying Qualities of Civil Transport Aircraft" shall be used as a guide in meeting the foregoing.

3.11 DISPATCH AND INFLIGHT RELIABILITY

It shall be a design objective that after 18 months of air carrier revenue operation the schedule delay rate, as well as the inflight turnback and destination deviation rate, for mechanical reasons shall be equal to or better than subsonic commercial jet transport aircraft of the 1965 era.

3.12 MAINTAINABILITY

Maintainability shall be a primary consideration in the design airplane. It shall be a design objective to include maintainability features that will minimize operating costs attributable to scheduled and unscheduled maintenance and servicing tasks and that will improve departure reliability and airplane utilization by minimizing the time required to accomplish maintenance and servicing tasks.

Maintenance requirements for specific systems and components are defined in the pertinent sections of this specification. Refer to Sec. 13.0 for maintainability requirements applicable to the entire airplane.

3.13 SAFETY

A comprehensive safety program shall be conducted and integrated into the airplane design program with the objective of substantially reducing the accident probability of the supersonic transport relative to current commercial subsonic transport aircraft. Numerous safety requirements for individual subsystems are identified in this specification. Collectively and individually these subsystem safety requirements reflect the minimum requirements for compliance with current airworthiness standards and define the baseline from which airplane safety shall be further improved. The following general safety requirements shall apply to the 2707 airplane:

- No combination of related failures shall result in the existence of a catastrophic hazard.

- It shall be a design objective to provide a flight-crew/airplane interface environment superior to current subsonic jet transports.
- Environmental conditions hazardous to maintenance personnel shall be minimized during the design of airplane subsystems and related ground support equipment, and in the preparation of maintenance and inspection procedures.
- Crashworthiness shall be of primary consideration in the design of airplane subsystems to minimize hazards to the passengers and flight crew.
- All airplane subsystems shall function with no significant degradation of safety of the airplane, flight crew, or passengers during all operational conditions defined by the airframe structural limitations.

3.14 ESTIMATED WEIGHTS (LB) (280-PASSENGER ARRANGEMENT)

For the 2707 (GE):

Manufacturer's Empty Weight		277,280
Standard Items		4,185
Unusable Fuel	1,192	
Unusable Oil-Hydraulics and Lubrication	252	
Emergency Equipment	512	
Oxygen Equipment (Portable)	40	
Crash Axes (2)	6	
Escape Slides (8)	466	
Unusable Water-Washing and Drinking	10	
Toilet Water and Chemical	150	
Galley Structure (6)	2,069	
Basic Empty Weight		281,465
Operational Items		6,635

Crew and Crew Baggage	1,850
Flight Crew (3)	510
Cabin Attendants (8)	1,040
Crew Baggage (11)	275
Captain's Briefcase (1)	25
Usable Oil-Lubrication	80
Emergency Equipment	1,979
25-Man Life Rafts (12)	1,500
Automatic Emergency Beacon (4)	20
Life Vests (306)	459
Usable Water-Washing and Drinking	386
Passenger Service Equipment (280 Persons)	728
Food and Beverage (291 Persons, including crew)	436
Galley Service (291 persons including crew)	646
Liquor Service (280 persons)	398
Lavatory Supplies	57
Plug-In Food Trays (30)	75
Operational Empty Weight	288,100
<u>For the 2707 (P&W):</u>	
Manufacturer's Empty Weight	275,400
Standard Items	4,185
Unusable Fuel	1,192
Unusable Oil-Hydraulic and Lubrication	252

Emergency Equipment		512
Oxygen Equipment (Portable)	40	
Crash Axes (2)	6	
Escape Slides (8)	466	
Unusable Water-Washing and Drinking		10
Toilet Water and Chemical		150
Galley Structure (6)		2,069
Basic Empty Weight		279,585
Operational Items		6,635
Crew and Crew Baggage		1,850
Flight Crew (3)	510	
Cabin Attendants (8)	1,040	
Crew Baggage (11)	275	
Captain's Briefcase (1)	25	
Usable Oil-Lubrication		80
Emergency Equipment		1,979
25-Man Life Rafts (12)	1,500	
Automatic Emergency Beacon (4)	20	
Life Vests (306)	459	
Usable Water-Washing and Drinking		386
Passenger Service Equip- ment (280 persons)	728	
Food and Beverage (291 per- sons including crew)	436	

Galley Service (291 persons,
including crew) 646

Liquor Service (280 persons) 398

Lavatory Supplies 57

Plug-In Food Trays (30) 75

Operational Empty Weight 286,220

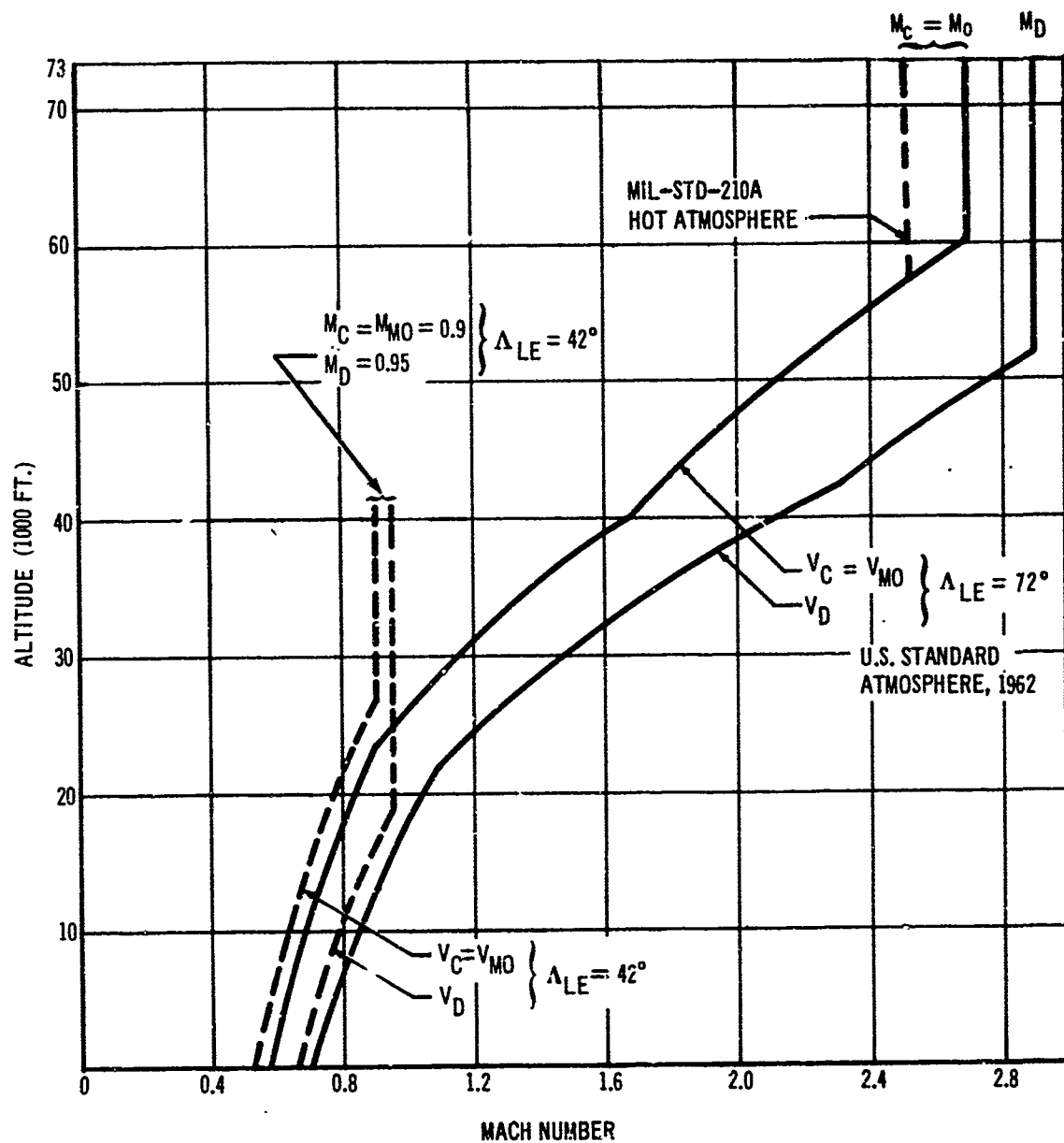


Figure 3-1. Estimated Limit Speeds

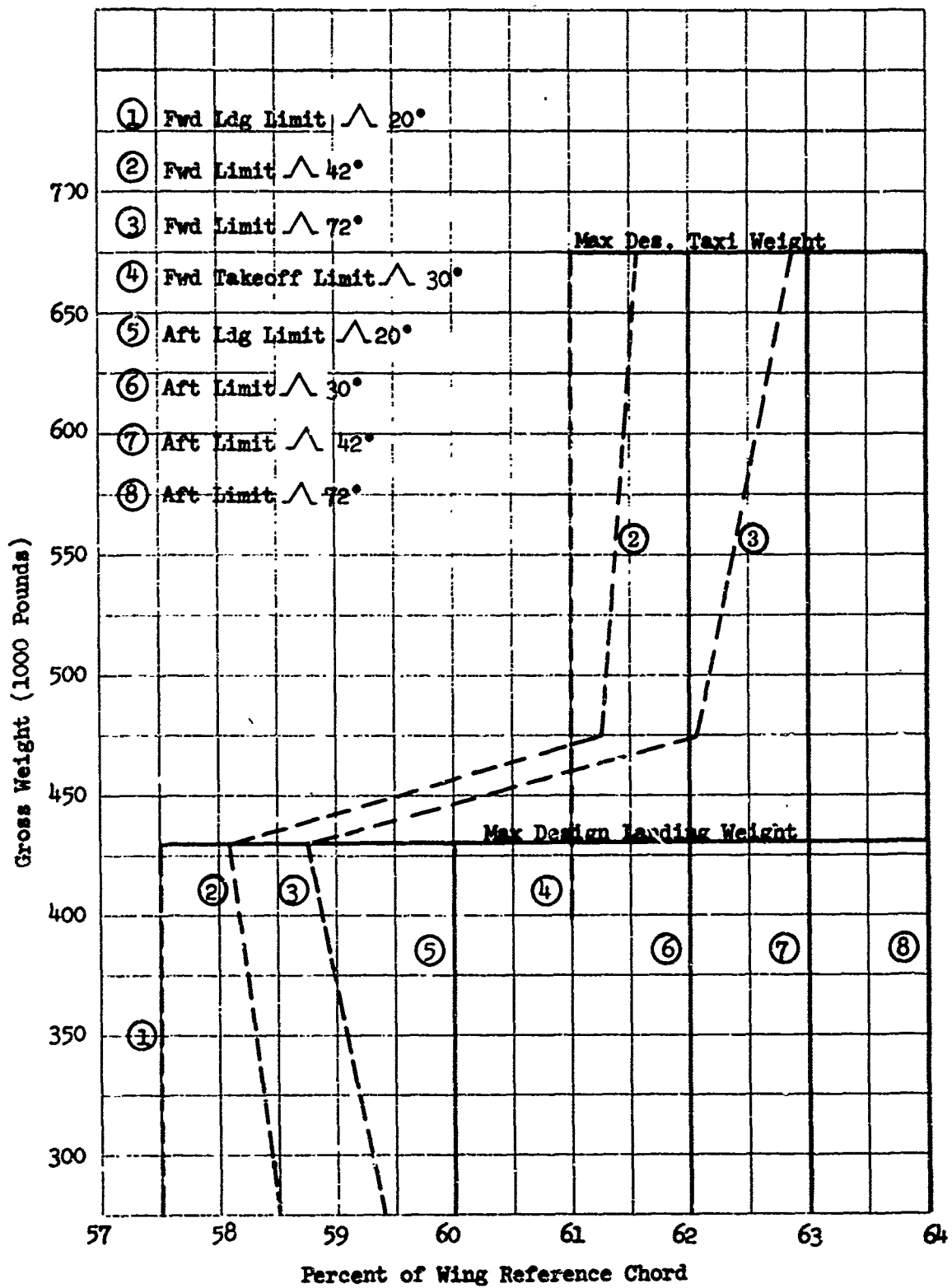


Figure 3-2. Operational Center of Gravity Limits

SECTION 4 AIRFRAME STRUCTURES

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SECTION 4 AIRFRAME STRUCTURES

4.1 GENERAL

4.1.1 Service Life

A service life of not less than 50,000 flight hours shall be the criterion to which the primary structure of the airplane is designed; however, the structure shall be designed to be repairable or replaceable, thus permitting extension of service life beyond the 50,000 hr. criterion. The structural life shall be verified by analyses and from results of structural tests.

Protection against structural fatigue shall be the foremost consideration throughout the design. Attention shall be given to the reduction of stress levels, to ensure adequate radii, to provide proper surface finish and corrosion protection, and to minimize discontinuities.

Maximum consideration shall be given to the design and location of such items as service doors, filler caps, liquid drains, and ice accretion areas of the wing, fuselage, horizontal stabilizer, and engines to preclude foreign object damage to the engines.

Adequate access panels shall be provided for lubrication and structural inspection. Where practicable, all fasteners on any one access panel shall be of the same length. When necessary to use fasteners of different lengths, fasteners of each length shall be of different diameter than those of any other length.

4.1.2 Materials

The structure, in general, shall be fabricated of titanium alloy. Panel assemblies made of titanium and/or glass reinforced fabric faces bonded to glass reinforced fabric nonperforated honeycomb shall be used in selected applications. (See Fig. 4-1.) Limited use shall be made of alloy steels heat treated to high strength levels. Other steels and aluminum alloys may be used as dictated by design requirements. The selection of steel alloys and their heat treatment shall be based on extensive investigation and testing. In the design of the landing gear, due consideration shall be given to selection of alloy and heat treat such that fatigue life and insensitiveness to operating conditions shall be satisfactory for airline operation.

It shall be a design objective to limit the use of blind fasteners to isolated closure areas and to areas where

blind fasteners are required to achieve part assembly and/or manufacture. Blind fasteners shall not be used for primary structural fastening or attachment except where the use of other types of fasteners is not practicable. Gang-nut channels or nut plates shall be used for all blind bolts or in areas of restricted access.

Extruded seals subject to contamination by fuel, engine oil, hydraulic fluid, etc., shall have a satisfactory service life when in contact with these fluids.

Sealants such as aerodynamic smoother subject to contamination by fuel, engine oil, hydraulic fluid, etc., shall be resistant to such fluids or adequately protected with a suitable topcoating to provide such resistance.

No magnesium sheet, castings, or forgings shall be used as primary structure.

4.1.3

Fabrication

Conventional methods of manufacture shall be used, including roll, brake and stretch forming; machining; and chem-milling. Fusion welding, spot welding, bonding and mechanical fasteners shall be used to assemble primary and secondary structures. All fusion welds in the primary structure shall have 100-percent radiographic (or equivalent) inspection.

All faying surfaces shall be designed to minimize chafing. All movable parts such as wing-to-fuselage fairings, non-structural access doors, actuator fairings, etc., shall have rub pads or strips used to prevent damage to primary structure and shall be removable and replaceable.

Structural joints involving single bolted or pinned attachments subject to intentional or unintentional rotation shall incorporate replaceable bushings, except that bushings may be omitted at locations subject to unintentional rotation where bearing stresses are maintained at a sufficiently low level and where the future installation of bushings can be accomplished by normal machine shop tools and operation.

The design of hinge attachments of all primary control surfaces shall be such that failure or loss of any single hinge component in normal operation will not preclude ability to safely continue to a reasonable destination.

Wherever piano-type hinges are used, except on small access panels, at least the last 4 in. on each end shall be constructed from a long-wearing material with a service life

equivalent of steel. Any piano hinge not replaceable shall have allowance for bushing. Piano hinges shall be designed so that the hinge pins may be easily removed.

All removable screwdriver type fasteners used for individual removable panels or installations shall have a common type head slot.

All movable control surfaces shall be attached using self-aligning antifriction bearing hinges.

All types of honeycomb and bonded structure shall be 100 percent inspected by adequate nondestructive means.

4.1.4 Drainage and Ventilation

Provisions shall be made for automatic drainage at points where any fluids are likely to collect. These provisions shall permit rapid drainage of flushing agents that may be used to remove flammable fluids in areas where fuel lines are installed. Removal of access panels shall be acceptable for providing entry into such areas for flushing. (For propulsion pod drainage description, refer to Par. 5.3.) The airplane design shall be such that all fluids used for exterior cleaning or washing, at 125 psi pressure, shall completely drain and that no fluids can enter or damage the interior or other critical items, such as jackscrews, actuators, etc. (fuel tank vent outlets, engine, etc., are considered exceptions). During such operation entry and service doors into the passenger compartment and cargo doors shall require sealing of the gaps between the door and the fuselage.

Means shall also be provided to prevent entry of ceiling condensation into the passenger cabin interior.

Ventilation shall be provided to prevent accumulation of hazardous vapors. Galley areas and lavatory compartments shall be adequately vented. (Refer to Par. 12.2.1.)

4.1.5 Protective Finish

Corrosion protection shall be provided for all structure, either by choice of corrosion resistant materials or by use of protective finishes. Special attention shall be given to providing protection against corrosion where dissimilar materials and metals are employed.

4.1.6 Smoothness

Structural smoothness criteria, as determined by the Seller, shall be compatible with the airplane speed characteristics.

In determining the smoothness criteria, consideration shall be given to the normal degradation of smoothness as experienced in airline service. An airplane of normally degraded smoothness shall be able to substantially meet the performance requirements.

4.1.7 Jacking

Three main jack points, one on the forward body and two on the horizontal tail, shall be provided for use during normal airframe jacking.

In addition, a minimum of one jack point on each outboard wing shall be provided for stabilization and for use during wing pivot-bearing maintenance. Means for jacking shall also be provided on each main landing gear and on the nose landing gear.

The main jacking points shall be designed for an ultimate load factor of 2.5 based on an airplane weight of 410,000 lb. The axle jacking points shall be designed for jacking the airplane at the design taxi gross weight and shall permit changing all wheels and brakes on an individual truck.

4.1.8 Towing

Fore and aft lugs, suitable for towbar towing forward or backward or pushing backward, shall be provided on the main gear and the nose gear. These lugs shall be replaceable if damaged. Provisions shall be made to permit backward cable towing from each main gear. A simple means shall be provided to connect the towbar to the nose gear and towing shall be possible within the design steering angle without disconnecting the torsion links.

The design ultimate towing or pushing loads shall be 152,000 lb. for the nose gear and 114,000 lb. for each main landing gear.

4.1.9 Hoisting

Provisions shall be incorporated to facilitate hoisting and handling major assemblies and components *which weigh in excess of 200 lb., giving due consideration to accessibility*, such as the movable wing sections, elevons, tail cone, trailing edge flaps, rudder and the variable-geometry body nose section.

4.1.10 Wheels-Up and Failed Gear Landings

The airplane structure shall be designed to minimize damage to primary structure and to minimize the hazards of fire

and fuel tank rupture in the event of a wheels-up landing or gear failure during landing and shall have inherent provisions for application of emergency lifting equipment for raising the airplane. During design, consideration shall be given to the recommendations contained in FAA Technical Report ADS-19.

4.1.11 Turbine Disk Failure Protection

The design of the airplane shall be based on consideration of compressor and turbine wheel burst as determined by suitable analysis. Insofar as practicable, the design shall permit the airplane to survive such turbine wheel rupture by suitable protection as indicated by the analysis with respect to fire, control, stability, dynamics, balance, residual structural strength, and thrust.

4.2 WING

4.2.1 General Description

The wing shall be composed of five major sections: one main center section extending from the wing pivot on the left to the pivot on the right, two fixed sections forward of the main center section, and two movable wing sections extending outboard from the pivots. *The main center section shall be permanently attached to the body.*

4.2.2 Basic Structure

Primary wing structure shall be fabricated from titanium alloy tapered skin, stiffened with extruded and formed titanium alloy stringers. Two spars shall serve primarily as shear-carrying members; the skin and stringers shall carry the major portion of wing bending loads. Spars shall be built of extruded upper and lower chords and a tapered web.

Wing spar caps shall be of sufficient size to permit installation of the next full size fasteners. The movable wings, center section, and the two fixed sections forward of the center section shall be designed to contain fuel. The center section also shall be designed to support the main landing gear. Access to the wing box for fabrication, inspection, and repair shall be provided.

The primary structure of the wing pivots shall be laminated, segmented construction to provide multipath fail-safe characteristics consistent with those of the inner and outer wing structure.

The pivots shall incorporate large-diameter bearing assemblies using nonmetallic bearing surfaces that require

no lubrication. It shall be possible to inspect and/or replace the bearing assemblies without removing the outer wing panels. *Sealing shall be provided as a barrier to the entry of foreign material and liquids which would detract from the service life of the bearing.*

4.2.2.1 Leading Edge

The fixed portion of the wing leading edge shall consist of ribs and skin assemblies. Access shall be provided through nonstructural honeycomb panels in the lower surface. *Leading edge construction, including slats, shall be suitable to minimize denting or other damage that could result from flight through hail or from ground operations.*

4.2.2.2 Trailing Edge

The fixed portion of the wing trailing edge shall be constructed of ribs, skin, and honeycomb panel assemblies. *Access shall be provided to all trailing edge device actuators and other service points. Access panels shall be of the nonstructural type.*

4.2.3 Leading-Edge Slats and Trailing-Edge Flaps

The movable leading-edge slats shall be of honeycomb and built-up construction. Slotted trailing-edge flap sections shall be provided and shall be of honeycomb and built-up construction. (See Fig. 7-1.) *Structural design of the trailing edge devices shall be such as to minimize damage due to slush, water, tire tread, etc.*

4.2.4 Spoilers

Spoilers, hinged near the rear spar, shall be installed on the upper surface of the movable wings. (See Fig. 7-1) The spoilers shall be of honeycomb and built-up construction.

4.2.5 Ailerons

Ailerons shall be provided on the movable wings. (See Fig. 7-1.) They shall be constructed of ribs, skins, and honeycomb panel assemblies.

4.3 EMPENNAGE

4.3.1 Vertical Fin

4.3.1.1 General Description

The vertical fin shall be composed of three basic sections: a fixed leading edge forward of the structural box, a

structural box extending from within the body to the fintip, and a full-span rudder. The structural box shall be permanently attached to the body.

4.3.1.2 Basic Structure

Primary vertical fin structure shall be fabricated of spars and ribs with machined, sculptured skins and stiffeners. Secondary structure shall consist of corrugated ribs and spars with bonded honeycomb panels. *Means shall be provided for visual inspection and repair of the primary structure.*

4.3.1.3 Rudder

The rudder shall be mounted on hinge fittings attached to the rear spar of the vertical fin. Construction shall be of ribs and spars with bonded honeycomb panels.

4.3.2 Ventral Fin

The ventral fin shall consist of ribs and spars with bonded honeycomb cover panels. It shall be mechanically attached to the body. *The ventral fin shall be designed for easy replacement of damaged parts by the use of replaceable components. Equipment necessary for aircraft operation such as antennas, etc., shall not be installed in those areas of the ventral fin likely to be damaged.*

4.3.3 Horizontal Stabilizer

4.3.3.1 General Description

The horizontal stabilizer shall be a fixed stabilizer with movable elevators and elevons. It shall consist of a structural box, a forward leading-edge section and a trailing-edge section. The elevons shall form the tips of the stabilizer. The elevators shall be located aft of the rear spar and shall form the trailing edge between the engines. Portions of the stabilizer shall be constructed to contain fuel.

4.3.3.2 Basic Structure

Primary stabilizer structure shall be of ribs, spars, tapered skins, and stiffeners. Secondary structure shall consist of ribs and spars with bonded honeycomb panels. Support for the engines, auxiliary drive system, and environmental control system shall be provided.

Adequate access shall be provided in the leading and trailing edges to the control runs, actuators, etc. Adequate access to the horizontal stabilizer box for fabrication, inspection, and repair shall be provided.

4.3.3.3 Elevons and Elevators

Elevon structure shall consist of ribs and spars with bonded honeycomb assemblies. The elevons and elevators shall be supported by hinges attached aft of the rear spar.

4.4 BODY

4.4.1 General Description

The body shall be composed of six sections: the forward section composed of the nose, flight deck, and electronics compartment; the forward section of the passenger compartment and the nose gear well; the forward center section of the passenger and lower-lobe cargo compartments; the aft center section of the passenger and lower-lobe fuel compartments; the over-the-wing section, the aft section of the passenger compartment, the over-the-stabilizer section, the aft main gear well, and the aft cargo compartment; and the tail section. The dimensions of the body shall be substantially as shown in Fig. 1.1.

The body shall be of semimonocoque construction, consisting of frames and skins stiffened with longitudinal stringers. Honeycomb panels may be used in secondary structure areas but not as pressurized skin.

The nose section shall be of variable geometry, faired for maximum efficiency during supersonic flight. The nose shall rotate down about a single pivot point for improved subsonic flight visibility. (Refer to Par. 9.16.) A forward portion of the nose shall also rotate and be sequenced to maintain alignment of the pitot probe and weather radar equipment in all positions of the nose-down travel. The nose section shall include a radome to house the weather radar (Par. 10.2.2), which shall be of fiberglass construction and interchangeable. *The movable nose section shall have provisions to prevent damage or faulty operation due to accumulation of water, slush, snow, ice, or dirt during flight, takeoff, landing, taxiing, or when parked. The design of the movable nose and its support structure and actuation means shall be such as to ensure adequate crew protection in the event of failure of the nose gear during a landing with the movable nose extended, provided the recommended emergency landing techniques are used.*

The body shall be sealed to contain air pressure within the boundaries shown in Fig. 12-2. Normal maximum differential operating pressure shall be 11.12 psi. Decompression panels, or other means of pressure relief, shall be provided between adjacent pressurized compartments in the body.

The external surfaces of the primary body skin shall be smooth, and skin joints shall be flush. Skin splices in the area of the toilet drains subject to corrosive leakage from the drains shall be faying-surface sealed to prevent entry of toilet drain leakage from outside the airplane into the faying surfaces. Such sealing shall be required on skin splices located 3 ft. on either side of the toilet drains and down to the bottom centerline of the airplane.

4.4.2 Interior Arrangement

4.4.2.1 Passenger Cabin

The interior arrangement of the passenger cabin shall be substantially as shown in Fig. 11-1. Refer to Sec. 11 for a description of passenger and cargo accommodations.

4.4.2.2 Flight Deck

The arrangement of the flight deck shall be substantially as shown in Fig. 6-1. Refer to Sec. 6 for a description of flight crew accommodations.

4.4.2.3 Cargo Compartments

The compartments shall be designed to accommodate cargo having an average density of 10 lb/cu ft. (Refer to Par. 4.4.3.4 for structural limitations.) The forward and aft cargo compartments shall be designed for maximum weight capacities of 17,750 and 13,650 lb., respectively.

Access to the cargo compartments shall be provided from inside the passenger cabin without the necessity of removing fixed equipment, such as galleys and toilets, in the event of internal blocking of the cargo loading doors.

4.4.3 Flooring

4.4.3.1 General

The passenger cabin floor, aft cargo compartment floor, and a portion of the flight deck floor shall be readily removable by means of screw attachments. The passenger cabin floor shall be resistant to impact of high-heeled shoes. *All floor panels shall be fabricated with titanium face sheets.* The underside of the flight deck floor shall be accessible from the compartment below the flight deck (accessible from outside the airplane) and through access panels in the flight deck floor.

Floor panels shall be readily removable without the need for removing fixed partitions and galley sections (except

panels directly under galley sections). Removal of floor panels having sealed joints may require breaking the seals and reinstalling new seals.

A minimum number of different floor panel configurations shall be provided. Whenever practicable, floor panels shall be interchangeable within the airplane and between airplanes.

4.4.3.2 Passenger Cabin Floor

The passenger cabin floor arrangement shall provide for trackmounted passenger seats. The tracks, flush with the floor, shall be in sections that can be easily replaced without removing major passenger items and shall provide for fore and aft seat location adjustment in increments of 1-in. except in the service and main entry door areas.

4.4.3.3 Passenger Cabin Floor Loading

The passenger cabin floor and supporting structure shall be designed for the following loads:

- Seat loads consisting of passengers and seats with a static weight not exceeding an average of 200 lb. per seat to the ultimate load factors specified in Par. 11.2.3 and based on four, five, and six abreast seating, as applicable, at 32-in. seat spacing.
- Cargo load of 100 lb/sq ft., uniformly distributed, but not more than 38 lb/in. of compartment length.

The floors in the heavy traffic areas shall be capable of withstanding a concentrated load of 300 lb. applied with a 3/4-in diameter steel ball at any point on the top surface, without failure or permanent indentation greater than 0.050-in. The remainder of the floors shall be capable of withstanding a concentrated load of 200 lb. applied in a similar manner without a failure or permanent indentation greater than 0.050-in..

4.4.3.4 Cargo Compartment Floor Loading

The cargo compartment floors shall be designed for uniformly distributed loading of 150 lb/sq ft. but not more than 50 lb/in. of compartment length. (Refer to Par. 4.4.2.3 for compartment weight capacities).

All cargo compartment flooring shall be capable of withstanding a concentrated load of 400 lb. applied with a 3/4-in. diameter steel ball at any point on the top surface, without failure or permanent indentation greater than 0.050-in.

4.4.3.5 Protection

Structural components in the vicinity of the lavatory compartments, storage battery compartments, galleys, and the main and service entryways shall be protected against corrosive action of liquids that may accidentally come in contact with them. The floor joints in the lavatory, galley and main and service entry areas shall be sealed to prevent seepage through joints. Moisture barriers shall be provided in galley, lavatory and entry or service door areas to prevent liquids from entering the lower fuselage area and shall extend to cover areas where normal spillage or leakage would occur.

Other joints in the passenger cabin floor shall be designed to minimize seepage, and the floor material shall be resistant to absorption of water. It shall be a design objective to provide floor sealing by mechanical means. Additional protection in the form of shields shall be provided to protect the cable runs, electrical bundles, etc., under galleys, entryways, and lavatories.

4.4.4 Windows

The arrangement of windows shall be substantially as shown in Fig. 1-1.

4.4.4.1 Passenger Cabin Windows

Passenger cabin windows, including windows in the overwing exits, shall be approximately 6.5 in. in diameter at approximately 21-in. spacing, except that every sixth position shall have no window. The windows shall consist of two pressure panes and an inner cover pane. Failure of the inner pressure pane shall not cause loss of the outer pane. Cabin windows will incorporate antiglare provisions.

The window panes shall be interchangeable. Any window component shall be capable of being replaced within 20 min.

4.4.4.2 Flight Deck Windows

Two forward windshields and four side windows shall be provided in the flight deck area and shall be of fail-safe design. Each forward windshield shall consist of an outer monolithic pane and an inner laminated pane, with an air space between the panes. Each side window shall consist of an outer pane, an intermediate pane, and an inner pane, with air space between panes. One pane of each side window shall be laminated. (Refer to Par. 12.7.5 for anti-icing and antifogging provisions.)

Windows shall be provided in the movable nose section. *These windows shall be of laminated construction.*

4.4.4.3 Observation Windows

Wide-angle viewing shall be provided through each entry and galley service door with pan-type recesses sufficient to make full use of the viewing system.

Lens-type viewing shall be provided for observation from the passenger compartment to both the forward and aft cargo compartments.

4.4.5 Doors and Hatches

4.4.5.1 General

The external doors and exits shall be arranged substantially as shown in Figs. 1-1, 1-2, 6-1, 11-1, 11-4, and 11-5. They shall be plug-type and operable from inside or outside the airplane (except for maintenance access doors). Hold-open latches suitable to restrain the doors in 75 mph wind gusts (limit load) shall be provided for all doors whose final open position is outside the airplane.

Door operation shall be designed to suit the requirements of SAE ARP 488. With trim installations complete, main entry and service door opening and closing forces shall not exceed approximately 30 lb. handle load for a stewardess' normal standing position.

Adequate snubbing of doors shall be provided during the opening and closing cycle.

All doors shall be designed for reliability and ease of operation. All doors shall open identically (hinged opposite on opposite sides of the airplane). Door sills shall be as flush and level with the floor as practicable.

All moving parts of the door, rollers, hinges, etc., shall have lubricated bearings or bushings. Provisions for lubrication will be readily accessible.

4.4.5.2 Main Entry Doors

Four entry doors approximately 72 in. high shall be provided on the left side of the airplane. The forward and aft doors shall be approximately 32 in. wide; the two center doors shall be approximately 42 in. wide. See Fig. 11-1 for station locations of the main entry doors.

4.4.5.3 Service Doors

Four service doors approximately 60 in. high shall be provided on the right side of the airplane. *The forward and aft doors shall be approximately 32 in. wide; the two center doors shall be approximately 42 in. wide. See Fig. 11-1 for station locations of the service doors.*

4.4.5.4 Cargo Doors

Outward-opening, plug-type doors shall be provided in each of two cargo compartments. The clear opening of the forward compartment doors shall be approximately 50 by 120 in., and that of the aft compartment doors shall be approximately 45 by 84 in. *External means shall be provided to gain access to cargo door latches in the event of mechanism failure. The forward cargo doors shall accommodate the loading of rough boxes (caskets) with the dimensions 89 by 32 by 27 in. (Ref. SAE ARP 883.)*

4.4.5.5 Exits

Two inward opening Class III exits approximately 20 by 38 in. shall be located in the passenger compartment. Placement of the exits over the wing shall be established with consideration for the flexibility of interior arrangement.

Two escape hatches shall be provided in the flight deck area. (See Fig. 6-1.) *The escape hatch on the left side of the airplane shall be a simple, reliable, plug door and shall hinge aft for oral communication and escape. The upper escape hatch shall be a removable plug.*

4.4.5.6 Equipment Access Doors in Lower Body Sections

Plug-type doors shall provide access through the bottom of the body to equipment installed in the lower forward body sections. All access doors shall be operable from outside the airplane. *The door handle position shall positively indicate from the exterior whether the door is securely latched or open.*

Access doors shall be capable of being opened from inside the airplane if there is a reasonable probability that the door could be closed and latched with personnel inside the compartment.

4.4.5.7 Seals

All door seals shall be designed and located to minimize damage from service and maintenance. They shall be attached by mechanical means to facilitate quick and easy replacement.

The seals shall be resistant to fluids normally encountered in service.

External doors shall seal by outward acting pressure and shall be weathertight, either pressurized or unpressurized.

4.4.5.8 Scuff Plates

Replaceable, wear-resistant scuff plates shall be provided at entry, service and cargo doors.

4.4.5.9 Lock Indicators

Indicators located in the flight deck area shall be provided to warn when any of the following doors are not closed and locked: main entry doors, service doors, external cargo doors, landing gear doors, and lower-body equipment access doors. The switches activating the indicators for the above doors shall be readily accessible.

4.5 LANDING GEAR

The landing gear shall be retracted and extended hydraulically. (Refer to Par. 8.4.1 for details of operation.) Principle dimensions of the landing gear shall be as shown in Figs. 1-1, 1-2, and 4-2. Means for emergency extension of the nose and main gears shall be provided. Emergency extension by free-fall shall be as described in Par. 8.4.1. The landing gear shall be designed to minimize aircraft difficulties relating to "chatter," "spring back," and other dynamic considerations which can produce either discomfort or unacceptable stress levels. Major components of the main and nose landing gears shall be fabricated from heat-treated steel, aluminum alloy, and/or titanium alloy forgings. All movable and static pin joints in the landing gear structure and retracting mechanism shall be provided with replaceable flanged bushings or bearings. All movable and static pins shall be plated to be compatible with the bushing material.

Accessible grease fittings shall be provided to permit periodic lubrication of moving and static structural joints. All lugs shall have adequate wall thickness to allow oversizing of holes.

Due consideration shall be given in design to materials and stresses for low crack-propagation rates and reasonable insensitivity to operating conditions. To this end, attention shall be given to fatigue, fretting, corrosion, galvanic action, and potential bearing or pin failure and

its related effect on primary structural components. Fatigue tests shall be conducted on the landing gear structure. A representative landing-taxi load spectrum shall be used. The main gear shall be designed for loads imposed by rotating the airplane about one gear with nose gear torsion links disconnected.

The main gear support structure shall be designed with a fuse to fail prior to damage of primary structure. The landing gear shall separate from the airplane in an aft direction when subjected to more than the design ultimate loads. The design objective shall be to have the landing gear separate without causing critical damage to the airframe structure, without rupture of fuel tanks or fuel lines, and without endangering passengers or crew from the separated gear.

Where practicable, internal surfaces of the landing gear shall be visually inspectable. The entire landing gear including internal surfaces, shall be adequately protected against corrosion. Means other than painting shall be given prime consideration. All faying-surface finish shall be in accordance with Par. 4.1.5.

Grounding straps shall be easily replaceable. All nose and main gear axles shall be removable, and each main gear axle shall be interchangeable with any other main gear axle.

4.5.1

Main Gear

The main gear arrangement shall consist of four individual landing gear assemblies. (See Figure 1-1.) The forward and aft shock struts on each side of the airplane shall be hydraulically manifolded together such that the vertical load is equally distributed between the forward and aft gears. Manifolding shall be effective for all anticipated runway crown or runway crown-taxiway intersections and shall allow rotation of the airplane during takeoff without overloading the aft gears. Each main gear shall consist of a four-wheel, four-tire truck, an oil-air shock strut, and a hydraulic actuation system. The forward main gears shall retract forward, and the rear main gears shall retract aft. Provisions shall be made for jacking and towing. (Refer to Pars. 4.1.7 and 4.1.8.) A grounding lug shall be provided on each forward main gear. Equalizing rods shall be provided to distribute the load between the wheels on the front and rear axles of each truck to reduce truck pitching during braking. Fusible plugs shall be provided on all wheels incorporating brakes. Replaceable sleeves shall be used on the axles. Shields shall be provided to protect the underside of each truck beam against external damage.

4.5.2 Nose Gear

The nose gear shall consist of a single *interchangeable* axle with two wheels and two tires, an oil-air shock strut, and a hydraulic actuation system. The nose gear shall retract forward. *Towing and jacking lugs shall be protected against possible towbar damage arising from normal operational procedures.*

4.5.3 Wheels, Brakes and Tires

Wheels, brakes and tubeless tires shall be as listed in App. I-A. Brakes shall be equipped with heat shields and ground cooling fans. (Refer to Par. 8.4.3 for operation and control of the brake and antiskid system.) *See Fig. 4-2 for tire footprint criteria.*

4.5.4 Steering

Landing gear steering shall be provided by the nose and aft main gears. The gears shall provide for coordinated turns. Steering shall be in accordance with the requirements of Par. 8.4.2. The maximum nose gear steering angle shall be *approximately 76 deg. either side of center.* *Rudder pedal steering shall be limited to approximately 5 deg. either side of center.*

4.5.5 Ground Locks

Provisions shall be made for ground locks on the main and nose landing gears. The landing gear installation shall not be damaged if the gear actuation system is pressurized with the ground locks in place and the airplane on jacks. *One set of ground locks shall be provided as flyaway equipment.*

4.5.6 Landing Gear Up- and Down-Locks

Positive engaging up- and down-locks shall be provided. The up-locks shall be designed to retain the landing gear in the retracted position under all flight conditions without hydraulic pressure. The down-locks shall be capable of holding the landing gear in the down position during all routine conditions of landing, taxiing, and ground handling without hydraulic pressure.

4.5.7 Landing Gear Up- and Down-Lock Indication

Indicator lights shall be provided *on the pilots' instrument panel (Fig. 6-2)* to indicate when the main and nose gears are up and locked or down and locked. Separate indicator lights shall also be provided to indicate when

the main and nose gear doors are closed and locked *and to indicate the position of the main gear truck beams.* Means shall also be provided to visually determine in flight when the main and nose gears are down and locked. An aural warning system shall be provided for improper positioning of the landing gear in relation to throttle settings and wing flap and during sweep positions as specified in Par. 9.14.

4.6 BALLAST SYSTEM

A water ballast system shall be provided for airplane operation with low payloads. The system shall consist of a water tank with a capacity of 14,500 lb. with provisions for filling and draining. The system shall be installed in the lower body forward of the nose gear well.

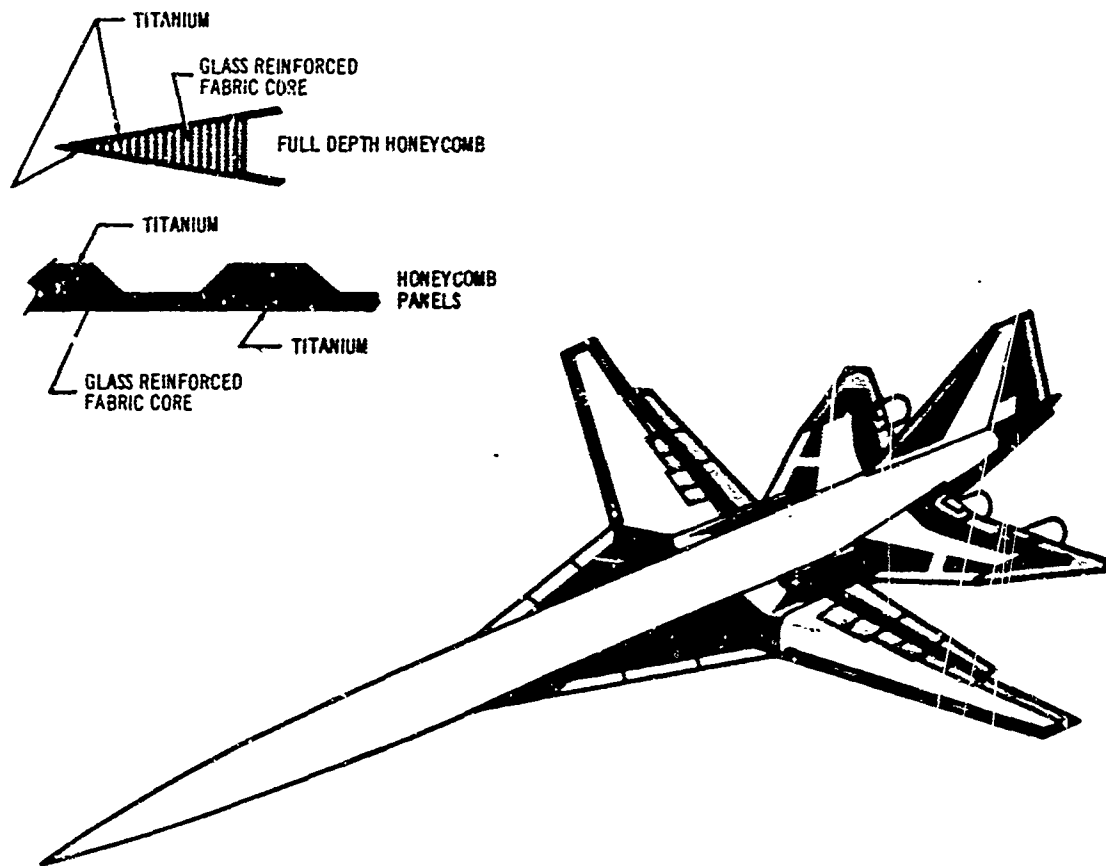
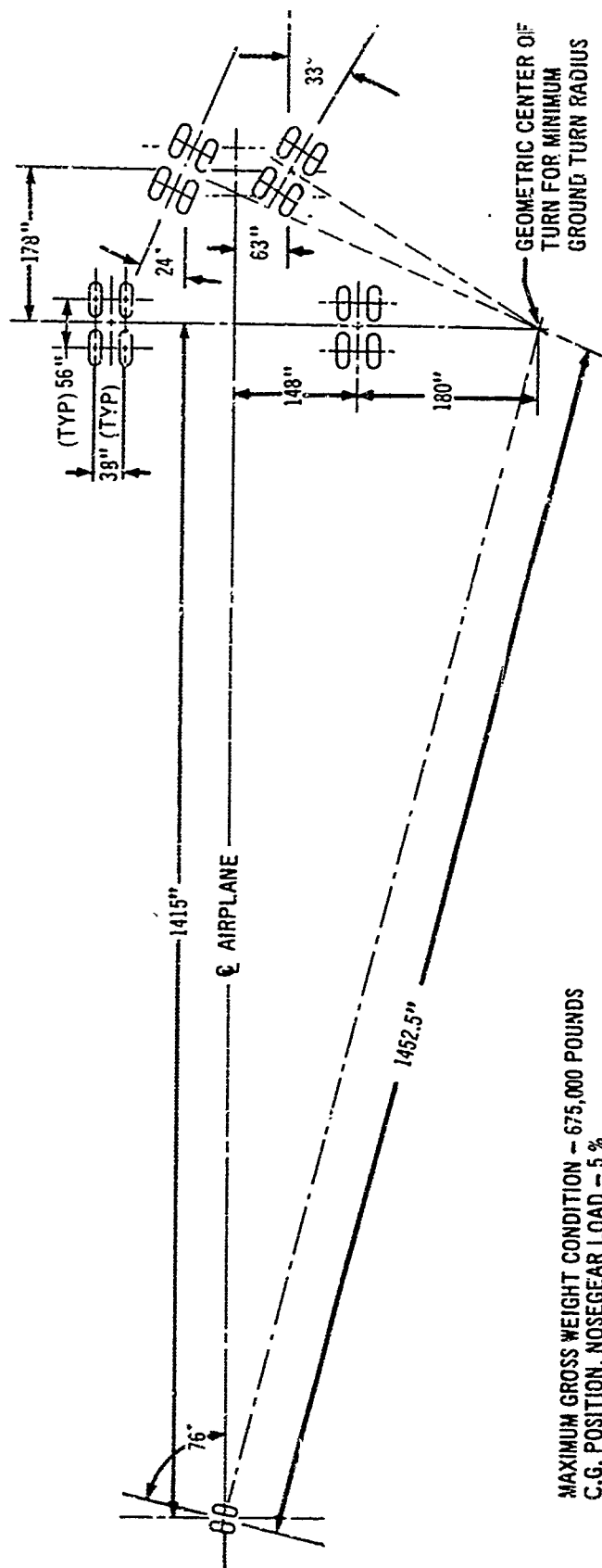


Figure 4-1. Honeycomb Usage

D6-17850



MAXIMUM GROSS WEIGHT CONDITION - 675,000 POUNDS
C.G. POSITION, NOSEGEAR LOAD - 5 %

FOOTPRINT AREA	223 SQ. IN.	NOSE GEAR	100 SQ. IN.
FOOTPRINT LOAD	40,080 LB		16,875 LB
TIRE PRESSURES	180 PSI		170 PSI

STEERING ANGLES SHOWN ARE APPROXIMATE MAXIMUMS
FOR MINIMUM GROUND TURN RADIUS WITH TORSION
LINKS CONNECTED.

Figure 4-2. Landing Gear Footprint and Steering Diagram

SECTION 5 PROPULSION

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SECTION 5 PROPULSION

5.1 GENERAL

5.1.1 Description

The propulsion system shall consist of four functionally independent propulsion pods with ancillary equipment and systems for control, operation, and monitoring by the flight crew. *Each propulsion pod shall be located to maintain aerodynamic independence between pods and shall consist of the following major components and subsystems:*

- o *inlet assembly*, including the mounting structure, and accessory systems for automatic operation and icing protection.
- o *Engine (as specified in Par. 1.7) and engine accessories*, including the engine cowling, structural mounting provisions, structural provisions for fire protection, engine fuel and nozzle control systems, lubrication system, drainage system, icing protection system, and windmilling brake.

- o *Exhaust system:*

- For 2707 (GE)

- Exhaust system, including the afterburner, ejector nozzle, thrust reverser, and integral control system.

- For 2707 (P&W)

- Exhaust system, including the duct heater, ejector nozzle, thrust reverser, and integral control system.

Additional components of each propulsion system shall include instrumentation for monitoring inlet, engine, and exhaust systems performance; and control systems for inlet, engine thrust, and thrust reverser systems. *The engine and accessory equipment will be designed to the operating environment of the propulsion pod. Engine-mounted equipment and accessories shall be as listed in App. I.*

The airplane's fuel system, fire protection system, engine starting system, air bleed system, and the accessory drive system are also described in this section. The propulsion and fuel systems shall be designed for use with commercial aviation kerosene meeting the minimum requirements for ASTM D1655-63T Jet A or A-1.

5.1.2 Maintainability

During design, special attention shall be given to the ease with which components can be serviced, inspected, maintained, and repaired. Engine accessories and equipment will be readily replaceable. The inlet and exhaust systems will be designed to permit their removal or installation without removing the engines from the airplane.

Removable connectors shall be provided at all plumbing and electrical connections at the disconnect point for engine change and for ground port connections. Quick-disconnect fittings shall be provided for hydraulic lines. Electrical connectors shall be of the crimp type where temperature levels do not exceed 550°F. Above this temperature, metal jacket wire with brazed or welded connectors shall be used.

5.1.3 Interchangeability

It shall be a design objective that the common parts and assemblies of each propulsion pod subject to removal for routine maintenance be made interchangeable or replaceable-interchangeable. (Refer to Para. 14.2.) Each propulsion pod, each inlet assembly, and each exhaust assembly shall be interchangeable between pod positions and airplanes.

5.2 PROPULSION PODS

5.2.1 Materials and Construction

The propulsion pods shall be constructed principally of titanium alloy and stainless steel. *It shall be a design objective to use materials which minimize the hazards that could result from the ignition of flammable fluids or vapors in the event of a wheels-up landing.*

5.2.2 Mounting

Each propulsion pod shall be attached to the horizontal stabilizer lower surface. Support fittings shall be designed to allow for thermal expansion of the engines and shall also include means to effectively isolate the cabin from mechanical vibration of the engine and accessories.

The engine-mounting attach fittings on the airframe shall be designed to retain the engine in the event of sudden engine stoppage at a uniform deceleration from takeoff rpm to zero rotational speed in 1.0 sec and shall permit installation and removal of the engine with standard tools. During design of the propulsion pod installation, consideration shall be given to possible engine growth.

It shall be a design objective to attach the pods and mount the engine accessories, fuel lines, etc., to minimize the hazards that could result from the ignition of flammable fluids or vapors in the event of a wheels-up landing.

5.2.3

Inlet

The inlet shall be axisymmetrical, incorporating a variable-diameter centerbody to control inlet throat area and louvers to bypass excess air and control the normal shock. (See Fig. 5-1.) The inlet system shall be supported from the engine. However, the engine may be removed without removing the inlet and the inlet may be removed without removing the engine. Automatic and optional manual control, using an individual, self-contained, engine-driven hydraulic system with two pumps, shall be provided for positive inlet operation. The pumps shall be identical, either one of which shall provide sufficient power for normal inlet control in either automatic or manual modes. The inlet hydraulic system shall be completely independent from the engine hydraulic system and shall be designed with adequate protection against a pump failure causing system contamination or damage to the other pumps. The automatic and manual control capability shall include starting the shock system, buzz elimination, re-starting the shock system, compressor noise reduction, excess-air control, and maintaining high inlet performance with distortion characteristics acceptable to the engine through all operating regimes. Means shall be provided to allow for small incremental trim control of bypass air.

The inlet shall be provided with a vortex valve controlled terminal shock stability system which shall allow the inlet to have an inherent stability margin against sudden downstream disturbances causing a decrease in engine corrected weight flow. The vortex valves shall handle those disturbances that are beyond the control response of the main bypass system. The vortex valves shall also allow the throat mach number to remain constant so that inherent inlet tolerances to upstream and downstream transients can be maintained simultaneously independent of the centerbody and bypass louver control loops for maintaining started inlet operation.

Inlet instrumentation shall be provided on the flight engineer's panel for the purpose of permitting accurate manual control, in addition to monitoring the automatic control system operation. (See Fig. 6-7).

No single fault in any inlet control or sensing system shall affect any other inlet control or sensing system or affect performance of more than one inlet throughout the operating envelope of the airplane.

Operation of the landing gear, wing flaps and spoilers under any flight and ground operating condition within the operating speed/altitude restrictions of these items, shall not significantly affect the engine and/or inlet performance, shall not cause engine operating problems such as stall, surge, vibration or flameout, or require special operating techniques for the engine or inlet.

It shall be a design objective to select fasteners, clips, etc., for the inlet that minimize the possibility of their ingestion into the engine.

During approach and climbout when the Mach number is less than 0.3 and the maximum dry power setting is less than 50 percent, the inlet will operate in the choked mode to reduce compressor noise escaping forward through the inlet.

5.2.4 Cowling

Cowling enclosing the engine section shall extend from the aft end of the inlet assembly outer surface to the exhaust system and shall be divided longitudinally into three panels. Positive clearance shall be provided between cowling structure and power plant components. Blowout panels shall be provided in the cowling to protect against cowl overpressure. Quick-release latches shall be provided to facilitate opening and removal of the panels. The use of special tools to release the latch shall be avoided. Cowling support rods shall be provided to hold the cowling in the open position, and the support rods shall be positively stowed to prevent damage to engines, cowling, or support rods. During cowling design, consideration shall be given to possible engine growth.

Access panels shall be provided in the engine cowling for engine oil system servicing and for ground fire extinguishing equipment access. Engine fuel and oil system filters requiring frequent inspection shall be readily accessible.

5.2.5 Exhaust System

For 2707 (GE)

The exhaust system will be supported from the engine. (See Fig. 5-2.) It will consist of a variable-area, convergent-divergent, two-stage ejector nozzle, an afterburner; an integrated thrust reverser, actuators, controls; and associated plumbing. The variable-area nozzle and the thrust reverser will be activated by a hydraulic system which will be self-contained within each pod. The reverser will be designed to minimize reingestion of exhaust gases on airplane

structure and controls. The thrust reversers shall have the capability of being operated at all ground speeds. The exhaust hydraulic system shall use the same fluid as the engine lubrication system and shall be completely independent from other fluid systems.

For 2707 (P&W)

The exhaust system will be supported from the engine. (See Fig. 5-3.) It will consist of a variable-area, convergent-divergent ejector nozzle with blow-in doors, a duct heater, an integrated thrust reverser system, actuators, controls, and associated plumbing. The variable-area nozzle and the thrust reverser will be activated by a hydraulic system which will be self-contained within each pod. The reverser will be designed to minimize reingestion of exhaust gases into the engine and to minimize impingement of exhaust gases on airplane structure and controls. The thrust reversers shall have the capability of being operated at all ground speeds.

5.2.6 Engine Air Bleed

For 2707 (GE)

The engine will provide bleed air for aircraft environmental control and engine starting. The engine bleed system shall also supply high-temperature air for the engine and inlet anti-icing system.

For 2707 (P&W)

The engine will provide bleed air for aircraft environmental control and engine starting. The engine bleed system shall also supply high-temperature air for the inlet anti-icing system.

5.3 ENGINE COWLING DRAINAGE

Each engine will be provided with a drainage system to prevent the accumulation of flammable fluids within the engine cowling. Leakage from failed lines or equipment shall be collected and drained into the engine exhaust system. The minimum outside diameter of drain lines shall be 3/8 in.

5.4 ENGINE CONTROLS

5.4.1 Engine Thrust Controls

Forward and reverse thrust of each engine shall be controlled by a thrust lever, located on the aisle control stand, which

shall actuate by mechanical means (i.e. cables, pushrods, etc.) a control system to the respective engine. (See Fig. 6-7.) A no-back device shall be provided to prevent thrust control lever creep.

The reverser shall incorporate a safety interlock with the power control in such a manner that:

- Power cannot be increased in the forward thrust regime unless the reverser is in the forward thrust position.
- Power cannot be increased above essentially idle in the reverse-thrust regime unless the reverser is in the reverse-thrust position.
- In the event that, at any power condition, the reverser should depart from the position dictated by the thrust lever position, the engine power shall be reduced to essentially idle.

The flight crew shall be provided with indication when a reverser is in a position other than the forward thrust (stowed) and when a reverser is in full reverse-thrust position. (See Fig. 6-2.) The reverser system shall preclude inadvertent reversal in flight or in the event of an engine or hydraulic system failure. The thrust reverser indicating switch shall be designed to withstand the engine environment.

5.4.2

Engine Mode Selector

For 2707 (GE)

Engine operating modes of cruise-holding, run, descent, shutdown, and windmill brake shall be selectable by positioning a mode selector lever on the aisle control stand. (See Fig. 6-3.) The mode selector lever shall actuate by mechanical means (i.e. cables, pushrods, etc.) a control system to the respective engine. Means shall be provided to prevent lever creep.

For 2707 (P&W)

Engine operating modes of cruise, run and shutdown shall be selectable by positioning a mode selector lever on the aisle control stand. (See Fig. 6-3.) The mode selector lever shall actuate by mechanical means (i.e. cables, pushrods, etc.) a control system to the respective engine. Means shall be provided to prevent lever creep.

5.5

ENGINE LUBRICATION SYSTEM

The engine lubrication system, including filters, oil tank, and engine oil/fuel heat exchanger, will be an integral part of the engine and will be suitable for use with a lubricant approved by the engine manufacturer. The oil tank mounted on each engine will have means for determining oil level *visually* and will have provisions for both pressure and gravity filling. The oil temperature will be automatically maintained within required limits for each engine through use of and engine oil/fuel heat exchanger. *The lubrication system will operate satisfactorily with the oil at a temperature of -40°F without preheating and/or dilution of oil. Fireproof materials will be used for all plumbing in the system.*

5.6

ENGINE ACCESSORIES

For 2707 (GE)

The following engine accessories, *plus transmitters or pick-ups for the instrumentation described in Par. 5.8.1*, will be mounted on each engine.

- Fuel control
- Fuel pumps
- Engine oil/fuel heat exchangers
- Engine hydraulic oil/fuel heat exchangers
- Oil tank and pumps
- Hydraulic pumps (for inlet and exhaust system control)
- Control alternator
- Ignition units
- Inlet and engine anti-icing components.

For 2707 (P&W)

The following engine accessories, *plus transmitters or pick-ups for the instrumentation described in Par. 5.8.1*, will be mounted on each engine:

- Fuel control
- Fuel pumps
- Engine oil/fuel heat exchangers

- Oil tank and pumps
- Hydraulic pumps (for inlet and exhaust system control)
- Ignition units
- Inlet anti-icing components.

5.7 WINDMILLING BRAKE

An integral engine windmilling brake shall be provided. The windmilling brake shall be controlled by positioning the engine mode selector lever to the "shutdown" position and actuating a guarded switch on the pilots' overhead panel. (See Fig. 6-6.) *The mode selector lever and the electric switch which controls the air supply valve must both be in the proper position to operate the engine brake. The brake may be released after shutdown actuation.*

5.8 INSTRUMENTATION

5.8.1 Propulsion-System Performance Indicators

The following instrumentation shall be installed in the flight deck compartment for each engine pod: engine thrust indication, inlet pressure recovery, inlet shock position, inlet bypass area, inlet throat area, engine speed, exhaust gas temperature, engine nozzle position, thrust reverser position, anti-icing valve position, fuel inlet temperature, engine nozzle fuel temperature, fuel flow rate, and *total fuel consumed*. (See Figs. 6-2, 6-5, 6-7, and 6-10.)

5.8.2 Airborne Vibration-Monitoring System

An engine vibration-monitoring system shall be installed. Controls and indicators for the system shall be located at the flight engineer's station. (See Fig. 6-7.)

5.8.3 Propulsion-System Warning Indicators

In addition to the fire detection system described in Par. 9.14, warning lights shall be installed on the flight engineer's panel to indicate the following inlet or inlet control system abnormalities (See Fig. 6-7.):

- Inlet buzz
- Inlet unstart
- Hydraulic fluid out of normal operating temperature range
- Hydraulic pump low pressure.

5.9 ENGINE-STARTING SYSTEM

Four identical pneumatic starters, one for each engine, shall be installed. (Refer to Par. 5.11.) Any engine may be started by using high-pressure air from a ground supply. After one engine has been started, it shall be possible to start the remaining engines with air from the operating engine. *A pressure gage shall be installed on the flight engineer's panel for monitoring operation of the starter valves and pneumatic operation of the accessory drive system. (Refer to Par. 5.11 and Fig. 6-11.)*

The engine-starting controls shall consist of a continuous ignition switch and four guarded starter-valve switches located on the aisle control stand for use with the respective mode selector levers. (See Figs. 6-3 and 6-4.) Manual override provisions for the starter valve shall be incorporated and shall be reasonably accessible.

5.10 FIRE PROTECTION

5.10.1 Firewall

Titanium alloy and/or stainless steel firewalls shall be provided to isolate each propulsion pod from the airframe structure and each engine from its inlet. Material used for the upper portions of the engine cowling shall effectively serve as a fire barrier to protect the horizontal stabilizer lower surface.

5.10.2 Electrical Wiring

Electrical wiring shall be isolated from, or installed above, fluid carrying lines where practicable. All fluid carrying lines and electrical leads shall enter the engine compartment through fireproof fittings. *Electrical wiring in fire zones shall conform to the requirements given in Par. 9.2.*

5.10.3 Engine Fire Detector System

A quick-acting *dual-element, continuous, heat sensitive, armored type* fire detector system shall be installed for each engine. (Refer to Par. 9.14.4.)

5.10.4 Fire Extinguishing System

A fire extinguishing system shall be installed to supply bromotrifluoromethane fire extinguishing agent to each propulsion pod. Two extinguisher bottles shall be installed on each side of the airplane. The system shall be designed to permit either or both bottles on one side of the airplane to

be discharged into either propulsion pod engine compartment on that side of the airplane, as selected by the pilots. (See Fig. 6-4.) Bottle discharge indication shall be provided.

5.10.5 Fire Shutoff Control

A fire switch, located on the pilots' overhead panel, shall be provided for each engine. This switch shall shut off systems in accordance with Par. 9.15.

5.11 ACCESSORY DRIVE SYSTEM (ADS)

Four airplane accessory drive gearbox systems, each powered by a shaft from its respective engine through an electrically actuated coupler shall be provided. *The design of the ADS compartment shall provide an operating environment within the ADS and ADS drive shaft specified limits. The ADS drive shafting shall be so contained that in the event of any shaft failure, no airplane structural damage shall occur.* Each system shall drive the following equipment:

- Generator
- Cabin-air boost compressor
- Two hydraulic pumps

An air turbine starter shall be mounted on each ADS gearbox and shall:

- Drive the engine through the gearbox for engine starting. (Refer to Par. 5.9.)
- Drive the gearbox for separate ground checkout of the electrical, hydraulic, and air-conditioning system without engine operation.
- Drive the gearbox in flight for powering the electrical and hydraulic systems in the event of shutdown of the engine normally powering the gearbox.

Access to the ADS shall be through a panel underneath the ADS. The complete ADS gearbox with accessories shall be removable or installed as a unit without removal of the drive shaft. Each accessory shall be removable separately. The air turbine starter, generator, cabin-air boost compressor and two hydraulic pumps shall be attached to each ADS gearbox with machined quick-attach-detach (QAD) type flanges and clamps. The ADS gearbox shall have provisions, independent of the mounting provisions, for attachment of a hoisting device for installation or removal. The gearbox shall be interchangeable

at each of the four locations. The capability for removal and replacement of the gearbox, power transmission shaft, or coupler as an individual component shall be provided.

The ADS Drive Shaft shall be designed in one or more sections, such that it is removable and replaceable in the airplane without affecting the other ADS subassemblies. If more than one section is required, the sections shall be connected to each other by splined couplings. The shaft shall be designed to operate continuously at the maximum specified load with up to 3-degree angular and ± 0.5 inch axial misalignment. The shaft shall be provided with a separately removable and replaceable cover, of one or more sections, depending on shaft length, which shall protect the shaft and contain it in the event of shaft failure. Because of different locations of the PTO on the Pratt & Whitney and General Electric engines, different shaft lengths are required.

Individual disconnects shall be provided to permit disconnecting the generator from the gearbox, the air boost compressor from the gearbox, and the gearbox from the engine. The disconnect functions shall be initiated electrically by separate switches at the flight engineer's station. The ability to reconnect the generator, air boost compressor, or gearbox in flight shall not be a requirement; however, these units shall be readily connectable on the ground.

Each accessory drive system shall have an independent lubrication system with scavenge and supply strainers, and shall provide for ground check of oil quantity. The lubricant used in the accessory drive system, air turbine starter, generator and cabin-air boost compressor shall be the same as specified for use in the engines. Separation of the lubrication systems for the ADS and the starter, generator, and cabin-air boost compressor shall be provided for protection of each of the individual subsystems from oil which may be contaminated by a failure of one of the other subsystems.

Controls (guarded toggle switches) for each ADS coupler shall be provided on the flight engineer's panel to permit coupling or decoupling, and to initiate driving a decoupled ADS by the air turbine starter. An indicator light shall be provided adjacent to each switch to indicate when the selected air-turbine starter control valve is open. Warning lights for low ADS oil pressure and high ADS oil temperature, and instrumentation for absolute values of ADS oil pressure and temperature shall also be provided on the flight engineer's panel. (See Fig. 6-11.)

An ADS compartment drainage system shall be provided to prevent the accumulation of flammable and nonflammable fluids within the compartment.

5.12 FUEL SYSTEM

5.12.1 General Description

The airframe fuel system shall provide independent sources of fuel for each engine, interconnected through a crossfeed manifold so that fuel may be delivered from any tank to any engine or combination of engines. (See Fig. 5-4.) Fuel within the wing and horizontal stabilizer shall be contained in integral tanks. Fuel contained in the lower lobe of the body forward of the wing center section, and in the forward portion of the aft body fuel tank shall be contained in bladder cells. Means shall be provided to transfer fuel between tanks on the ground.

The airframe fuel system, over the entire operational flight regime, shall provide fuel to the engine fuel systems at a rate, pressure, and temperature compatible with the engine requirements. In addition, the fuel system shall be designed to be used as a source of aircraft and engine systems cooling.

5.12.1.1 Altitude and Temperature

The fuel system shall be suitable for operation at the altitude and temperature conditions specified in Par. 3.4. Aerodynamic heating, insulation, and location in the airplane shall be considered in the design of the fuel system. *However, the viscosity of the fuel delivered to the engine shall not exceed 12 centistokes, or the fuel temperature shall not be less than 10°F above the fuel freezing point, whichever is most critical. The fuel temperature in the tanks on takeoff shall be limited as shown in Figs. 5-6 and 5-7 to provide a cooling source for the airframe systems and to satisfy the engine system temperature requirement for ground operations, climb and cruise. For descent conditions, a fuel recirculation system shall be provided to satisfy the airframe and engine cooling requirements.*

5.12.1.2 Engine Fuel Shutoff and Crossfeed Manifold Valves

Engine fuel shutoff and crossfeed manifold valves shall be de-operated and connected to the battery bus. Operation of only one valve shall be required to stop fuel flow to any one engine. Operation of this valve shall be controlled by the particular engine fire control switch, as well as by a switch on the flight engineer's fuel panel. (See Fig. 6-10.) *The fuel shutoff valve installation shall provide protection for the valve in case of structural damage to the engine or propulsion pod. Fuel control valve motors shall be sealed.*

5.12.2 Fuel Tanks

There shall be four main tanks and four auxiliary tanks located substantially as shown in Fig. 5-5. The total usable fuel capacity shall not be less than 55,930 U.S. gal. Manually operated sump drain valves shall be provided in each tank to allow removal of water or complete drainage of the tank when in the taxi attitude (wing sweep position fully forward). Drain valves shall be replaceable while fuel is in the tank. *The tanks shall be designed to prevent coking of residual fuel. The interiors of all fuel tanks shall be accessible for inspection.*

5.12.3 Fuel Boost Pumps

Each main and auxiliary tank shall be equipped with a minimum of two ac-powered boost pumps. The main tank pumps shall be capable of delivering fuel to any one or combination of two engines throughout the certificated operational limits of the airplane. Each main tank boost pump shall be capable of delivering fuel at the required rate and pressure to an engine-driven pump inlet throughout the operating range of the engine. Means shall be provided to prevent all pumps in a tank from becoming inoperative because of a single electrical failure. The fuel boost pump installation shall be designed so that uncoordinated turns and rolls will not adversely affect engine operation. The boost pumps shall be replaceable without draining or entering the tank. *Fuel boost pumps shall be capable of dry operation during the reaction time required from the first indication of malfunction to turning the pumps off. Protection shall be provided to prevent boost pump overheat.*

5.12.4 Fuel Lines

Fuel lines shall be fabricated of aluminum alloy, titanium alloy, stainless steel, or flexible hose as appropriate. Fireproof tubing shall be used in all designated fire zones. *Fuel lines shall not be routed through the pressurized habitable portions of the passenger cabin. Shrouds shall be provided around fuel lines and/or fittings, in areas other than fire zones, where leakage would result in a fire hazard. Such shrouds shall be appropriately drained and shall be readily inspectable and replaceable. All fittings shall be designed to provide leakfree connections capable of accepting normal plumbing alignment and tolerances.*

5.12.5 Fuel Cleaning Devices

No in-line fuel filters or strainers shall be provided. Each engine will provide its own filtration protection. *Number 4 mesh screens shall be installed at the fuel-inlet ports of all boost pumps.*

5.12.6 Fuel Vent System

An open, unpressurized vent system shall be installed to maintain fuel tanks and dry-bay cavity pressures within design operating limits under the following conditions:

- Failure of a pressure fueling level-control valve at the maximum fueling rate
- Maximum emergency descent rate with only reserve fuel in the tanks
- Maximum rates of climb under all certificated operating conditions. Refer to Par. 5.1.1 for fuel definition.

The vent system shall be designed to prevent draining, surging or siphoning of fuel out of the vent outlets during any normal flight- or ground-handling maneuvers of the airplane. *Other maneuvers which may result in temporary surging, siphoning, or draining of fuel through the vent outlets shall not compromise the fuel system operation or the safety of the aircraft. Particular attention shall be given in design to lightning strike protection. The design of the vent outlets shall preclude icing.*

5.12.7 Fuel System Instrumentation

5.12.7.1 Fuel-Quantity Indication System

Fuel-quantity indicators, located on the flight engineer's panel (*Fig. 6-10*), shall read pounds of fuel contained in each fuel tank; indicators shall be located at one fueling station. (Refer to Par. 5.12.8.) The flight engineer's and fueling station fuel-quantity indicators shall be provided with separate tank units. Means shall be provided to use either set of tank units with either set of indicators. A single fuel indicator shall be installed on the flight engineer's panel to indicate total quantity of fuel in the airplane. (See *Fig. 6-10*.)

It shall be a design objective to provide a system which is insensitive to airplane attitude and wing position, incorporating a fuel quantity gaging system having an overall probable accuracy within 1 percent of fuel remaining in all normal ground and flight attitudes regardless of wing sweep position.

5.12.7.2 Fuel Flowmeters

A fuel-consumed and rate-type gravimetric fuel flowmeter, calibrated in pounds, shall be provided for each engine. Fuel consumed indication for each engine shall be provided

on the flight engineer's panel. (See Fig. 6-8.) Fuel flow-rate indication for each engine shall be provided on the pilots' main instrument panel. *Flowmeters shall be installed with the objective of being self-bleeding.*

5.12.7.3 Fuel-Pressure Indication

A fuel low-pressure warning light for each boost pump shall be installed on the flight engineer's panel. (See Fig. 6-10.)

5.12.7.4 Fuel-Temperature Indication

Fuel-temperature sensing bulbs shall be installed in each fuel tank. Two fuel-temperature sensing bulbs shall be installed in the fuel feed line for each engine. Fuel temperature indicators shall be installed on the flight engineer's panel. (See Fig. 6-10.) *The sensing devices shall be removable from tanks or lines without draining.*

5.12.7.5 Fuel-Valve-Position Indication

A valve in-transit light for monitoring valve actuation shall be placed adjacent to the control for each electric-motor-operated valve in the engine fuel feed, dump, and pressure fueling systems. Control switches on the fuel feed panel shall be oriented to indicate valve position. (See Fig. 6-10.)

5.12.8 Fueling System

Fueling shall be accomplished through a single manifold having two illuminated fueling stations (Fig. 5-8), each with two nozzle adapters, grounding jacks, and interphone jack. No provisions shall be made for gravity fueling. During design of the fueling system, consideration shall be given to available knowledge of design features to reduce electrostatic field strength in the fuel.

The fueling system shall be designed to be serviced with an MS 29520 nozzle and fueling equipment having a maximum delivery pressure of 50 psi at the nozzle inlet. The fueling rate, with four nozzles, with such equipment shall be 2,000 gpm minimum.

One fueling control panel shall incorporate the following:

- *Fuel quantity indicator for each tank*
- *Test switch for checking operation of fuel quantity indicators*
- *Fueling valve control switch for each tank*

- Valve in-transit light for each tank selector valve
- Electrical power switch.

Automatic shutoff valves in each tank shall close at the full-fuel level. Provisions shall be incorporated to prevent structural damage in the event of malfunction in the level control system, provided the fueling equipment pressure at the nozzle inlet does not exceed 55 psi. Means shall be provided to prevent damage to *airframe fueling system components* due to surges when the fueling valves close, if serviced by compatible fueling equipment. Manual controls installed adjacent to the right hand fueling station shall be provided to permit selective, simultaneous, or partial filling of the tanks.

5.12.9 Defueling

The defueling system shall use the fueling system manifold and adapters. A manual valve, operable only from the ground, shall connect the fueling manifold to the engine fuel feed system to allow use of the boost pumps in defueling. Using the crossfeed manifold, it shall be possible to defuel to the sump level. It shall not be possible to close the access panel to the manual valve with the valve in any *position* other than the closed position. It shall be possible to defuel to the design reserve level in any tank when the respective fuel dump valve is opened. Approximate defueling rates attainable, using boost pumps, shall be 200 gpm per tank. It shall also be possible to defuel using suction.

5.12.10 Fuel Dump System

The fuel dump system shall use the pressure fueling system manifold and, through appropriate valving and controls, the fuel tank boost pumps. (See Fig. 5-4.) The fuel dump nozzle shall be located in the aft section of the airplane. The dump system shall automatically shut off to maintain the designed fuel reserves. It shall be possible to stop dumping at any higher level by use of the tank selector dump valve. All fuel dump system functions shall be controlled at the flight engineer's station. (See Fig. 6-10.)

5.12.11 Fuel System Checkout

The fuel system checkout provisions shall consist of the boost pump low-pressure lights, shutoff light, manifold valve in-transit lights, and a fuel quantity indicator tank unit selector provided at the flight engineer's panel. (See Fig. 6-10.)

5.12.12 *Fuel Deicing*

Means shall be provided to prevent fuel system malfunctions caused by freezing of moisture in the fuel.

5.12.13 *Fuel Tank Inerting System*

Space provisions for a fuel tank inerting system shall be provided.

5.13 AUXILIARY POWER SYSTEM

Space provisions for a gas turbine auxiliary power unit shall be provided in the fuselage tail section.

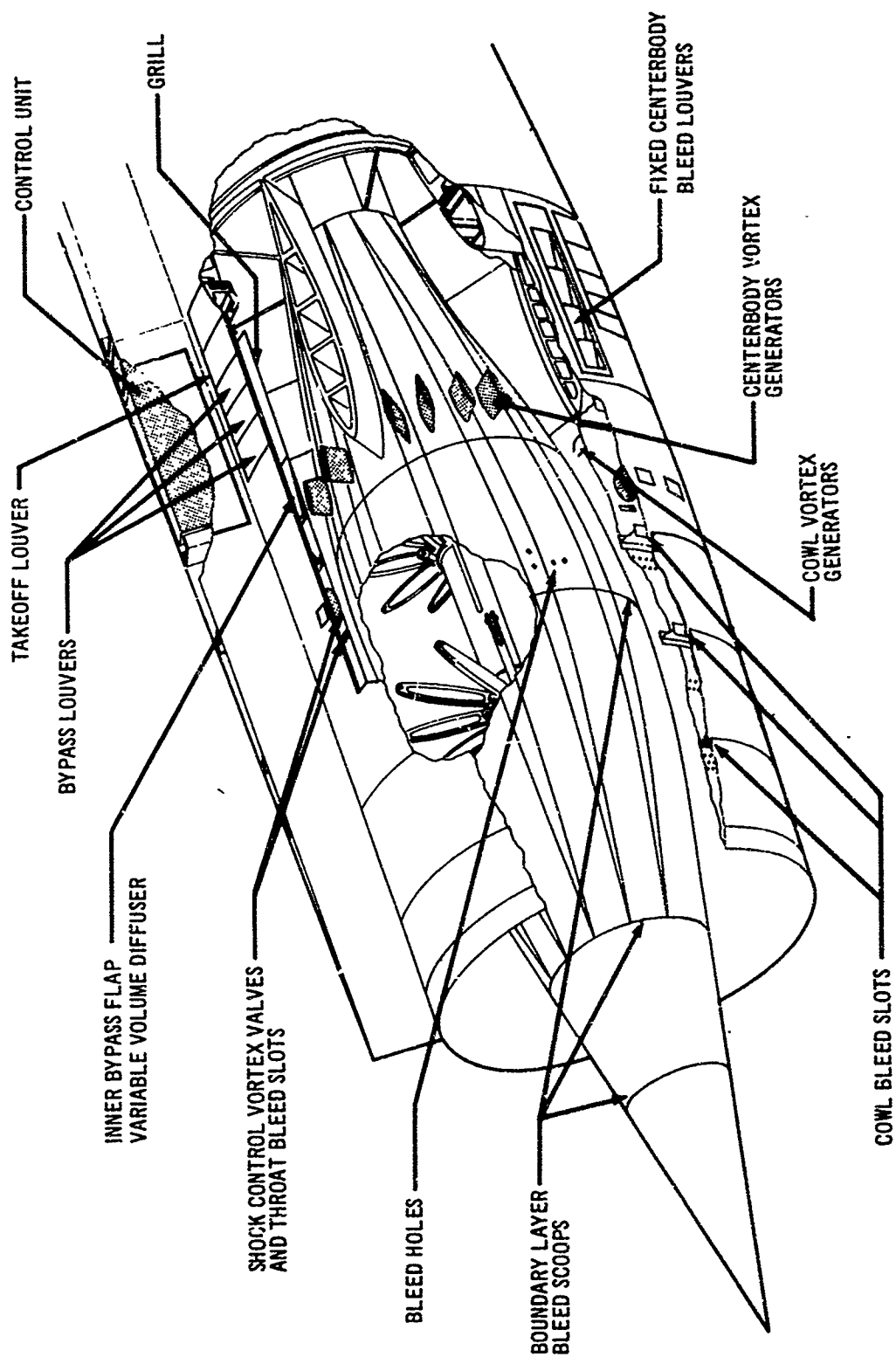


Figure. 5-1 Inlet Arrangement

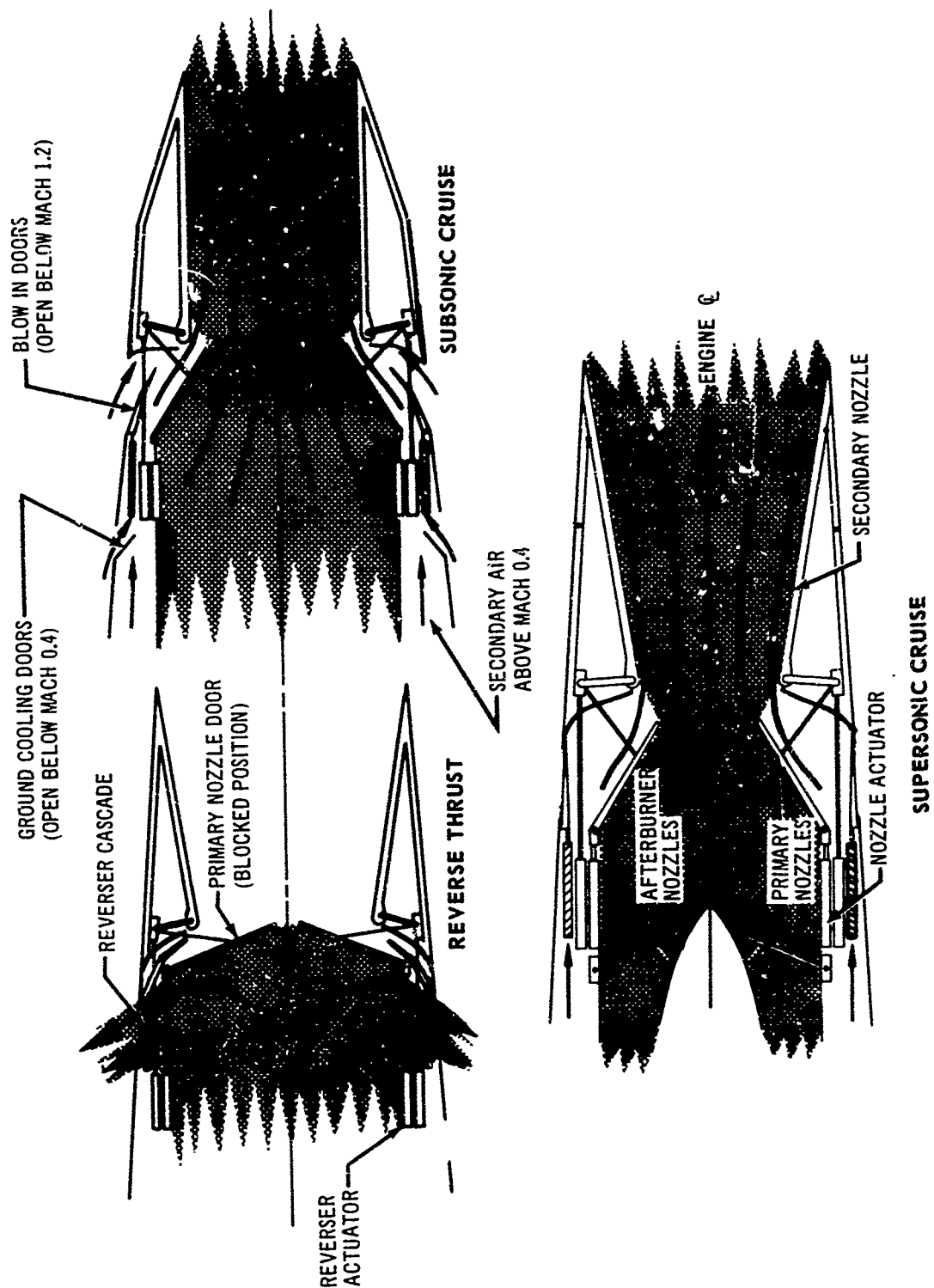


Figure 5-2 Exhaust System Arrangement - B-2707 (GE)

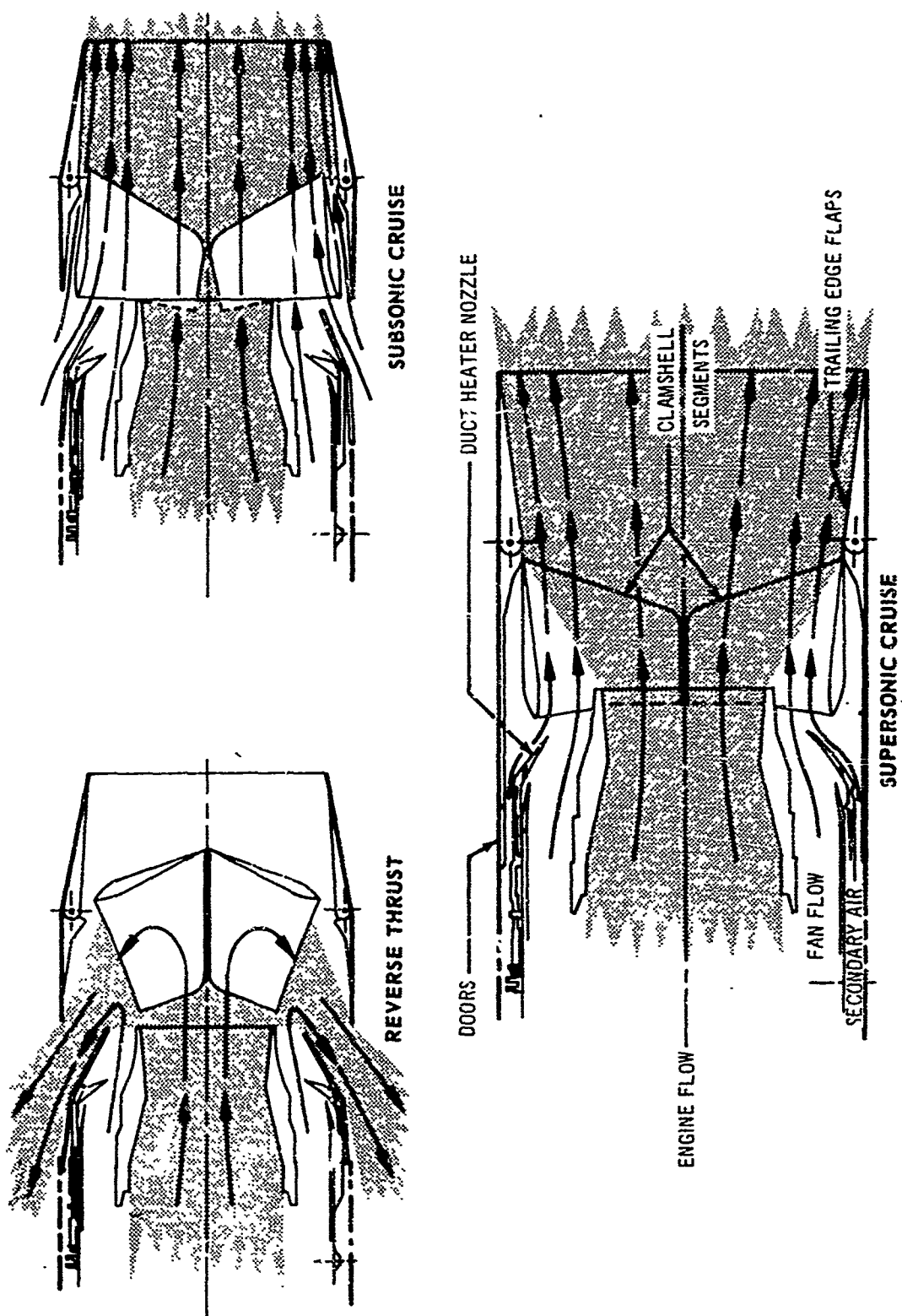
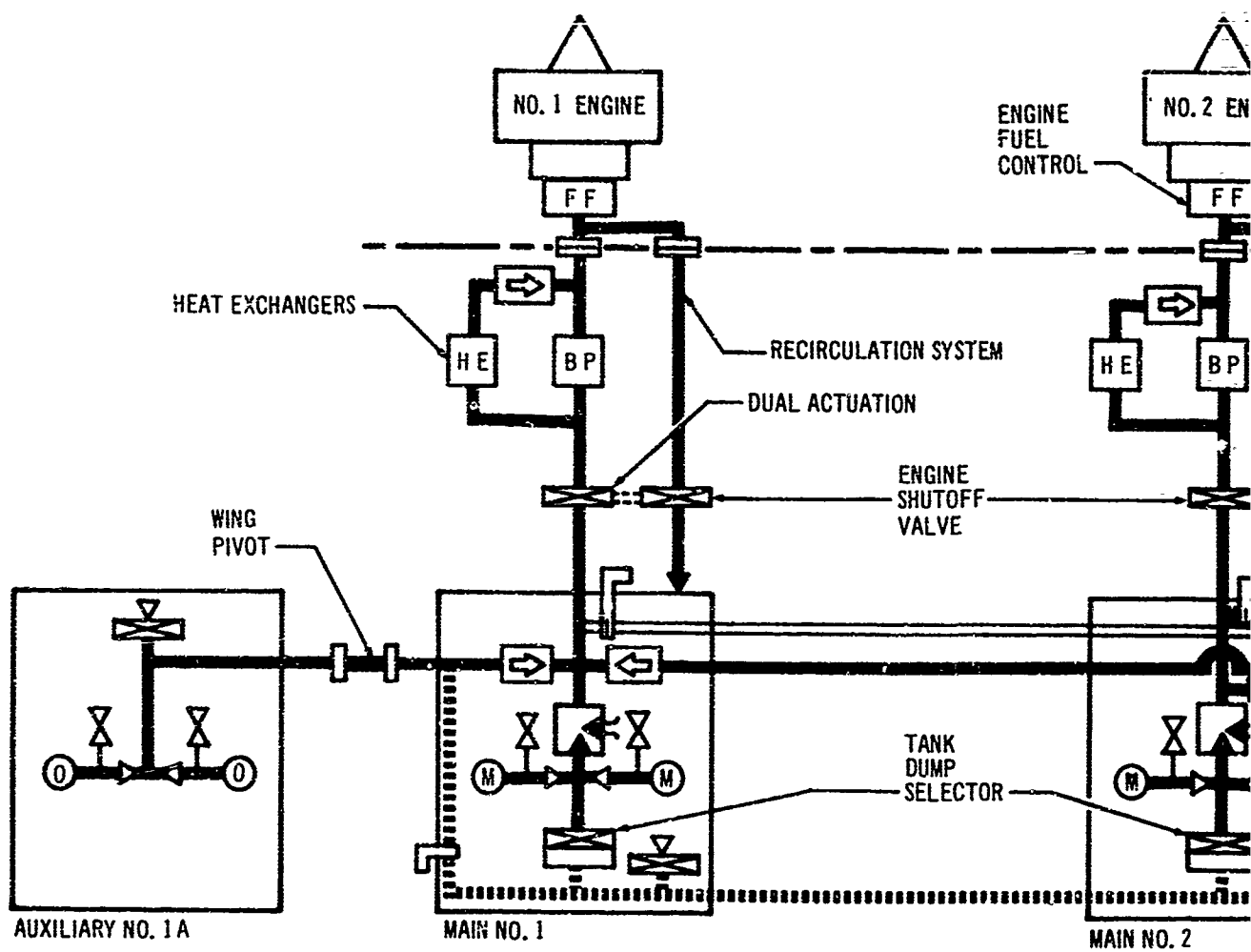


Figure 5-3 Exhaust System Arrangement - B-2707 (P&W)



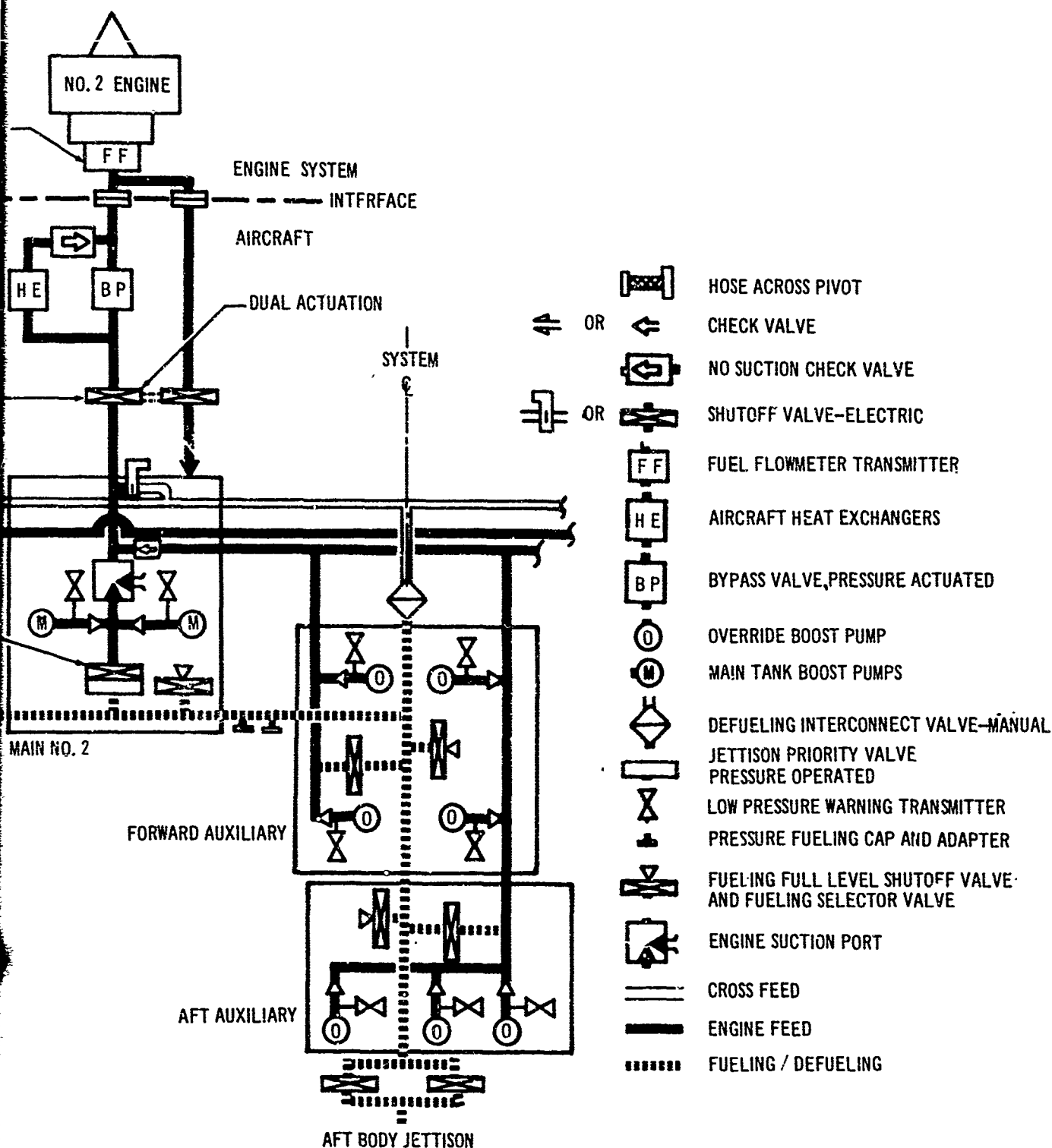


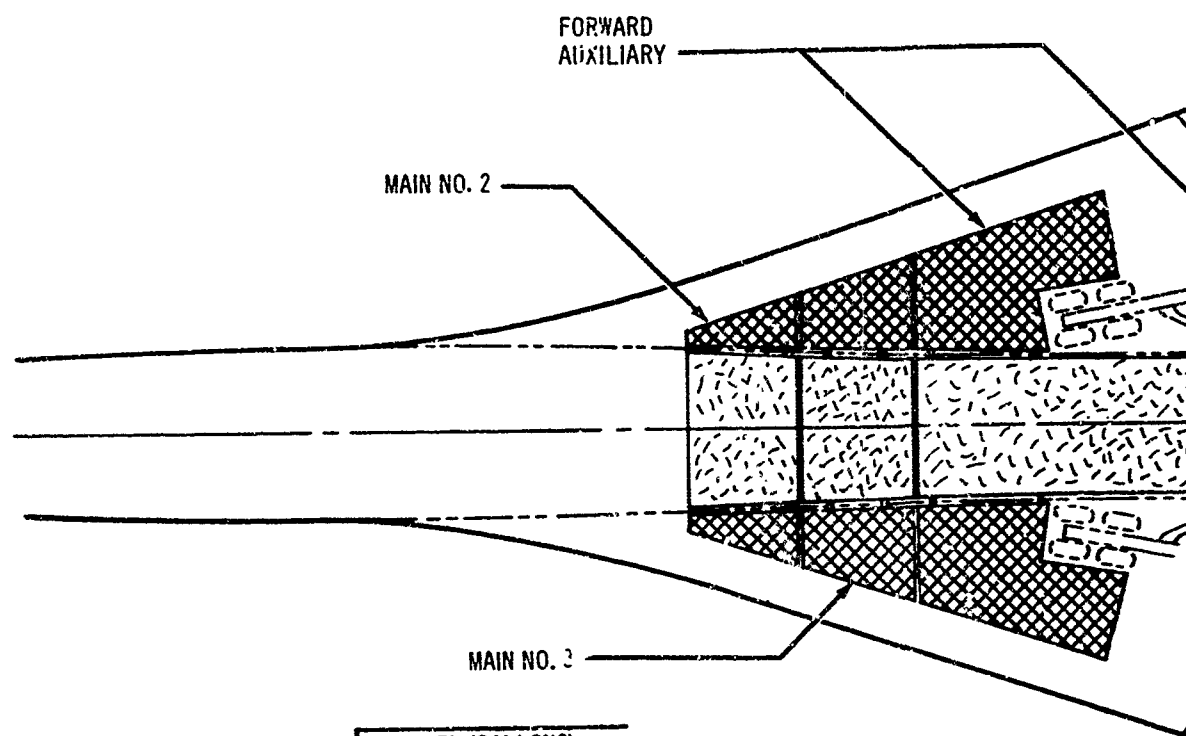
Figure 5-4. B-2707-100 Fuel System Diagram

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TANK	FUEL (GALLONS)	
MAIN NO. 1	4,150	
2	4,150	
3	4,150	
4	4,150	
FORWARD AUXILIARY	20,450	
AFT AUXILIARY	3,820	
AUXILIARY NO. 1A	7,530	
AUXILIARY NO. 4A	7,530	
TOTAL	55,930	

NOTE: INDIVIDUAL TANK VOLUMES
SHOWN ARE APPROXIMATE.

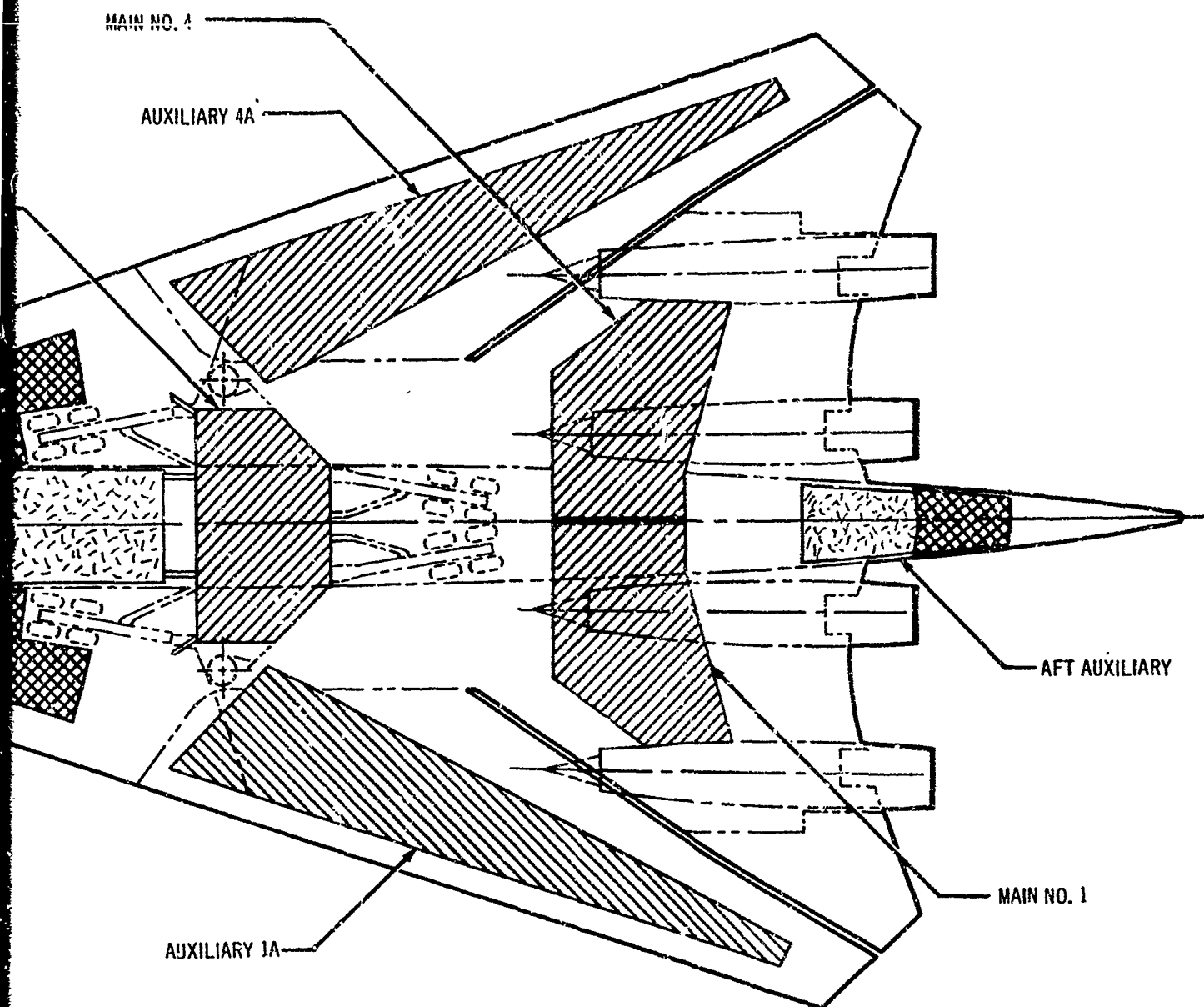


Figure 5-5. Fuel Tank Arrangement

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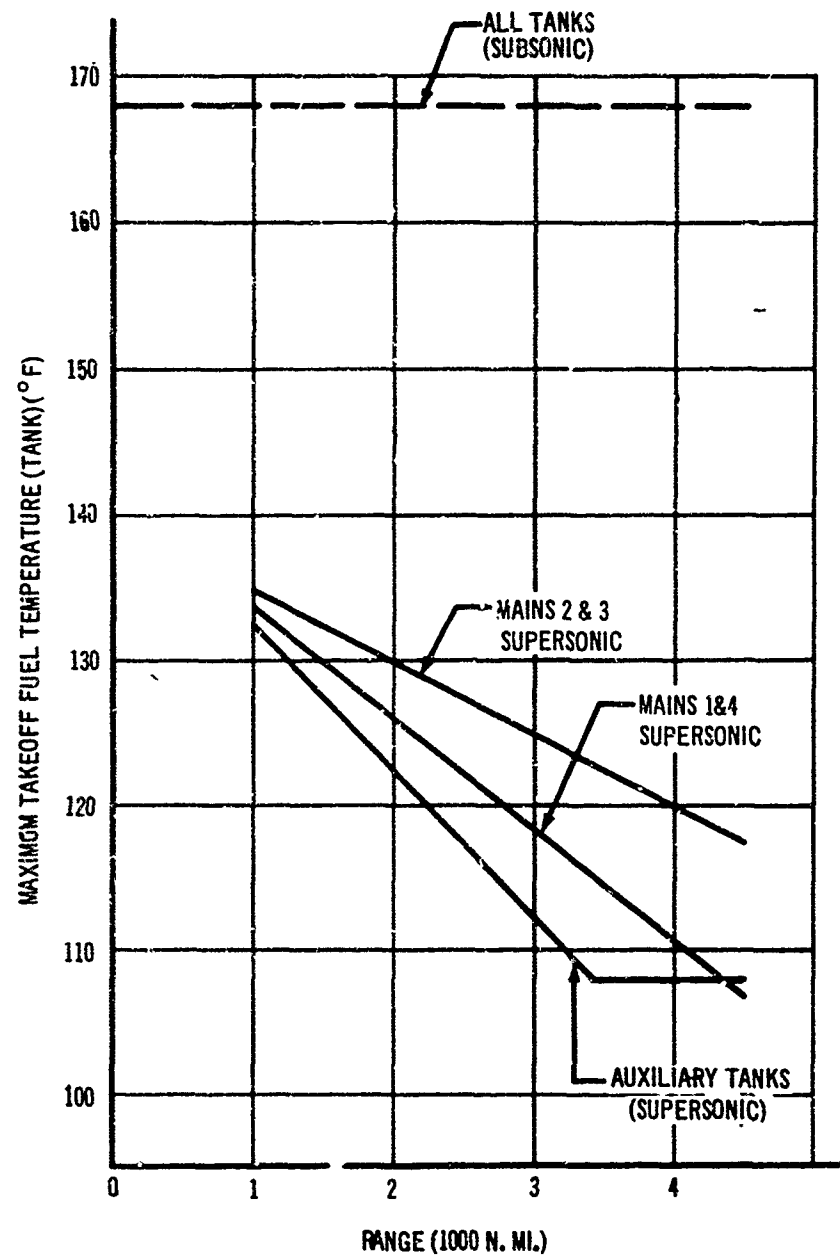


Figure 5-6. Fuel Temperature Limit, B-2707 (GE)

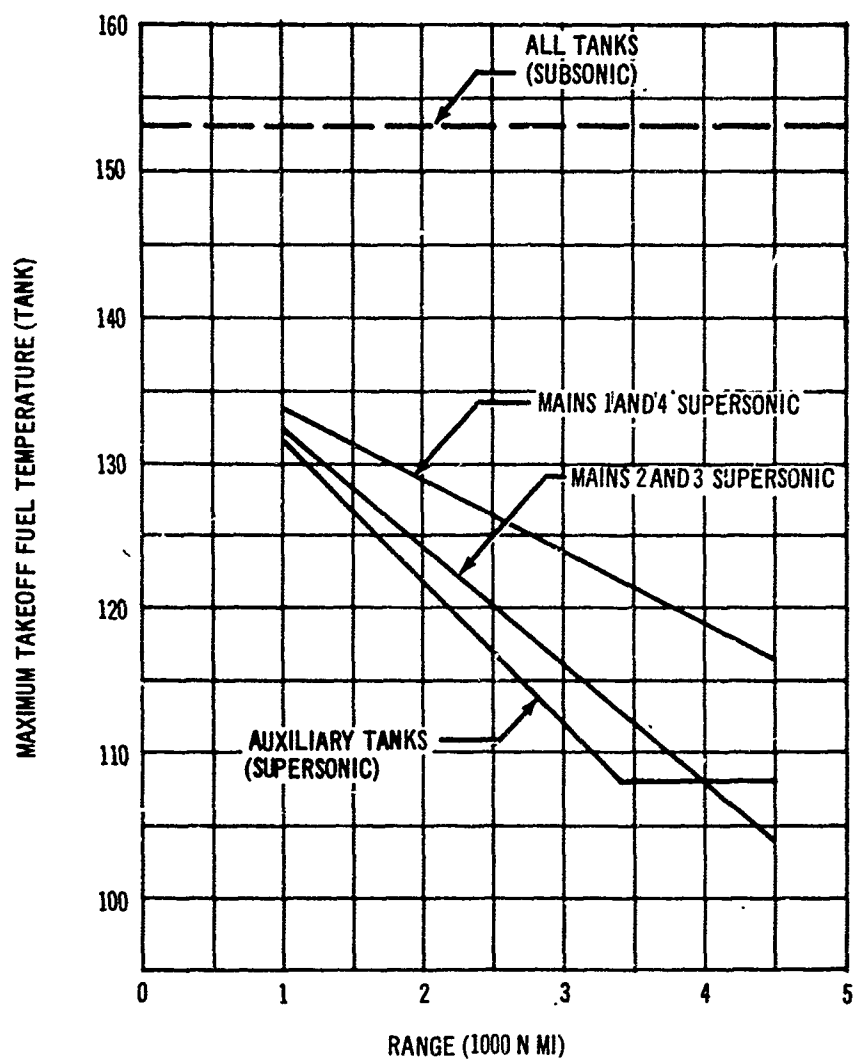
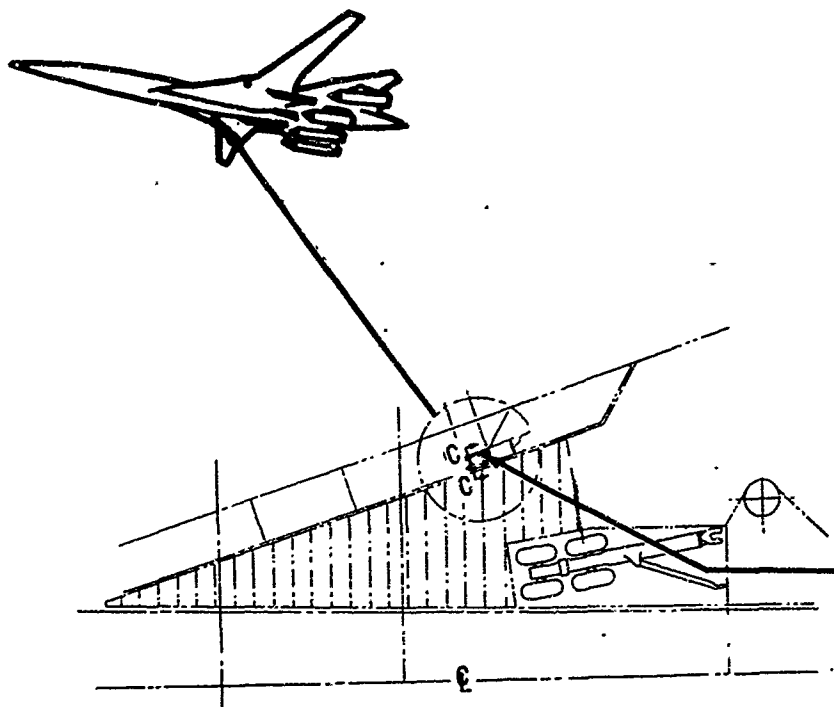
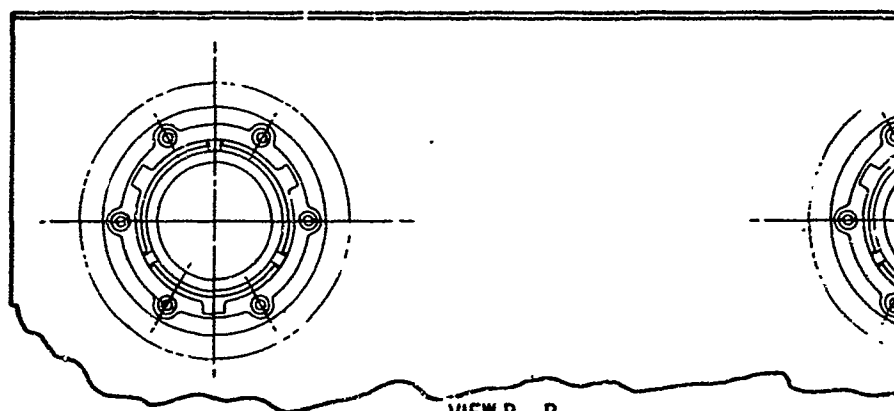


Figure -7. Fuel Temperature Limit B-2707 (P&W)

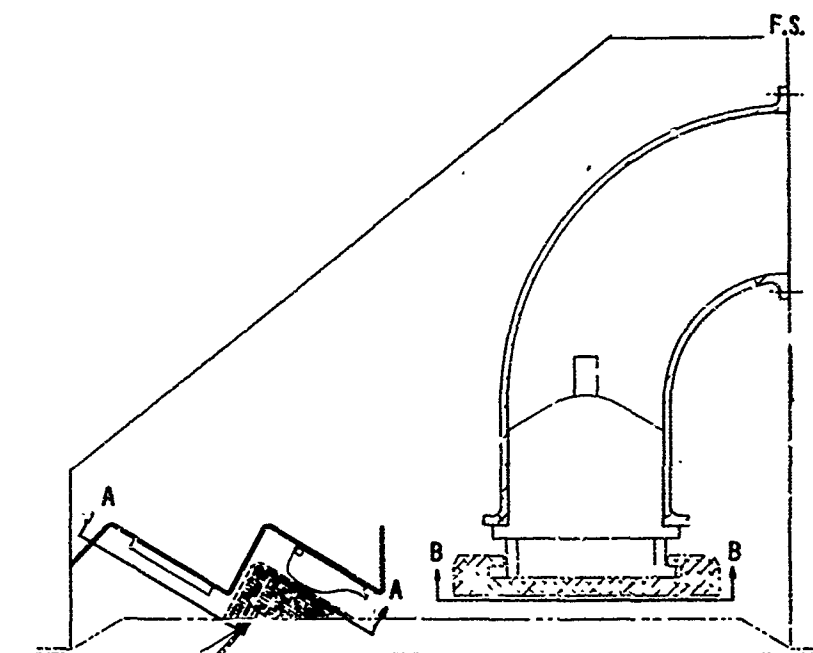


R H SHOWN, L H IN SAME LOCATION



VIEW B - B
BOTH SIDES

CONTROL PANEL AND FUELING ADAPTERS R H
ADAPTERS ONLY ON L H SIDE



SECTION C - C

STOPS INTEGRAL WITH THE DOOR
PREVENT DOOR CLOSING IF ANY SWITCH
IS OPEN.

Figure 5-8. Fueling Station

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SECTION 6
FLIGHT DECK ACCOMMODATIONS

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SECTION 6 FLIGHT DECK ACCOMMODATIONS

6.1 GENERAL

Detail finish requirements for the interior color scheme, upholstery, and floor covering shall be in accordance with applicable references listed in Par. 2.2.2. Cabin trim shall be removable in sections to facilitate inspection of fuselage structure. In general, blind fasteners shall be used for the retention of all trim and lining. Screw heads shall not appear in the finished interior. Painted surfaces shall be kept to a minimum. Solid color fabrics, trim, and coverings shall be provided.

6.2 ARRANGEMENT

The flight deck shall include accommodations for the captain, first officer, flight engineer, and two observers. The arrangement of the flight deck shall be substantially as shown in Fig. 6-1.

6.2.1 Miscellaneous Crew Equipment

The following miscellaneous equipment shall be provided in the flight deck:

- *Oxygen masks, with mask-mounted regulator (5 stations)*
- *Oxygen mask stowage with quick-release hangers (5 stations)*
- *Headset, including earpiece and boom microphone (4 stations)*
- *Ashtray and cup holder (5 stations)*
- *Provisions for lighted mechanical checklist (captain and first officer only)*
- *Smoke goggles (5 stations)*
- *Detachable adjustable reading station light (5 stations)*
- *Sunvisors (captain and first officer only) similar to 707 and 727 type will be provided if windshield coatings do not provide adequate light shielding*
- *Mirror*
- *Work table and drawer (flight engineer)*
- *Removable waste containers*

The following Buyer-furnished equipment shall be installed:

- *Holder for flight crew information bulletin*
- *Emergency equipment diagram*
- *Flashlight holders for captain, first officer, and flight engineer*

6.2.2 Stowage

Stowage shall be provided in the flight deck for the following:

- *Crew coats and caps*
- *Flight kits (captain, first officer, and flight engineer)*
- *Checklists (captain, first officer, and flight engineer)*
- *Approach charts and maps (captain and first officer)*
- *Manuals and books*

Space shall be provided for the crew's overnight baggage.

6.2.3 Sidewall Lining and Floor Covering

A hard-surface sidewall lining and a nonskid, nonglare, and replaceable surface on the floor shall be provided in the flight deck area.

6.2.4 Delethalizing Provisions

The aft edges of the pilots' main panel lightshield shall be padded, except in the area where controls or indicator lights are located. In areas adjacent to crew stations, protuberances and sharp edges shall be avoided or padded.

6.2.5 Placards and Signs

Placards and signs in the flight deck area shall be in the English language; however, placards and signs in other languages shall be available. A NO ADMITTANCE placard shall be installed on the passenger cabin side of the electronics equipment area door.

6.3 CREW SEATS

6.3.1 General

All crew member seats shall be removable from the airplane without disassembly. Any associated parts of the crew seat that are a part of the airplane and subject to wear shall be easily replaceable. The seat cushion of each seat shall have flotation capability.

6.3.2 Pilots' Seats

The captain's seat shall be reclinable, and power-operated vertically and fore and aft to facilitate monitoring the flight engineer's panel. The first officer's seat shall be reclinable, and adjustable laterally and power-operated vertically and fore and aft. To facilitate entry into the seats, folding arm rests shall be provided. *Means shall be provided at the captain's and first officer's stations to locate the pilots' eye reference points. Means shall be provided to position and lock the pilots' seats manually, as a backup to the powered operation.*

6.3.3 Flight Engineer's Seat

The flight engineer's seat shall swivel and be adjustable laterally and shall be power-operated vertically and fore and aft. Vertical adjustment shall allow the flight engineer's eye to be at the same level as the pilot's eye when in the forward position. *Means shall be provided to position and lock the flight engineer's seat manually as a backup to the powered operation.*

6.3.4 Observers' Seats

Stowable and nonadjustable seats for two observers shall be provided on the flight deck.

6.3.5 Seat Harnesses

Inertia-type seat harnesses shall be provided for the captain's, first officer's and flight engineer's positions.

A noninertia-type seat harness shall be provided for the observers' positions.

6.3.6 Seat Loads

All flight deck seats shall be designed for the following ultimate load factors acting separately; forward, 16g (acting within a 20-deg angle either side of forward); upward, 7.5g; and downward, 13g.

6.4 EMERGENCY EQUIPMENT

Portable emergency equipment shall be readily accessible and positively identified. The following equipment shall be located in the flight deck:

- One CO₂ fire extinguisher
- A lifejacket for each crew station

- *An overhead escape hatch and a hinged side escape hatch with escape ropes attached to the airplane structure adjacent to each escape hatch*
- *Smoke goggles at each crew station*
- *One 11-cu ft of free oxygen, 1,850 psi, portable oxygen bottle with a full face protective oxygen mask*
- *Crash axe*
- *First aid kit*
- *Asbestos gloves.*

6.5

FLIGHT CREW OXYGEN SYSTEM

The flight crew oxygen system shall be substantially as shown in Fig. 6-17. Two 1,850 psi gaseous oxygen cylinders shall be installed to provide a total of 228 cu ft of free oxygen. The oxygen cylinders shall be readily replaceable and shall also be provided with means to recharge without removal from the airplane if the operator so desires.

Refer to Par. 11.4.3 for a description of passenger oxygen provisions.

Quick-donning, pressure-breathing mask, mask-mounted regulator, and stowage shall be provided at each flight deck station. A quick-disconnect coupling shall be provided for connecting the mask hose to the airplane supply line.

Sufficient oxygen shall be provided for 1.5 hr of flight for *either of the pilots*, with the pressure demand regulator set at NORMAL under a cabin pressure equivalent to a nominal 6000-ft altitude. In addition, there shall be sufficient oxygen for use during descent following a decompression and for a 2-hour post-decompression flight for five crewmembers during the time that cabin altitude is 14,000 ft or lower.

6.6

INSTRUMENTS AND CONTROL PANELS

6.6.1

Standards

SAE Aeronautical Recommended Practices and Aerospace Standards shall be used as a guide in arrangement of the flight deck area.

The arrangement and presentation of flight deck instrumentation and controls will reflect airline experience with Boeing subsonic jet aircraft. However, where advisable, logical changes will be incorporated which result from technological advancements or the operating requirements of the airplane.

6.6.2 Instrument-Panel Mounting

Instrument panels shall not be shock mounted. Vibrators shall be provided as required to reduce instrument friction error.

6.6.3 Flexible Lines

Flexible lines shall be provided at pressure-operated instruments to facilitate removal and servicing of instruments and panels. The design shall ensure that connectors cannot be mismated.

6.6.4 Instrument Wiring

Wherever practical, electrical instruments shall have individual instrument connectors. Flexible wire bundles shall be provided, where necessary, to permit the instrument panels to be opened. The design shall ensure that connectors cannot be mismated.

6.6.5 Instrument Mounting

Where practical, all instruments shall be front-mounted.

6.6.6 Instrument Faces

Instrument dials shall be dull black and all numerals, graduations, nomenclature, and pointers shall be matte white. All primary digital readouts shall be bold stroke numerals as large as possible, but at least 0.25-in. high.

6.6.7 Instrument Markings

All appropriate instrument operating range and limit markings shall be provided and shall be located on the instrument dial (not on the cover glass). These markings shall be clearly visible when the instruments are integrally lighted.

6.6.8 Instrument Lighting

Refer to Par. 9.11 for instrument lighting.

6.6.9 General

All flight, engine, and miscellaneous instruments specified in App. I shall be installed.

Instrument references:

Power Plant and Fuel System - Sec. 5
Flight Control System - Sec. 7

Hydraulic System - Sec. 8
 Electrical System - Sec. 9
 Flight Instruments - Sec. 10
 Air Conditioning and Pressurization - Sec. 12
 Anti-icing and Antifogging - Sec. 12

6.7 PITOT-STATIC SYSTEM

Primary and secondary pitot-static systems shall be provided as shown in Fig. 6-16. The primary system shall consist of a single nose-mounted probe, providing two pneumatically independent pitot sources and two pneumatically independent static sources to supply pitot and static pressures to the two air data computers (Par. 10.3.2) under normal operating conditions.

The secondary pitot-static system shall consist of a dual body-mounted pitot probe and three independent flush static sources. The No. 1 pitot source and No. 1 static source shall be connected to the captain's pneumatic instruments. The No. 2 pitot source and No. 2 static source shall be connected to the first officer's pneumatic instruments. The No. 3 static source shall supply a pressure reference to the environmental control instrumentation.

A selector valve shall be provided to enable operation of the air data computers from either the primary pitot-static system or the secondary pitot-static system.

The nose probe and the body-mounted pitot probe shall be electrically deiced. Adequate water collection traps, drainage provisions, and test fittings shall be provided.

6.8 CONTROL PANELS

The arrangement of the control panels in the flight deck area shall be substantially as shown on the following figures:

Pilots' Main Instrument Panel	Fig. 6-2
Aisle Control Stand	Fig. 6-3
Aisle Control Stand Panel	Fig. 6-4
Pilots' Overhead Panel	Fig. 6-5
Pilots' Aft Overhead Panel	Fig. 6-6
Propulsion System, Flight Engineer's Panel	Fig. 6-7
Electrical System, Flight Engineer's Panel	Fig. 6-8
Hydraulic System, Flight Engineer's Panel	Fig. 6-9
Fuel System, Flight Engineer's Panel	Fig. 6-10
Environmental Control System, Flight Engineer's Panel	Fig. 6-11
Flight Engineer's Miscellaneous Instruments	Fig. 6-12

Flight Engineer's Bulkhead Panels
Circuit Breaker Panels
Observers' Panels
Pitot-Static System Diagram
Flight Crew Oxygen System Diagram

Fig. 6-13
Fig. 6-14
Fig. 6-15
Fig. 6-16
Fig. 6-17

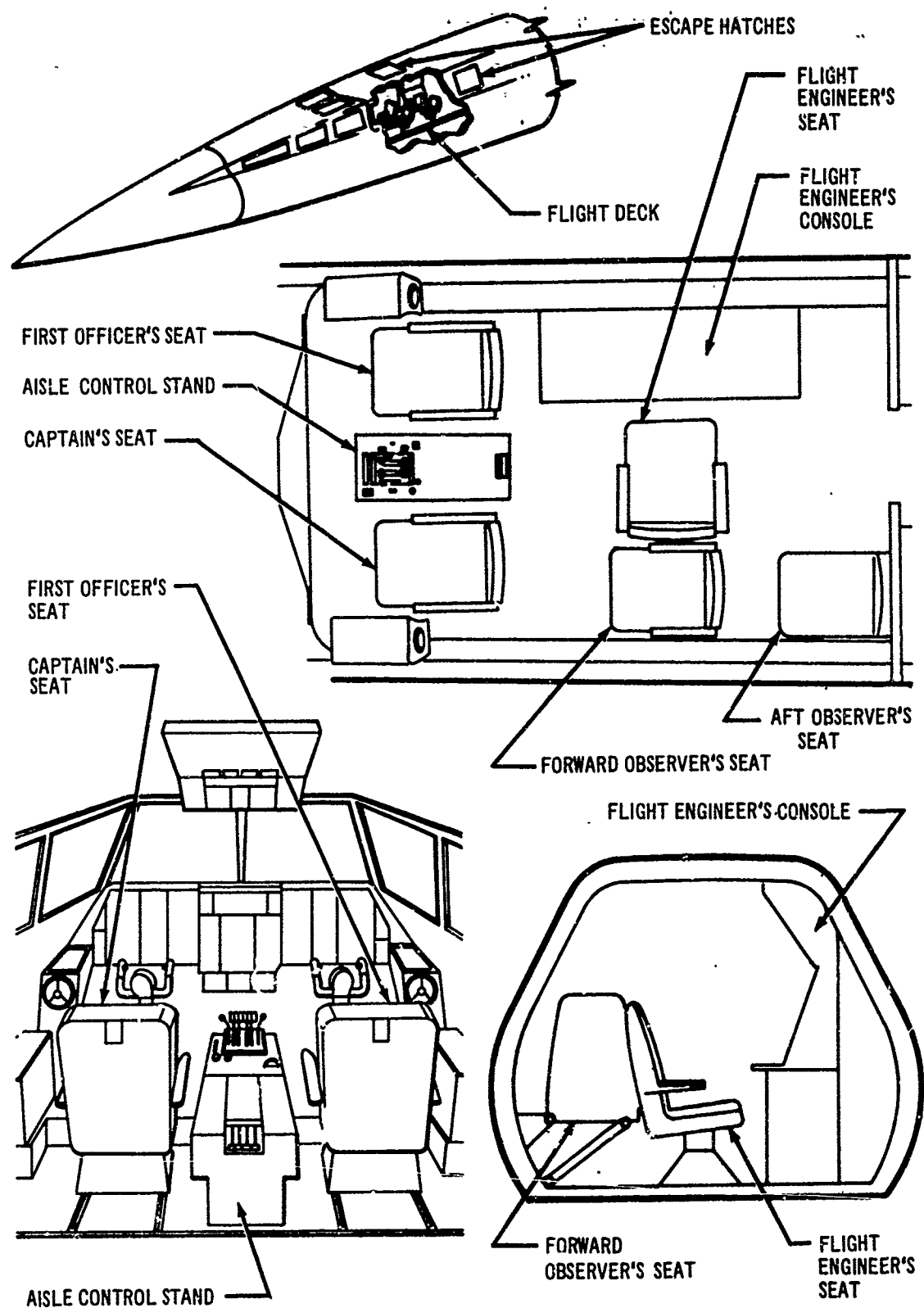
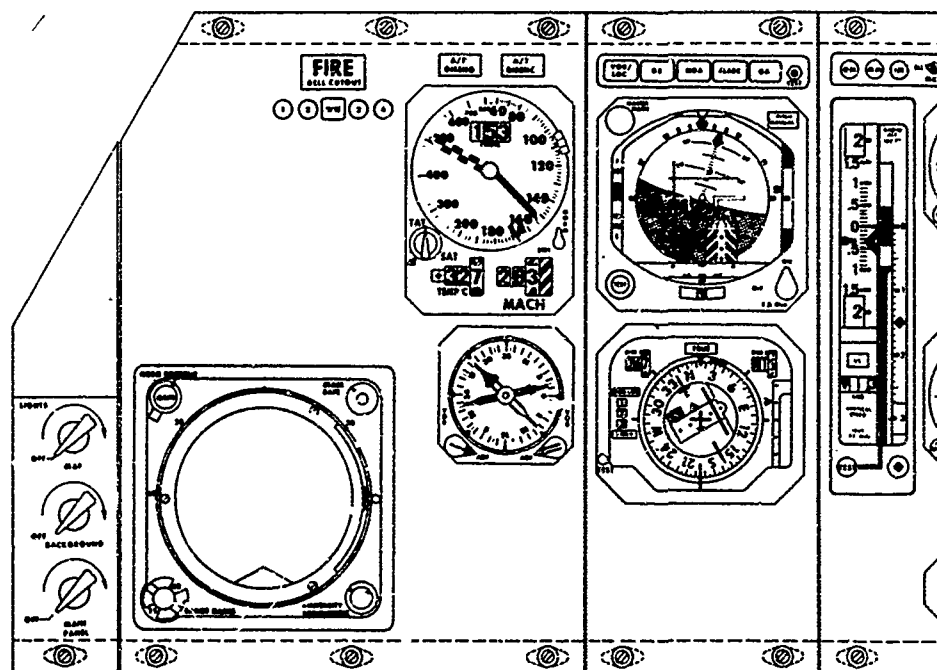
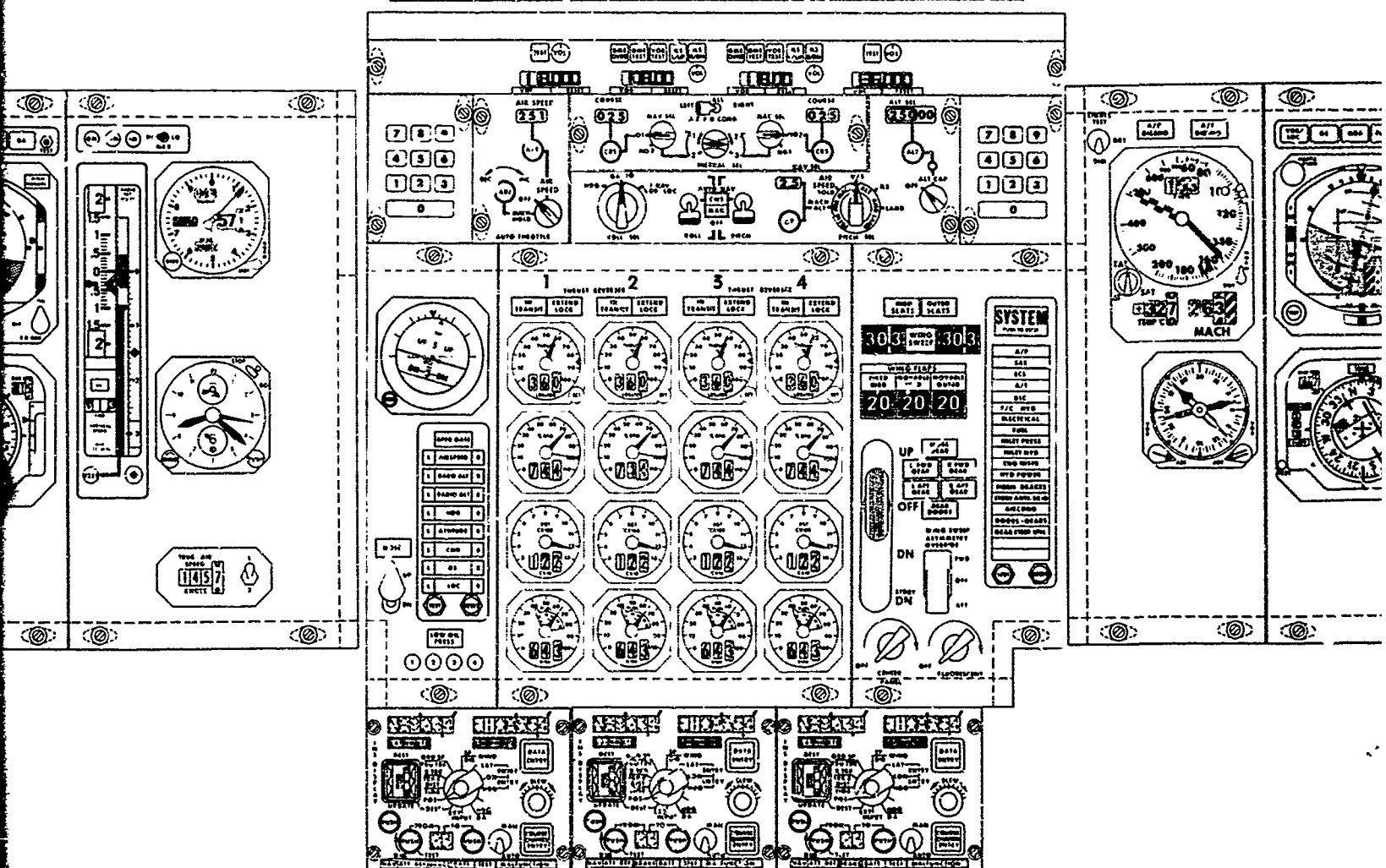
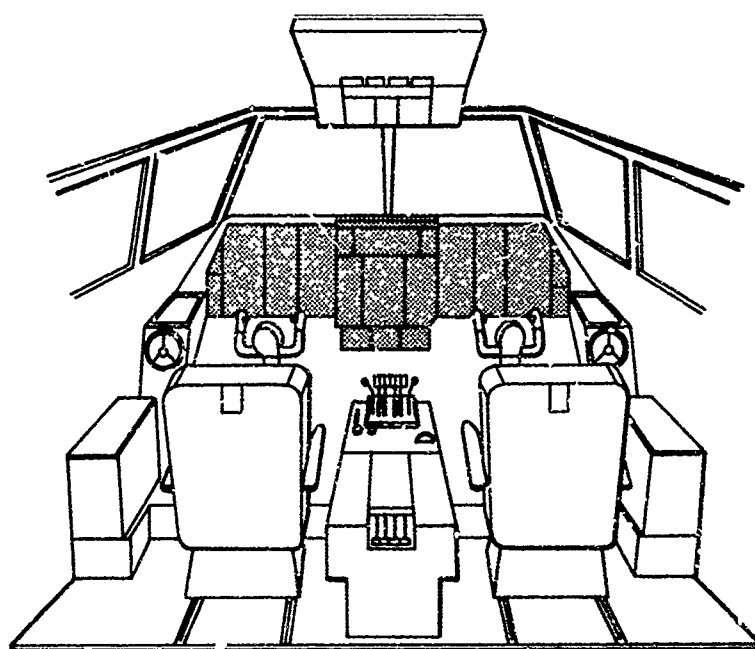


Figure 6-1. Flight Deck Arrangement

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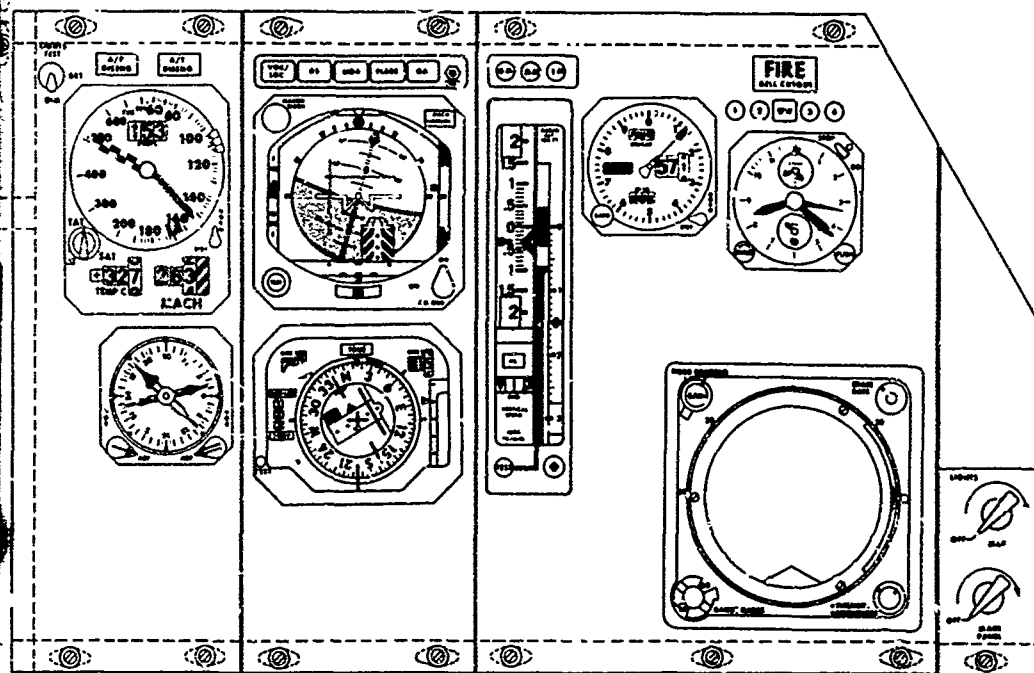
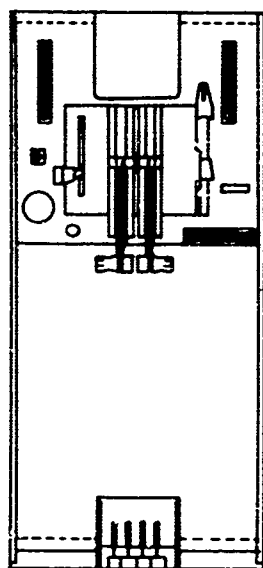
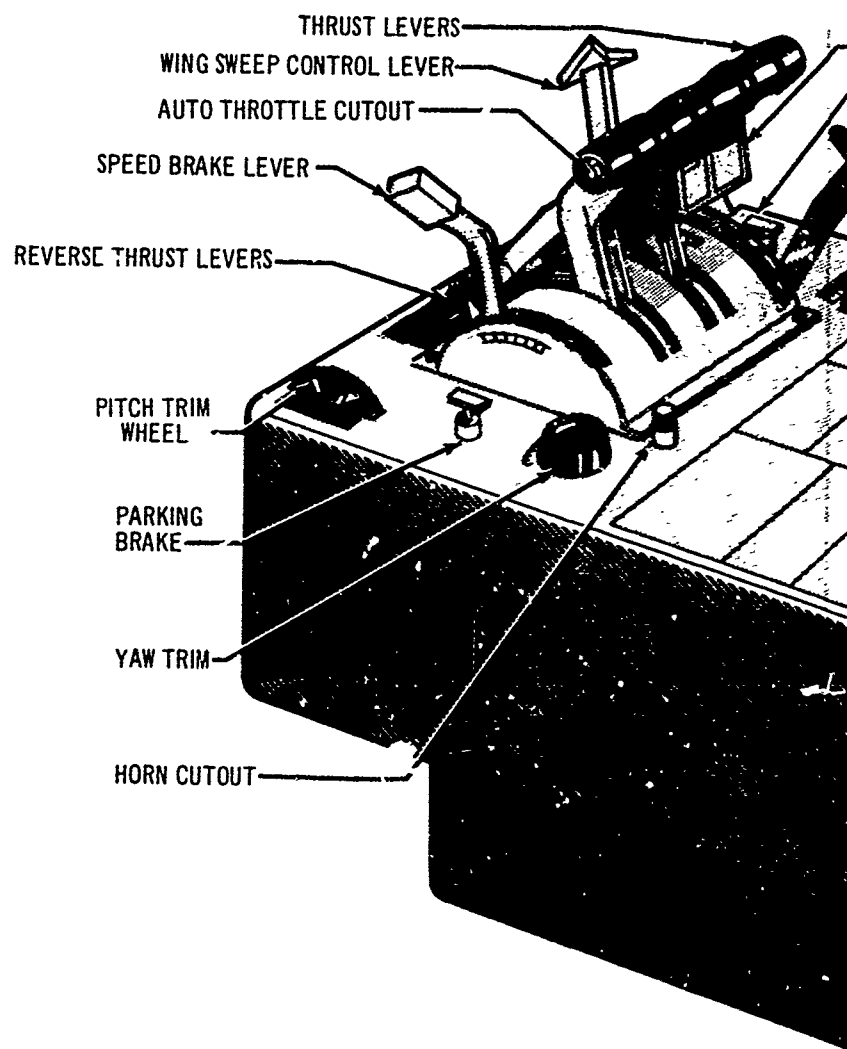


Figure 6-2. Pilots' Main Instrument Panel



TOP VIEW

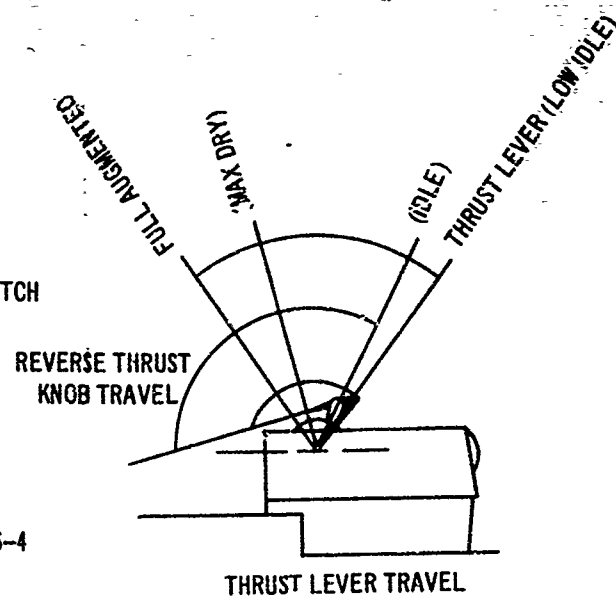
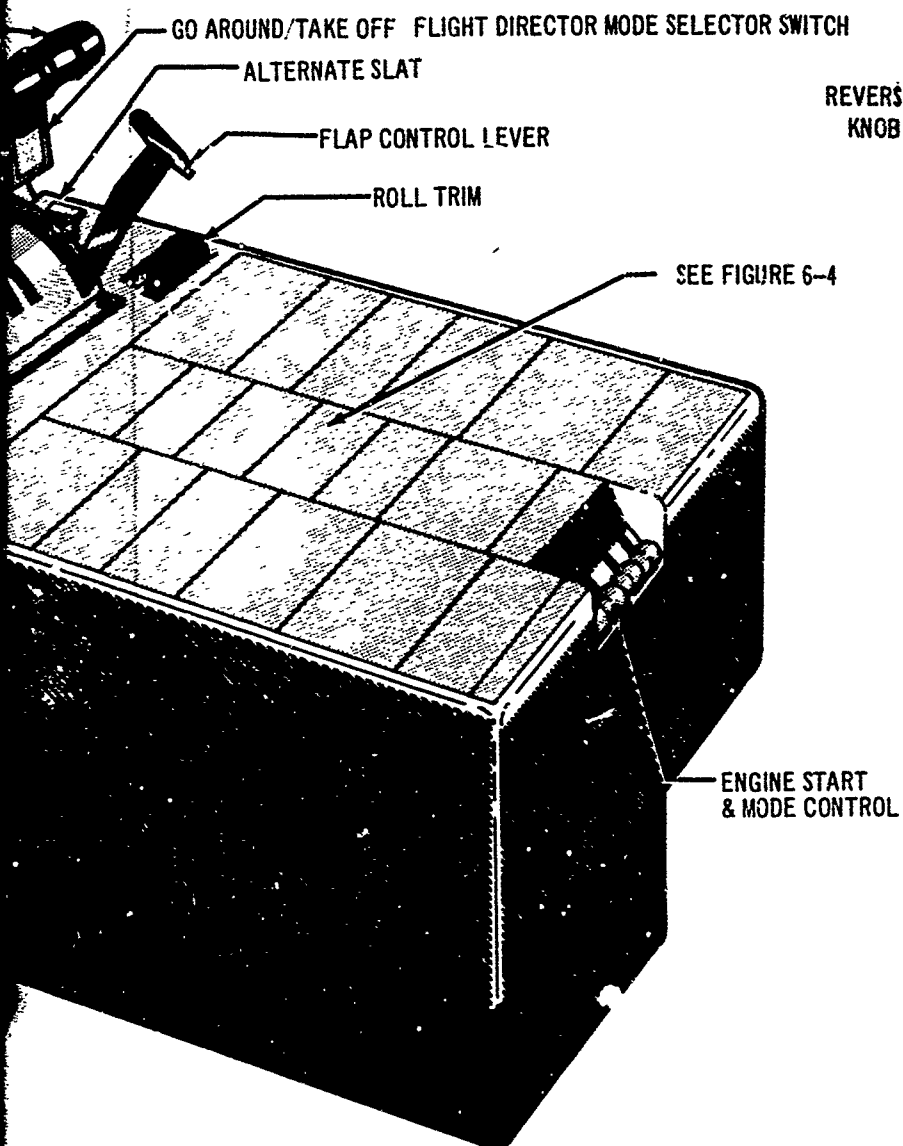


Figure 6-3. Pilots Aisle Control Stand

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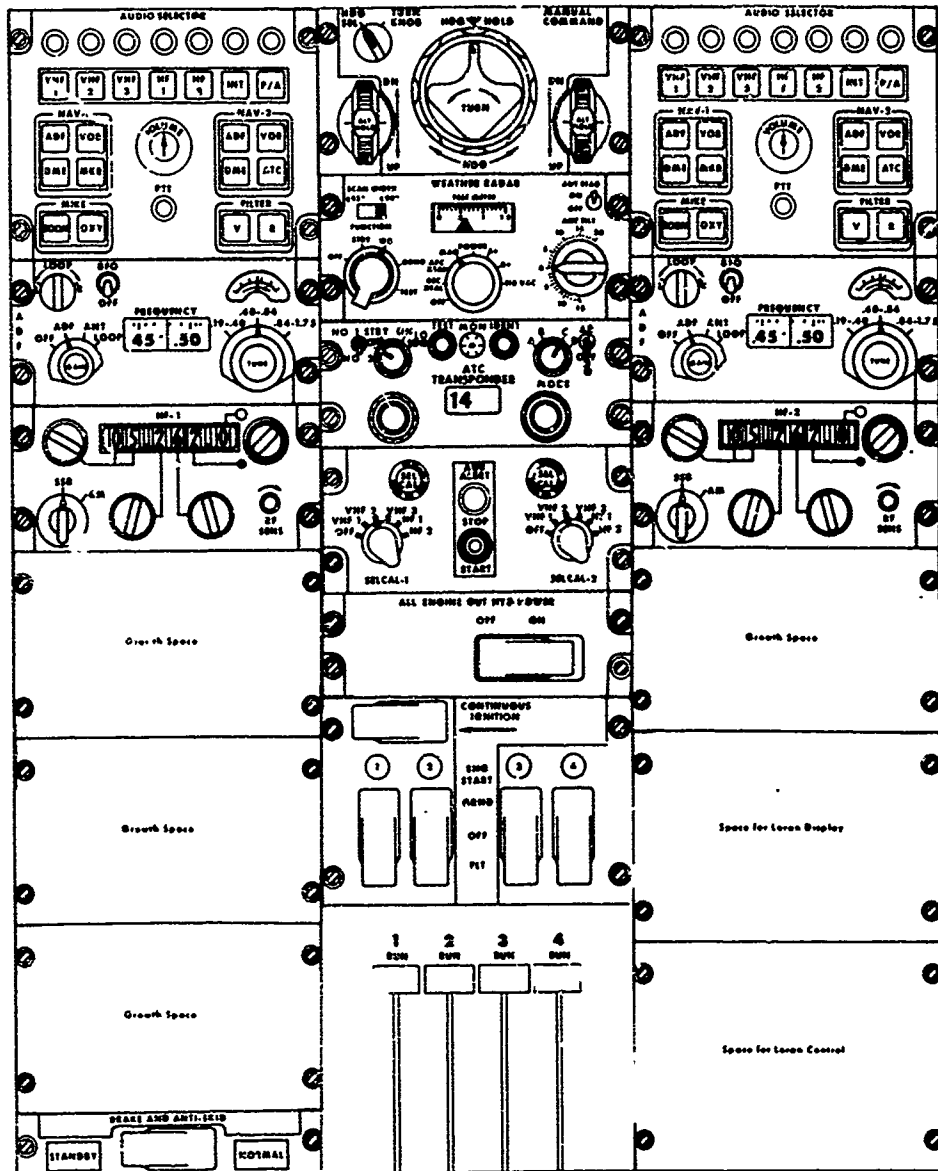
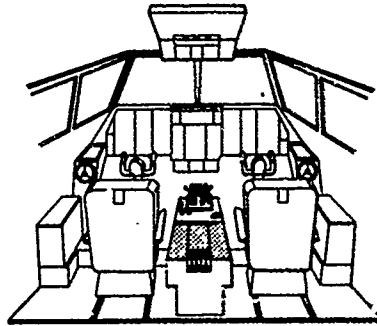
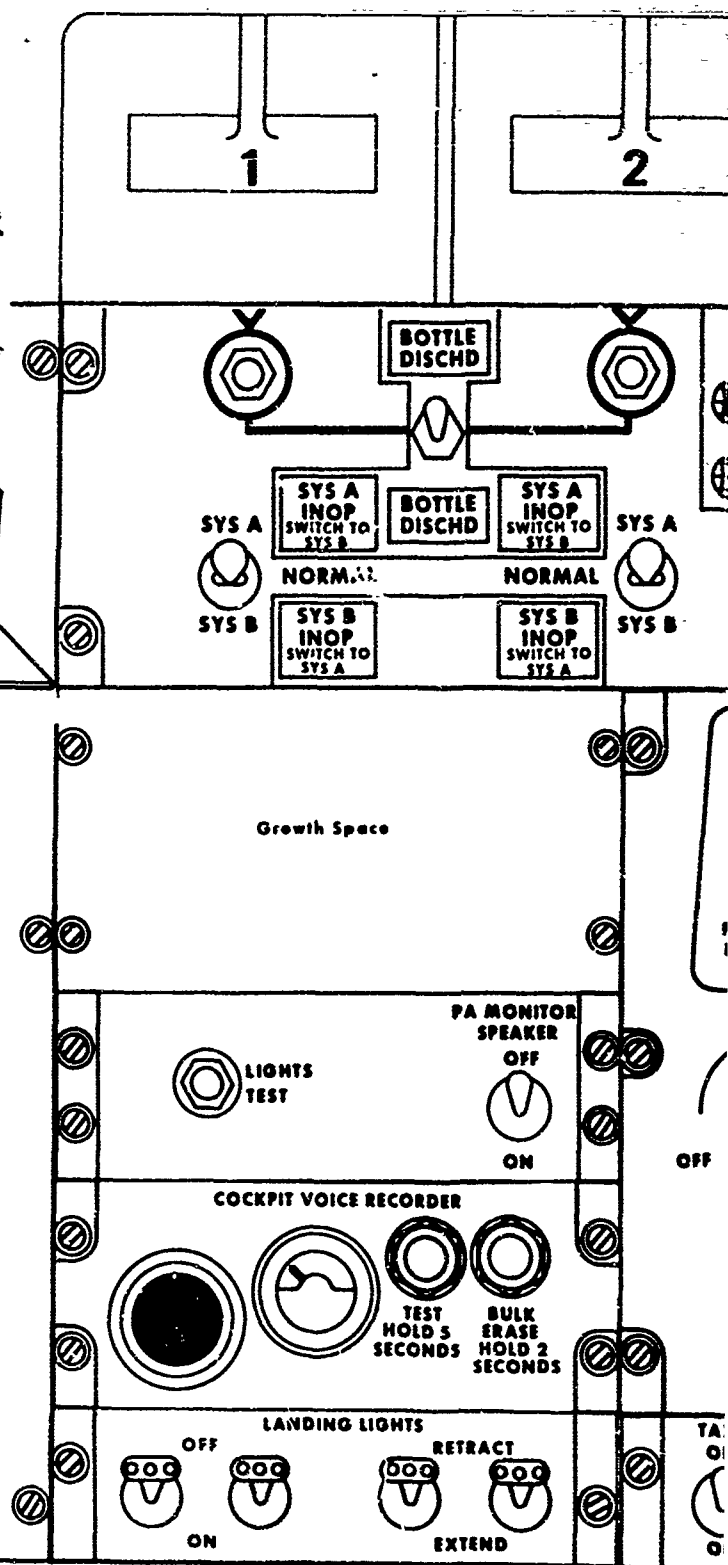
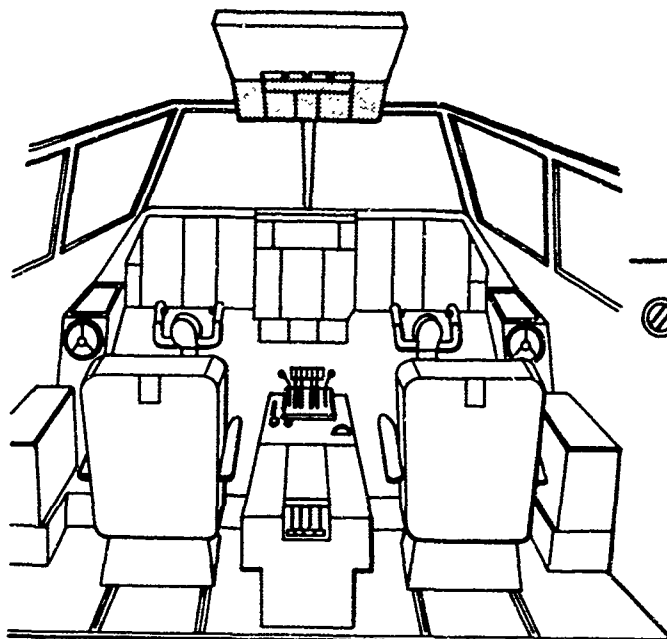


Figure 6-4. Aisle Control Stand Panel

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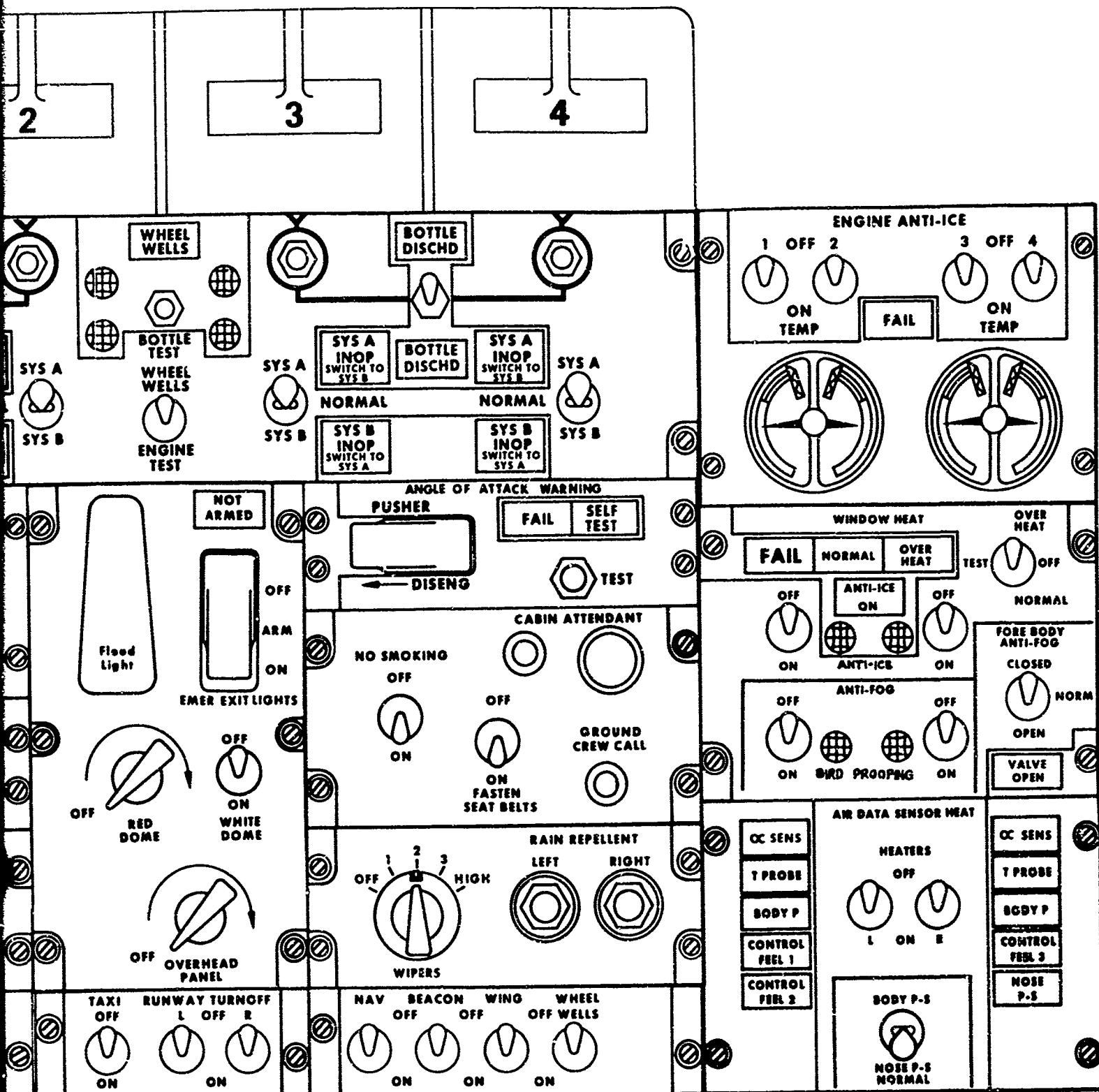


Figure 6-5. Pilots' Overhead Panel

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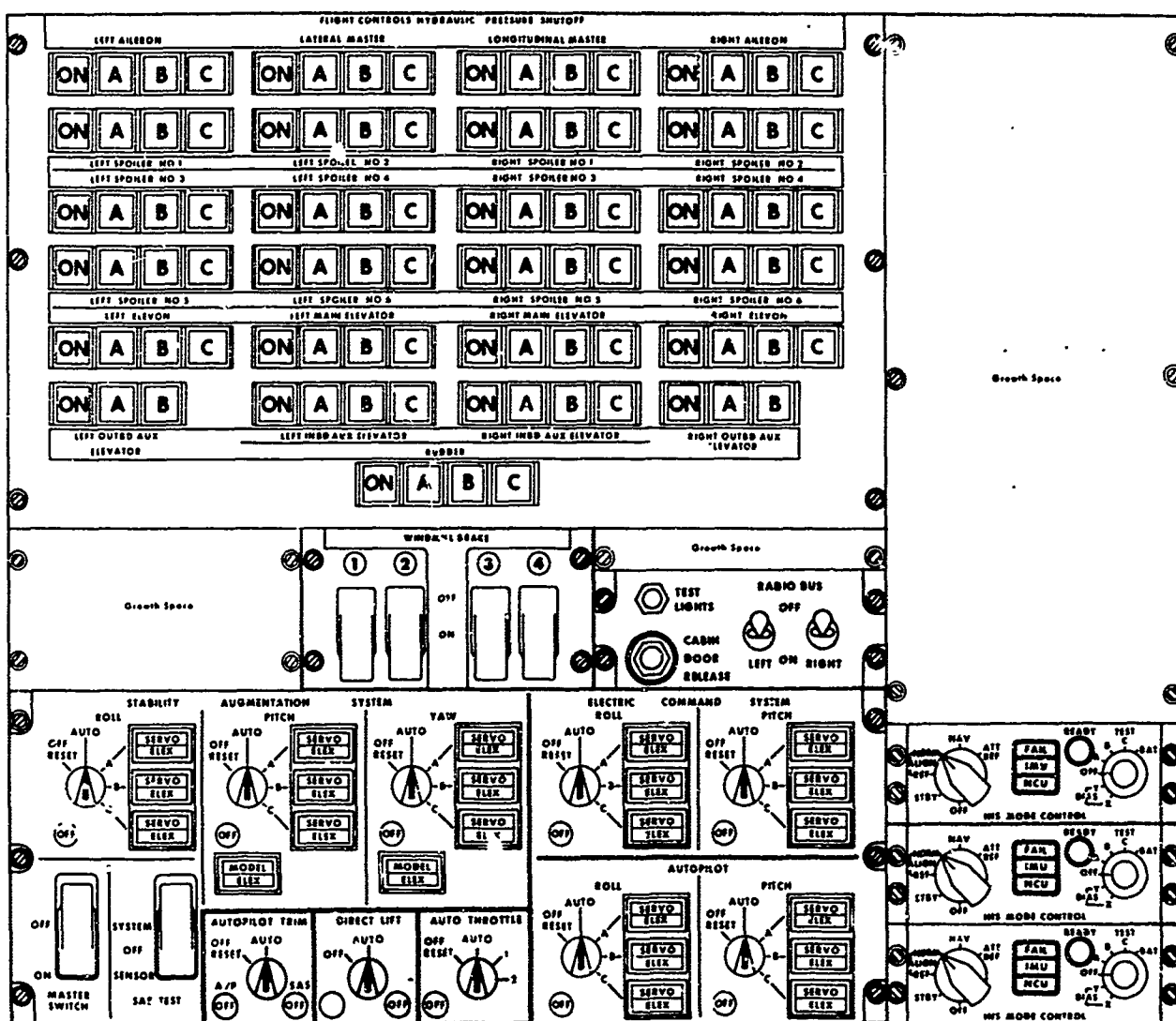
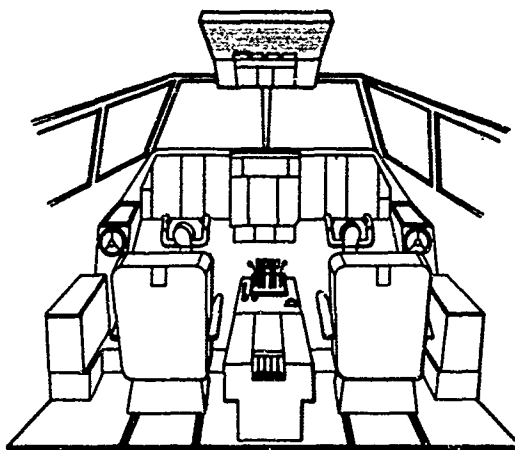


Figure 6-6 Pilots' Aft Overhead Panel

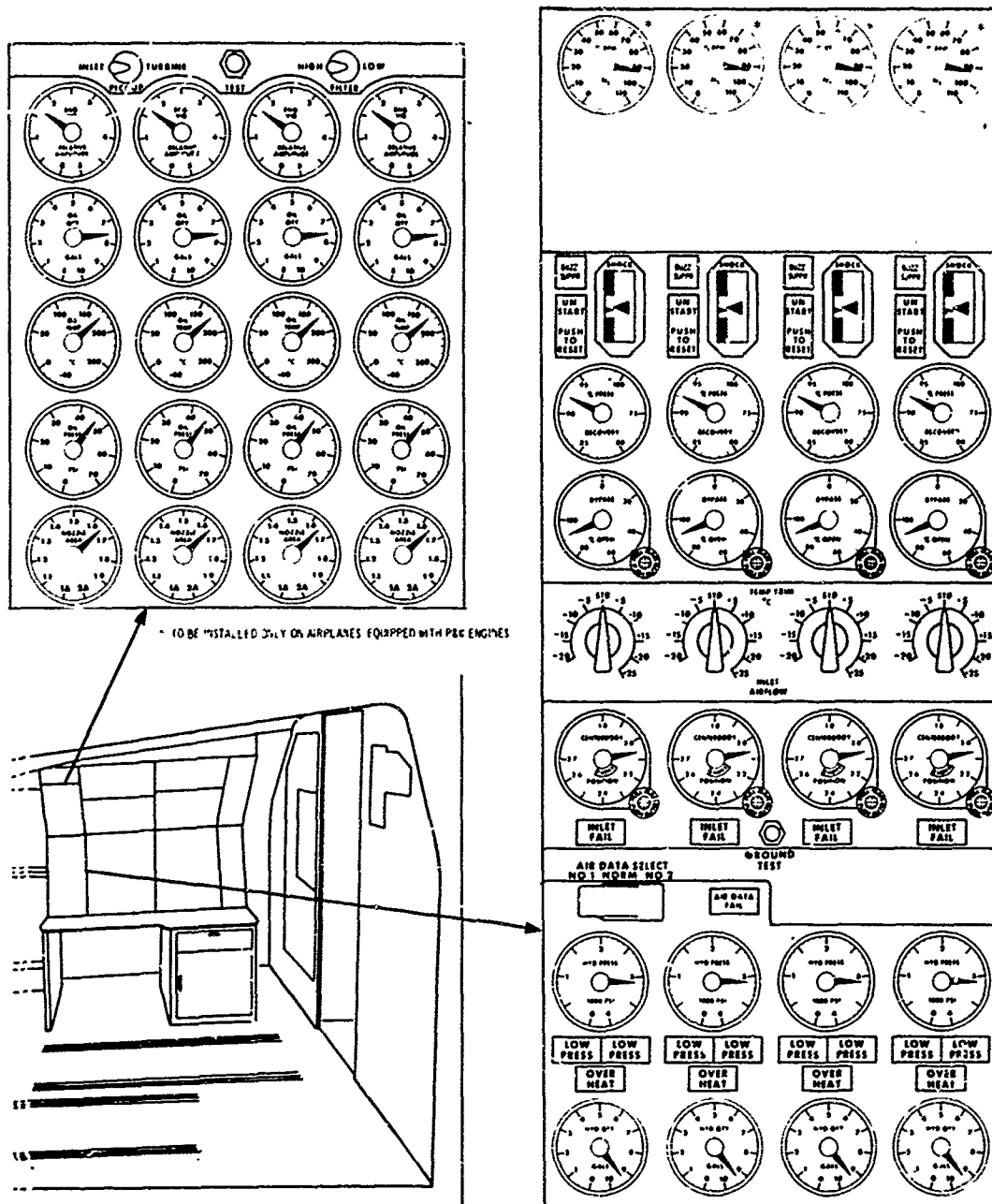


Figure 6-7. Propulsion System, Flight Engineer's Panel

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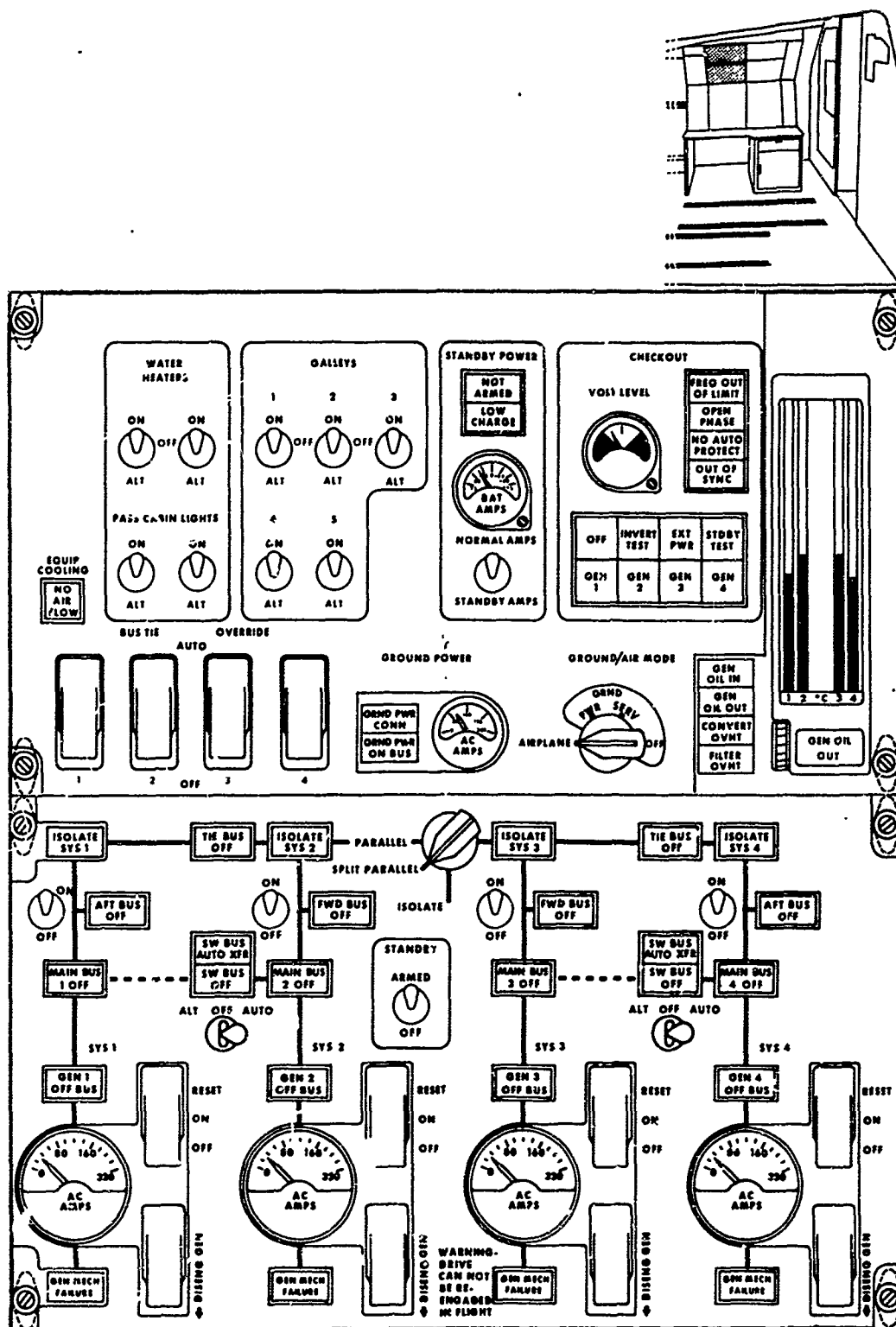


Figure 6-8. Electrical System Flight Engineer's Panel

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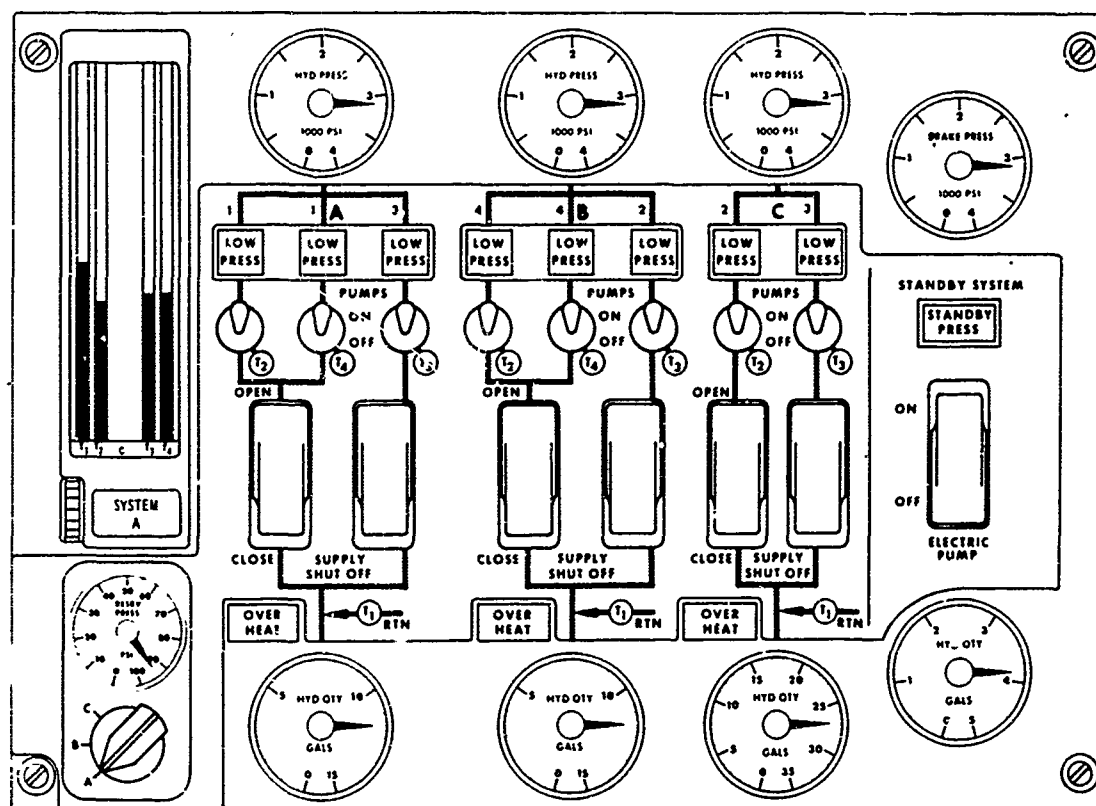
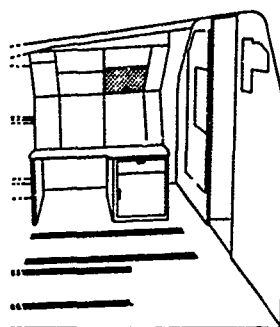


Figure 6-9. Hydraulic System, Flight Engineer's Panel

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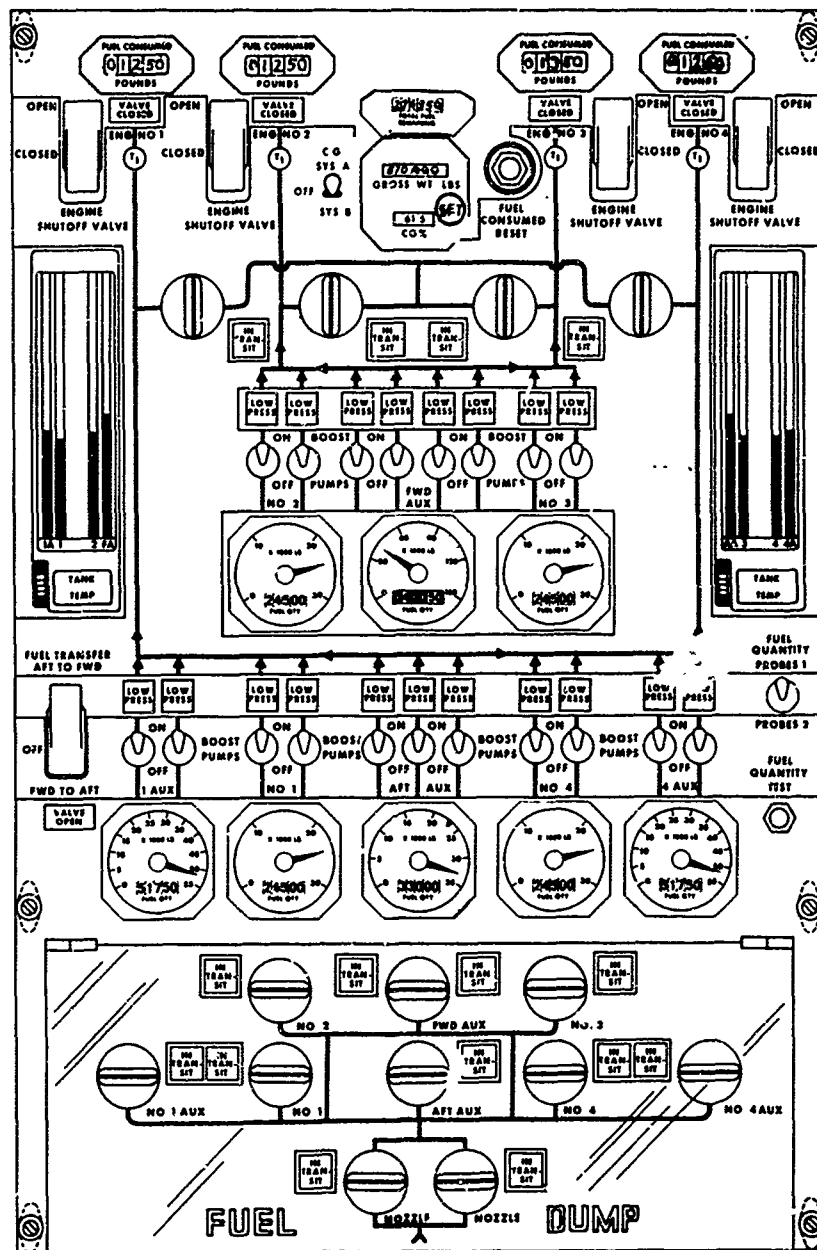


Figure 6-10. Fuel System, Flight Engineer's Panel

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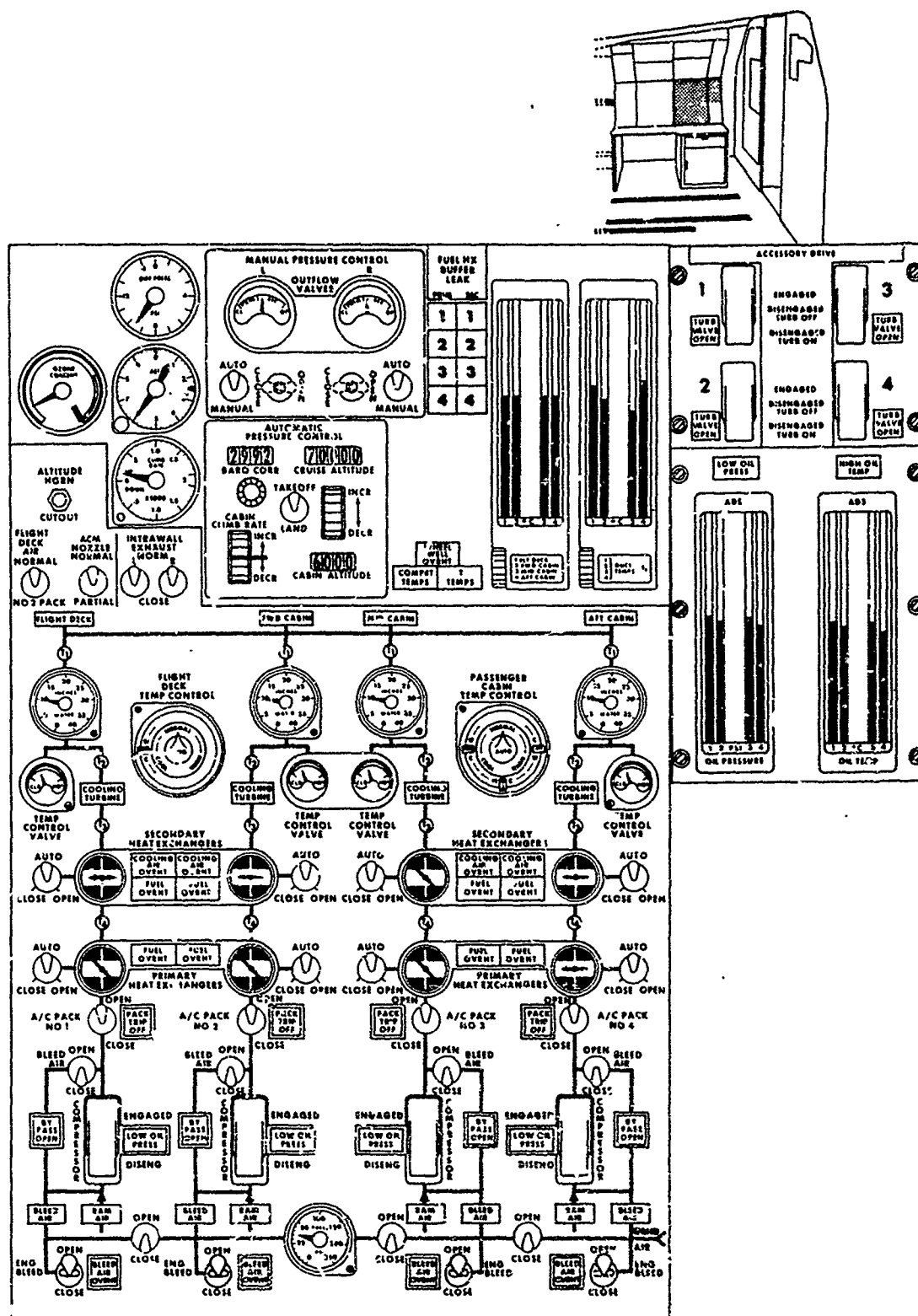


Figure 6-11. Environmental Control System, Flight Engineer's Panel

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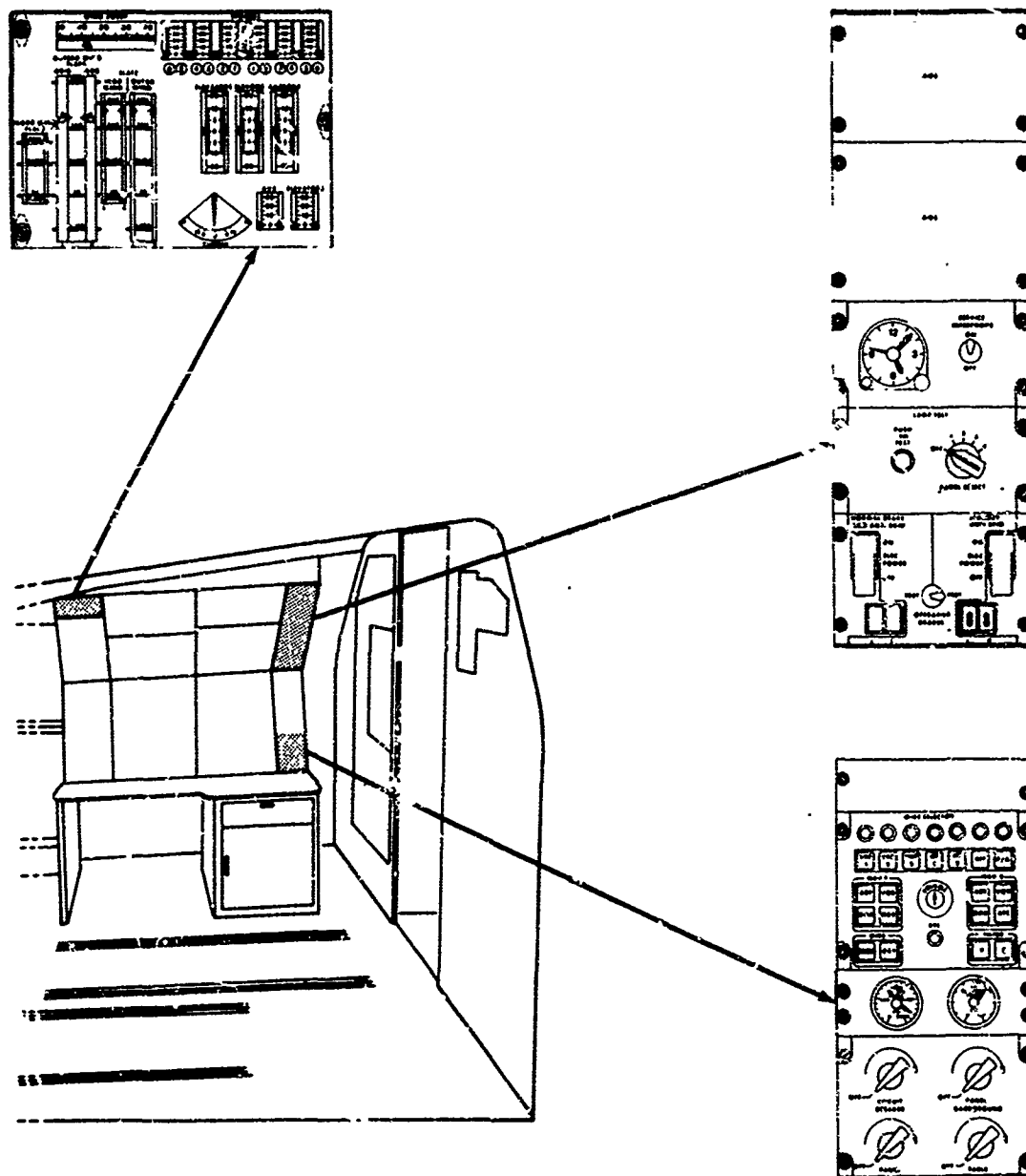


Figure 6-12. Flight Engineer's Miscellaneous Instruments

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PRESSURE DOORS - GEARS			TEST	
FWD ENTRY	FWD GALLEY	MAIN ENTRY		
MAIN GALLEY	AFT GALLEY	AFT SERVICE		
FWD CARGO	AFT CARGO	FUEL DOORS		
L STEER LOCKED	R STEER LOCKED	LOCK PINS IN		
L SYS FAIL	R SYS FAIL	CHAM FAIL		

LF MAIN GEAR	LR MAIN GEAR	NOSE GEAR	RR MAIN GEAR	RF MAIN GEAR
OLIO SWITCH OPEN	OLIO SWITCH OPEN	OLIO SWITCH OPEN	OLIO SWITCH OPEN	OLIO SWITCH OPEN
DOORS NOT OPEN	DOORS NOT OPEN	DOORS NOT OPEN	DOORS NOT OPEN	DOORS NOT OPEN
DOORS NOT CLOSED	DOORS NOT CLOSED	DOORS NOT CLOSED	DOORS NOT CLOSED	DOORS NOT CLOSED

UL WING BRO	LL WING BRO	LR WING BRO	UR WING BRO

TEST		RESET	
DIFF PROTECTION	1 2 3 4		
OVER VOLTAGE	1 2 3 4		
UNDER VOLTAGE	1 2 3 4		
OVERLOAD	1 2 3 4		
PARALLELING PROTECT	1 2 3 4		
WAVE SHAPE	1 2 3 4		
FREQUENCY	1 2 3 4		
OF 4 DISENGAGED	1 2 3 4		
NO COOLING - GEN BUS	1 2 3 4		

FWD DC BUS FAN	MAIN BUS 1 DWF PROTECT	1 TH BUS DWF PROTECT
AFT DC BUS FAN	MAIN BUS 2 DWF PROTECT	2 TH BUS DWF PROTECT
IN FAN	MAIN BUS 3 DWF PROTECT	3 TH BUS DWF PROTECT
NO COOLING FWD FUEL SYS	MAIN BUS 4 DWF PROTECT	4 TH BUS DWF PROTECT

TEST		RESET	
EMERG BYPASS OPEN	1 2 3 4		
TURBO FAN OFF-GRND			
TURBO FAN ON-AIR			
ACM OVERSPEED			
DUCT OVERHEAT			
ADS DISENGAGED			
COMPE DISENGAGED			

LEFT PRESSURE RELIEF OPEN	RIGHT PRESSURE RELIEF OPEN

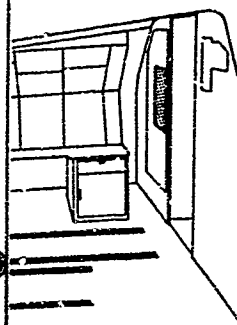
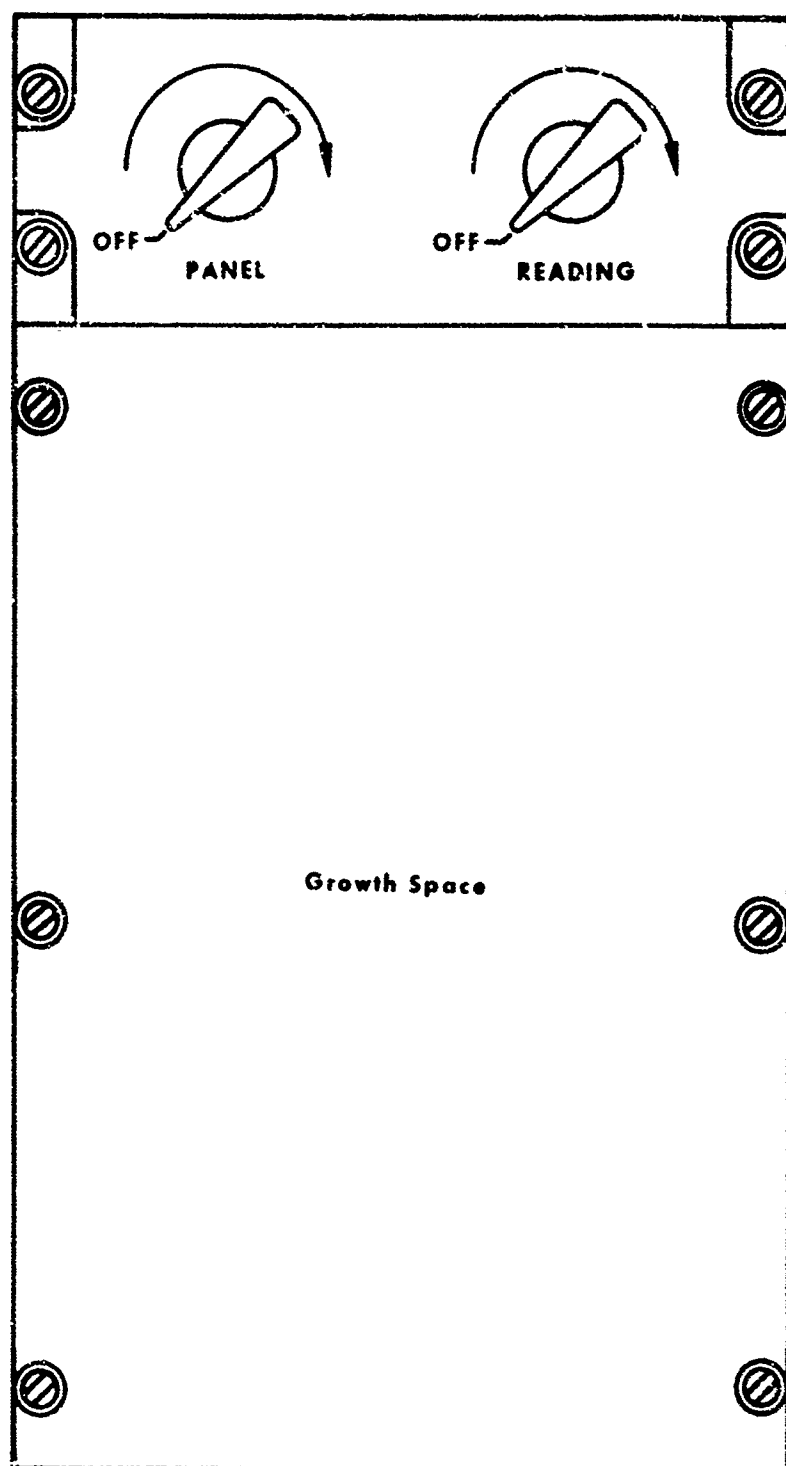


Figure 6-13. Flight Engineer's Bulkhead Panels

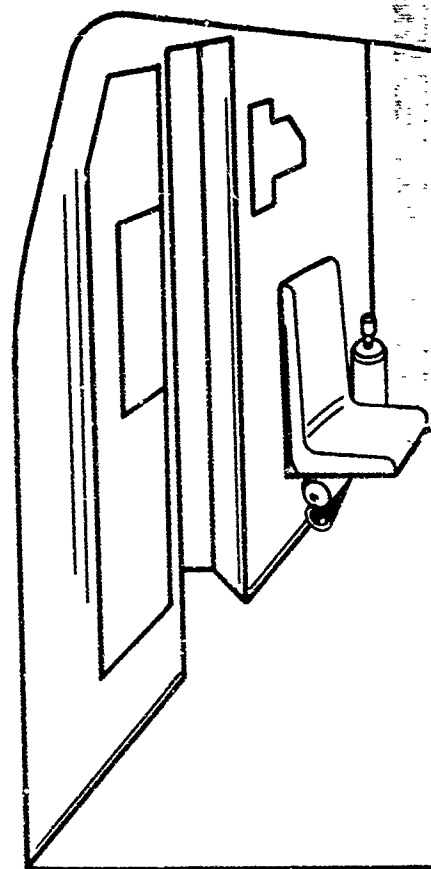


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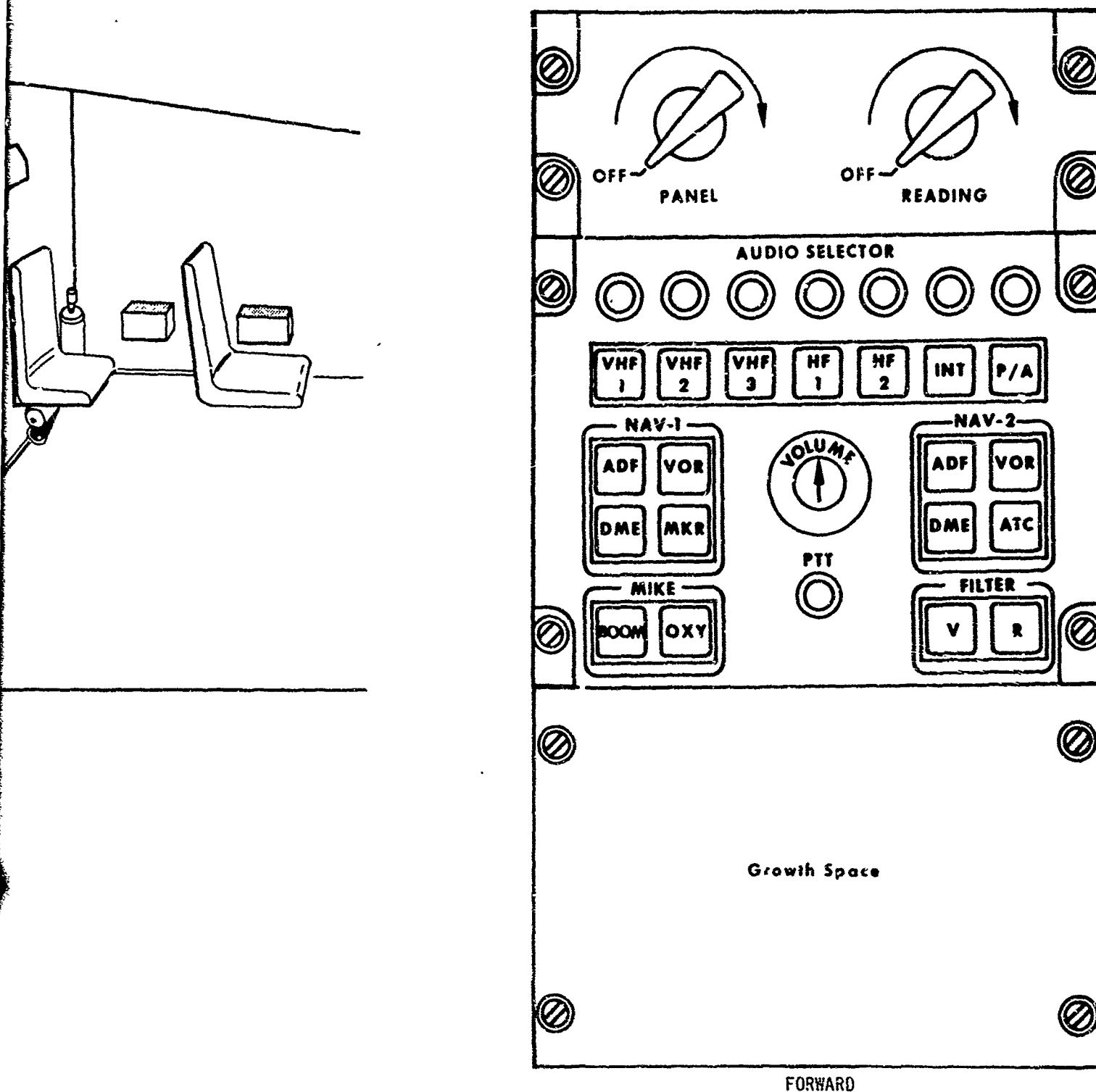


Figure 6-15. Observers' Panels

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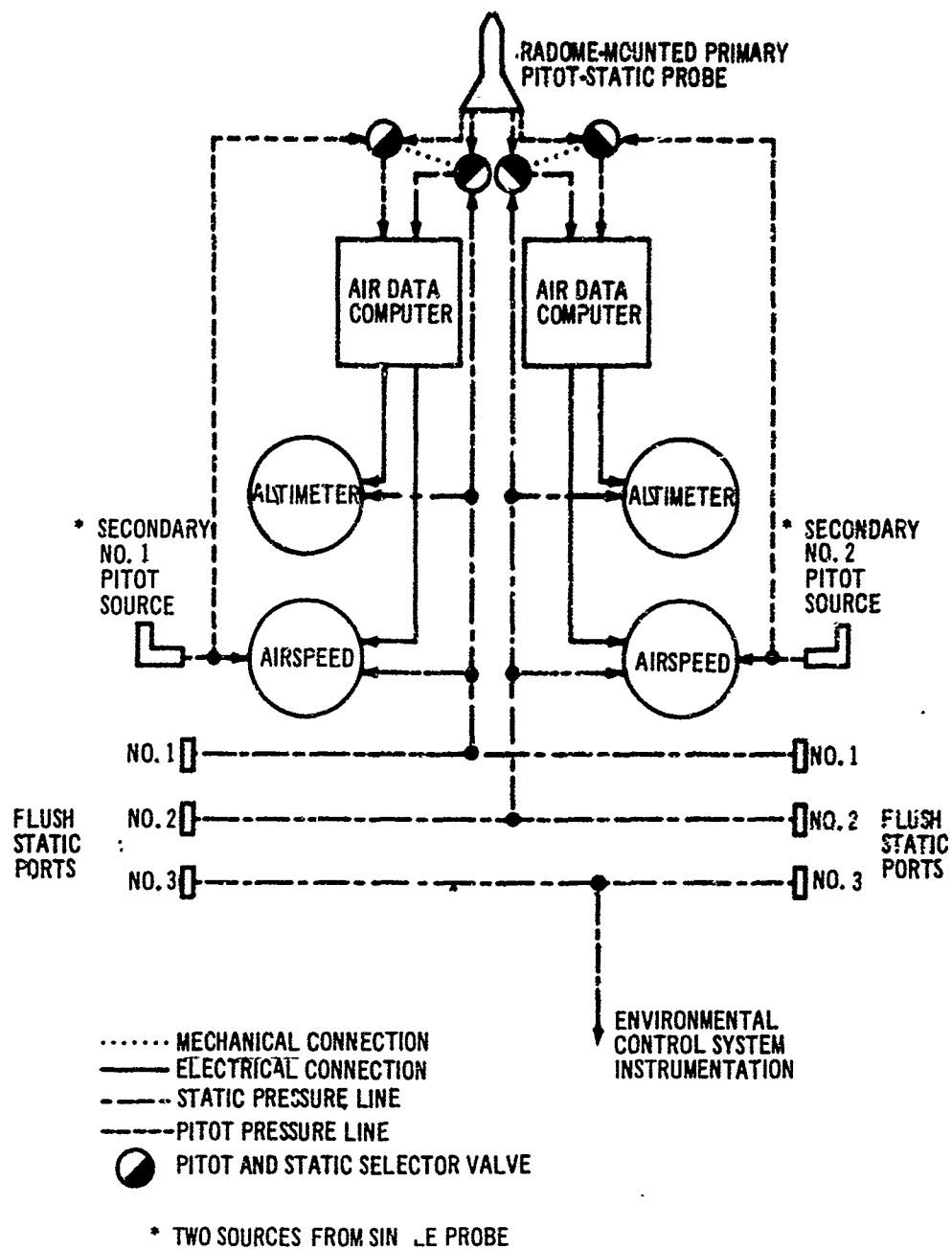


Figure 6-16. Pitot-Static System Diagram

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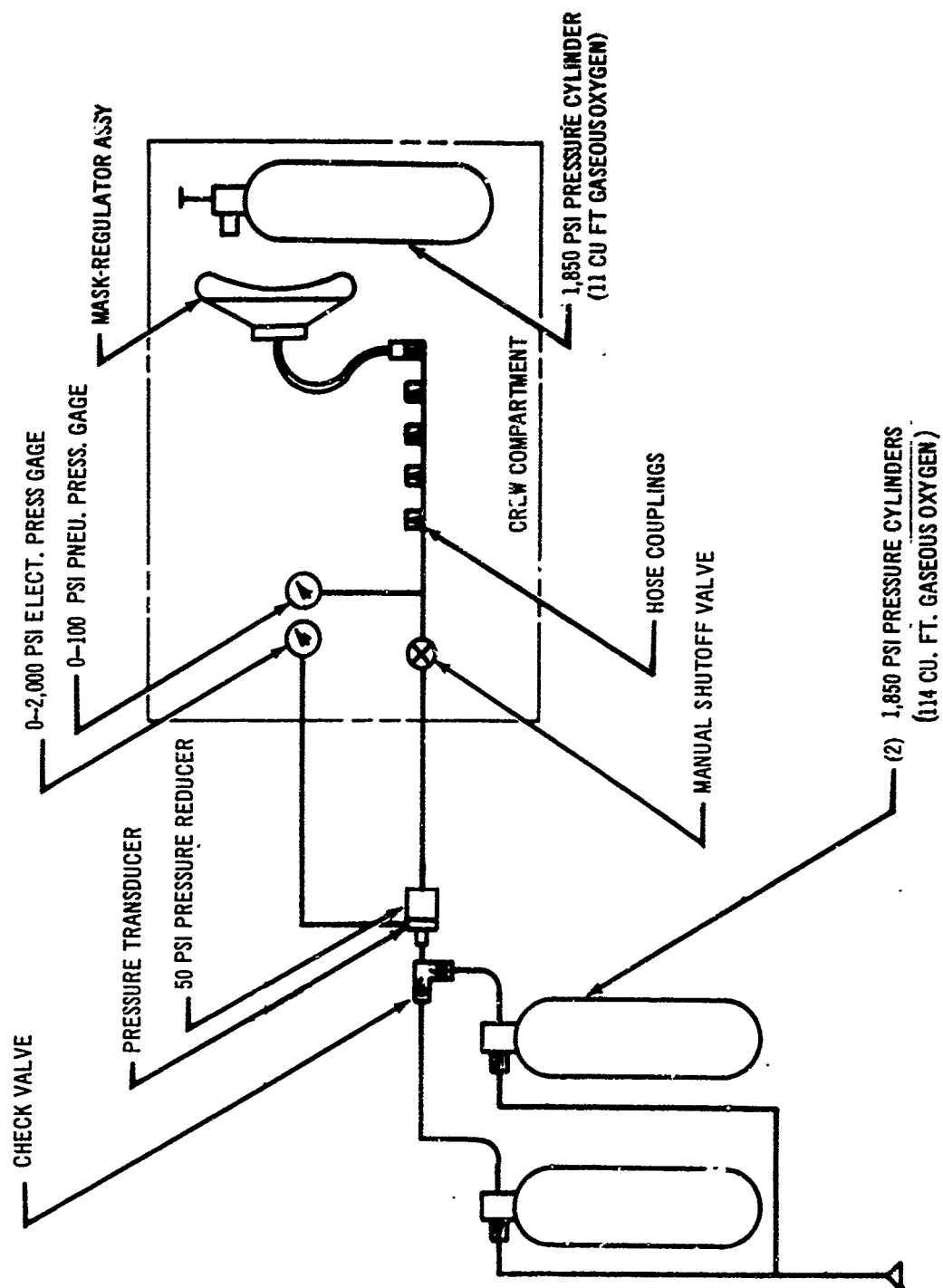


Figure 6-17. Flight Crew Oxygen System Diagram

SECTION 7 FLIGHT CONTROLS

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ILLUSTRATION

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SECTION 7 FLIGHT CONTROLS

7.1 GENERAL

The flight controls shall consist of primary flight controls, secondary flight controls, and an automatic flight control system (AFCS).

7.1.1 Control Systems--General Description

All primary flight control surfaces shall be positioned by triple irreversible hydraulic actuators, each powered by an independent hydraulic system. (Refer to Par. 8.2.1.)
In all three control axes, artificial feel that meets pilot force and travel requirements throughout the flight envelope shall be provided.

The primary flight controls shall consist of primary elevators, auxiliary elevators, and elevons for pitch control; spoilers for direct lift control for landing; ailerons and spoilers for low-speed lateral control; spoilers and elevons for high-speed lateral control; a rudder for directional control; and variable-sweep wings for optimum lift/drag characteristics. (Refer to Par. 7.2 and see Fig. 7-1.) For longitudinal control, the control columns shall be connected by dual mechanical cables to a master hydraulic power servo which, through dual cables and linkages, controls the hydraulic surface actuators. The control wheels shall be connected to the lateral surface actuators in the same manner. In order to provide the optimum control forces, the normal mode of longitudinal and lateral operation shall employ an electric command system (Par. 7.2.1) whereby pilot control forces are converted to electric signals which control the master servos. The mechanical cable control system shall have force authority over the electric command mode. For direct lift control, the control columns shall be connected electrically through the electric command system pitch axis (Pars. 7.2.1 and 7.2.6) to a direct lift control hydraulic power servo in each wing, which through dual cables and linkages, controls the hydraulic spoiler actuators. Rudder pedal movement shall be transmitted to the rudder surface actuator by mechanical cables. *An override or automatic disconnect feature shall be provided in the pitch and roll axes of each pilot's controls to ensure that one of the pilots can control the airplane in the event of a jammed control cable in one system between the control cabin and the master servo packages.*

The secondary flight controls shall consist of a high-lift system utilizing wing leading-edge slats and trailing-edge flaps; longitudinal, lateral, and directional trim systems

utilizing primary control surfaces; and a speed braking system utilizing wing spoilers. (Refer to Par. 7.3.)

The automatic flight control system shall consist of a stability augmentation system, autopilot system, and autothrottle system. (Refer to Par. 7.4.)

Loss of thrust from all four engines shall not result in loss of flight control. (Refer to Par. 8.2.3.)

In the event of any single control system component or dual power source failure, the airplane shall have sufficient control for continued flight and landing.

7.1.2 Component Fabrication

It shall be a design objective to use materials other than magnesium. Control cable quadrants, brackets, cranks, and levers shall be fabricated from steel, titanium alloy, or aluminum alloy in the form of forgings, castings, sheet or bar stock. Flexible steel control cables shall be used.

A mechanically operated control cable tension readout shall be provided for all flight control cable runs.

All cable ends, rod ends, hydraulic lines, etc., shall be designed to prevent inadvertent improper installation. Push-pull rod ends, torque tubes, and fittings shall not be installed with rivets without taking into consideration the need for initial close clearance between tube and fitting and for matched drilling of tube and fitting.

7.1.3 Rubbing Strips and Grommets

Rubbing strips and grommets shall be used to minimize cable wear and to maintain cable alignment under slack conditions. The grommet diameter shall be large enough to allow passage of cable terminals during rigging. Positive retention of pressure seals shall be provided where cables pass between areas of pressure differential. *The seals shall be replaceable without breaking the cable run.*

7.1.4 Bearings

Prelubricated antifriction bearings and plain bearings shall be used throughout the flight control system.

All pin joints, either static or dynamic, shall incorporate replaceable bearings or bushings. Control surface hinge bearings shall be replaceable without removing the surface from the airplane or disturbing the control rigging where practicable. All staked bearings shall incorporate the outer ring staking feature.

7.1.5 Ground-Gust Protection

Control surfaces shall be protected against damage caused by air-gust loads up to 70 mph on the ground by restricting fluid flow through the actuators.

7.1.6 Control Surface Fittings

All primary structural static pin joints and all control surface hinges, support fittings, pivot points, and pin joints subject to intentional or unintentional rotation shall incorporate replaceable bearings or bushings. Such bearings or bushings shall be replaceable without the need for removal of control surfaces or other components, including fittings and hinges as practicable. The bearing life design objective shall be 10,000 hr.

7.1.7 Surface Position Indication

A flight control surfaces position indicator shall be provided in the flight deck. This indicator shall permit verification of all control surface movements from the flight deck. (See Fig. 6-12.)

7.2 PRIMARY FLIGHT CONTROLS

Primary flight controls shall consist of ailerons, spoilers, elevons, primary elevators, auxiliary elevators, rudder, and variable-sweep outboard wings.

7.2.1 Electric Command

A triple-channel electric command system utilizing control force sensors shall be the normal method of transmitting control signals to the master servo units in the lateral and longitudinal axes. *The electric command system shall include gain scheduling for force gradient control.* The master servo units shall also back-drive the mechanical cable system to reposition the pilots' controls. (In the event of complete failure of all three electric command channels, the master servo units shall be controlled by a mechanical cable system.) Each electric command axis shall fail operational upon the first failure and fail passive upon the second failure. The AFCS control panel (Fig. 6-6) shall allow separate axis and channel selection and engagement. The electric command system shall be automatically engaged in all axes whenever the main electrical power busses are energized. (The rudder power unit shall not be controlled by the electric command system.) The electric command system also transmits pitch control force signals from the control columns to the direct lift servos during landing. (Par. 7.2.6).

7.2.2 Longitudinal Control

Longitudinal control shall be provided by primary elevators, auxiliary elevators, and elevons on the fixed horizontal stabilizer. In addition to the electric command signals, longitudinal axis autopilot and stability augmentation system signals shall also be transmitted to the elevons. (The elevons shall be moved symmetrically for both low- and high-speed longitudinal control and differentially for high-speed lateral control.)

7.2.3 Lateral Control

Lateral control shall be provided through the scheduled use of ailerons, spoilers, elevons, and rudder. The ailerons and outboard spoilers shall be utilized at low speeds only. *The inboard spoilers shall be utilized at all times.* Lateral control signals shall also be transmitted mechanically from the elevon programmer to the rudder surface actuators to provide automatic turn coordination. The ailerons shall automatically lock out when the flaps are raised. This flap motion shall automatically transfer lateral control signals to the elevons, which shall move differentially for high-speed lateral control.

The outboard spoilers shall automatically lock out as the wings are swept fully aft. This wing motion shall increase the gain of the lateral control signal to the elevon actuators.

7.2.4 Directional Control

Directional control shall be provided through the use of a single rudder. The pilots, through a dual mechanical cable system operated by rudder pedals, shall directly control hydraulically powered surface actuators. The pilots' input to the actuators shall be summed with inputs from the yaw stability augmentation servo and with lateral control inputs from the elevon programmer. The resulting output shall pass through the rudder control travel limiter, which shall limit the control input to the rudder actuator as a function of wing flap position and wing sweep position. When the wings are forward and the flaps are down, maximum rudder control shall be available. When the flaps are raised, the rudder control travel input shall be reduced. When the wings are swept fully aft, the input shall be further limited. *Each set of rudder pedals shall be adjustable in a fore and aft direction by a single nonslipping-type control*

7.2.5 Wing Sweep

The outboard-wing-sweep-actuation system, including the actuators and differential gearbox, shall be designed with dual structural and actuation paths.

Wing sweep shall be provided by two identical ball-bearing screw actuators, one attached to each movable wing near the wing pivot. The actuators shall operate through a dual torque-tube drive from a common differential gearbox driven by three hydraulic motors, each of which shall be supplied by a separate hydraulic system. (See Par. 8.5 for associated hydraulic system requirements.)

An automatic shutoff system shall ensure that asymmetric wing motion shall not result from any failure in the sweep mechanism. Thrust brakes in each screw actuator shall make the actuators irreversible. Wing sweep actuation shall be mechanically sequenced with wing leading-edge slat and trailing-edge flap actuation. Wing sweep shall be controlled from a lever on the aisle control stand. (See Fig. 6-3.) The system shall prevent structural interferences and ensure proper sequencing with other control surface movements. (Refer to Par. 7.3.1.2.)

7.2.6 Direct Lift Control

Direct lift control shall be provided for landing by symmetrical actuation of the inboard spoilers. For this mode, these spoilers shall be controlled by the electric command system, autopilot system, and stability augmentation system. Direct lift control shall be activated by positioning the wings at 20° leading edge sweep angle. During this mode, the spoilers may also be utilized symmetrically as speed brakes (Par. 7.3.1.3) or differentially for lateral control (Par. 7.2.3).

7.3 SECONDARY FLIGHT CONTROLS

The secondary flight controls shall consist of the lift and drag increasing devices and the trim control system.

7.3.1 Lift- and Drag-Increasing Devices

The lift- and drag-increasing devices shall consist of inboard-wing leading-edge slats and trailing-edge flaps, outboard-wing leading-edge slats and trailing-edge flaps, and speed brakes (spoilers).

7.3.1.1 Leading-Edge Slats

Slats shall be installed on the leading edges of the inboard and outboard wings. The slat segments shall be actuated by mechanical screwjacks connected by torque tubes. The torque tube system for the inboard wing slats shall not be inter-

connected with the torque tube system for the outboard wing slats. Each of the two torque tube systems shall be driven by a separate power unit, each of which shall utilize two hydraulic systems. Asymmetric actuation of either slat drive system shall automatically shut off that system. Slat actuation shall be mechanically sequenced with trailing-edge flap actuation and wing sweep actuation.

7.3.1.2 Trailing-Edge Flaps

Flaps shall be installed on the trailing edges of the inboard and outboard wings. (See Fig. 7-1.) The flap segments shall be actuated by mechanical screwjacks connected by torque tubes. Three separate flap drive systems shall be utilized. One power unit shall drive the inboard wing flaps, one shall drive the inboard flaps on the outboard wing, and one shall drive the outboard flaps on the outboard wing. The inboard wing flap drive unit shall be powered by two hydraulic systems. Each of the two outboard wing flap drive units shall be powered by three hydraulic systems. Asymmetric actuation of any flap drive system shall automatically shut off that system. Flap actuation shall be controlled by a lever on the aisle control stand and shall be mechanically sequenced with leading-edge slat actuation and wing sweep actuation.

A mechanical feedback of flap position in the control valve mechanism shall provide flap extension proportional to control lever movement.

7.3.1.3 Speed Brakes

The wing spoilers may also be raised symmetrically as speed brakes. Speed brake control shall be accomplished by actuation of a lever labeled SPEED BRAKE on the aisle control stand (Fig. 6-3). There shall be no interlocks to prohibit speed brake erection by the pilots at any time. There shall be no automatic speed brake actuation features. Differential motion of spoilers for lateral control shall be superimposed when they are erected as speed brakes. (Refer to Par. 7.23.)

7.3.2 Trim Control Systems

The trim control systems shall consist of longitudinal trim, lateral trim, and directional trim.

7.3.2.1 Longitudinal Trim

Longitudinal trim shall be accomplished by symmetrical movement of the elevators and elevons. Trim control inputs shall move the neutral position of the pilots' control

columns. Longitudinal trim shall be controlled by an electric trim button on each pilot's control wheel and by mechanical trim wheels on the aisle control stand. (See Fig. 6-3.)

The longitudinal control electric command mode shall be trimmed by introducing electric trim signals into the electric command system by a trim button on the pilots' control wheels. These signals may be overridden by introduction of an opposing signal from the electric command force transducers in the pilots' control wheels or by disengaging the electric command mode with application of a control wheel force slightly greater than normally required for the longitudinal control.

The alternate mechanical cable system longitudinal control mode shall be trimmed by the electric trim button or the mechanical trim wheel controlling the trim actuator. The trim actuator shall move the mechanical centering spring neutral position. This trim may be overridden by an opposing longitudinal control column force.

7.3.2.2 Lateral Trim

Lateral trim shall be accomplished by introducing trim inputs into the ailerons at low speeds and into the elevons at high speeds. Trim control inputs shall move the neutral position of the control wheels. Lateral trim shall be operated electrically and shall be controlled by a control knob on the aisle control stand. (See Fig. 6-3.)

The lateral control electric command mode shall be trimmed by introducing electric trim signals into the electric command system. These signals may be overridden by introduction of an opposing signal from the electric command force transducers in the pilots' control wheels or by disengaging the electric command mode with application of a control wheel force slightly greater than normally required for lateral control.

The alternate mechanical cable system lateral control mode shall be trimmed by an electromechanical actuator, which moves the mechanical centering spring neutral position. This actuator shall be controlled by the trim control knob. This trim may be overridden by an opposing lateral control wheel force.

7.3.2.3 Directional Trim

Directional trim shall be accomplished by introducing trim inputs into the rudder centering spring, which shall move the neutral position of the rudder pedals. Directional trim

shall be controlled by an electric control knob on the aisle control stand panel (Fig. 6-4) which shall control an electromechanical actuator that moves the mechanical centering spring neutral position. Trim may be overridden by an opposing rudder pedal force.

7.4 AUTOMATIC FLIGHT CONTROL SYSTEM

The automatic flight control system (AFCS) shall consist of a stability augmentation system, autopilot system, and an autothrottle system.

The AFCS operational status shall be capable of being ascertained from the flight deck while on the ground. A failure detection capability shall be provided for each channel of each axis and shall automatically remove defective channels from operation. Controls and indicators shall be provided on the AFCS computer front panels for conducting separate channel tests of an axis using built-in test equipment (BITE). Axis computers within a system shall be interchangeable. The electronic cards and modules for each channel of an axis, within a system, shall be interchangeable. Manually operated channel engage/disengage switches for each axis shall be provided on the AFCS control panel located in the pilots' aft overhead panel. (See Fig. 6-6.)

7.4.1 Stability Augmentation System

A stability augmentation system (SAS) having limited authority shall be provided for the roll, pitch, and yaw axes and shall be operated in series with the pilots' controls. The stability augmentation system shall provide handling quality improvement, including Dutch roll damping, turn coordination, autopilot inner-loop damping, and alleviation of structural loads.

The SAS shall be automatically engaged in all axes whenever the main electrical busses are energized.

The triple-channel roll control axis shall remain operational automatically after the first failure. A subsequent failure of the roll control axis shall result in fail-passive operation. The pitch and yaw control axes, each utilizing three channels plus a servo model, shall remain operational automatically after the second failure. A subsequent failure of the pitch or yaw control axes shall result in fail-passive operation of the affected axis. Warning lights shall provide the crew with failure status. The crew may identify and manually engage the remaining operable control channel. (See Fig. 6-6.)

No failure of the stability augmentation system shall produce asymmetrical control moments in the roll axis.

7.4.2

Autopilot System

A triple-channel autopilot (A/P) system shall be provided for the roll and pitch axes. Yaw signals for coordinated turns shall be provided by the SAS. The autopilot shall operate through parallel servos and shall be authority-limited mechanically.

A flight-mode selector panel shall be provided for the autopilot, autothrottle, and flight director. The panel shall be located directly above the pilots' center panel. (See Fig. 6-2.) *Split-axis autopilot operation shall be possible by selective engagement of the roll or pitch axis.* With the autopilot engaged in the control wheel steering mode, the maneuvering inputs shall be controlled by the pilot through the control wheel. With the autopilot engaged in the manual mode, the manual mode inputs shall be controlled by the pilot through the Manual Control Panel. (See Fig. 6-4.) The Auto-Nav position engagement of the autopilot shall provide flight path control by the selected Auto-Nav Mode(s).

The roll and pitch mode selectors (Fig. 6-2) indicate the mode of flight director operation and, when engaged, autopilot operation.

The autopilot, by axis, shall remain operational automatically after first failure. A subsequent axis failure shall result in fail-passive operation. The crew may manually engage the remaining operable control channel. (See Fig. 6-6.) Warning lights shall provide the crew with failure status.

Autopilot approach and landing capability shall be as defined in Par. 3.7.

The autopilot may be engaged at any altitude and speed within the normal flight envelope of the airplane, for the various modes of operation, as noted below:

- Control Wheel Steering Mode
- Platform Stability
- Maneuvering - shall be accomplished by applying a force to the control wheel

Manual Modes

Pitch Axis

Vertical Speed

DS-17850

- Altitude rate control of $\pm 8,000$ ft/min

Altitude Control

- Altitude range of 0 to 80,000 ft
- Roll-to-pitch crossfeed to maintain altitude in turns to compensate for loss of lift

Roll Axis

Roll Attitude/Heading Hold

- Wings leveling bank angle greater than ± 2 deg
- Less than ± 2 deg hold heading
- Deactivate heading hold for commands greater than ± 2 deg

Heading Select

- Hold to selected heading

Auto-Nav Modes

Pitch Axis

Vertical Speed

- Altitude rate control of $\pm 8,000$ ft/min

Altitude Hold

- Altitude range of 0 to 80,000 ft
- Roll-to-pitch crossfeed to maintain altitude in turns to compensate for loss of lift

Airspeed Hold

Mach-Altitude (Sonic Boom/overpressure ΔP)

- Overpressure control range of 1.5 psf to 3.5 psf

Altitude Capture

- Range of 1,000 to 80,000 ft

Glideslope

- Automatic capture may be accomplished from above or below beam
- After capture, the airplane shall stabilize on beam within 20 sec of intercept for initial conditions of:

Altitude above airport of 1,000 to 3,000 ft
Ground speed of 160 knots or less

Land

- Control altitude rate to reduce sink rate to 2.8 ± 1 fps at touchdown
- Automatically engaged at 50 to 100 ± 2 ft of altitude with glideslope engaged

Go-Around/Takeoff (actuated by the heel of the pilot's throttle hand)

- This mode is independent of normal autopilot functions and shall result in loss of altitude of less than 45 ft for initial flight path angle of 2.75 deg, landing threshold speed, and throttles advanced to recommended setting.

Roll Axis (with Yaw SAS)

Go-Around/Takeoff

Heading Select

- Hold to selected heading

Inertial Navigation

Localizer

- Capture up to ± 90 deg of intercept angle
- Track command limits of ± 30 deg at capture, linearly decreasing to ± 5 deg at flare

VOR

- Airplane decoupling from VOR radial when over VOR station
- Course changes may be made while over VOR station

- *The airplane shall maneuver and fly out of the zone of confusion on the selected course*

Flight Director Display Commands

Similarity of commands for autopilot and flight director displays shall be provided. The flight director shall not display manual modes.

Interlocks shall prevent engagement of incompatible modes.

Transients resulting when control is switched between control-wheel-steering, manual, and automatic shall be minimized.

Integrating type control, or equivalent, shall be used.

7.4.3 Angle-of-Attack Warning and Control System

Angle-of-attack warning and control system shall be provided to warn the pilots of impending excessive angle of attack. The system shall shake the pilots' control columns and provide an automatic pitch-down signal to the electric command system if pilot response does not adequately correct the excessive angle of attack.

7.4.4 Autothrottle System

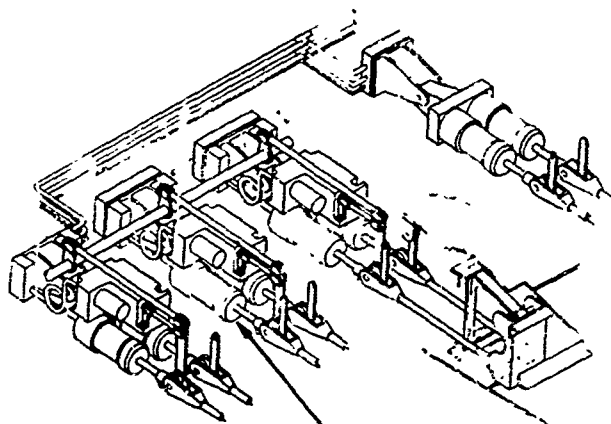
A dual channel autothrottle (A/T) system shall have airspeed select and Mach hold-control modes. It shall drive the throttle levers and shall be rate and authority limited. In the autothrottle mode of operation, the thrust developed by the engines shall be capable of being manually equalized. The autothrottle shall fail-passive with the first failure, after which it shall have the ability to operate a single channel in other than auto-land mode. *Pilot easy-override of autothrottles shall be provided.*

The *airspeed select* shall provide for the capture and holding of selected airspeeds.

The Mach hold-control shall hold the airplane to the Mach number existing at the time of engagement.

Airspeed hold shall hold the speed existing at the time of engagement.

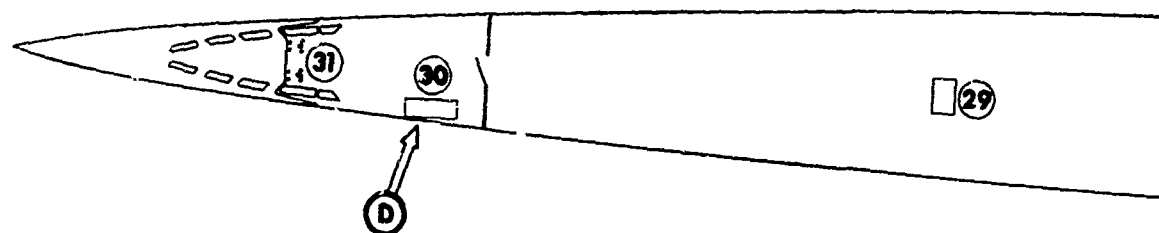
Changes in command speed setting shall not result in abrupt throttle movements.



DETAIL (A)

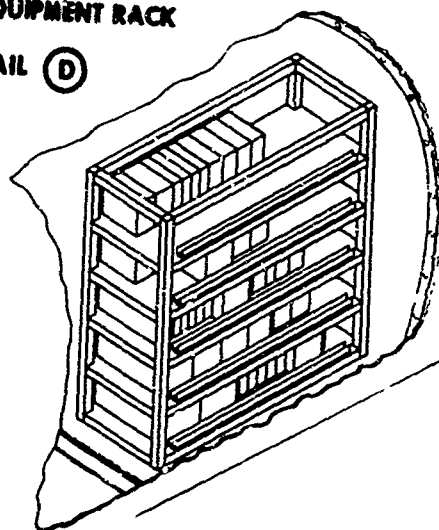
DOUBLE BARREL
ACTUATOR

DETAIL (B)



ELECTRONIC EQUIPMENT RACK

DETAIL (D)



ORIZ

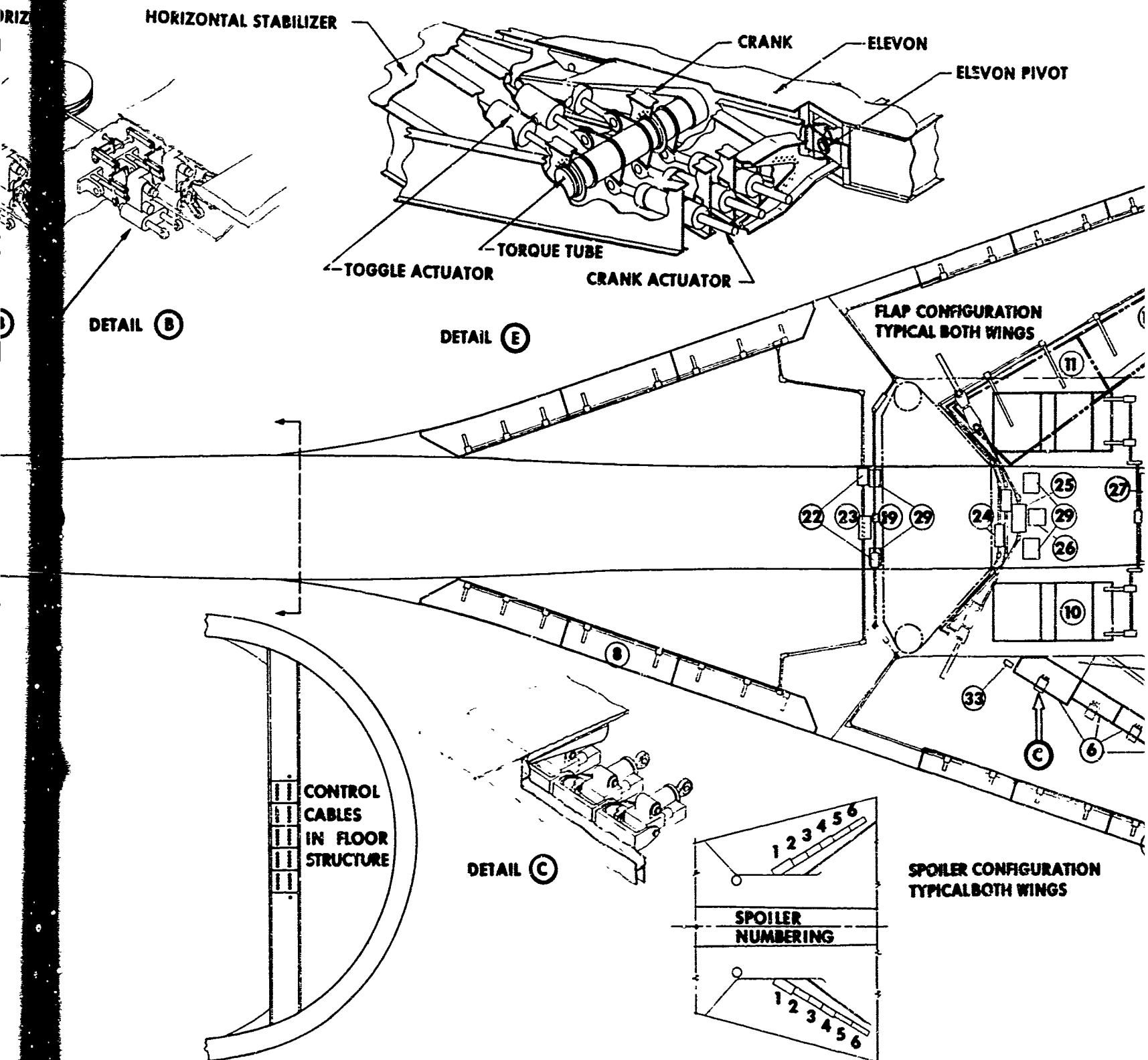


Figure 7

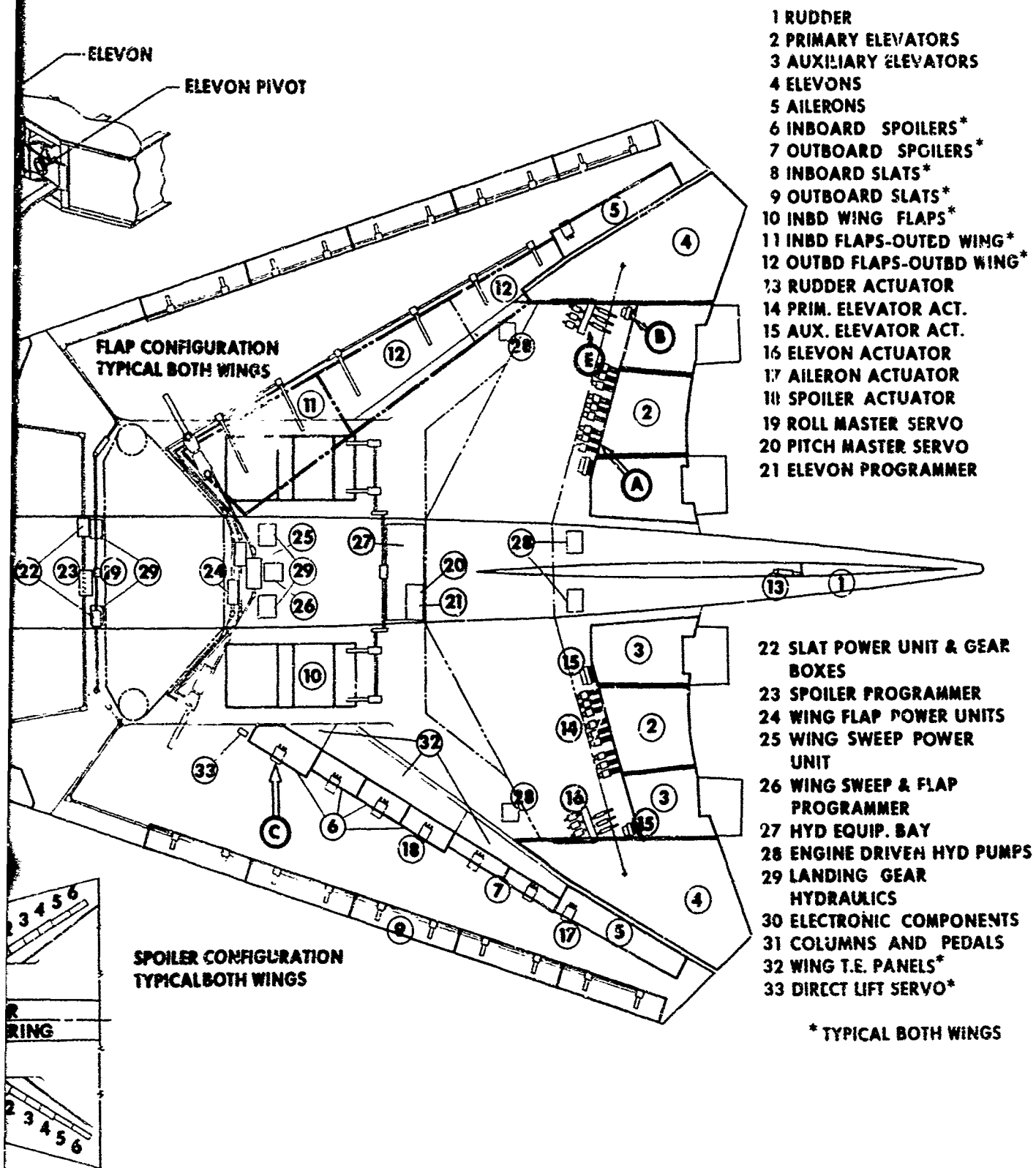


Figure 7-1 Flight Control System Diagram

SECTION 8 HYDRAULIC POWER SYSTEM

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SECTION 8 HYDRAULIC POWER SYSTEM

8.1 GENERAL

8.1.1 System Description

The airplane shall be equipped with three completely independent main hydraulic systems, identified as Systems A, B, and C. *There shall be no interconnecting fluid paths between any of the three systems in the distribution or return lines, at the loads, or in the reservoir fill system. The hydraulic fluid shall be a triester-base fluid (WSX6885) manufactured by the Humble Oil Co. per BMS 3-10. Line routing of hydraulic tubes shall be such that systems shall be separated in critical areas. Consideration shall be given to avoiding loss of all three systems resulting from a tire, engine compressor failure, etc. Fluid pressure shall originate from pumps mounted on each accessory drive gearbox. (Refer to Pars. 5.11 and 8.5.1.) Each system shall be designed for an operating pressure of 3,000 psi and shall be capable of full performance within a hydraulic fluid temperature range of +60° to 350°F. Each system shall be capable of starting and operating at -50 deg F and shall be capable of operating for 1 hr with a pump inlet temperature of 400°F. Fluid cooling shall be provided. A block diagram of the airplane's hydraulic power system is shown in Fig. 8-1.*

A standby hydraulic power system shall be provided. Fluid pressure for the standby system shall be supplied by a hydraulic-motor-driven pump, activated by the normal landing gear extension system and powered by fluid pressure from main System B. A backup source of fluid pressure for the standby system shall be provided by an electric-motor-driven pump.

8.1.2 Fire Protection

Motor-driven shutoff valves shall be installed in the engine-driven pump supply lines and shall be controlled by switches located on the flight engineer's panel. (See Fig. 6-9.) *Components and lines shall be located outside of designated fire zones.*

8.2 SYSTEM FUNCTIONS

8.2.1 Main Power System Functions

The following functions shall be operated by all three main hydraulic systems:

- Longitudinal flight control system (Par. 7.2.2), except for the outboard auxiliary elevators.
- Direct lift control system (Par. 7.2.6).

- Lateral flight control system (Par. 7.2.3)
- Directional flight control system (Par. 7.2.4)
- Wing sweep (Par 7.2.5)
- Outboard wing trailing-edge flaps (Par. 7.3.1)

The loss of any one hydraulic system shall not be cause for flight turnbacks, deviations, or emergency action. In the event of loss of any two hydraulic systems, sufficient power shall be available for flight control. (Refer to Par. 8.2.3 for all-engines-out capability.)

The following functions shall be operated by two main hydraulic systems, either of which shall be capable of providing sufficient power for control:

- Wing leading-edge slats (Par. 7.3.1.1)
- Inboard wing trailing-edge flaps (Par. 7.3.1.1)

The following functions shall be operated by one main hydraulic system:

- Main and nose landing gear extension and retraction
- Landing gear steering
- Main wheel braking system
- Pressure for driving one standby system pump (Par. 8.5.1)

8.2.2 Standby Power System Functions

The standby hydraulic power system shall provide power for operation of the standby main and nose landing gear extension systems, aft main gear steering, and the standby main gear wheel braking system.

8.2.3 All-Engines-Out Capability

For the 2707 (GE)

Windmilling engines shall provide hydraulic power above airspeeds of Mach 0.75. Below Mach 0.75, a ram air turbine shall provide sufficient supplementary hydraulic power down to and including landing flare. The ram air turbine-driven constant-horsepower hydraulic pump shall provide power to the B hydraulic system. (See Fig. 8-1.) The ram air turbine shall be extended or retracted into the air stream by

a hydraulic actuator and operated by a single switch located on the pilots' aisle control stand. (See Fig. 6-4.) For standby electrical power capability, refer to Par. 9.6.

For the 2707 (P&W)

Windmilling engines shall provide hydraulic power down to and including landing flare. Optimum distribution of hydraulic loads shall be accomplished by a single switch located on the pilots' aisle control stand. (See Fig. 6-4.) For standby electrical power, refer to Par. 9.6.

8.3 WING-SWEEP-ACTUATION SYSTEMS

Hydraulic power shall be provided to the wing-sweep differential drive mechanism from Systems A, B, and C. Each system shall be hydraulically independent and shall be individually capable of providing full hinge moment at one-third normal rate. (Refer to Par. 7.2.5 for a description of the wing-sweep control system.)

8.4 LANDING GEAR HYDRAULIC SYSTEMS

8.4.1 Landing Gear Operation

8.4.1.1 Power Source and Control

Power for extension and retraction of the main and nose landing gears and operation of the wheel-well doors, landing gear steering, and braking shall normally be provided by a single hydraulic system. A cable-operated, four-way control valve, positioned by a single control handle located on the pilots' main panel (Fig. 6-3), shall control landing gear position. Detents shall be provided in the control handle quadrant to retain the handle in the UP, OFF and DOWN positions. In addition, a fourth gated position shall be provided for standby extension. Standby landing gear extension shall be accomplished by a power system that, by mechanical sequencing, first releases the door locks and then the gear-up locks, allowing the gear to fall free. The aft retracting main landing gear shall be, in addition, powered into the down position. Landing gear steering, braking, and retraction systems shall be depressurized when the control handle is in the OFF position.

8.4.1.2 Ground Safety

Movement of the normal landing gear lever to the UP position, except with the oleos fully extended, shall be prevented by

a landing gear actuated locking device. The lock shall be automatically released when the oleo struts are fully extended and the gears are centered. A manual control shall be provided to override the landing gear actuated locking device.

8.4.1.3 Position Indication

The landing gear position indicators (Fig. 5-2) shall consist of the following lights:

- One landing gear door light (red - *dimnable*)
- Five landing gear lights (red - *dimnable*)
- Five landing gear lights (green - *dimnable*)

The door light shall indicate when any door is not locked.

The red gear lights shall indicate the following:

- When the respective gear position is not consistent with the landing gear control lever position
- When gear is down but not locked

The dimmable green gear lights shall be illuminated only when each respective gear is down and locked.

An alternate means, other than the position lights, shall be provided to determine whether the landing gears are down and locked.

All landing gear lights shall be extinguished when the landing gear and doors are up and locked.

An aural warning device shall be used to indicate an unsafe relationship between landing gear position and throttle setting, or between gear position and flap position.

8.4.1.4 Landing Gear Doors

All landing gear doors, except the gear strut doors, shall be hydraulically operated through mechanically actuated sequence valves that cause the doors to open, then close, during normal gear extension or retraction. A door release system shall be provided for opening the landing gear doors from the ground. This release system shall position a three-way hydraulic valve, which shall block the door-close line to prevent door retraction.

The gear strut doors shall be sequenced to open during normal gear extension and then close during retraction.

8.4.2 Landing Gear Steering

The nose gear shall be provided with hydraulic steering actuated by steering wheels at both the captain's and first officer's stations and by the rudder pedals. The maximum steering angle shall be approximately 76 deg to either side of center (see Fig. 4-2) by use of the steering wheels and shall be limited to approximately 5 deg to either side of center by use of the rudder pedals. When the oleo is fully extended, the rudder pedal steering system shall be disconnected and the nose gear properly aligned for retraction. Rudder pedal steering capability shall be gradually increased from 0 deg each side of center at approximately 1 in. of oleo compression to the full approximate 5 deg each side of center when the oleo is compressed 5 in. or more. The steering wheels shall be capable of overriding pedal steering under all conditions. The aft main gears shall be mechanically locked at 0 deg steering angle for nose gear steering angles less than 20 deg. For nose gear steering angles greater than 20 deg, the aft main gears shall be unlocked and steered by hydraulic pressure from the standby system. The aft main gear steering angle shall be controlled by the nose gear steered angle input to an electrical command type system.

The nose gear shall turn through its steering angle without disconnecting the torsion links during towing. The aft main gears shall be steered during towing, as described above, by the standby power system supplied by the electric-motor-driven pump.

The position of each aft main gear steering lock shall be shown on the flight engineer's panel by a position light which shall be illuminated whenever the gear steering is unlocked.

8.4.3 Hydraulic Brake Systems

8.4.3.1 Hydraulic Power

Hydraulic power shall be available from System C for normal braking of the main gear wheels. Standby hydraulic pressure for braking shall be supplied by the standby hydraulic power system. (See Fig. 8-1.) A brake system accumulator shall provide parking brake pressure and backup for the normal and standby hydraulic brake pressure systems. Differential braking shall be available on both the normal and standby systems.

The main landing gear wheels shall be automatically braked before retraction.

8.4.3.2 Normal Braking System

The normal braking system shall receive power from System C through control valves, electrically modulated by summed inputs from brake pedal force transducers and antiskid wheel transducers, to provide individual wheel control and adaptive type antiskid protection. *An indicator light shall be incorporated in the system annunciator on the pilots' main panel, and readouts of main brakes shall be installed on the flight engineer's panel.*

8.4.3.3 Standby Braking System

The standby braking system shall receive power from the standby hydraulic system through metering valves, cable-actuated by brake pedal movement, and control valves for paired-wheel antiskid protection. An accumulator shall be installed in the standby braking system to provide parking brake pressure. The accumulator shall also provide a third power source for standby braking. Switchover to standby braking shall be automatic upon loss of normal (System C) hydraulic power or electrical power.

The brake system accumulator shall provide parking brake pressure and backup, for a minimum of three full brake applications, for the standby hydraulic brake pressure system.

8.4.3.4 Parking Brake

A mechanically controlled hydraulic parking brake shall be provided with control accessible to the pilots. The control shall indicate parking brake position.

8.4.3.5 Fuses

Quantity measuring fuses shall be provided for each brake to limit the loss of hydraulic fluid in the event of brake system failure downstream of the valve.

Self-sealing disconnect fittings shall be provided in the hydraulic lines between the brakes and the shuttle valves to permit replacement of the brakes without system bleeding.

8.5 HYDRAULIC SYSTEM COMPONENTS

8.5.1 Hydraulic Pumps

Fluid pressure for each main hydraulic system shall be supplied by variable displacement pumps, mounted on separate engine driven accessory drive gearboxes (Par. 5.11) as follows:

- System A power shall be supplied by two pumps mounted on the accessory drive gearbox driven by Engine No. 1 and one pump on the accessory drive gearbox driven by Engine No. 3.
- System B power shall be supplied by one pump mounted on the accessory drive gearbox driven by Engine No. 2 and two pumps on the accessory drive gearbox driven by Engine No. 4.
- System C power shall be supplied by one pump mounted on the accessory drive gearbox driven by Engine No. 2 and one pump on the accessory drive gearbox driven by Engine No. 3.
- Standby system power shall be supplied by a hydraulic motor driven pump and an electric-motor-driven pump located in the hydraulic equipment compartment.

All system A, B, and C hydraulic pumps shall be identical and interchangeable in all respects.

8.5.1.1 Ground Checkout

For ground checkout, each hydraulic pump may be driven by an external pneumatic power source through its associated accessory drive gearbox. (Refer to Par. 5.11.) Provisions for ground cart hookup shall be installed in each system.

8.5.2 Temperature Indication

Instrumentation shall be provided on the flight engineer's panel to allow monitoring of Systems A, B, and C for pump case drain and main system return temperatures; in addition, overheat warning lights shall be installed for Systems A, B, and C. (See Fig. 6-9.)

8.5.3 Hydraulic Fluid Reservoirs

Each system shall be supplied by its individual pressurized reservoir, designed in accordance with the requirements of MIL-R-8931. A reservoir pressure gage with system selector switch shall be provided at the flight engineer's station. (See Fig. 6-9.)

8.5.3.1 Fluid-Level Indicators

Systems A, B, and C and the standby reservoirs shall be equipped with fluid level transmitting devices. One fluid-quantity indicator for each system shall be located on the flight engineer's panel, (Fig. 6-9) and one indicator for each system shall be provided at the pressure filling point. In addition, fluid-quantity indication shall be provided at each reservoir.

8.5.3.2 Reservoir Pressurization

Systems A, B, and C reservoirs shall be of the combination "boot strap" and air-charge type. The air charge shall be separated from the fluid in each reservoir.

8.5.4 Filling and Draining Provisions

Fluid reservoirs shall be pressure-filled through filters installed on the aircraft. Each hydraulic system shall be capable of being readily drained and flushed.

8.5.5 Filters

Each hydraulic system shall be protected by disposable filter elements passing 25-micron absolute particle size for the pressure line and the case drain line of each pump. Pressure and case drain filters shall be nonbypass-type. The return filters shall be two-stage; the normal system flow shall be through both stages in series. High flows shall bypass the first stage and pass through the second stage only. The first stage shall pass 3-micron absolute particle size, the second stage shall pass 15-micron absolute particle size. Bypass valves, set at approximately 500 psi, shall be installed across the second stage. All filters shall be equipped with temperature-compensated, clogged-element warning indicators.

8.5.6 Lines and Hoses

8.5.6.1 Rigid Tubing

Rigid tubing shall be fabricated of high-strength, corrosion-resistant metal. Lines shall be connected with welded or swaged fittings and shall be routed so that loosening or removal shall be minimized for any maintenance operation.

8.5.6.2 Flexible Lines

Line flexibility shall be provided by tubing coils, swivel joints, or hoses, in this order of preference. Swivel

joints or hoses shall be used only where dictated by envelope and motion requirements.

8.5.7 Component Attachment

In general, hydraulic-system lines shall be attached to components with manifolds that are permanently connected to the fluid lines. Self-sealing connections shall be provided, where practical, to prevent fluid loss or entry of contamination during component removal for maintenance.

Adequate provisions shall be made to prevent crossing hydraulic lines in components powered by more than one hydraulic system.

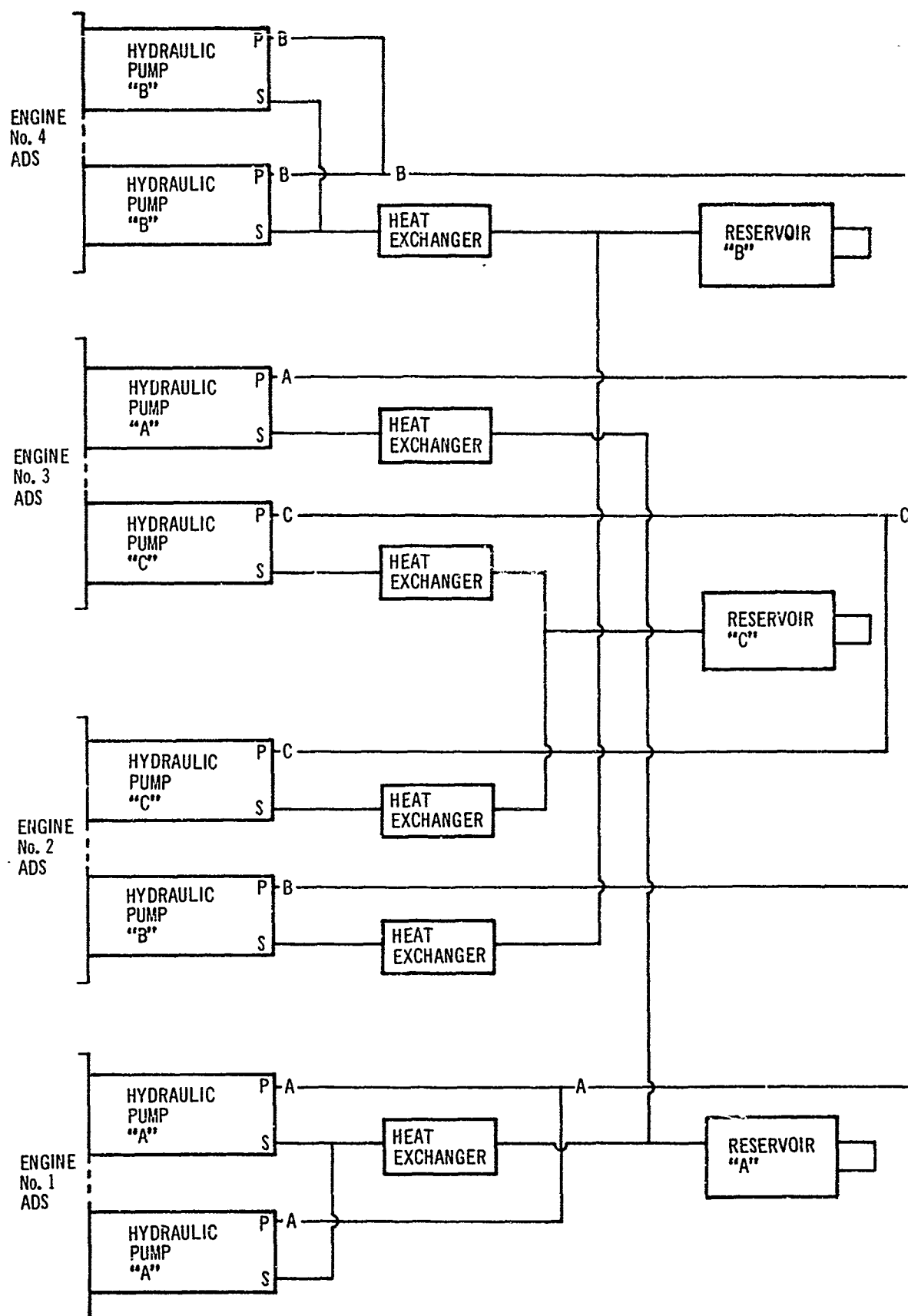
8.5.8 Seals

Continuously pressurized dynamic external seals shall be two stage with bleed between stages to return. Surfaces contacted by seals shall be chrome plated. Metal or plastic rings shall be used for actuator-rod and piston seals.

Carbon-faced seals shall be used in high-speed rotary applications. Static seals shall be metal or Viton O-rings, supported by filled teflon backups.

8.5.9 Pressure Indicators and Warning Lights

Remote-pressure-reading indicators shall be installed on the flight engineer's panel to provide pressure indication for each hydraulic power system and for the landing gear brake system. (See Fig. 6-9.) Lights shall be provided adjacent to the pressure indicators to provide a caution indication when any pump output falls below a minimum value. A pressure gauge shall also be installed adjacent to each accumulator charging connection.



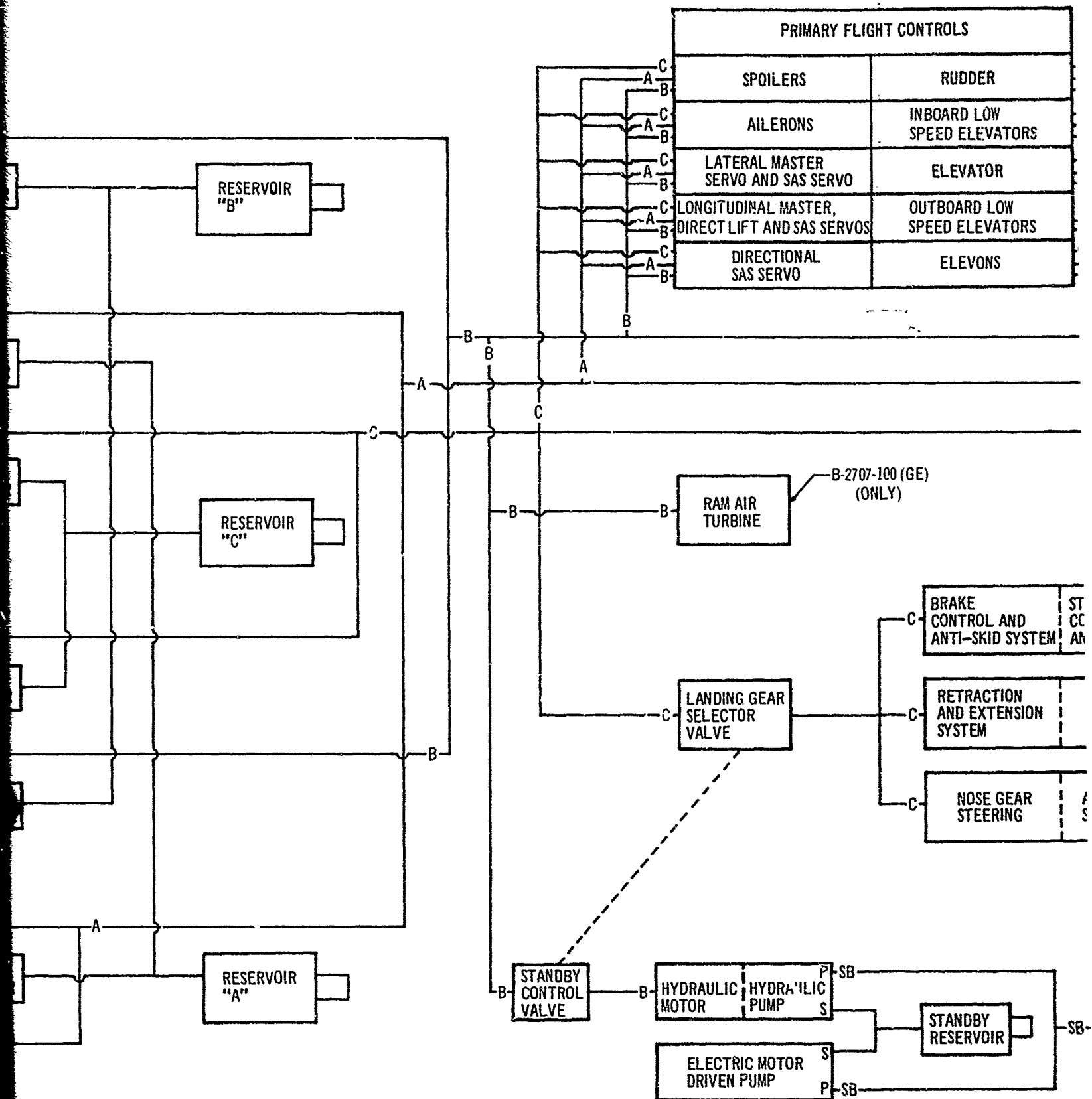


Figure 8-1. Hy

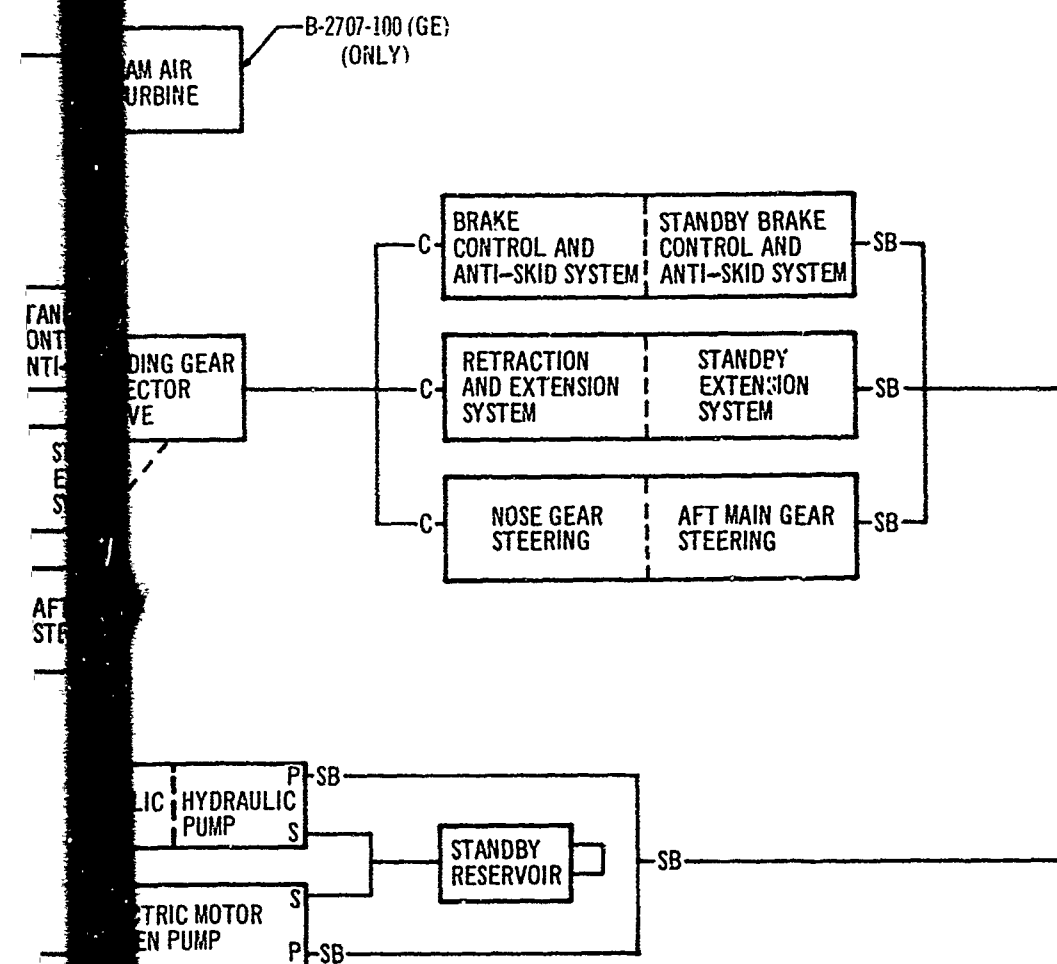
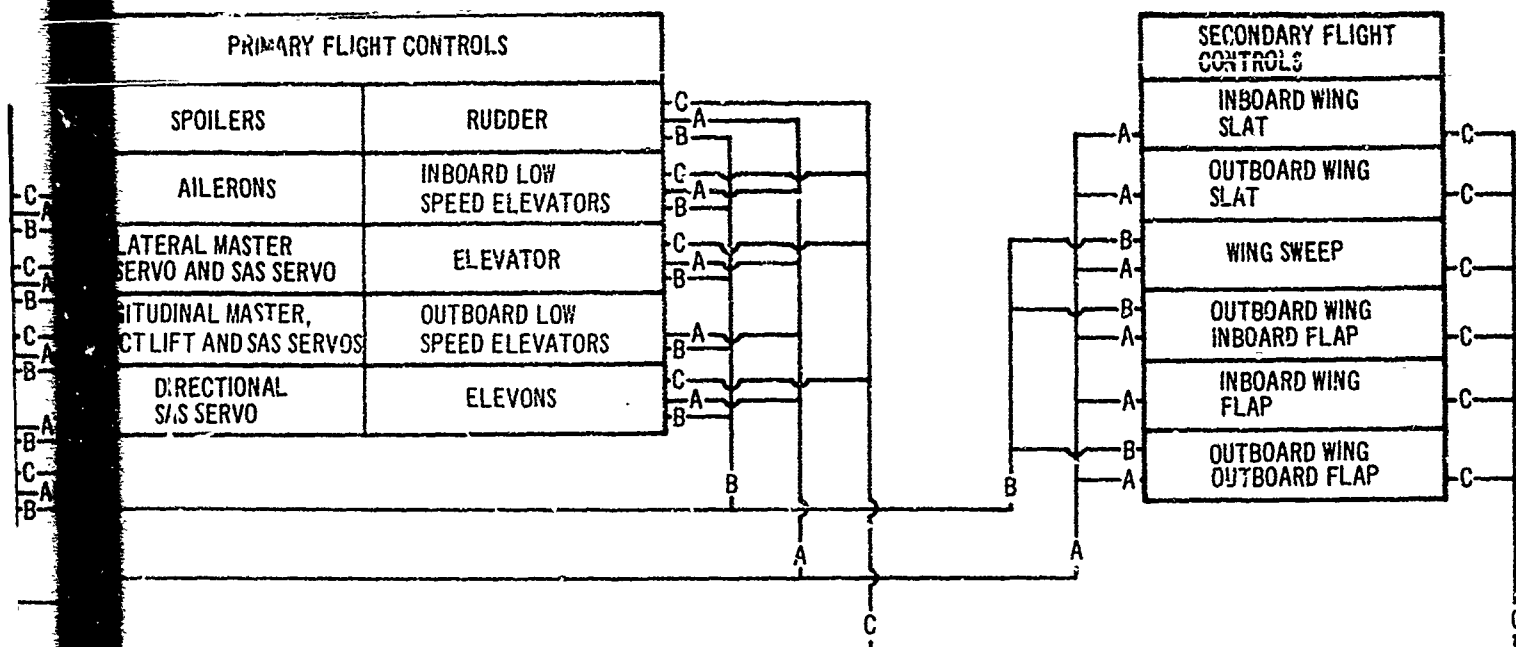


Figure 8-1. Hydraulic System Diagram

SECTION 9 ELECTRIC POWER SYSTEM

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SECTION 9 ELECTRIC POWER SYSTEM

9.1 GENERAL

The ac and dc power systems shall be substantially as shown in Figs. 9-1, 9-2, and 9-3. The major components of the electrical system are listed in App. I.

9.2 WIRING

9.2.1 General

General airplane interconnecting wiring, shielded and unshielded, shall comply with applicable Boeing material specifications. Wiring shall be compatible with the electrical load requirements and the environment of the area in which it is installed.

Insulated wire or multiconductor cable may be used for interconnecting wiring, but shall be no smaller than Size 22 except when part of a molded multiconductor cable of seven or more wires. Wires smaller than Size 22 shall be of high strength alloy. Wires smaller than Size 26 shall not be used. Individually shielded wires shall be used as needed in sensitive circuits. Wiring shall be grouped and separated into bundles according to power levels, circuit sensitivity, and flight safety.

The general requirements of ATA Specification 100, dated May 1, 1958, shall be used as a guide for the preparation and format of the airplane wiring diagram manuals.

9.2.2 Wire Protection

All load circuit wiring shall be protected by trip-free circuit breakers of suitable rating. Limiters and fuses shall not be used. Circuit breaker ratings shall be chosen that are consistent with no-nuisance trips and current protection requirements. *Circuit breaker applications shall be in accordance with criteria established in AIA "Design Manual on Aircraft Electrical Installation" (June 1958).* All ac and dc circuit breaker controls shall be located in the flight deck compartment and shall be accessible to flight crew members during flight. *Controls for the circuit breakers essential to safe flight shall be accessible to flight crew members while seated at their flight crew stations. Space shall be reserved for approximately 10 percent additional circuit breakers. Each circuit breaker shall be labeled to indicate its rating and circuit function. The wiring diagram manuals shall show the same designations.*

9.2.3

Design Practices

The AIA "Design Manual on Aircraft Electrical Installation" (June 1958) shall be considered as a guide to define acceptable industry practices for electrical installations but shall not preclude use of other types of installations that provide equivalent or improved performance.

Multiconductor cables may be installed in raceways without bundle ties and with a minimum number of cable clamps. *If bundle ties or cable clamps are not used, means shall be provided to prevent or protect against cable chafing or shifting within the raceway.*

Special attention shall be given to protection of the wiring and connectors against mechanical damage, fatigue, fluid impingement, and other hazards in areas exposed to extreme local environmental conditions (wheel wells, wing trailing edge, propulsion pods, etc.). The use of connectors shall be minimized. Wiring in such areas shall not be smaller than Size 18 unless enclosed in a metal jacket. The use of limit switching devices, mechanical or electronic, shall be carefully considered for the effects of such devices on airplane safety, reliability, and maintainability in commercial airline operation. Wiring runs under the passenger cabin floor shall be protected from seepage of fluids originating above the floor.

Circuits that could create an emergency or hazardous condition shall be given special consideration in assembly, installation, and routing.

Electrical terminals, terminal strips, busses, or any open-type termination shall be so installed as to minimize the probability of shock hazard or accidental shorting.

The major power components (e.g., frequency changer, control panels, etc.) for each generator system shall be packaged in ATR-type packages

Heavy power-switching relays for each generating channel may be grouped in a single package or container and shall be isolated from each of the other generating channel components. Design of the packages and installation shall minimize the possibility of a fire in one component damaging a component in another generator channel.

Conduit may be used to provide mechanical protection, reduce radio noise, or facilitate routing and maintenance in inaccessible areas. *However, the use of conduit for these purposes shall be held to a minimum.* Conduit, when used,

shall not be filled to more than 75 percent of its cross-sectional area.

Preinsulated crimp-type wire terminals shall be used except where environmental and safety considerations require use of other types of terminals. *Splices shall not be used in generator power feeders.*

Electrical connectors shall be crimped (solderless), removable-pin-type, except that brazed or welded connectors may be used within molded multiconductor and metal-jacketed cables to provide greater reliability.

9.2.4 Component Identification and Terminal Marking

Each permanently installed junction box shall be identified. Each terminal of terminal strips of two or more posts shall be durably identified. The terminal numbers shall be identical to those used on the wiring diagrams. Approximately 10-percent spare terminals or space provisions for additional terminals shall be provided in all multicircuit junction boxes and terminal areas.

Discrete identification (equipment number, as listed in wiring manual, and component function description) shall be made by placards or other suitable markings adjacent to each component. Dymo tape and paper placards on junction box shield covers shall not be used. Junction box/unit hookup wiring information shall be published in the Charts Section of the Wiring Manual.

Identification shall be provided to ensure correct connections of cables and wires without reference to numbers or coding where the likelihood of incorrect connection otherwise exists.

Placards shall be installed at conspicuous locations on junction boxes, power shields, etc., to warn that danger of contact with high voltage exists.

9.3 GROUNDING, BONDING, AND ELECTROMAGNETIC INTERFERENCE

9.3.1 General

The intent of the grounding and bonding section of the AIA Design Manual shall be met by using design methods that are in accordance with the "Electrical Bonding and Grounding Design Requirements" specification, and by installing grounds and bonds in accordance with Par. 5.4 of the "Electrical Requirements for Installed Equipment" specification; these specifications are listed in Par. 2.2.2 of this specification. These documents reflect ground return and bonding requirements that are peculiar to the

2707 with its predominant use of titanium structure.

All external movable surfaces shall be bonded to the fixed surfaces.

Use of common ground wires for more than one system or function shall be avoided except where design of the system requires or justifies such common use. Separate ground wires shall be used between units of a system when use of common ground returns could cause noise or malfunctioning because of circulating currents in the basic ground return system or to assure reliable ground return. *Where single-point grounding is used, any single failure in that ground system shall not cause the failure of more than one system.*

Normal operation of any electrical or electronic system or unit shall not cause malfunctions or undesirable response in any other system or unit. Undesirable response limits shall be as indicated below:

- Performance of receiving systems shall not be degraded by more than 4 db because of radio frequency interference from equipment and/or power supplied in the airplane.
- Undesirable noise (hum) shall be at least 50 db below the nominal audio signal output level used at the headphones in all systems including the interphone system. The nominal signal level for all modes of audio system operation, except passenger address, shall be taken as 1 volt across the headphones with a nominal impedance of 600 ohms. This corresponds to a maximum noise (hum) level of 3.16 mv across the headphone.
- The cross-talk interference level shall be at least 50 db below the audio signal level producing the cross-talk signal.
- Noise from short-term transients exceeding the above limits shall not occur more than once in a period of 120 times the transient duration during normal operation.

Interference exceeding the preceding limits caused by Buyer-Furnished Equipment not meeting the susceptibility or interference generation requirements of the applicable Boeing document cited in Par. 2.2.2 shall be the responsibility of the Buyer.

9.3.2

Static Dischargers

A means for controlling interference resulting from precipitation or engine static charging shall be provided.

Static dischargers shall be readily replaceable. A sufficient number of dischargers shall be installed to permit dispatch of the airplane with one discharger missing from each surface.

9.4 PRIMARY ELECTRICAL POWER SYSTEM

9.4.1 AC Electrical Power Generation System

The primary ac electrical power system shall be a four-channel, 60-kva per channel, 115/200 volt, 3-phase, 400-cps system which may be operated as a split paralleled, fully paralleled, or isolated system. Two physically isolated sync-bus tie breakers shall be used to assure reliable operation of the system in a fully paralleled mode. One variable-speed, brushless, oil-cooled generator shall be installed on each of the four accessory drive system gear boxes. (Refer to Par. 5.11.) Variable-frequency power from each generator shall be converted to 400-cps constant-frequency power by an electronic frequency changer and filter. A supervisory control system shall include automatic paralleling devices, protection devices, and logic circuitry as required for automatic system operation. Provisions for monitoring and manual override of automatic switching shall also be provided at the flight engineer's station. (See Fig. 6-8.) There shall be no provision for overriding protective functions.

The automatic system shall provide protection against the following conditions:

- Overvoltage
- Undervoltage
- Load unbalance
- Overfrequency
- Underfrequency
- Differential current
- Anticycling
- Waveform deterioration

Differential current protection shall be provided for the following:

- Generators and generator feeders
- Generator main busses
- Generator tie busses
- Forward distribution feeders
- Galley feeders
- External power feeders

The ac-power-generation system shall be substantially as shown on Fig. 9-1.

9.4.2 DC Electrical Power System

The 28 vdc power shall be obtained from six 75-amp static, unregulated transformer-rectifier units installed in the forward electronic equipment racks and in the main power-

distribution bay. The dc-power system shall be substantially as shown in Fig. 9-2.

9.5 ELECTRICAL POWER CONTROLS

All electrical system controls and operational indicators for the primary and standby power systems shall be installed at the flight engineer's station. (See Figs. 6-8 and 6-13.)

9.6 STANDBY ELECTRICAL POWER SYSTEM

A standby power system shall be provided to supply all ac and dc electrical power necessary for sustaining limited-duration controlled flight and effecting a safe landing. The standby power system shall be energized automatically and will provide power for the emergency loads for a minimum period of 30 min. In addition, the standby power system shall provide selected ground-handling loads. The standby electrical power system shall be substantially as shown on Fig. 9-3.

The standby power system shall consist of (1) a nickel cadmium normal battery for ground handling use and a battery charger, (2) a nominal d.c. 28 V power source for inflight use, (3) a single phase, 400 Hz, nominal 115 V source to supply standby loads requiring a.c., and (4) associated logic, switching, and monitoring controls. The a.c. source shall be capable of continuous operation without forced-air cooling and may be operated full time if the operator desires.

The standby system bus shall supply 28-vdc power to the following components and systems during standby power system operation for flight operations (unless otherwise noted):

- **● Generator control indication
- **● Interphone
- *● Fueling valves
- *● Fueling service light
- *● Fueling quantity gages
 - Fire detection and extinguishing system
 - Fuel shutoff valves
 - Fuel crossfeed valves
 - Flight trim controls
 - Warning horn and landing gear indicating lights
 - Emergency flight deck lights
 - Emergency exit lights (self-contained batteries)
 - Emergency cabin lights (self-contained batteries)
- VOR/LOC
- VHF No. 1
- Air conditioning disconnect
- Passenger address
- Inertial system No. 3

- Integrated flight instrument system No. 1
- Magnetic compass light
- Standby instrument panel lights
- ADS disconnect
- Interwall cooling valve
- Cabin pressurization control
- Hydraulic pump depressurizing control
- Oxygen valve control
- Air Induction Control System

* Ground operation only

** Ground and flight operation

The standby ac bus shall supply 115-vac power to the following systems when the standby power switch is in the ARMED position:

- VOR/LOC
- Stability augmentation system No. 1
- Integrated flight instrument system No. 1
- Inertial system No. 3
- Air Induction Control System

A test feature for the standby power system shall be provided.

9.7 ESSENTIAL POWER

9.7.1 General

The airplane's electrical loads shall be distributed between the four generator channels and respective busses to ensure continuity of power to the essential loads under multiple failure conditions. The primary electrical power generation system shall be capable of maintaining power to essential loads during supersonic flight with two generator channels inoperative, and to maintain power to essential loads during subsonic flight with three generator channels inoperative. Priority shall be given to supplying those loads essential for subsonic flight in the event that available power is insufficient for supersonic flight.

9.7.2 Subsonic Essential Power Loads

Essential power loads for subsonic flight shall include the following functions:

- All of the flight functions connected to the standby system bus as described in Par. 9.6
- All of the flight functions connected to the inverter bus as described in Par. 9.6
- Autopilot No. 1 or 2

- ADF No. 1 or 2
- VOR/LOC/US No. 1 or 2
- DME No. 1 or 2
- SELCAL No. 1
- ATC transponder No. 1 or 2
- HF No. 1 or 2
- Nose pitot-static probe heater
- Feel pitot probe (left or right) heater
- Secondary pitot probe (left or right) heater
- Marker beacon
- Landing lights
- Movable nose section actuation
- Passenger warning signs
- Window deicing
- Weather radar
- Radio altimeter No. 1 or 2

9.7.3 Supersonic Essential Power Loads

Essential power loads for supersonic flight shall include the following functions:

- All of the essential functions listed in Par. 9.7.2 for subsonic flight
- A minimum of one fuel boost pump in each main tank
- Total temperature probe heaters

9.7.4 Essential Power Selection

Power application from the generator channels to essential loads distributed between ac and dc busses shall be controlled from the flight engineer's station. (See Fig. 6-8.) Redundant loads shall be distributed between busses and may be selectively de-energized to provide continuity of power to essential loads in the event of loss of the normal generating channel(s). *The switched ac busses, when faulted, shall automatically transfer to the nonfaulted bus or may be manually switched from the flight engineer's panel.* Warning lights shall be installed on the flight engineer's panel to indicate loss of power to each of the two switched ac busses. (See Fig. 9-1.) Additional warning lights shall be provided to indicate the operational status of each main circuit breaker and main bus.

9.8 EXTERNAL POWER

One external ac power receptacle shall be provided for ground operation. A light located on the flight engineer's panel (Fig. 6-8) shall indicate when external power is connected. The airplane electrical system shall include protection from overvoltage, reverse-phase rotation, and open-phase voltage of the external power source. Airplane systems shall function

satisfactorily when the electrical power delivered at the external power receptacles is within the voltage and frequency limits specified in Par. 9.9.

Means shall be provided to connect external power to the principal interior lights, position lights, convenience outlets (Par. 9.12), and other ground handling loads without energizing the balance of the airplane power distribution system.

9.9 POWER SYSTEM-VOLTAGE AND FREQUENCY

power system voltages and frequencies at the main busses shall be as follows:

	<u>Voltage (volts)</u>	<u>Frequency (cps)</u>
AC Bus-Airplane Power	115 + 4.5 - 3.5	400 ± 1
AC Bus-Ground External Power	115 + 4.5 - 3.5	400 ± 10
DC Bus (transformer-rectifier powered)	27 + 2.5 - 2.5	

Characteristics of electrical power at terminals of load equipment, and restrictions placed on power-using equipment, shall be in accordance with Pars. 3.2 and 3.3 of the "Electrical Requirements for Installed Equipment" specification, which is referenced in Par. 2.2.2.

9.10 EQUIPMENT INSTALLATION

Equipment shall be selected and installed with due regard to operating conditions to which it may normally be subjected. Forced-air cooling shall be provided for equipment that requires cooling. Whenever practicable, equipment installations shall permit ready inspection, access and replacement without removal of other equipment. Electrical equipment installations shall be identified by *permanent-type* markings.

9.11 LIGHTING

9.11.1 General

All lighting shall be powered by ac power, except for the emergency lighting, which shall use 28-vdc power or self-contained batteries. Bulb replacement shall be possible with common handtools. Spare-bulb stowage shall be provided *in the flight deck area*. Single-contact incandescent bulbs shall be used wherever practicable. *Imbedded-type lamps requiring destructive removal of material for lamp replacement*

shall not be used in light plates or in any other light assembly.

9.11.2 Flight Deck Area Lighting

All instruments in the flight deck area shall be white integrally lighted, and all panel lightplates shall be white lighted. Variable-intensity white flood lighting shall be provided for all instrument, circuit breaker, and control panels and shall have maximum brightness at least equivalent to fluorescent lighting on 707/727 aircraft. Red and white floodlighting shall be provided for the general flight deck areas. Variable-intensity control shall be provided for all lights except the red general lighting. In general, the lighting shall be in conformance with SAE Aeronautical Standard Practice 264D.

9.11.3 Passenger Cabin Lighting

A reading light shall be provided for each passenger seat, with its switch convenient to the passenger. The design shall permit adjustment of the reading light for optimum position.

Main cabin general illumination shall be provided by incandescent and fluorescent lights. Controls for the cabin lights shall be on the attendants' panel. (See Fig. 11-2.)

Lavatories shall be illuminated by fluorescent lights when the lavatories are in use. When not in use, the lavatories shall be illuminated by a low-intensity incandescent bulb. Upon actuation of the doorlock, the fluorescent light shall illuminate. Means shall be provided to energize all lavatory lights for maintenance purposes, irrespective of doorlock actuation.

Maintenance lights shall be provided in the lower sidewalls of the passenger cabin to illuminate the underseat areas during cabin servicing.

Each galley shall have lights to illuminate the working areas, including the above- and below-work-deck areas, and shall be adequate for all galley servicing requirements. The lights shall be of the variable-intensity type and shall control light intensity from OFF through DIM to BRIGHT. The switches shall be located in the vicinity of the galleys.

Each main entry doorway shall be provided with a light suitable for checking passenger lists and with a door threshold light; both lights shall be controlled by a switch on the respective attendants' control panel. The entry-area

lights shall be operable when power is connected to the external power receptacle, regardless of the position of the external power control switch on the flight engineer's panel.

NO SMOKING and FASTEN SEAT BELT signs shall be installed in view of the passengers. A RETURN TO SEAT sign shall be installed in each lavatory. OCCUPIED indication signs shall be provided for the lavatories. The appropriate sign shall be visible to each passenger. A switch for the NO SMOKING and a switch for the FASTEN SEAT BELT and RETURN TO SEAT signs shall be located on the pilots' overhead panel. In addition to the signs, these switches shall actuate a chime, audible to the cabin attendants.

9.11.4 Emergency Lighting System

An emergency lighting system shall be provided, consisting of one light assembly in the flight deck area, one light assembly in the electronics compartment aisle, one light assembly at each exit, and ceiling light assemblies evenly spaced along the cabin aisle centerlines. Each assembly shall consist of two lamps, control circuitry, and nickel-cadmium battery of approximately 1-amp-hr capacity. At the exits, the lights shall illuminate the cabin interior adjacent to the exits. Illumination of the wing upper surface, adjacent to the overwing exits and exterior evacuation areas, shall be provided by the emergency lighting system. A master control switch, providing ON, ARMED, and OFF switch positions shall be located on the pilots' overhead panel. (See Fig. 6-5.) An indicator light adjacent to the switch shall illuminate whenever the switch is not in the ARMED position. Trickle-charging from a switched bus shall be provided for all batteries. The light assembly shall be capable of being turned off and on when removed from its normal installed position for use as a portable light.

With the master switch in the ARMED position, loss of airplane ac essential power shall automatically energize all emergency lighting circuits. With the master switch in the ON position, all emergency lighting circuits shall be energized. Each emergency light assembly installation shall be designed to withstand at least 20g loads.

9.11.5 Electrical, Electronic, and Cargo Compartment Lighting

Electrical, electronic, and cargo compartments shall have lights for illumination of equipment and cargo. Control of the lights shall be located adjacent to the compartment doors and also within the passenger cabin adjacent to the viewing windows for the lower cargo compartment.

The cargo compartment lights shall be shielded against damage by cargo and shall be chosen and located to eliminate the possibility of charring cargo. These lights shall also provide sufficient illumination outside of each cargo compartment door to allow reading of baggage tags and identification of cargo at a distance of 25 ft from the door opening.

9.11.6 Equipment Area Lighting

Lights shall be provided for illumination of the wheel wells, air-conditioning and accessory-power compartments, major junction boxes, ground fueling panel, and aft body interior. Switches for the compartment lights shall be located within the compartment. Switches for the major junction box lights shall be located adjacent to the boxes.

9.11.7 Exterior Lighting

The landing light installation shall consist of a minimum of two high-intensity light fixtures on each side of the airplane. The lights shall be controlled by individual switches located on the pilots' overhead panel. (See Fig. 6-4.)

Position lights shall be provided and shall give coverage in accordance with Federal Air Regulations, irrespective of wing-sweep position.

High-intensity anticollision lights shall be provided for subsonic flight and shall comply with FAA requirements.

Runway turnoff-taxi lights shall be installed with separate control switches located on the pilots' overhead panel. (See Fig. 6-4.) These lights shall also provide illumination to assist in ground service of the airplane.

Lights shall be installed in the side of the fuselage to illuminate the wing leading edge.

9.12 SERVICE OUTLETS

The galleys shall be serviced by a total of 60 kw of 3-phase, 400-cps, 115/00-vac power. This service shall be controlled by switches at the flight engineer's station. (See Fig. 6-8.)

Each lavatory shall be provided with one 115-vdc shaver outlet.

115-vac, 400-cps power outlets shall be installed at the electrical and electronic equipment racks for test equipment.

2

A minimum of four convenience outlets, each capable of supplying 1 kva of 115-vac, 400-cps power shall be provided in the galley areas within the passenger cabin, and one outlet of equal rating shall be provided in the flight deck area for test equipment.

9.13 CALL SYSTEM

9.13.1 Attendants

A master call annunciator light fixture shall be installed in the passenger cabin. Separate colored lights shall indicate calls from the flight crew or attendants, the lavatories, or passenger cabin. Call buttons shall be installed in each lavatory, in the flight deck area, and at each passenger seat location. Operation of the passenger call system button shall illuminate a light at the seat and the applicable master light and shall sound a tone at the nearest attendants' station. Resetting the passenger call light shall be accomplished at the light location. The master light shall extinguish when all seat lights have been reset. Lavatory call lights shall be reset at the respective attendants' control panel. The flight-crew-to-attendant call shall illuminate the applicable master call light and sound the tone at the attendants' station that shall operate a single-stroke tone and light in the flight deck area. A second call button shall be provided at each attendants' station for calling between attendants' stations. This button shall operate the same system as the flight-crew-to-attendant call. (See Fig. 11-2.)

Call-light circuitry shall be adjustable so that calls originating ahead of the variable location class divider partition shall register at the forward annunciator light, and calls originating aft of the partition shall register at the annunciator lights aft of the partition.

9.13.2 Ground crew

A horn shall be installed in the nose wheel well to enable the flight crew to call a ground crewman to the interphone. The control for the horn shall be accessible to the pilots.

9.14 WARNING INDICATORS

9.14.1 Aural Takeoff and Landing

An aural warning device in the flight deck area, audible to the flight crew, shall warn against:

- Operation of the override lever locking device to prevent inadvertent gear retraction with the airplane on the ground

- Takeoff with the outboard wing sections, wing flaps, or spoilers in improper positions.
- Landing with the landing gear in other than the down position when the throttle settings are reduced and the wings are at the 30-deg sweep position. A manual silencer shall be provided *only* for a warning caused by retarding of the throttles.
- Landing with the landing gear in other than the down position when the wing flaps are extended to the recommended position for landing. A landing gear warning, initiated by flap position, shall be silenced by extending the landing gear or retracting the flaps.

Separate position indicator lights shall be provided for the landing gear and gear doors as specified in Par. 4.5.7.

9.14.2 Mach Number and Total Temperature/Airspeed Warning

An aural warning, distinctly different from all other warnings, shall be installed to indicate when Mach, total temperature, or airspeed placard limits are exceeded.

9.14.3 Cabin Altitude Warning

An audible warning device shall provide automatic warning if the cabin altitude exceeds a nominal 10,000 ft. It may be silenced by a switch on the cabin pressure control panel and shall automatically reset when the cabin altitude returns below the warning altitude.

9.14.4 Fire and Overheat Warning

9.14.4.1 Engine Fire Detection System

Each engine shall be provided with a fire detection and control system. Activation of the detector system shall energize a warning bell and shall illuminate a master fire light, the appropriate individual fire area identification light on the captain's panel, and the appropriate fire warning light in the handle of the fire switch on the pilots' overhead panel. The warning bell and lights shall be activated when a detection circuit is tested. A push-button switch shall be installed adjacent to the warning lights; this switch shall silence the warning bell and automatically reset the circuitry so that the bell will sound again on the next warning.

9.14.4.2 Wheel Well Overheat Warning

Each main wheel well shall be provided with an overheat detector system. Activation of this detector system shall energize a warning device in the flight deck area. The

warning device shall be activated when the detection circuits are tested.

9.14.5 Master Warning Light

A master *warning* light shall be installed on the pilots' main panel. The light shall emit a flashing signal whenever a system's warning light is illuminated on the flight engineer's instrument panel. It shall be a push-to-reset type. Resetting shall extinguish the light and arm the circuitry for a succeeding warning light signal from the flight engineer's panel.

9.15 ENGINE FIRE SWITCHES

A fire switch for each engine, accessible to the pilots and flight engineer, shall be provided on the pilots' overhead panel. Actuation of the switch shall accomplish the following functions *electrically, regardless of the position of the standby power switch:*

- Close engine fuel shutoff valve
- Arm engine fire extinguishing system
- Close engine air bleed shutoff valves
- Close engine anti-ice valve
- Close the secondary air supply doors

9.16 NOSE SECTION ACTUATION

Operation of the movable nose actuation system shall be accomplished electrically from the pilots' station. (See Figure 6-2.) The actuation system shall be designed with dual structural and actuation paths and shall consist of a dual ball-bearing screw actuator driven by two electric motors through a differential-type gear box.

The system shall normally operate with both motors energized; however, each motor individually shall be capable of driving the actuation system at half the rated speed. *A means for manual operation of the actuation system shall be provided.*

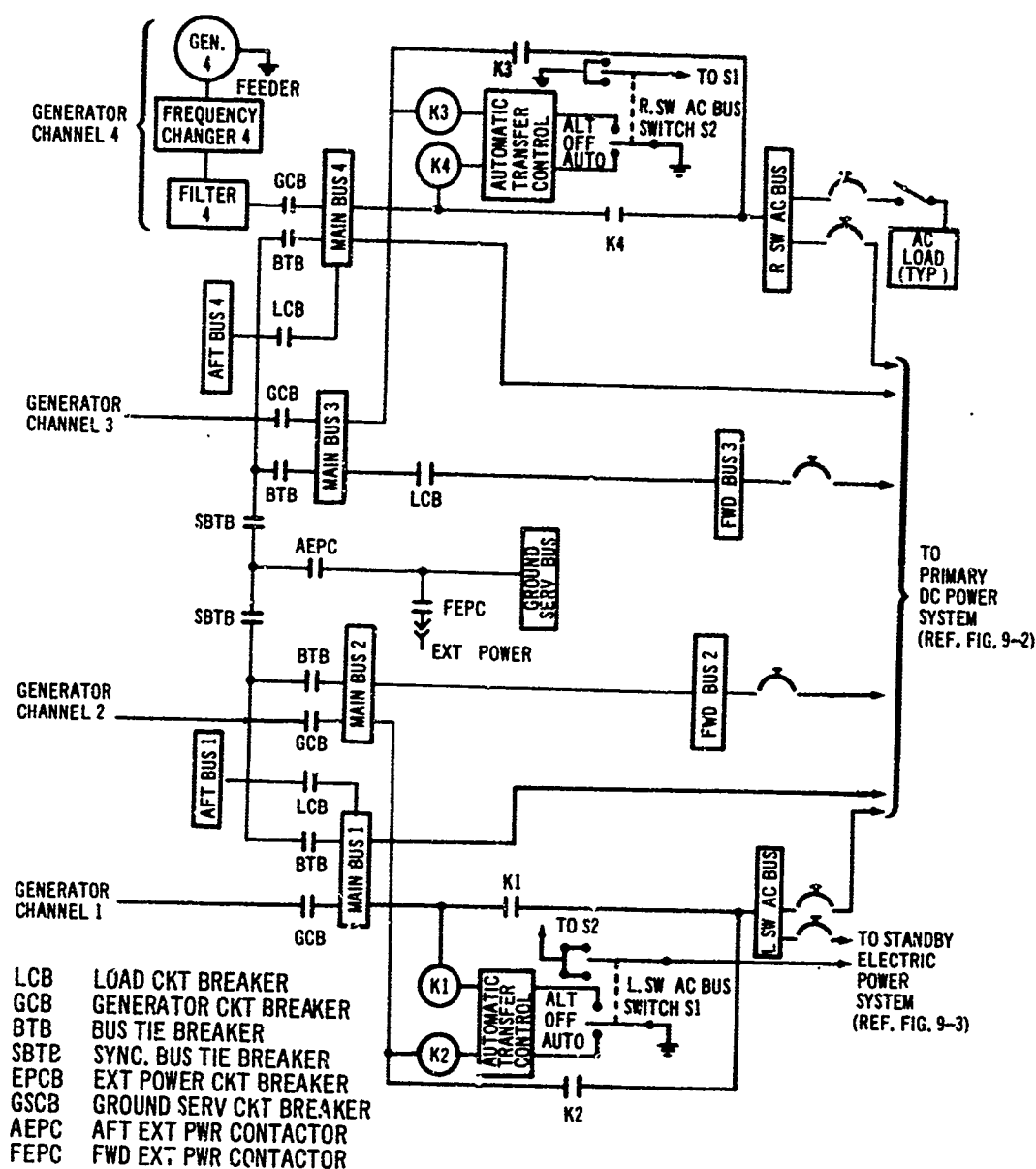


Figure 9-1. Primary AC Power System

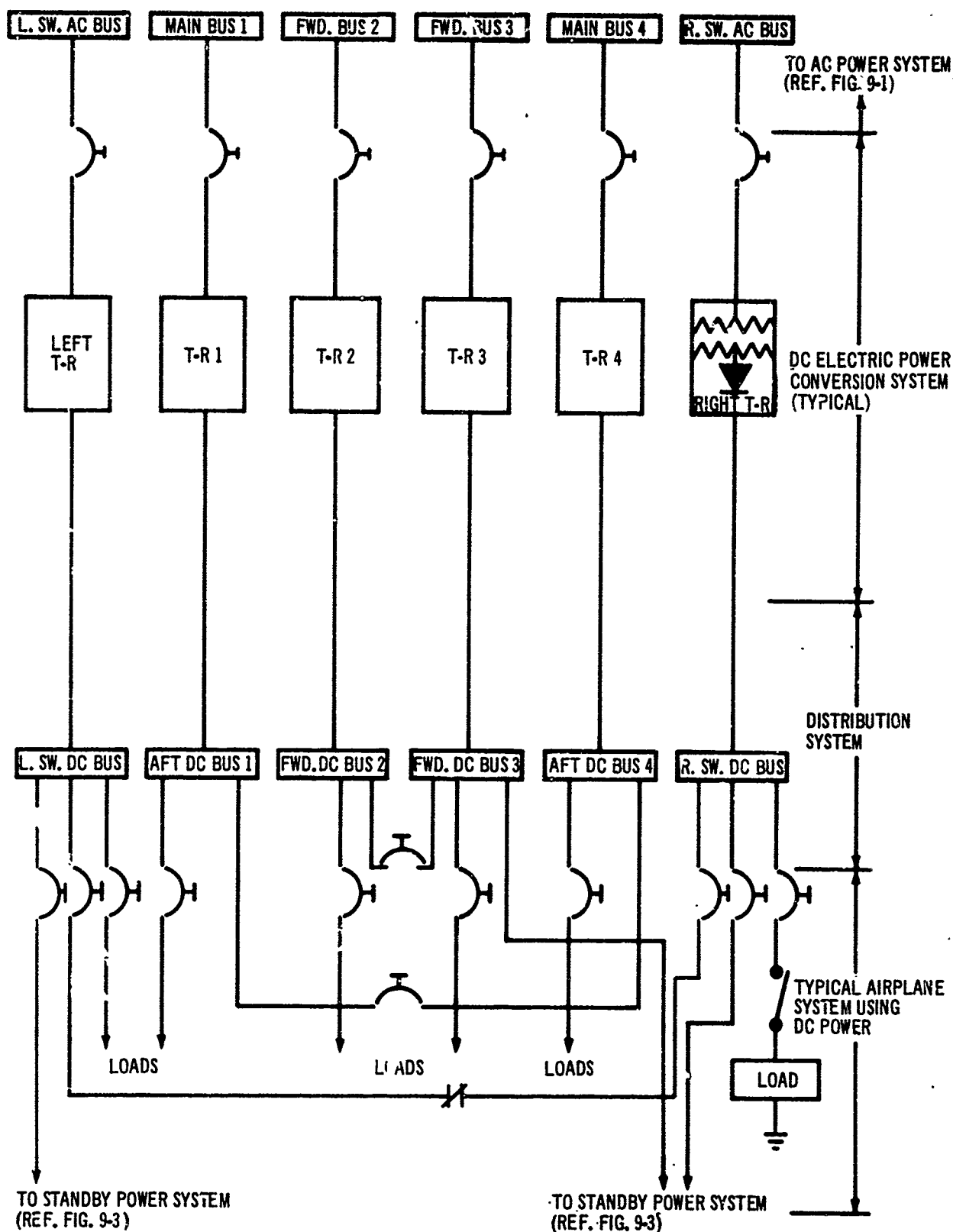


Figure 9-2. Primary DC Power System

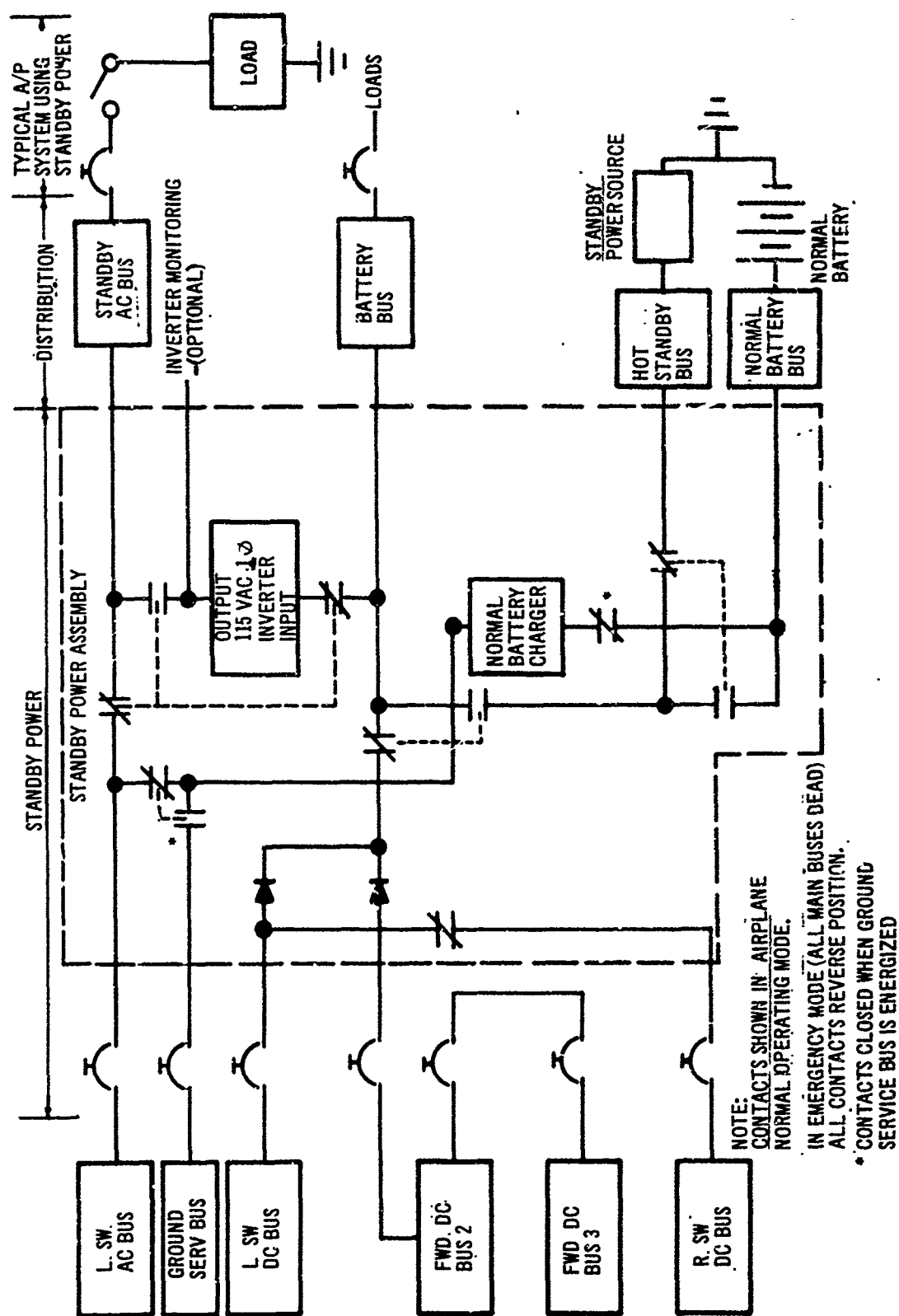


Figure 9-3. Standby Electric Power System

SECTION 10 ELECTRONICS

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SECTION 10 ELECTRONICS

10.1 GENERAL

10.1.1 Installation

The radio and electronics equipment listed in App. I and the systems defined herein shall be provided. All miscellaneous electronic components required to adapt the electronics systems to the airplane (e.g., resistors, relays, diodes, etc.) shall be installed in related ATR-type boxes.

Each antenna assembly (having the same part number), except those such as the ADF sense and HF communications antennas which are integral with the structure, shall be interchangeable between airplanes. (Refer to Par. 14.2.1)

10.1.2 Grounding, Bonding, and Electromagnetic Interference

Refer to Par. 9.3

10.1.3 Wiring

Refer to Par. 9.2 for general wiring installation requirements. Except as specified elsewhere in this specification, removable end segments shall be provided on all coaxial cable lead-ins where it is difficult to replace the entire cable.

Coaxial cables associated with receiving or transmitting equipment shall either be connected to the front of the unit or have an inline connector in the vicinity of the unit; the connector shall be easily accessible for testing and measurement purposes. Circuits that are critical with respect to performance may be an exception as specified elsewhere in this specification.

A joint shall be provided in each coaxial cable lead-in to the electronic equipment rack. The joint shall be near the rack so as to permit replacement of only the short sections most subject to damage. To avoid replacement of complete cables when defective plug-to-cable connections occur, sufficient slack shall be provided where possible at the plug ends to permit removing of plug attachments. Removable end segments shall be provided on all antenna coaxial cable lead-ins where it is difficult to replace the entire cable itself, except for systems where the possibility of performance degradation may exist because of the additional disconnects.

Transmission-line cables shall be installed and routed in a manner to permit easy removal of associated equipment without damage to cable and connectors. The bend radii shall

be 10 times or greater than the diameter of the coaxial cable unless the cable manufacturer's specification allows a smaller bend radius. Adequate slack shall be provided to permit two replacements of the coaxial connector.

To facilitate maintenance and modification of electronic equipment, inter-tie wiring shall be located in plug-in-type interface boxes.

10.1.4 Power Control

Two master radio power switches shall be located in the flight deck area and shall be accessible to the pilots.

10.1.5 Equipment Racks

Electronic equipment racks shall be located in the forward and aft sections of the fuselage. The forward racks shall be located between the passenger and flight deck compartments and the aft racks shall be located between the passenger and aft cargo compartments. *Forced air flow shall be provided to all equipment racks, on the ground and in flight, to cool equipment and remove smoke resulting from possible equipment malfunction.* Space provisions for additional units shall be provided in the equipment racks.

10.1.6 Miniaturization

Microminiaturized circuitry and other solid-state techniques shall be utilized to the maximum extent practicable. Minimum application of mechanical switching shall be used.

10.2 EN ROUTE NAVIGATION SYSTEM

10.2.1 Inertial System

Three inertial navigation systems shall be installed per ARINC 561 to provide the following:

- Geographical position of the airplane, on a worldwide basis, independently of external aids
- Guidance information for either manual or autopilot-coupled control of the airplane along a predetermined course
- Navigation data for en route reporting and flight schedule evaluation
- Attitude and directional references for the flight and navigation instrument systems

- Weather radar antenna stabilization.

Navigation display outputs, selectable on each navigation display panel, (Fig. 6-2) shall include the following:

- Present position latitude and longitude
- Waypoint latitude and longitude
- Drift angle
- Cross-track deviation and track-angle error
- System status annunciators
- Ground speed and track angle
- Distance and time to waypoint
- Course-change warning
- Wind speed and wind direction
- Waypoint code
- True heading.

Each system shall provide means of operation as a back-up vertical reference unit in the event of computer failures. The purpose of this mode is to provide the highest reliability and the highest practical signal integrity of pitch and roll angle.

The system shall incorporate self-test features which will detect, isolate, and warn of malfunctions within the system.

The inertial navigation equipment shall be installed in the forward electronics equipment racks. The control and display panels shall be installed in the flight deck area, accessible and visible to the pilots. (See Fig. 6-2)

The magnetic-azimuth detectors and compensators shall be interconnected to the inertial systems. Inertial heading shall be used to amp the unstabilized magnetic-heading signal.

The Inertial Navigation System shall provide position data with sufficient accuracy so the cross-track and/or along-track position error shall not exceed 14.0 nautical miles during 95 percent of all flights of 2.5 hr duration or less

which are conducted at an average ground speed of 1,500 knots. The cross-track and/or along-track position error of the system shall not exceed 20 nautical miles during 95 percent of all flights of 8.0 hr duration or less which are conducted at an average ground speed of 500 knots. Position updating shall not be required to achieve the above.

10.2.2 Televisual Taxi Aid System

A televisual aid system shall be installed to provide the pilots with visibility of the landing gear position relative to the runway/taxiway. The system shall also permit viewing of the nose and main landing gear during gear extension, retraction, and door closure cycles. It shall be a design objective to provide the visual display for this system on the pilots' main instrument panel utilizing the weather radar display indicators on a time-sharing basis.

10.2.3 Weather Radar System

A weather radar system shall be installed and shall provide a normal direct-view bright-tube video display of weather targets and rainfall gradient (iso-echo contour map). The system shall be optimized for weather detection and shall be usable at all altitudes up to the maximum certificated altitude. Ground mapping and display features shall also be provided; however, these features shall be considered a secondary benefit. The radar antenna shall be installed in the radome. (See Fig. 10-1) The antenna shall be stabilized by roll and pitch attitude signals from the inertial navigation system. The receiver/transmitter shall be installed in a pressurized container as close as possible to the antenna. The container shall be pressurized from the cabin pressurization system. One control on the pilots' aisle stand (Fig. 6-4) and two display indicators on the pilots' main panel (Fig. 6-2) shall be provided. The radome shall be installed on the body nose section and shall have adequate draining provisions to prevent entrapment of moisture and to prevent pressure differential buildup. Rain erosion protection shall be applied to the forward portion of the radome.

It shall be a design objective that the average one-way power transmission of the radome be not less than 90 percent and the minimum transmissivity at any given point be not less than 85 percent throughout the window area. However, the design objective for minimum one-way transmission shall be 75 percent in the forward 10-deg cone of the window area centered

on the radome-mounted pitot-static probe installation. The window area is defined as that portion of the radome through which the main lobe of energy must be transmitted as the antenna is tilted and rotated to all mechanical limits.

It shall be a design objective that the power reflected back into the radar system by the radome shall be less than 0.5 percent of the impinging energy at all positions of the antenna within its mechanical limits, that no side lobe shall be changed more than +3 db by the presence of the radome and associated structure, and that no side lobe shall exceed the level of -18 db with respect to the main beam, except in the forward 10-deg cone which shall be 6 db and -15 db, respectively.

The radar and components attached to and within the radome shall be protected against damage caused by lightning. Radome-lightning-diverter devices shall be capable of handling high-energy lightning strikes and shall be grounded in a positive manner. The ground path shall have the capacity of handling the attendant high-current discharges and shall not be seriously damaged other than by discoloration and/or pitting by a lightning stroke current defined as follows:

- Initial component of current increasing to 200,000 amp in 5 μ sec and decaying to 50,000 amp in 10 μ sec followed immediately by
- A second component of current increasing to 2,000 amp within 5 msec and a total charge transfer of 20 coulombs, and followed immediately by
- A third component of 500 coulombs charge transfer in 2 sec or less

10.2.4 LORAN

Space provisions for a LORAN system installation shall be provided in the forward electronic equipment rack and flight deck area. The No. 2 ADF sense antenna or a fin-tip mounted isolation cap may be used as a LORAN antenna.

10.3 FLIGHT INSTRUMENTATION

10.3.1 Integrated Flight Instrument Systems

Two integrated flight instrument systems shall be installed.

Attitude director indicators (ADI), horizontal situation

indicators (HSI), and radio magnetic indicators (RMI) shall be installed on the pilots' main panel. (See Fig. 6-2.)

The ADI shall be equipped with a master warning light and warning flags and shall display the following:

- Airplane attitude
- Attitude commands
- Vertical flight path and *expanded-scale* localizer deviation
- Radio altitude *low range* (0 to 200 ft)
- Turn rate and slip
- Speed error
- Decrab indication

The HSI shall display the following:

- Selected heading or drift angle
- Magnetic heading
- VOR/LOC deviation
- Distance to DME stations
- Glideslope deviation during terminal area operation
- True heading
- Desired track angle
- Cross-track deviation during en route operation.

The RMI shall display the following:

- Magnetic heading
- ADF No 1 or VOR No 1 bearing
- ADF No. 2 or VOR No. 2 bearing

A third attitude display instrument, installed on the pilots' main panel, shall display attitude information for the third inertial navigation system.

Three combined flight director/autopilot computers shall be installed in the forward electronics equipment rack. The computers shall provide roll and pitch channel command information for manual and automatic flight. The autopilot flight reference selector shall be the source of mode selection. (See Par. 7.4.2.)

An approach progress annunciator shall be installed on each pilots' main panel. (See Fig. 6-2.) The annunciator shall visually confirm system mode changes during the following:

- Approach and landing
- Minimum radio-altitude warnings

An instrument warning system shall be installed. the comparator portion of the system shall automatically cross-check essential instruments and warn the crew of any discrepancy in compared parameters. During ILS approaches, the approach gate monitor shall warn the crew if the airplane exceeds the boundaries of a pre-established "gate" or "window" through which a safe landing can normally be accomplished. Appearance of flag warnings on individual indicators shall be annunciated by the instrument warning system.

The captain shall be provided switches for transferring input data to his RMI as follows:

- VOR No. 1 (narrow needle) or
ADF No. 1
- VOR No. 2 (wide needle) or
ADF No. 2

The first officer shall be provided switches for transferring input data to his RMI as follows:

- VOR No. 1 (narrow needle) or
ADF No. 1
- VOR No. 2 (wide needle) or
ADF No. 2

Switching shall be provided for selection of either the No. 1 or No. 3 inertial navigation information or No. 1 or No. 2 VOR for the captain's HSI and ADI and selection of either the No. 2 or No. 3 inertial navigation information or No. 2 or No. 1 VOR for the first officer's HSI and ADI.

Pitch and roll command information from each of the three automatic flight control systems (autopilot/flight director computers) shall be supplied to both pilots ADI. Midvalue

logic circuitry selects the source of information for operation of the attitude command presentation. Loss of one AP/FD computer shall have no effect on the command information display. The midvalue logic circuitry shall be bypassed if single channel AP/FD operation is employed.

10.3.2 Air Data System

Two air data systems shall be installed. The air data computers *shall be interchangeable and* shall be located in the forward electronics equipment rack. Each computer shall receive pitot and static pressures from the pitot-static system described in Par. 6.7. Two total temperature probes shall be installed. Space shall be reserved in the forward electronic equipment racks for a third air data computer. The air data computers shall supply information to the following equipment and systems:

- Air data displays
- Autopilot/flight director computers
- Autothrust computers
- Inertial navigation systems
- Propulsion instrumentation
- Flight recorder
- Angle of attack and warning control system
- ATC transponders (altitude reporting)
- Overspeed aural warning
- Hydraulic fluid/air cooling control
- AIDS (provision)

Radio altitude-vertical speed indicators shall be installed on the pilots' main panel (Fig. 6-2) and shall display the following:

- Radio altitude
- Selected minimum altitude
- Vertical speed and vertical speed command.

Pressure altitude indicators shall be installed on the pilots' main panel and shall display the following:

- Pressure altitude (servo-pneumatic type)
- Selected barometric pressure correction.

Airspeed-Mach-air temperature indicators shall be installed on the pilots' main panel and shall display the following:

- Calibrated-indicated airspeed (servo-pneumatic type)
- Calibrated airspeed command
- Maximum operating speed
- Mach number
- Air temperature (static, total, and nonstandard day difference).

A true airspeed indicator shall be installed on the pilots' main panel and shall display true airspeed based on the output of either of the two air data computers.

10.3.3

Radio Altimeter

Two low-range radio altimeter systems Per ARINC 552 shall be installed to provide accurate height data during approach and landings. Aural warning of selected minimum decision altitude (MDA) shall be provided to the captain and first officer's audio systems from their respective indicators. The receiver/transmitter units shall be installed in proximity to the antennas. Transmitting and receiving antennas shall be installed on the bottom body centerline as shown in Fig. 10-1. Radio altitude shall be displayed on both pilots' ADI and radio altitude-vertical speed indicator.

All future function and suggested spare wires for the radio altimeter system shall be installed in accordance with ARINC 552 and supplements. The coaxial connecting circuit between antennas and transmitter-receiver units shall be a continuous low-loss transmission line.

10.4

TERMINAL NAVIGATION SYSTEM

10.4.1

Automatic Direction Finding Systems (ADF)

Two ADF systems shall be installed. Each system shall consist of a loop antenna, sense antenna, receiver, and control panel. The receivers shall be located in the aft electronics equipment rack. The control panels shall be installed in

the flight deck area and shall be accessible and visible to the pilots. ADF bearing from each system shall be selectable on both pilots' RMI. *The performance of the ADF systems shall equal or exceed minimum requirements currently established by the FAA and RTCA.*

10.4.2 VOR/LOC/Glideslope

Two VOR/LOC/glideslope systems shall be installed per ARINC 547. The receivers shall be installed in the forward electronic equipment rack. The VOR/LOC antennas shall be installed as shown in Fig. 10-1.

A dual-feed glideslope antenna system shall be installed as shown in Fig. 10-1. *For automatic landing, the localizer and glideslope antennas shall be located sufficiently close to the aircraft center of gravity so that electrical compensation of the yaw displacement signal shall not be required to compensate for the effect of aircraft crab angle during maximum cross-wind landing.*

The VHF NAV-1/VHF COMM-1 control panel and the VHF NAV-2/VHF COMM-2 control panel shall be installed in the flight deck area and shall be accessible to both pilots. (See Fig. 6-4.) *Both units shall provide control of the companion glideslope receiver and DME interrogator and shall also provide for the following:*

- *Combined frequency selection VOR, LOC, G/S, and DME*
- *Audio volume control*
- *VOR/ILS self-test*
- *OVERRIDE, and SELF-TEST.*

Instrumentation output and instrumentation control circuits from VHF navigation receivers and glideslope receivers shall be connected to the appropriate navigation indicators located on the pilots' panels. VOR bearing shall be selectable on both pilots' RMI. The following shall apply when the deviation selectors are in the VOR/LOC position:

- *VOR deviation and TO-FROM information shall be displayed on each HSI when VOR frequencies are selected.*
- *Localizer deviation shall be displayed on each HSI and ADI when localizer frequencies are selected.*
- *Glideslope deviation shall be displayed on each HSI when localizer frequencies are selected.*

The glideslope bar and glideslope flag of each HSI shall be biased out of view when the navigation set selected to supply deviation signals to the indicator is operating on a VOR channel. The bias shall be obtained from the navigation set.

If a single VOR/LOC antenna is used, a failure in one receiver or its transmission line disconnects shall not reduce the input signal level to the other receiver by more than 10 db.

VOR range shall not be less than 95 percent of the radio horizon distance at the maximum altitude capability of the aircraft. This range shall be maintained through 360 deg in azimuth and for bank angles up to 20 deg.

10.4.3 Distance Measuring Equipment (DME)

Two DME systems shall be installed per ARINC 521D. The transmitter-receivers shall be installed in the forward electronic equipment rack, and the antennas shall be installed on the lower forward body centerline as shown in Fig. 10-1. Distance information shall be displayed on each HSI located on the pilots' main panel. (See Fig. 6-2.) DME control and channel selection shall be provided on the VHF control panels described in Par. 10.4.2.

Split-channel DME operation shall be provided, and the frequencies shall be paired with the 50-kc VOR frequency. Suppression pulse lines shall be installed between the two DME equipments and the two radar-beacon transponders.

The DME systems shall operate satisfactorily from overhead the station to a range of not less than 95 percent of the radio horizon at the maximum altitude capability of the airplane or the maximum inherent range of the DME equipment, whichever is less. This range shall be attainable for 360 deg in azimuth and at bank angles up to 15 deg.

10.4.4 Marker Beacon

A marker-beacon system shall be installed. The receiver shall be installed in the forward electronics equipment rack. The antenna shall be installed as shown in Fig. 10-1. Over-the-station indication shall be provided visually and aurally.

10.5 SHORT RANGE COMMUNICATION SYSTEM

10.5.1 VHF Communications

Two VHF communications systems shall be installed per ARINC 546, and space provisions for a third system

shall be provided. The VHF transceivers shall be located in the forward electronics equipment rack. Two VHF blade antennas shall be installed as shown in Fig. 10-1. Mounting provisions for a third VHF blade antenna shall be installed on the bottom centerline of the fuselage. Controls for the VHF communication systems shall be provided on the control panel as described in Par. 10.4.2.

Each VHF system shall be capable of providing solid two-way communication to the radio horizon for all cruising altitudes and at bank angles up to 20 deg.

An audio volume control shall be provided for each VHF system. The side tone level shall be independent of the setting of this control.

Self-test provisions shall be provided for each VHF system.

10.5.2 VHF Satellite Communications

Space provisions for a VHF satellite communications system shall be provided in the forward electronics equipment rack.

10.5.3 ATC Transponder

Two ATC transponder systems shall be installed per ARINC 532B. The two transponders shall be located in the forward electronics equipment rack. Two flush antennas shall be installed as shown in Fig. 10-1. A dual system control panel shall be installed in the flight deck area and shall be accessible to both pilots. Pressure altitude information for altitude reporting shall be provided to the ATC transponders from the air data system. The interconnection circuitry shall permit supplying altitude encoding information from either of the two air data systems to either of the two transponders at the pilot's option. The selection of the altitude encoding source shall be made from the ATC transponder control panel in the flight deck.

Each ATC transponder shall provide full replies to ground station interrogation at all normal climb and descent attitudes and at roll attitudes up to 20 deg from overhead the station to the radio horizon not exceeding 200 nmi range.

10.5.4 Interphone System

Flight and service interphone system shall be installed. The systems shall comply with the intent of ARINC 412, where practicable.

The flight interphone section of the system shall provide for communication between all members of the flight crew.

A switch shall be provided on the flight engineer's panel for interconnection with the service interphone system.

The service interphone system shall provide for communication between *ground service, maintenance personnel*, and cabin attendants at stations located in the following areas:

- Flight deck
- Cabin attendants' stations
- Electronic equipment areas
- Nose wheel well
- Fueling stations
- Propulsion pods (4)

Audio selector panels shall be located at the captain's, first officer's, flight engineer's, and observer's stations.

The interphone amplifiers shall be located in the electronics equipment area.

Handsets shall be installed at each cabin attendant's station and in the flight deck area.

Headphones, boom microphones, oxygen mask microphones, and stowage provisions shall be installed at the captain's, first officer's, flight engineer's, and observer's stations. Microphone selector switches shall be provided.

Two-position, push-to-talk switches for interphone and air-to-ground communications shall be installed on the outboard horns of the pilots' control wheels and on the side panels. A MAINTAINED position shall be provided on each switch to permit interphone communication and emergency external communication to be maintained without the necessity for the pilot's hand to remain on the switch. Push-to-talk switches shall be provided at the flight engineer's and observer's stations.

Loudspeakers, audible at the pilots' seated positions, shall be installed in the flight deck area. (Refer to Par. 10.5.5.)

10.5.5

Passenger Address System

A passenger address system shall be installed to provide voice and music reproduction in the passenger cabin.

The system shall provide all areas of the passenger cabin with quality sound reproduction, free from feedback, during all flight and ground operations.

Transistorized noise-cancelling microphones shall be installed at the cabin attendants' stations. The pilots shall have priority over the cabin attendants in the use of the passenger address system. A switch controlling priority between the cabin attendants shall be installed on the forward attendants' panel.

Loudspeakers in the passenger cabin shall be located as necessary to provide essentially uniform sound distribution. Supplementary loudspeakers shall be installed in each lavatory. Cabin-attendant-initiated passenger address system announcements may be monitored by the flight crew through a flight deck loudspeaker. (Refer to Par. 10.5.4.)

10.5.6 Flight Data Recorder System

A flight recorder system shall be provided. The recorder unit shall be installed in the aft end of the airplane in compliance with TSO C51a. A normal accelerometer shall be installed within the airplane center of gravity limits. Minimum data recorded shall be pressure altitude, indicated airspeed, magnetic heading, normal acceleration, and time. The recorder unit shall be capable of recording additional parameters.

A control panel shall be installed at the flight engineer's station. *A test switch, indicator lights, and an encoder shall be located on the control panel.* Power to the flight recorder shall be available from airplane power or, through the test switch, from external power.

10.5.7 Flight Deck Voice Recorder

A flight deck voice recorder unit *per ARINC 557* shall be installed *per TSO-C84* in the aft end of the airplane. A control panel shall be located on the pilots' overhead panel. (See Fig. 6-5.) *The control panel shall include a test meter, test switch, erase switch, area microphone, and headset monitor jack.*

10.6 LONG RANGE COMMUNICATION SYSTEM

10.6.1 HF Communications

Two HF communication systems shall be installed *for AM and single-side band voice communications.* The two transceivers and antenna-coupler controls shall be located in the forward

electronics equipment rack. The antenna couplers and transfer switch shall be installed in the aft cargo compartment adjacent to the No. 1 HF antenna. The No. 1 HF antenna shall provide the transmit antenna function for the No. 1 and 2 HF communication systems and the receive function for No. 1 HF. The No. 2 HF antenna shall provide the receive-only function for the No. 2 HF system. The control panels shall be located in the pilots' aisle stand and shall be accessible to both pilots. (See Fig. 6-4.)

The performance of the antenna over the frequency range of 2.0 to 22.0 Mc shall be equivalent to or better than that of a conventional long-wire aircraft antenna.

The antenna couplers shall be capable of handling the peak powers generated by the ARINC 533A equipment, with adequate margins. In any case, the antenna couplers shall be capable of handling 1,000-watt peaks in the most extreme aircraft environment expected. Placard holders and HF frequency placards shall be installed. Location and installation of the HF frequency placards shall be subject to Buyer approval.

10.6.2 Selective Calling System

A dual-channel selective calling system (SELCAL) shall provide visual and aural alerting indication when receiving properly coded HF and VHF communications. *The decoder shall be installed in the forward electronics equipment rack so the code selector controls are readily accessible without removing the equipment from its mounting rack. The control panel shall be located in the flight deck area and shall be accessible to the pilots. (See Fig. 6-4.) The control panel shall permit pilot selection of the SELCAL inputs to either channel from any of the HF or VHF communications equipment. (Refer to Pars. 10.5.1 and 10.6.1.)*

The receiver outputs shall not be attenuated between the receiver and the SELCAL input. A correctly coded SELCAL signal shall actuate a chime and light (one light for each SELCAL channel). Each SELCAL channel shall be resettable by depressing its indicator light. One SELCAL placard shall be installed as near as practicable to the SELCAL unit in the equipment rack. A second SELCAL placard shall be installed in the flight deck and shall be readily visible to both pilots. Both placards shall include the airplane serial number, the FAA registration number, and the airplane SELCAL code.

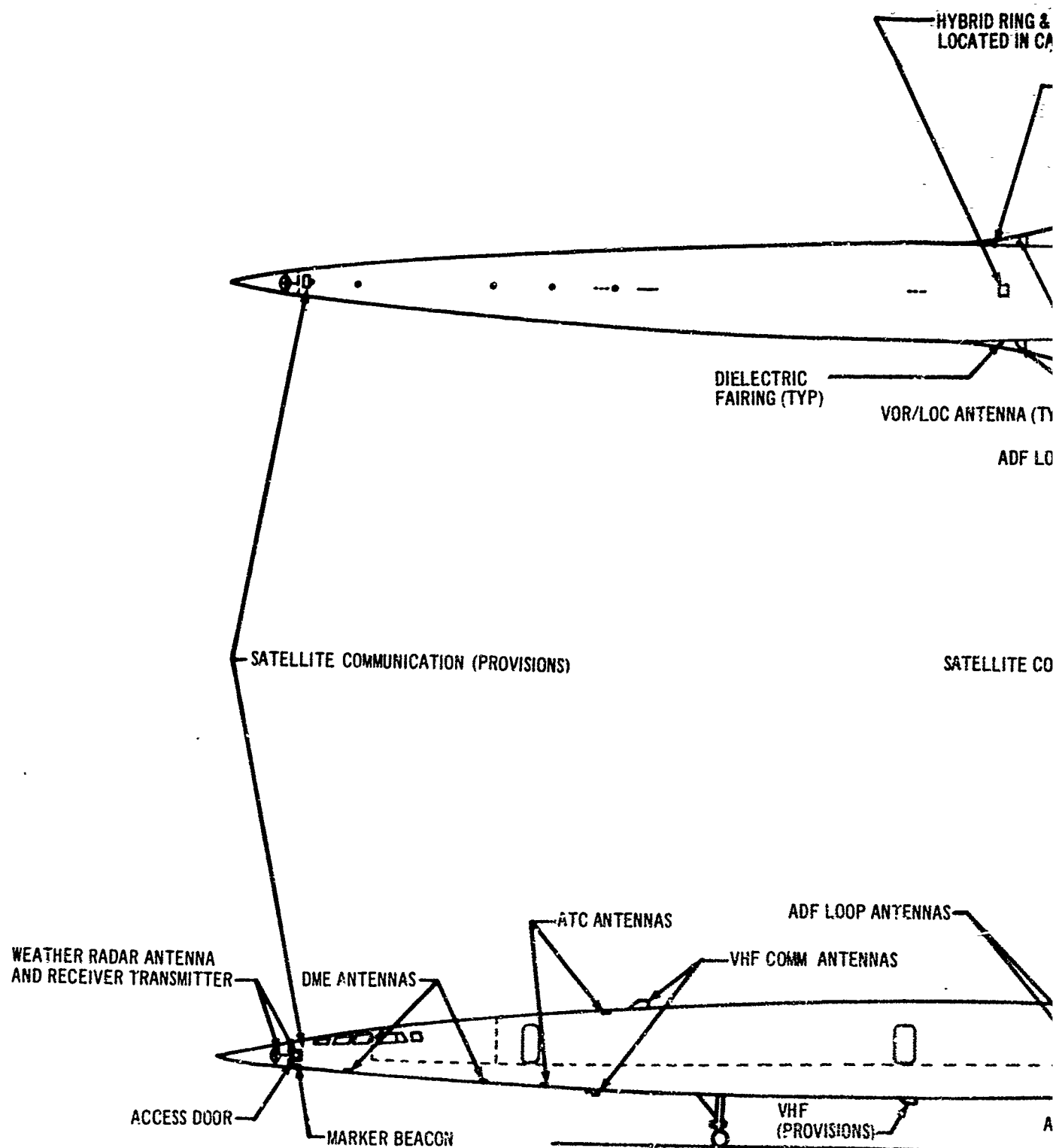
10.7 FLIGHT CONTROL AND NAVIGATION INTEGRATED CHECKOUT SYSTEM

In-line monitoring and checkout provisions shall be included where practical in the individual systems.

10.8

AIRCRAFT INTEGRATED DATA SYSTEM

Provisions for the control panel, magnetic tape recorder, maintenance action indicator, central address control, computer, and display of the aircraft integrated data system (AIDS) shall be incorporated. This shall include the coaxial cable from the forward electronics rack to the area where space provisions shall be provided for the data collection units.



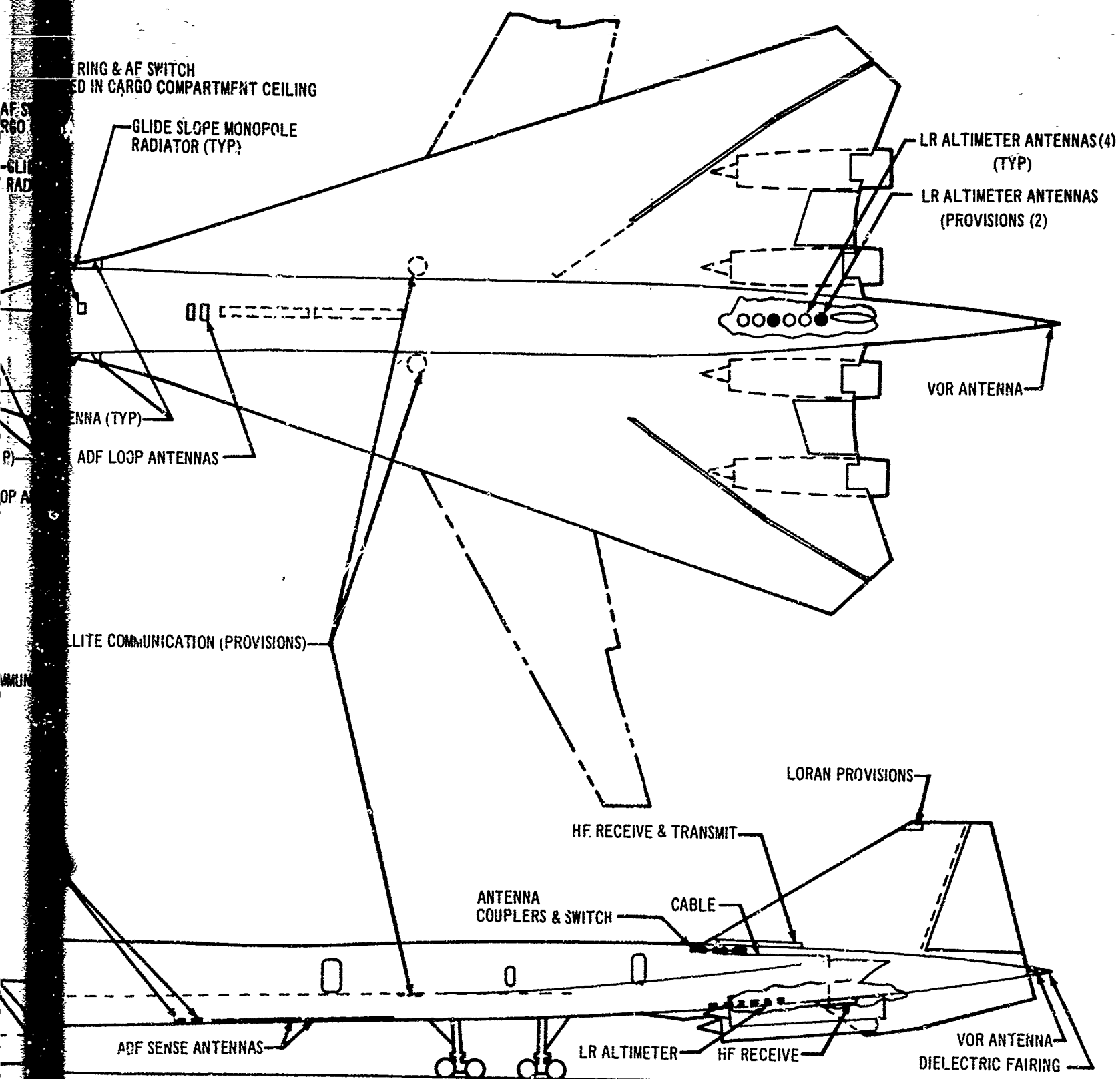


Figure 10-1. Antenna Locations

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SECTION 11 PASSENGER AND CARGO PROVISIONS

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SECTION 11
PASSENGER AND CARGO PROVISIONS

11.1 GENERAL

The basic passenger cabin arrangement shall be substantially as shown in Fig. 11-1. *The entry and service door sizes and locations; exit sizes and location; and escape devices and emergency equipment installation shall be designed to accommodate the maximum certificated passenger capacity defined in paragraph 11.2.2.2. For drainage and ventilation information, refer to Par. 4.1.4.*

11.1.1 Interior Finishes and Colors

Detail finish requirements for the interior color scheme, upholstery, and floor covering shall be in accordance with applicable references listed in Par. 2.2.2.

11.1.2 Furnishings and Equipment

Furnishings and equipment shall be provided as listed in App. I.

11.1.3 Insulation

Thermal and acoustical insulation panels shall be installed in the main cabin sidewall and ceiling. *The panels shall be nonwicking and nonabsorbent and shall be readily removable to facilitate structural inspection. (For internal sound levels, refer to Par. 3.6.)*

11.2 ACCOMMODATIONS

11.2.1 Cabin Attendants' Accommodations

The cabin attendants' stations shall be located substantially as shown in Fig. 11-1. The attendants' seats shall automatically return to the folded position when unoccupied. *Padded headrests shall be provided at each attendants' seat. Seat harnesses shall be provided for all attendants' seats.*

The attendants' panels (Fig. 11-2) shall be located near their seated stations. One fixed work light shall be installed at each attendant's station.

11.2.2 Passenger Accommodations

11.2.2.1 Basic Arrangement

The basic passenger cabin arrangement shall provide for 280 passengers (28 first-class passengers at 40-in. seat spacing and 252 tourist-class passengers at 34-in. seat spacing) as shown in Fig. 11-1. This arrangement shall be certificated.

11.2.2.2 Alternate Arrangements

At the option of the Buyer, the following alternate arrangements *may be provided by altering the number and location of seats, galleys, closets, and lavatories* and may be certificated instead of that described above:

- 300 tourist class passengers at 34-in. spacing
- 259 passengers (48 first-class passengers at 38-in. seat spacing and 211 tourist-class passengers at 36-in. seat spacing).

Flexibility of interior arrangements shall be provided through modular concepts of component design.

11.2.3 Passenger Seats

Passenger seats, including belts, shall be installed substantially as shown in Fig. 11-1. Design of the seats shall be in accordance with the applicable reference listed in Par. 2.2.2.

Interior cabin dimensions shall provide for the use of first class 54-in. wide double seats with 21-in. width between armrests; 63-in.-wide triple tourist seats with 18-, 19-, and 18-in. width between armrests; and 42-in. wide double tourist seats with 18-in. width between armrests. A minimum aisle width of 18 in. up to a height of 25 in. above the floor will be maintained. Above 25 in., the aisle width shall not be less than 20 in.

The passenger seats shall be designed to the following ultimate load factors acting separately: upward, 4.5g; downward, 7.5g; forward, 9.0g; sideward, 3.0g. These load factors shall be multiplied by 1.33 for design of seat and seat belt attachments.

11.2.4 Passenger Service Facilities

Passenger service units shall be provided for each passenger. All units shall be designed to permit matching the seat spacing selected and shall provide individual passenger reading lights, NO SMOKING and

FASTEN SEAT BELT signs, an attendant's call button with integral indicator light, and gasper air outlets which shall be adjustable for direction and volume. Outlets shall not have objectional leakage or noise and shall have directional adjustment to prevent directing of air into adjacent seats. (Refer to Par. 12.2.1.) Lateral passenger seat identification shall be provided and shall read A, B, C, D, E, and F, from right to left; and seat rows shall be identified numerically, reading consecutively from front to rear.

11.2.5 Lavatory Compartments

Lavatories shall be provided and shall be located substantially as shown in Fig. 11-1.

11.2.5.1 Lavatory Equipment

Each lavatory shall include the following equipment:

- o Toilet, toilet seat, and cover
- o Wash basin
- o Soap dispenser
- o Ashtray
- o Airsickness bag dispenser
- o Toilet tissue dispenser
- o Toilet seatcover dispenser
- o RETURN TO SEAT sign
- o NO SMOKING sign
- o Sanitary napkin dispenser
- o Call button
- o 115-vdc shaver outlet
- o Used towel disposal
- o Tissue dispenser
- o Paper towel dispenser
- o Paper cup dispenser
- o Used razor blade disposal
- o Mirror
- o Assist handle
- o Gasper air outlet

All lavatory replenishable supplies and dry waste shall be contained in modular units serviceable from outside the compartments.

11.2.5.2 Lavatory Door Locks

A lavatory door lock of the sliding bolt type, incorporating a large OCCUPIED indicator and interconnected with the OCCUPIED sign, shall be provided for each lavatory door.

It shall be possible to unlock the lavatory door lock from the outside of the lavatory compartment without tools. *A door latch (knob type) shall also be provided on each lavatory door.*

11.2.5.3 Flushing-Type Toilets

Flushing-type toilets shall be provided. Each shall include a 3-phase ac motor to drive a pump and filter, a flushing cycle timer, and a drain valve. *The flush control shall be handle operated.* The flushing mechanism, including motor, pump, filter, and timer, shall be readily accessible for maintenance. Each toilet tank shall have a capacity of approximately 20 gal. Corrosion-resistant materials shall be used throughout. The flush pump shall be capable of operating dry for extended periods without damage. The ground flush and drain lines shall be protected against freezing in flight and shall not be damaged as a result of repeated freezing while the airplane is parked. The drain lines shall be capable of withstanding the full cabin pressure differential without collapsing. (See Fig. 11-3.)

11.2.5.4 Toilet Servicing Provisions

All toilets shall be capable of being serviced from external servicing panels. A 4-in.-diameter drain connection and a hinged cap shall be provided on each drain outlet. The ground flush line fittings shall be thermally insulated.

11.2.6 Galleys

The galley units shall be located substantially as shown in Fig. 11-1 and shall conform to the requirements of the "Galley Design and Installation Requirements" specification, which is listed in Par. 2.2.2.

Each galley installation shall be serviceable through an adjoining service door and permit simultaneous galley loading or unloading and interior in-transit servicing within the times specified in Par. 13.1.

The galley units shall be designed to the following ultimate load factors acting separately: upward, 4.5g; downward, 7.5g; forward, 9.0g; sideward, 3.0g. These load factors shall be multiplied by 1.33 for the design of fittings that attach the galley to the airplane structure. Galley mounting provisions shall be adequate for 700-lb galley units under 12g deceleration loads.

Electrical power and water lines for the galley units shall be located adjacent to the galley. *The electrical connection shall be located above the water connection and physically isolated.* Disconnect fittings shall be readily accessible through the galley structure. (Refer to Par. 9.12.)

11.2.7 Water System

A pressurized water tank supply of 80 U.S. gal capacity, with a pressure of 25 psi automatically maintained, shall be provided for washing, galley, and drinking purposes. (See Fig. 11-3.) A water-quantity indicator shall be provided at an attendant's panel and at the external service panel. Routine servicing requirements for the water system shall be provided at the single servicing panel.

The system supply tank shall be capable of withstanding a pressure of 125 psig. All components of the water system shall be constructed of corrosion-resistant materials suitable for use with superchlorinated water. Construction shall be in accordance with the requirements of the U.S. Public Health Service.

11.2.7.1 Water System Distribution

Hot and cold water shall be supplied at each lavatory, and cold water shall be supplied at the galley units. A water shut-off valve, accessible in flight, shall be provided in the main supply line at each lavatory wash basin, and at the galleys.

The water distribution lines shall be *protected against freezing during flight and shall be* fabricated of materials that will sustain repeated freezing without rupture or permanent distortion.

11.2.7.2 Filling

The service fill panel shall be accessible from outside the airplane. The fill overflow valve shall be operable from the service fill panel. The valve shall be located in a thermally insulated area.

11.2.7.3 Water System Drainage

An air connection shall be installed on the water service panel to provide for ground pressurization of the water system.

Waste water from the lavatory basins shall be drained into the toilet tanks.

11.2.8 Stowage

Stowage provisions, including plug-in coat closets, shall be located substantially as shown in Fig. 11-1. A literature container shall be provided for each seat. Magazine racks shall be provided. Overhead facilities shall be provided for stowage of blankets, pillows, coats, etc., and they shall be of sufficient strength to withstand hand loads of passengers walking in the aisle during flight in rough air. Retention devices shall be provided in the overhead racks to allow safe storage of small carry-on luggage.

Equipment located aft of the passengers shall be retained to avoid dislodgement and the endangering of lives of passengers and crew in the case of a survivable crash landing.

11.2.9 Assist Handles

An assist handle shall be provided at each entry and service door as required for easy and safe operation of the door by personnel inside or outside the airplane. An assist handle shall also be provided in each lavatory.

11.2.10 Cabin Entrance Areas

Self-draining moisture-resistant mats shall be provided in lieu of carpeting in all passenger cabin main entrance, galley, and service door areas.

11.2.11 Doors and Partitions

Doors (Par. 4.4.5) and partitions shall be provided substantially as shown in Fig. 11-1. A key-operated lock and viewing lens shall be installed in the door between the electronics compartment and the passenger cabin. The key-operated doorlock shall also be remotely controlled from the flight deck. A signalling system, such as a buzzer, shall be installed to notify the flight crew to open the flight deck door. Provisions shall be installed on the door to permit its being opened and closed for maintenance purposes without pushing a release button or using a key. Door-opening warning straps shall be provided for all entry and service doors not over the wings.

11.2.12 Call System

A call system shall be installed to indicate calls from the flight crew or attendants, the lavatories, and the passengers. (Refer to Par. 9.13.)

11.2.13 Passenger Address System

A passenger address system shall be installed. (Refer to Par. 10.5.5.)

11.2.14 Passenger Signs and Placards

All signs and placards shall be in the English language (*the Buyer shall have the option of including a second language*). Illuminated NO SMOKING, FASTEN SEAT BELT, RETURN TO SEAT, and EXIT signs shall be provided. (Refer to Par. 9.11.3.) *The NO SMOKING and FASTEN SEAT BELT sign shall be visible from each passenger's and cabin attendant's seated location. Self-illuminated EXIT signs shall be provided in the ceiling above the center aisle at the exits and on each bulkhead or partition which requires passage-way in order to reach an exit.*

11.3 CARGO COMPARTMENTS

A forward and an aft compartment shall be located in the airplane substantially as shown in Figs. 11-4 and 11-5. Both compartments shall be lined with a rigid, high-impact-resistant and fire-resistant, reinforced, plastic-laminated glass sheet. Both compartments shall have only the capability for accepting hand-loaded cargo. Refer to Pars. 1.5.3 and 4.4.2.3 for cargo compartment volumes and weight capacities, respectively.

Means for restraining hand-loaded cargo shall be provided in both compartments. For fire protection, both cargo compartments shall be designed as FAR Class D.

11.4 EMERGENCY EQUIPMENT

The emergency equipment listed in App. I shall be located in the main cabin substantially as shown in Fig. 11-6. The installation of emergency equipment, such as life rafts, life vests, escape slides, fire extinguishers, portable oxygen bottles, first aid kits, etc., shall be designed to provide positive identification and rapid utilization. Consideration shall be given to airline and industry improvement studies in the design and installation of emergency equipment.

The Seller shall demonstrate and obtain certification of emergency evacuation capability of the airplane for the maximum passenger capacity specified in Par. 11.2.2.

11.4.1 Escape Facilities

An escape device, capable of rapid automatic deployment, shall be installed at each entry or service door for a total of eight. *The device shall be designed to permit*

arming prior to each flight and shall automatically deploy on door opening. Four of these escape devices shall be double width and located at the two middle (42-in. by 72-in.) doors on each side. The forward and aft service and entry doors shall have single-width escape devices. The escape devices located at the two aft doors on each side shall be suitable for over-wing evacuation. (Fig. 11-6 shows location of these devices.)

11.4.2 Fire Extinguishers

Portable fire extinguishers shall be installed and located as shown in Fig. 11-6.

11.4.3 Portable Oxygen

Portable oxygen gas generators shall be installed and located as shown in Fig. 11-6.

11.4.4 Crash Axes

Two crash axes shall be provided and located as shown in Fig. 11-6.

11.4.5 First Aid Kits

Two first aid kits shall be provided and located as shown in Fig. 11-6.

11.4.6 Liferafts and Automatic Emergency Beacons

Twelve 25-man liferafts shall be stowed in hard packs in locations as shown in Fig. 11-6. An automatic emergency light shall be provided with each raft. Four automatic emergency beacons shall be provided in the area near the double-width main entry door. Three shall be integral with liferafts and one shall be portable.

11.4.7 Lifejackets

One lifejacket shall be provided under each passenger seat. In addition, lifejackets shall be located as follows:

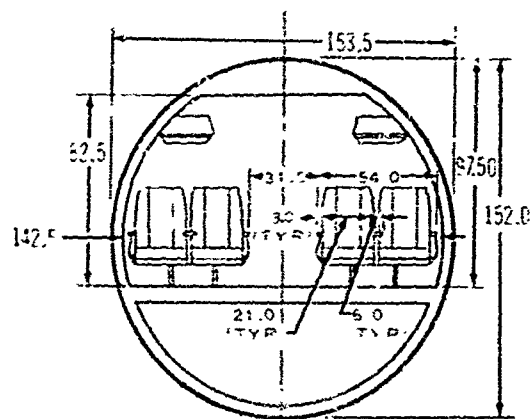
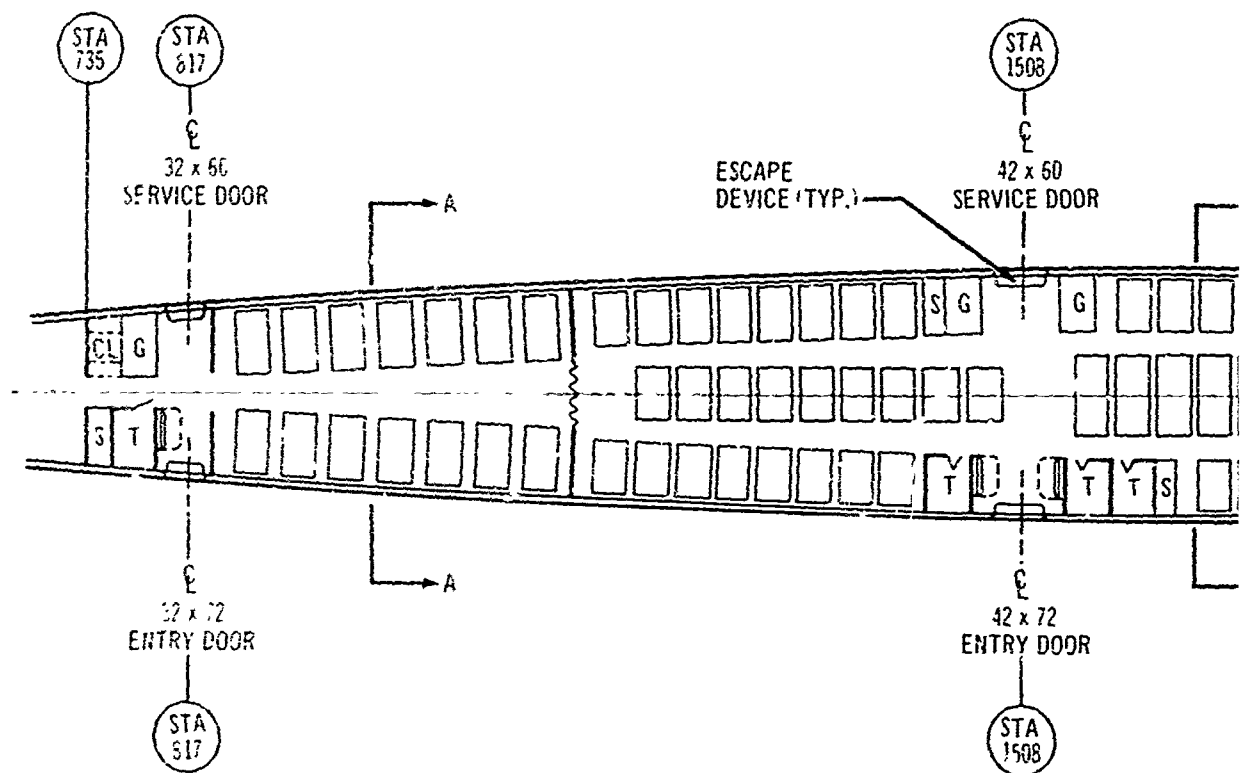
- Two lifejackets at each two-place attendant's station
- Five lifejackets in a crew closet (with liferafts)
- Five lifejackets in an aft emergency cabinet
- Five lifejackets in the double-width main entry door area (with liferafts)
- *● Provisions for children's lifejackets
- *● Provisions for infant flotation gear

11.4.8

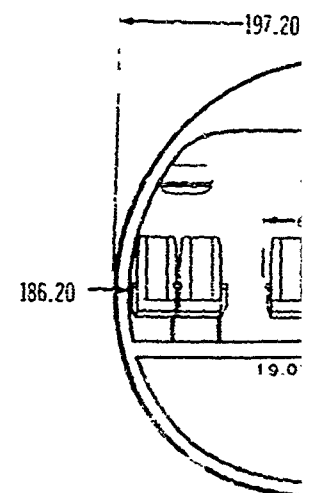
Escape Ropes

A 3/4-in. cotton rope shall be provided at each overwing entry, service, and exit door in the cabin and each escape hatch in the flight deck. The ropes shall be provided with catches to permit their usage as a handrail or latching.

**Number per customer's requirements.*



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230 PASSENGER INTERNATIONAL MIXED CONFIGURATION

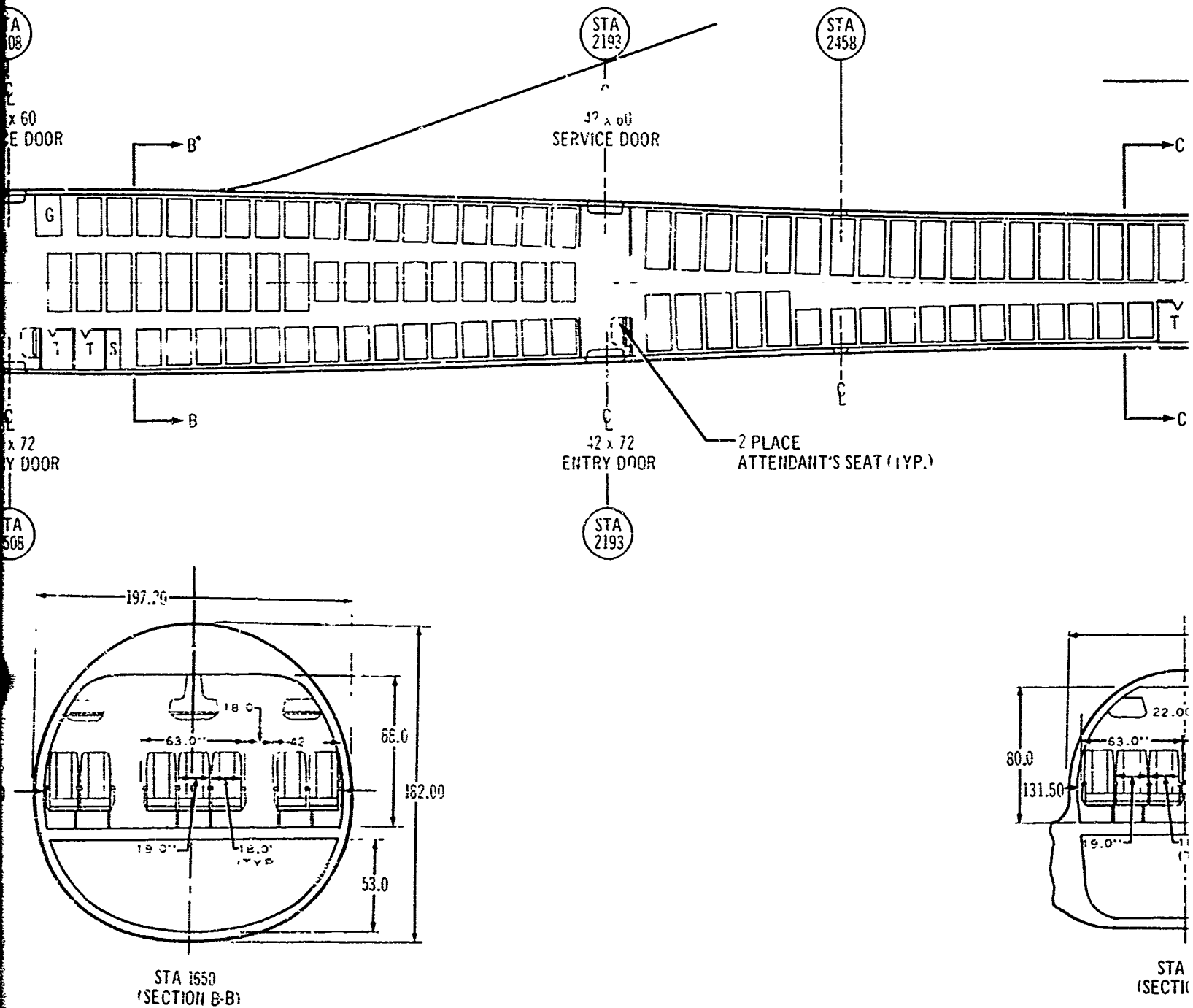


Figure 11-1. Basic

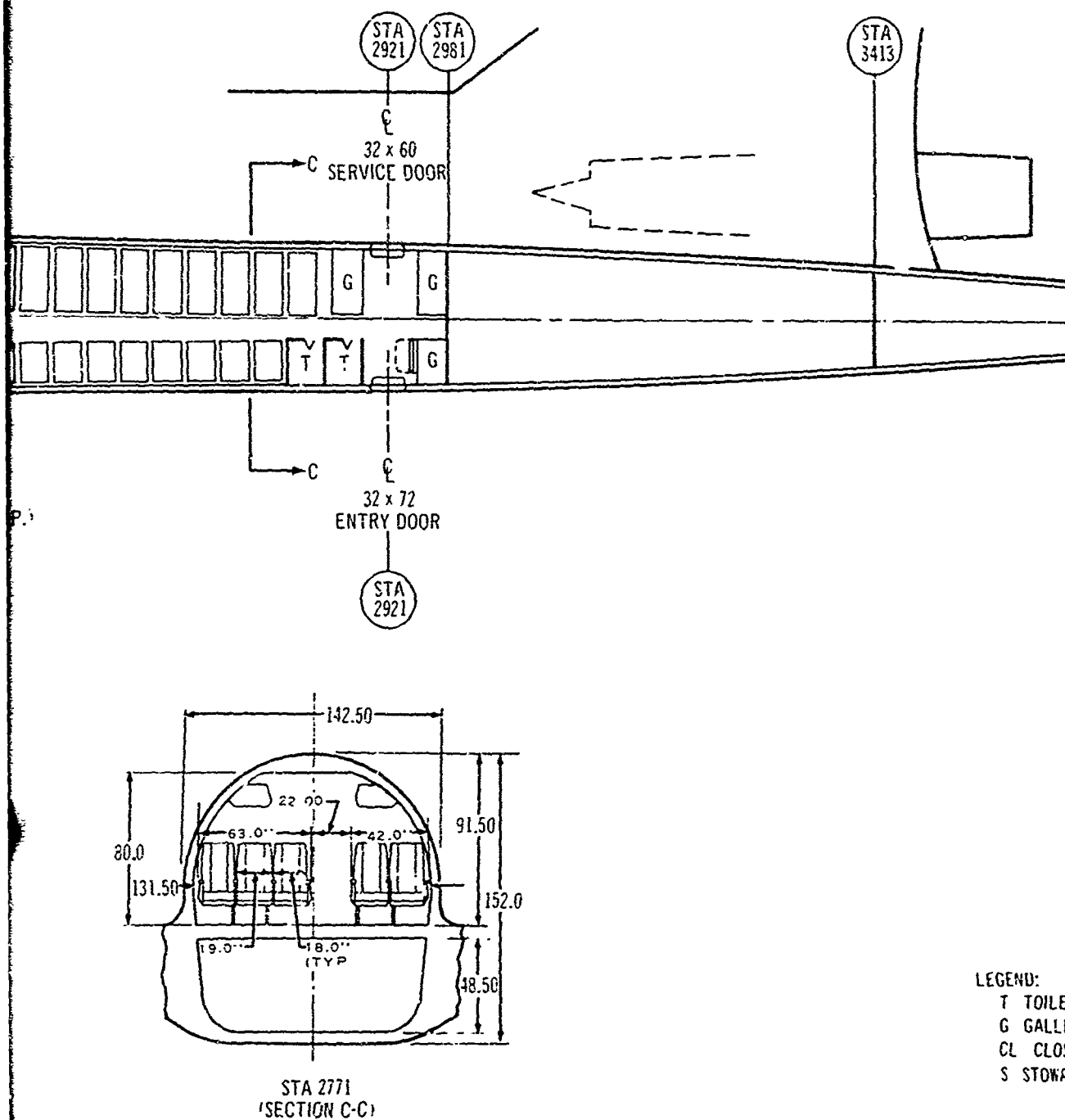
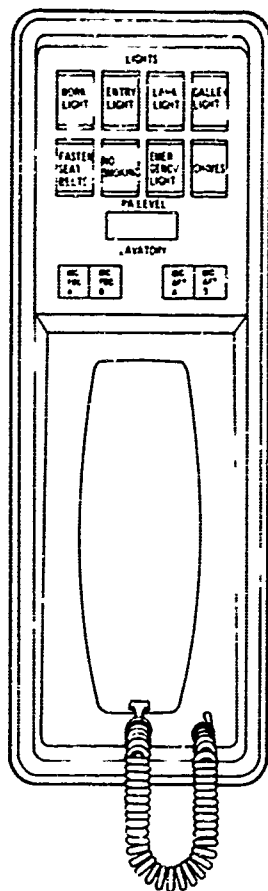
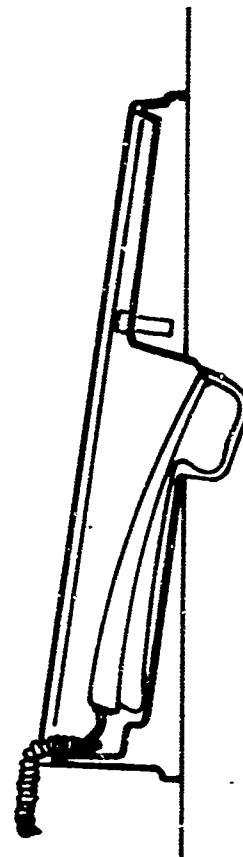


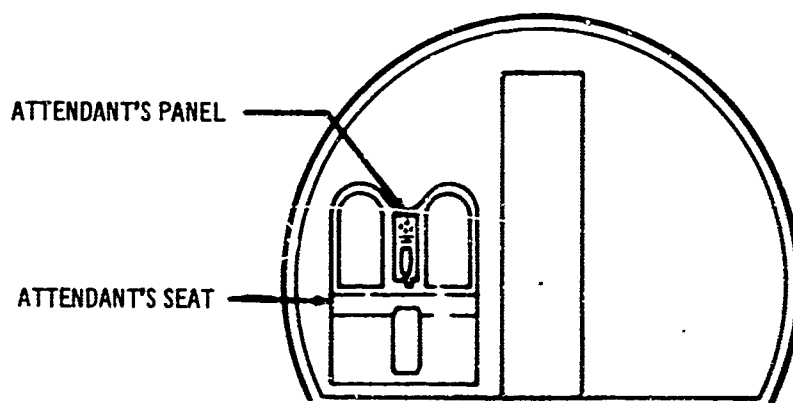
Figure 11-1. Basic International Passenger Arrangement



ATTENDANT'S PANEL (TYPICAL)



TYPICAL SECTION



TYPICAL PANEL LOCATION

Figure 11-2. Attendants' Panels

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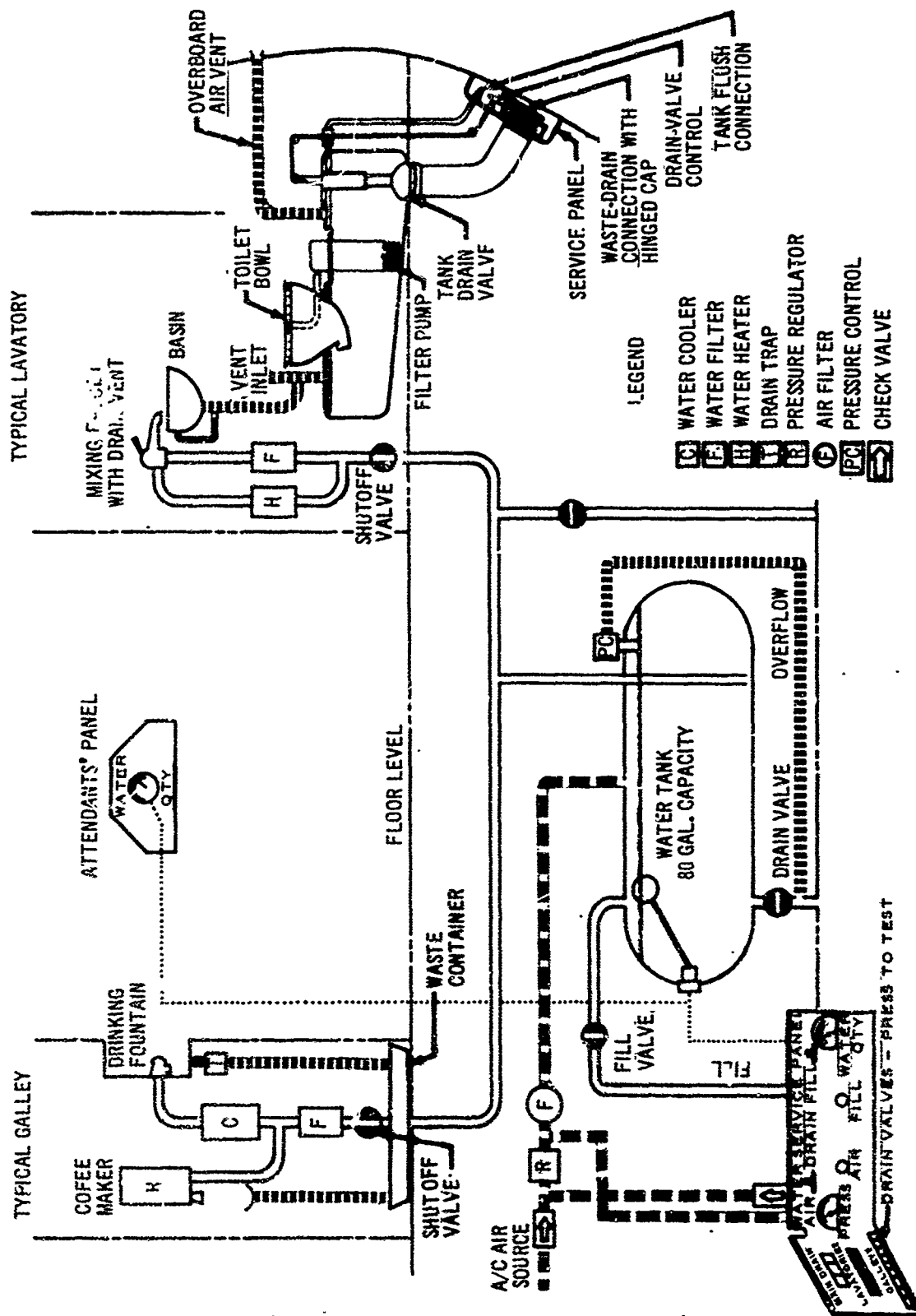


Figure 11-3 Passenger Water and Waste System

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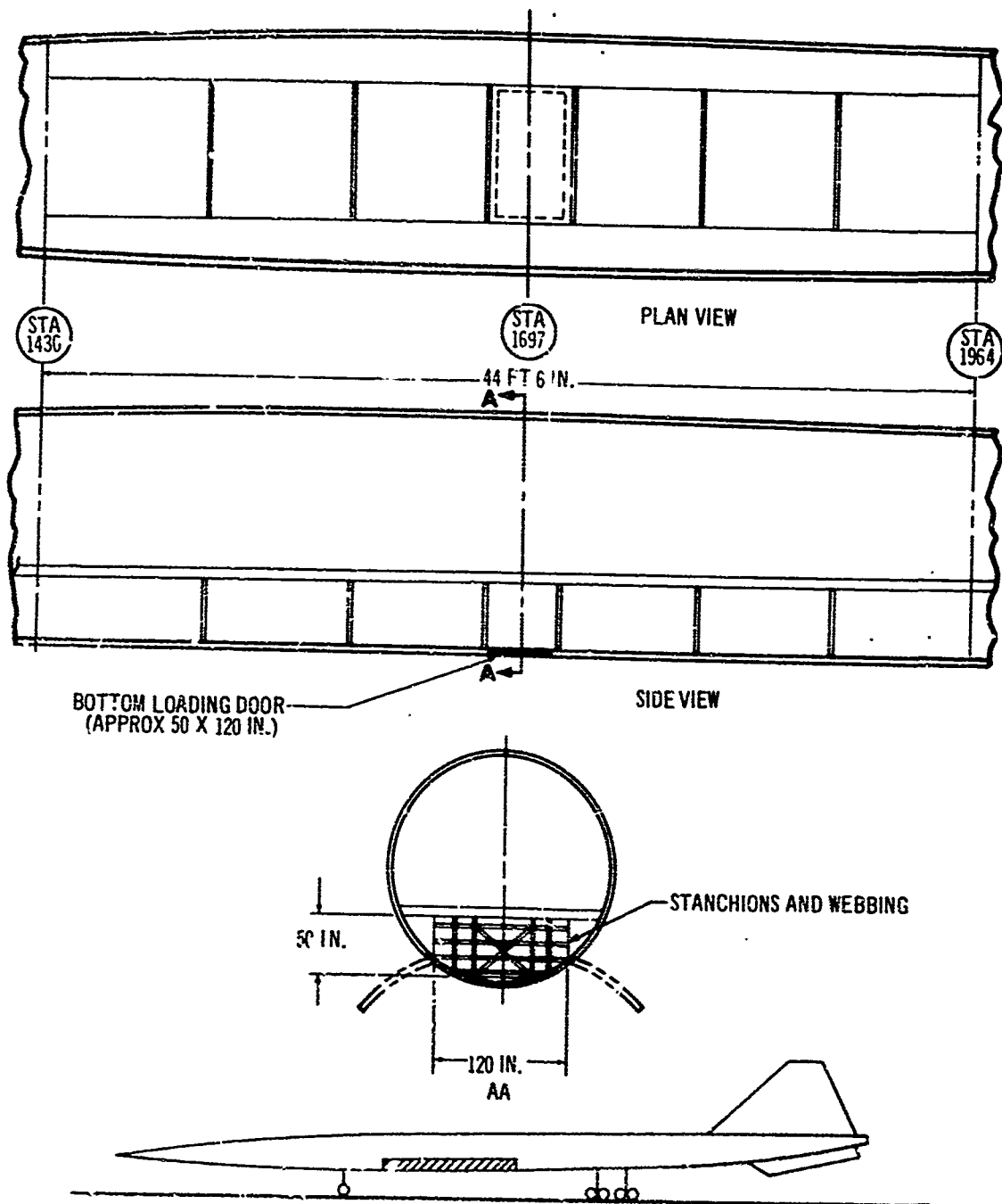


Figure 11-4. Forward Cargo Compartment

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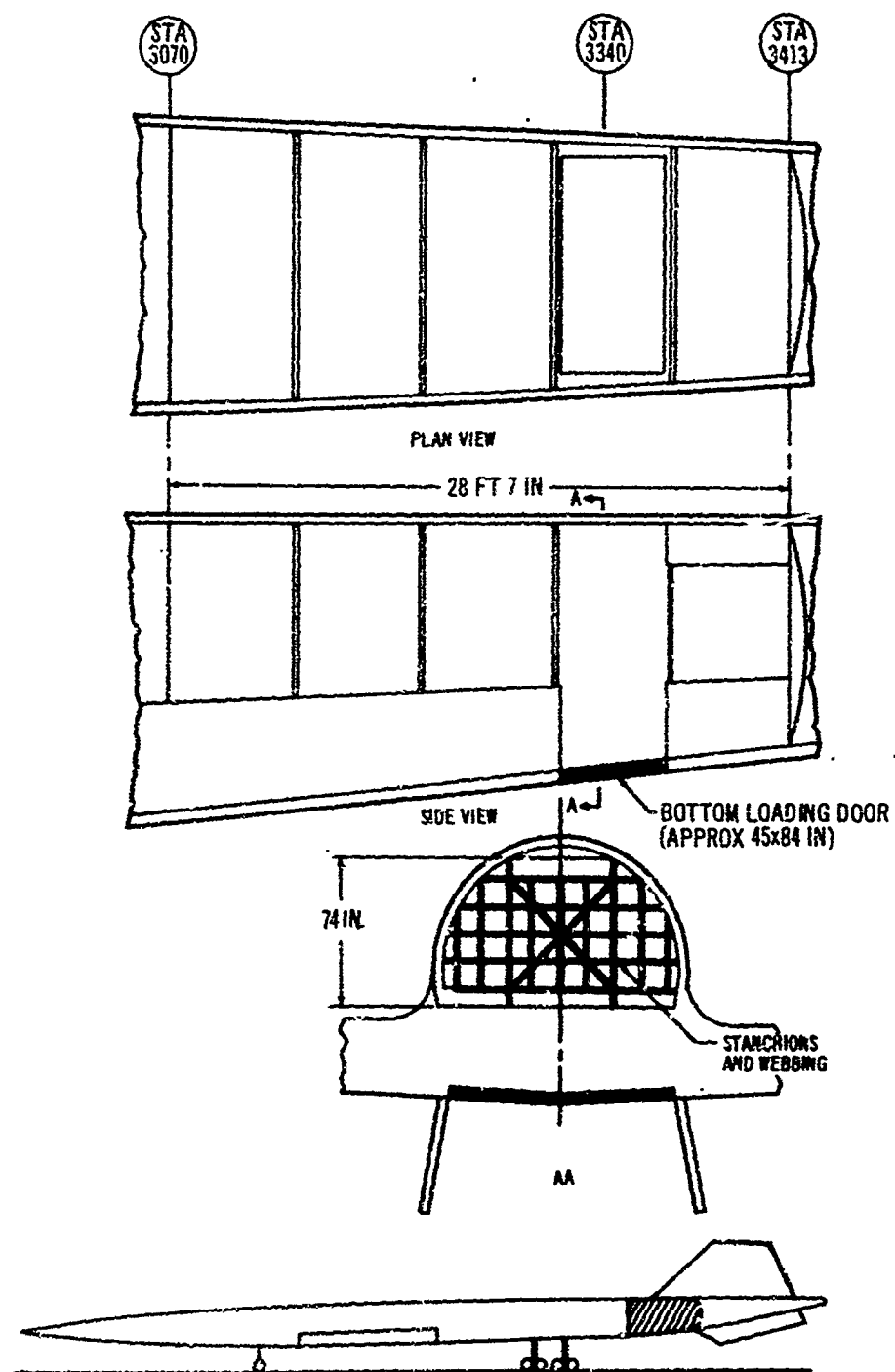
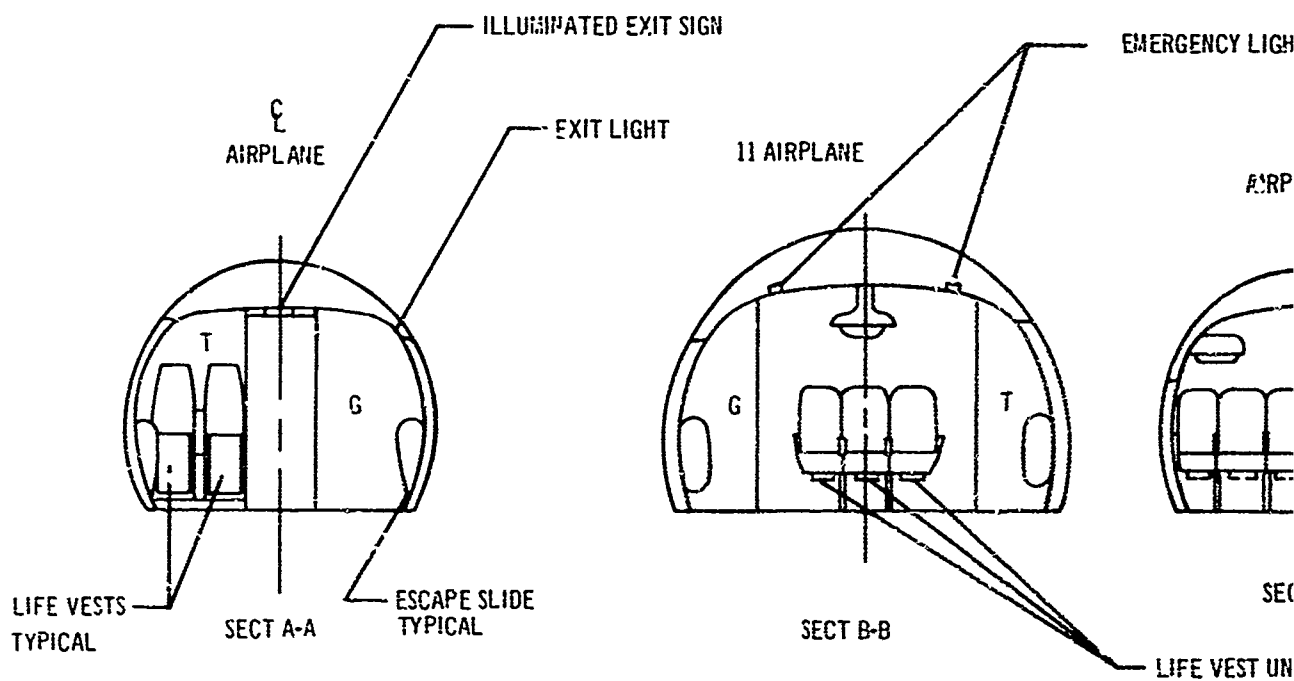
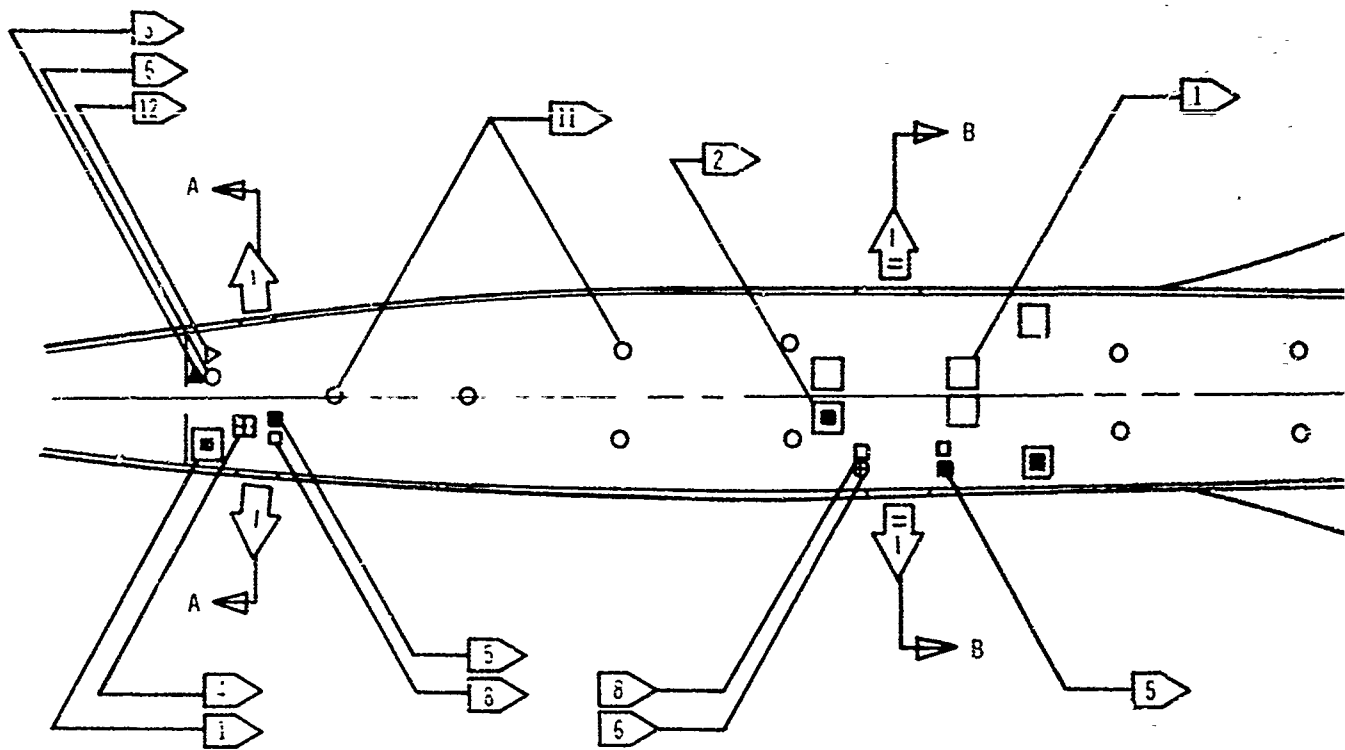
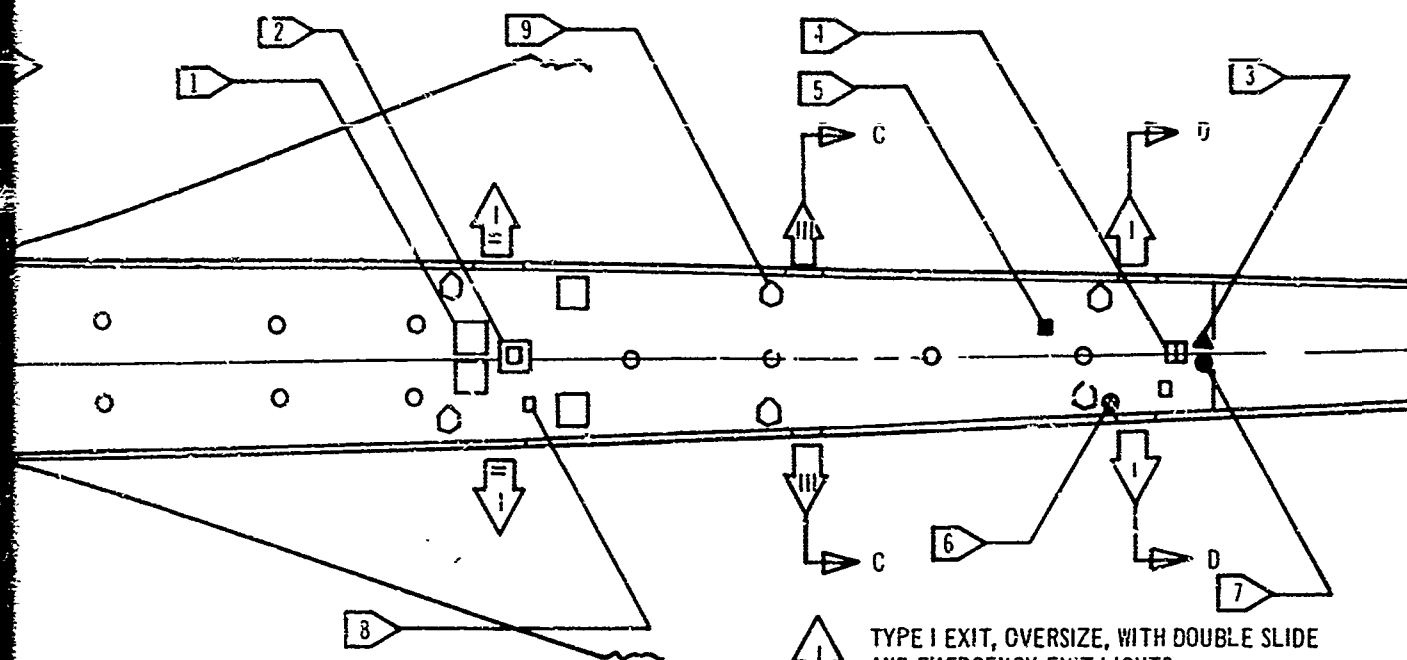


Figure 11-5. Aft Cargo Compartment

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↑ I TYPE I EXIT, OVERSIZE, WITH DOUBLE SLIDE AND EMERGENCY EXIT LIGHTS

↑ I TYPE I EXIT WITH SINGLE SLIDE AND EMERGENCY EXIT LIGHTS

↑ III TYPE III EXIT WITH EMERGENCY EXIT LIGHTS

1 LIFE RAFT 25 MAN

2 AUTOMATIC RADIO BEACON

3 POWERED MEGAPHONE

4 FIRST AID KIT

5 FIRE EXTINGUISHER (H₂O)

6 FIRE EXTINGUISHER DRY CHEMICAL

7 FIRE EXTINGUISHER (CO₂)

8 PORTABLE OXYGEN

9 ESCAPE ROPE

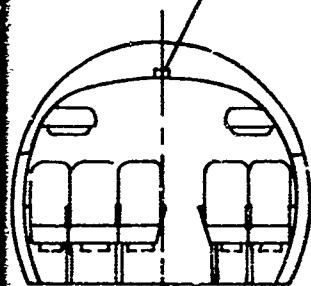
10 SPARE LIFE VESTS

11 EMERGENCY LIGHTS

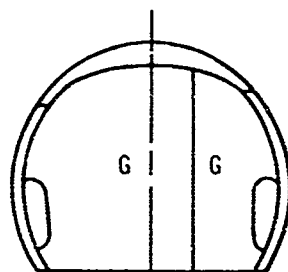
12 FIRE AXE

EMERGENCY LIGHTS

AIRPLANE



SECT C-C



SECT D-D

LIFE VEST UNDER EACH SEAT

Figure 11-6. Emergency Equipment Diagram

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11-19

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12

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SECTION 12 ENVIRONMENTAL CONTROL

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SECTION 12 ENVIRONMENTAL CONTROL

12.1 GENERAL

The cabin air-conditioning and pressure-control systems shall be substantially as shown in Figs. 12-1 and 12-2, respectively. The cabin air source for air conditioning and pressurization during normal cruise operation shall be ram air. During ground operation and descent, engine compressor bleed air may be used and shall be available as an alternate air source during cruise. Compressors driven by the Accessory Drive Systems (Par. 5.11) shall be used to boost the pressure as required.

Anti-icing, antifogging, and windshield rain removal systems shall be installed as defined in Par. 12.7.

Indicated temperature values shall be in degrees Fahrenheit.

SAE AIR 746, or later, shall be used as a guide for the environmental control system, except as superseded by any of the following paragraphs.

12.2 AIR-CONDITIONING SYSTEM DESCRIPTION

Four independent and essentially identical air-conditioning packs shall be installed. Cabin air shall be cooled by using air/air and air/fuel heat exchangers and air-cycle machines. *All cabin-air heat exchangers utilizing fuel shall incorporate a buffer zone between the cabin-air and fuel passages. Remote indication shall be provided in the cockpit for any leakage from the buffer zone. A malfunction in any air-conditioning pack shall not adversely affect the operation of any other.*

It shall be possible to dispatch the airplane with one air-conditioning system inoperative and complete the flight to destination in case of failure of a second air-conditioning system. With one air-conditioning system inoperative, the design cooling capacity of the airplane shall be available, and the ventilation rate shall not be less than 15 cfm per passenger during normal cruise.

The design objective shall be to be able to dispatch the airplane on subsonic flight with two air-conditioning packs inoperative.

12.2.1 Conditioned-Air Distribution

Four temperature zones shall be provided; one for the flight deck and three for the main cabin. A conditioned-air distribution system shall be installed for each zone. A distribution crossover duct shall be installed to ensure air supply to all areas in the event that some air-conditioning packs are not operating.

Individual gasper air outlets shall be provided to supply conditioned air to each passenger seat, each crew seat, and in each lavatory. Minimum air velocity shall be approximately 600 ft/min at a distance of 18 in. from the outlet with all outlets open during ground and flight operations. Outlets shall be adjustable for direction and volume and shall not have objectionable leakage or noise. Directional adjustment shall prevent directing air into adjacent seats.

The design of sidewall riser and overhead distribution-system ducts shall consider corrosion protection and instability and service problems, i.e., splitting, collapsing and melting of nonmetallic ducting materials.

The design of the air-return grill shall minimize the entry of combustible materials into the air-return cavity, and means shall be provided to prevent the propagation of fire within the sidewalls.

Air filters which may be easily cleaned and replaced, shall be provided in the return air system, to prevent accumulation of dust, lint, and other solid combustible material.

Provision shall be made to prevent condensation from dripping into the passenger area from distribution ducts.

For odor control, air from the lavatory compartments and galley areas shall be vented overboard. Ventilation rate of each galley unit shall be at least 32 cfm during cruise. Fixed exhausts shall be provided at the lavatories and shall be muffled or designed to eliminate objectionable noise.

12.2.2 Cabin Temperature Control

Two automatic temperature selectors shall be provided, one for the flight deck and one for the passenger cabin. The selectable temperature range shall be from 65° to 85° F; however, the selector shall read in terms of "increase" or "decrease" temperature. Electrical manual override operation shall be provided for the flight deck and for each cabin zone. The selector shall allow individual selection and trimming of each passenger zone while maintaining automatic temperature control of all passenger cabin zones.

The system shall be designed so that the flight deck and each cabin zone are controlled at the sensed point to within $\pm 2^{\circ}\text{F}$ of the selected temperature. In the event of shutdown of the unit which normally provides environmental control of the flight deck, temperature control in the flight deck shall still be maintained.

12.2.3 Ozone and Radiation Detection

The air-conditioning system shall be designed to limit ozone concentration. Cabin ozone concentration shall not exceed 0.2 parts per million by volume for normal operation, or 0.3 parts per million by volume for short-term duration. An ozone concentration measuring system shall be installed with indication at the flight engineer's station. (See Fig. 6-11). Devices for detecting and monitoring cosmic radiation levels shall be provided, if required by FAR. *The ozone concentration measuring system and the devices for detecting and monitoring cosmic indication levels shall have a means for determining if they are functioning properly. Space for the incorporation of a radioactive debris filter shall be provided for in the basic system design.*

12.2.4 Equipment Cooling

Electronics and electrical equipment areas, wheel wells, and equipment bays shall be cooled by exhaust air from the cabin during flight. Forced air shall be provided for ground cooling of electrical and electronic equipment. (Refer to Par. 10.1.5.)

12.2.5 Ground Connectors

High- and low-pressure air connectors shall be provided.

12.2.5.1 Low-Pressure Connector

The low-pressure connector shall allow conditioned air from a ground unit to be supplied to the airplane distribution system. The connector shall be designed to permit delivering 300 lb/min of conditioned air at an inlet pressure of 2 psi and any temperature from 40° to 120°F .

12.2.5.2 High-Pressure Connector

The high-pressure connector shall allow air to be supplied to the airplane system from a ground unit. The connector shall be designed to permit delivering 244 lb/min of air at 60 psi and at a temperature of 400°F or lower.

Air supplied to the airplane through this connector may also be used to start any engine.

AIR-CONDITIONING PERFORMANCE

The performance specified in Pars. 12.3.1 and 12.3.2 shall be met: for normal airplane operations *throughout* the design atmospheric ambient temperature and humidity envelopes shown in Fig. 12-3 and 12-4, respectively.

12.3.1

Cabin Temperature

Air supplied to either the high- or low-pressure air connectors from a suitable ground unit shall be *capable of cooling the passenger cabin to 85°F in 30 min, starting with a heat-soaked airplane, on a hot day, and with no passengers or operating heat sources in the passenger cabin. Air supplied as stated above shall be capable of heating a cold-soaked airplane from -50°F to 75°F in 30 minutes, with no passengers or operating heat sources in the passenger cabin.*

During ground operation with air supplied to either air connector from a suitable ground unit, the system shall have the capability to cool the flight deck and the cabin to 85°F (75°F effective) with 300 persons in the passenger cabin and to heat these areas to 75°F with 60 persons in the passenger cabin.

During ground operations, with engines at idle power, the system shall have the capability to cool the flight deck and cabin to 75°F (70°F effective) with 300 persons in the passenger cabin and to heat these areas to 80°F with 60 persons in the passenger cabin.

During flight operations with 300 persons in the passenger cabin, the system shall have the capability to cool the flight deck and the passenger cabin to 75°F at sea level and to 70°F at 20,000 ft and above with straight-line variation in temperature at intermediate altitudes. *The system shall have the capability to heat these areas to 80°F at all operating altitudes with 60 persons in the passenger cabin.*

Under stabilized cruise flight conditions, the system shall be capable of controlling the passenger cabin temperature variations within the values shown on Fig. 12-5. The maximum temperature variations apply for a uniformly distributed passenger load in the seated portion of the passenger cabin. Areas immediately adjacent to lavatory and galley facilities are excluded.

It shall be a design objective that the maximum temperature variation shall not exceed $\pm 3^\circ\text{F}$ within the volume of each temperature zone. (See Fig. 12-5.)

The maximum supply steady-state temperature of air entering the cabin from the supply ducts shall not normally exceed 120°F. *Maximum surface temperature of the passenger cabin interior sidewall during normal operation with either 3 or 4 air-conditioning packages operating shall not exceed 100°F. The inner surface temperature of the passenger cabin windows and flight deck windows and windshields shall not exceed 110°F.*

Separate temperature control of cargo compartments shall not be provided; however, during normal cruise operation, the average stabilized compartment temperature shall be not less than 35°F nor more than 85°F. *Air supplied to the forward cargo compartment shall be by infiltration only and shall be adequate for sustaining animal life.*

All temperatures specified in this paragraph are dry-bulb temperatures.

12.3.2 Ventilation

The system shall be capable of supplying 6,000 cu ft/min of fresh air and 6,000 cu ft/min of recirculated air for ventilation of the passenger cabin from sea level to 65,000 ft altitude. From 65,000 ft altitude to the design certification altitude of 73,000 ft, the system shall be capable of supplying 4,500 cu ft/min of fresh air and 4,500 cu ft/min of recirculated air.

The system shall have the additional capability of supplying 375 cu ft/min of fresh air for ventilation of the flight deck.

Air delivered to the cabin during flight, under normal operating conditions, shall contain no objectionable fumes, odors, or toxic gases produced by airplane equipment, including engines, or cargo compartments.

12.4 CABIN PRESSURE SYSTEM DESCRIPTION

The cabin pressure control system shall be substantially as shown in Fig. 12-2.

A variable isobaric controller shall be located on the flight engineer's panel and shall permit selection of automatic control of cabin altitudes from -1,000 to +10,000 ft. (See Fig. 6-11.) A variable rate selector shall permit selecting rate of change of cabin altitude from 50 to 2,000 ft/min. Barometric correction shall be provided. *The system shall be designed to minimize cabin pressure fluctuation associated with transients of air inflow and exhaust, airplane maneuver, and engine power change during ground and flight conditions.*

Valves shall be installed to provide cabin pressure control, vacuum relief, and pressure relief. *Cabin outflow-valve-position indicators shall be provided in the flight deck.*

Override control of each outflow valve shall be provided on the flight engineer's panel. Separate manually actuated valves, in series with each outflow valve, shall permit shutting off airflow through the outflow valves. These valves shall be controlled from the flight engineer's station.

12.5

CABIN PRESSURE SYSTEM PERFORMANCE REQUIREMENTS

The performance specified in this paragraph shall be met for normal airplane operations *throughout* the design atmospheric ambient temperature and humidity *envelopes* shown in Figs. 12-3 and 12-4, respectively.

The cabin pressurization system shall be capable of maintaining a nominal maximum cabin pressure differential of 11.12 psi. This permits maintaining a sea-level cabin altitude to an airplane altitude of 34,300 ft, and a 6,200-ft cabin altitude at the certification altitude of 75,000 ft. *The system shall provide the above pressurization capability during descent from cruise altitude with the engines at idle.* Satisfactory cabin pressurization shall be obtainable with any two engines inoperative.

Cabin pressure relief shall limit the cabin-to-ambient pressure differential to 12.34 psi. Vacuum relief shall limit the negative differential to 1.00 psi. It shall be possible to reduce inflight and on-ground cabin-to-ambient pressure differentials to 0.35 and 0.25 in. of mercury, respectively. A cabin altitude limiter shall be installed to close the outflow valves at 14,000 ft.

The response characteristics of the pressurization-control system shall have the capability of preventing cabin pressure excursions in excess of the rate of change versus time curve shown in Fig. 12-6 unless higher rates of change have been selected by the crew. Under steady-state cruise conditions, no normal change in cabin air inflow or outflow shall change absolute cabin altitude in excess of 50 ft (sea-level equivalent).

With any single failure in the pressurization system combined with the loss of a door seal, loss of a cabin window, or a failure in the pressure vessel, the pressurization system shall have the capability of limiting the cabin altitude to 15,000 feet.

12.6

CONTROLS AND INDICATORS

Controls and indicators for the environmental control system shall be mounted at the flight engineer's station. (See Fig. 6-11.) These shall include the following:

- o Switches to control each conditioning system, the high-pressure manifold system, outflow-valve-override systems, and intrawall exhaust system
- o Temperature controls for the flight deck and main cabin
- o Temperature indication for selective monitoring of cabin supply duct and each passenger compartment zone
- o Position indication for each temperature-control valve
- o Cabin pressure controls for both automatic and manual operation
- o An aural warning device to sound in the flight deck whenever the cabin altitude exceeds a nominal 10,000 ft
- o *Cabin rate of climb*
- o *Differential pressure*
- o *Cabin altimeter*
- o *Outflow-valve-position indicators*
- o *Temperature indication of moisture separator inlet*
- o *Duct supply pressure indicator system.*

12.7

ICING PROTECTION, ANTIFOGGING, AND WINDSHIELD RAIN REMOVAL

12.7.1

Design Conditions

The airplane shall be certificated with an icing-protection system designed to allow safe flight through icing conditions as defined by FAR 25.1419.

12.7.2

Wings, Tail Surfaces, and Radome Anti-Icing

The wings, tail surfaces, and radome shall not be anti-iced.

12.7.3

Engine-Icing Protection

Engine inlet and engine components requiring protection shall be anti-iced by engine bleed air modulated by a flow-regulating device and controlled by a shutoff valve. The system for protecting engine components shall be supplied by the engine manufacturer and shall be integrated with the inlet anti-icing system.

Inlet surfaces protected by the system shall include:

- o Leading edge and inner surface of cowl lip
- o Leading edge of centerbody support struts
- o Forward surfaces of inlet centerbody
- o Inlet air data sensor probes
- o Cowl vortex generators

Engine components to be protected by the engine manufacturer are:

For the 2707 (GE):

- o Inlet guide vanes
- o Bearing support struts

For the 2707 (P&W):

None

Four switches, one for each propulsion pod, shall be provided to control all engine anti-icing system shutoff valves. Means shall be provided to check the functioning of the shutoff valves. The controls and indicators shall be mounted on the pilots' overhead panel. (See Fig. 6-5.)

12.7.4 Air Data Sensors Anti-Icing

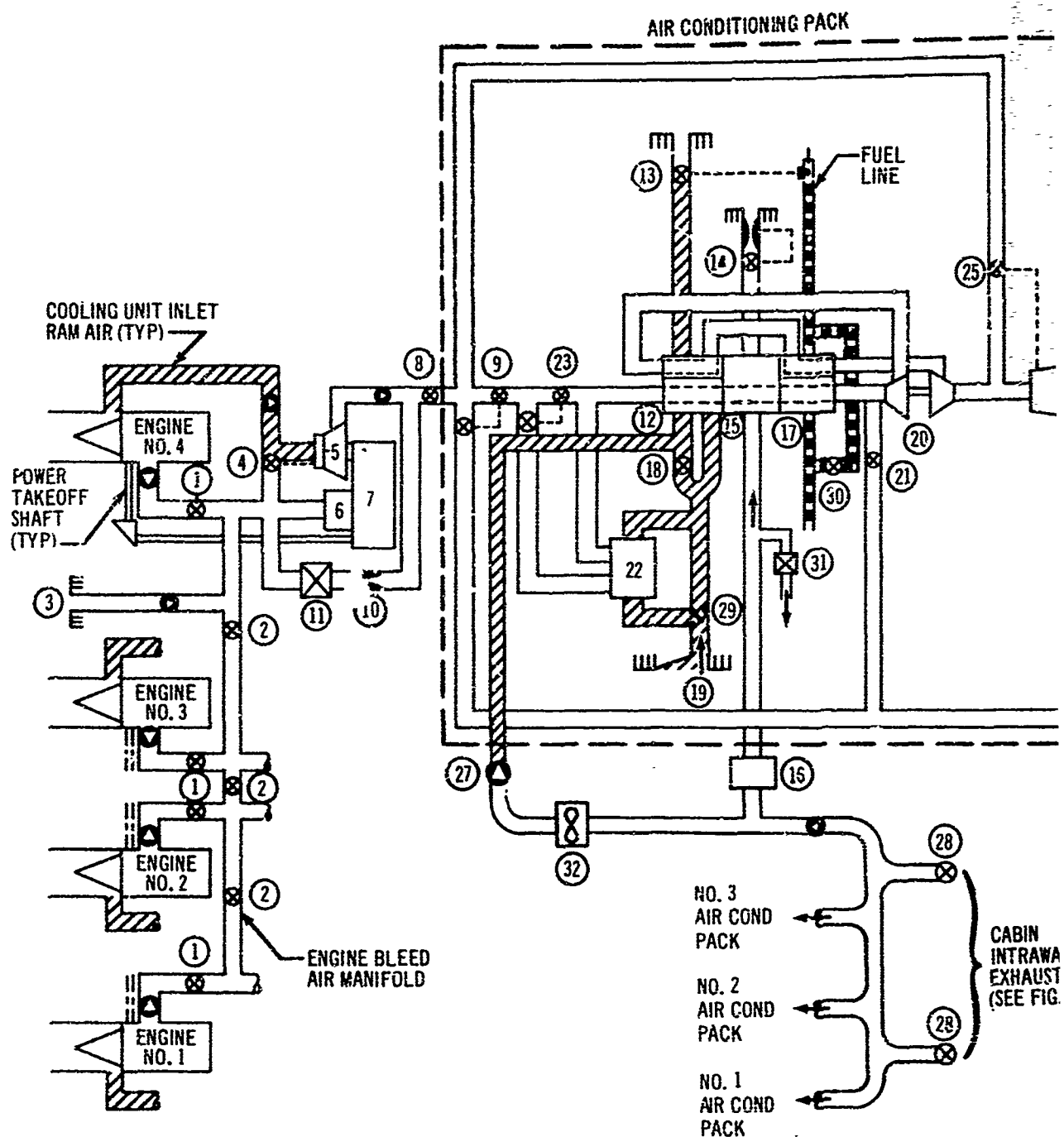
Air data sensors, excepting the secondary flush static ports, shall be electrically heated. Indicators and switches shall be provided for operating control on the pilots' overhead panel. (See Fig. 6-5.)

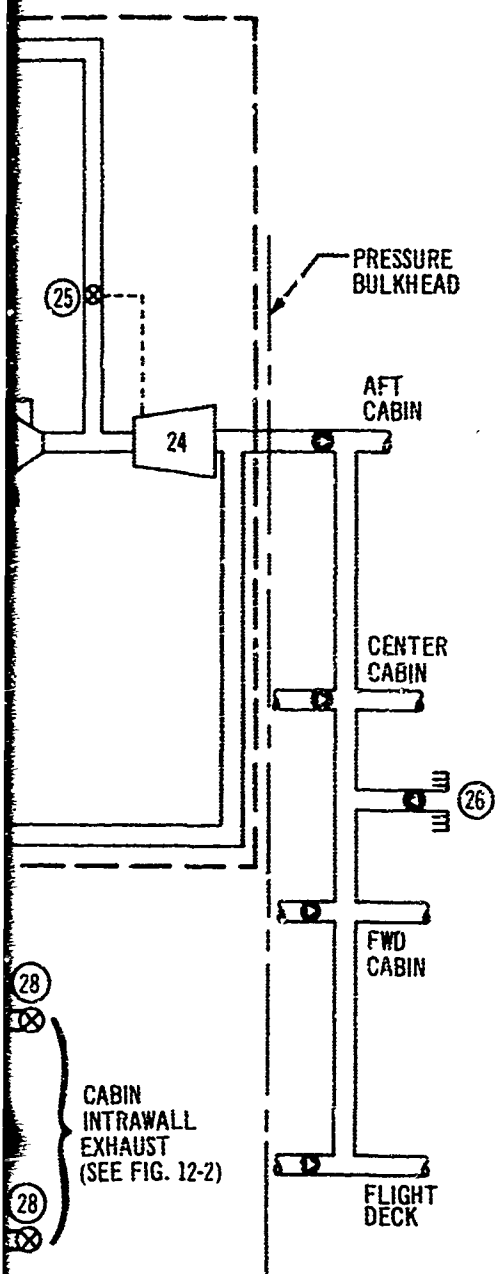
12.7.5 Window Anti-Icing and Antifogging

Flight deck forward windshields shall be heated by electrically conductive coatings for anti-icing and antifogging purposes. The system shall be used to control the inter-layer temperature of the forward windshields to obtain maximum bird impact resistance. Antifogging shall be provided for the three windows on each side of the movable nose. This shall be accomplished by the use of air from the air-conditioning system. Controls and indicators shall be provided on the pilots' overhead panel. (See Fig. 6-5.)

12.7.6 Windshield Rain Removal

Rain shall be removed from the forward windshields by a chemical rain-repellent system augmented, as necessary for static or taxi conditions, by electrically operated windshield wipers. *This system may also be used to clean the forward windshields.* Controls shall be located on the pilots' overhead panel. (See Fig. 6-5.) *A pressure gage shall be provided in the flight deck to indicate repellent system pressure.*





1. EMERGENCY SHUTOFF VALVE
2. BLEED AIR MANIFOLD VALVE
3. HIGH PRESSURE GROUND CONNECTOR
4. BOOST COMPRESSOR BLEED AIR CONTROL VALVE
5. CABIN AIR BOOST COMPRESSOR
6. AIR TURBINE STARTER AND CONTROL VALVE
7. ACCESSORY DRIVE (ADS)
8. AIR CONDITIONING UNIT SHUTOFF VALVE
9. CABIN TEMPERATURE CONTROL VALVE
10. AIR FLOW LIMITER
11. PRESSURE REGULATING SHUTOFF VALVE
12. PRIMARY AND SECONDARY HEAT EXCHANGER, AIR/AIR
13. PRIMARY AND SECONDARY HEAT EXCHANGER COOLANT AIR CONTROL VALVE
14. THRUST RECOVERY CONTROL VALVE
15. REGENERATIVE HEAT EXCHANGER, AIR/AIR
16. ACCESSORY DRIVE SYSTEM HEAT EXCHANGER, OIL/AIR
17. PRIMARY AND SECONDARY HEAT EXCHANGER, AIR/FUEL
18. SECONDARY HEAT EXCHANGER COOLANT AIR SHUTOFF VALVE
19. AMBIENT AIR SCOOP
20. AIR CYCLE MACHINE
21. EMERGENCY DESCENT BYPASS VALVE
22. GROUND COOLANT AIR TURBO FAN
23. TURBO FAN AIR SHUTOFF VALVE
24. MOISTURE SEPARATOR
25. MOISTURE SEPARATOR ANTI-ICE VALVE
26. LOW PRESSURE CONDITIONED AIR CONNECTOR
27. ACCESSORY DRIVE SYSTEM RAM AIR CHECK VALVE
28. INTRAWALL EXHAUST SHUTOFF VALVE
29. TURBO FAN BYPASS AIR SHUTOFF VALVE
30. FUEL BYPASS VALVE - NORMALLY CLOSED
31. BYPASS VALVE
32. ADS HEAT EXCHANGER AMBIENT AIR FAN

 CHECK VALVE
 RAM AIR

Figure 12-1. Air Conditioning System Diagram

D6-17850

12-11
(12-12 BLANK)

2

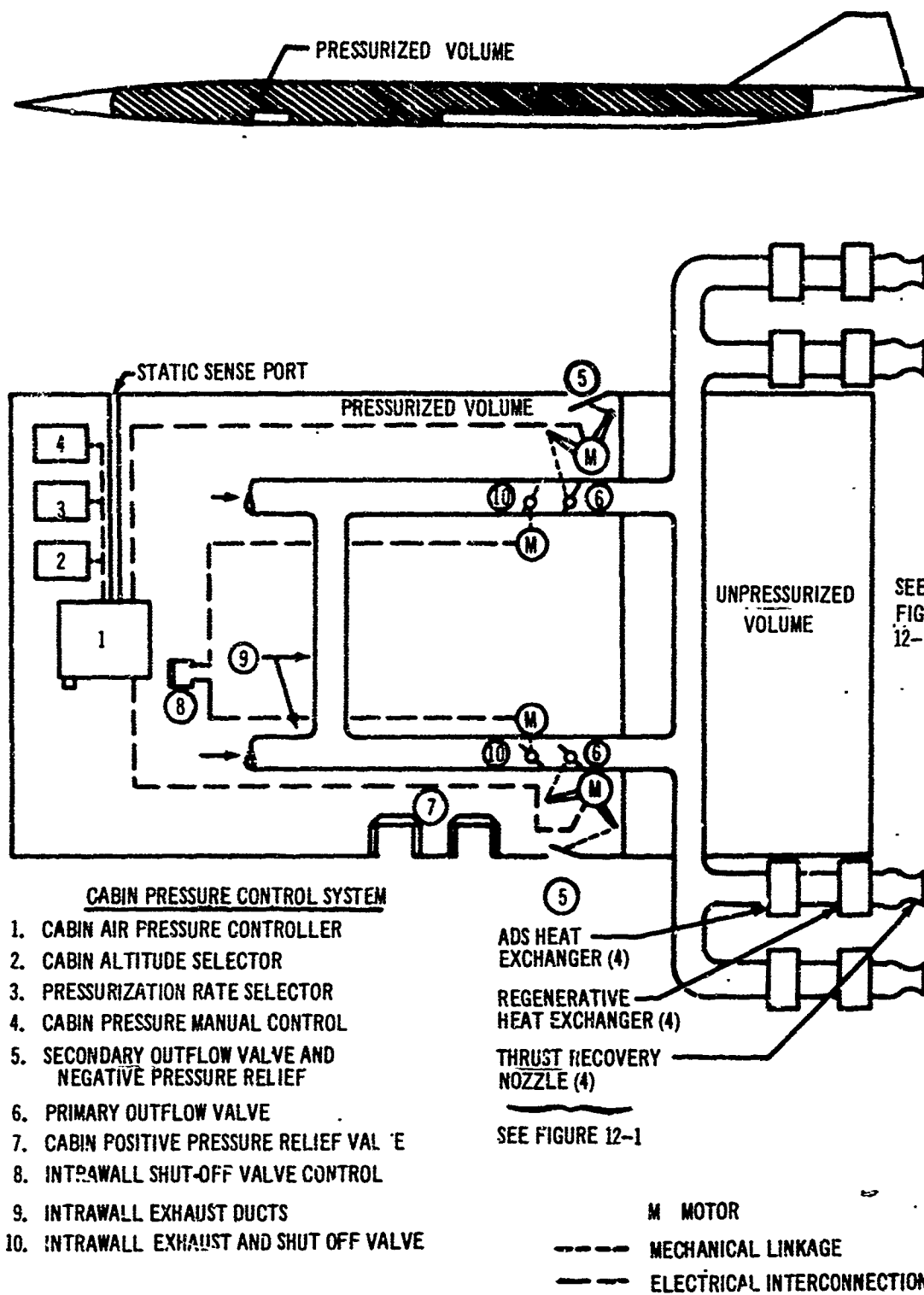


Figure 12-2. Pressure Control System Diagram

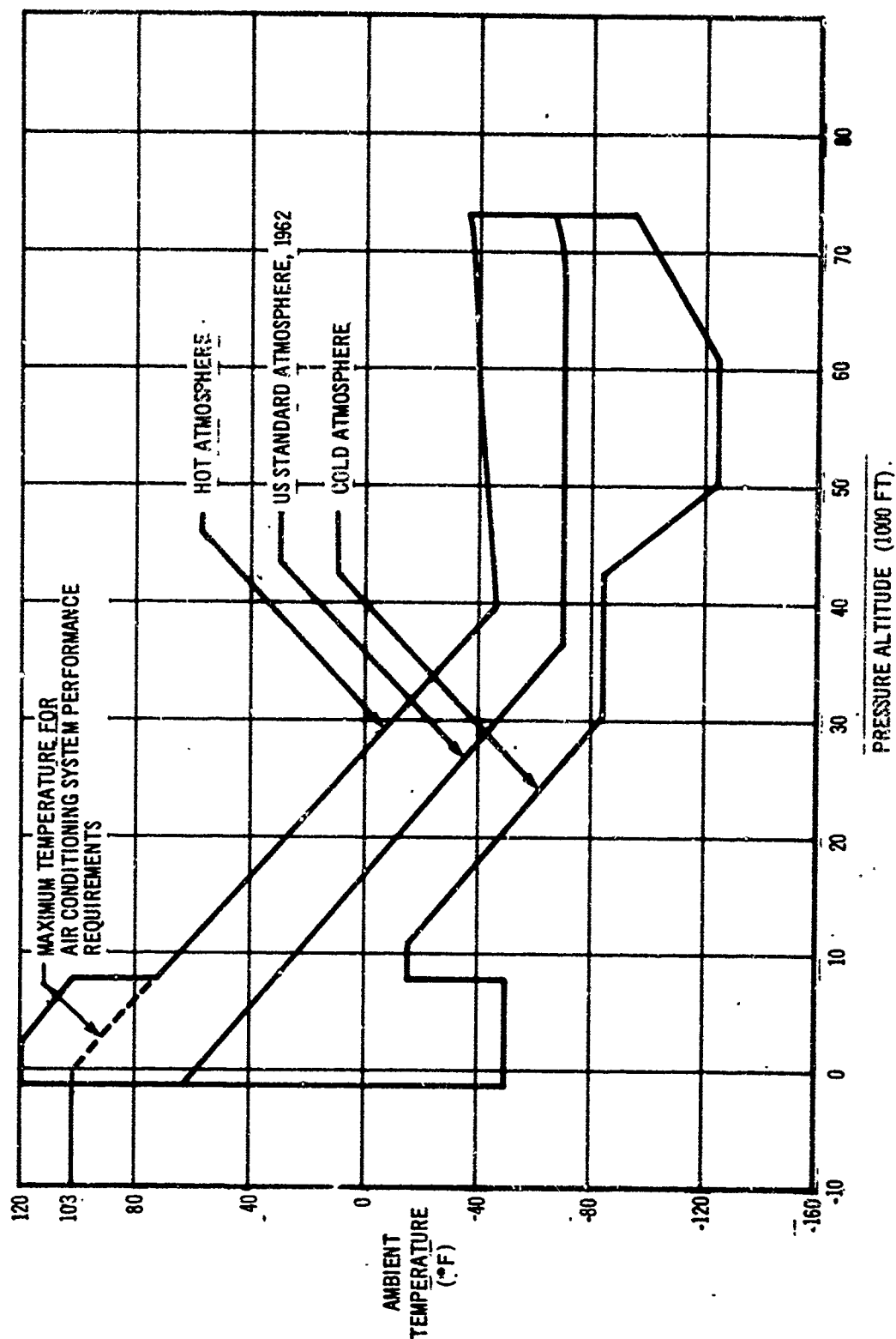


Figure 12-3 Design Ambient Temperature

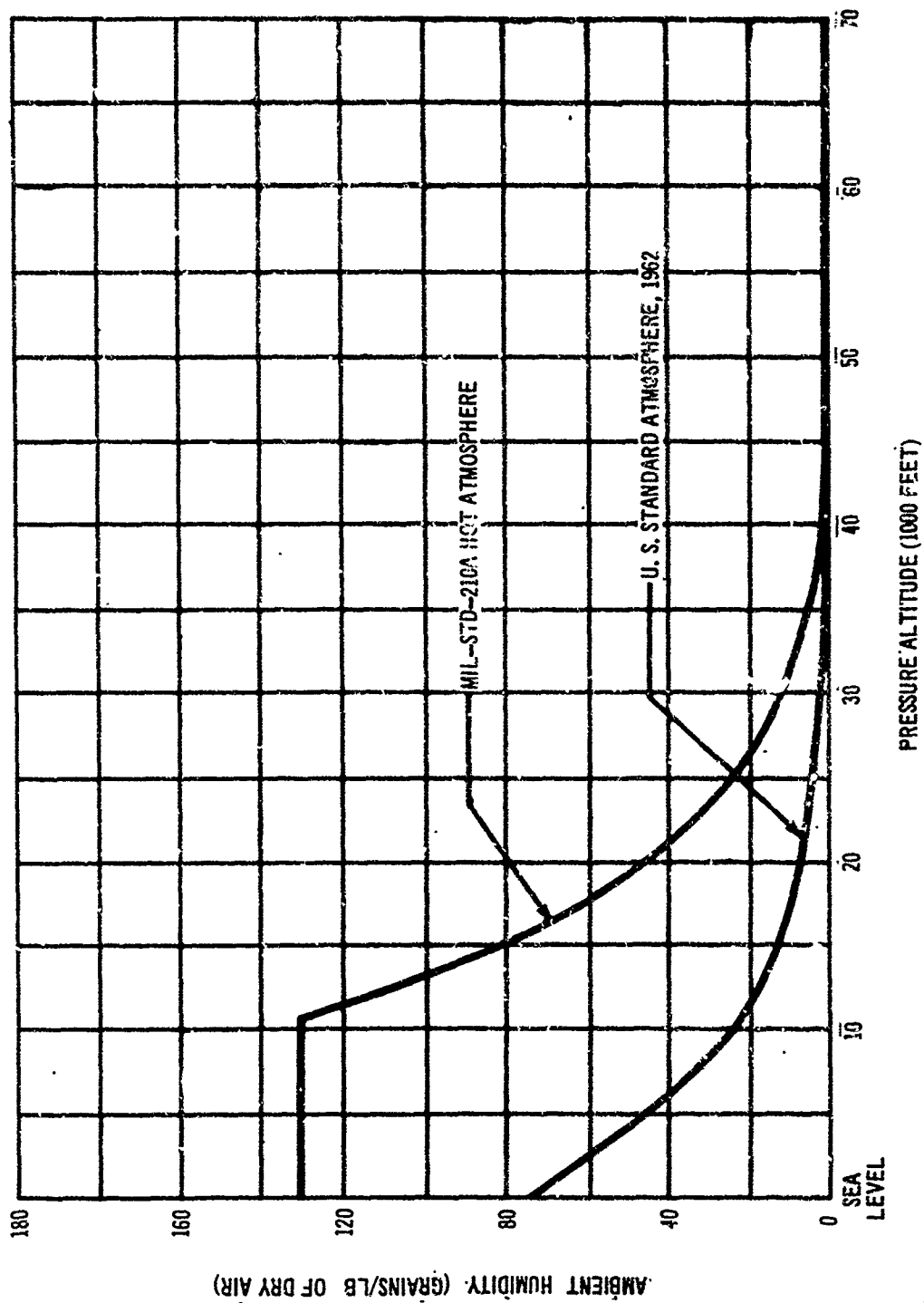


Figure 12-4 Design Humidity Condition

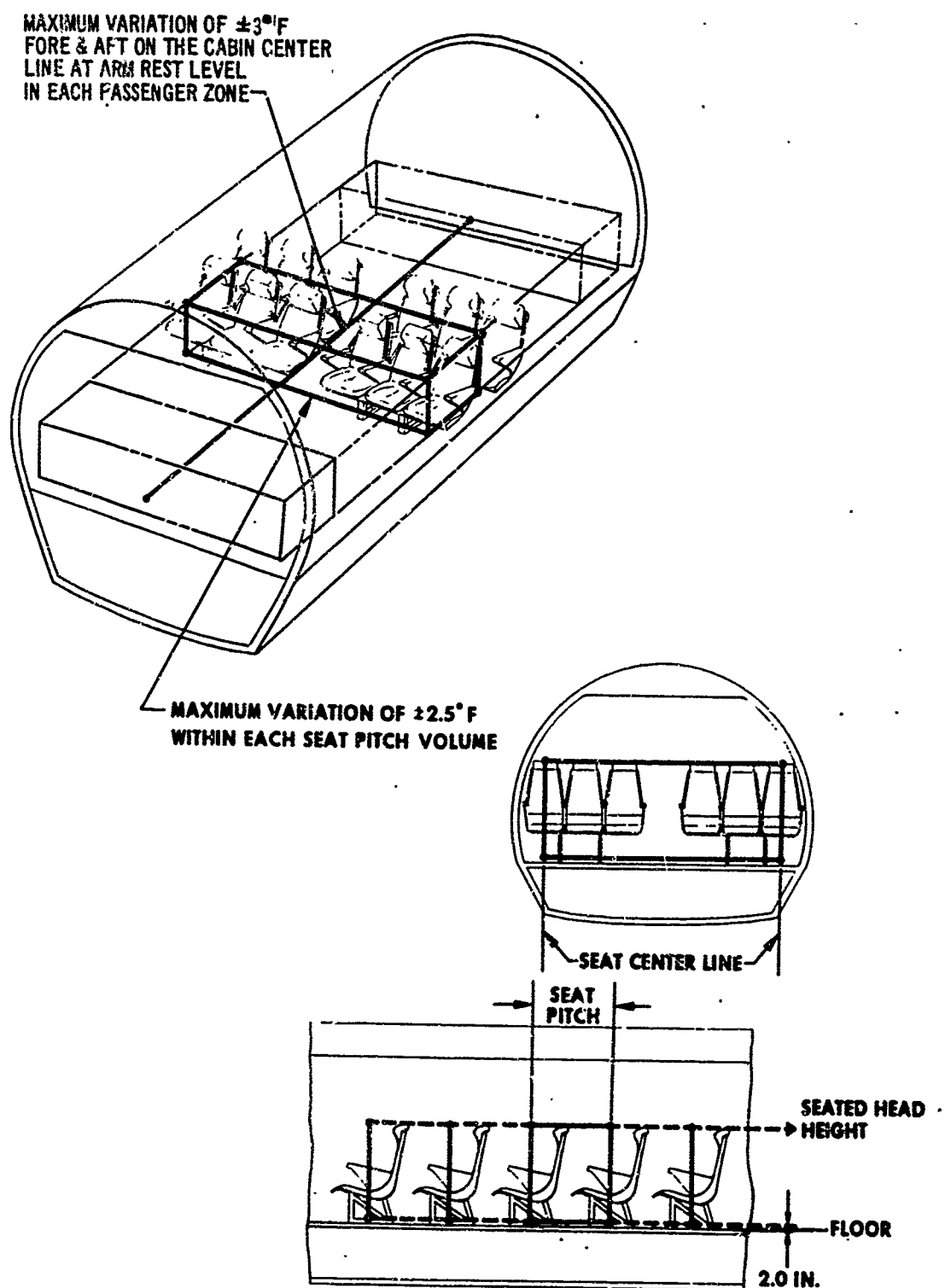


Figure 12-5. Cabin Temperature Variation

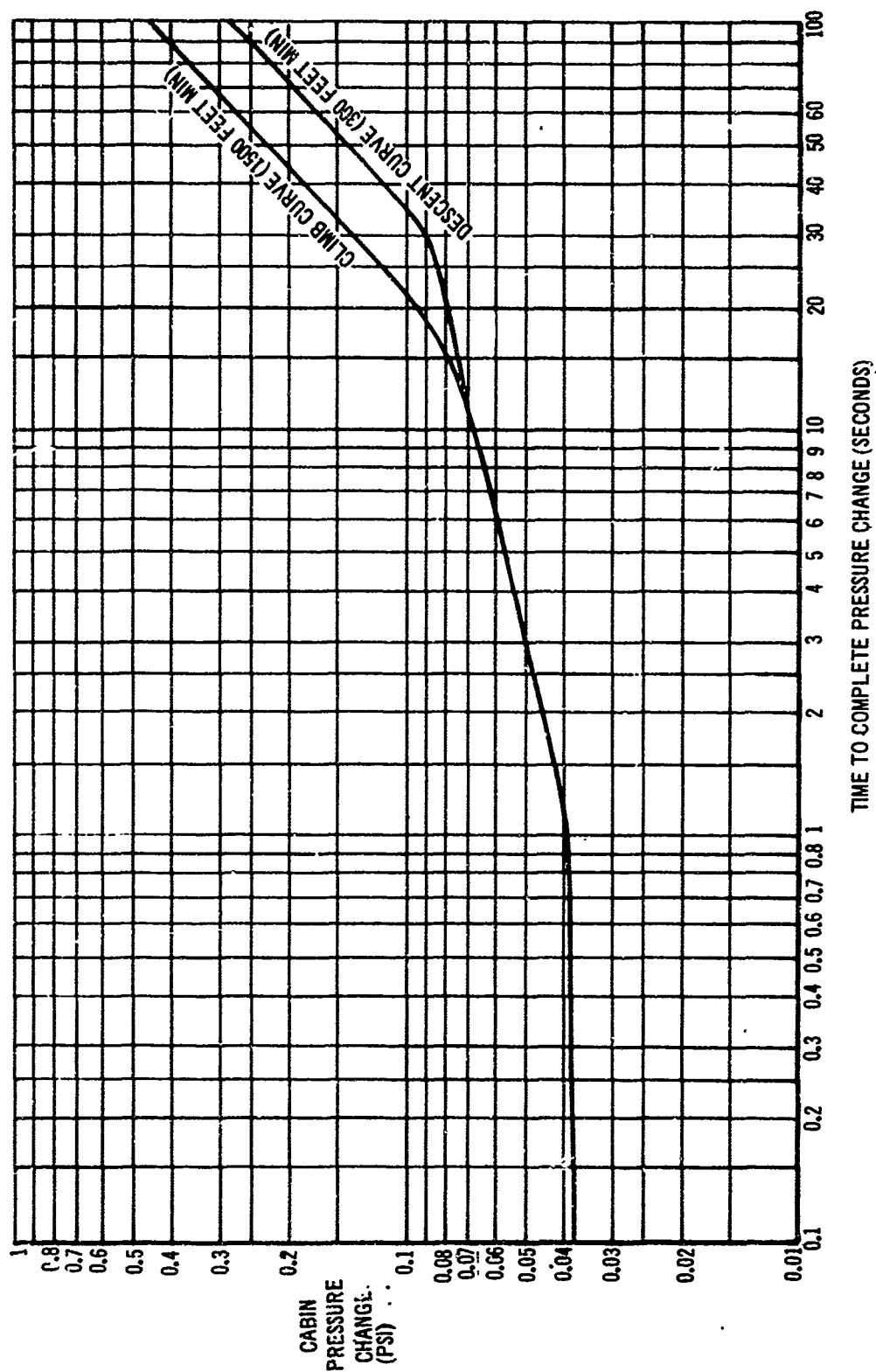


Figure 12-6. Design Limits For Short Duration Cabin Pressure Changes

SECTION 13
MAINTAINABILITY

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SECTION 13 MAINTAINABILITY

13.1 GENERAL

Maintainability shall be a primary consideration in the design of the airplane. It shall be a design objective to include maintainability features that will minimize operating costs attributable to scheduled and unscheduled maintenance and servicing tasks, and that will improve departure reliability and airplane utilization by minimizing the time required to accomplish the maintenance and servicing tasks. Specific maintainability design objectives shall include the following:

- Provide the capability of accomplishing a complete ground handling through-flight service in 30 minutes, including unloading and loading 50 percent of the payload, and a complete ground handling turnaround-flight service in 90 minutes under full-load passenger conditions.
- Support an airplane utilization of 13 block hours per day in commercial airline service. For short-term accelerated peak-load operation, the following additional objectives apply:

No airplane design characteristic shall preclude a through-stop time of 20 minutes, provided a maximum fuel load is not required and unscheduled maintenance does not require more than 20 minutes.

No airplane design characteristic shall preclude a turnaround time of 30 minutes, provided that unscheduled maintenance does not require more than 30 minutes.

No airplane design characteristic or planned maintenance or service activity shall preclude a utilization of 16 block hours per day for short periods.

- Reduce to a minimum the airplane downtime necessary for access, repair, and replacement associated with both scheduled and unscheduled maintenance requirements.
- Minimize maintenance/overhaul costs and ground support equipment requirements.
- Utilize, to the maximum extent possible, ground facilities and items of ground support equipment presently used by the airlines.
- Utilize maintenance personnel skill levels presently utilized by the airlines on subsonic jet transport aircraft in the determination of maintenance and servicing functions and procedures.
- Schedule inspection and servicing functions to coincide with scheduled maintenance operations.

- *Provide for in-place inspection of installed equipment, systems, and primary structural components.*

13.2 ACCESSIBILITY

13.2.1 General

System components shall, wherever practicable, be grouped and located so as to provide adequate accessibility for component replacement, fault isolation, inspection, and servicing and to provide for test and calibration of an individual component without removing that component. Accessibility provisions shall be designed with consideration of the possible necessity to accomplish maintenance operations under the extreme ground ambient environmental conditions defined in Sec. 3. *Identification of major equipment items, relays, and valves shall be by nameplates or other suitable permanent markings.*

Alignment marks shall be installed on all oil-, hydraulic-, and other fluid-carrying tank caps to indicate the position of the servicing caps with respect to the closed and locked position. All caps shall be secured by normal hand operation without the use of special tools. This requirement need not be applied to standard threaded-type caps or to the fuel tank caps.

13.2.2 Access Doors

All removable access doors and inspection panels used during normal maintenance shall be identified on the exterior of each door or panel utilizing the ATA-index numbering system to the maximum extent practicable. All external access doors installed in the fuselage shall be removable from outside the airplane and shall be fastened in a manner to comply with the objectives of Par. 13.1. Access provisions for equipment installed in the wing, empennage, and propulsion pods shall be as specified in applicable sections of this specification.

13.2.3 Instrument and Control Panels

The pilots' main and overhead panels and the flight engineer's panels shall be designed to provide quick access to the rear side of each panel.

13.2.4 Aisle Control Stand

Access to the interior of the aisle control stand shall be provided by quickly removable side panels *designed to prevent accidental entry of the panels into the aisle control stand.*

13.2.5 Wheel Well Access

Provisions shall be made for opening the main and nose landing gear wheel well doors on the ground to facilitate inspection and maintenance. Provision shall also be made to prevent inadvertent closing of these doors.

13.2.6 Cowling

The propulsion pods shall include hinged cowl panels, equipped with quick-disconnect latches to permit access to the engine compartment. (Refer to Par. 5.2.4.) Each cowl panel shall be suitably identified.

13.2.7 Fuel Tanks

Fuel tanks shall be completely accessible through man-sized openings and crawl-ways, no smaller than commercial jet transports of the 1965 era, for interior inspection and maintenance. Except for bladder cells, external fuel tank access doors shall be of clamping type.

13.2.8 Actuators and Control Cables

Adequate access shall be provided for inspection and maintenance of actuators, push-pull rods, and control cables throughout the airplane. Rigging pin holes and/or marks shall be provided to facilitate rigging system valves, actuators, push-pull rods, and cable control systems. Major components shall be replaceable without rerigging the cable systems.

13.2.9 Landing Gear

Access for inspection shall be provided, where practicable, for inside areas of landing gear parts, such as the truck beams.

13.2.10 Wing Pivot Inspection

Means shall be provided to check the wing pivot area without structural disassembly. At intermediate and periodic maintenance checks (at approximately 300- to 1,200-hr intervals), it shall be possible to visually inspect the wing pivot area, including the pivot lug structure and fuel lines, hydraulic lines, and control cables routed through the pivot area, for security and condition and to perform an operational check of the pivot system, if required, in 2 elapsed hours (maximum of 4 manhours labor). This time limit shall include gaining access and close-up of the area. At overhaul periods, at approximately 8,400-hr intervals, it shall not be necessary to disassemble the wing pivot structure for detailed structural

inspection, and it shall not be necessary to disassemble all pivot bearing assemblies for wear determination. A method of inspection shall be provided to determine the condition of the bearing assembly. This inspection shall identify whether bearing replacement is required or not and whether the bearing assembly is in a satisfactory condition to operate properly until the next scheduled inspection period.

It shall be a design objective that the elapsed time required to replace the upper or lower pivot bearing assemblies on one wing shall not exceed 8 elapsed hours and labor manhours shall not exceed 50.

13.3 SERVICING

13.3.1 General

Servicing functions shall, wherever practicable, be accomplished without removal of access doors or panels. All servicing receptacles (except engine oil, hydraulic fluid, and oxygen replenishing provision) shall be located on the underside of the airplane to provide visual and manipulative access. All system gauges checked during a routine preflight walk-around inspection shall be installed on the underside of the airplane to facilitate inspection.

13.3.2 Service Markings

Permanent nameplates indicating types of fluids, volumes, and/or pressures shall be provided on hydraulic fluid, engine oil, and potable water tanks, landing gear oleos, and all units that have fluid service requirements for lubrication or operation of the unit or accessory. Markings for nameplates and component part numbers shall be photo-etched, engraved, cast, or steel stamped and shall be in the applicable units of weight and measures specified in Par. 2.11. Permanent identification shall be provided at service points for potable water, oxygen, fuel, oil, and hydraulic systems and for other systems requiring servicing.

13.3.3 Maintenance Markings

High-temperature-resistant markings shall be applied to external surfaces of the airplane for identification of major body and wing stations, walkways, access doors, inspection panels, and servicing points.

All gas and fluid lines shall be labeled in accordance with AN or MS standards. The markings shall be able to withstand operating environmental conditions and shall indicate the direction of flow and the purpose of the line. The part

number of each tube assembly shall be identified on each part. In addition, check and relief valves associated with these fluid lines shall be identified with markings, adjacent to the valves, to show valve type and flow direction. Fuel check valves shall be designed to preclude reversed installation.

Suitable markings shall be provided to distinguish between similar components mounted adjacent to each other. System isolation features shall be clearly identified. *All maintenance markings and part numbers shall be readable in the installed position.*

13.3.4 Lubrication

Scheduled lubrication frequencies shall be specified to coincide with the accomplishment of scheduled maintenance checks. All lubrication fittings shall be designed *and be readily accessible* for use with standard aircraft-lubrication equipment. Lubrication channels shall be provided on bushing-type bearings. *Adequate and accessible means shall be provided on landing gears to permit lubrication without jacking the airplane.*

13.3.5 Cleaning

It shall be possible to clean the exterior and interior surfaces of the airplane with approved, commercially available cleaning agents.

13.4 SYSTEM TESTING AND CHECKOUT

A test and checkout capability shall be provided for performance monitoring, failure detection, and fault isolation where such installed capability proves to be economically advantageous. This capability shall be developed for all operating components of the airplane, utilizing flight deck instrumentation and equipment checkout provisions, for airline preflight and maintenance operations. Appropriate ground test points shall be provided to facilitate monitoring of system and component condition with the objective of on-condition system/component replacement or repair. Provisions for additional airborne system test equipment shall be as specified in Par. 10.8.

13.5 GROUND HANDLING

13.5.1 Towing, Jacking, and Hoisting

Provisions for towing and jacking the airplane, and for hoisting into position and handling of assemblies or

components of the airplane, shall be as specified in Par. 4.1.

13.5.2 Leveling

Visual leveling indicators shall be provided for rapid determination of airplane lateral and longitudinal attitudes when parked.

13.5.3 Weighing

The airplane shall be designed to permit the use of standard-type weighing devices.

13.5.4 Alignment Points

Points shall be provided to permit alignment checking of the airframe. *Alignment points shall be readily identifiable.*

SECTION 14
STANDARD PARTS, INTERCHANGEABILITY, AND REPLACEABILITY

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SECTION 14
STANDARD PARTS, INTERCHANGEABILITY, AND REPLACEABILITY

14.1 STANDARD PARTS

AN, AS, and NAS standard parts, including rivets, bolts, screws, nuts, fittings, bearings, etc., shall be used wherever practicable. Boeing commercial standard parts or other commercial parts may be used at the option of the Seller. *The use of Boeing standard parts shall be held to a minimum.*

14.2 INTERCHANGEABILITY

14.2.1 Definitions

The term "interchangeability" is defined as that quality which will allow a part to substitute or be substituted for a part of the same part-number designation and meet all physical, functional, and structural requirements and be installed by the application of attaching means only (bolts, nuts, screws, washers, pins, etc.). This specifically precludes the need for trimming, cutting, filing, reaming, drilling, shimming, and forming during installation. No tools other than those normally available to service mechanics are required for installation of the item. No operation or alterations except designed adjustments are required on supporting and surrounding structure in order to install the item.

Jacking shall be employed as required to ensure alignment and to prevent forcing when conducting interchangeability coordination checks. Jacking shall be confined to the limits established by the jacking procedures for the airplane.

NOTE: Interchangeability of assemblies does not necessarily mean that the *structural* components thereof are interchangeable.

The term "replaceability-interchangeability to attach points only" is defined as that quality which will allow a part to substitute or be substituted for a part of the same part-number designation and meet all physical, functional, and structural requirements and requires only the application of attaching means (bolts, nuts, screws, washers, pins, etc.) and only minor trim of the item to suit surrounding structure. This specifically excludes drilling and/or reaming of attach points during installation. It allows use of adjustment operations such as shimming, drilling, and/or reaming of other than attach points, cutting, sawing, filing, etc. No tools other than those normally available to service mechanics are required for installation of the item.

NOTE: "Minor trim" is defined as removal of a minimum of excess periphery material, which can be accomplished in less than 1 hr per linear foot of trim by use of hand held tools.

14.2.2 *List of Interchangeable and Replaceable-Interchangeable Items*

Interchangeability shall be limited to the items listed below, except as specific additions are noted to meet individual airline customer requirements. Items followed by an asterisk are replaceable-interchangeable.

Structure

- *Wing tips**
- *Flaps*
- *Leading-edge devices*
- *Spoilers*
- *Wing pivot bearing assembly*
- *Outer wing structural assembly*
- *Ailerons*
- *Flap tracks*
- *Leading-edge slats*
- *Elevators*
- *Auxiliary elevators*
- *Elevon tips**
- *Elevons*
- *Rudder*
- *Nose gear assembly (and all major components)*
- *Main gear assembly (and all major components)*
- *Main landing gear axles*
- *Nose landing gear axle*
- *Nose-section windows*
- *Movable-body nose section**
- *Flight deck windshields, side windows, and passenger cabin windows*
- *Fuel-tank access doors*
- *Landing gear doors (nose and main)**
- *Fuselage tail cone**
- *All exterior cargo doors*, entry doors*, service doors*, heater, and air-conditioning doors**
- *Ventral fin skid**

Propulsion

- *Propulsion pod assembly, including engines and engine accessories*
- *Cowling and cowl panels*
- *Propulsion pod inlets*
- *Bladder fuel cells*

Flight Deck

- Aisle control stand assembly (all major components to be interchangeable or replaceable)
- *Flight deck instrument and control panels*
- *Crew seats*
- *Control columns and rudder pedals*

Passenger Cabin and Cargo Compartments

- *Passenger water tank*
- *Toilet tanks and lids*
- *Window shades*
- *Passenger cabin floor panels*
- *Passenger cabin movable partitions, bulkheads, and interior personnel doors*
- *Crew and passenger seat cushions and covers-seat back and bottom*
- *Passenger seats*
- *Passenger service units (except location legend)*
- *Webbing*
- *Tiedowns*
- *All parts required to be installed or removed to convert the interior arrangement to any of the configurations listed in this specification, i.e., galleys (by position only), bulkheads (by position only), etc.*

Controls, Electronics, etc.

- *Radome*
- *Control system components, such as bellcranks, levers, cables, and push-pull rods*
- *Hydraulic tanks and system accessories*
- *Landing light assembly*

14.3 REPLACEABILITY

14.3.1 Definition

The term "replaceability" is defined as that quality which will allow a part to substitute or be substituted for a part of the same part-number designation and meet all physical, functional, and structural requirements, but which may require operations in addition to the attaching means. Such operations may be performed by the use of handtools normally available to service mechanics and will not normally include those for which special equipment is required, such as spotwelding, heat treating, etc.

14.3.2 *List of Replaceable Items*

Replaceability shall be limited to the items listed below, except as specific additions are noted to meet individual airline customer requirements:

Structure

- *Wing leading edges*
- *Wing leading-edge access panels*
- *Wing fillets*
- *Maintenance access doors*
- *Vertical fin tip*
- *Vertical fin leading edge*
- *Stabilizer leading edges*
- *Propulsion pod/stabilizer fairings*
- *Ventral fin*
- *Towing lugs*

Interior

- *Passenger entry, galley, and cargo-door scuff plates*
- *Passenger cabin interior items*
- *Flight deck interior items*

Access and inspection panels whose replacement can be accomplished with the use of standard-gage sheet metal without forming or assembling are not listed in this section.

APPENDIX I

EQUIPMENT

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GENERAL NOTES

This appendix lists selected major items of equipment used on the airplane(s) described in this document.

The Seller reserves the right to substantiate equivalent equipment and/or accessories in lieu of those specified herein whenever such substitution is necessary to prevent delay in installation or delivery, improve the product, or meet the requirements of the FAA.

As stated in the introduction to this Specification, such equipment items as passenger seats, galleys, electronics equipment, and emergency equipment, which normally are Buyer-Furnished Equipment (BFE), are included as Seller-Furnished Equipment (SFE) in this appendix.

A. SELLER-FURNISHED EQUIPMENT

1. AIRPLANE STRUCTURES

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>MAIN LANDING GEAR</u>				
1	16	Tire, Tubeless, 45.5x18.7-19, 28-Ply Rating, 225 mph, Type VIII		
2	16	Brake Assembly (Including Heat Shields and Cooling Fans)		
3	16	Wheel Assembly, 19-in. Rim		
<u>NOSE LANDING GEAR</u>				
4	2	Tire, Tubeless, 34x16-14, 26-Ply Rating, 225 mph, Type VIII		
5	2	Wheel Assembly, 14-in. Rim		
<u>ANTISKID BRAKE SYSTEM</u>				
6	1	System, Brake, Antiskid		

A. SELLER-FURNISHED EQUIPMENT (Continued)

2. PROPULSION

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>PROPULSION</u>				
1	4	Inlet Assembly, including inlet control system		
2	4	System, Fire Protection		
3	4	System, Fire Detection		
4	4	Extinguisher Bottle, Fire (Bromotrifluoromethane)		
5	19	Pump, Fuel Boost		
6	4	Cowling, Engine		
7	4	Starter, Air Turbine, includ- ing starter valve assembly		
<u>For the 2707 (GE):</u>				
8	4	Engine and Exhaust System, including the following accessories: Control Unit, Fuel Pumps, Fuel Heat Exchanger, Engine Oil/ Fuel Heat Exchanger, Engine Hyd. Oil/Fuel Pumps, Oil, Engine Control Alternator Ignition Units Inlet and Engine Anti- Icing Components Tank, Engine Oil Pumps, Inlet and Exhaust Systems Control	GE	
<u>For the 2707 (P&W):</u>				
	4	Engine and Exhaust System, including the following accessories: Control Unit, Fuel Pumps, Fuel Heat Exchanger, Engine Oil/ Fuel Tank, Engine Oil	P&WA	

A. SELLER-FURNISHED EQUIPMENT (Continued)

2. PROPULSION (Continued)

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
------	----------	-------------	------	----------------------

For the 2707 (P&WA) (Continued)

Pumps, Engine Oil
Pumps, Inlet and Exhaust
Systems Control
Ignition Units
Inlet Anti-Icing System
Components

ACCESSORY DRIVE SYSTEM

1	4	System, Accessory Drive, including accessory drive gear box, disconnect coup- ling, drive shaft, and engine-mounted gear box		
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2	4	Heat Exchanger (Triple Unit), ADS Oil/Air, Generator Oil/Air, Cabin Boost Compressor Oil/Air		
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PROPULSION SYSTEM INSTRUMENTS

3	4	Indicator, Thrust		
4	4	Indicator, Engine Oil Quantity		
5	4	Indicator, Engine Oil Temperature		

6	4	Indicator, Engine Oil Pressure		
7	4	Indicator Light, Thrust Reverser Position and Warning		

8	4	Indicator, Engine Vibration		
9	4	Indicator, Engine EGT		
10	4	Indicator Light, Fire Warning		
11	4	Indicator Light, Fire Exting- uisher Discharge		
12	1	Indicator, Total Fuel		
13	8	Indicator, Fuel Tank Quantity		
14	4	Indicator, Fuel Flow Rate		
15	4	Indicator, Fuel Consumed		
16	2	Indicator, Fuel Temperature		
17	4	Indicator, Engine Inlet % Pressure Recovery		

A. SELLER-FURNISHED EQUIPMENT (Continued)

2. PROPULSION (Continued)

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>PROPULSION SYSTEM INSTRUMENTS (Continued)</u>				
1	4	Indicator, Engine Exhaust Nozzle Area		
2	4	Indicator, Engine Inlet Shock Position		
3	4	Indicator and Control, Engine Inlet Centerbody Position		
4	4	Indicator and Control, Engine Inlet Bypass Position		
5	4	Indicator Light, Low Oil Pressure Warning		
6	1	Indicator Light, Oil Filter Differential Pressure Warning		
7	4	Indicator Light, Windmilling Brake "ON"		
8	4	Indicator, Hydraulic Oil Quantity		
9	4	Indicator, Temperature, ADS Oil		
10	4	Indicator, Pressure, ADS Oil		
<u>For the 2707 (GE):</u>				
11	4	Indicator Light, Turbine Cooling Valve "Open"		
12	4	Indicator Light, Nozzle Cooling Valve "Open"		
13	4	Indicator, Engine % RPM		
<u>For the 2707 (P&W):</u>				
14	8	Indicator, Engine % RPM		

A. SELLER-FURNISHED EQUIPMENT (Continued)

3. FLIGHT DECK

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
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INSTRUMENTS

General

1	1	Annunciator, Brake Antiskid		
2	2	Clock, 3-in., 12-hr.		
3	1	Clock, 2-in., 12-hr.		
4	1	Display, Wing Sweep and Flap Position		
5	1	Display, Control Surfaces Position		
6	1	System Annunciator, Pilots'		
7	1	Indicator, Landing Gear and Doors		
8	1	Annunciator, Landing Gear Retraction Fault		
9	1	Annunciator, Pressurized Cabin Doors		

MISCELLANEOUS EQUIPMENT

10	2	Shaker, Control Column		
11	2	Sensor, Angle-of-Attack		
12	2	Transducer, Flap Position		
13	2	Transmitter, Wing Sweep		

CONTROL CABIN FURNISHINGS

14	1	Seat, Captain		
15	1	Seat, First Officer		
16	1	Seat, Flight Engineer		
17	2	Seat, Observer		

EMERGENCY EQUIPMENT

18	2	Rope, Escape		
19	1	Bottle, Oxygen, Portable		
20	1	Axe, Crash		
21	1	Kit, First Aid		
22	1 pr	Gloves, Asbestos		
23	1	CO ₂ Extinguisher, Fire		
24	5	Mask, Oxygen, Oronasal-Type with Regulator		
25	5	Jacket, Life		
26	5 pr	Goggles, Smoke		
27	2	Cylinder, Gaseous Oxygen, 1850 psi		

A. SELLER-FURNISHED EQUIPMENT (Continued)

4. FLIGHT CONTROLS

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>AUTOMATIC FLIGHT CONTROL SYSTEM</u>				
1	1	System, Autopilot (Triple Channel)		
2	1	System, Stability Augmentation (Triple Channel Roll; Four-Channel, Pitch and Yaw)		
3	1	System, Electric Command (Triple Channel)		
4	1	System, Autothrottle (Dual Channel)		

A. SELLER-FURNISHED EQUIPMENT (Continued)

5. HYDRAULIC POWER SYSTEM

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>HYDRAULIC EQUIPMENT</u>				
1	8	Pump, ADS Driven		
2	1	Pump, Electric-Motor Driven		
3	1	Pump, Hydraulic-Motor Driven		
4	6	Heat Exchanger, Hydraulic (Fluid/Fuel)		
5	3	Heat Exchanger, Hydraulic Fluid/Air		
6	4	Reservoir, Hydraulic Fluid		
<u>HYDRAULIC SYSTEM INSTRUMENTS (MAIN)</u>				
7	3	Indicator, Hydraulic Oil Pressure		
8	4	Indicator, Hydraulic Oil Quantity		
9	1	Indicator, Hydraulic Oil Temperature		
10	1	Indicator, Hydraulic Brake Pressure		
11	1	Indicator, Hydraulic Reservoir Pressure		

A. SELLER-FURNISHED EQUIPMENT (Continued)

6. ELECTRIC POWER SYSTEM

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>ELECTRICAL EQUIPMENT</u>				
1	4	Generator, Variable Frequency		
2	4	Frequency Converter, 400-cps, 115/200 vac		
3	4	Filter, 60 kva		
4	6	Transformer-Rectifier Unit, DC Power		
5	4	Control Unit Assembly, Generator		
6	1	28-vdc Battery, Normal		
7	1	Standby Power Assembly, (Including Inverter and Battery Charger)		
8	1	28-vdc Standby Power Source		
9	4	Distribution Unit, Main Power		
10	1	Distribution Unit, Forward Power		
<u>ELECTRICAL SYSTEM INSTRUMENTS</u>				
11	1	Multi-Voltmeter (ac and dc)		
12	4	Ammeter (ac)		
13	1	Ammeter (dc)		
14	1	Indicator, Generator Temperatures		
15	1	Ammeter (ac), Ground Power		

A. SELLER-FURNISHED EQUIPMENT (Continued)

7. ELECTRONICS

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>ENROUTE NAVIGATION</u>				
<u>Inertial System</u>				
1	3	Inertial Navigation Unit		
2	3	Display Panel		
3	3	Control Unit		
4	1	Switching Unit		
5	2	Converter Unit		
6	3	Battery		
7	1	Interface Box		
8	2	Magnetic Azimuth Detector (with Compensator)		
<u>Weather Radar System</u>				
9	1	Receiver-Transmitter		
10	1	Control Unit, Panel		
11	1	Antenna (with Waveguide Assembly)		
12	2	Display Indicator		
13	1	Radome		
<u>FLIGHT INSTRUMENTATION</u>				
<u>Integrated Flight Control Instrument System</u>				
14	1	Control Unit, Instrument Warning System		
15	1	Display Unit, Instrument Warning System		
16	2	Annunciator, Approach Progress		
17	2	Indicator, Attitude Director		
18	1	Indicator Standby Attitude		
19	2	Indicator, Horizontal Situation		
20	1	Interface Box, Flight Instrument		
21	2	Indicator, Radio Magnetic		

A. SELLER-FURNISHED EQUIPMENT (Continued)

7. ELECTRONICS (Continued)

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>FLIGHT INSTRUMENTATION (Continued)</u>				
<u>Air Data System</u>				
1	2	Computer Unit		
2	2	Probe, Total Temperature		
3	1	Probe, Pitot-Static, Dual		
4	2	Probe, Pitot		
5	3	Ports, Static		
6	1	Interface Box, Air Data,		
7	2	Computer, Air Data		
8	1	Primary-Alternate Pitot- Static Selector		
9	2	Indicator, Radio Altitude/ Vertical Speed		
10	2	Indicator, Airspeed/Mach/ Air Temperature		
11	1	Indicator, True Airspeed		
12	2	Indicator, Pressure Altitude		
<u>TERMINAL NAVIGATION</u>				
<u>Automatic Direction Finder (ADF)</u>				
13	2	Receiver		
14	2	Control Panel		
15	2	Antenna Assembly, Loop		
16	2	Coupler		
17	2	Quadrantal Corrector		
18	2	Antenna Assembly, Sense		
<u>Radio Altimeter System</u>				
19	2	Transceiver		
20	4	Antenna		
<u>VOR/LOC, Glideslope</u>				
21	2	Receiver, VOR/LOC/GS		
22	2	Antenna, VOR/Localizer		
23	1	Antenna, Glideslope (Dual)		
24	1	Interface Box, Navigation		
25	2	Control Panel, VOR/LOC/GS/ DME/VHF Communications		

A. SELLER-FURNISHED EQUIPMENT (Continued)

7. ELECTRONICS (Continued)

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC NO.
<u>DISTANCE MEASURING EQUIPMENT</u>				
1	2	Interrogator		
2	2	Antenna		
<u>Marker Beacon</u>				
3	1	Receiver		
4	1	Antenna		
<u>SHORT RANGE COMMUNICATION</u>				
<u>VHF Communications</u>				
5	2	Transceiver		
6	2	Antenna, VHF		
7	1	Control Panel (Combined with VOR/LOC)		
<u>ATC Transponder</u>				
8	2	Transponder		
9	1	Control Panel		
10	2	Antenna		
<u>Interphone System</u>				
11	1	Amplifier		
12	4	Audio Select Panel		
13	2	Speaker, Flight Deck		
14	1	Audio Control Center		
15	Req'd	Handset		
16	4	Boom, Microphone and Earphones		
<u>Passenger Address</u>				
17	2	Amplifier		
18	5	Control Panel		
19	1	Tape Reproducer, Music		
20	60	Loudspeaker, (8-inch) Passenger Cabin		
21	Req'd	Loudspeaker, (5-inch) Lavatory and Galley		
22	2	Microphone		

A. SELLER-FURNISHED EQUIPMENT (Continued)

7. ELECTRONICS (Continued)

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>LONG RANGE COMMUNICATION</u>				
<u>HF Communications</u>				
1	2	Transceiver		
2	2	Tuning Coupler, Antenna		
3	2	Coupler Control, Antenna		
4	2	Antenna		
5	1	Switching Feedthrough Unit, Antenna		
6	2	Control Panel		
7	1	Interface Box		
<u>Selective Calling System</u>				
8	1	Decoder, Dual Channel		
9	1	Chime		
10	1	Control Panel		
<u>RECORDER SYSTEMS</u>				
<u>Flight Data Recorder System</u>				
11	1	Recorder Unit		
12	1	Accessory Unit		
13	1	Accelerometer		
14	1	Control Panel Unit		
<u>Flight Deck Voice Recorder</u>				
15	1	Recording Unit, Voice (Including Tape Assembly)		
16	1	Microphone/Monitor Panel		

A. SELLER-FURNISHED EQUIPMENT (Continued)

8. PASSENGER PROVISIONS

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>PASSENGER CABIN</u>				
1	32	Seat, Triple, Tourist Class		
2	14	Seat, Double, First Class		
3	78	Seat, Double, Tourist Class		
4	280	Belt, Passenger Seat		
5	5	Seat, Double, Attendant		
6	10	Harness, Attendant Seat		
7	6	Galley (Including Service Equipment)		
8	6	Compartment, Lavatory		
9	124	Service Unit, Passenger		
10	1	Tank, Water		
11	26	Tray, Plug-in Food		
<u>OVERSEAS EMERGENCY EQUIPMENT</u>				
12	12	Raft, Life, 25-man		
13	4	Emergency Beacon, Automatic		
14	306	Vest, Life, Adult		
15	*	Vest, Life, Child		
16	*	Flotation Gear, Infant		
<u>EMERGENCY EQUIPMENT</u>				
17	40	Cylinder, Passenger and Attendant, Portable (Including Chemical Oxygen and Mask)		
18	1	CO2 Extinguisher, Fire		
19	3	Water Extinguisher, Fire		
20	3	Fire Extinguisher, Dry Chemical		
21	2	Megaphone		
22	4	Slide (Single), Escape		
23	4	Slide (Double), Escape		
24	2	Axe, Crash		
25	2	Kit, First Aid		
26	6	Rope, Escape		

* Quantity per customer's requirements

A. SELLER-FURNISHED EQUIPMENT (Continued)

9. ENVIRONMENTAL CONTROL

ITEM	QUANTITY	DESCRIPTION	MAKE	PART OR SPEC. NO.
<u>CABIN AIR</u>				
1	4	Compressor, Air Boost		
2	4	Air Cycle Machine		
3	4	Heat Exchanger, Primary, Air/Air (Regenerative)		
4	4	Heat Exchanger, Primary, Air/Air		
5	4	Heat Exchanger, Secondary, Air/Air		
6	4	Heat Exchanger, Primary, Air/Fuel		
7	4	Heat Exchanger, Secondary, Air/Fuel		
8	1	Pressure Controller, Automatic/Manual		
9	1	Temperature Selector, Flight Deck		
10	1	Temperature Selector, Passenger Cabin		
<u>ANTI-ICE AND RAIN PROTECTION</u>				
11	4	System, Engine Anti-ice		
12	2	System, Windshield, Anti-ice and Antifogging		
13	2	System, Windshield Rain Repellent		
14	1	System, Windshield Wiper		
<u>ENVIRONMENTAL CONTROL INSTRUMENTS</u>				
15	2	Indicator, Oxygen Pressure		
16	2	Indicator, Temperature, Quadruple		
17	1	Indicator, Ozone Concentration		
18	1	Indicator, Cabin Rate of Climb		
19	1	Indicator, Cabin Altitude		
20	1	Indicator, Cabin Differential Pressure		
21	4	Indicator, Air Pressure		
22	1	Indicator, Start Manifold Pressure		
23	14	Indicator, Valve Position		
24	8	Indicator, Fuel Heat Exchanger Buffer Zone		

A. SELLER-FURNISHED EQUIPMENT (Continued)

9. ENVIRONMENTAL CONTROL (Continued)

ITEM	QUANTITY	DESCRIPTION	MAKE	PART SPEC. NO.
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ENVIRONMENTAL CONTROL INSTRUMENTS (Continued)

1	2	Indicator, Pressure, Rain Repellant System		
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APPENDIX II
MANUFACTURER'S EMPTY WEIGHT ALLOWANCES

The weight allowances for certain items included in the Manufacturer's Empty Weight specified in Section 3 are subject to variation. These items are listed below:

PROPULSION

Engines (4)

<u>For the 2707 (GE):</u>	
General Electric GE4/JSP	44,950 lb
<u>For the 2707 (P&W):</u>	
Pratt & Whitney Aircraft JTF-17A-21B	42,560 lb

NOTE:

In the event that the timing of production airplane contract signing is such that the prototype engine program has provided verification of the production engine weights, the above items will be deleted.

APPENDIX III

STANDARD OPTIONS FOR THE 2707 AIRPLANE

The airplane price contained in any Boeing proposal or agreement with respect to the airplane described by this Model Specification does not reflect the incorporation of any of the options set forth in this Appendix III unless otherwise noted.

The following pages describe the optional features available.

Each page of this Appendix is numbered to indicate the section of the Model Specification appropriate to the options described therein. Within each section, the option items are numbered serially.

The appropriate specification language and the effects on the Estimated Weight Empty and the Estimated Operating Weight Empty shall be developed during Phase III or during negotiation with the Buyer of the details of the option.

Additional options will be developed during Phase III and subsequent phases and will be added to this Appendix.

Standard Option 4.1

Periscopic Sestant Mount

Install a periscopic sestant mount and an adjustable stool in the flight deck. No sighting window will be provided.

Standard Option 5.1

Auxiliary Power Unit

Install an APU, operable on the ground only, to supply:

- Pneumatic power for starting
- Pneumatic power for air conditioning

Standard Option 5.2

Inerting System-Full Time

Install a full-time fuel tank inerting system to automatically provide an inert atmosphere in the vapor space of all fuel tanks and vent passages.

Standard Option 5.3

Fuel Consumed and Rate Meters-Calibration in Kilograms

Provide engine fuel consumed and rate meters calibrated in kilograms of fuel per hour in lieu of meters calibrated in pounds.

Standard Option 5.4

Fuel Quantity Gages-Calibration in Kilograms

Provide fuel quantity gages calibrated in kilograms of fuel in lieu of quantity gages calibrated in pounds.

Standard Option 5.5

Fuel Shut-Off Valve

Install a supplemental mechanically operated fuel shut-off valve in addition to the basic electrically operated shut-off valve.

Standard Option 5.6

(Deleted)

Standard Option 5.7

Engine Zone Temperature Indication

Install flight deck indication and sensors in the propulsion pod to indicate temperature in the cavity surrounding the engine controls and accessories.

Standard Option 6.1

Flight Crew Instrument and Control Panels

Arrangement of the instruments on the captain's and first officer's panels will conform to the Buyer's individual requirement consistent with space and depth limitations.

The Buyer's selection of options will govern variations in arrangement of instruments and modules on the other flight deck panels.

Standard Option 6.2

Third Altimeter

Install a third altimeter on the pilots' main instrument panel.

Standard Option 6.3

Weight and Balance Indicator

Install a STAN weight and balance indicating system.

Standard Option 6.4

Automated Preflight Checklist

Provide an automated preflight checklist system.

Standard Option 6.5

Overhead Panel Switch Orientation

Switch positions on overhead panel oriented to Buyer's individual requirements.

Standard Option 6.6

Valuables Locker

Provide a valuables locker complete with hasp.

Standard Option 6.7

Yaw Indication

Provide a yaw indication system.

Standard Option 6.8

Captain's Seat-Lateral Adjustment Power Drive

Install power drive for lateral adjustment of the captain's seat.

Standard Option 6.9

First Officer's Seat-Lateral Adjustment Power Drive

Install power drive for lateral adjustment of the first officer's seat.

Standard Option 6.10

Flight Engineer's Seat-Lateral Adjustment Power Drive

Install power drive for lateral adjustment of the flight engineer's seat.

Standard Option 6.11

Observers' Seats-Floor Mounted

Install floor-mounted observers' seats in lieu of side-mounted foldable seats.

Standard Option 6.12

Time-To-Next-Checkpoint Indicator

Install a time-to-next-checkpoint indicator on the pilots' main panels.

Standard Option 6.13

Body Pitot Probes

Replace body pitot probes with compensated pitot-static probes.

Standard Option 9.1

Second External Electrical Power Connector

Install second external electrical power connector to permit complete functional check of airplane systems.

Standard Option 10.1

Aircraft Integrated Data System

Install an aircraft integrated data system (AIDS) to monitor and record selected airplane subsystem-performance parameters.

Standard Option 10.2

Third VHF Antenna

Install a third VHF antenna and coaxial transmission line to the equipment rack.

Standard Option 10.3

Third VHF Communication System

Install a third VHF transceiver and associated controls.

Standard Option 10.4

LORAN

Install a LORAN system including receiver and associated controls. The LORAN will use the No. 2 ADF sense antenna.

Standard Option 10.5

Third Air Data Computer

Install a third air data computer.

Standard Option 10.6

(Deleted)

Standard Option 10.7

Independent Switching of Attitude and Heading Between Inertial Platforms

Install independent switching of attitude and heading between inertial platforms.

Standard Option 10.8

Digital Altitude Indicator

Install a five-digit, digital counter altitude indicator referenced to the selected barometric setting.

Standard Option 11.1

Cargo Container System-Forward Compartment

Install a complete cargo container system in the forward cargo compartment. The system will include a self-contained container-handling system and the containers.

Standard Option 11.2

Cargo Container System-Aft Compartment

Install a complete cargo container system in the aft cargo compartment. The system will include a self-contained container-handling system and the containers.

Standard Option 11.3

Installation of Galley No. 2 in Lieu of Seats

Remove seats, carpet, hutchbacks, and associated passenger services at galley position No. 2. Install galley and connect to electrical and water supply.

Standard Option 11.4

Installation of Galley No. 5 in Lieu of Seats

Remove seats, carpet, hatracks, and associated passenger services at galley position No. 5. Install galley and connect to electrical water supply.

Standard Option 11.5

Installation of Galley No. 6 in Lieu of Seats

Remove seats, carpet, hatracks, and associated passenger services at galley position No. 6. Install galley and connect to electrical and water supply.

Standard Option 11.6

Installation of Seats in Lieu of Galley No. 3

Remove Galley No. 3. Install carpet, seats, hatracks and associated passenger services.

Standard Option 11.7

Installation of Seats in Lieu of Galley No. 4

Remove Galley No. 4. Install carpet, seats, hatracks, and associated passenger services.

Standard Option 11.8

Installation of Seats in Lieu of Galley No. 7

Remove Galley No. 7. Install carpet, seats, hatracks, and associated passenger services.

Standard Option 11.9

Installation of Additional Mid-Cabin Toilet

Remove passenger seat, hatrack and associated passenger service located immediately ahead of mid-cabin toilets and replace with additional toilet compartment module.

Standard Option 11.10

Installation of Toilet in Lieu of Coat Closet

Remove forward left-hand coat closet and replace with toilet compartment module.

Standard Option 11.11

Installation of Coat Closets in Lieu of Seats

Install plug-in coat closet (either 20-in. or 40-in.) in lieu of seats at any location.

Standard Option 11.12

Installation of Additional Passenger Address Speakers

Install passenger address speakers at the galley and attendants' stations. The adjacent speaker will be deactivated when a call is originated from that station.

Standard Option 11.13

Two-Position Galley Exhaust System

Install two-position high- and low-flow overboard exhaust to control galley exhaust airflow.

Standard Option 11.14

Replaceable Filters in Galley Vent System

Install a replaceable filter in each galley vent system.

Standard Option 11.15

Visual Entertainment System

Install a visual entertainment system for showing motion pictures. The projection will be by use of small hatrack-mounted television monitor units. Sound will be through use of individual Buyer-furnished passenger headsets.

Standard Option 11.16

Provisions for Visual Entertainment System

Install provisions for the visual entertainment system described in Option 11.15. Provisions will include wiring, space for reproduction equipment, and television monitor units.

Standard Option 11.17

Stereo Music Entertainment System

Install a 10-channel stereo music entertainment system including tape reproducer and amplifiers. Individual headsets to be Buyer-furnished. One channel is to be reserved for use with a visual entertainment system and one channel for boarding music through the passenger-address system.

Standard Option 11.18

Provisions for Stereo Music Entertainment System

Install provisions for the music entertainment system described in Option 11.17. Provisions will include wiring and space for reproducer and amplifiers.

Standard Option 11.19

Underseat Stowage

Install stowage container under each passenger seat for passenger personal items.

Standard Option 11.20

Buyer-Furnished Seats in Lieu of Seller-Furnished Seats

Install Buyer-furnished seats in lieu of Seller-furnished seats.

Standard Option 11.21

Buyer-Furnished Lifejackets in Lieu of Seller-Furnished Lifejackets

Install Buyer-furnished lifejackets in lieu of Seller-furnished lifejackets.

Standard Option 11.22

Buyer-Furnished Liferrafts in Lieu of Seller-Furnished Liferrafts

Install Buyer-furnished liferafts in lieu of Seller-furnished liferafts.

Standard Option 11.23

(Deleted)

Standard Option 11.24

Shaver Outlets

Install one 28-vdc outlet in lieu of one 115 vdc outlet.

Standard Option 12.1

Cabin Pressure Controller

Install a cabin pressure controller providing automatically maintained preselectable cabin pressure scheduled for cruise flight and landing.

SUPPLEMENT 1
PROTOTYPE SPECIFICATION

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INTRODUCTION

This supplement describes the Boeing Model 2707 preproduction prototype supersonic transport.

The 2707 supersonic transport prototype is designed to demonstrate the feasibility of the production supersonic transport as a commercial passenger/cargo airplane. It is further intended that the design of the 2707 prototype be as similar as practical to that of the initial commercial production aircraft. The 2707 supersonic transport prototype design and test program includes the following specific objectives:

- Confirm that airline standards of safety, economics, and reliability are attainable
- Provide a base for developing production tooling, fabrication methods, and an assembly plan that will optimize production schedules and minimize costs
- Demonstrate airplane performance, flight characteristics, systems, and structural capabilities to representatives of the U.S. Government, airlines, airport operators, and financial agencies
- Provide means to further improve and develop SST technology, safety, economics, and equipment
- Provide a base for developing an efficient supplier program for airplane component and equipment items
- Utilize Boeing subsonic commercial jet airplane experience and SST technology available in the United States, where appropriate, in SST design
- Provide a base for developing ground servicing, maintenance, operation, and training requirements

To provide a representative test airplane, the preproduction prototype is designed to have the same aerodynamic configuration and physical size as the basic production airplanes. Preflight rating test (PFRT) engines of the type planned for production installation will be used on the prototype. *The 2707 prototype shall be capable of being flown, starting from a maximum taxi weight of 675,000 lbs. with reduced load factors, in order to demonstrate characteristics of the production airplane.*

The prototype airplane will be capable of flying at a maximum operating Mach number (M_{MO}) of 2.7 and total stagnation temperature of 500°F for a sufficient period of time to establish steady-state temperature conditions. The foregoing maximum operating Mach number and total stagnation temperature are the same as those required for the production aircraft. All systems described will be evaluated during the 100-hr flight program, although certain items may not be installed and/or operable for a specific flight. The airplane configuration for any specific flight shall be separately documented. The test equipment to be installed

in the prototype airplane for the flight-test program and the test plan shall be separately documented.

Changes from approved specifications in order to maintain schedule, performance, or cost will be governed by established configuration management procedures.

The definition of the preproduction prototype airplane contained in this supplement has been prepared in the form of a change list in order to provide a compact summary of the differences between the production and prototype airplanes.

Entries in this supplement are identified by the same section and paragraph number under which each subject item appears in the basic portion of Model Specification D6-17850. Where no entry is made in this Supplement for a specific paragraph of the basic Model Specification, the entire paragraph shall be applicable to the prototype airplane. Where any portion of any section or paragraph of the basic Model Specification is inapplicable to the prototype airplane, this section or paragraph is replaced, revised, or deleted. Deletion of a principal section or paragraph heading shall include deletion of all subparagraphs thereunder without individual notation of deletion for each subparagraph.

SECTION 1
GENERAL AIRPLANE DESCRIPTION

1.2 TYPE AND PURPOSE

Change to read:

The airplane shall be a preproduction prototype of a four-engine, land-based, supersonic airplane for commercial transportation of passengers and cargo. The airplane shall, within practical and economic limits, be representative of the initial production airplane and suitable for supporting the certification of the production airplane.

1.3 SELLER'S NAME AND MODEL NUMBER

Change to read:

Boeing Model 2707 Prototype.

1.4.1 Structural Design Weights

Change to read:

For the 2707 (GE):

Maximum Design Taxi Weight	635,000 lb
Maximum Design Flight Weight (Flaps Up)	627,000 lb
Maximum Design Landing Weight	425,000 lb
Maximum Zero Fuel Weight	359,100 lb

For the 2707 (P&W):

Maximum Design Taxi Weight	635,000 lb
Maximum Design Flight Weight (Flaps Up)	627,000 lb
Maximum Design Landing Weight	415,000 lb
Maximum Zero Fuel Weight	357,220 lb

1.4.2 Delete

1.5.1 Crew

Change to read:

Captain
First Officer
Flight Engineer
Observer (2)
Cabin Attendant (1)
Flight Test Observers (As Required)

1.5.2 Passengers (Basic Intercontinental Arrangement)

Change to read:

Passengers
Accommodations for approximately 50 passengers shall be
provided.

SECTION 2
GENERAL REQUIREMENTS

2.1 PURCHASE AGREEMENT GOVERNS

Change to read:

CONTRACT GOVERNS

In the event of any conflict or discrepancy between this specification and the contract, the terms in the contract shall govern.

2.2.2 Supplemental Specifications

Add the following:

• Subsystem Specifications

The following subsystem specifications apply to the prototype airplane:

- D6A10078-1 Starting Subsystem Specification
- D6A10089-1 Accessory Drive Subsystem Specification
- D6A10090-1 Aircraft Integrated Data Subsystem Specification
- D6A10107-1 Airframe Subsystem Specification
- D6A10108-1 Landing Gear Subsystem Specification
- D6A10109-1 Flight Deck Subsystem Specification
- D6A10110-1 Passenger & Cargo Accommodations Subsystem Specification
- D6A10111-1 Propulsion Performance Specification (General Electric)
- D6A10112-1 Propulsion Performance Specification (Pratt & Whitney)
- D6A10113-1 Aircraft Engine Installation Subsystem Specification
- D6A10114-1 Air Induction Subsystem Specification
- D6A10115-1 Fire Detection & Extinguishing Subsystem Specification
- D6A10116-1 Fuel Subsystem Specification
- D6A10117-1 Engine Inlet Anti-Icing Subsystem Specification
- D6A10118-1 Air Induction Control Subsystem Specification
- D6A10119-1 Electrical Power Subsystem Specification
- D6A10120-1 Flight Controls & Hydraulics Subsystem Specification
- D6A10121-1 Environmental Control Subsystem Specification
- D6A10122-1 Communications/Navigation/Radar Subsystem Specification

2.3.1 General

Change to read:

It shall be the intent to design the prototype airplane in conformance with FAR 25, insofar as practicable. (Refer to Par. 3.1.) During the prototype supersonic transport program, continuous liaison with the FAA shall be maintained to develop rule changes to and interpretation of FAR 25 as supplemented by the Tentative Airworthiness Standards for Supersonic Transports, dated November 1, 1965. Although certification of the prototype for commercial operations is not contemplated, substantiating data shall be accumulated and coordinated with the FAA to obtain certification of the production 2707 in the most efficient manner.

2.3.2 Delete

2.4 AIRPLANE SPECIFICATION CHANGES

Change to read:

Changes that are variations from the airplane described in this specification shall be defined and processed as outlined in V5-B2707-1, Configuration Management Plan.

2.4.1 Delete

2.4.2 Delete

2.4.3 Delete

2.4.4 Delete

2.4.5 Delete

2.5 WORKMANSHIP, MATERIALS, AND METHODS

Change to read:

Workmanship, materials, and methods, substantially in accordance with the Seller's standard for airplanes of the transport category, shall be used in the construction of the aircraft.

2.6 INSPECTION AND TESTS

Change to read:

An accurate and complete system of inspection covering all materials, fabrication methods, and finished parts shall be

maintained by Boeing. Inspection and testing of materials or parts shall be in accordance with procedures established by Boeing.

2.7 Delete

2.9 MOCKUPS

Change to read:

Mockups requested by the Procuring Agency, which are additional to those required by the Seller, may be constructed by the Seller when agreed to by change order to the contract or by separate written agreement between the Procuring Agency and Seller.

2.10 BUYER-FURNISHED EQUIPMENT

Change to read:

EQUIPMENT FURNISHED BY PROCURING AGENCY

The contract defines the obligations of the Procuring Agency and Seller concerning equipment to be furnished by the Procuring Agency for installation in the airplane. Refer to App. I.B for a listing of such equipment.

2.12.1 Seller's Name

Change to read:

The Seller's name, model number, and exterior markings shall be displayed on the outside of the airplane.

2.13 CERTIFICATE OR SANITARY CONSTRUCTION

Change to read:

The requirements set forth in Public Health Service Bulletin 308 shall be used as a design guide. However, a certificate of sanitary construction, issued by the U.S. Public Health Service, shall not be obtained for the airplane.

2.14.1 Terms and Abbreviations

Change to read:

The terms and abbreviations defined below shall have the meanings specified in this paragraph wherever used in this Specification:

"FAA" shall mean the regulatory branch of the United States

Federal Aviation Administration.

"FAR" shall mean the Federal Air Regulations promulgated by the United States Federal Aviation Administration.

"NASA" shall mean the National Aeronautics and Space Administration.

"Boeing" or "Seller" shall mean The Boeing Company.

"Procuring Agency" shall mean the procuring agency of the U.S. Government for the airplane(s) described in this Specification.

"Contract" shall mean the contract between Boeing and the Procuring Agency relating to the design, fabrication, and testing of the airplane(s) described in this Specification.

"Standard Day" shall mean U.S. Standard Atmosphere, 1962 Geometric.

"ARINC" shall mean Aeronautical Radio, Inc.

"SAE" shall mean Society of Automotive Engineers.

"ATA" shall mean Air Transport Association.

"AIA" shall mean Aerospace Industries Association of America, Inc.

"ASTM" shall mean American Society for Testing Materials.

SECTION 3
GENERAL AIRPLANE CHARACTERISTICS

3.3 DESIGN BALANCE LIMITS

Change to read:

The center-of-gravity limits (percent of the Wing Reference Chord specified in Par. 1.6) shall be substantially as shown in Fig. S1.3-2.

For the 2707 (GE):

The center-of-gravity position for the Operational Empty Weight shall be approximately 65.3 percent of the Wing Reference Chord Specified in Par. 1.6 with the movable wing sections in the 20-deg sweep position and the landing gear down.

For the 2707 (P&W):

The center-of-gravity position for the Operational Empty Weight shall be approximately 64.9 percent of the Wing Reference Chord Specified in Par. 1.6 with the movable wing sections in the 20-deg sweep position and the landing gear down.

- 3.11 Delete
- 3.12 Delete
- 3.13 Delete
- 3.14 Delete

Fig. 3-2 Delete and replace with Fig. S1.3-2.

SECTION 4
AIRFRAME STRUCTURES

4.1.1 Service Life

Change to read:

A service life of not less than 50,000 flight hours shall be the criteria to which the primary structure of the airplane is designed. Substitution of processes, designs, and/or materials to meet program requirements may affect prototype service life. Because of calendar time required for Seller's SST structural test program, some of the resulting development may not be incorporated in the prototype.

4.4.5.5 Exits

Add the following paragraph:

A crew inflight escape device, consisting of an egress chute with spoiler door, shall be provided adjacent to the flight deck area.

4.4.5.9 Lock Indicators

Change to read:

Indicators located in the flight deck area shall be provided to warn when any of the following doors are not closed and locked: main entry doors, galley and service doors, external cargo doors, landing gear doors, lower body equipment access doors, and crew egress chute-spoiler door. The switches actuating the indicators for these doors shall be readily accessible.

SECTION 5 PROPULSION

5.1.2 Maintainability

Change to read:

During design, special attention shall be given to the ease with which components can be inspected, maintained, repaired, and replaced. The inlet and exhaust systems will be designed to permit their removal or installation without removing the engines from the airplane.

5.1.3 Interchangeability

Change to read:

It shall be a design objective that the common parts and assemblies of each propulsion pod subject to removal from the engine for routine maintenance be made interchangeable or replaceable-interchangeable. It shall be a design objective to make each propulsion pod interchangeable between pod positions and airplanes.

SECTION 6 FLIGHT DECK ACCOMMODATIONS

6.3.2 PILOTS' SEATS

Add the following sentence:

The pilots' seats shall be designed to accommodate a "back-pack" parachute.

6.3.3 FLIGHT ENGINEER'S SEAT

Add the following sentence:

The flight engineer's seat shall be designed to accommodate a "back-pack" parachute.

6.3.4 OBSERVERS' SEATS

Add the following sentence:

Each observer's seat shall be designed to accommodate a "back-pack" parachute.

6.4 EMERGENCY EQUIPMENT

Add the following sentence:

An inflight escape device shall also be provided adjacent to the flight deck area. (Refer to Par. 4.4.5.5.)

Fig. 6-2 Delete and replace with Fig. S1.6-2.

SECTION 7
FLIGHT CONTROLS

No changes made.

SECTION 8
HYDRAULIC POWER SYSTEM

No changes made.

SECTION 9
ELECTRIC POWER SYSTEM

9.2.1 General

Change to read:

General airplane interconnecting wiring, shielded and unshielded, shall comply with applicable Boeing material specifications. Wiring shall be compatible with the electrical load requirements and the environment of the area in which it is installed.

Miniaturized insulated wire of multiconductor cable may be used for interconnecting wiring, but shall be no smaller than Size 24 except where mechanical strength is not limiting. Individually shielded wire shall be used as needed in sensitive circuits.

9.3.1 General

Change last paragraph to read:

Interference exceeding the preceding limits caused by equipment furnished by the Procuring Agency that does not meet the susceptibility or interference generation requirements of the applicable Boeing document cited in Par. 2.2.2 shall be the responsibility of the Procuring Agency.

SECTION 10 ELECTRONICS

10.1.1 Installation

Change to read:

Because the equipment planned for the production airplane may not be available during the prototype program, current state-of-the-art electronics equipment may be installed.

10.2.2 Televisual Taxi Aid System

Change to read:

A televisual taxi aid system shall be installed to provide the pilots with visibility of the landing gear position relative to the runway/taxiway. The system shall also permit viewing of the nose and main landing gear during gear extension, retraction, and door closure cycles. The visual display unit shall be installed on the captain's main instrument panel (see Fig. S1.6-2).

10.2.3 Weather Radar System

Change eighth sentence of first paragraph to read:

One control unit on the pilots' aisle stand (see Fig. 6-4) and one display indicator on the pilot's main panel (see Fig. S1.6-2) shall be provided.

10.8 AIRCRAFT INTEGRATED DATA SYSTEM

An Aircraft Integrated Data System (AIDS) shall be incorporated to monitor and record selected airplane subsystem performance parameters for inflight fault detection, trend analysis information and isolation of failures to the line replaceable unit (LRU).

SECTION 11 PASSENGER AND CARGO PROVISIONS

11.2.2 Passenger Accommodations

Change to read:

The passenger area arrangement shall provide accommodations for 50 passengers as shown in Fig. S1.11-1.

11.2.2.1 Delete

11.2.2.2 Delete

Fig. 11-1 Replace this figure with Figure S1.11-1.

SECTION 12 ENVIRONMENTAL CONTROL

12.2.3 Ozone and Radiation Detection

Change to read:

The air-conditioning system shall be designed to limit ozone concentration. Cabin ozone concentration shall not exceed 0.2 parts per million by volume for normal operation, or 0.3 parts per million by volume for short-term duration. An ozone concentration measuring system shall be installed with indication at the flight engineer's station.

Test equipment for detecting and monitoring cosmic radiation levels shall be provided.

12.3.1 Cabin Temperature Control Requirements

Add the following paragraph immediately ahead of the last paragraph:

The air-conditioning system in the test personnel area shall be substantially identical to that in the passenger area. However, because of differences in equipment installed, the temperature variations noted above for the passenger area will not apply to the flight test area.

SECTION 13 MAINTAINABILITY

No changes made.

SECTION 14 STANDARD PARTS, INTERCHANGEABILITY, AND REPLACEABILITY

Replace entire section as follows:

14.1 STANDARD PARTS

AN, MS, and NAS standard parts, including rivets, bolts, screws, nuts, fittings, bearings, etc., shall be used wherever practicable. Boeing commercial standard parts or other commercial parts may be used at the option of the Seller.

INTERCHANGEABILITY AND REPLACEABILITY

Because of tooling and other manufacturing considerations associated with the design and fabrication of the prototype airplane, the interchangeability and replaceability normally provided for commercial production airplanes will not be obtained. However, Boeing recognizes that a degree of component replacement and repair is required for the prototype airplanes. Design and fabrication shall allow for replacement and repair of major components with reasonable downtime.

Notwithstanding the above, design consideration will be given to the factors of Interchangeability and Replaceability in the prototype airplane program. Adoption of specific features to provide for Interchangeability and Replaceability will be based on reasonable determinations of the penalties involved.

APPENDIX 1

EQUIPMENT

GENERAL NOTES

Change to read:

This appendix lists selected major items of equipment used on the airplane described in this document.

The Seller reserves the right to substitute equivalent equipment and/or accessories, *except for the Inertial Navigation System and Weather Radar System*, in lieu of those specified herein as Seller-Furnished Equipment whenever such substitution is necessary to improve the product or prevent delay in installation or delivery.

The Procuring Agency's obligations with respect to Procuring-Agency-Furnished Equipment are defined in the Contract.

A. SELLER-FURNISHED EQUIPMENT

2. PROPULSION

Delete Item 8

8. FURNISHINGS

Page AI-15

Delete Item 1

Change quantity of Item 4 from 280 to 50

Change quantity of Item 9 from 124 to 25

Change quantity of Item 14 from 306 to 70

Add to Appendix 1 as follows:

B. PROCURING AGENCY-FURNISHED EQUIPMENT

2. PROPULSION

ITEM	QUANTITY	DESCRIPTION
1	4	Engine, complete with exhaust-reverser system.

APPENDIX II

MANUFACTURER'S EMPTY WEIGHT ALLOWANCE

Delete entire section.

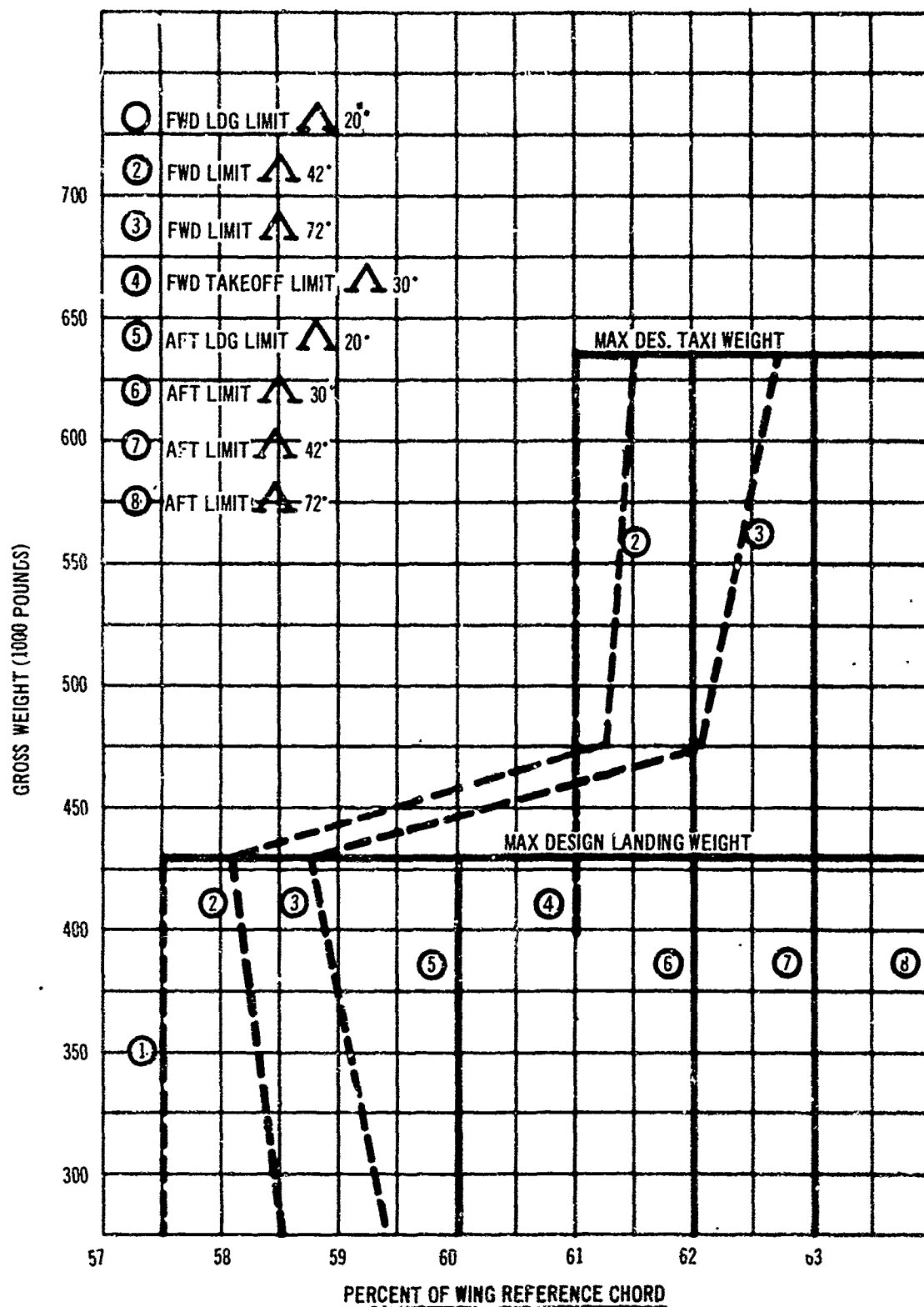
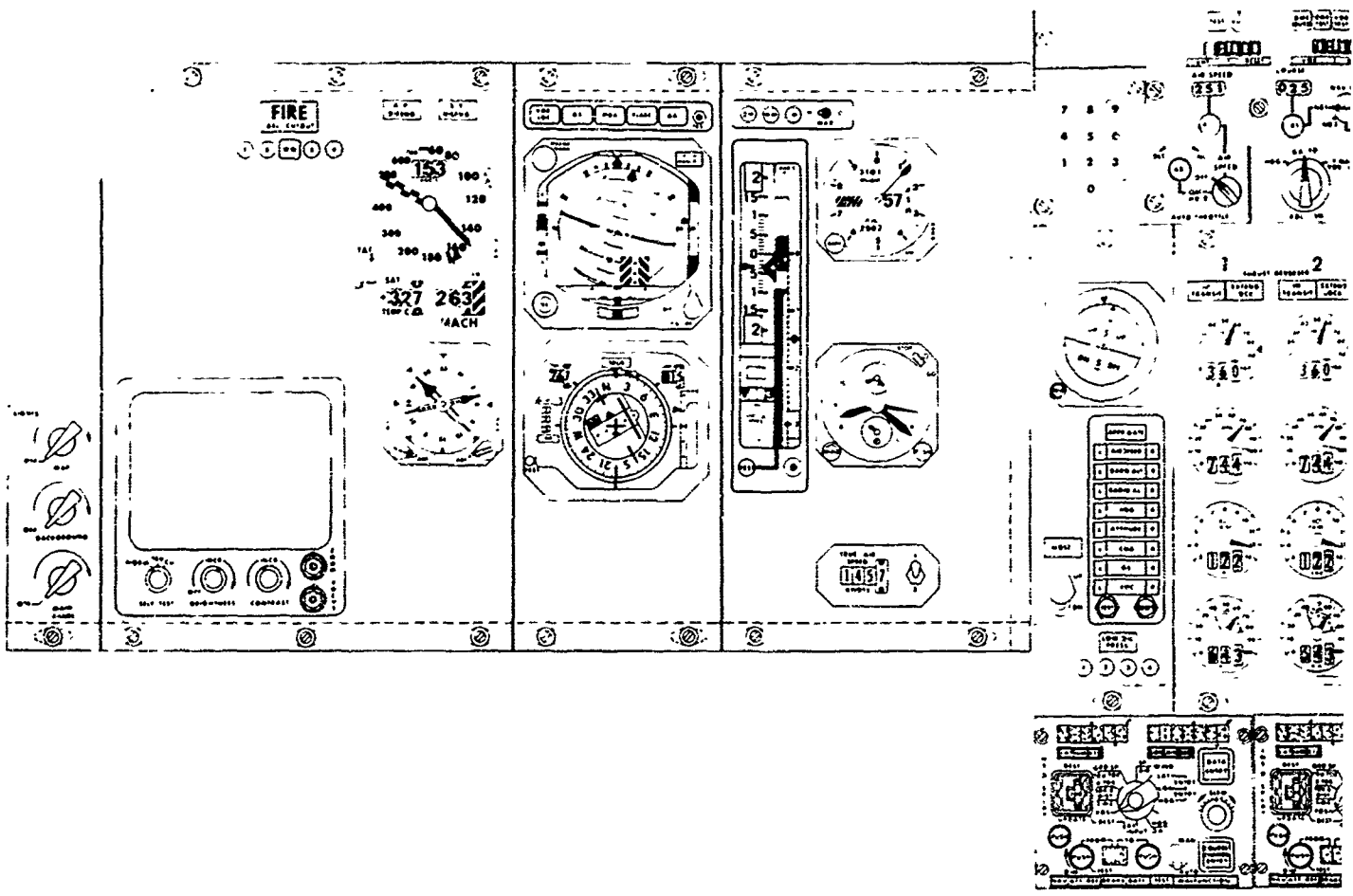


Figure S1.3-2 Operational Center-of-Gravity Limits

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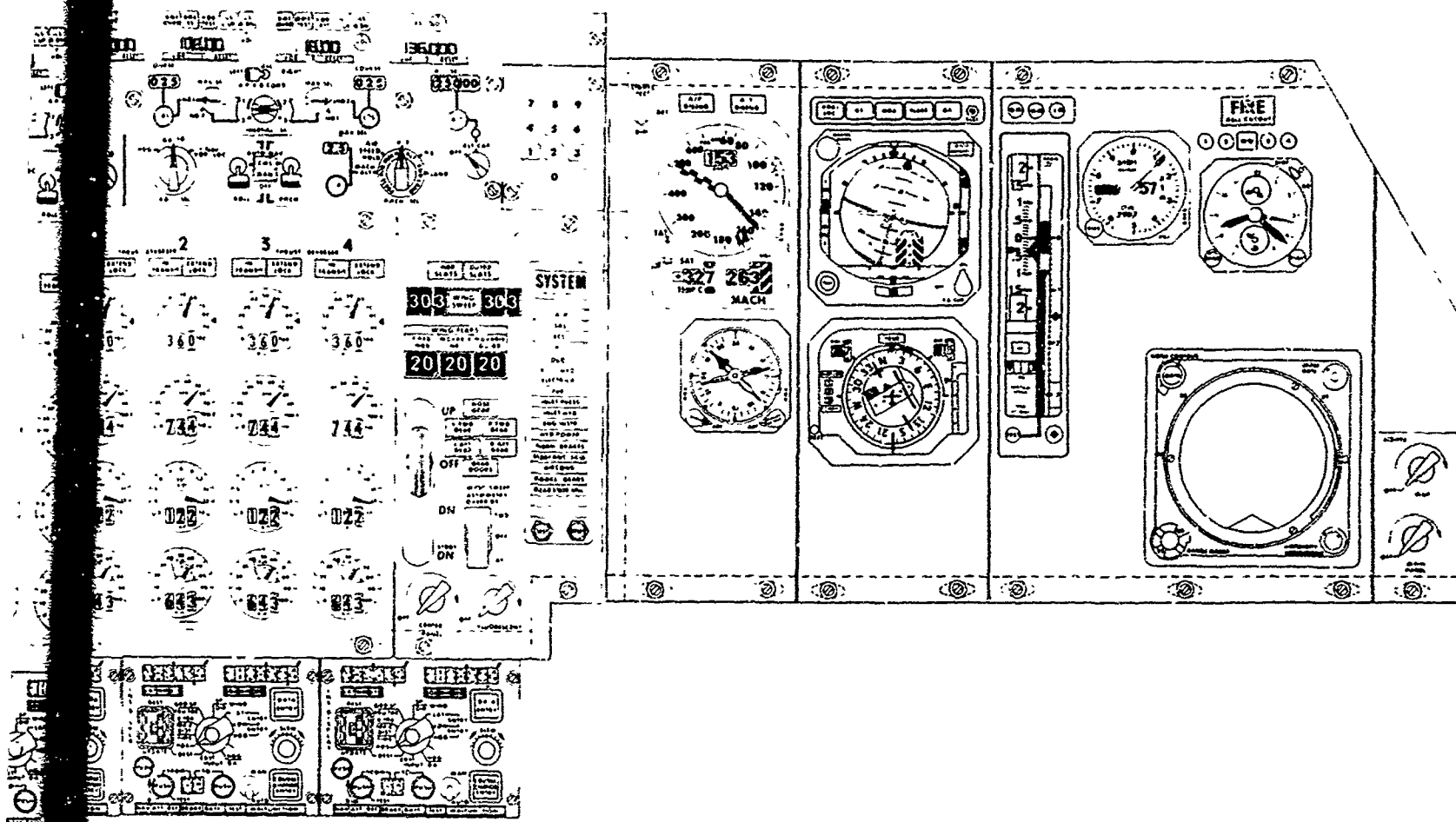


Figure S1.6-2. Pilot's Main Instrument Panel

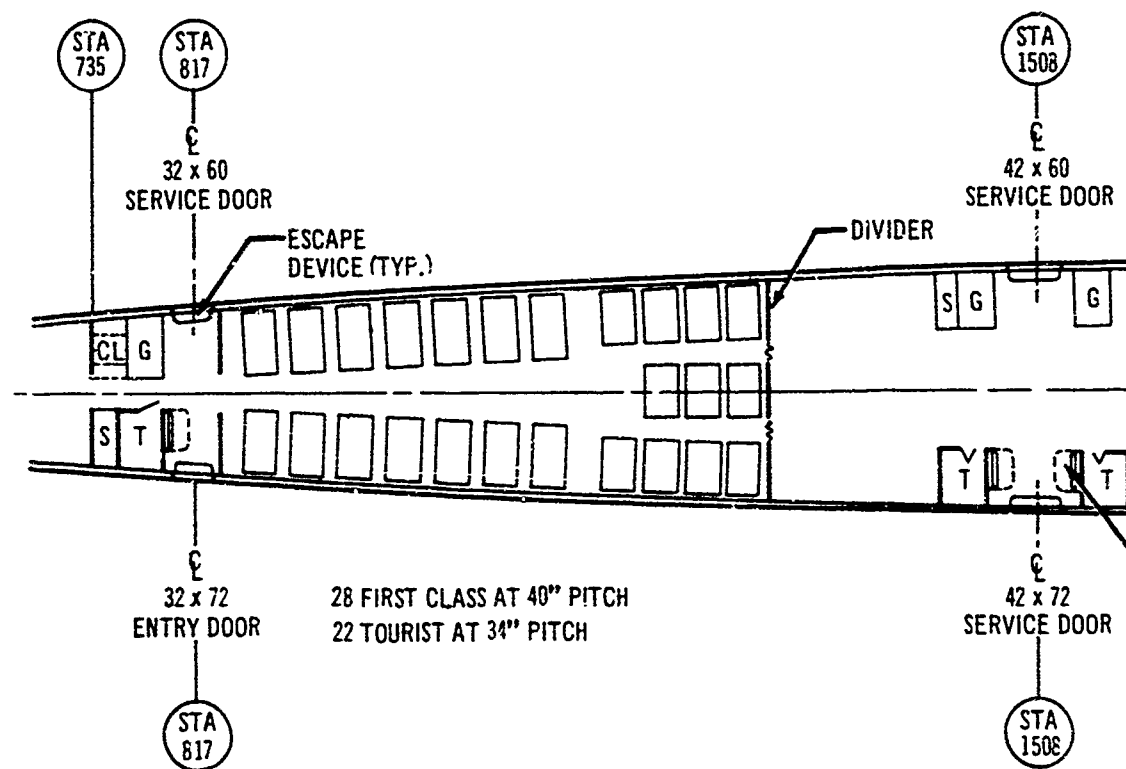
06-17850

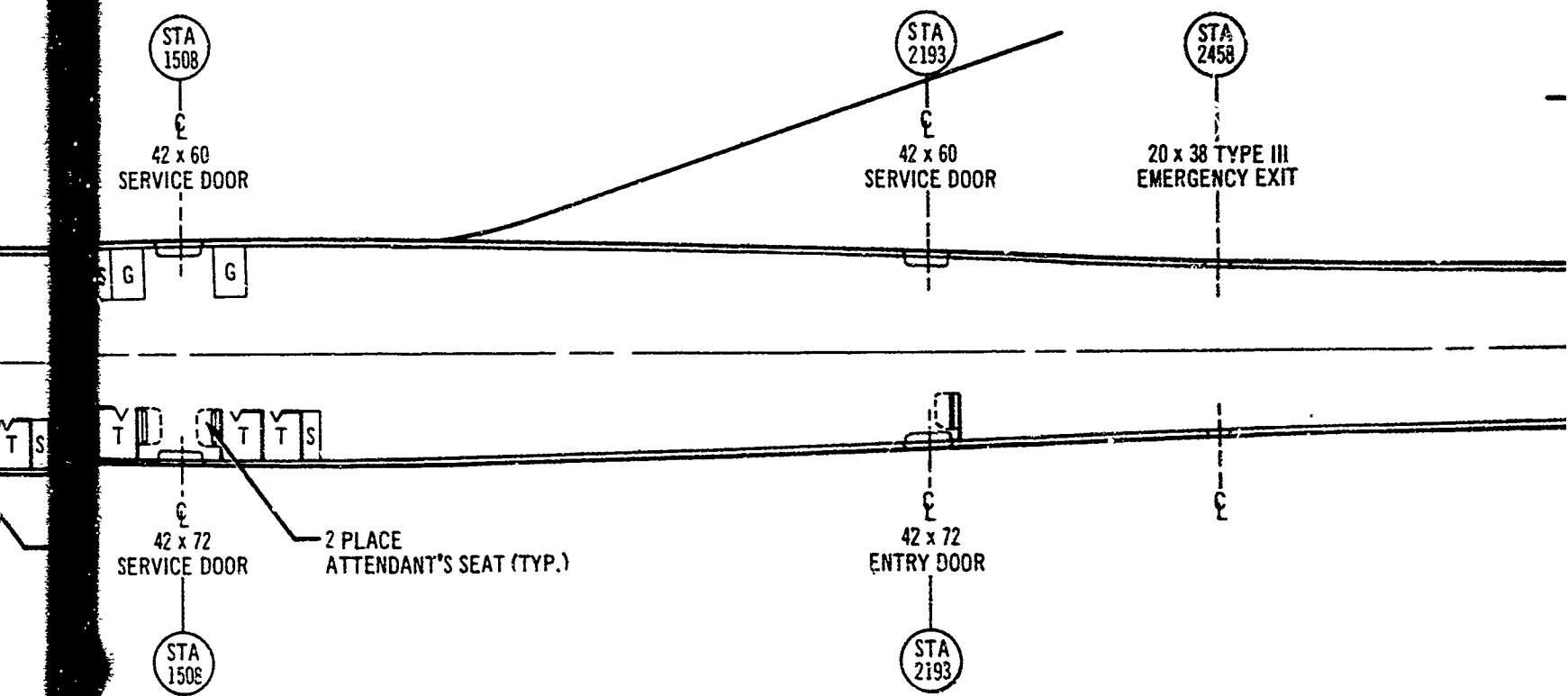
S1-21

(S1-22 BLANK)

2

NOTE: THIS ARRANGEMENT IS THE 280-PASSENGER
INTERNATIONAL MIXED ARRANGEMENT, EXCEPT
FOR THE NUMBER OF PASSENGER SEATS.
SEE FIG. 4.





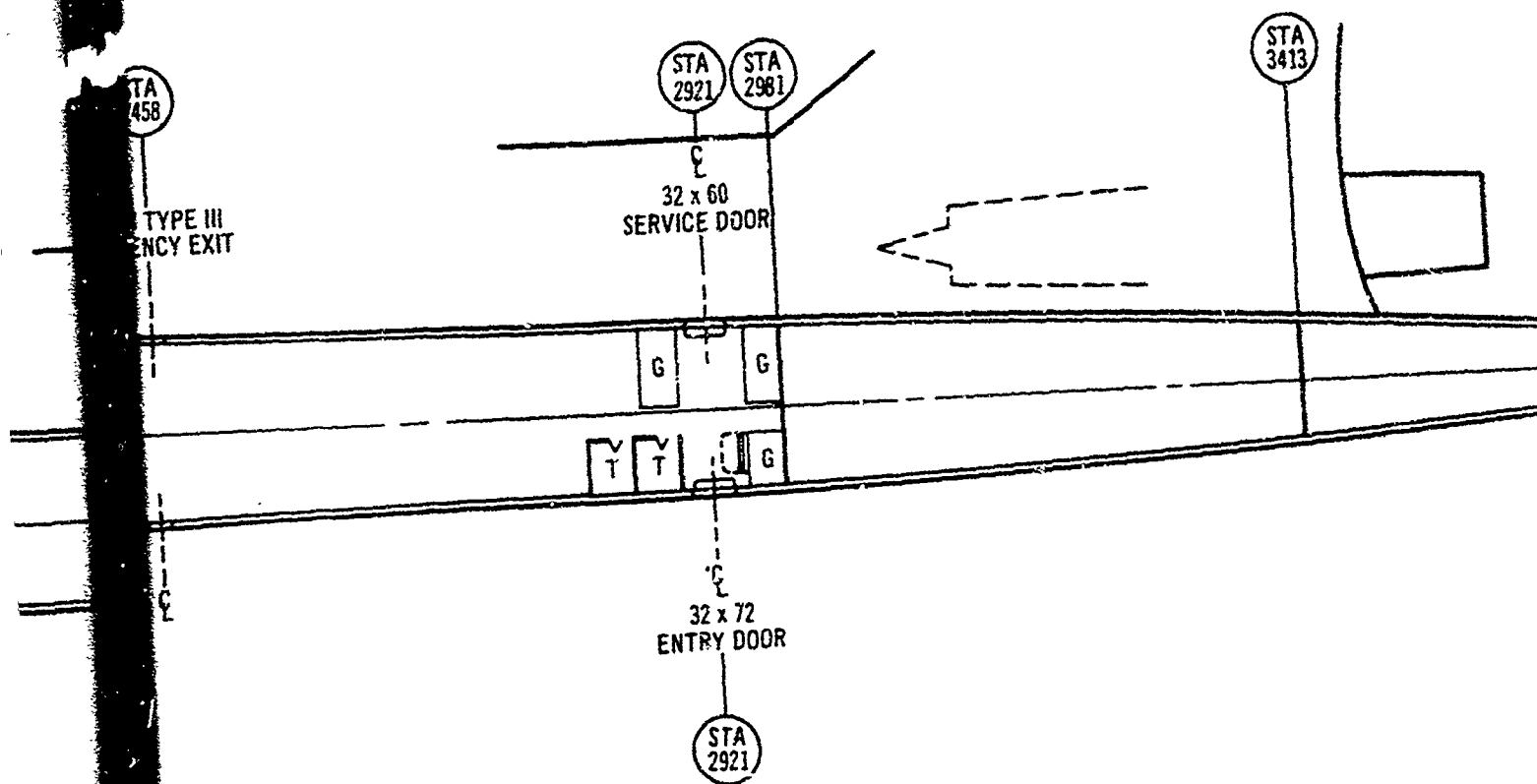


Figure S1.11-1. Prototype Passenger Arrangement

D6-17550

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(S1-24 BLANK)

SUPPLEMENT 2
GUARANTEES

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SUPPLEMENT 2
GUARANTEES

S2-1 GUARANTEED PERFORMANCE

S2-1.1 LIFTOFF SPEED

The liftoff speed shall not exceed 162 knots equivalent airspeed at the certificated maximum takeoff weight and with the airplane in takeoff configuration.

S2-1.2 TAKEOFF DISTANCE

For the Boeing Model 2707-100 (GE)

The certificated takeoff field length shall not exceed 6,800 + 700 feet for the certificated maximum takeoff weight on an 86-degree F day. The airplane shall be capable of a safe takeoff in a 30-knot, 90-degree crosswind.

For the Boeing Model 2707-100 (P&W)

The certificated takeoff field length shall not exceed 7,600 + 800 feet for the certificated maximum takeoff weight on an 86-degree F day. The airplane shall be capable of a safe takeoff in a 30-knot, 90-degree crosswind.

S2-1.3 RANGE, PAYLOAD, AND CRUISE SPEED

For the Boeing Model 2707-100 (GE)

The airplane shall be capable of carrying a payload of 58,600 pounds a distance of 4,000 statute miles at a cruise speed of not less than Mach 2.7, with fuel, including reserve, in accordance with Par. S2-3.1 below. This mission will be accomplished with a certificated maximum takeoff weight that will not exceed the field length takeoff limitations defined in Par. S2-1.2 above and with an operational empty weight of 288,100 lb.

For the Boeing Model 2707-100 (P&W)

The airplane shall be capable of carrying a payload of 62,800 pounds a distance of 4,000 statute miles at a cruise speed of not less than Mach 2.7, with fuel, including reserve, in accordance with Par. S2-3.1 below. This mission will be accomplished with a certificated maximum takeoff weight that will not exceed the field length takeoff limitations defined in Par. S2-1.2 above and with an operational empty weight of 286,220 lb.

S2-1.4 FINAL APPROACH SPEED

For the Boeing Model 2707-100 (GE)

The final approach speed shall not exceed 135-knots equivalent airspeed at a gross weight of 430,000 lb, and with the airplane in landing configuration.

For the Boeing Model 2707-100 (P&W)

The final approach speed shall not exceed 133-knots equivalent airspeed at a gross weight of 420,000 lb, and with the airplane in landing configuration.

S2-1.5 LANDING DISTANCE

For the Boeing Model 2707-100 (GE)

The certificated landing field length shall be 6,200 + 600 ft at 430,000 lb gross weight.

The airplane shall be capable of being landed safely in a 30-knot, 90-degree crosswind.

For the Boeing Model 2707-100 (P&W)

The certificated landing field length shall be 6,100 + 600 ft at 420,000 lb gross weight.

The airplane shall be capable of being landed safely in a 30-knot, 90-degree crosswind.

S2-1.6 NOISE LEVEL GUARANTEES

S2-1.6.1 Airport Noise

The perceived noise level at the start of takeoff ground roll shall not exceed 116 PNdb measured at any point on a line 1,500 feet from and parallel to the runway centerline, at any certificated gross weight.

S2-1.6.2 Community Noise

S2-1.6.2.1 Takeoff Noise

For the Boeing Model 2707-100 (GE)

The perceived noise level, following thrust reduction to maintain a 500-ft-per-min rate of climb, shall not exceed 93 PNdb measured at a point on the ground directly beneath the airplane and three statute miles from the start of takeoff roll, at any certificated gross weight.

For the Boeing Model 2707-100 (P&W)

The perceived noise level, following thrust reduction to maintain a 500-ft-per-min rate of climb, shall not exceed 104 PNdb measured at a point on the ground directly under the airplane and three statute miles from the start of takeoff roll, at any certificated gross weight.

S2-1.6.2.2 Approach Noise

For the Boeing Model 2707-100 (GE)

With engine thrust required for the certificated landing configuration consistent with the landing runway requirement of Par. S2-1.5 on a glideslope approach path of three-degree which crosses the approach end of the runway at a 50-ft height, and at a gross weight of 430,000-lb; the perceived noise level shall not exceed 109 PNdb measured at a point on the ground directly beneath the airplane and one statute mile from the approach end of the runway.

For the Boeing Model 2707-100 (P&W)

With engine thrust required for the certificated landing configuration consistent with the landing runway requirement of Par. S2-1.5 on a glideslope approach path of three-degree which crosses the approach end of the runway at a 50-ft height, and at a gross weight of 420,000-lb; the perceived noise level shall not exceed 118 PNdb measured at a point on the ground directly beneath the airplane and one statute mile from the approach end of the runway.

S2-2 MANUFACTURER'S GUARANTEED EMPTY WEIGHT

The manufacturer's empty weight, plus the unusable fuel, specified in Par. 3.14, is guaranteed not to exceed specified values, plus 3 percent, subject to adjustment for Master Changes, changes required to obtain certification, and variation in actual weights from the allowances provided in Appendix II.

S2-3 GUARANTEE CONDITIONS

S2-3.1 ADJUSTMENTS

Unless specifically stated to the contrary, all performance data shall be based on the U. S. Standard Atmosphere, 1962, geometric. Takeoff and landing field lengths are based on level, hard surface dry runways at sea level, with no wind and with automatic anti-skid in operation. Range and payload performance data will be established without sonic boom restrictions and with the following fuel requirements:

- (1) Sufficient fuel to proceed from departure to destination (includes taxi, takeoff and climb, transonic acceleration, cruise, descent, and one instrument approach at destination to touchdown); plus
- (2) Enroute contingency fuel equal to 7 percent of (1); plus
- (3) Fuel to execute a missed approach at destination, climb out, and divert to a 300 statute mile alternate, arriving there at 1500 ft; plus
- (4) Fuel to hold at alternate for 30 min at 1500 ft at standard temperature; plus
- (5) Fuel for one instrument approach and landing at alternate.

All airplane performance data shall be adjusted for differences between actual engine performance, and that set forth in the engine manufacturer's model specification and data defined by the following:

For the Boeing Model 2707-100 (GE)

- o General Electric Model Specification E-2056 dated September 6, 1966
- o General Electric Engine Performance Card Deck GE4/J5P engine R66FPD228E, and Nozzle Performance Card Deck GE4/J5P nozzle R66FPD228N, both dated August 1966, modified by incorporation of GE4/J5 study F overlay deck provided Boeing October 7, 1966.

For the Boeing Model 2707-100 (P&W)

- o Pratt & Whitney Model Specification 2710, dated August 8, 1966
- o Pratt & Whitney Performance Card Deck S553, revised August 8, 1966, modified by incorporation of letter J. W. Clyne of Pratt & Whitney to W. A. Reinhart of Boeing dated August 19, 1966.

Data derived from tests shall be adjusted, as required, by conventional methods of correction, interpolation, or extrapolation, in accordance with established aeronautical practices, to show compliance.

S2-3.2

ALLOWANCES

Production airplane range performance includes allowances for normal engine bleed and power extraction which shall be

defined as the amount of engine power that will provide a maximum cabin altitude not greater than 8,000 ft with an average fresh air ventilation rate of at least 15 cubic ft per min per person for 300 people, plus 20 cubic ft per min per person for 4 flight deck crew members.

No allowances are included for headwinds or anti-icing.

S2-3.3 FAR COMPLIANCE

Performance specified in Pars. S2-1.1 through S2-1.5 is as defined in FAR 25, Sections 101 to 125, inclusive, effective February 1, 1965, and FAR 121, Section 195, effective November 19, 1965. Any reference to FAR 25 shall be deemed to include Amendments 1 through 7 thereto.

S2-3.4 AIRPLANE CONFIGURATION

The guaranteed performance data of Secs. S2-1 and S2-2 are based on the airplane configurations as defined in this document. Appropriate adjustment shall be made for changes in configuration requested or approved by the Buyer that change the performance of the airplane.

S2-3.5 EXTERNAL NOISE CALCULATIONS

The PNdb levels of Par. S2-1.6 shall be substantiated by measurements taken during flight tests. Data derived from tests shall be adjusted as required by procedures outlined in SAE Document AIR876 "Jet Noise Prediction" dated July 10, 1965.