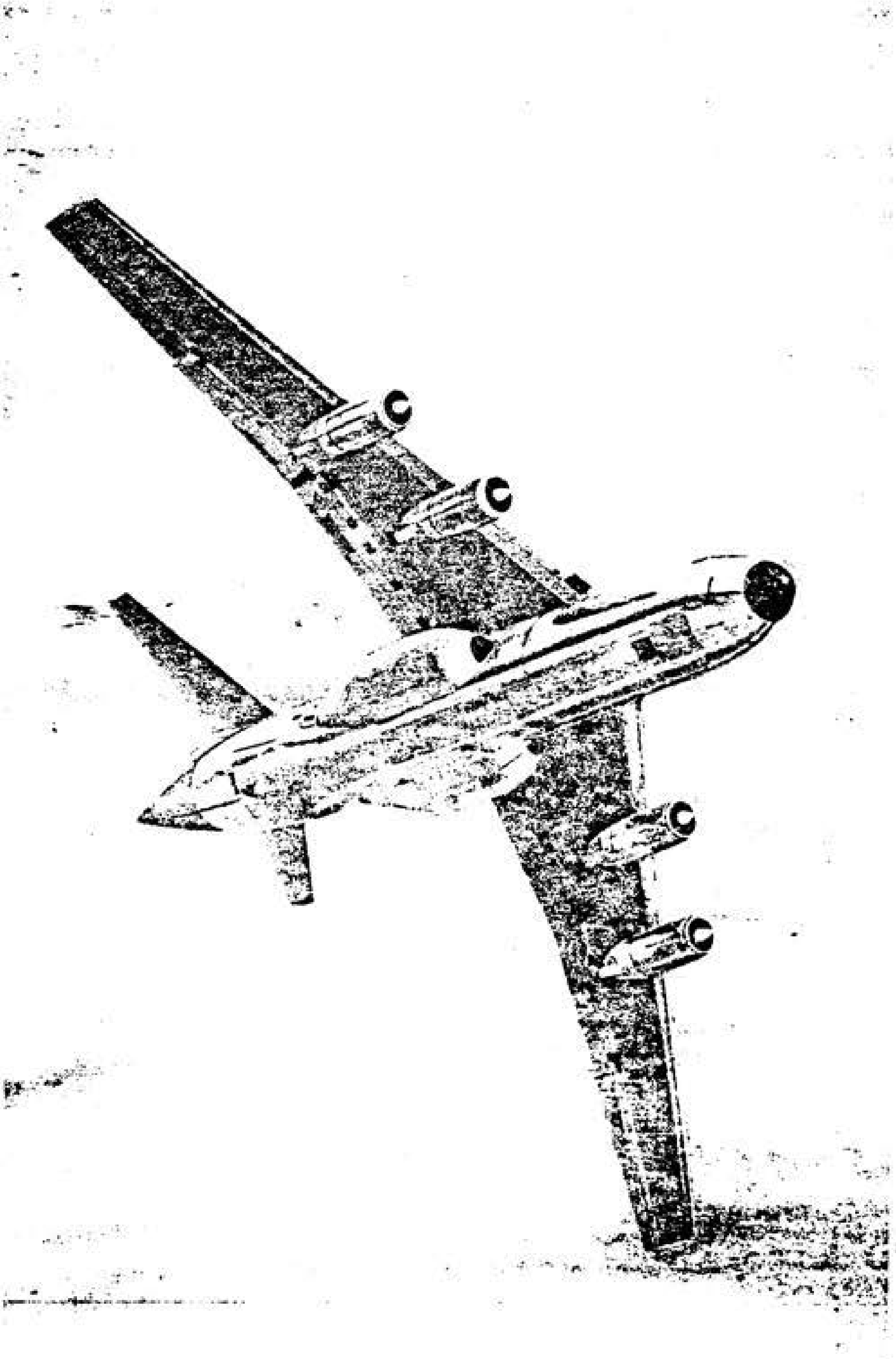
STARLIFTER TRAINING MANUAL • VOLUME I



GENERAL AIRCRAFT

Customer Training Department • Lockheed - Georgia Company • Marietta, Georgia 3006(

STARLIFTER TRAINING MANUAL

VOLUME I

GENERAL AIRCRAFT

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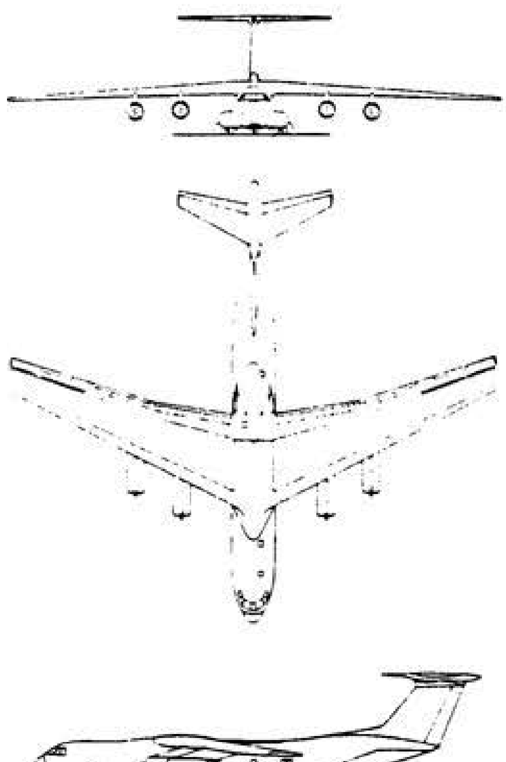
DESCRIPTION

GENERAL.

The Lockheed StarLifter is a modern swept wing jet aircraft designed primarily for the transportation of cargo. Powered by four Pratt and Whitney JT3-D(TF33) turbojet engines each rated at 20,250 pounds of static thrust, this aircraft is capable of airlifting in excess of 68,000 pounds of cargo at speeds approaching mach 0.89. In its military configuration, it is capable of transporting 154 troops, 123 fully equipped paratroops, or 80 litter patients with up to 24 attendants.

Design features include a fully pressurized and air conditioned flight station and cargo compartment. Cargo loading is straight in from the rear over an adjustable ramp. Personnel loading is through a personnel door on each side of the fuselage near the rear or over the cargo ramp. The single high wing is fully cantilevered and swept back at a 25 degree angle. Intergral wing fuel tanks have sufficient capacity to permit a ferry range of 5,925 miles. A high "T" tail provides improved operating characteristics and simplified cargo loading. The fully retractable tricycle landing gear consists of dual nose wheels mounted under the forward fuselage and a four wheel bogie type main gear mounted in a pod attached to each side of the fuselage. Deceleration



on the ground is accomplished by eight multiple disc type wheel brakes with full anti-skid protection and by reverse thrust provisions on each of the four aircraft power plants.

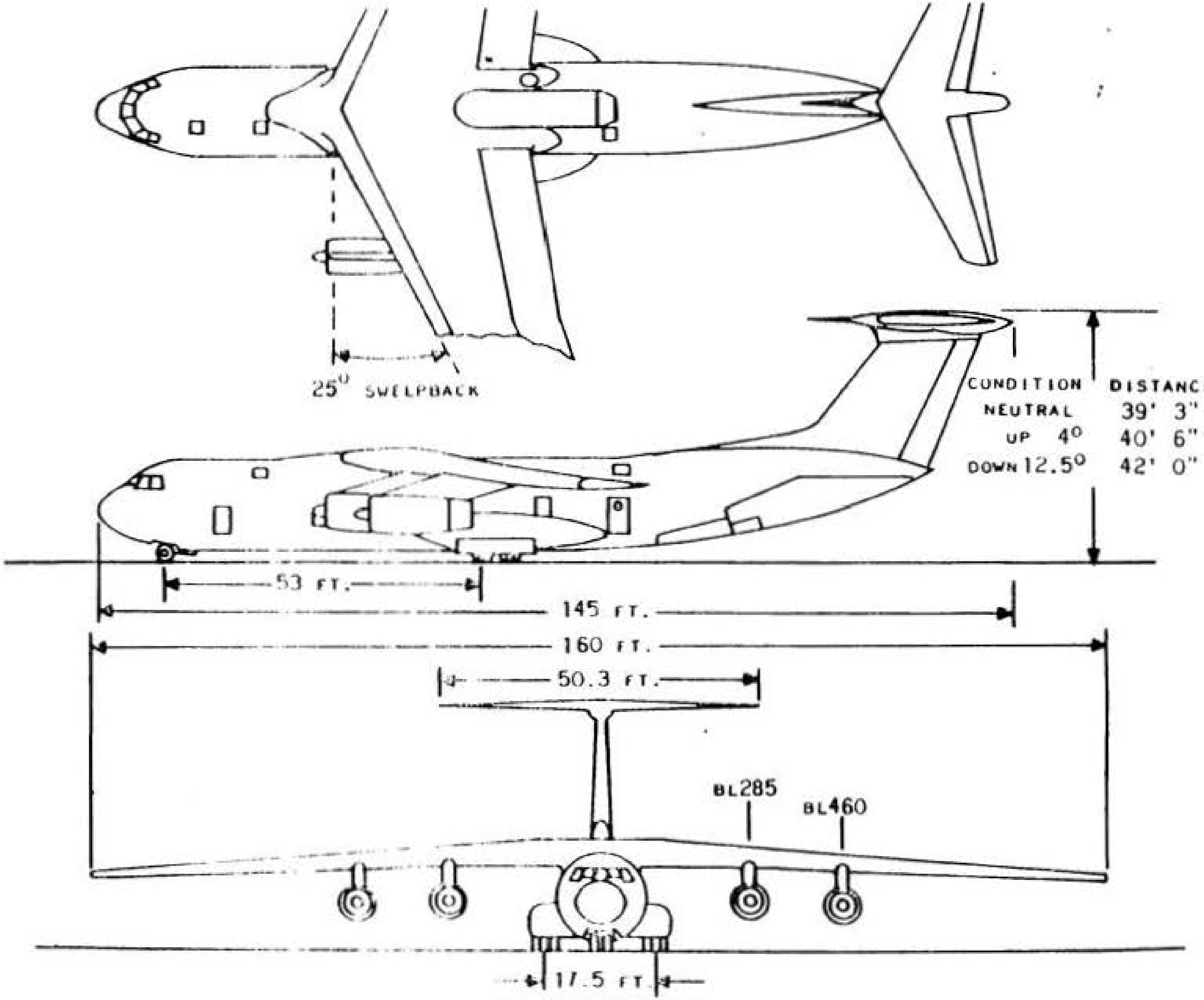
The spacious flight station contains provisions for a normal crew complement of four, a full relief crew, and a removable seat for use by personnel performing crew checks. Facilities include a crew lavatory and a galley that features a refrigerator and a seven meal oven. Entrance to the flight station is through a crew door on the left forward side of the fuselage, into the cargo compartment, and then forward up a small ladder and through a flight station door.

An auxiliary power unit (APU), mounted in the left main landing gear pod, furnishes compressed air for the aircraft pneumatic systems and mechanically drives an A-C generator to supply an alternate source of electrical power. The APU is operational on the ground only and function to allow the aircraft to operate independently of ground support equipment when necessary.

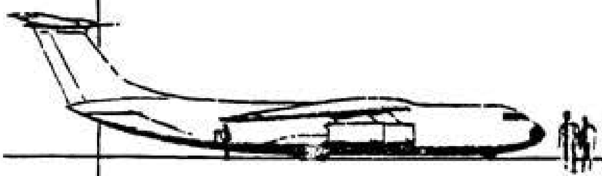
Conventional, fully powered controls provide aircraft maneuverability while airborne. Control about the roll axis is provided by ailerons mounted on the outboard trailing edge of each wing. Primary and back up power for the ailerons is furnished by aircraft hydraulic systems. Emergency operation is made possible by mechanically operated booster trim tabs that are a part of each aileron. Control about the yaw axis is furnished by a rudder attached to the trailing edge of the vertical fin and powered by aircraft hydraulic systems. Control about the pitch axis is furnished both by an elevator mounted on the trailing edge of the horizontal stabilizer and by a movable horizontal stabilizer. The elevators are powered by the aircraft hydraulic systems and the stabilizer is powered by a combination hydraulic and electric pitch trim actuator.

Fowler type wing trailing edge flaps, in addition to spoilers mounted on the upper and lower surface of each wing, serve to decrease aircraft speed and increase the angle of descent. On the ground, these units assist the wheel brakes and thrust reversers in minimizing ground roll.

All weather flying capability is assured by wing and engine anti-ice, horizontal stabilizer deice, windshield defog, rain removal, and rain repellent provisions in addition to complex electronics equipment and an all weather landing system (AWLS) that permits landing with extremely limited visibility.



MAJOR DIMENSIONS



CONSTRUCTION

GENERAL.

Fuselage construction is based on a "fail-safe" design. That is, any structural failure that might occur would not lead to catastrophic failure and loss of the aircraft. The semi-monocoque design features a heavily stressed skin of 7079 aluminum alloy attached to a large number of stringers, formers, and structural units. All skin splices are reinforced with titanium straps and all openings are encircled with doublers placed between the skin and the underlying structure. Four massive forgings transmit fuselage loads to the wing or to the main landing gear.

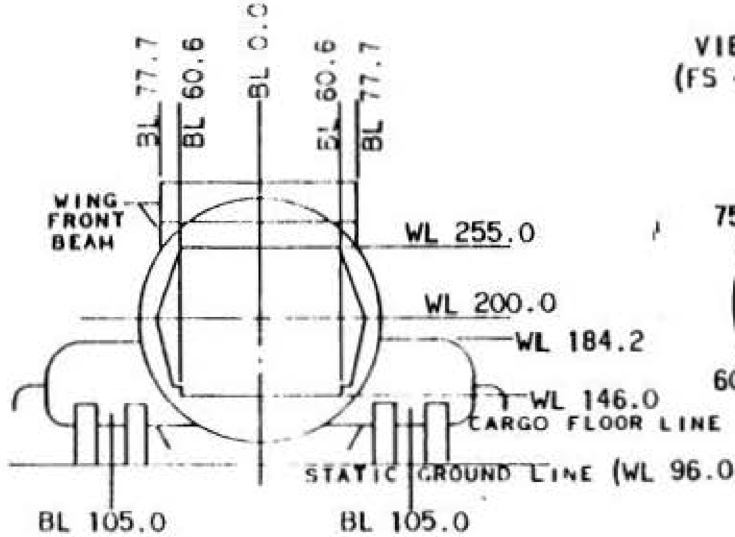
FLIGHT STATION.

The area above water line (WL) 200.0 aft of fuselage station (FS) 275.0 and forward of FS 445.0 is termed the flight station. This section functions as the control center and crew quarters of the aircraft. Working positions are provided here for the normal crew of four. In addition to the normal complement of controls, all crew stations are fully instrumented as required for systems monitoring and navigation. Where possible, tape type vertical scale indicators are used and warning lights are grouped into an annunciator panel. The pilot's and copilot's positions are of the standard side by side arrangement in the nose of the aircraft and separated by a console containing various aircraft and communications systems controls. The nagivator's position is just aft of the pilot's position and faces the left side of the aircraft. The flight engineer's position is located just behind the copilot's position and faces the right side of the aircraft. The flight engineer's panel features instruments and controls for the engines as well as the electrical, fuel, hydraulic, and pneumatic systems.

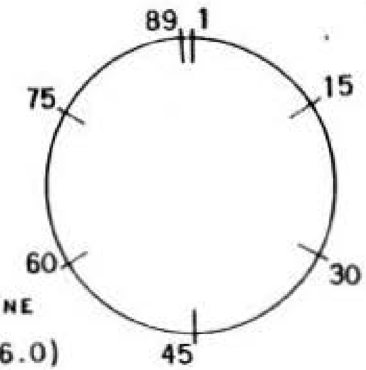
Auxiliary crew facilities include two bunks mounted against the aft bulkhead of the flight station and two removable back rests that convert the bottom bunk into two crew seats when needed. One additional crew seat is located on each side of the flight station entrance door.

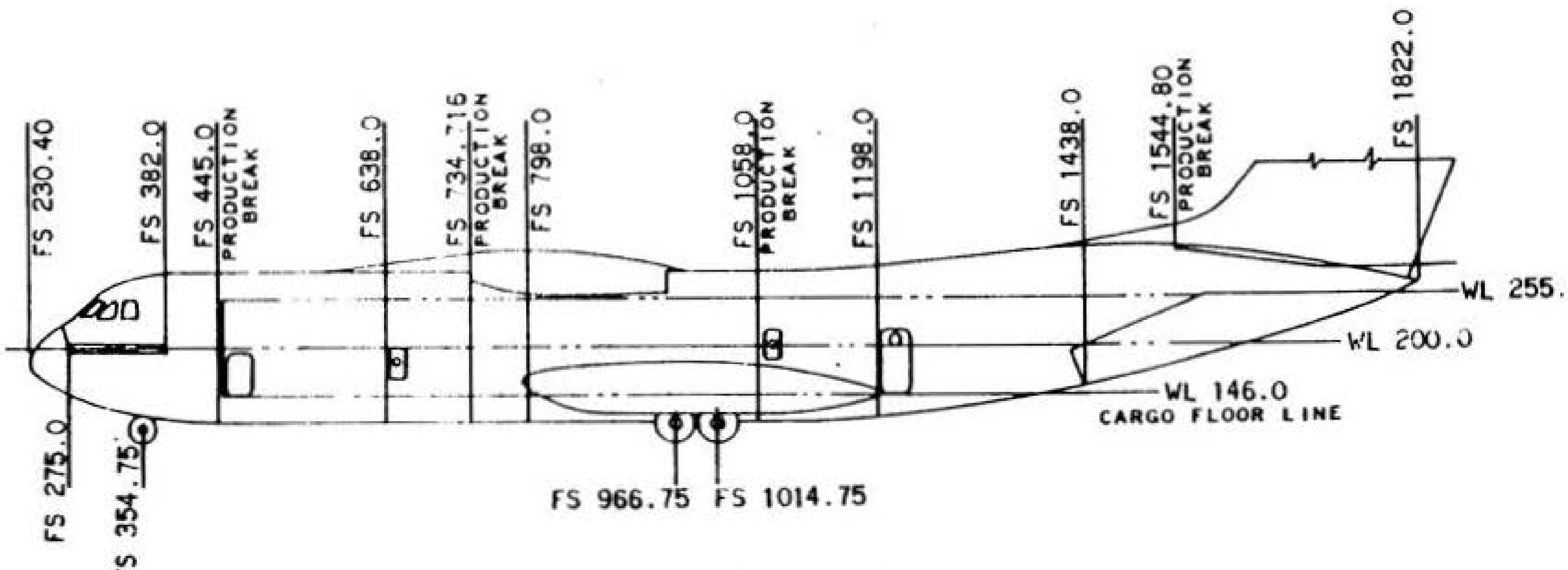
UNDERDECK AREA.

The area beneath the flight station houses the nose landing gear, the equipment racks, the crew lavatory, and the crew galley.

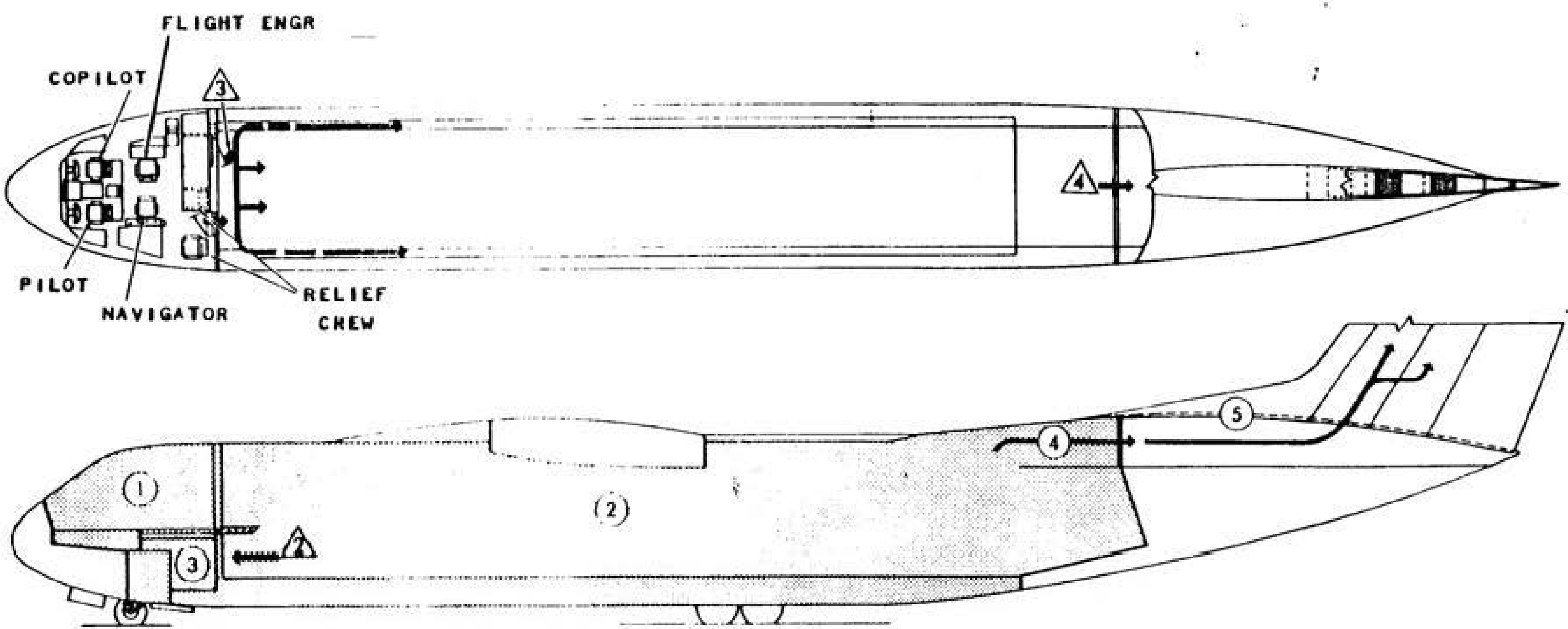


VIEW LOOKING FORWARD
(FS 451.5 TO FS 1108.0)





FUSELAGE STATION LAYOUTS



NOTE:

1. WALKWAYS ARE PROVIDED FOR CREW MOVEMENT WHEN THE CARGO COMPARTMENT IS LOADED TO WIDTH CAPACITY. MOVEMENT UNDER OTHER CONDITIONS IS LIMITED BY THE CONFIGURATION OF THE LOAD.

2. ACCESS TO LEFT HAND AND LEFT HAND CENTER UNDER-DECK EQUIPMENT. ACCESS UNDER CREW LADDER.

3. ACCESS TO RIGHT HAND CENTER AVIONICS UNDERDECK EQUIPMENT, BATTERY, ELECTRICAL EQUIPMENT, AND NOSE LANDING GEAR INSPECTION WINDOW. ACCESS THROUGH CREW LATRINE.

AIR CONDITIONED AND PRESSURIZED AREAS (CABIN)

4. ACCESS TO AFT FUSELAGE UPPER DECK COMPARTMENT AND VERTICAL STABILIZER.

5. THE FOLLOWING CIRCLED ITEMS CONSTITUTE THE CABIN: 1 2 3 4

1 FLIGHT STATION

2 CARGO COMPARTMENT

3 FORWARD FUSELAGE UNDERDECK EQUIP COMPARTMENT

4 AFT CARGO COMPARTMENT UPPER DECK AREA

5 AFT UPPER DECK COMPARTMENT

PRESSURIZED AREA

CARGO COMPARTMENT.

The cargo compartment extends from FS 452 to FS 1292. Dimensions are 70 ft. long by 10 ft. 3 inches by 9ft. 1 inch high. Additional cargo space is available over the cargo ramp. Polyester film covered glass fiber batts are used as insulation and soundproofing within the fuselage. Glass cloth hardboard liners are used inside the cargo compartment as interior trim and to protect interior components.

Stiffened aluminum alloy panels are used to form the cargo compartment floor. The underfloor insulation consists of heavy cloth heat baffles suspended halfway between the floor and the fuselage skin. This creates a dead air space that minimizes the loss of underfloor heat through the aircraft skin. Inspection of the area beneath this insulation is accomplished by means of a special borescope inserted in openings provided in the cargo floor.

Provisions are incorporated in the floor panels for personnel seat mounting as well as 10,000 pound and 25,000 pound cargo tie down fittings. Cargo loading provisions compatable with the 463L loading system include conveyor rollers and side rails for palletized cargo. The conveyor rollers are installed in channels that may be inserted upside down to form a smooth cargo floor. With removable sections installed, the side rails serve to guide the loading and off loading of palletized cargo and to restrain cargo during flight.

With a normal cargo load, walkways are present at the front and each side of the cargo compartment. These walkways permit access to the crew galley and lavatory in addition to allowing inspection of cargo during flight. The walkways are covered with a skid resistant abrasive coated cloth. The side walkways are elevated above the normal cargo floor. The two outside cargo compartment floor panels are of reinforced construction for use as vehicle treadways.

The cargo ramp is approximately 11 feet 4 inches wide by 11 feet long and is stressed for cargo support. The front of the ramp is hinge mounted to the rear of the cargo floor. Basically the same cargo tie down provisions, conveyor rollers, and guide rails contained in the cargo compartment are continued on the ramp surface. Two hydraulic actuating cylinders, attached near the rear of the ramp, position it for loading or offloading from either truck bed heigth or ground level. When loading from ground level, ramp extensions that are stored on each side of the cargo compartment just above the ramp may be used. In the full up position, the ramp is locked to the fuselage by means of hydraulically actuated mechanical locks located along the fuselage structure that contact mating locks along the outside upper surface of the ramp.

A pressure door measuring approximately 10 feet wide by seven feet high and constructed of honeycomb serves as the aft closure of the pressurized cargo compartment. It is attached to the fuselage structure by a piano-hinge located at the top of the door. A single hydraulic actuating cylinder powers the pressure door to the open position and the door is held open by a latch attached to the lower surface of the aft fuselage upper deck. In the down position, the door attaches to the cargo ramp by means of 13 hydraulically operated mechanical locks to enable both the aft pressure door and the ramp to withstand the forces generated by aircarft pressurization.

Air leaks in this area are minimized by rubber pressure seals installed around the edges of the cargo ramp and the aft pressure bulkhead. Aerodynamic fairing of the aft fuselage opening is provided by two large petal doors that are constructed of aluminum honeycomb. These doors may be opened in flight or on the ground and closed to fair in the fuselage. They are actuated by mechanical jackscrews that are powered by a single hydraulic motor. Both doors are hinged, along their canted upper edges, to the aircraft structure and lock together in the down position with two hydraulically actuated mechanical locks.

AFT FUSELAGE.

A horizontal bulkhead above the petal doors and ramp is referred to as the aft fuselage upper deck. Part of the area above this deck is outside the pressurized section of the fuselage. Entrance into this area, while in flight, is through a hatch in the pressure bulkhead above the aft pressure door. Access while the aircraft is on the ground can be either the above mentioned hatch or through an inspection plate above the petal doors

Exit from the fuselage may be through a crew entrance door on the left forward side of the fuselage, through either of two personnel doors located on opposite sides of the fuselage just forward of the cargo ramp, through the ramp and petal doors, through either of three overhead hatches spaced along the top of the fuselage, or through emergency side hatches located on the left and right sides of the aircraft at FS 650 and FS 1075.

MAIN GEAR PODS.

The main landing gear pods are installed for aerodynamic reasons only and provide no structural support for the landing gear. Primary construction is of aluminum honeycomb over stringers and formers The nose and tail covers, as well as other sub-structure, are laminated glass cloth.

VERTICAL FIN.

Box beam type construction is used in the vertical fin with milled skin panels attached to web type front and rear spars and a truss type center spar. A false spar mounted just aft of the box beam serves as an attach point for the rudder. The leading edge is of conventional construction and is attached to the front of the box beam with flush head screws. A heavy forging, used as the top rib for the fin, serves as the hinge point for the horizontal stabilizer and as a mount for the pitch trim actuator. Two passage ways that are lighted and contain built-in ladders are located inside the box beam.

The passage way forward of the center truss spar provides access to the pitch trim actuator, to the horizontal stabilizer hinge points, and to the upper surface of the horizontal stabilizer. The rear passage is located aft of the center truss spar and provides access to the elevator input quadrant and its controls. Access to these passages is from the aft fuselage upper deck. The entire vertical fin is attached to the fuselage by a series of bolts that surround the bottom of the fin.

HORIZONTAL STABILIZER.

The horizontal stabilizer assembly consists of a center tie-box and right and left stabilizers that utilize box beam type construction. These three units are permanently joined to form a one piece unit. The leading edge of the center tie box is a bullet shaped HF antenna and the trailing edge is a loran antenna. Stabilizer outer panel leading edges are formed in eight sections. Construction of these panels is of fiberglas with a bonded outer skin of 0.005 inch stainless steel for rain erosion protection. Electrical heating elements are imbeded in the fiberglas for stabilizer anti-icing. Two piece elevators are attached to the horizontal stabilizer rear spar at 12 hinge points. Elevator construction is conventional with aluminum honeycomb used to form the trailing edge. Depleted uranium is used for the main elevator counter balance weights.

WING ASSEMBLY.

The wing assembly is of box beam construction with integrally stiffened milled skin panels attached to web type front and rear spars to form an extremely strong box assembly. This box is further strengthened by the addition of truss type ribs or bulkheads spaced at approximately 20 inch intervals. The bulkheads divide the wing into 10 compartments which are sealed to form fuel tanks and associated vent and surge boxes.

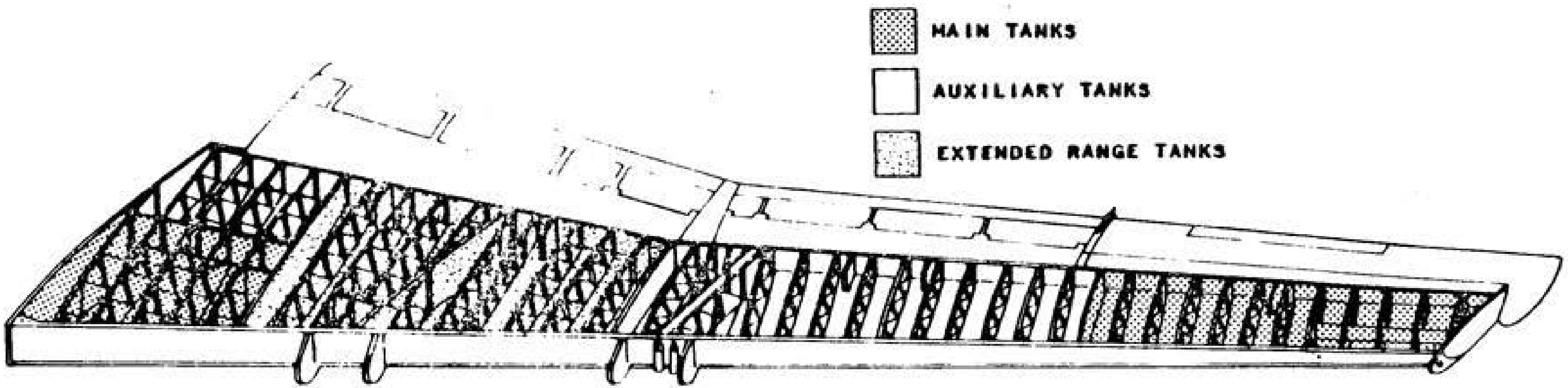
Individual units that make up the wing assembly include a center section, two inner wing sections, and two outer wing sections. The center section is an integral part of the fuselage. A pressure diaphragm within the center section continues the fuselage outer contour. The area beneath this diaphragm is pressurized with the fuselage. Access to the area below the pressure diaphragm is through an access door in the center section bottom skin within the fuselage. Access to the area above the pressure diaphragm is through an access door in the wing upper skin. The outer wing panels join the inner wing panels at approximately buttock line (BL) 415. These wing assemblies are attached to the center section by Taper-Lok fastners through butt joints and by a large bolt at each of the four corners of the wing and center section box beams.

The leading edge of each wing is manufactured in eight sections. The two inboard sections and the two small sections at the pylons are formed of honeycomb material. The section between the engine pylons and the three outboard sections are of conventional construction with ribs and skin. These sections have double skins. A mixture of ambient air and hot bleed air from the pneumatics manifold is circulated between these double skins for wing anti-icing. With fuel in the integral wing tanks, the dihedral of the wing is increased to the point that jacking of the wing is required for leading edge removal or replacement. Access panels in the upper and lower surfaces of the wing box and the leading edge provide access to installed components.

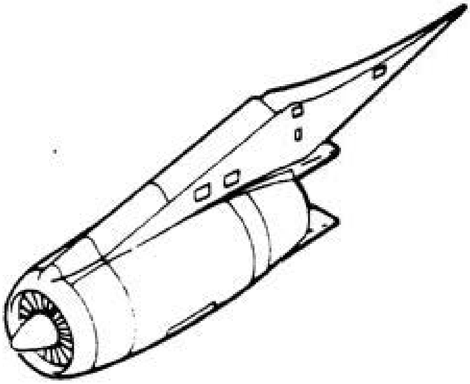
The trailing edge of the wing is made up of upper and lower skins, ribs, and a false spar. The false spar contains mounting provisions for the ailerons, flap tracks, and spoilers. Rivets and lock bolts fasten the trailing edge permanently to the wing box beam. Panels in the trailing edge lower skin hinge down to permit access to interior components. Construction of the trailing edge utilizes both conventional aluminum alloy skin and honeycomb material. A wing tip of conventional construction is used to fair in the outboard ends of the wing.

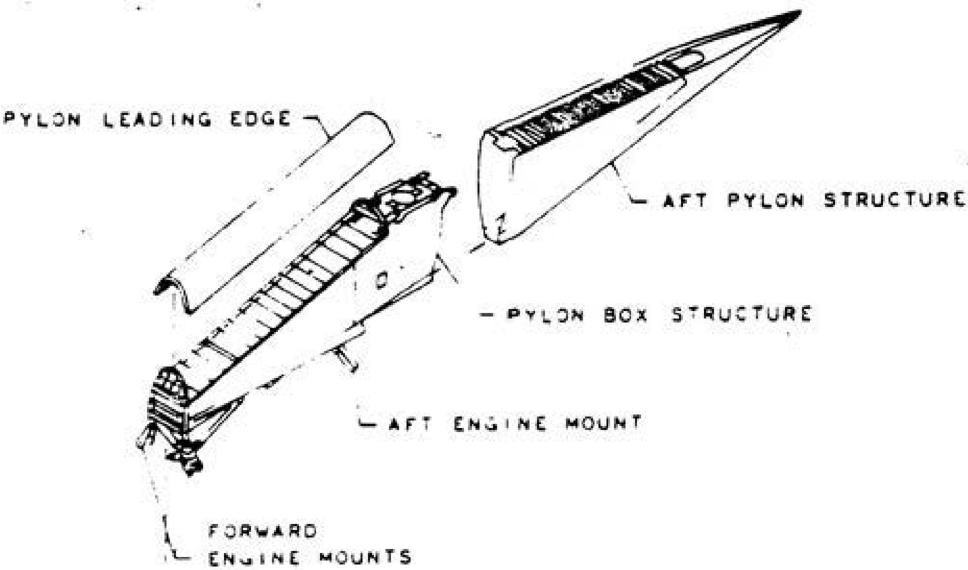
ENGINE PYLONS.

All four power plants are pylon mounted to the wings at BL 285 and 460 left and right. The pylons are of box type construction with the leading and trailing sides of the box formed by a heavy fabricated beam. The leading edge fairing is constructed of aluminum alloy honeycomb. The trailing edge forms a tension type mount and is built from aluminum alloy honeycomb. Other materials utilized in the pylon are titanuim and corrosion resistant steel.



INTEGRAL TANK STRUCTURE




PYLON LEADING EDGE
AFT PYLON STRUCTURE
PYLON BOX STRUCTURE
AFT ENGINE MOUNT
FORWARD
ENGINE MOUNTS

POWER PLANT

GENERAL.

Power for the StarLifter is provided by four JT3-D (TF33) forward fan turbojet engines that are flat rated at 20,250 pounds of thrust. The primary purpose of the flat rated engine is to provide constant thrust over a wide range of ambient temperatures. Based on sea level pressure altitude, rated thrust will be obtained at any temperature below 15°C. Above 15°C thrust decreases as temperature increases.

CONSTRUCTION.

This engine has a sixteen stage split compressor which includes two stages of oversize blades that comprise the fan assembly. It has an eight can, can-annular combustion chamber and a four stage, twin spool turbine assembly. The main accessory case is located on the bottom of the diffuser section and a smaller accessory drive is located on the front of the compressor air inlet case. The engine is divided into five operating sections: the compressor section, the diffuser section, the combustion section, the exhaust section, and the accessory drive section.

The forward section of the split compressor is called the number 1 (N1) compressor and consists of two fan stages and seven compressor stages. Driving power for this compressor is furnished by the last three stages of the turbine by means of a shaft that interconnects the turbine and compressor sections. The rear seven stages of the split compressor form the number 2 (N2) compressor. Motive power for this compressor is furnished by the first stage of the turbine through a shaft that surrounds the N1 compressor shaft. These two compressor sections do not mechanically interconnect and their speed relationship is a function of air flow only.

Air from the outboard sections of the two fan stages is ducted around the engine and overboard to provide approximately 10,000 pounds of thrust at maximum power settings. The remaining 10.250 pounds of thrust results from the movement of a gaseous mass through all stages of compression, combustion, and exhaust.

The JT3-D engine utilizes a compressor unloading system that includes a six inch valve and a 4-3/4 inch valve to relieve 12th stage pressure and prevent the formation of stalls. The difference between compressor inlet pressure and 12th stage pressure is utilized to control these valves which are actuated by 16th stage pressure.

The speed of both the N1 and N2 compressors is measured and presented individually. Instruments reflecting these compressor speeds are located on the center instrument panel and on the flight engineer's panel.

The diffuser case directs air flow from the compressor into the combustion chambers. Air is extracted from the diffuser for engine anti-ice and the aircraft pneumatic systems. The main accessory drive case is mounted on the lower center of the diffuser case. Power for the accessory drive gears is transmitted by a shaft located in the case support strut at the six o'clock position.

The combustion section consists of an inner combustion liner, split outer combustion case, and eight burner cans. Air from the diffuser section enters the combustion section, mixes with the fuel, and is burned. A portion of the air not required for combustion flows around the combustion cans to form an insulating and cooling blanket.

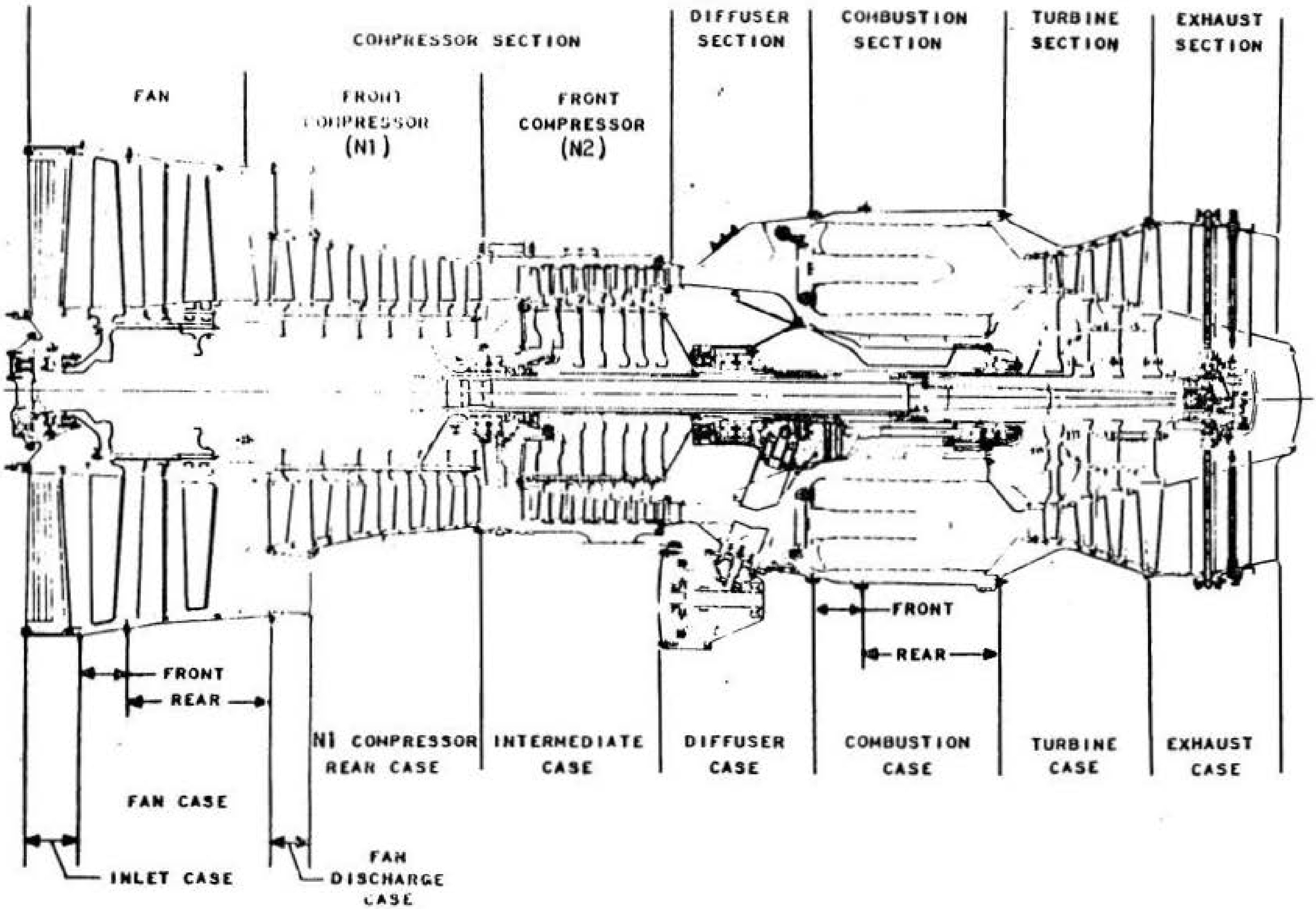
Fuel is furnished by the engine fuel system through a dual fuel manifold. Fuel from the manifold goes to six fuel nozzles located on the front of each combustion can where it is sprayed into the combustion can and ignited.

Combustion cans four and five contain provisions for installing sparkigniters. Flame from these two cans is allowed to spread to the other six cans by means of cross-over tubes that interconnect all cans.

The exhaust section consists of a twin spool, four stage turbine, nozzle guide vanes, and a turbine exhaust case.

OPERATION.

Engine speed and power are controlled in the conventional manner by varying fuel flow to the combustion section. The unit used to vary fuel flow is a hydromechanical devise called the engine fuel control. Factors that influence the output of the fuel control are throttle position, burner pressure, compressor inlet pressure, and N2 compressor speed. To obtain a power measurement, air inlet pressure is compared to exhaust gas pressure. The resultant is an engine pressure ratio (EPR) that will vary directly with thrust. EPR readings serve as an indication of power. Exhaust gas temperature (EGT) is measured



ENGINE SECTIONS

to provide additional operating and condition information.

STARTING.

A pneumatic starter mounted on the main accessory drive is used to rotate the N2 compressor for engine start. Self-contained engine starts are possible by utilizing the aircraft auxiliary power unit to furnish compressed air and electrical power for the initial start. This operating engine will then provide the necessary air and electrical power to start the remaining engines. A 28 volt D-C ignition exciter rated at 20 joules provides ignition.

FUEL.

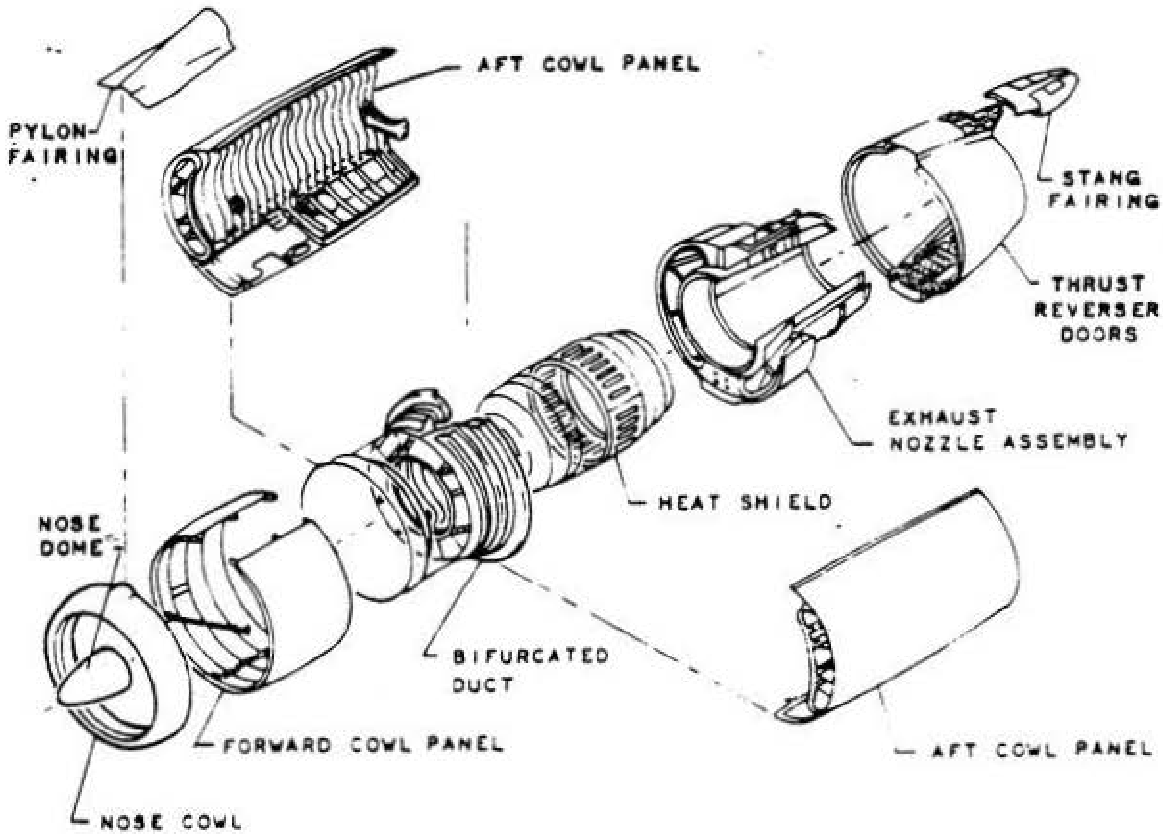
Fuel pressure and fuel flow control are provided by a dual element fuel pump and a fuel control mounted on the main accessory drive. A fuel flow transmitter provides a fuel consumption reading in pounds per hour (PPH) for the flight engineer.

OIL.

The engine is lubricated by a high pressure, self-contained oil system. Lubrication is provided for engine bearings, bearing seals, and accessory drives. A synthetic lubricating oil, MIL-L-7807, is used in this system. Each engine has its own oil tank, pressure and scavenge pumps, air oil cooler, fuel oil cooler, rotary breather, and breather pressurizing valve. The engine oil supply is contained in a steel saddle-type tank mounted on the upper right side of the rotor case. Total volume of this tank is 7.77 U. S. gallons. Oil capacity is 6.09 gallons and the remaining space is used for expansion. A switch in the tank will illuminate a LOW OIL QTY light on the flight engineer's panel anytime the oil quantity in the tank drops to one gallon.

NACELLE.

Each engine is contained in an individual power plant nacelle which provides aerodynamic contour for the engine and various components related to engine operation. The complete power plant consists of the engine, the engine nose dome, the nose cowling, the forward cowling, the bifurcated duct, the access doors, the cowling support structures, the aft cowl and duct assembly, the engine mounts, the engine tail pipe, the fan duct nozzle, and the thrust reverser assembly. A horizontal firewall of corrosion-resistant steel protects the pylon assembly from heat or fire. A vertical firewall separates the nacelle into two sections called zone one and zone two. Zone one is aft of the firewall and zone two is forward of the firewall. Both zones are equipped with an overheat warning system, a fire detection system, and a fire extinguishing system.



NACELLE AND PYLON STRUCTURE

The nose cowling assembly contains springloaded auxiliary inlet doors that will open at low air speeds to prevent air separation at the inlet lip. The forward cowling is composed of two doors that can be swung outward to give access to the forward part of the engine.

The left cowling door contains a small door that will permit easy servicing of the constant speed drive oil tank. The right cowling door has a small door to provide access to the engine oil tank.

A bifurcated duct, fan duct, divides the fan exhaust into two axial ducts which direct the air flow aft to a fan duct nozzle. The engine tail pipe and fan duct nozzle direct the engine and fan exhaust aft and overboard. The fan exhaust nozzle encloses the primary engine exhaust duct.

THRUST REVERSER.

The aft nacelle contour is composed principally of the two thrust reverser doors in the stowed position. From the stowed position, the doors swing aft to an extended position behind the fan and engine exhaust for reverse thrust application. Actuation of these doors is accomplished by two hydraulic actuators located on the top and bottom centerlines of the fan exhaust case.

ENGINE INSTRUMENTS.

Instruments used to indicate compressor speed, fuel flow, exhaust gas temperature, and engine pressure ratio are tape type indicators. Scale markings are vertical and each instrument incorporates readings from all four engines so that they may be easily compared.

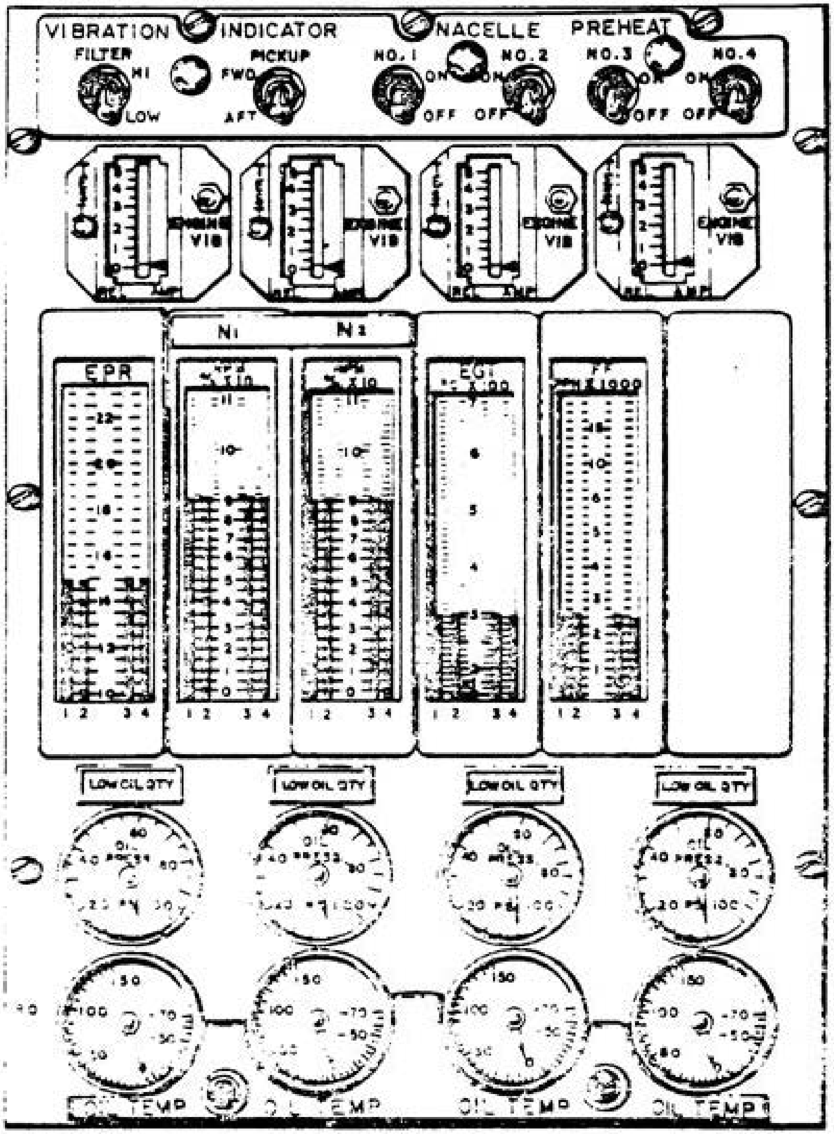
Oil pressure and oil temperature indicators are dial type instruments and individual instruments are provided for each of the four engines. Individual linear type indicators, located on the flight engineer's panel, receive signals from vibration pick-ups mounted on each engine to provide a further indication of engine condition.

AUXILIARY POWER UNIT.

In order to enhance the ability of the StarLifter to operate independently of ground support equipment, a gas turbine auxiliary power unit (APU) is installed in the left main landing gear pod. This APU is a single shaft gas turbine engine with a two stage centrifugal compressor, a single can combustion chamber, and a single stage radial inflow turbine. When operating, the APU provides a supply of compressed air for the aircraft pneumatic system and mechanically drives an A-C generator that serves as a source of electrical power when the aircraft engines are not operating or external power is not available. Fuel is supplied to the APU from the aircraft fuel system and oil is supplied from a tank attached to the compressor section of the unit. Installed weight of this unit is approximately 260 pounds.

Controls for the APU are located on the flight engineer's panel. Protective devices are installed to prevent operation of the APU when any one of the following condition exist:

1. Improper oil pressure
2. Turbine overtemperature
3. Improper exhaust or intake door position
4. Landing gear squat switch open (aircraft in flight)



ENGINE INSTRUMENTS
(FLIGHT ENGINEER'S PANEL)

AIRCRAFT SYSTEMS

BLEED AIR SYSTEM.

Air under pressure is used to operate a number of systems on the StarLifter. These include the engine starter system, a nacelle preheat system, the wing anti-ice system, windshield rain removal, underfloor heat, and aircraft air-conditioning. The output from the air conditioning system is, in turn, used for aircraft pressurization, windshield defog, and electric-electronic component cooling.

While in flight, air pressure to operate these systems is available from the diffuser section of each of the four engines. On the ground, air can be supplied from one or more of the ships engines, the APU, or an external air supply. These sources furnish very hot air since air experiences a drastic temperature increase during compression. This hot, high pressure air is stored and ducted as necessary by a bleed air system. The bleed air system consists of an insulated stainless steel manifold, that runs cross-wing next to the front box beam, along with the necessary valves and plumbing to connect this manifold to the air sources and to the using systems.

The plumbing that connects the APU and external air source to the manifold is also used to conduct hot bleed air to the underfloor heat system. Pressure in the manifold is indicated by a bleed manifold pressure gauge located on the environmental control panel.

ENGINE START SYSTEM.

A pneumatically powered starter is used to start the engine while the aircraft is on the ground. A starter control valve controls the flow of air to the starter as well as limiting inlet air pressure to a predetermined maximum value. The starter, when supplied with pneumatic and electric power, provides rotational torque to the engine N2 compressor until a selected starter or engine speed has been reached. At this time, a cutout switch actuates and automatically closes the starter control valve. When this valve is closed, the starter is disengaged from the engine by means of a clutch.

NACELLE PREHEAT.

The nacelle preheat system consists of a nozzle and an electrically operated shutoff valve. Its purpose is to increase the temperature of engine components for very cold weather starts. This is accomplished by circulating hot air from the bleed air system around the inside of the nacelle. Use of this system is recommended only when the engine has been cold soaked by prolonged exposure to a temperature of -40°C or below.

WING AND EMPENNAGE ANTI-ICE.

Ice formation on the wings is prevented by an evaporative anti-icing system which uses air directly from the bleed air manifold. This system heats the wing leading edge surface by using a jet-pump to circulate a mixture of bleed air and leading edge plenium air through double skin heat transfer passages. A thermostatically controlled valve regulates the amount of hot air supplied. Lights on the pilot's overhead panel and on the annunciator panel warn of system overheat. The system may be turned on or off by positioning three switches that are located on the pilot's overhead panel. The horizontal stabilizer is electrically deiced. No ice protection is required for the vertical stabilizer.

WINDSHIELD RAIN REMOVAL.

The StarLifter is equipped with a jet blast rain removal system. The pilot's and copilot's windshields are cleared by high temperature, high velocity air supplied through slot type nozzles at the base of the windshield. This air is routed through the primary heat exchanger after leaving the bleed air manifold and is somewhat cooler than the air in the manifold. The primary heat exchanger will be discussed further in the section on air conditioning which is to follow.

UNDERFLOOR HEAT.

Hot air for the underfloor heat is furnished directly from the bleed air manifold. The air passes through a flow limiting venturi, an electrically operated shutoff valve, a pneumatically controlled modulating valve, and into an ejector assembly located under the cargo compartment floor. Hot air from the ejector is mixed with underfloor ambient air and distributed by ducts to circulate under the floor and vent into the cargo compartment. The temperature of the air being circulated is sensed by a pneumatic thermostat and a pneumatic anticipator that work together to position a pneumatic modulating valve. This valve maintains the temperature in the underfloor area at approximately 65°F. A continuous loop sensor functions to shut off the system in the event of overheat.

AIR CONDITIONING.

Air conditioning for the flight station and cargo compartment is provided by two parallel air conditioning systems that share a common system of distribution ducts. Normally, both systems are operated in unison but either system is capable of furnishing limited air conditioning to both compartments.

Each of these parallel systems can be considered as being a union of three sub-systems, a primary heat exchanger sub-system that limits the temperature and pressure of air to be processed, a refrigeration sub-system that furnishes a supply of cold air, and a temperature control sub-system that controls the amount of hot air added for temperature control.

In the primary heat exchanger sub-system, air from the bleed air manifold passes through a flow limiting venturi to a pressure regulator valve that limits pressure to approximately 70 PSIG and then into the primary heat exchanger which limits air temperature at the outlet to approximately 450°F. System protection in the event of pressure regulator failure is furnished by a relief valve that opens at approximately 110 PSIG. A temperature control system regulates the flow of ram air across the primary heat exchanger to maintain the air outlet temperature as desired. At low air speeds, ram air flow across the primary heat exchanger is induced by a jet pump using bleed air. Above mach 0.3, use of the jet pump is not required and it is automatically discontinued.

Air from the primary heat exchanger sub-system is furnished to the remaining two sub-systems. The refrigeration sub-system causes this air to pass through a secondary heat exchanger and to a turbine bypass valve that further directs air flow either around a cooling turbine or through this cooling turbine. These paths of air flow then join and enter a moisture separator. The turbine bypass valve position is controlled by a temperature sensing system that will maintain the temperature of air entering the moisture separator at approximately 35°F. The function of the moisture separator is to remove excess water from the air before it enters the air conditioning ducts.

The temperature control sub-system consists primarily of an aircraft temperature control system (flight station or cargo compartment) and a refrigerator bypass valve. This valve is positioned by the temperature control system to govern the amount of 450°F air that is allowed to mix with the 35°F air prior to its entering the air conditioning distribution ducts so as to provide temperature control.

Two valves located in the distribution ducts control the distribution of the two air conditioning systems. An environmental control panel at the flight engineer's position contains the various instruments and switches that allow monitoring and control of this system. Air conditioning is available anytime the bleed air manifold is pressurized and air from this manifold is not being used for engine start.

ELECTRICAL AND ELECTRONICS COMPONENT COOLING.

The majority of the aircraft avionics and electrical equipment is located in racks beneath the flight station floor. The equipment is cooled by crew compartment discharge air which circulates over the unducted equipment, then through the ducted equipment into the exhaust plenums, and overboard through the cooling system flow control valve.

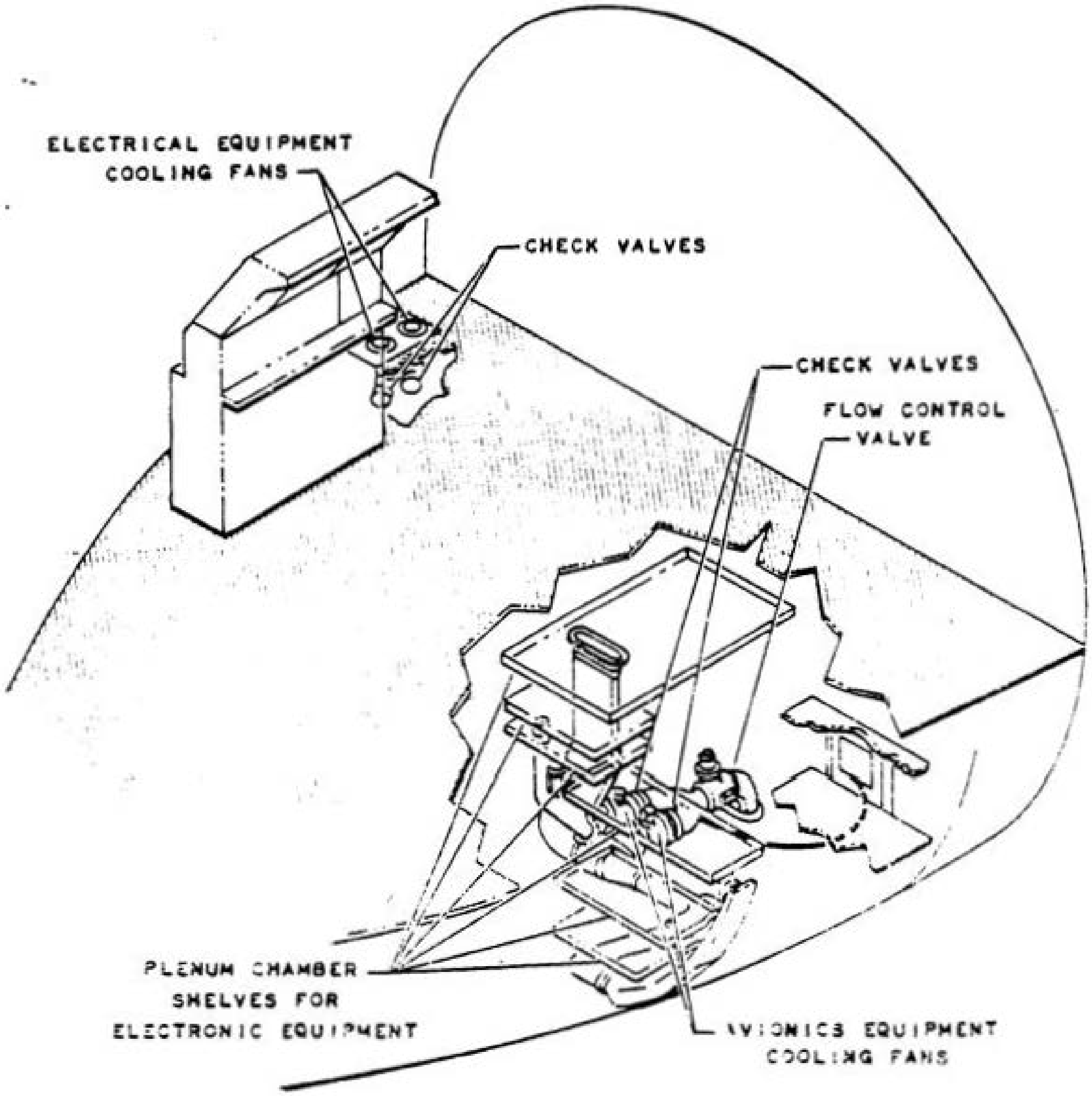
Flow is proportioned to the ducted equipment by orifices. Two large fans are used to assure cooling air flow through the electronics equipment racks. Whenever electrical power is on the aircraft, the electronics cooling system is in operation. One fan operates continuously during flight and both fans operate on the ground. The flow control valve is actuated to the open position when the aircraft is on the ground and modulates to limit pressure loss while in flight. In case of a malfunction of the operating fan in flight, the second fan automatically comes on.

Two small fans are used to assure cooling of electrical components. These fans pull air from the flight station across the back of the main A-C panel then dump it under the floor in the vicinity of the electrical equipment racks on the right side of the aircraft. Control of these fans is similar to control of the larger electronics cooling system fans.

AIRCRAFT PRESSURIZATION.

A large quantity of air flows into the aircraft to provide air conditioning. If this air were not allowed to escape, pressure would build up inside the fuselage. On modern high altitude aircraft, it is desirable to maintain a pressure within the aircraft as near sea level atmospheric pressure as is practical since the low atmospheric pressure at altitude forms a hostile personnel environment. By sealing most of the openings in the fuselage and installing air outlets with variable openings, a pressure build up can be accomplished and controlled. Basically, this is the method used for pressurization control in the StarLifter.

Airflow from the pressurized portion of the fuselage is controlled by two large combination outflow-safety valves mounted on the pressure bulkhead at the rear of the cargo compartment. These valves are of the balanced-poppet type, each having two chambers that are separated by a diaphragm attached to the poppet valve.


ELECTRICAL EQUIPMENT
COOLING FANS
CHECK VALVES
CHECK VALVES
FLOW CONTROL
VALVE
PLENUM CHAMBER
SHELVES FOR
ELECTRONIC EQUIPMENT
AVIONICS EQUIPMENT
COOLING FANS

Cabin pressure is felt on one side of this diaphragm and a control pressure is sensed on the other side. Any change in cabin pressure or control pressure will result in a pressure difference across the diaphragm that will reposition the outflow valve and change the amount of air leaving the pressurized compartment.

The control pressure used in these outflow valves is established in either of two pressure controllers. One of these pressure controllers can be setup to automatically control aircraft pressurization. The other must be maually reset when a change in control pressure is desired. Cabin pressure is allowed to enter these controllers through a metered orifice and they create the desired control pressure by controlling the airflow from the controller to a negative pressure source. A jet pump, operated by bleed air pressure, provides this negative pressure source.

This system will allow a sea level cabin pressure to be maintained to an aircraft altitude of 21,000 feet or a cabin pressure altitude of 8,000 feet be maintained to an aircraft altitude of 40,000 feet. The automatic pressure controller permits the selection of any cabin pressure altitude between -1,000 feet and 10,000 feet and the selection of a rate of pressure change as desired between 200 and 2,000 feet per minute.

A warning light on the annunciator panel will illuminate anytime the cabin pressure altitude exceeds 10,000 feet. One feature of the system will limit the cabin pressure altitude to approximately 13,500 feet unless an override is actuated to permit complete pressure release.

A control venturi and fan assembly, wired through the landing gear touchdown switch, functions to prevent aircraft pressurization on the ground. This fan must be deactivated if ground test of the pressurization system is desired.

Emergency depressurization of the aircraft can be accomplished either electrically or manually. Electrical operation is accomplished by either of two switches which are located on the pilot's overhead panel and on the environmental control panel at the flight engineer's station. These switches function to open two pneumatic valves that will port pressure from the bleed air manifold to the cabin pressure side of the outflow valve diaphragm and force the outflow valves open. Manaual depressurization provisions consist of a handle and cable assembly that will release the aft escape hatch in the cargo compartment.

A cabin rate of climb indicator and a cabin pressure instrument, located on the environmental control panel, assist the flight engineer in monitoring the aircraft pressurizing system.

OXYGEN.

Since the StarLifter is a fully pressurized aircraft, oxygen systems are installed primarily for emergency use or for use on medical evacuation missions. Provisions are incorporated in the aircraft for two complete systems. One of these systems, intended for the protection of the air crew, is always maintained in operation. A system, intended for the use of passengers, may be installed as required.

The crew system consists of nine diluter demand regulators, five portable bottles, five recharger outlets for portable bottles, a manual shutoff valve, two heat exchangers, a 25 liter converter, and a service, build-up, and vent valve. This system operates at a pressure of approximately 300 PSI provided from a supply of liquid oxygen stored in a converter. The converter is located in the left side of the nose wheel well area and can be serviced from the exterior of the aircraft. An oxygen indicator is installed on the copilot's side console. A light on the annunicator panel will illuminate anytime oxygen quantity falls below 2.5 liters.

The passenger oxygen system is a continuous flow system which operates at a supply pressure of approximately 300 PSI and a distribution pressure that will vary from 29 PSI at low altitude to 69 PSI at maximum aircraft altitude. Not all of the components of this system remain installed on the aircraft. Provisions are incorporated in the aircraft for the installation of varying components to meet mission requirements.

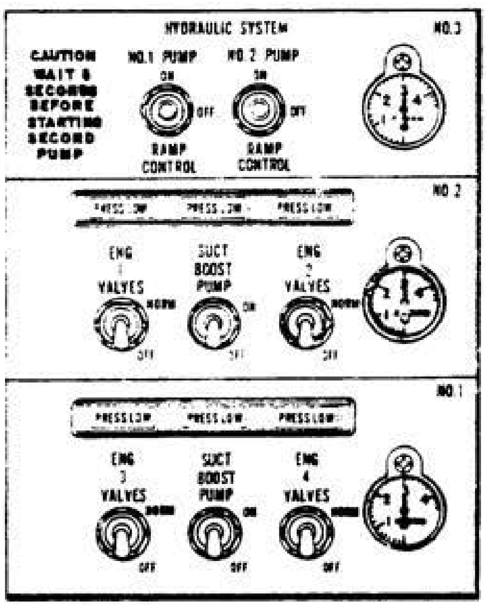
A removable oxygen supply kit is available that utilizes either one or two 72 liter liquid oxygen converters. This kit is installed in the forward end of the right main landing gear pod. Either one or two converters can be installed depending upon anticipated requirements. This kit also contains a regulator panel that includes two continuous supply regulators, two oxygen quantity gauges, and associated warning lights, valves, and controls. Either of the two regulators is capable of supplying full system requirements but both are normally used in unison to preclude the interruption of oxygen flow in the event of failure of one of the regulators.

Components of the passenger system that normally remain installed in the aircraft include distribution lines and self-sealing outlets with metering valves. These metering valves will control the flow of oxygen to disposable masks based upon distribution system pressure. Two additional kits are available that will supply additional distribution components for various passenger configurations.

Operation of the passenger system is normally controlled automatically. The oxygen flow will begin automatically when cabin pressure altitude reaches 12,500 to 14,000 feet. The systems can be operated maually from a manual override switch on the regulator panel or from two manually operated shutoff valves mounted on the right side of the cargo compartment.

HYDRAULIC SYSTEMS.

The StarLifter utilizes three separate and independant 3000 PSI hydraulic systems. A fourth system is installed to provide facilities for emergency nose gear extension. These systems are identified by number. System No. 1 is used to provide half the power required to operate the primary flight control dual power packages. System No. 2 provides the remaining power required for the flight control power packages as well as power for landing gear operation, nose wheel steering, the normal brake system, an emergency A-C/D-C generator, the hydraulic portion of the pitch trim actuator, and half the power requirements for the flaps and spoilers. System No. 3 provides hydraulic power to operate the cargo ramp, the aft pressure door, the petal doors, the emergency brake system, the APU starter motor, and the remaining requirements of the flaps and spoilers. A hydraulic systems control panel, mounted on the left side of the flight engineer's panel, provides the primary point for control of these systems.



HYDRAULIC SYSTEMS CONTROL PANEL

SYSTEM NUMBER ONE.

Hydraulic system No. 1 is powered by two variable volume pumps that are connected in parallel and driven by engines No. 3 and 4. The majority of the components for this system are arranged as a service center located on the right side of the cargo compartment. Connections for a hydraulic test stand are provided in the forward section of the right wheel well to permit ground check out of the system. An electrically driven booster pump is provided to assure an adequate fluid supply to the suction side of the engine driven pumps.

System pressure is normally limited to 3000 PSI by action of the engine driven pumps.

Should this feature on one or both pumps fail, system pressure would be limited to approximately 3600 PSI by a system relief valve. An electrically operated gate-type shutoff valve is provided in the suction line and a solenoid controlled shutoff valve is provided in the pressure line for each of the engine driven pumps to allow isolation of an individual pump. These valves may be controlled by switches on the hydraulic control panel or by the appropriate fire "T" handle. Lights on the hydraulic control panel provide a warning in the event of pump failure or loss of system pressure. Use of system pressure to power the flight controls will be discussed in a section of flight controls which is to follow.

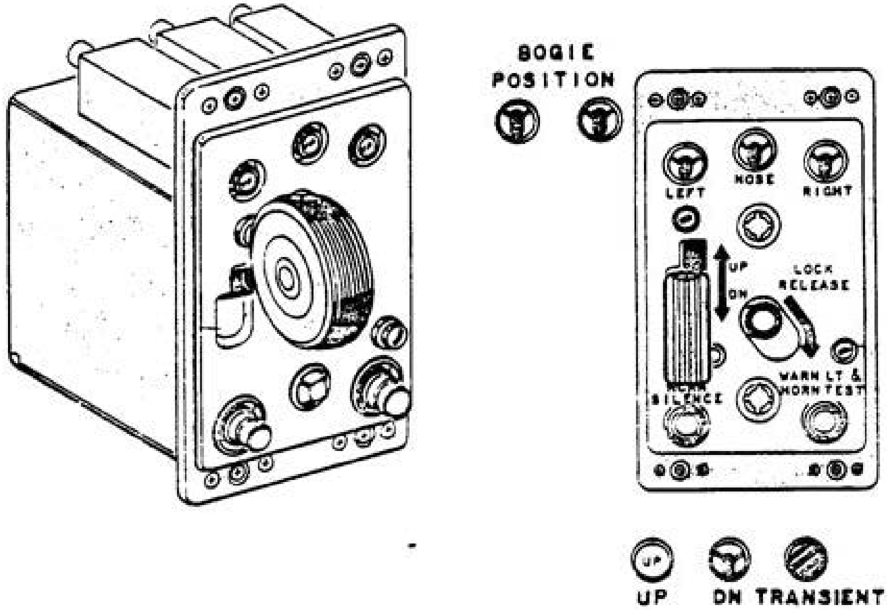
SYSTEM NUMBER TWO.

The power section of system No. 2 is very similar to the power section of system No. 1. The major differences are location of the engine driven pumps, the location of other components, and the number and type of suction booster pumps. The engine driven pumps for this system are mounted on the accessory section of engine No. 1 and 2. Test stand connections are located in the forward end of the left wheel well and the majority of the system components are located in a service center on the left side of the cargo compartment. In addition to an electrically driven suction boost pump of the type used in system No. 1, a hydraulically driven boost pump is used to assure an adequate supply of fluid to the suction side of engine driven pumps. Pressure to drive this boost pump is provided by the system as it becomes operational.

LANDING GEAR-Both the left and right bogie type main landing gear as well as the nose gear are fully retractable. They are hydraulically powered by actuating cylinders and all retract forward and upward into their respective wheel wells. The doors used to fair in the wheel wells are connected to the landing gear by rods and torque tubes in a manner that will cause them to open and close as the gear is extended and retracted. A small door at the top of each of the main gear pods opens to allow the main gear oleo strut to protrude when the gear is in the down position. An axle beam positioner and a leveler rod, incorporated into each main gear, cause the bogie type gear to remain roughly parallel to the centerline of the aircraft when extended or retracted.

An electrical switch, mounted on the center instrument panel, controls the position of four landing gear selector valves that are used to direct the flow of hydraulic fluid during landing gear operation.

This switch panel includes a position indicator for each main gear and the nose gear, a lock to prevent inadvertent retraction of the landing gear, a release for this lock, and control switches for the landing gear warning horn. Mounted



CONTROL PANEL

just to the left of this panel are bogie position indicators for each of the main gear bogies. Hydraulically actuated locks retain the nose and main gear in either the extended or retracted position.

Emergency extension of the main landing gear is made possible by a separate emergency extension system for each gear. Each system consists of a cable and handle to release the door uplock, a cable and handle to release the gear uplock, and a handle and bellcrank mechanism to force the draglink into the down and locked position after the gear has been allowed to free fall.

Nose gear emergency extension is made possible by the No. 4 hydraulic system. This system consists of a control panel, a handpump, a reservoir, and the necessary plumbing. When the handle on the control panel is selected to the "EMER" position, pressure from the hand pump is directed through a shuttle valve to the gear uplock and downlock. This allows the gear to free fall into the down position. Pressure from the hand pump is used to assure that the gear is forced firmly into the down lock. Retraction of the nose gear after use of the emergency extension system will result in fluid transfer from the No. 4 system to the No. 2 system. Caution must be exercised in this event to prevent overservice of the number 2 reservoir.

NOSE WHEEL STEERING- The nose landing gear steering system consists primarily of a steering column assembly and indicator, a steering actuator, and a steering control valve. Movement of the nose steering wheel, located to the left of the pilot, results in movement through the steering column and indicator, through a cable and chain assembly, and to the steering control valve. Movement of the steering control valve ports fluid to the appropriate side of the dual steering actuator which, moves the nose wheel to the left or right as desired. The steering column assembly is connected to the rudder pedals by means of a bungee assembly that will permit limited nose wheel steering by movement of the rudder pedals any time main wheel speed is above 50 knots.

A maximum of 80° rotation of the nose wheel to the left of right of center is possible using the nose steering wheel. A total movement of eight degrees left or right of center is possible using the rudder pedals. When the weight of the aircraft is removed from the landing gear, an integral centering mechanism in the nose strut centers the nose strut for retraction. With the nose gear retracted, the nose steering mechanism is disconnected from the steering column and locked in the center position.

EMERGENCY GENERATOR- The emergency generator is an A-C/D-C generator driven by a hydraulic motor and controlled by a solenoid operated three way, two position, hydraulic valve. Normal control of the generator is automatic. The solenoid operated valve is normally energized closed anytime power is on the aircraft. Loss or normal electrical power will open the solenoid valve and start the hydraulic motor. An emergency power test switch is provided on the flight engineer's upper panel. The positions available on this switch are "NORMAL" and "TEST". The instrument power switch on the pilot's instrument panel may be used to turn on the emergency generator if D-C power is lost and A-C power remains normal. This is a three position switch with "OFF," "NORMAL," and "EMER" positions.

SYSTEM NUMBER THREE.

Hydraulic system No. 3 is powered by two electrically-driven, variable volume pumps connected in parallel. The pumps are located in the forward end of the left wheel well. A number of system components are grouped into a service center and located on the left of the cargo compartment just forward of the No. 2 system service center. Manually operated interconnect valves are provided to allow hydraulic power from system No. 3 to be delivered to system No. 2 during ground check out. This is the only purpose of these valves and they remain safety wired to the off position during normal system operation.

Two 400 cubic inch piston-type accumulators are installed at the No. 3 service center to store a reserve supply of fluid under pressure to be used for APU starts and emergency braking. A hand pump is incorporated to charge these accumulators and to permit manual operation of the cargo ramp, aft pressure door, and petal doors. An 80 cubic inch fuse is installed in the pressure line of each electric pump to minimize the starting load on the pump motors. Controls for this system are located on the hydraulic control panel at the flight engineer's station and on the ramp control panel at the rear of the cargo compartment. Pump selector switches on the ramp control panel are operative only when the pump selector switches on the hydraulic control panel are in the "RAMP CONTROL" position. Operation of the flaps or spoilers and some emergency procedures will result in automatic pressurization of the No. 3 system.

WHEEL BRAKES-A multiple disk manually adjusted brake assembly is installed on each main wheel. Hydraulic fluid under pressure pushes eleven equally spaced pistons against a non-rotating disk to compress the assembly. Half of the disks rotate with the wheel and half are keyed to the brake assembly. This provides a large area of braking surface having a high coefficient of friction. Four manually adjustable screws provide a means of compensing for normal brake wear.

The power system for these brakes provides for normal operation from the No. 2 hydraulic system and emergency operation from the No. 3 hydraulic system. Anti-skid protection can be selected but will function only when the normal brake system is used. A method for locking the brakes while the aircraft is parked is provided.

The brake selector switch located on the copilot's instrument panel is used to select either normal or emergency operation of the brakes. When this switch is in the "NORM" position, an emergency brake selector valve is energized to shut off the supply of pressure from the No. 3 system. When this switch is in the "EMER" position, a normal brake selector valve is energized to shut off the supply of pressure from the No. 2 system. In the absence of electrical power, both selector valves are deenergized open and both systems No. 2 and 3 will provide pressure for the brake system.

Two dual pilot metering valves are located underneath the cockpit floor. These valves are actuated by the pilot's and copilot's rudder pedals and serve to regulate pressure to the anti-skid valves in direct proportion to the force applied to the depressed rudder pedal. Pressure from the normal side of the dual pilot metering valve is routed to each half of two dual anti-skid control valves which causes No. 2 system pressure from the main landing gear down line to be metered to the appropriate brake assembly. Pressure from the emergency side of the dual pilot metering valve is routed to a dual main metering valve which meters No. 3 system pressure to the appropriate brake assembly.

Eight hydraulic fuse assemblies are installed in the normal brake system to limit the loss of fluid in the event of a serious leak. During landing gear retraction, the main landing gear wheels are slowed by braking action created by a back pressure in the fluid return lines at the anti-skid valves.

CARGO DOORS-The petal doors, aft pressure door, and cargo ramp normally operate in unison. They are collectively referred to as the cargo doors. Hydraulic pressure for the operation of these doors is supplied exclusively by the No. 3 hydraulic system. Four separate control panels may be used when controlling or monitoring cargo door position. Aerial delivery system (ADS) control panels, located at both the pilot's and copilot's position, permit operation of all doors in flight. A crew door interphone and public address control panel can be used to open and close the aft pressure door in flight. A DOOR AND RAMP CONTROL panel, located in the rear of the cargo compartment, is used when the cargo doors must be positioned while the aircraft is on the ground. The door arming switch on the pilot's ADS panel must be in the "ARM" position to permit use of the DOOR AND RAMP CONTROL panel.

When static line "A" frame actuators are installed, only the PRESSURE DOOR switch on the DOOR AND RAMP CONTROL panel will close the aft pressure door. If the static line "A" frame actuators are not installed, adapter plugs must be placed in the actuator connectors. When these adapter plugs are installed, sequence operation of all doors is possible from the ALL DOORS switch on the DOOR AND RAMP CONTROL panel.

FLIGHT CONTROLS.

The primary flight controls are utilized for maintaining altitude and directional control of the aircraft. The ailerons are controlled by turning the control wheel. The elevators are controlled by fore and aft movement of the control column and the rudder is controlled by fore and aft movement of the rudder pedals. The output from dual sets of controls in the cockpit is transmitted to individual flight control power units through mechanical linkages and cables. Each flight control cable system has tension regulators to compensate for changing temperatures. Each regulator consists of two metal quadrants which are mounted on a common shaft and are connected by a compression spring assembly. A scale on each regulator is used to rig the cable tension in relation to ambient temperature.

AILERONS.

A separate cable system connects each of the two control wheels to an input quadrant assembly mounted on the center wing rear beam in the cargo compartment. The autopilot servo and the aileron trim actuator also connect to the input quadrant. A springloaded cartridge attached to the input quadrant artificially creates the "feel" normally associated with flight control movement and serves to return the system to neutral when forces on the control wheel are relaxed.

Input motions from these control sources can rotate the input quadrant in either direction from neutral. Rotary motion of the input quadrant is transferred by push-pull rods, bellcranks, and cable assemblies to the dual power control units that are mounted on the rear wing beam at each aileron. Each of these dual power units has two actuators. Power for one of these actuators is furnished by the No. 1 hydraulic system and power for the other is furnished by the No. 2 system.

During normal operation, each actuator provides one half of the force required to operate the attached aileron. Either actuator is capable of providing sufficient force for aileron operation in the event of hydraulic power failure to the other actuator. Emergency operation is possible through servo tabs mounted on the rear of each aileron. These tabs may be manually operated by the same linkage that is used to position the aileron through the power unit. Tab movement will generate aerodynamic forces that will position the aileron as desired. The aileron tab is locked to the aileron and does not deflect during normal power on system operation. The selection of either of two switches on the pilot's overhead panel to the "TAB OPERABLE" position will cause hydraulic pressure from system No. 3 to release one of the tabs for operation.

Combination shutoff and bypass valves are installed in the lines to each of the actuators. During normal operation these valves direct system pressure to the appropriate side of the system control valve on the power unit. They can be individually shut off to block hydraulic pressure and deactivate a particular actuator. These valves are controlled by the aileron system switches on the pilot's overhead panel. In the event of a pressure loss, pressure switches in each of the hydraulic POWER OFF lights on the pilot's overhead panel and an AILERON SYS PWR light on the annunicator panel.

RUDDER.

The rudder pedals are connected by push-pull rods and levers to cable tension regulators under the flight deck floor. The pilot's and copilot's rudder pedals are interconnected through mechanical linkage at the tension regulators. Mechanical stops restrict the movement of rudder pedals to the amount necessary to provide full control surface travel.

A separate cable system connects each of the two tension regulators to an input quadrant located near the rudder power control unit. Rotary motion of this input quadrant is transferred by push-pull rods and bellcranks to displace the servo control valve on the power control unit. An artificial feel unit that simulates rudder forces is attached to the input quadrant. The rudder trim mechanism repositions the neutral position of the feel unit to provide rudder trim.

The dual power control unit includes two actuators mounted so that they must work in opposite directions to position the rudder. Hydraulic power for one of these actuators is furnished by system No. 1 and power for the other is furnished by system No. 2. Both actuators normally work in unison to provide the power necessary for rudder operation. In the event of a pressure failure in one of the systems, the actuator powered by the remianing system would be capable of providing the required operating force.

A yaw damper servo unit, located on the rudder power control unit, attaches directly to the servo control valve. Signals from a yaw rate gyro cause the damper servo to move the servo control valve and position the rudder to correct the yawing movement. This rudder movement is independant of input quadrant movement except for feedback forces that would be felt through the artificial feel device.

At higher air speeds, normal system pressures would allow forces to be generated that could exceed the structural limits of the aircraft. To prevent this, hydraulic pressure to the rudder power control unit is normally limited to 900 PSI at any airspeed above 160 knots. Below this airspeed, pressure is allowed to reach 2,450 PSI. This is accomplished by load limiting relief valves inside the power control unit that are controlled by signals from a central air data computer (CADC). A rudder high pressure override switch on the pilot's overheat panel can be selected to the "OVERRIDE" position to permit rudder operation with 2450 PSI system pressure if necessary.

Two combination shutoff and bypass valves permit selection of one hydraulic system for rudder operation if desired. These valves are controlled by switches on the pilot's overhead panel. Pressure switches incorporated in both hydraulic system No. 1 and 2 will cause a rudder system POWER OFF light to illuminate in the event system pressure is lost. This would be accompanied by illumination of the RUDDER SYS PWR light on the annunciator panel. In addition, a HI PRESS light on the pilot's overhead panel will illuminate anytime system pressure exceeds 1650 PSI and a RUD OVER PRESS light on the annunicator panel will illuminate if the pressure reaches 1650 PSI with airspeed above 160 knots.

ELEVATOR.

Each control column is connected to a cable tension regulator by a push-pull rod. The pilot's and copilot's elevator controls are interconnected through a push-pull rod attached to the input bellcranks of the tension regulators. The control columns are equipped with bobweights which work in conjunction with an installed artificial feel spring to produce a slight forward column movement with positive "G" forces and a slight aft column movement with negative "G" forces.

A separate cable system connects each tension regulator to an input quadrant assembly located in the empennage. This quadrant assembly includes two large quadrants used to attach the cables from the tension regulator and a smaller quadrant used to attach the cable from the autopilot servo. An artificial feel "Q" spring is mounted between the two large cable quadrants. One end of the "Q" spring attaches to aircraft structure and the other end attaches to the input quadrant through an electric "Q" actuator. Signals from the CADC adjust the "Q" actuator to vary artificial feel with changes in airspeed. An elevator input neutral detent device is included to provide an elevator neutral position that can vary with changes in "Q" spring tension. A malfunction in the "Q" actuator system will cause the "Q" spring actuator motor to be automatically deenergized and an ELEV FEEL MALFUNC light on the annunicator panel to be illuminated. The actuator can be positioned to a mid point of travel following a malfunction in flight but cannot be reset until the aircraft is on the ground.

The elevator power control unit has three actuators, each of which is supplied by a separate hydraulic system. Each actuator is capable of operating the elevator without assistance, but two are operated in unison when possible to provide assurance of uninterrupted power. One of the actuators is supplied by system No. 1 and the second is supplied by system No. 2 for normal operation. Hydraulic system No. 3 provides power to the third actuator for emergency operation. Three combination shutoff and bypass valves provide control of the flow of fluid to the actuators. Two switches on the pilot's overhead control panel are used to position these three valves. With both of these switches in the "NORM" position, the valves for system No. 1 and 2 are open and the valve for system No. 3 is closed. When either or both of these switches are selected to the "EMER" position, the selected valve or valves will go to the closed position and the valve for system No. 3 will open.

Pressure switches, located in the supply lines from system No. 1 and 2, will illuminate an elevator system POWER OFF light on the pilot's overhead control panel and an ELEV SYS PWR light on the annunicator panel in the event of pressure loss in either of these systems. A pressure switch in the supply line from the No. 3 system will cause illumination of an EMER PWR ON light on the pilot's overhead panel anytime system pressure is sensed at the No. 3 actuator. A loss of pressure in system No. 3 while either of the elevator control switches on the pilot's overhead panel are in the "EMER" position will cause the ELEV EMER PWR light on the annunicator panel to illuminate.

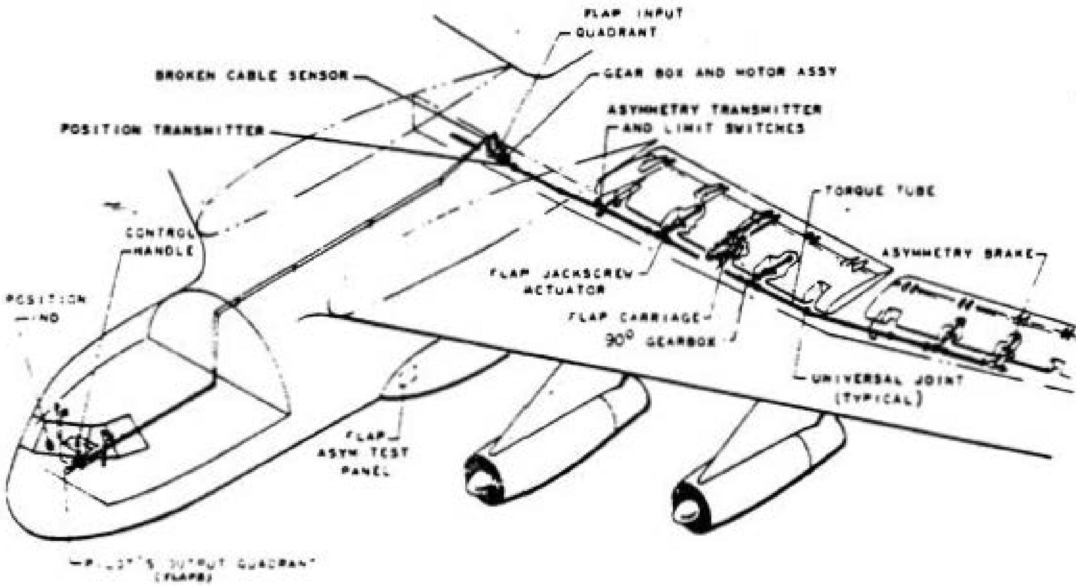
FLAPS.

Four sections of double-slotted Fowler-type flaps are installed on the StarLifter to improve landing and takeoff characteristics. They are mounted on carriages which roll on curved tracks that extend aft from the structure of the wing. A flap control handle, located on the center console, governs flap position. The knob on the flap control handle is shaped like an airfoil. The rear of this knob must be tilted forward to decrease friction sufficiently to permit flap control handle movement. Three detents in the track portion of the flap selector assist in locating the "UP", "TAKEOFF AND APPROACH", and "LANDING" positions. A flap position indicator is located on the center instrument panel.

The flap control handle is connected by means of a cable assembly to an input quadrant and gear box installtion located on the rear wing beam in the cargo compartment. The gear box is powered by two hydraulic motors. Hydraulic system No. 2 is utilized to drive one of these motors and system No. 3 to drive the other. During normal operation, each motor provides half the torque required to drive the gear box. In the event pressure is lost in one of these systems, a differential gear and brake arrangement will allow flap operation at approximately one half normal speed. A feedback function within the gear box assures that flap position will be as selected.

Torque tubes that run the length of the flaps along the wing rear box beam transmit the torque output of the gear box and jackscrew assemblies. These jackscrew assemblies drive the flaps fore and aft along their mounting tracks while track contour forces them to the faired or down position. Brake assemblies, mounted on the outboard ends of the torque tube, lock the flaps in place anytime an asymmetrical flap condition is detected by a sensing circuit. Flaps, that are locked in place as the result of an asymmetrical flap condition detected in flight, cannot be repositioned until the aircraft is on the ground.

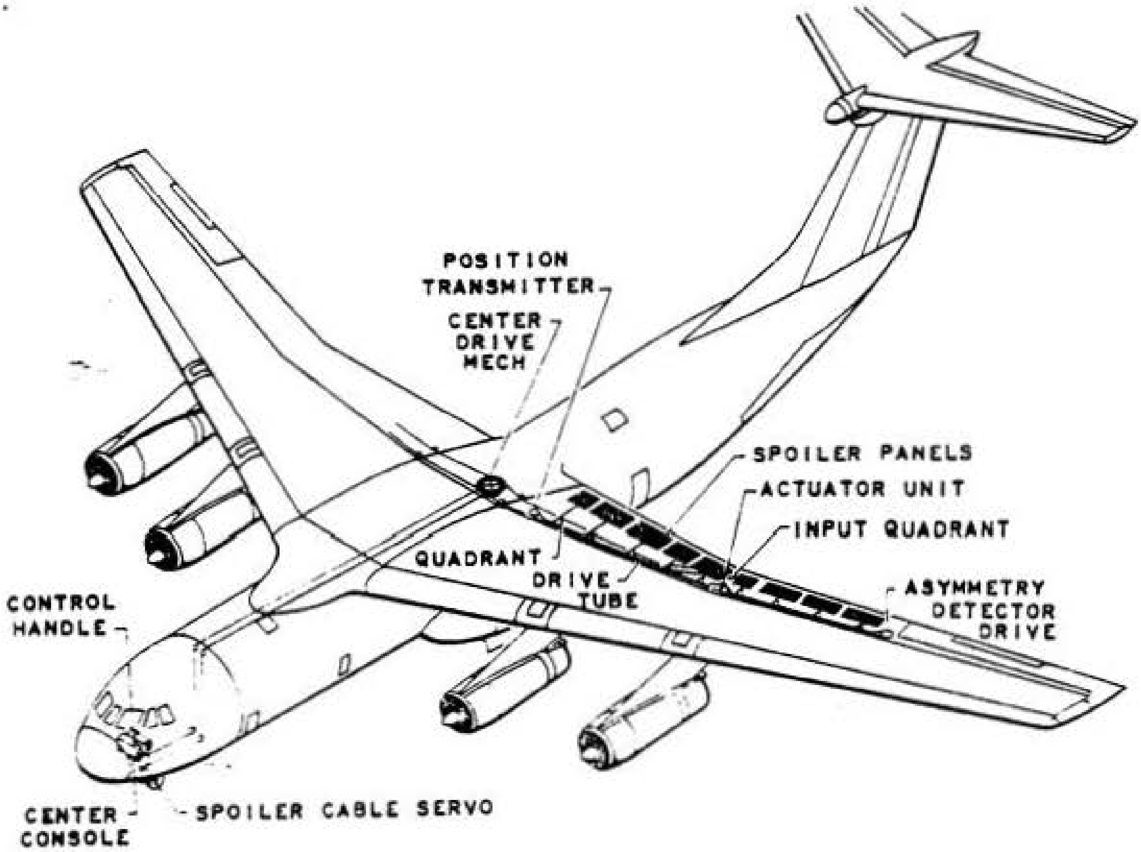
A manually operated shutoff valve, located adjacent to the flap drive gearbox, must be closed anytime hydraulic system No. 3 is used to operate the components of system No. 2. Damage to the flap drive gearbox is possible if this procedure is not followed. It will be noted that this condition would occur during ground checkout of hydraulic system components while using the electrically driven pumps of system No. 3 to furnish pressure.



FLAP SYSTEM INSTALLATION

SPOILER SYSTEM.

Hydraulically actuated, lift-spoiling panels are installed on the upper and lower surface of the aircraft wings. These spoilers are used during a rejected takeoff to reduce speed and lift. In flight, spoilers are used as a speed brake to promote a high rate of sink or simply to slow the aircraft. During landing, spoilers are used to spoil the effective extra lift created by the flaps so that the aircraft may be stopped in a relatively short distance.



SPOILER CONTROLS INSTALLATION

The spoiler system is controlled by manual movement of the spoiler control handle on the center console. The system may also be armed to operate automatically at touchdown or in the event of a rejected takeoff. Arming the system is accomplished by positioning a rotary SPOILER SELECT switch on the center console and by pulling the spoiler control handle outward.

A spoiler actuator unit is located on each wing and is attached to the wing rear beam where the trailing edge starts to sweep back. Each spoiler actuator unit contains two tandem hydraulic actuators. One of the actuators drives the spoiler panels located inboard of the actuator unit, and the other actuator drives the spoiler panels located outboard of the unit. The movement of the actuators is transmitted to the spoiler panels by mechanical linkage. A drive tube is threaded onto each actuator and is connected by cables to a drive quadrant for each spoiler panel in the group. The spoiler panels are connected to the drive quadrants by push-pull rods. There are 36 spoiler panels on the wings that are divided into an inboard and an outboard group. Each group contains panels on both the upper and lower surface of the wing. There are five upper and five lower panels in the inboard group and four upper and four lower in the outboard group.

During flight, the tandem actuators for both spoiler actuator units are jointly powered by hydraulic systems No. 2 and 3 for all spoiler operation. For ground operation, the inboard actuators use the No. 2 system and the outboard acutators use the No. 3 system. In the event of pressure loss in either system, the remaining system will provide for all spoiler operation. Should an asymmetrical spoiler condition occur, all spoiler panels automatically close.

Spoiler position is indicated on a dual instrument located on the center instrument panel. An ARMED light and a GROUND light are located on the center console to indicate system operation. DETECTOR lights are located on the copilot's side panel and SPOILER ASYM lights are located on the annunciator panel to indicate a spoiler asymmetry condition.

STALL PREVENTION SYSTEM.

Separate pilot's and copilot's stall prevention systems are installed. Although these systems operate independently, the output signals are tied together so that both will receive stall data should one system fail. The stall prevention system uses signals of speed, angle of attack, and yaw to sense and indicate the approach of a stall.

A stall signal will automatically turn on STALL lights on the side consoles, energize hydraulic system No. 3, and start operation of a stick shaker assembly. The stick shaker will vibrate the control column until action is taken to avert the stall. Should the aircraft be allowed to continue into stall producing conditions, a stick pusher will be energized that will force the control column forward. When a stall condition is corrected, the shaker and pusher functions will first be removed from the copilot's column and after a three second delay the shaker and pusher action will be removed from the pilot's column. The purpose of this delay is to permit a smoother recovery of proper aircraft attitude upon removal of the forces from the control columns.

The copilot's stall prevention system is powered by hydraulic system No. 2 and the pilot's system is powered by hydraulic system No. 3. Controls for the stall prevention systems are located on the pilot's and copilot's side console. An emergency shutoff switch is located on the pilot's overhead panel. Additional warning is provided if an attempt is made to operate the spoilers while the aircraft is near the stall regime. In this event, a white light will illuminate on the annunicator panel and an audible warning will be heard.

FUEL SYSTEM.

The aircraft fuel system is made up of ten integral fuel tanks, a spanwise fuel manifold, twenty fuel boost pumps, two single-point refueling adapters, flow control valves, fuel jettison provisions, warning and indicating systems, and a fuel management panel.

There are four main tanks, four auxiliary tanks, and two extended range tanks. The main and auxiliary tanks are numbered one through four to correspond with engine numbering. The extended range tanks are identified as left and right. The center of the wing over the cargo compartment does not contain fuel. All main and auxiliary tanks are single compartment and the extended range tanks are double compartment tanks. The extended range tank filler openings are in the inboard compartments and the boost pumps are located in the outboard compartments. Flapper vlaves in the partitions between the compartments allow the fuel to flow outboard only. Condensate drains that are accessible from the lower surface of the wing, are located in each of the tanks to permit removal of water condensate.

Two fuel boost pumps are mounted in each of the fuel tanks primarily as a safety feature since a single pump in each tank can meet all system needs. These pumps are powered by three phase A-C current and have a quick disconnect feature that will allow the operating units of the pump to be changed without entering the tank or disconnecting the plumbing. A constant supply of fuel to the boost pumps is assured by a series of ejectors. These ejectors use fuel flow from the boost pumps and the venturi principle to induce a large flow of fuel to the areas surrounding the boost pumps.

The majority of the plumbing is physically located inside the fuel tanks. Fuel flow control valves that are inside the tanks are constructed so that their motors can be changed without draining the tanks or losing fuel.

A filler opening and cap is located on the top of each of the fuel tanks to permit over the wing servicing. Solenoid and float operated refuel valves are mounted in each tank and are connected through fuel lines with two single point receptacles located at the rear of the right landing gear pod. These valves are controlled by switches on the fuel management panel to permit single-point servicing of any and all tanks as desired. Normal defueling is accomplished through the single-point system using the aircraft boost pumps to motivate flow. Suction defueling through filler openings or access openings and pressure defueling through the jettison masts are alternate methods of defueling the aircraft.

Fuel tank venting is through two vent boxes located in each wing. Vent plumbing from each tank ties into one of the two vent boxes. Any fuel that collects in these boxes is removed by ejectors similiar to those used to supply fuel to the boost pumps. These two vent boxes are interconnected by a vent line, and a vent stand-pipe in the outboard vent box connects with a vent fitting that is mounted flush with the under surface of the wing near the outboard end.

The fuel pressure indicating system consists of a pressure transmitter in the center wing area, a fuel pressure indicator on the fuel management panel, and the necessary interconnecting wiring. A fuel temperature indicating system made up of two temperature bulbs, a selector switch, and a FUEL IN TEMP indicator is used to monitor the temperature of fuel leaving the aircraft fuel system. A fuel mismanage warning system alerts the crew when fuel is being used in a manner which is likely to deplete the main tanks before the auxiliary and/or extended range tanks are empty. Fuel PRESS LOW warning lights on the fuel management panel illuminate when pressure from a boost pump falls below a predetermined figure. Illumination of these warning lights during defueling is not to be considered as an indication of pump malfunction.

ELECTRICAL SYSTEM.

The StarLifter electrical system is designed for maximum reliability. The total system capacity is approximately double the normal maximum electrical loads. System design and equipment selection is based on concepts and components tested and proven in military and commercial service. Operation of this system is as automatic as is practicable. It normally requires only visual monitoring by the flight engineer.

This electrical system is made up of a primary A-C system and a secondary D-C system. A-C power is supplied by four air cooling brushless A-C generators rated at 40 KVA (kilovolt ampere). Each generator weighs approximately 90 pounds and is driven by an aircraft power plant through a hydraulic-mechanical constant speed drive (CSD) unit. The four generators normally operate in parallel to supply three phase, 200/115 volt, 400 hertz power to various load buses. The secondary D-C power is supplied through two transformer-rectifier units, rated at 200 amperes, which step-down and rectify the 115 volt A-C power to 28 volt DC. The D-C system is also a parallel system.

Auxiliary ground power is supplied by a 40 KVA A-C generator which is interchangable with the engine driven A-C generators. This generator is driven by the APU and may be operated only when the aircraft is on the ground. Ground power may also be supplied by external motor generator sets.

An eleven ampere-hour, lead-acid battery is located in a removable battery box in the right underdeck area forward of the crew lavatory. This battery is used to supply a limited amount of standby power to the isolated D-C and the isolated D-C avionics buses as well as to provide power for ignition for the APU. An emergency power system is provided for both AC and DC that, in essence, replaces the battery function in other aircraft. This emergency power source is a 2.5 KVA hydraulically driven A-C/D-C generator.

The four main generators supply A-C power to four main A-C buses, two essential A-C buses, an isolated A-C bus, an emergency A-C bus, and various avionics buses. Generator paralleling is accomplished by the use of a main A-C tie bus which is used as the generator synchronizing bus. The D-C bus system includes two main D-C buses, an isolated D-C bus, an emergency D-C bus, and various avionics buses.

INSTRUMENTS.

Essentially two types of instruments are used on this aircraft; the conventional dial type and a vertical scale tape instrument. The vertical scale tape instruments are used as the primary indicators for engine instrumentation and flight instrumentation. All dial type instruments use either clamp or bezel type front mountings for convenience of maintenance. The vertical scale tape instruments are all bezel mounted to the instrument panels. All instruments located in the flight station are integrally lighted except for standby indicators. The instruments are arranged on panels according to the system and function in which they fall. The most predominant panels are the main instrument panel, the flight engineer's instrument panel, and the navigator's instrument panel.

The main instrument panel is located at the front of the aircraft and consists of a pilot's panel, a center panel, and a copilot's panel. Each section can be removed without interferring with other panels. The flight engineer's instrument panel is divided into an upper panel and a lower panel, each of which contains individual sub-panels. Each sub-panel can be removed separately. This same basic layout is followed on the navigator's instrument panel.

Flight instruments are provided to furnish data necessary to enable crew members to maintain the desired position, attitude, and direction of aircraft movement. The flight instruments group consists of two vertical scale altitude vertical velocity indicators, two vertical scale airspeed-Mach indicators, an accelerometer, a navigator's true airspeed indicator, and a standby compass. The pressure altimeters and the standby airspeed indicator are operated directly by pitot-static system pressures. The altitude-vertical velocity indicator are electrically operated and receive computed data signals from the two central air data computers. The accelerometer is operated only by acceleration loads imposed on the aircraft.

Engine instruments, located on the center instrument panel and on the flight engineer's instrument panel, provide the crew with continuous visual indications of the operating condition of the engines. Both the dial type and the vertical scale tape instruments are used. The flight engineer's panel also contains the instruments necessary to monitor the aircraft fuel system, electrical system, hydraulics system, APU, and the environmental and pneumatics systems.

Instruments are also provided in the flight station for indication of wing flap position, spoiler position, and aileron, rudder, and elevator trim tab position.

AVIONICS SYSTEMS.

Avionics systems are provided in the aircraft for communication, navigation, intercommunication between the crew, and public announcements to personnel in or near the aircraft. Power is transmitted to these systems through circuit breakers mounted on the avionics circuit breaker panel at the navigator's station and the emergency circuit breaker panel located aft of the pilot's side console. Control units for this system are located on the center console, the navigator's console, the pilot's and copilot's side consoles, the main instrument panel, the flight engineer's panel, and at various other locations throughout the aircraft. Major components of the system are located in racks in the center and on the left side of the underdeck area.

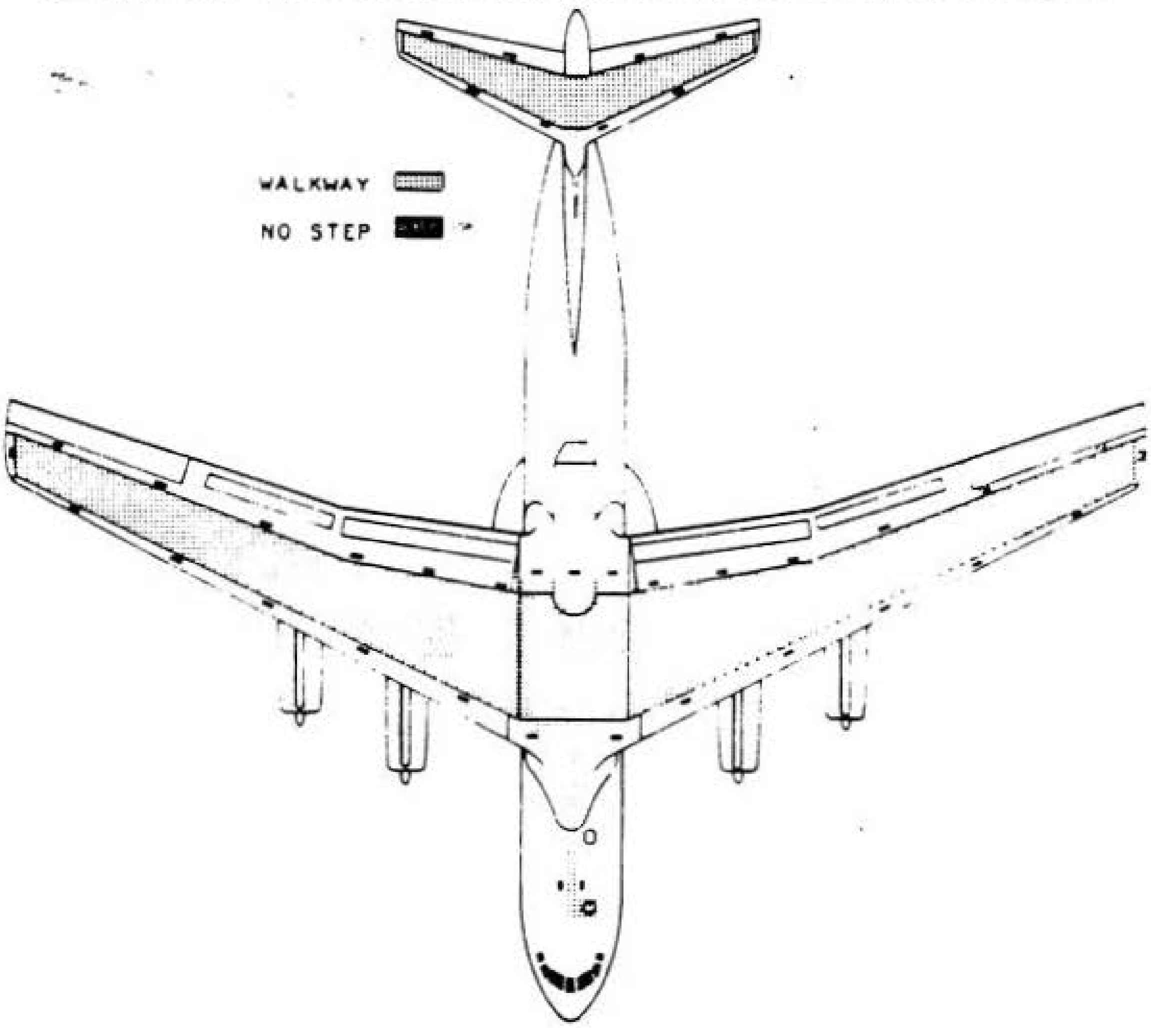
The following is a list of avionics equipment normally installed in the StarLifter:

1. Intercom System	AN/AIC-18
2. Public Address System	AN/AIC-13
3. HF Communications	Collins HF-102
4. VHF Communications	Collins 618M-1C or Wilcox 807A
5. Marker Beacon	Collins 512-3
6. TACAN System	AN/ARN-21C
7. LORAN System	AN/APN-157
8. Search Radar System	AN/APN-59B
9. Radar Pressurization	AN/ASQ-70
10. Doppler Radar System	AN/APN-147
11. Doppler Nav Computer	AN/ASN-35
12. Navigational Computer System	AN/ASN-24
13. Low Altitude Radar	
14. VHF Communications	AN/ARC-90
15. Automatic Direction Finder	ADF-73
16. VHF Navigation System	Wilcox 806A or Collins 51R-6
17. Glideslope System	Wilcox 800B or Collins 51V4A
18. IFF Radar System	AN/APX-64
19. Compass System	Sperry C-12
20. Automatic Flight Control System	Bendix PF-60A
21. Flight Director System	CPV-27A
22. Central Air Data Computer	Bendix CPV-43A
23. Flight Data Recorder	Fairchild
24. Crash Position Indication System	AN/URT-26
25. All Weather Landing System	
26. Vertical Navigation System	

GROUND HANDLING AND SERVICING

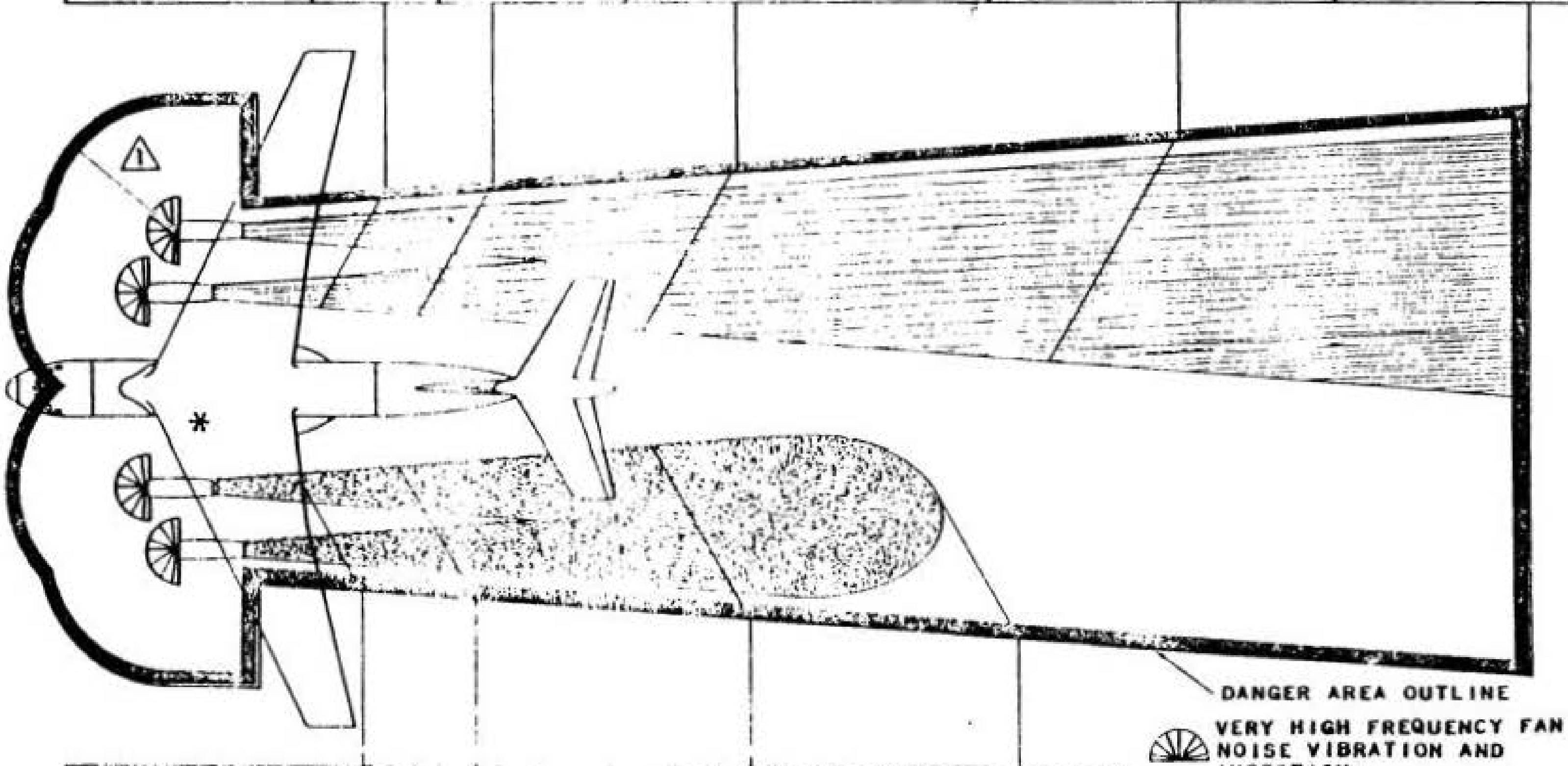
GENERAL.

Modern high speed jet aircraft present unique opportunities for personal injury, damage to the aircraft, or damage to support equipment when established procedures are disregarded. The StarLifter is no exception. The wide use of honeycomb panels creates a structure that is both light and strong but the thin skin of this structure is sensitive to improper handling.



WALKWAYS AND "NO STEP" AREAS

DISTANCE FROM EXHAUST	20FT	45FT	100FT	200FT	300FT
VELOCITY	1000MPH	500MPH	200MPH	100MPH	50MPH
IDLE THRUST VELOCITY	135MPH	40MPH			



DISTANCE FROM EXHAUST	15FT	40FT	100FT	150FT
TEMPERATURE	920°	400°F	200°F	150°F
IDLE THRUST TEMPERATURE	420°F	195°F		

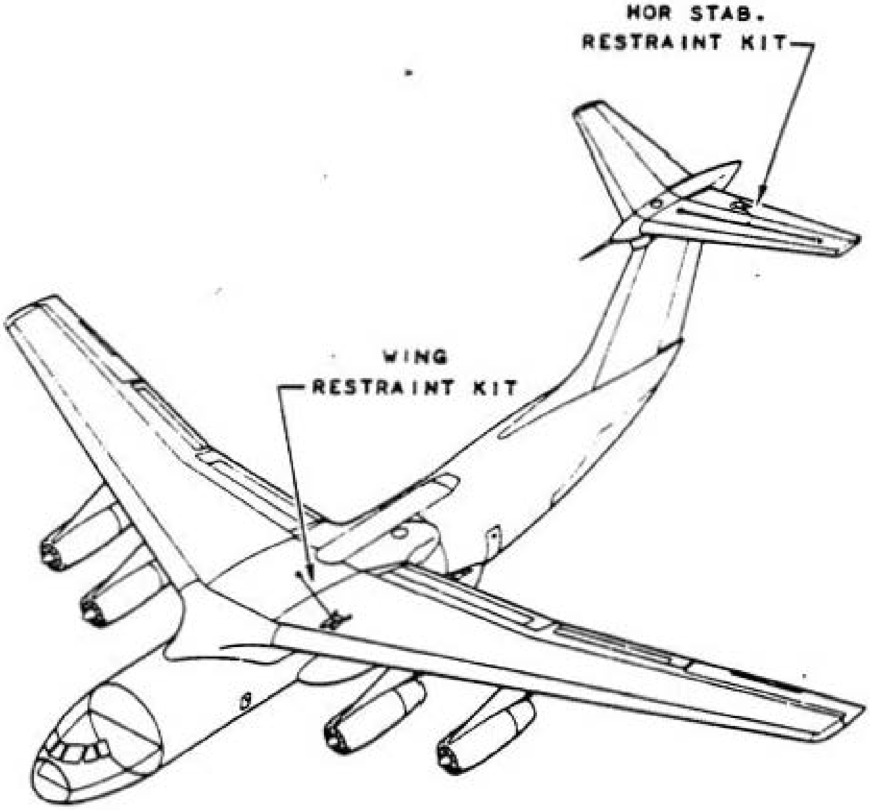
DANGER AREAS

Tool marks, dents, and scratches on the highly stressed skin of pressurized areas can lead to premature failure that could endanger the aircrew. Inproper cleaning promotes corrosion that will dramatically shorten component life. Construction characteristics and design limitation must be considered when moving, servicing, or otherwise working on or around this aircraft.

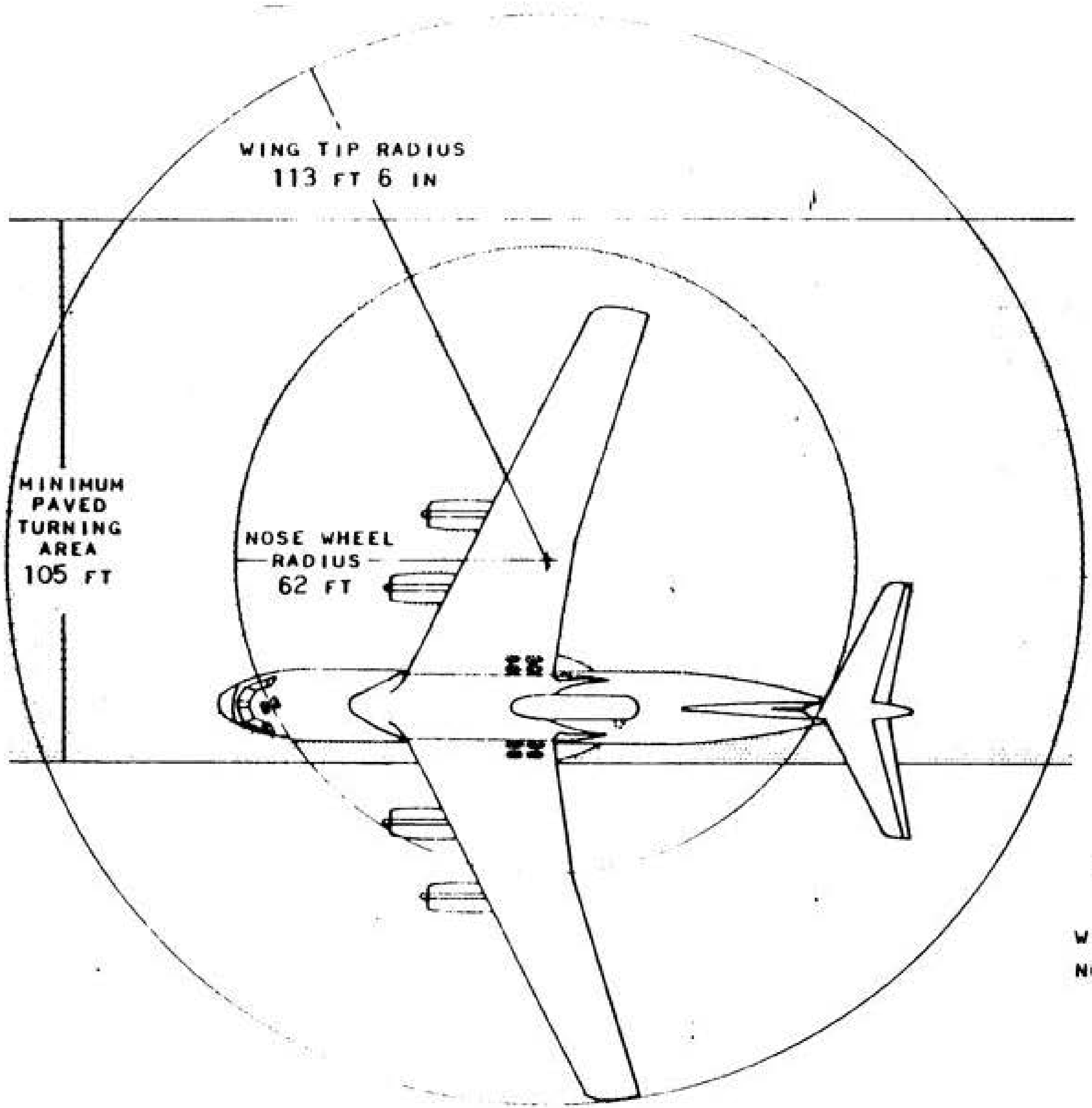
The sound, heat, and gas velocity created by the engines and APU of this aircraft present additional hazards for personnel as does the low pressure area around the air intake. The DANGER AREAS-MAXIMUM POWER illustration indicates the magnitude of this danger.

The size of the StarLifter presents additional hazards. Component weight and the necessity to work some distance above the ground require additional precautions.

Under no circumstance should the heretofore presented hazards be considered as a complete listing. All precautions common to aircraft maintenance as well as specific procedures called out for this aircraft must be followed.



PERSONNEL RESTRAINT KIT USES



EXAMPLE:
NOSE GEAR IN 60° TURN

NOTE:
NOSE GEAR IN 30° TURN

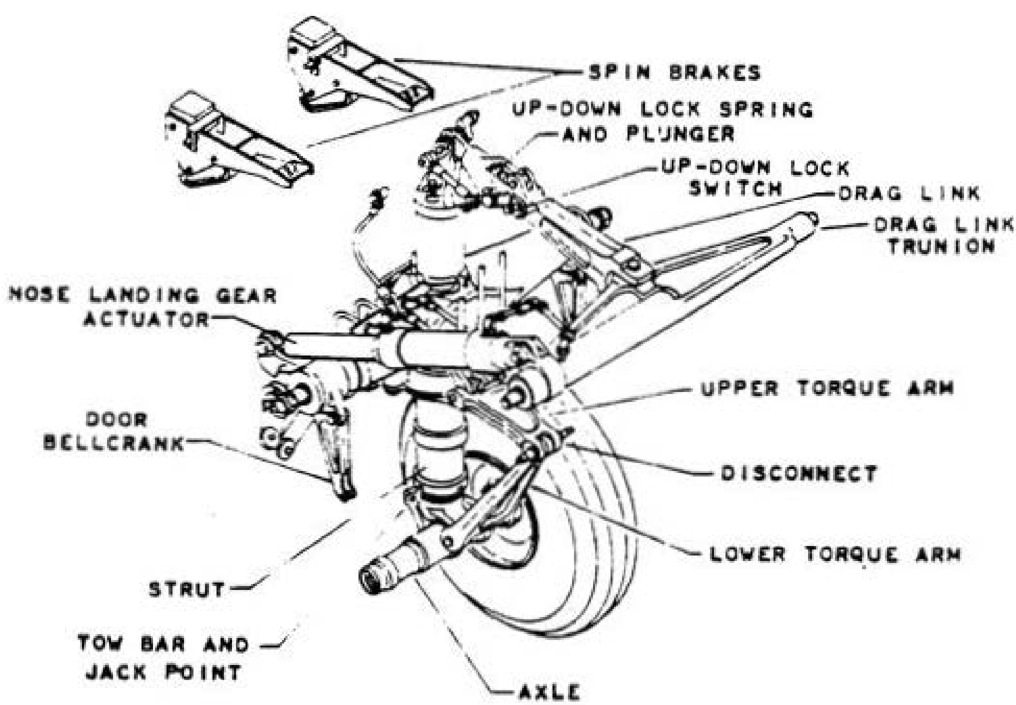
WING TIP RADIUS - 175 FT
NOSE WHEEL RADIUS - 106 FT

TURNING RADIUS

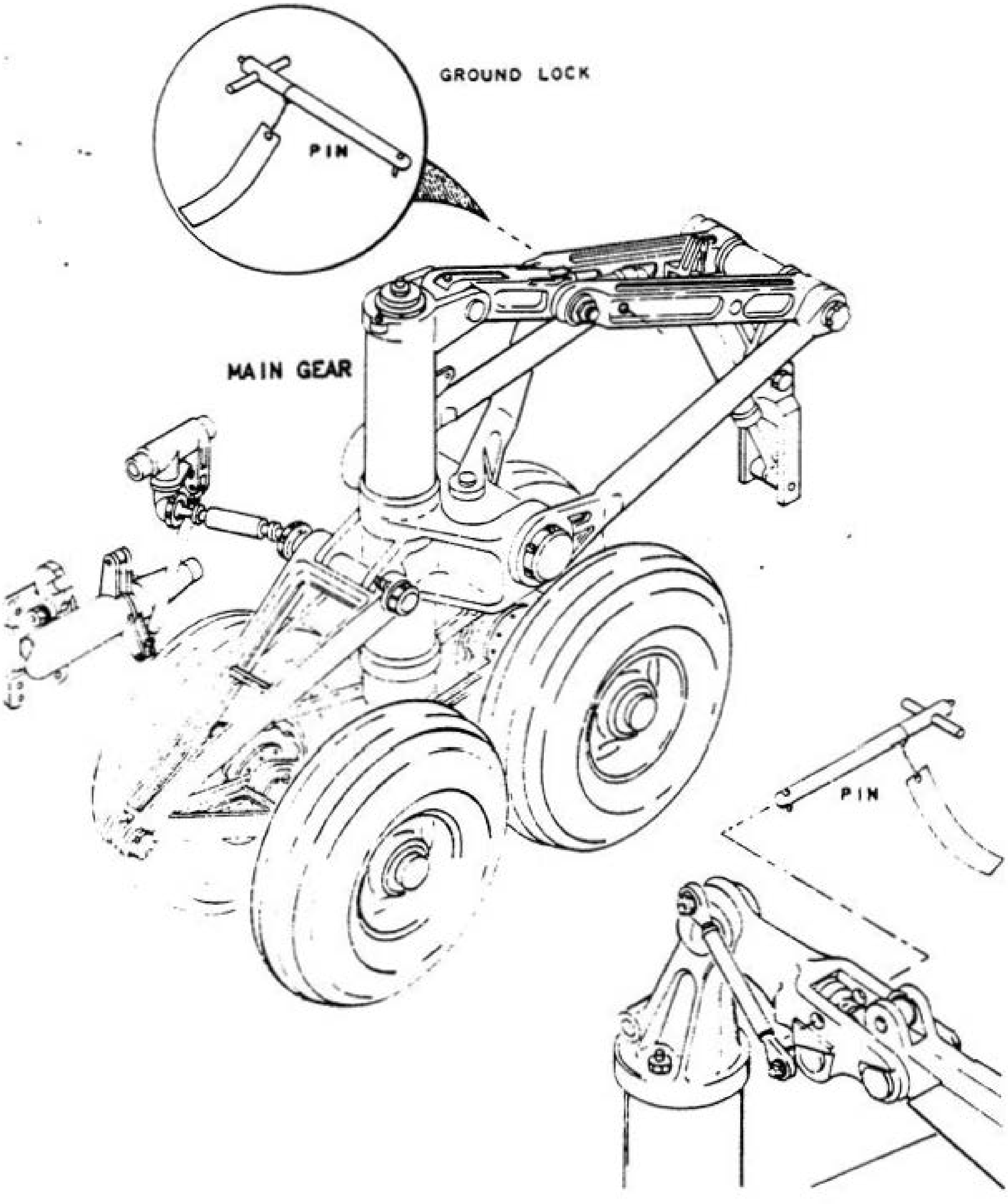
TOWING.

Caution should be used when towing the StarLifter since dual bogie type landing gear have an inherent tendency to develop extreme side loads during short radius turns. The aircraft should be moved in a straight line for a short distance before making any turns so that the magnitude of these side loads will be minimized. Towing this aircraft should be restricted to a minimum. When towing is required, either a tow bar or a towing bridle may be used depending upon surface condition. For hard surfaces having a five percent or less grade, a tow bar attached to the nose gear is sufficient. For soft ground, rough ground, or a surface having a grade of five percent or more, a towing bridle is necessary.

Provisions are incorporated on the nose gear for attaching a standard MD-1 tow bar. Upon hooking up the tow bar, the nose gear steering torque arms must be separated and the lower torque arm must be fastened to the strut. Failure to secure the lower torque arm can result in damage to the nose gear baffle. The steering torque arms should be immediately reconnected upon removal of the tow bar.



NOSE LANDING GEAR COMPONENTS



GROUND SAFETY LOCKS AND PINS

The main landing gear has provisions fore and aft for attaching a towing bridle. Two one inch steel cables 84 feet in length are used to make up this bridle. Wheel brakes are used to provide directional control when using this means of towing.

Wheel brakes are available during towing operations from the number 3 hydraulic system. Since pressure for this system is furnished either by two A-C electric powered pumps or a hand pump, brake operation will be severely limited unless the APU is operated to provide a source of A-C power. Should the aircraft be towed without the APU operating, it is necessary to check the emergency brake accumulators for adequate system pressure and station a man at the hand pump to maintain this accumulator pressure. Pumping the brakes in this situation could deplete brake pressure more rapidly than it could be restored with the hand pump. When towing with electrical power on the aircraft, the brake selector switch on the pilot's center instrument panel must be placed in the "EMER" position.

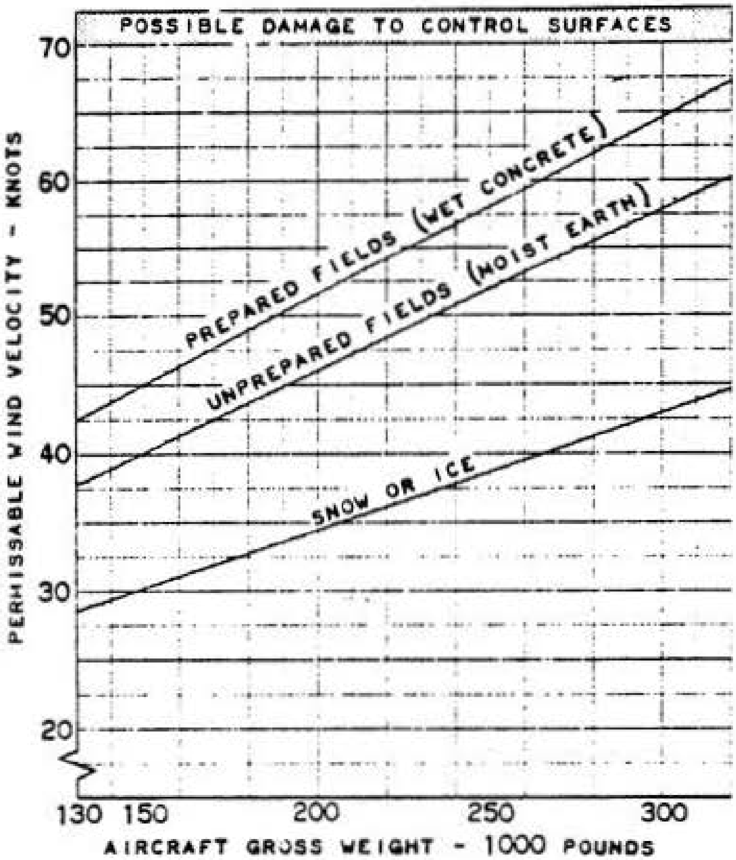
Landing gear ground safety pins are provided to prevent inadvertent gear operation. Each pin has a warning streamer. Main gear pins should be installed with the streamer inboard to facilitate removal during flight should it be left installed. These pins are stored in the cargo compartment when not in use.

Towing should not be attempted unless strut inflation is within limits. This particularly applies to the nose strut since the strut internal centering mechanism could be damaged should the nose wheels be turned with the strut overinflated. Two cargo loading stabilizing struts under the fuselage just forward of the ramp must be retracted before towing.

MOORING.

Four important factors that must be taken into consideration when determing aircraft mooring requirements are aircraft gross weight, wind velocity, parking surface, and control surface design limits. The heavier the aircraft and the greater the friction between the tires and the parking surface, the harder it is for the wind to move the aircraft. The chart shown here indicates conditions under which the StarLifter should be moored.

With the aileron, elevator, and rudder power unit control switches on the pilot's overhead control panel in the "NORMAL" position, the control surface power units will act as gust locks. Winds above 70 knots can exceed the capability of these units to hold the control surfaces and damage can result. For this reason, the aircraft should be evacuated anytime winds above this figure are expected. Should evacuation not be practical, the aircraft structure, controls, and control surface mounting provisions must be thoroughly inspected prior to flight. Control locks that are a part of the aircraft ground support equipment should be used to restrain control surfaces only when one or more power units have been removed.



Wing tie down fittings are provided in the lower surface of each wing at the intersection of FS 1020 and BL 400. The rings are springloaded and flush mounted into the wing box structure. The nose tie down ring is an integral part of the nose wheel steering actuator and is located on the front of the nose gear strut. A receptacle is provided in the lower part of the aft fuselage at FS 1288, BL 0.0, that will accommodate a standard 25,000 pound cargo tie down fitting to serve as the rear aircraft tie down.

The appropriate maintenance manual should be consulted for specific information concerning tie down equipment and examples of mooring to particular tie down patterns.

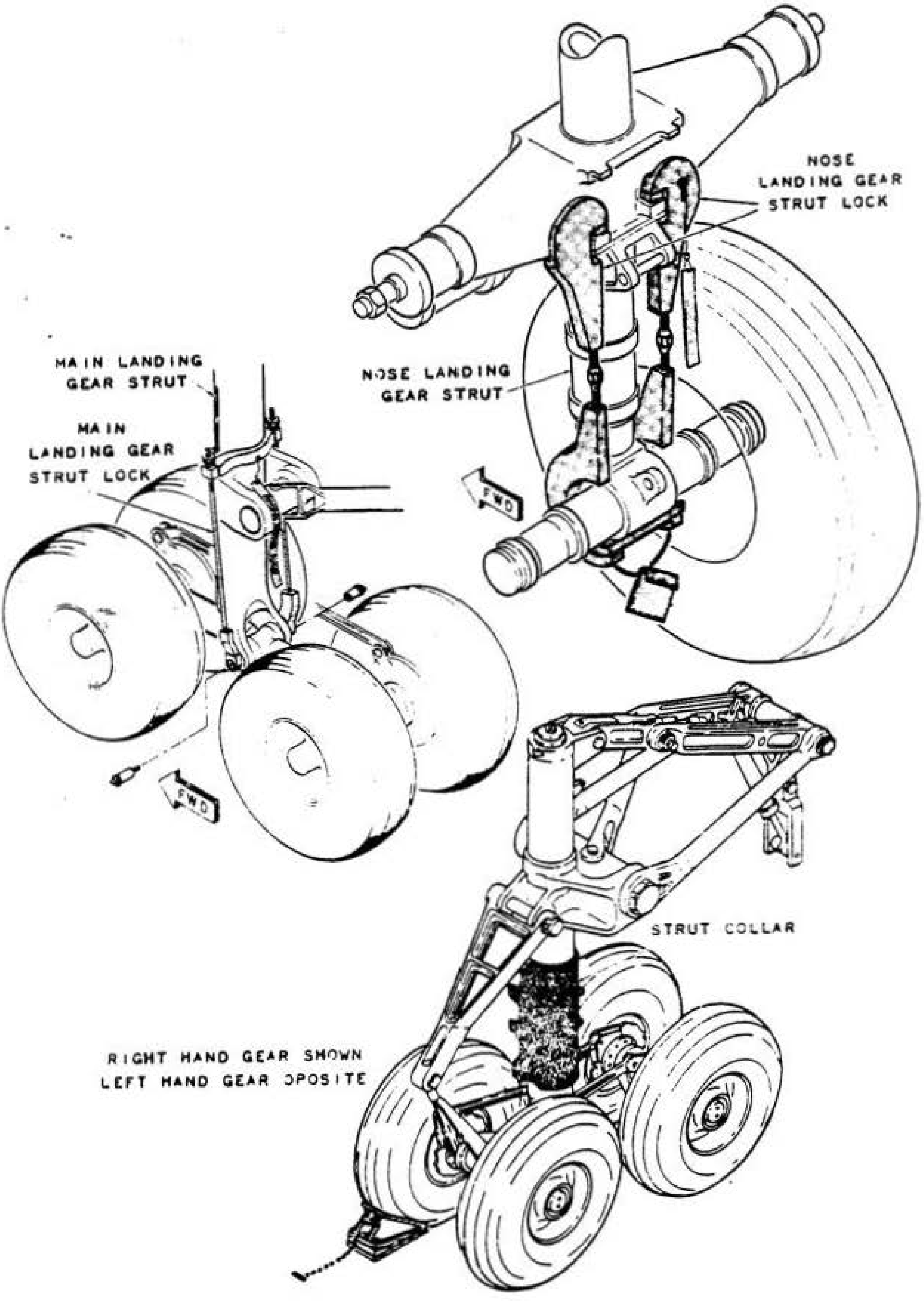
JACKING.

The method used for jacking this aircraft is dependent upon the reason for jacking (type of maintenance), the aircraft gross weight, and the aircraft center of gravity (CG). Provisions are incorporated for the use of hydraulic tripod jacks under each wing at BL 194.4L and R and BL 404.7 L and R and on both sides of the fuselage at the nose wheel well. Adapters are required when these jack points are used. The adapters for the forward fuselage jack points are constructed so as to support up to 2600 pounds of ballast weights for use in bringing the aircraft C.G. within limits for jacking.

Jack points for use with hydraulic axle jacks are located on each landing gear axle and at the rear of each main wheel well pod at FS 1056.9. The jack points on the landing gear axles feature integral adapters. Separate adapters are required for use at the fuselage jack points at FS 1056.9.

Tripod jacks and axle jacks can be used in combination for some jacking requirements. Whenever multiple jacks are used under one wing or on the aircraft nose, they must be manifolded to prevent unequal jacking pressure. Jacks on opposite wings of the aircraft must never be manifolded. When tripod jacks are used at the wing outboard jack points for aircraft stability only, they need not be manifolded.

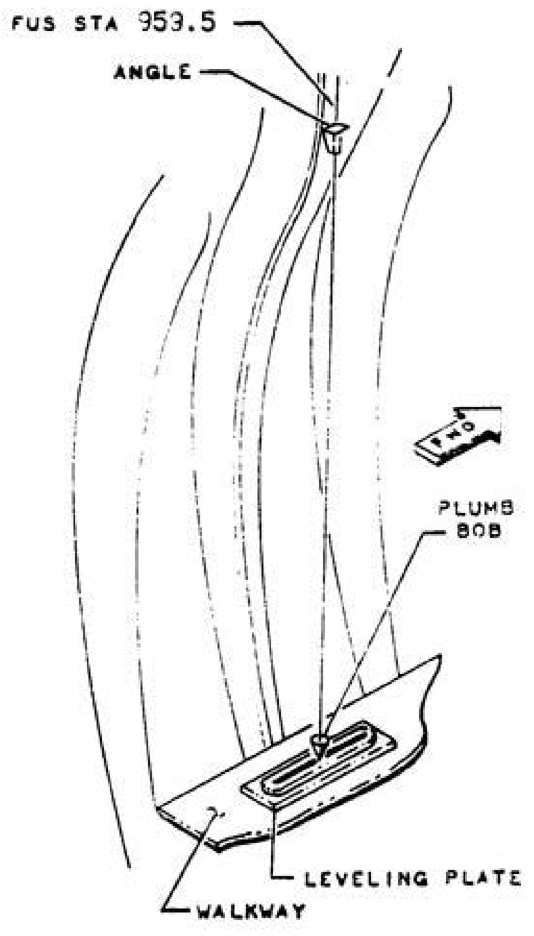
Landing gear strut locks are available to prevent strut extension during jacking. Never retract the gear with strut locks installed. Strut collars may be used to prevent strut compression during some phases of jacking. When it is desirable to jack only the nose gear, main gear struts can be extended by over inflation to create additional ground to fuselage clearance. Strut collars would be used in this instance.



LANDING GEAR STRUT LOCK AND STRUT COLLAR

Jacking at the landing gear axle jack pad for wheel or brake maintenance is possible even with multiple flat tires. When jacking only one axle of the main gear bogie, disconnect the bogie leveler rod. If multiple flat tires require jacking of both axles of the bogie and it is desired that the axles be jacked individually, the rear axle must be jacked and the tire replaced prior to jacking the front axle to prevent damage to the bogie positioning cylinder.

It is important to maintain the aircraft in a level attitude during jacking operations. Unequal jacking causes unequal loads on jack pads and aircraft structure that could result in structural damage. To maintain the aircraft in level attitude, use the leveling provisions within the cargo compartment at FS 959.5. These provisions consists of a leveling plate on the walkway and a plumb bob hung from an angle above the leveling plate.

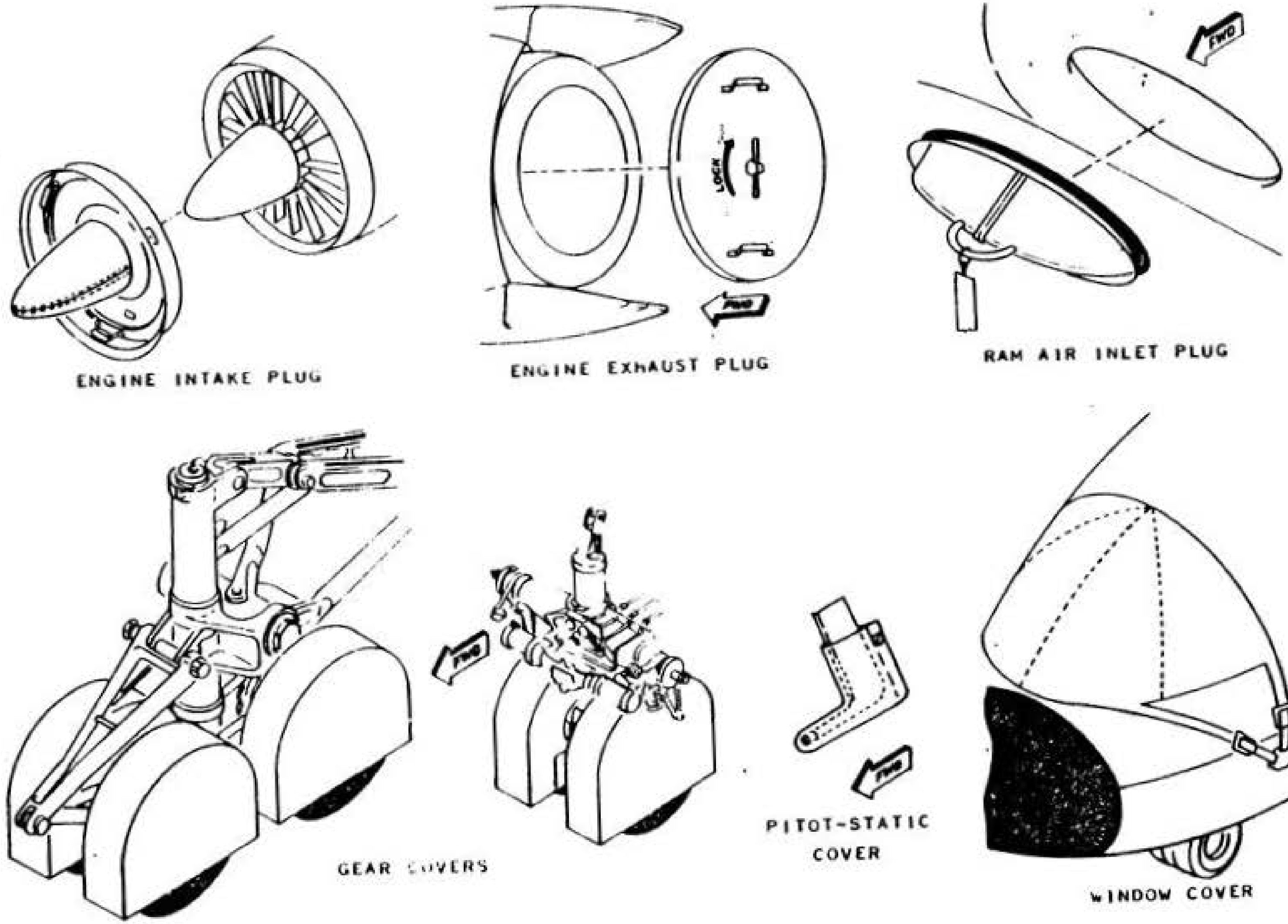


The aircraft should never be jacked with the cargo ramp at or near ground level. The appropriate maintenance manual should be consulted prior to jacking the aircraft in order to accertain precise requirements.

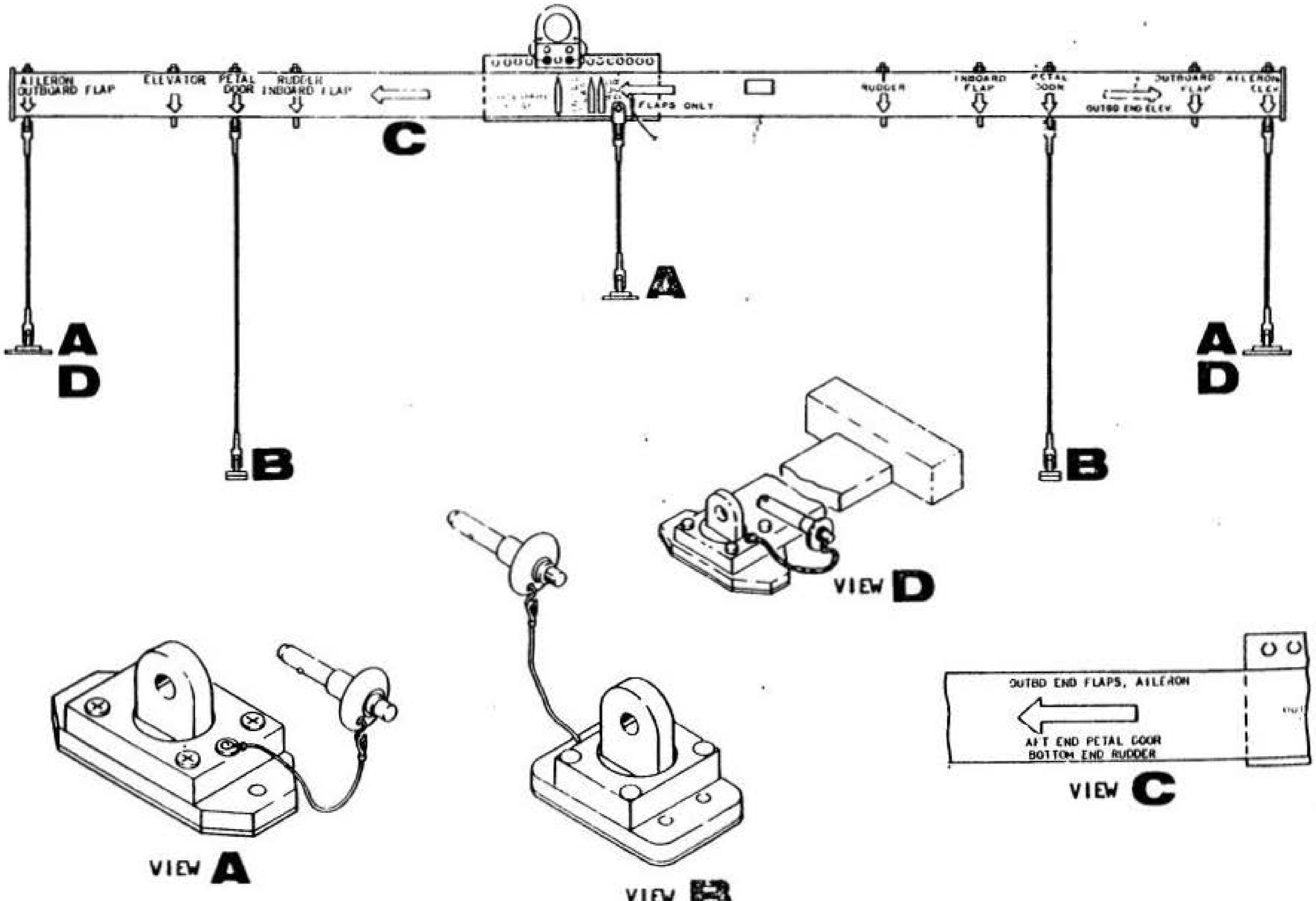
SUPPORT EQUIPMENT.

Dust excluders and protective covers for this aircraft are much the same as those required for any aircraft of similar size and complexity. Requirements for their use are well established within aircraft maintenance facilities. Standard items of test equipment, electrical, power supply, hydraulic test stands, etc, will not be discussed in detail in this manual since they are not peculiar to this aircraft. The minimum capabilities of such units used to support the StarLifter will be set out in applicable maintenance manuals.

Component size, weight, and location on this aircraft are such that a number of specially designed slings, stands, and dollies are required for maintenance support. Perhaps the most commonly


ENGINE INTAKE PLUG
ENGINE EXHAUST PLUG
LOCK
FWD
RAM AIR INLET PLUG
FWD
GEAR COVERS
FWD
PITOT-STATIC COVER
FWD
WINDOW COVER

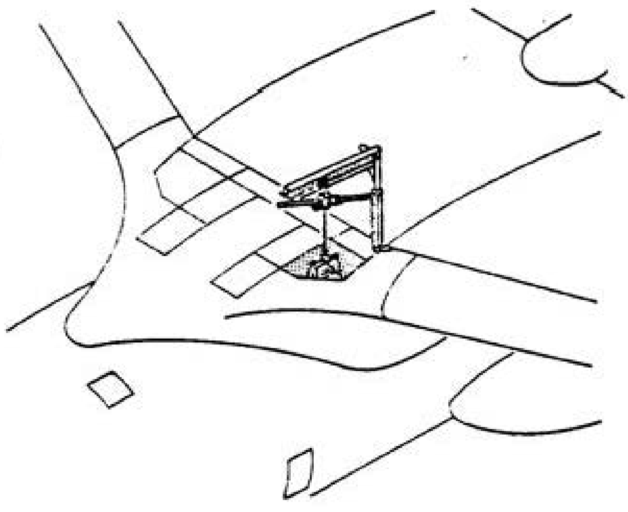
DUST COVERS



UNIVERSAL SLING ASSEMBLY

used of these slings is the universal sling assembly that is designed to assist in the removal of primary flight control surfaces, flaps, and petal doors. Additional slings that are not shown and have not been discussed here are used to handle such items as the HF antenna, the aft pressure door, and the horizontal stabilizer. A portable hoist assembly with a maximum capacity of 1000 pounds is provided to minimize the requirement for elaborate base support equipment. When used in conjunction with some of the slings that have previously been discussed, this hoist provides a built-in capability for raising aircraft components, tools, and test equipment to the top of the wing or the high "T" tail.

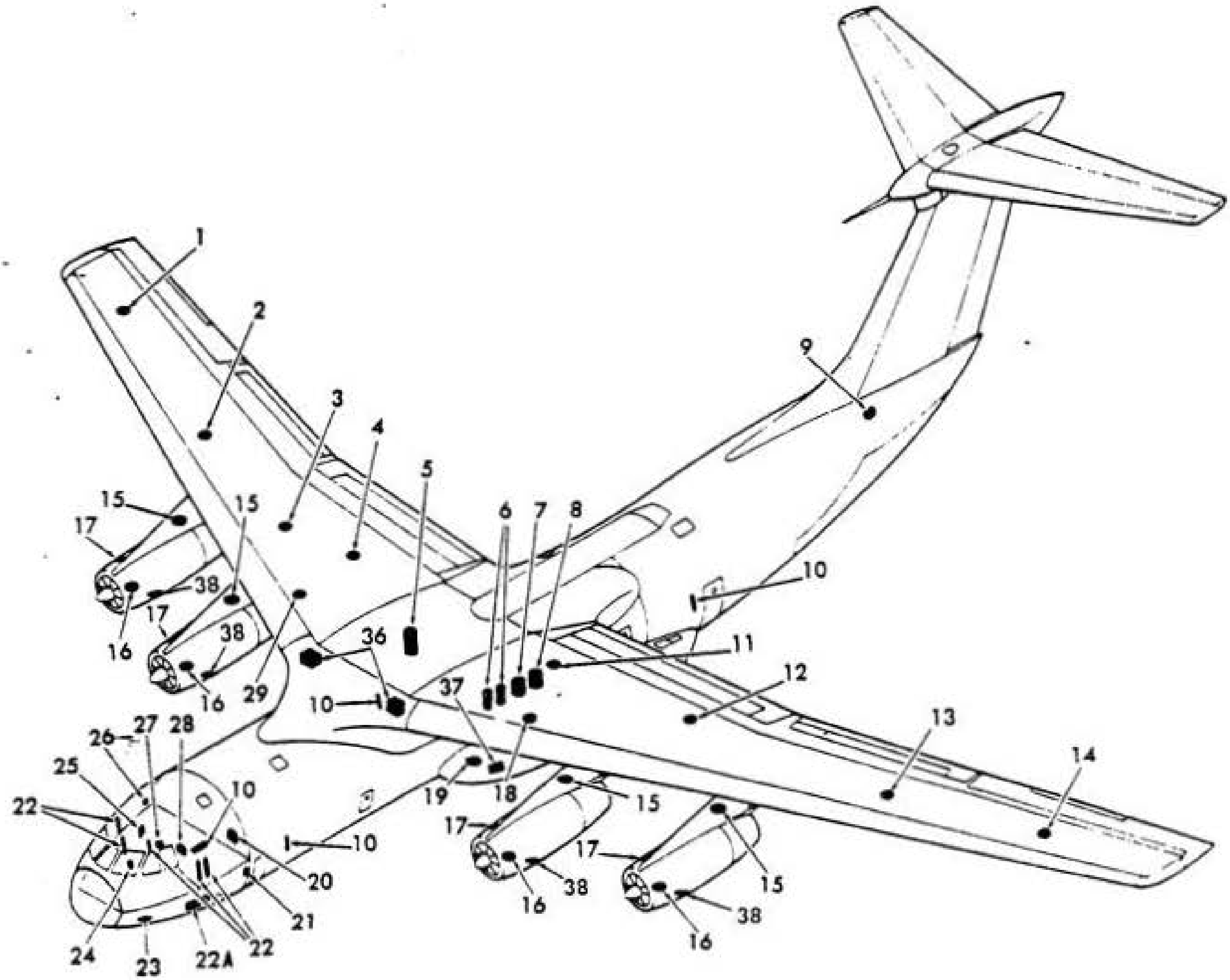
Locks are provided to retain wing spoilers and the aft pressure door in the open position for safety during maintenance. The spoiler lock consists of clamps that attach to the spoiler drive tubes and to the landing flap tracks along with a pin used to secure the two clamps together. A lock is required for each spoiler section during maintenance of the spoiler system. The aft pressure door lock consists of a sheet metal assembly that fits around the door actuating strut in a manner that will prevent strut retraction.



PORTABLE HOIST

SERVICING.

Servicing the various systems of of the StarLifter has been simplified to the maximum practical degree to provide ease of maintenance and quick turn around capability. Specific servicing procedures for individual systems are set out in detail in appropriate maintenance manuals. Attention to detail during servicing of an aircraft cannot be over emphasized since haphazard servicing will inevitably lead to an increase in unscheduled maintenance, system malfunctions, and component failures. The following illustration will assist in locating servicing points on this aircraft.



1. NO. 4 MAIN TANK FILLER CAP
2. NO. 4 AUXILIARY TANK FILLER CAP
3. RH EXTENDED RANGE TANK FILLER CAP
4. NO. 3 AUXILIARY TANK FILLER CAP
5. NO. 1 HYDRAULIC SYSTEM RESERVOIR
6. NO. 3 HYDRAULIC SYSTEM ACCUMULATORS
7. NO. 3 HYDRAULIC SYSTEM RESERVOIR
8. NO. 2 HYDRAULIC SYSTEM RESERVOIR
9. PETAL DOOR CENTRAL GEARBOX
10. A-20 PORTABLE FIRE EXTINGUISHERS
11. NO. 2 AUXILIARY TANK FILLER CAP
12. LH EXTENDED RANGE TANK FILLER CAP
13. NO. 1 AUXILIARY TANK FILLER CAP
14. NO. 1 MAIN TANK FILLER CAP
15. FIRE EXTINGUISHER SERVICING INSPECTION ACCESS
16. CSD OIL AND THRUST REVERSER FILLER ACCESS
17. ENGINE OIL FILLER ACCESS
18. NO. 2 MAIN TANK FILLER CAP
19. APU OIL FILLER ACCESS
20. GALLEY WATER TANK
21. GALLEY REFUSE CONTAINER
22. PORTABLE OXYGEN BOTTLE
22A. NO. 4 HYDRAULIC SYSTEM RESERVOIR.
21. GALLEY REFUSE CONTAINER
22. PORTABLE OXYGEN BOTTLE
23. CREW OXYGEN FILLER ACCESS
24. BATTERY AND SUMP JAR
25. FLIGHT ENGINEER'S FUEL MANAGEMENT PANEL
26. LAVATORY WASH WATER TANK
27. LAVATORY SERVICE CART CONNECTION
28. ELECTRICAL SPARES BOX
29. NO. 3 MAIN TANK FILLER CAP
30. MAIN LANDING GEAR TIRES
31. MAIN LANDING GEAR SHOCK STRUT
31A. MAIN LANDING GEAR AXEL BEAM POSITIONER CYLINDER AND AIR RESERVOIR
32. NOSE LANDING GEAR TIRES
33. NOSE LANDING GEAR SHOCK STRUT
34. CARGO COMPARTMENT OXYGEN FILLER ACCESS
35. SINGLE POINT REFUELING ADAPTERS
36. AIR CONDITIONING REFRIGERATOR COOLING TURBINE
37. APU FIRE EXTINGUISHER SERVICING INSPECTION ACCESS DOOR
38. STARTER OIL FILLER ACCESS (TYPICAL EACH ENGINE)

SERVICING POINTS

Refueling can be accomplished over the wing or through a single-point refueling system. Two identical single-point refueling receptacles, located on the rear of the right main landing gear pod, permit simultaneous refueling from two fuel sources. Control of the refueling operation is from the flight engineer's fuel management panel. Electrical power is required during refueling. In an emergency, this electrical power can be furnished by APU operation. Care must be exercised during over the wing refueling to prevent damage to aircraft skin, partículiarly the double skin of the wing leading edge where a dent could lead to the formation of a "hot spot" during subsequent use of wing anti-ice.

Aircraft defueling is possible over the wing, through the single-point system, or through the fuel jettison masts located on the wing trailing edge. Tank to tank transfer, either in flight or on the ground, is possible. Fuel tanks must not be serviced in a manner that will cause the aircraft to be excessively unbalanced laterally. Jet fuel has a natural affinity for water so tank sumps should be drained after a 30 minute waiting period following servicing.

The engine oil tank, the CSD oil tank, and the engine starter are all serviced with oil, MIL-L-7807, to the point of overflow. The CSD tank should not be checked for a period of five minutes following engine shutdown to allow the oil to return to its normal condition. If the engine tank is not checked within 30 minutes following engine shutdown, consult the appropriate maintenance manual before proceeding with servicing.

The APU oil tank is serviced with oil, MIL-L-7808, to the full mark on the dip stick. After initial service, wait five minutes for the oil level to stabilize then complete the service. If the aircraft is not level, allowances must be made when reading the dip stick.

Hydraulic reservoirs for all four systems are located within the fuselage. They are not pressurized and each contains a filler cap. Reservoirs for systems No. 1 and 2 are filled to the point of overflow with the flight controls in neutral and system pressure at zero. The No. 2 system should be serviced only with the landing gear down and locked except for inflight emergencies. With flaps and spoilers in the in the faired position, the ramp and aft pressure door closed and locked, and system pressure at zero, service the No. 3 system reservoir to the point of overflow. With system pressure at zero, service the No. 4 reservoir to a dot located in the center of the sight gauge. All four systems are MIL-H-5606 red colored hydraulic fluid.

Hydraulic accumulators, landing gear struts, and the main landing gear axle beam positioner air reservoir must be serviced with either dry air or oil pumped nitrogen. Servicing methods and valves are outlined in the approriate maintenance manual. Nose gear tires are normally inflated to 150 PSI. Main gear tire pressure will vary with gross weight, center of gravity, and anticipated landing surface. Consult the applicable maintenance manual prior to service.

Two cargo loading stabilizer struts are located in the lower section of the fuselage just forward of the cargo ramp. Access to these units is provided by an inspection door on each side of the fuselage. Service these struts with JP-4 fuel through two filler plugs that are located in the struts.

The two air conditioning cooling turbines are serviced with MIL-L-6085 oil to a level indicated by the dip stick. Damage to the turbine will result from over-servicing.

Power plant, APU, and portable fire extinguishers must be removed for service anytime the gauge attached to the extinguisher indicates below the safe range.

The crew galley fresh water tank, the hot beverage unit, the paper cup dispenser, the refuse container, the refrigerator, and the food and utensile storage drawer may require servicing prior to and after each flight. In any event, the unit should be checked and serviced as required on each postflight. The galley fresh water tank should be serviced prior to each flight with approximately 10 gallons of fresh water. This tank may be serviced by connecting a hose to the receptacle on the upper outboard corner of the tank or it may be serviced manually through the filler opening in the top of the tank. Access to the filler opening is from the flight station behind the outboard auxiliary crew seat. The water level may be determined by observing a sight gauge on the front of the tank.

Drain the fresh water tank after each flight, when possible. The spigot normally used to obtain water from the tank is used to drain it. The refrigerator should be cleaned at least each post flight and serviced with 20 pounds of dry ice when its use is anticipated.

The crew lavatory service connection is installed in a flush mounted box with a hinged door. This box is located on the right lower side of the nose fuselage at FS 446 and WL 123. Lavatory servicing will consist of servicing the wash water tank, waste water tank, toilet, paper towl dispenser, toilet tissue holder, waste paper container, and cleaning and disinfecting the lavatory.

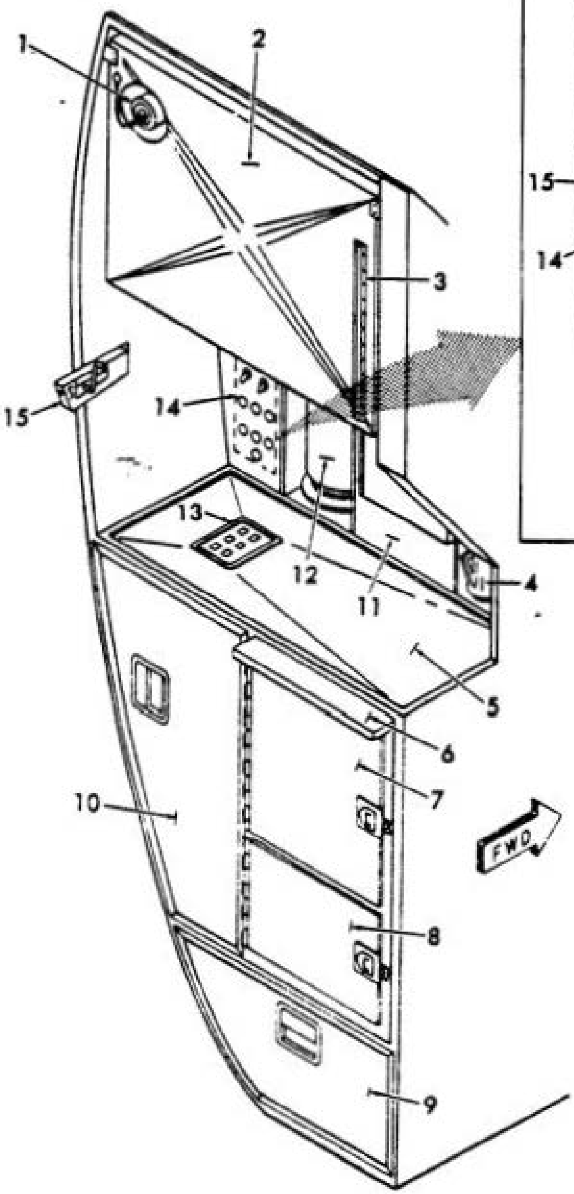
The wash water tank is filled through the plumbing and wash water tank filler opening access door that is located inside the lavatory. Fill the tank until water begins to flow from the tank overflow tube above the wash basin (approx. five gallons). Excess water is drained into the waste water tank.

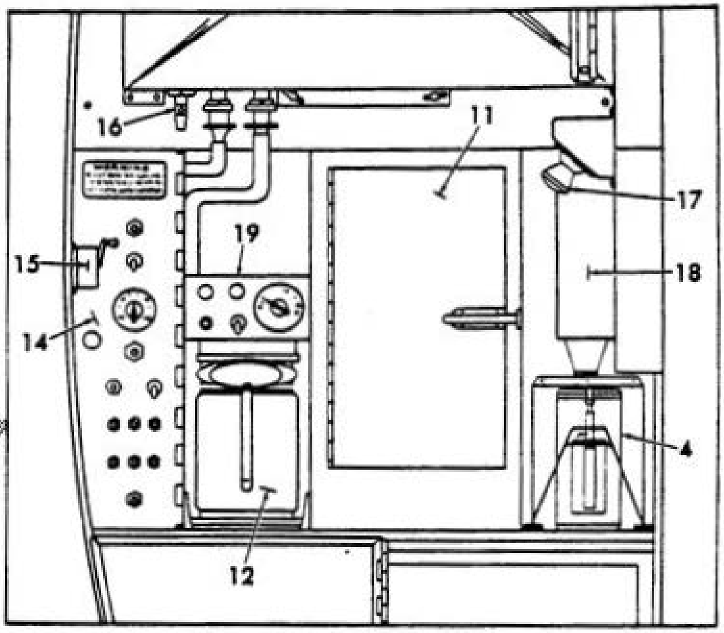
Service the waste water tank through the external door. Open the petcock and allow any accumulated water to drain. Remove the cover and connect the drain line from a lavatory service truck. Connect a water line from the service truck to the rinse water connection and rotate the drain handle to the "HOLD OPEN" position. Operate the pump on the service truck and remove the contents of the waste water tank. Meter in approximately ten gallons of water from the service cart through the rinse water line. Use caution during the rinse operation to prevent overflowing the toilet. Shut off the service truck pump, close the drain control handle, and disconnect the drain line at the aircraft. After reinstalling the drain cap, service the waste water tank with approximately 3.1 gallons of water and 0.4 gallons of detergent through the rinse water line. Disconnect the rinse water line at the aircraft, replace the cap, and close the access door. Detergent may be added to the waste water tank by pouring it into the toilet bowl facilities for mixing it with water in the service truck is not satisfactory.

The windshield rain repellent system reservoir is located just forward of the navigator's table. This is a pressurized reservoir and internal pressure can run as high as 90 PSI. Prior to attempting to service this reservoir, loosen the filler cap two full turns and allow the pressure to bleed off to zero. Remove the cap carefully ONLY after the pressure has been allowed to reach zero. Add Minnesota Mining and Manufacturing Co. rain repellent fluid type FC 147 until the reservoir sight gauge indicates full. A 400 micron filter in the filler neck restricts the flow of fluid into the reservoir, so care should be exercised in pouring the fluid.

After the cap has been reinstalled, check the system by placing the compressor switch on the pilot's side console to the "ON" position and pressurizing the system. Any fluid that might accumulate on the windshield during this test should be allowed to dry and then be removed by washing the windshield with water.

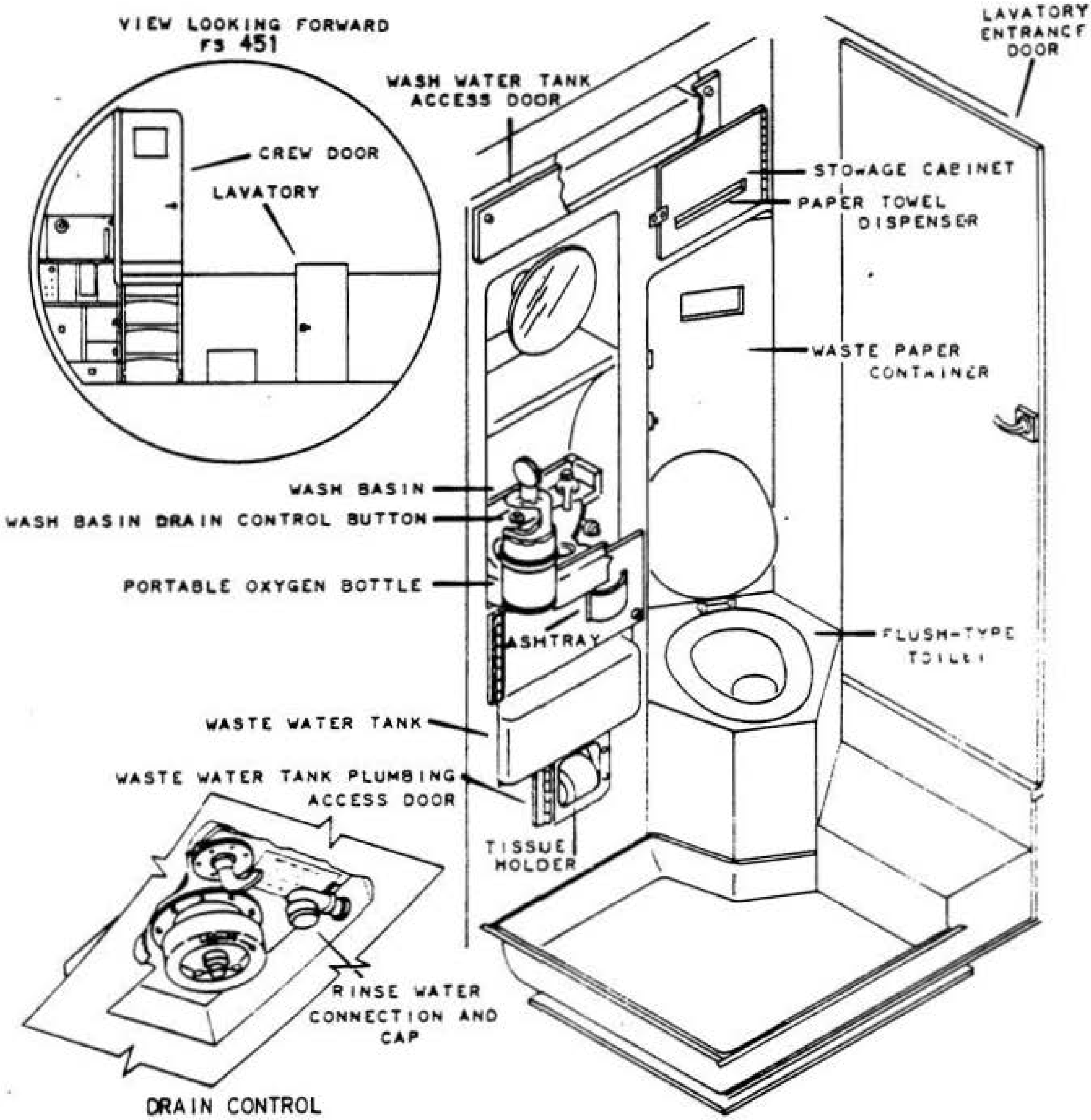
The aircraft should be lubricated exactly as shown in the associated maintenance manuals. The properties of a lubricant are not always apparent during casual observation. Any substitute desired in lieu of a lubricant called out in maintenance manuals must be thoroughly researched for acceptability prior to use. All lubricated surfaces should be clean and free from moisture, solvents, and other contaminants prior to adding lubrication. Never apply a lubricant over a corroded surface.





1. WATER TANK SERVICE CONNECTION
2. FRESH WATER TANK
3. SIGHT GAGE
4. HOT CUP
5. WORK COUNTER
6. PULL-OUT WORK TABLE
7. REFRIGERATOR (FREEZING COMPARTMENT)
8. REFRIGERATOR (COOLING COMPARTMENT)
9. STORAGE DRAWER
10. WASTE CONTAINER
11. WARMING OVEN
12. HOT BEVERAGE UNIT (PROVISIONS ONLY)
13. REFUSE OPENING
14. CONTROL PANEL
15. CAN OPENER
16. WATER SPIGOT
17. LIGHT ASSEMBLY
18. PAPER CUP DISPENSER
19. HOT BEVERAGE UNIT CONTROL PANEL (PROVISIONS ONLY)

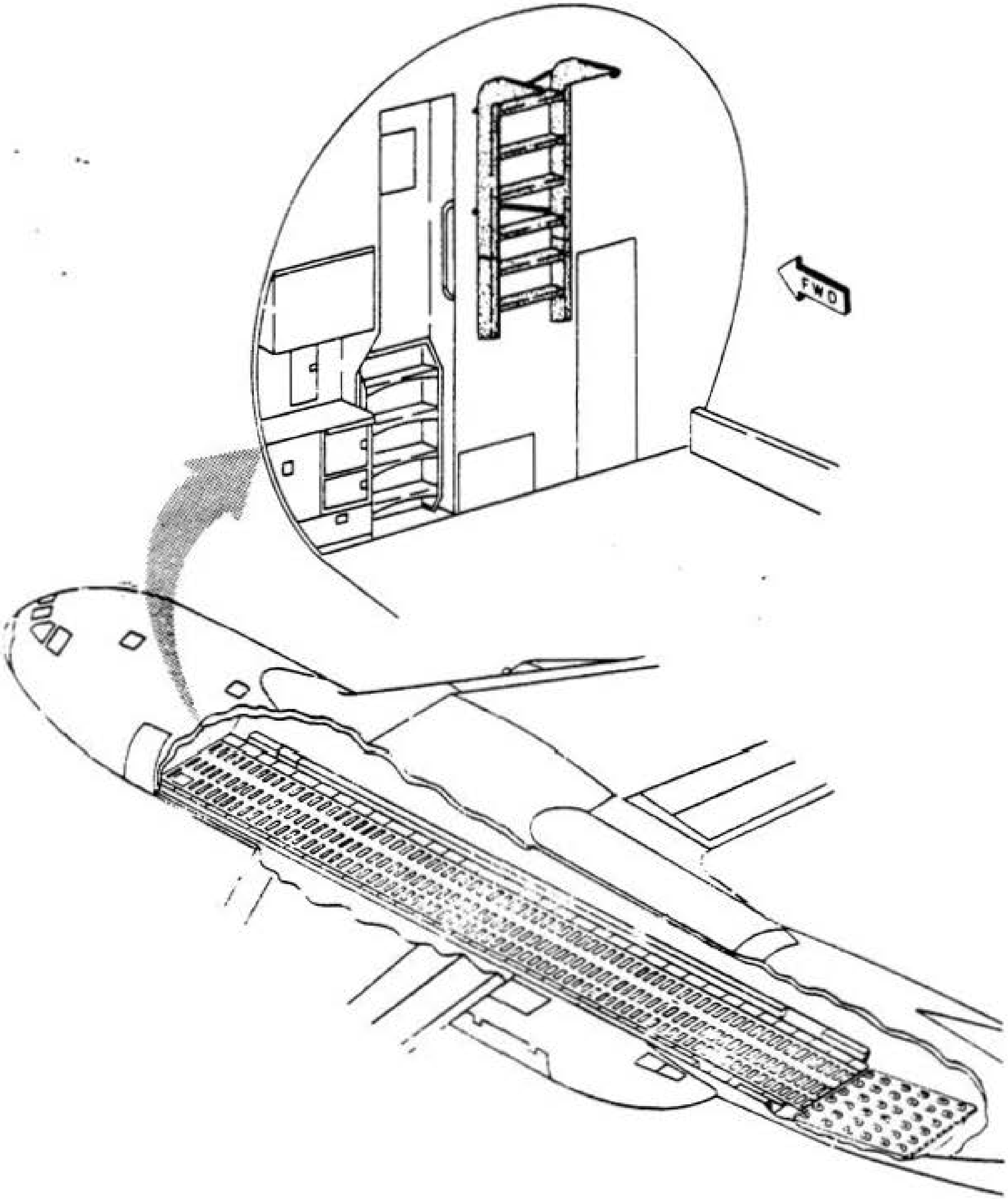
CREW GALLEY



CREW LAVATORY

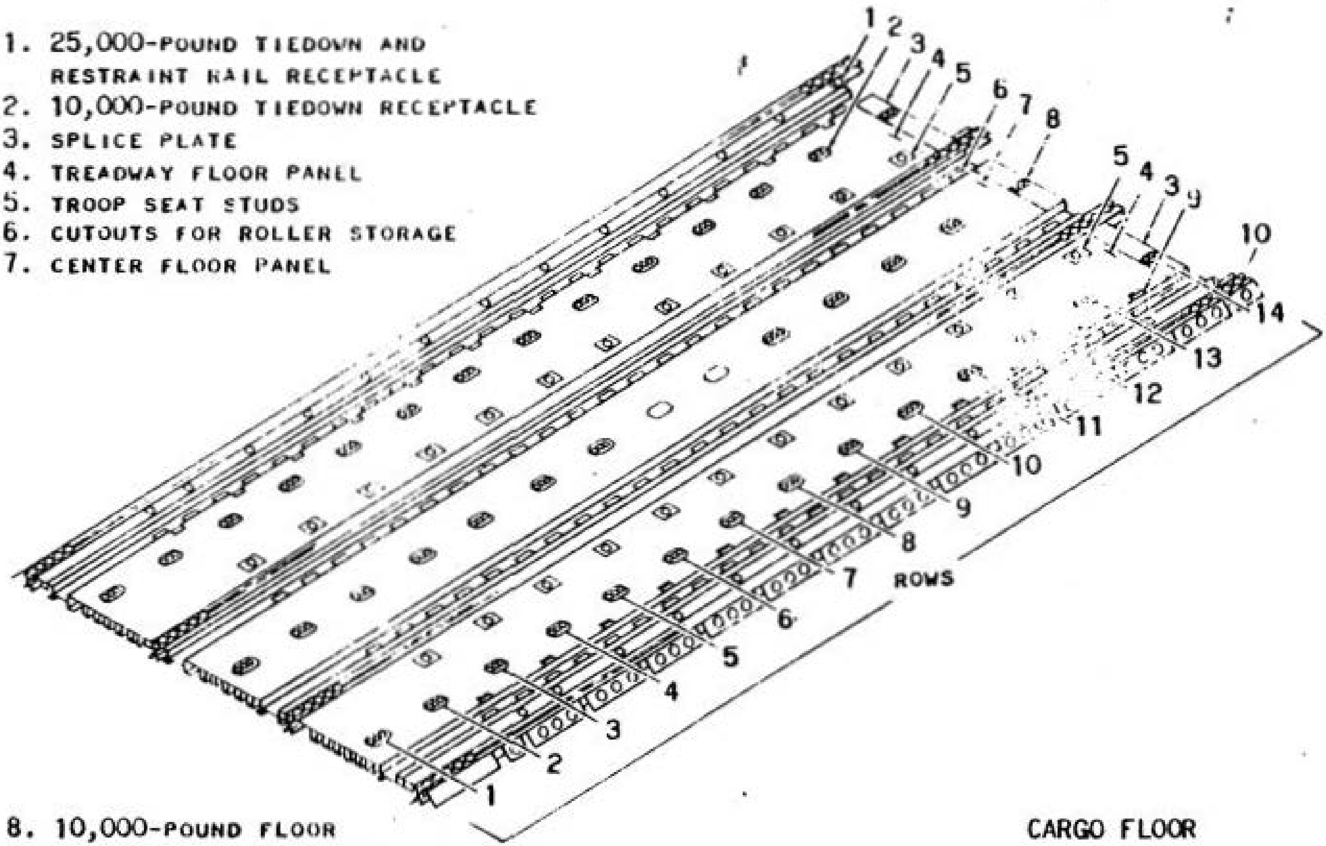
Operating conditions are the prime consideration when determining the frequency of lubrication since grease that is contaminated with dirt, dust, or other abrasives can actually serve as a base to retain these abrasives and promote abnormal wear. Solid film dry lubricants are used in various locations on the StarLifter to minimize this problem. The application of this solid film lubricant is a manufacturing process involving spraying and baking that cannot always be duplicated in the field. The characteristic dark gray color of this lubricant will allow worn spots to be apparent. Any component having faulty solid film lubricant should be removed, refinished, and replaced.

As an interim measure, components having a solid film lubricant may be lubricated with molybdenum disulfide to provide additional lubrication pending replacement of the component. In this event, the lubricated part should be inspected frequently for any sign of failure of the lubricant.



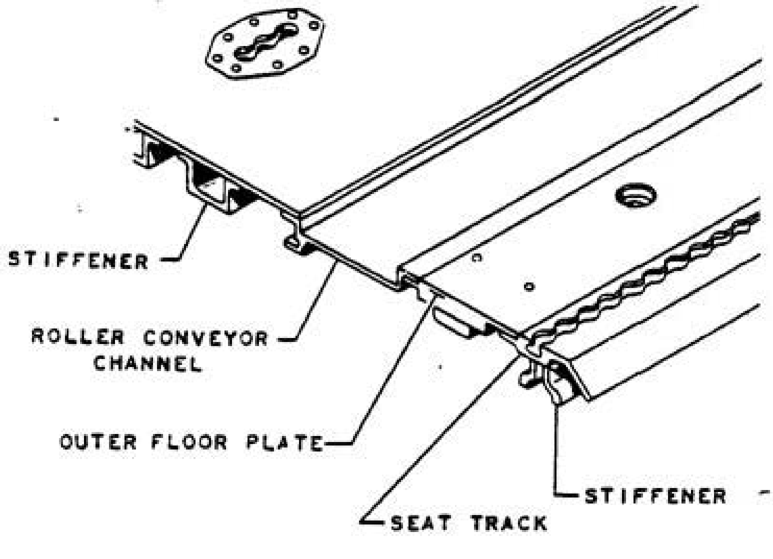
CARGO COMPARTMENT

1. 25,000-POUND TIEDOWN AND RESTRAINT RAIL RECEPTACLE
2. 10,000-POUND TIEDOWN RECEPTACLE
3. SPLICE PLATE
4. TREADWAY FLOOR PANEL
5. TROOP SEAT STUDS
6. CUTOUTS FOR ROLLER STORAGE
7. CENTER FLOOR PANEL



8. 10,000-POUND FLOOR SPLICE TIEDOWN RECEPTACLE
9. TROOP SEAT STUDS
10. CONTINUOUS SEAT TRACK (WITH 10,000-POUND TIEDOWN ATTACH POINTS)
11. STIFFENER
12. OUTER FLOOR PLATE
13. ROLLER CONVEYOR SUPPORT CHANNEL
14. PANEL STIFFENERS

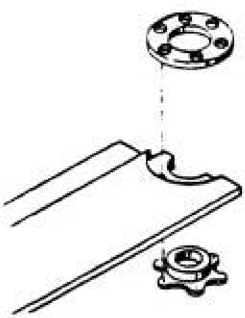
CARGO FLOOR CONSTRUCTION



CARGO FLOOR CONSTRUCTION

BL O and BL 40 left and right. Four track assemblies are recessed into the floor to permit simplified installation of personnel seats. Sections of these tracks at 20 inch intervals are designated as 10,000 pound tiedown receptacles to supplement the regular receptacles. This arrangment provides receptacles for 10,000 pound tiedown fittings on a 20 inch grid pattern over the entire cargo floor. These seat track sections that are intended as tiedown receptacles are marked by a yellow dot in the bottom of the center hole. Rows of receptacles for 10,000 pound tiedown fittings are identified from left to right by a letter and from front to rear by a number. This provides each individual receptacle with a distinct identifying mark composed of a letter and a number.

The 10,000 pound tie down fittings have a pull ring that will unlock the fitting from the receptacle when the ring is pulled and turned 1/4 turn. These fittings incorporate a heavy ring for use in attaching cargo restaining devices such as the MB-1.



TYPICAL 25,000 - POUND TIEDOWN RECEPTACLE

Receptacles for attaching 25,000 pound cargo tiedown fittings are located on 20 inch intervals on BL 56 left and right. The units located at FS 486 and FS 734 are exceptions to this spacing. These 25,000 pound receptacles are used to secure the cargo rail system when it is in use. A quantity of quick disconnect fittings for insertion in the 10,000 pound receptacles and a smaller quantity for insertion in 25,000 pound receptacles are stowed in racks provided within the cargo compartment. Fittings used to lock down the restraint rails are stowed on the rails.

A pull ring on the 25,000 pound fittings need only be pulled to release these fittings from the receptacles.

The entire fitting will swivel in the receptacle to permit alignment with the load. A tie down ring incorporated in these fittings is compatable with the hook on some MB-2 or equivalent cargo restraining devices. The restraint rail tie down fittings have an entirely different locking feature. The lock release is operated by a knurled knob and a release pin. A second version of this fitting includes a length of chain to permit simultaneous tiedown of the restraint rail and loose cargo using the same receptacle.

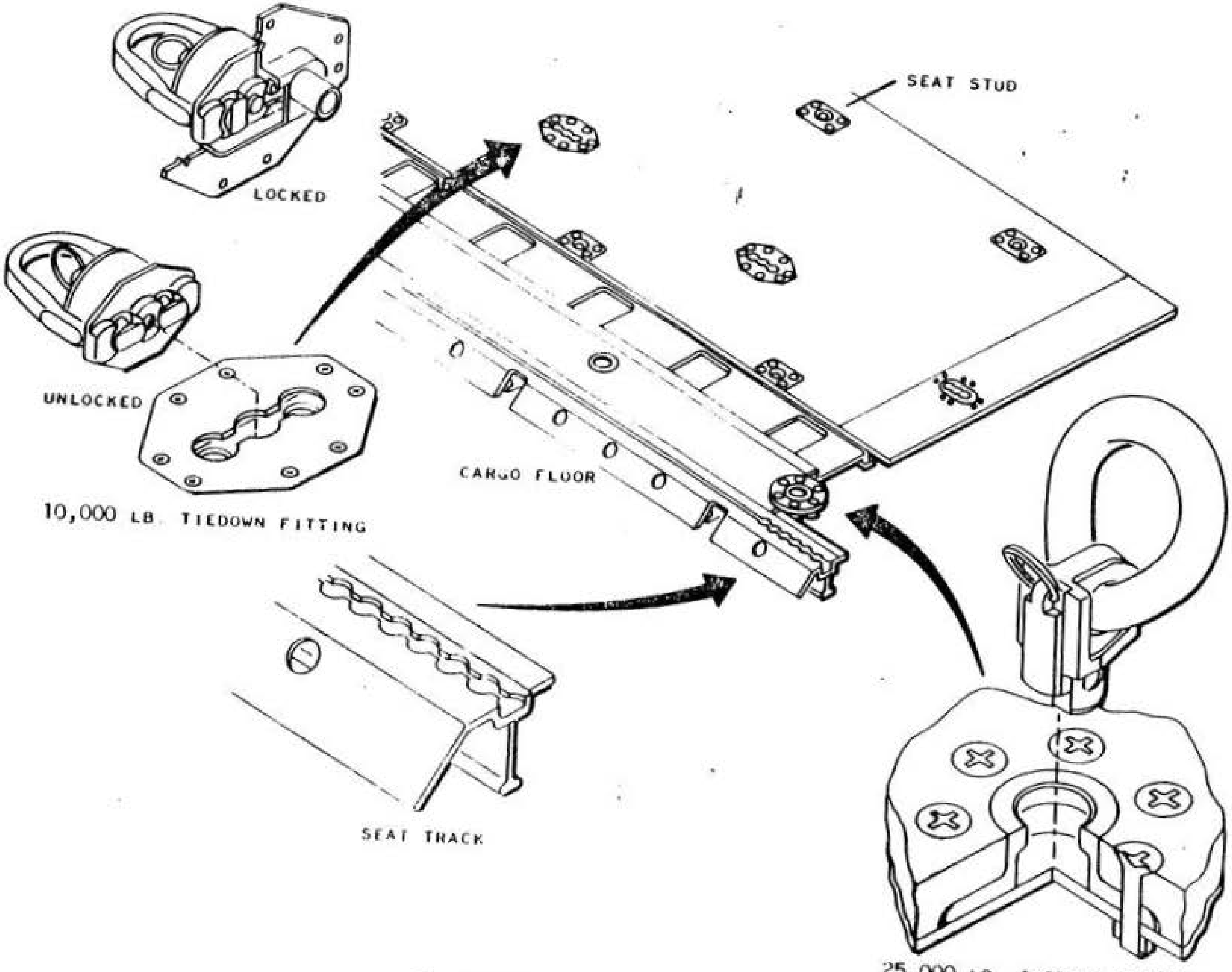
10,000 and 25,000 pounds are the rated strength values of the cargo tiedown receptacles when the strain vector in the direction which normally results from cargo restraint. When loads that would result from the attachment of such devices as the cargo winch or snatch blocks are considered, a lesser limiting value called the design limit load value should be used. This design limit load value for the 10,000 pounds receptacles is 6,667 pounds and for the 25,000 pound receptacles it is 16,667 pounds.

CONVEYER ROLLERS.

Movement of large bulky cargo and palletized cargo into and out of the cargo compartment is simplified by the presence of built in conveyer rollers that will allow a minimum of force to move heavy objects. The rollers are installed in four rows that run the length of the cargo compartment. Each row consists of groups of rollers mounted in channel assemblies that may be installed so that the rollers protrude above the cargo floor or reversed so that the smooth bottoms of the channel assemblies form part of the cargo floor.

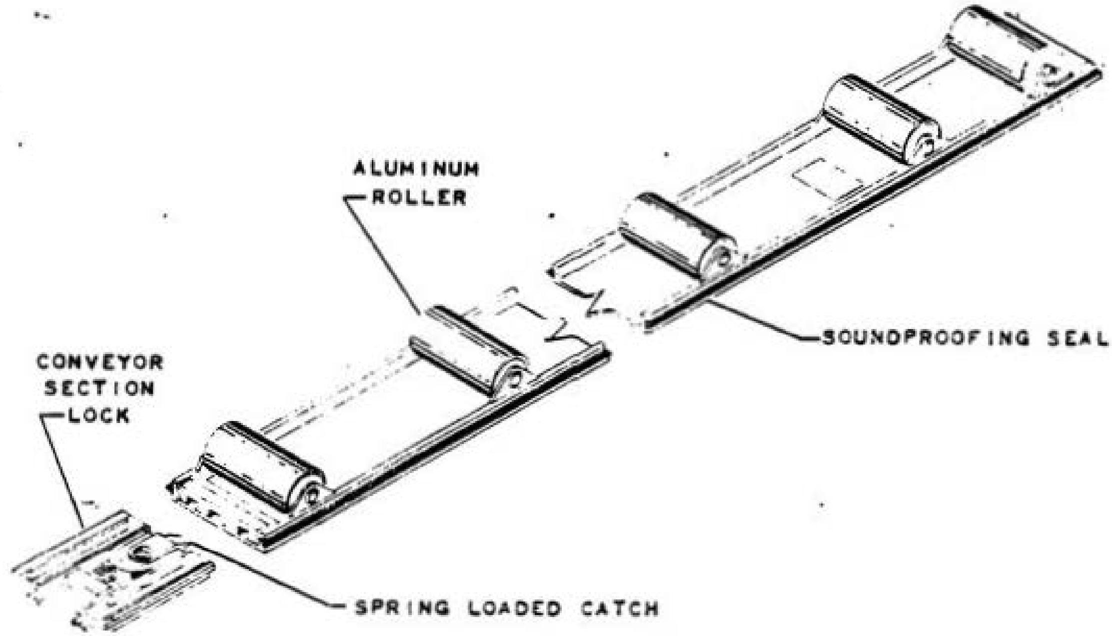
Each conveyer section consists of a modified "U" shaped channel which is flat on the bottom and contains rollers in the open side. A strip of soundproofing seal is installed down the length of each side of the channel to reduce noise coming from the underfloor area. The channel are 4-1/2 inches wide and vary in length from approximately seven feet to approximately 7-1/2 feet. All of the sections are interchangeable laterally, but only certain sections are interchangeable longitudinally due to their varying length. The most foward and the most aft lateral rows of conveyers are limited to their lateral row locations.

Each conveyer section contains individual bearing-mounted aluminum rollers on approximately ten inch centers. The rollers are 1-7/8 inches in 3-1/2 inches in length. With the conveyer channels turned upright, the rollers project 1-1/2 inches above the surrounding floor. With the channels inverted, the rollers project down into plastic dust shields that are installed in the recessed floor channels. A manually operated quick release lock is permanently installed in the floor channel for the conveyer sections at one end of each section. One end



TIEDOWN FITTING RECEPTACLES

of each conveyer section slides under a tapered section of the lock plate and the other end is locked in place by a springloaded latch assembly that can be retracted by movement of a recessed ring.



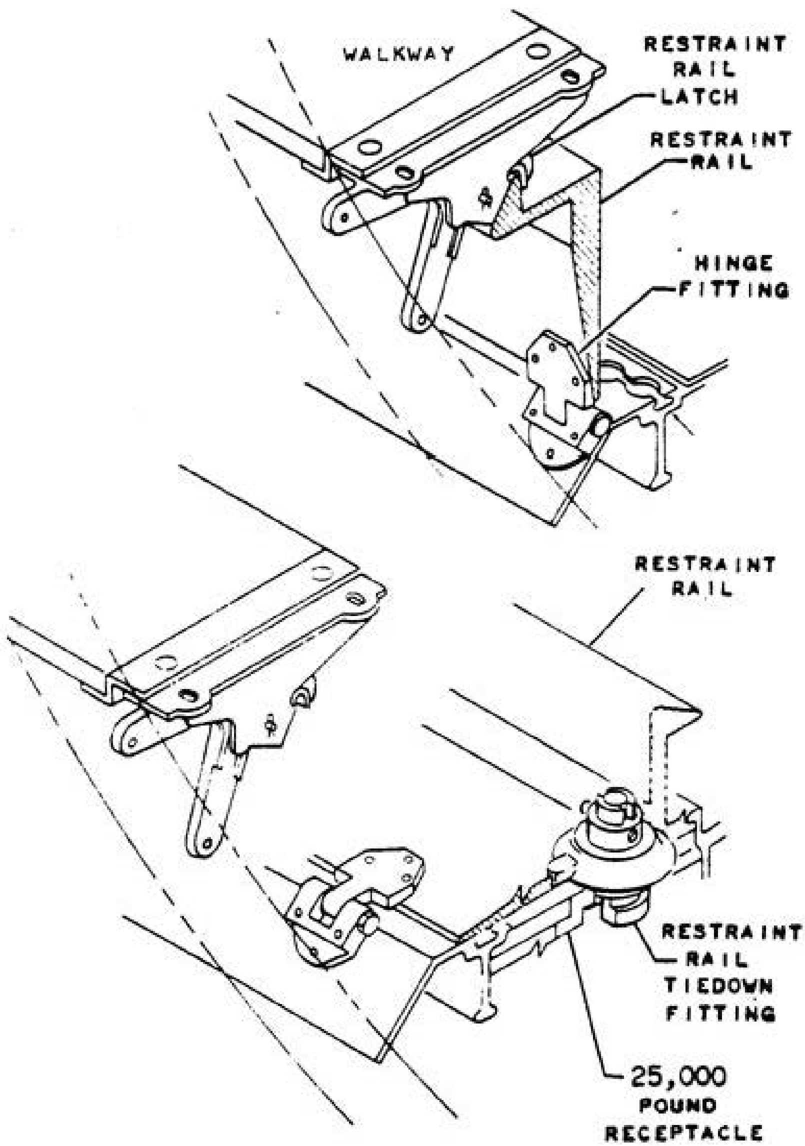
ROLLER CONVEYORS

CARGO RESTRAINT RAILS.

Retractable restraint rails are provided on both sides of the cargo compartment to aid in loading, restraining, and off-loading palletized cargo and airdrop platforms. When fixed in position, these rails provide a continuous channel the length of the cargo compartment. Restraint mechanisms, installed on the rail assemblies, make it possible to load palletized cargo that is properly secured to the pallet without the necessity for further cargo tiedown.

The rails are built in ten sections to facilitate handling. All sections, forward of the rear personnel doors, are attached to the side of the cargo floor by hinge straps and can be folded up under the side walkways when not in use. The remaining sections can be removed and stowed in brackets mounted on the fuselage side wall. Under some types of operation it may be desirable to have some of the rails in use and others stowed. The length of the forward rail assemblies will permit an 88 by 108 inch comfort pallet to be retained by these assemblies while the remainder of the rails are stowed to permit personnel seat installation.

Upward or sideward movement of pallets and airdrop platforms is prevented by rail sides and lips. Fore and aft movement is controlled by the restraint mechanisms. These mechanisms have detents that extend through the rails and engage indentations cut into the sides of both pallets and airdrop platforms. A cutout in the lip of the rail directly over the detent of each mechanism permits visual inspection for a positive lock.



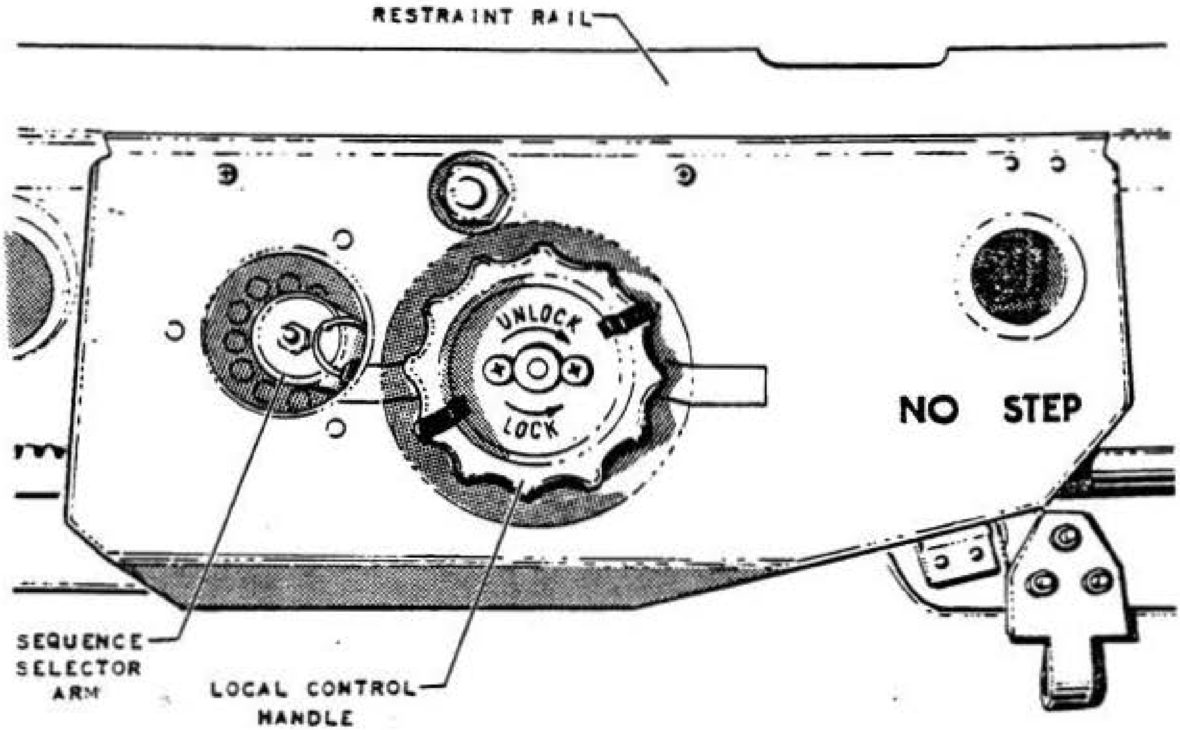
RESTRAINT RAIL TIEDOWN

The mechanisms on the right rail assemblies can be set to provide a calibrated amount of aft restraint during airdrop of cargo. This feature assures a more positive control of cargo pallets during airdrop manuevers. All mechanisms on each rail system may be released in unison by means of remote control handles located at the rail ends, or released individually by means of locking handles located on the individual mechanism. The left rail mechanisms can also be released individually in any desired sequence by means of the remote control handles. Control handles for the left rail system are located at the front and rear of the rail system. The right rail system has a single control handle located at the forward end of the rail.

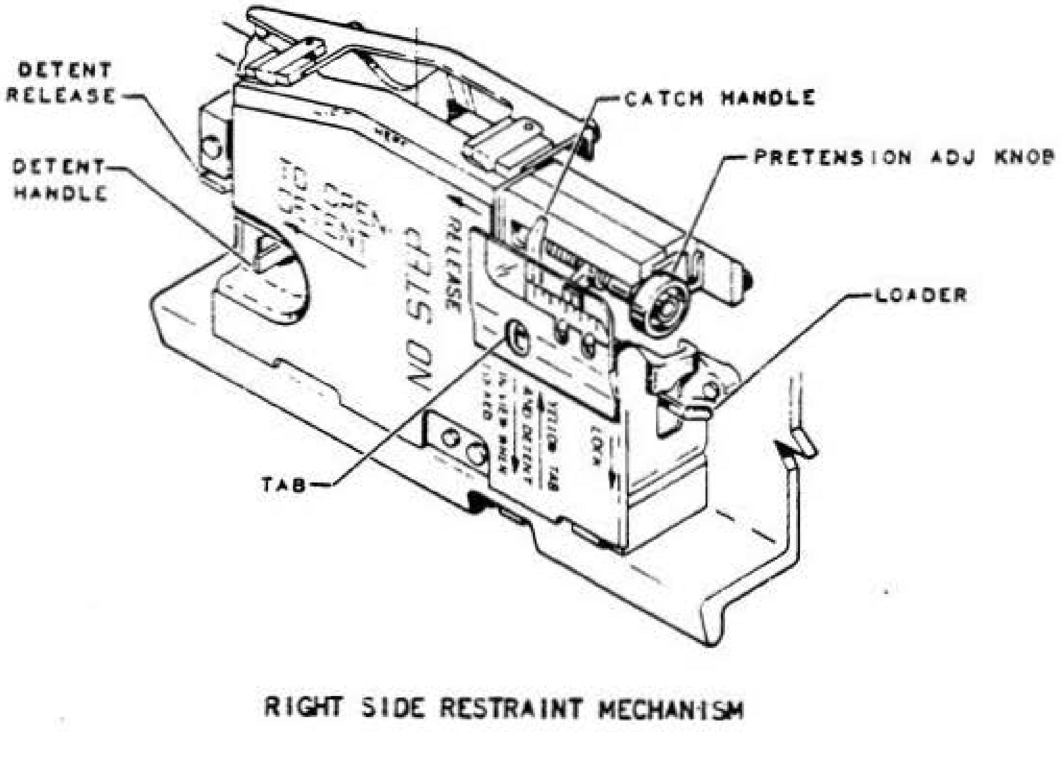
All the left rail system restraint mechanisms are identical. They consist of a detent with locking mechanism, a handle for manually locking or unlocking the mechanism, and a sequence selector arm and pinion for use with the remote control feature. In operation, the detent is locked in the retracted position providing unrestricted pallet movement within the rails. When the locking handle is turned to the locked position, a spring forces the detent outward through a cutout in the rail and a locking device engages to hold it extended. Index markings on the manual locking handle provide a quick visual indication of the handle position.

A sequence selector knob on the mechanism is geared to the restraint mechanism and to a remote control push-pull rod. The push-pull rod is in sections that are joined by quick disconnect couplings. Each restraint mechanism utilizes one section of push-pull rod. Both ends of the push-pull rod are connected to remote control assemblies that operate the push-pull rod through the action of rack and pinion units. An index plate on the requence selector knob is numbered "0" through "9" to correspond with numbers on the remote control rack and pinion unit. The operation positions the sequence selector of any or all restraint mechanisms to a desired number. When the remote handle is moved to align this number on the rack and pinion unit with an index, all selected restraint mechanisms will be unlocked. Movement of the control handle in the opposite direction will serve to lock all selected mechanisms. Up to nine pallets can be sequenced to lock or unlock individually. The force required to remotely operate the mechanisms increases with the number of locks that are selected to operate simultaneously so no more than eight mechanisms should be set to operate in unison. Only one control handle at a time should be used to position the remote control function and the control handle at the other end of the rail assembly should be in the stowed position.

The restraint mechanisms on the right rail system forward of FS 1292 are all identical. They provide positive locking action against a forward acting load, but have a variable amount of restraint against an aft acting load such as that

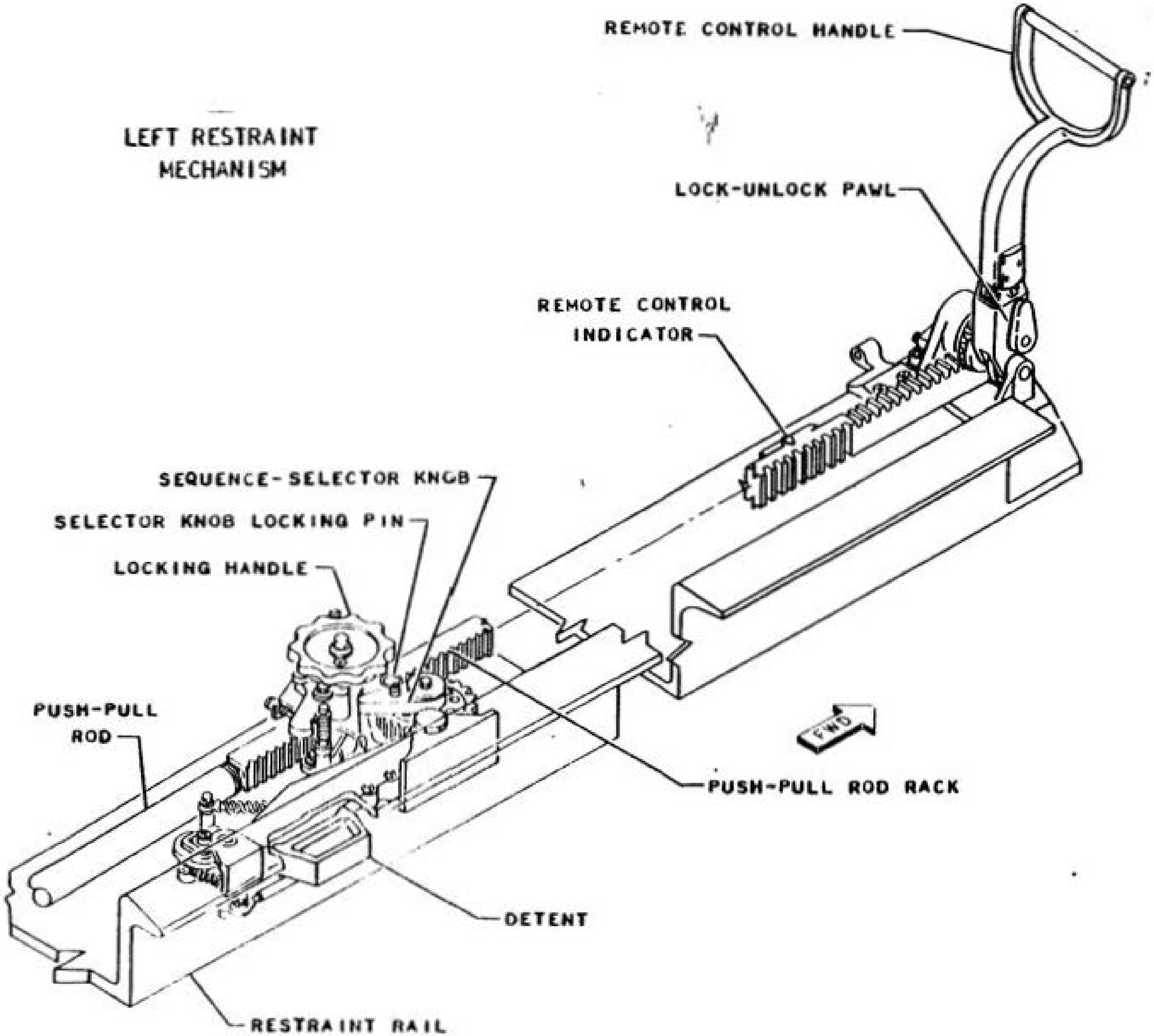


LEFT SIDE RESTRAINT MECHANISM



RIGHT SIDE RESTRAINT MECHANISM

LEFT RESTRAINT MECHANISM



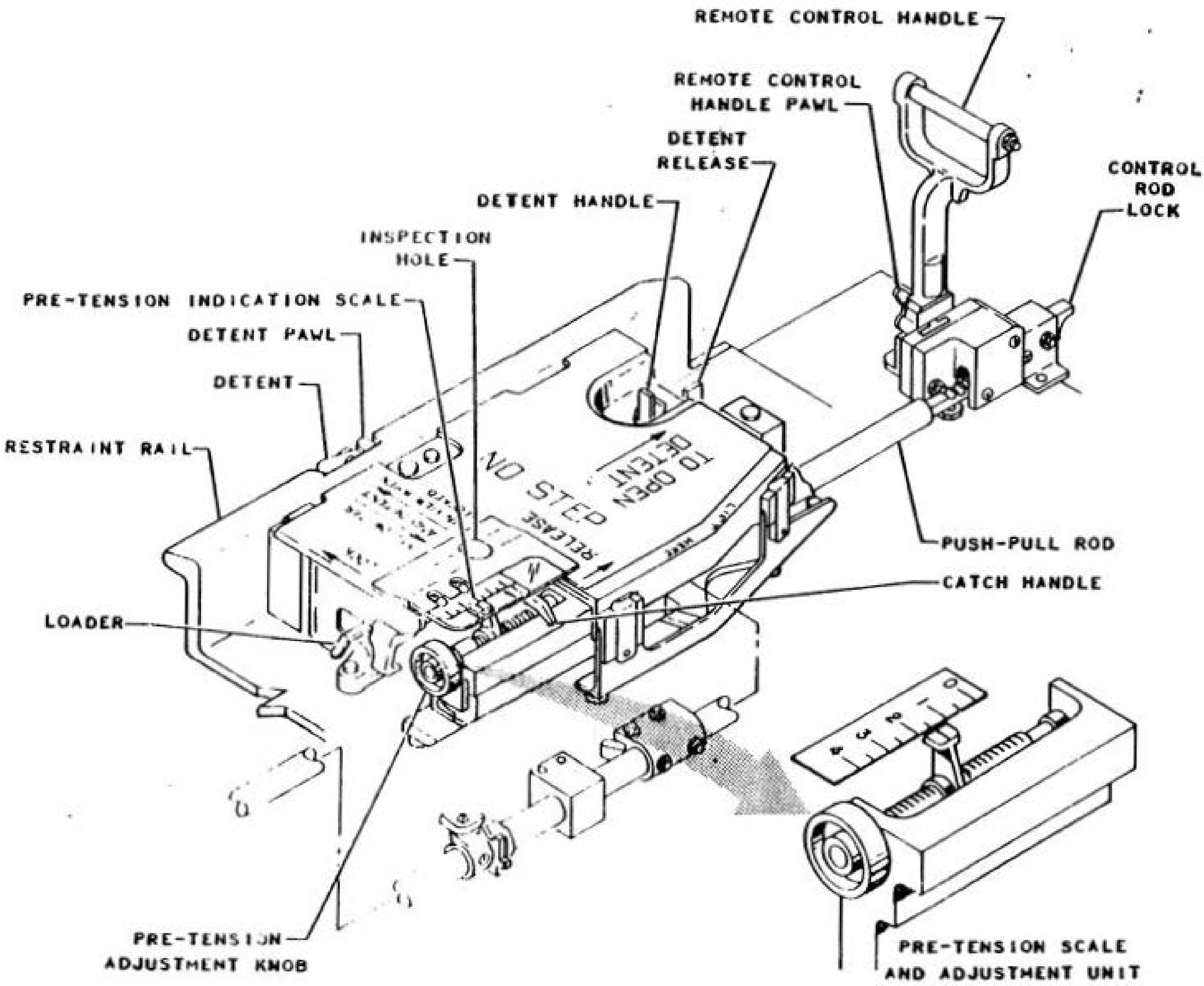
created when air drop platforms are being extracted. A restraint adjustment is provided for selection of the desired amount of aft restraint. With this adjustment set to "O", the detent stops forward motion but has no effect on aft pallet movement. As the adjustment is advanced toward "4", the detent offers an increasing amount of resistance to aft movement.

A retracable detent on each mechanism can be controlled locally by means of control levers on the mechanism or remotely by means of a control handle located at the forward end of the rail assembly. If the load attempts to move aft, this detent holds any force up to that set on the variable restraint adjustment and is then forced back through the rail to an unlocked position. When the detent is retracted by excessive aft forces, it will remain retracted until it is reset.

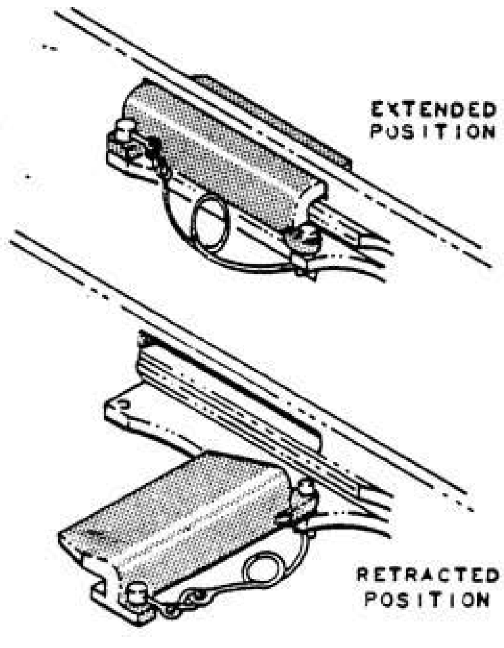
All locally operated controls on the right restraint mechanisms are painted yellow for easy identification. When the detent is extended and locked, the end of the detent will be seen protruding through the rail at a cutout in the rail lip and a small yellow tab will be visible through the inspection hole in the cover of the mechanism. The loader lever at the aft end of the mechanism locks the detent in either the extended or retracted position. The detent unlocking lever is the "catch handle" near the restraint scale. Moving this handle forward trips the detent lock mechanism and removes all aft restraint from the detent. The detent may be retracted manually using the "detent handle". Movement of the detent "release lever" will permit the detent to extend.

The remote control assembly for the right rail system operated the same as that of the left rail system except that it has only "locked" and "unlocked" positions. Operation of the push-pull rod through its full range of travel from "locked" to "unlocked" requires more than one stroke of the control handle. A black stripe is painted on the push-pull rod that will align with an index mark to indicate positioning of the remote control assembly. One further stroke of the control handle will unlock all detents. This pre-positioning may be used as a precaution during aerial delivery operations. A ratchet pawl located on the forward end of the remote control unit provides a holding stop for the push-pull rod in the full unlock position.

All rail assemblies aft of the rear personnel doors are constructed without the "lip" that provides restraint against upward cargo movement. This change is included since pallets that move up an inclining ramp must "tip" when moving from the ramp to the cargo floor. Retractable "lips" are provided that must be extended and retracted manually. Removable cargo stops are provided for installation in the forward end of the rail systems.



RIGHT RESTRAINT MECHANISM



RETRACTABLE LIPS

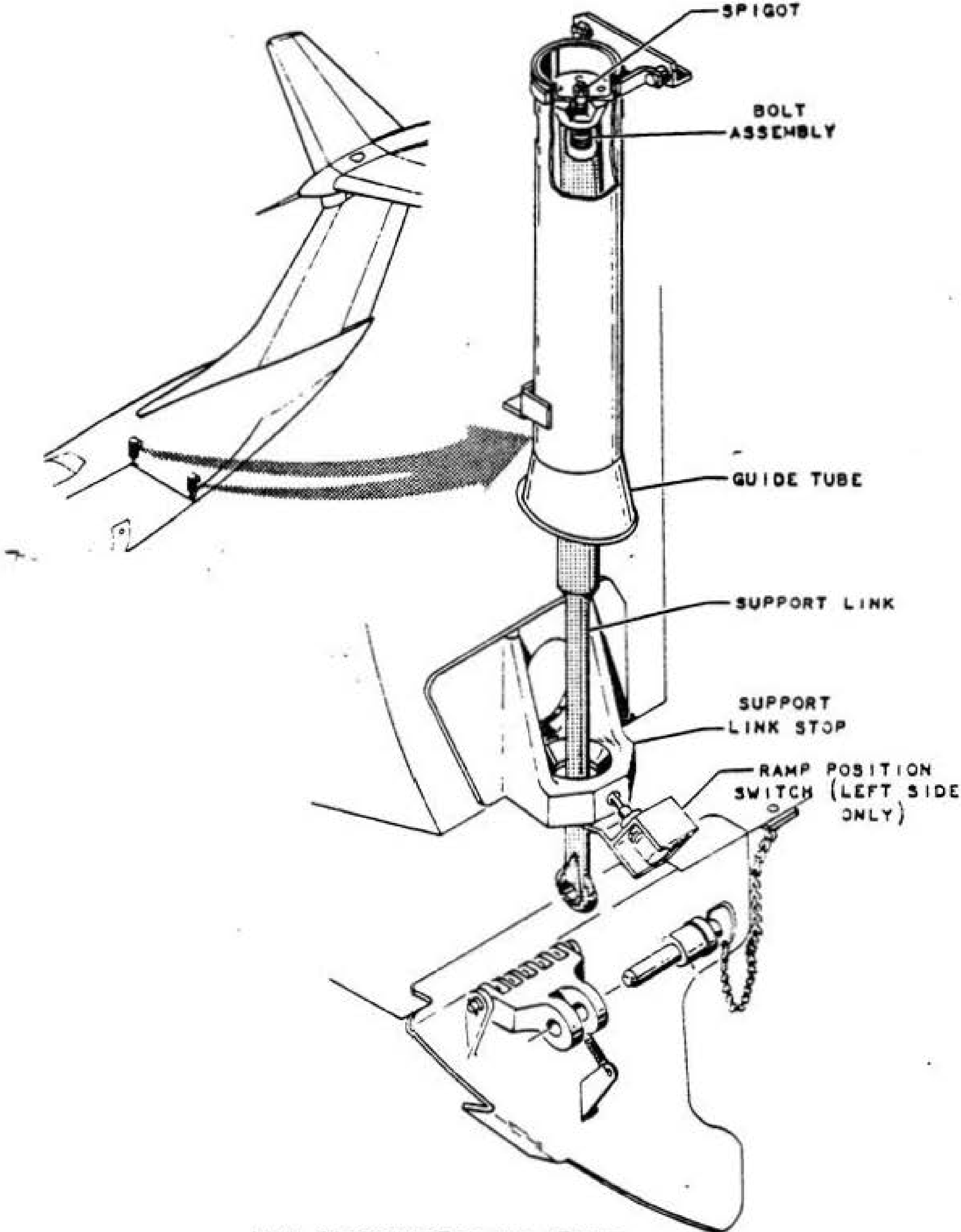
CARGO RAMP.

Construction of the cargo ramp is very similar to the construction of the cargo compartment floor. All the features of the floor are included except the recessed seat tracks and the seat studs. The forward end of the ramp is hinged to the aft end of the cargo compartment floor. Two hydraulic actuators are used to position the ramp as required for aircraft loading from the ground or from truck bed height and to fair the ramp into the fuselage for flight.

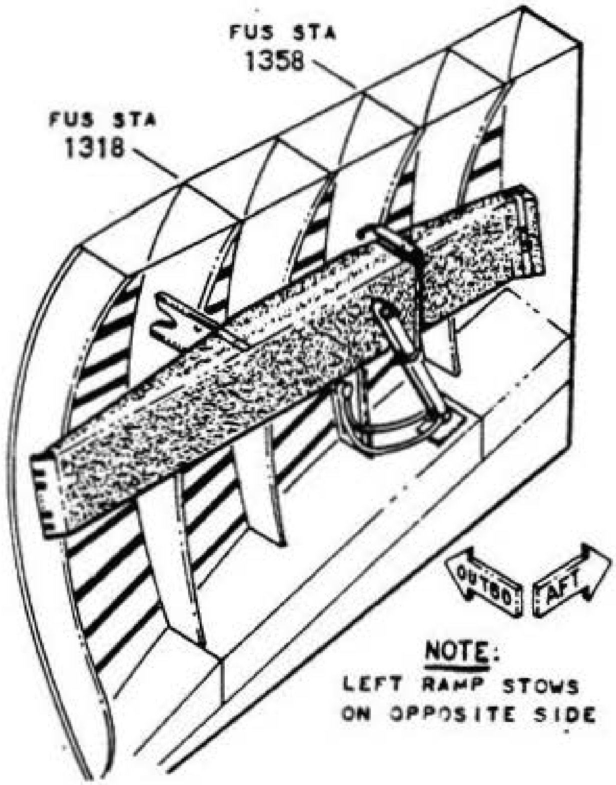
Stop links are attached to the rear corners of the ramp by quick-disconnect pins. These links serve to limit ramp movement during straight in cargo loading and airdrops. Removal of the quick-disconnect pins will permit the ramp to move downward 10 to 15 degrees past the horizontal position for ground loading. Care must be exercized when raising the ramp with the stop links disconnected to prevent damage to the aircraft.

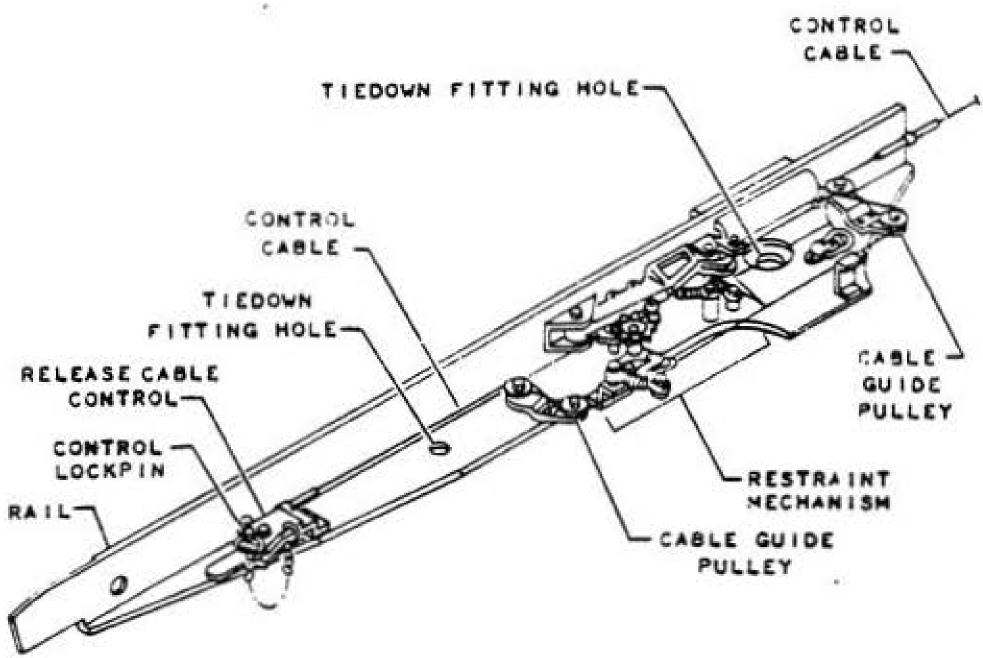
Two auxiliary loading ramps 8-1/2 feet long, 22 inches wide, and weighing approximately 95 pounds each are provided to bridge the distance from the ramp to the ground when the ramp is in the down position. These ramps are stowed in brackets provided on each side of the cargo compartment above the ramp. They attach to latches on the rear of the cargo ramp. Rubber "toes" are provided for the lower end of the auxiliary ramps where they contact the ground. Pallets or bulk cargo must be elevated to clear these "toes" before moving up the ramp.

The cargo ramp rail systems are similar to those sections of the cargo compartment rail system aft of the rear personnel doors. Major differences are in the restraint mechanisms and the funnel shaped rear sections that simplify the alignment of pallets with the rail sections. Each rail system consists of two rail assemblies and two restraint mechanisms. The primary differences between the ramp and cargo compartment restraint mechanisms for the left rail system are



LINK DISCONNECTED AND STOWED

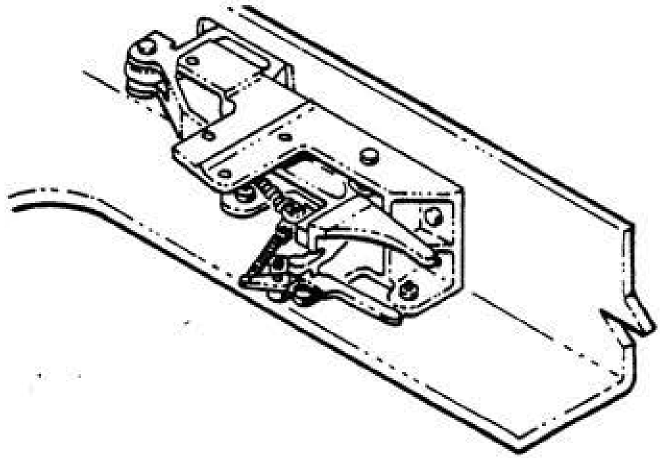




CARGO RAMP LEFT FORWARD RAIL

that the ramp restraint mechanisms do not have sequence selectors and that a cable operated remote release system is used.

Simplified restraint mechanisms are installed on the right rail system of the ramp. Both mechanisms must be individually locked or unlocked at the mechanism and no aft restraint is provided. When locked, the detent provides positive forward restraint.

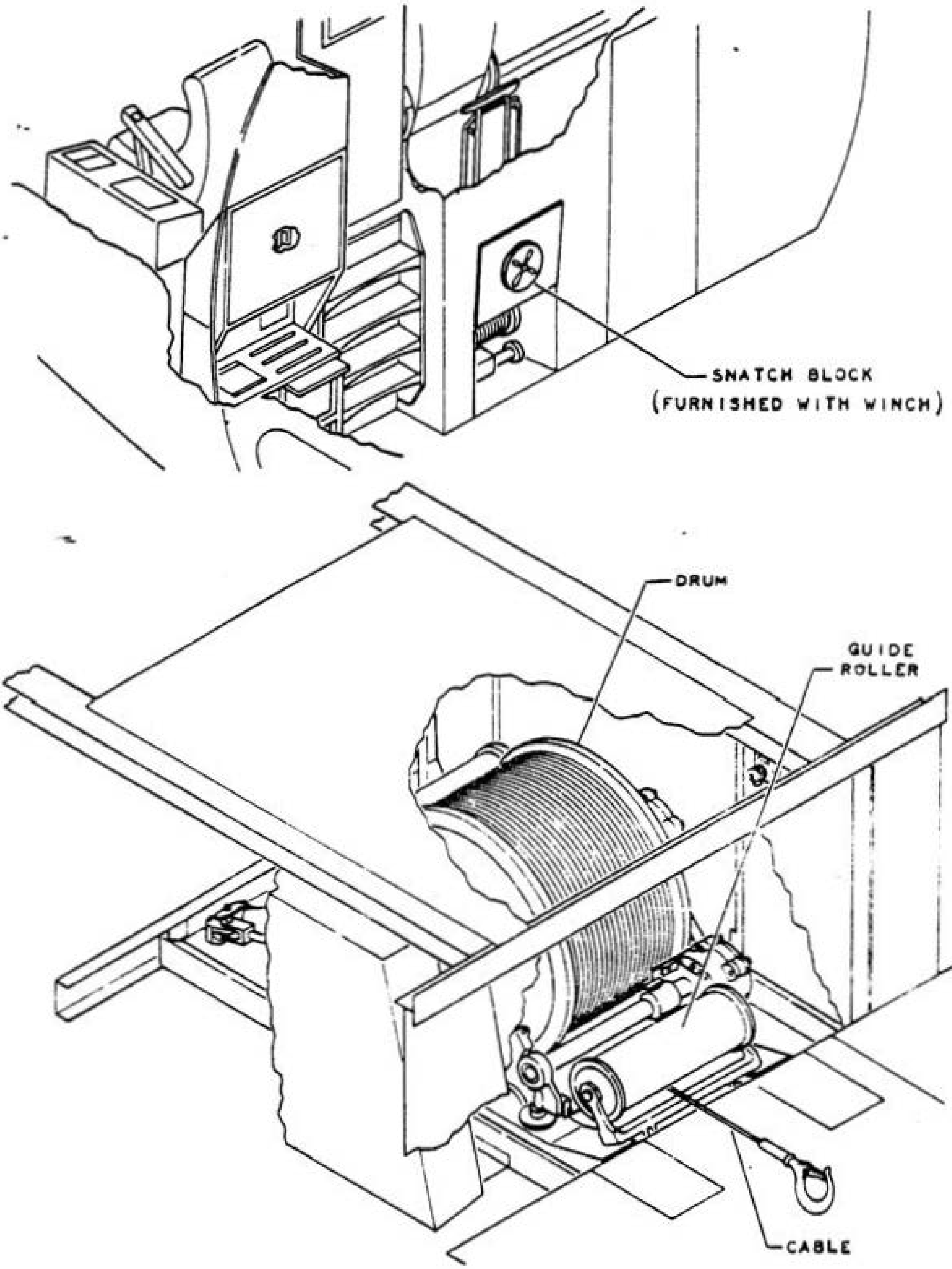


RIGHT RAMP RAIL RESTRAINT

CARGO WINCH.

A recessed compartment for mounting a cargo winch is located forward of the cargo compartment beneath the flight station. The winch normally installed in the StarLifter is a type HCU-9/A with a rated capacity of 6,500 pounds. The winch consists of a cable drum driven by a reversible electric motor through a conventional gear train. A gear driven cable follower distributes the cable evenly across the drum during rewind. The drum may be disengaged from the gear train for manually positioning the cable.

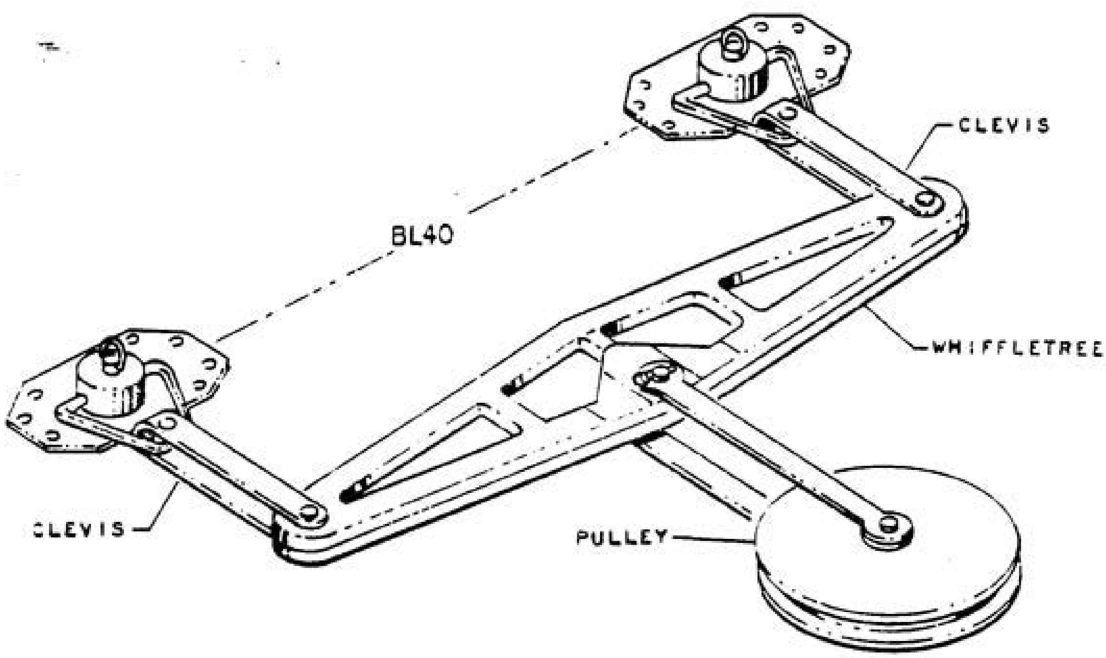
The winch is attached to the floor of the winch compartment by two forward fittings featuring quick release pins and one aft fitting near the door of the winch compartment. Four retractable wheels on the winch assembly simplify removal and installation of the 290 pound assembly. The floor of the winch compartment contains a drip pan which will collect fluid that results from leaks or spills near the winch reservoir. Control of the winch is provided by a toggle switch on a 50 foot pendant. A removable cable guide roller is installed on the aft edge of the winch platform to keep the winch cable close to the compartment floor. Removable electrical load limiting devices limit winch loads to a figure based on the particular device installed. The devices are inserted in receptacles located either on the winch junction box or the winch control pendant. With no device installed, the winch load will be limited to 4,500 pounds. If one of the limiting devices is installed, the winch load will be limited to either 6,600 pounds or 8,500 pounds dependant upon the device installed. In each case, the lower



CARGO WINCH

rated limiting device is bypassed when a higher rated device is installed. Limit switches which are mounted on the winch frame prevent cable over-travel.

A single snatch block is mounted on the door to the winch compartment for use in reducing the load applied to the winch. Two additional snatch blocks are stowed in the cargo compartment between FS 518 and FS 538. These snatch blocks may be attached to the cargo floor at any two adjacent 10,000 pound cargo tie down fittings. A "whiffle tree" arrangement permits the blocks to be rated at 13,000 pounds. For installation, a clevis on the snatch block is placed through the ring on each of two 10,000 tie down fittings and then they are pinned to the "whiffle tree".

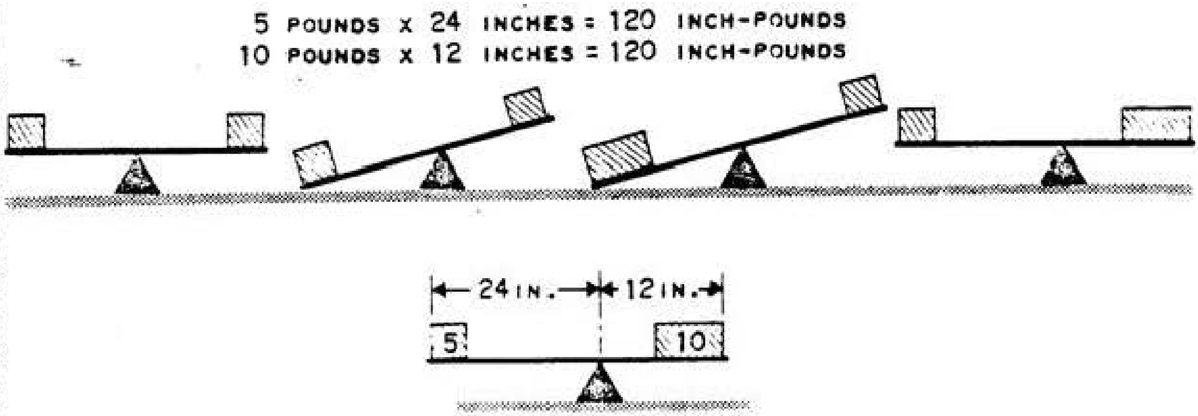


SNATCH BLOCK

AIRCRAFT LOADING

WEIGHT AND BALANCE.

Due to an aircraft's ability to be moved in more than one plane, weight distribution is of prime importance. The simple "see-saw" or "teeter board" can be used to illustrate some of the principals of weight distribution and point out why they are important to aircraft movement.



You will recall that when using a "teeter board" with weights of equal size, the board could be approximately centered on the fulcrum. If the board were not centered or if one weight was substantially larger, the board would not balance. By relocating the "teeter board" on the fulcrum so that the smaller weight had the longer segment of the board, balance would be resumed. Had you calculated the relationship of weight to board length in these instances you would have found that the board always balanced when the products of weight multiplied by board length from the fulcrum were equal. This product of weight times the board or lever length is called a moment arm. When calculating the moment arm of factors effecting the StarLifter, you will find that the combination of heavy weights and extensive lengths will result in figures that often run into the tens of thousands or even millions. To simplify calculations, this figure is generally divided by 10,000 and expressed as "moment/10,000".

The fulcrum of aircraft movement is a point called the center of gravity (CG). Each new aircraft is weighed prior to leaving the factory and this CG location is determined and recorded on a form for later reference. Since changes to the aircraft structure or equipment can change the location of the CG, good maintenance practice requires that the aircraft be weighed periodically to reestablish the exact location.

Some definitions that will be of value to you in your study of weight and balance are listed below:

1. MAXIMUM WEIGHT - The maximum authorized weight of the aircraft and its contents according to aircraft specifications.

2. EMPTY WEIGHT - The weight of the aircraft with all installed equipment that has a fixed or permanent location in the aircraft. The fuel and oil tanks are drained and the residual fluid becomes a part of the aircraft weight.

3. USEFUL LOAD - The empty weight subtracted from the maximum weight of the aircraft.

4. WEIGHT CHECK - Checks of the sum of the useful load against the authorized useful load.

5. DATUM - An imaginary vertical line in front of the aircraft. All horizontal measurements for balance purposes are made from this datum.

6. ARM (or MOMENT ARM) - The horizontal distance (in inches) from the datum to the center of gravity of the load.

7. MOMENT - The product of the weight multiplied by its arm.

8. CENTER OF GRAVITY (CG) - The point about which the aircraft would balance if suspended. The CG is given in inches which represents the distance from the datum to this point.

9. MEAN AERODYNAMIC CHORD (MAC) - The mean chord of the wind. Used for weight and balance purposes to locate the CG range of the aircraft.

10. LEMAC - The theoretical leading edge of the MAC.

11. OPERATING CG RANGE - The distance between the forward and aft limits of the center of gravity according to aircraft specifications; usually indicated by percent of MAC or in inches from the reference datum.

12. WEIGHING POINT - The point where weight of the aircraft is imposed on the weighing scales.

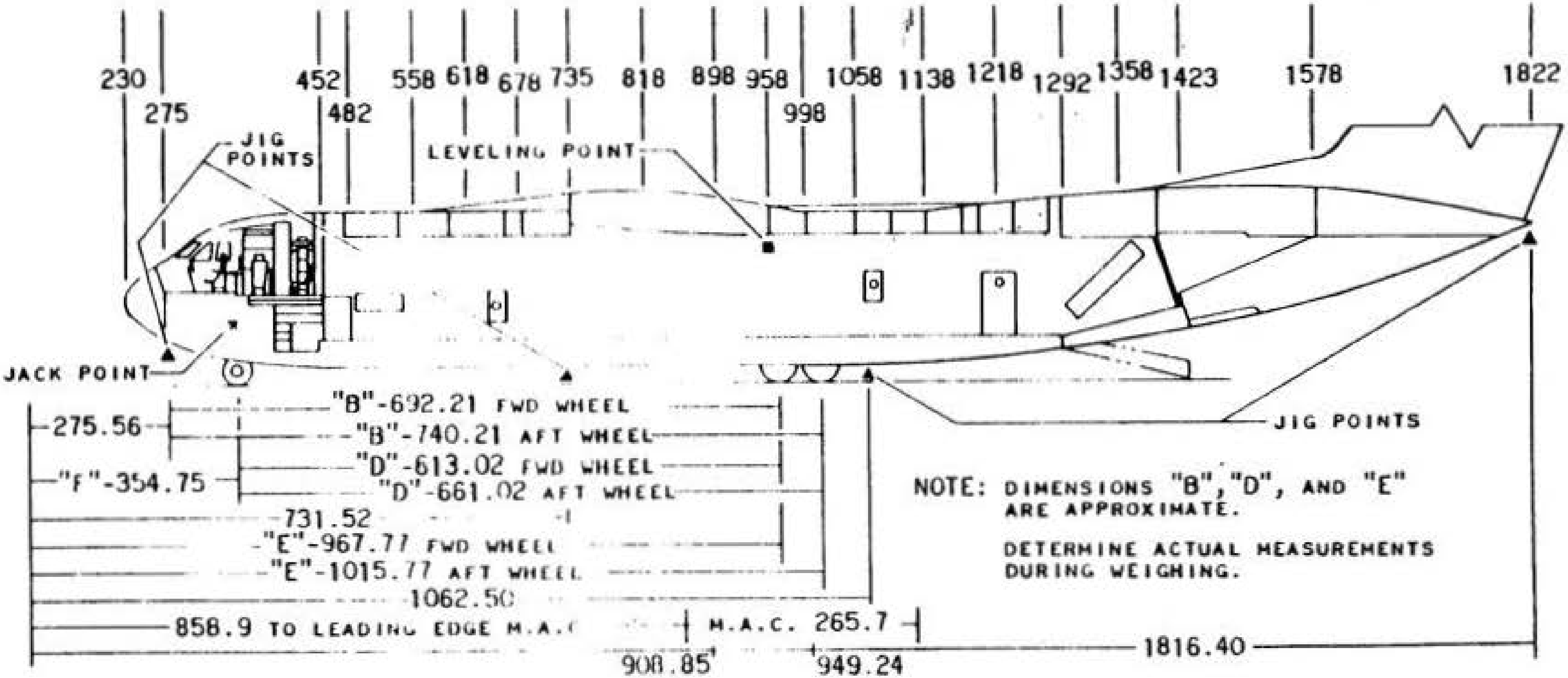
13. TARE - The weight of chocks, blocks, and miscellaneous equipment used in weighing an aircraft.

Several arrangements of equipment are possible when weighing the StarLifter. The one most commonly used involves electronic weighing kits and axle jacks. Five axle jacks are used to raise and level the aircraft. Two jacks are used at each main strut and one jack is used for the nose strut. A unit of the electronics weighing kit called a "pickup" is placed between each jack and the jack point and all are connected to an electronics control box that will indicate the stress on each "pickup" in terms of weight.

Spirit levels are fastened to each main landing gear truck beam and the aircraft is jacked sufficiently to clear the ground with all wheels. The jacks on the main gear are used to level the main gear truck beams and the jack on the nose gear is used to level the aircraft. The plumb bob within the cargo compartment at FS 956.5 is used to indicate any deviation of the aircraft from horizontal. The basic weight condition is established with fuel and oil tanks drained, wheels down, flaps fully retracted, and windows, crew entry door, rear personnel doors, ramp, pressure door, and petal doors closed. Any deviation from this condition will necessitate a correction in computing the CG location. As an example, weighing the aircraft with the flaps in the down position will result in a moment 10,000 correction of -15.9.

Line "E" on the weight and balance diagram is subject to change with strut inflation. The actual measurement can be determined by physically measuring the distance or it may be computed using the JACK POINT DIMENSION chart.

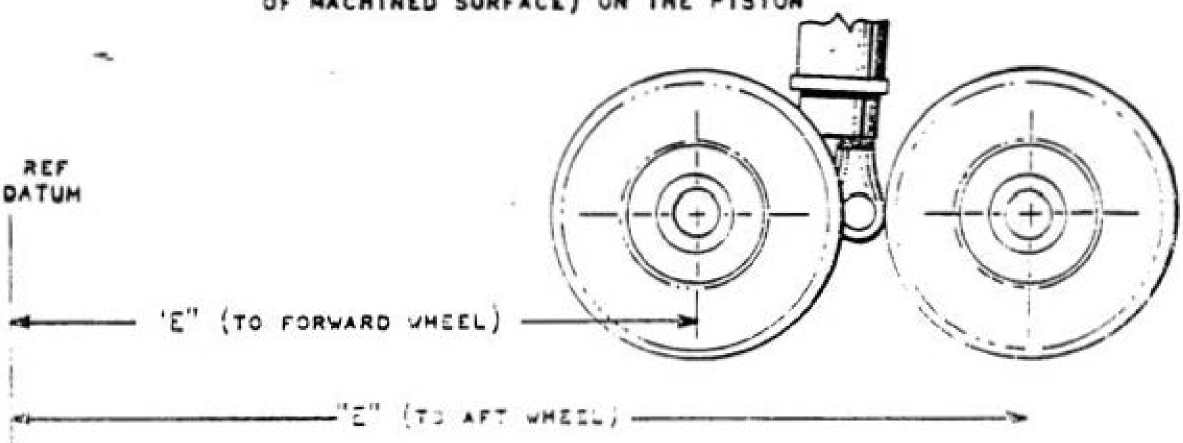
To compute the basic weight of the aircraft, simply add the readings of all pickups. To compute the CG location, the weight recorded on each pickup must be multiplied by the length of the appropriate arm to determine the moment. All moments are then added and the sum is divided by 10,000 to determine the moment/10,000. The basic weight is divided by the moment/10,000 to determine the CG location in inches from the datum. A simplified means of expressing the mathematically is: $\frac{\text{basic weight (10,000)}}{\text{moment}}$ = CG location.



AIRPLANE DIAGRAM

DIMENSION H*	DIMENSION E (FORWARD WHEEL)	DIMENSION E (AFT WHEEL)
0.56	967.77	1015.77
3.56	967.66	1015.66
6.56	967.55	1015.55
9.56	967.44	1015.44
12.56	967.33	1015.33
15.56	967.23	1015.23
18.56	967.12	1015.12
21.56	967.01	1015.01
24.56	966.90	1014.90
27.56	966.79	1014.79
28.56	966.75	1014.75

*DIMENSION H IS MEASURED ALONG THE CENTER LINE OF THE OLEO STRUT FROM THE LOWER EDGE OF THE OUTER CYLINDER TO THE SHOULDER (END OF MACHINED SURFACE) ON THE PISTON



JACK POINT DIMENSION DATA (APPROXIMATE)

The majority of references to CG location in the various StarLifter manuals are expressed in terms of percent of MAC. To convert inches from the datum to percent of MAC, subtract the distance from the datum to LEMAC (855.9 inches) from the CG location in inches and determine what percent of MAC (263.7 inches) is represented by the result.

Once the basic aircraft weight and CG location are determined and recorded, it is used as the basis for computations concerned with the effect of the addition of cargo and fuel on aircraft performance. As individual items of equipment, cargo, fuel, or personnel are loaded, their individual weights and moments must be added to the weight and moment of the basic aircraft to determine the existing status. A disc-type computer is included as aircraft equipment to simplify weight and balance computations.

CARGO LOADING.

Airplane weight and balance limitations must maintained both during and after cargo loading and care must be exercised not to exceed cargo floor structural limitations. For this reason, cargo weight and its center of gravity must be known in order to plan a cargo load. To simplify cargo load planning, the entire cargo compartment, including the ramp, has been divided into sub-compartments. The boundries and identification of each of these sub-compartments is marked on the sidewalls of the cargo compartment. To further aid in planning and loading, fuselage stations are identified by black lines marked on the cargo compartment at 20 inch intervals.

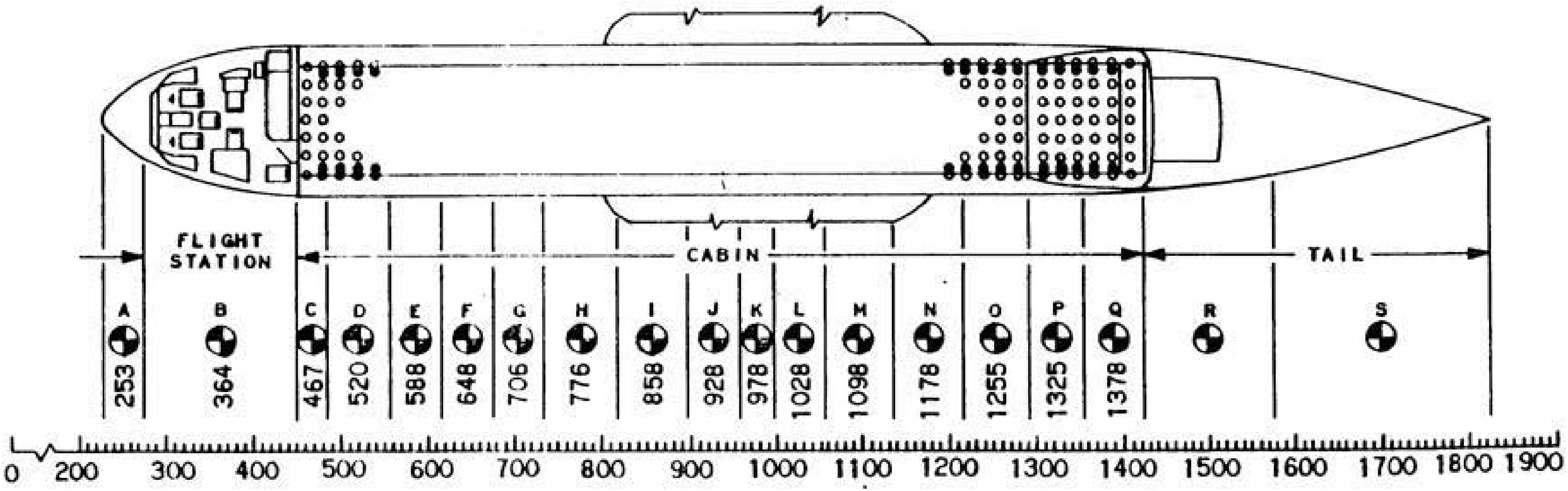
Aircraft cargo may be subjected to extreme forces caused by rough air, rough landings, crashes, and extreme flight attitudes. These forces may shift the cargo and damage the aircraft unless the cargo is properly secured. Counter forces applied to the cargo to prevent movement are identified by the direction in which the cargo would move if it were not restrained. Forward restraint keeps the cargo from moving forward, aft restraint prevents the cargo from moving rearward, lateral restraint prevents side to side movement, and vertical restraint prevents the cargo from rising off the cargo floor.

The minimum restraints used to prevent cargo movement in any direction are called the restraint criteria. Expressed in units of the force of gravity, minimum restraint criteria are as follows:

FORWARD (cargo to be off loaded on the ground)	3.0G
FORWARD (cargo to be airdropped)	4.0G
AFT	1.5G
LATERAL	1.5G
VERTICAL	2.0G

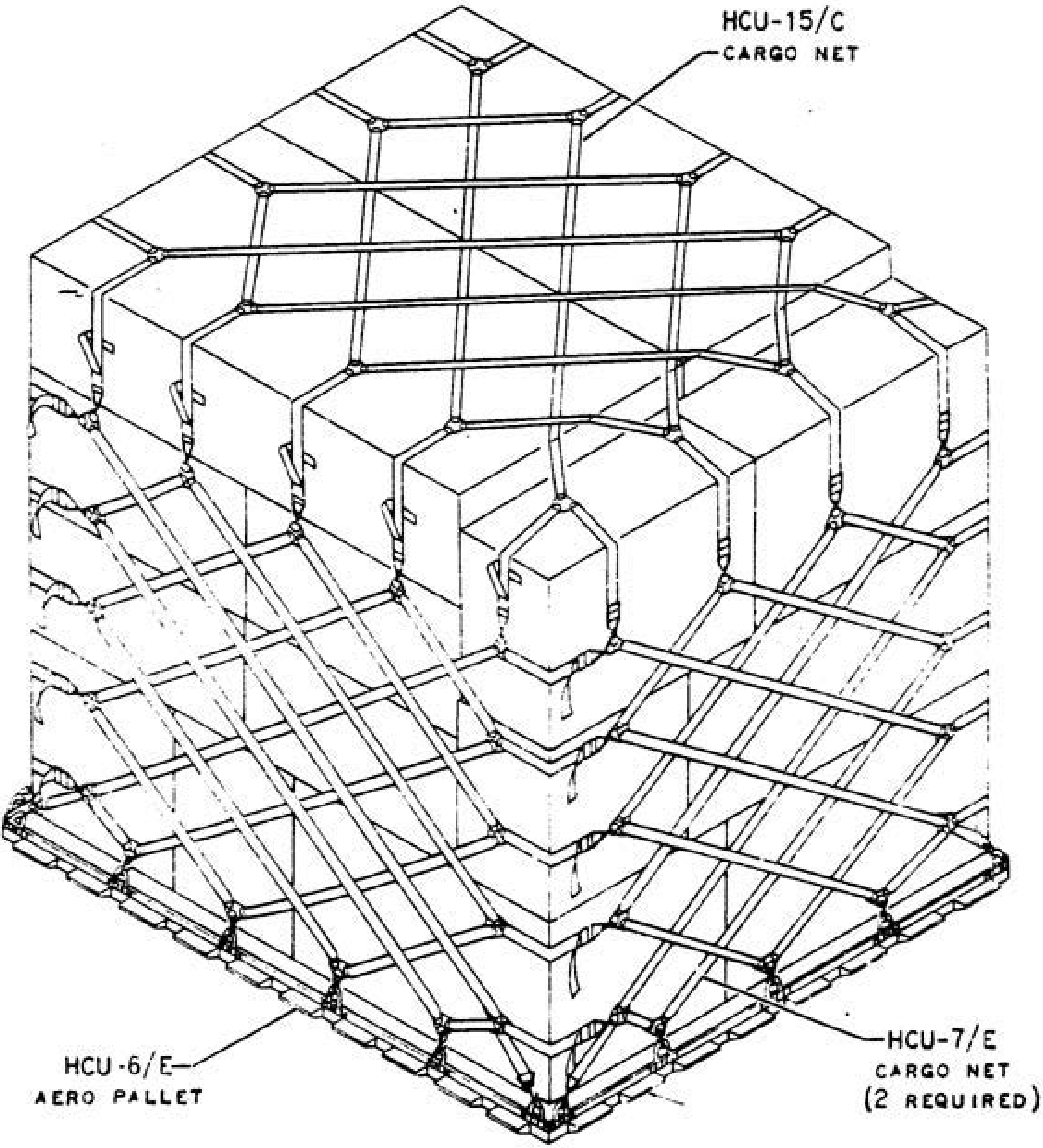
Cargo should always be restrained to meet these minimum limits. Cargo that has been properly loaded and tied down on approved cargo pallets may be loaded using the aircraft rail system without the use of additional restraint.

Some of the pallets approved for use with this aircraft are those that are a part of the 463L system. This system utilizes three different pallets and two compatable nets. The following is a list of this equipment.

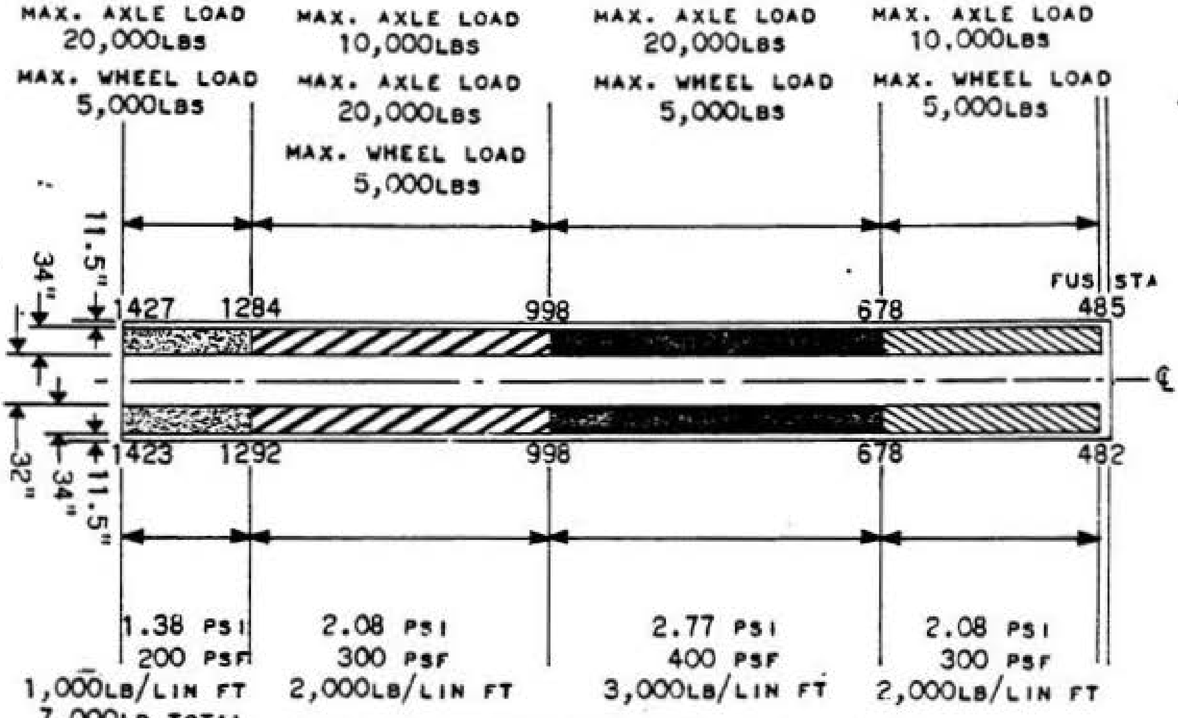


SUBCOMPARTMENTS

HCU-6/E Pallet - 88 x 108 inches with a rated capacity of 10,000 lbs.
HCU-10/C Pallet - 88 x 54 inches with a rated capacity of 5,000 lbs.
HCU-12/E Pallet - 88 x 54 inches with a rated capacity of 5,000 lbs.
HCU-7/E Net, Cargo tie down with a rated capacity of 10,000 lbs.
Consists of a top net and two side nets.
HCU-11/C Net, Cargo tie down with a rated capacity of 5,000 lbs.
Consists of a top net and two side nets.



PALLETIZED CARGO

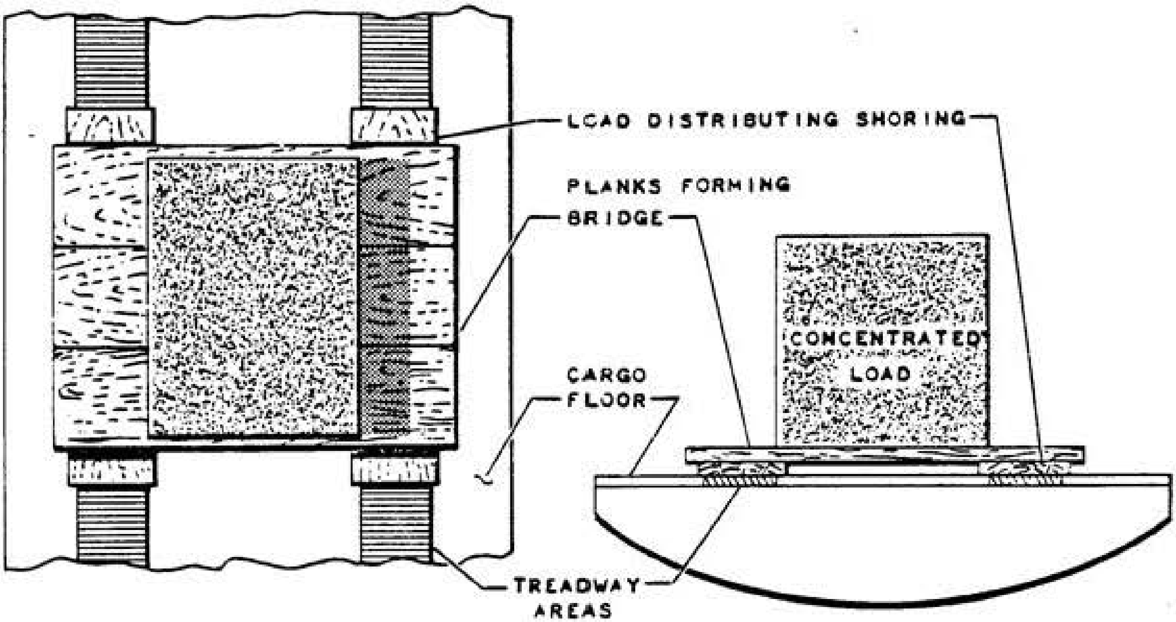


CARGO FLOOR WEIGHT CONCENTRATION LIMITS

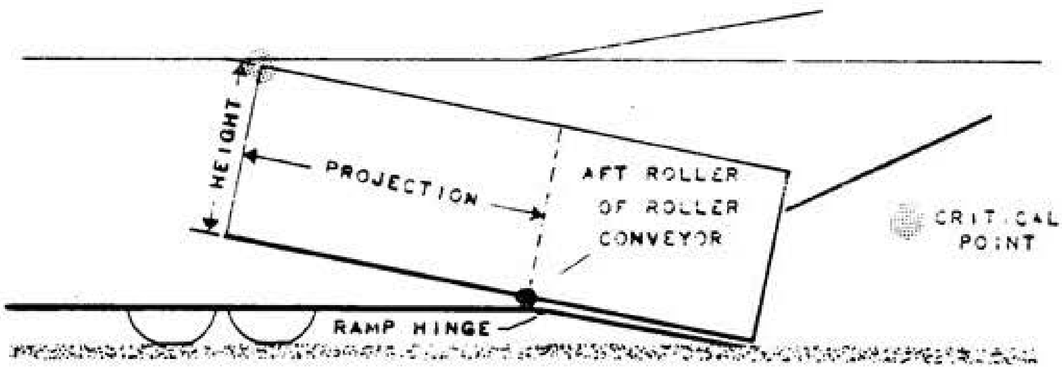
Bulk cargo corresponding with the interior demensions of the cargo compartment may be loaded with the ramp in a horizontal position as long as it does not exceed the structural limits of the cargo compartment floor. Very dense cargo that might exceed the structural limits of the cargo floor may be loaded by utilizing shoring to further distribute the weight. One example of the use of shoring is shown in the BRIDGE TYPE SHORING illustration.

When loading very large bulk cargo or vehicles, with the ramp in position for ground loading, care must be exercised to assure adaquate clearance for all demensions and to avoid an extreme weight concentration on the aft rollers in the cargo compartment. Single unit loads in excess of 10,375 pounds should not be loaded in this manner.

The number and size of restraint devices required to meet the minimum restraint requirement must be carefully calculated for bulk cargo and vehicles. Spring mounted vehicles, such as automobiles or small or medium trucks, must be tied down using points on the frame of the vehicle. Do not attach more than half the required restraint devices on the springs and axles of such vehicles. Aft restraint should be applied equal to and opposite, the forward restraint devices and an even number of restraints should be used when possible. Since some angle is always present between the tie down device and the cargo being restrained, it is not possible to utilize the full capacity of tie down devices. At an angle of 30 degrees



BRIDGE TYPE SHORING



CRATED CARGO PROJECTION LIMITS

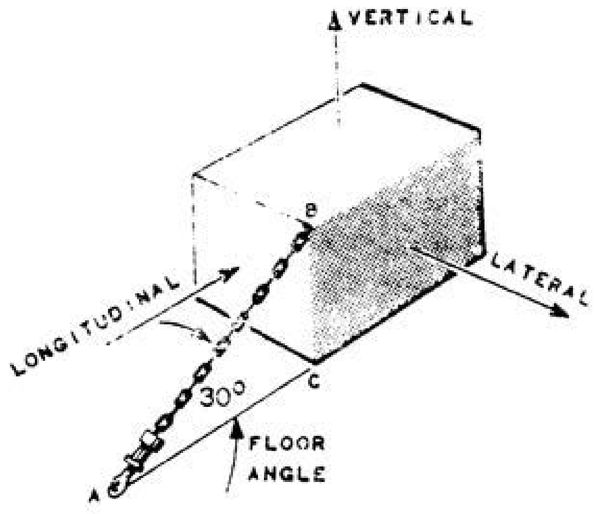
these devices will carry approximately 75% of their rated load. Where possible, a 30 degree angle should be used. If more than a 30° angle is necessary on a number of restraint devices, the appropriate manual should be consulted prior to calculating restraint requirements.

SPECIAL MISSION EQUIPMENT.

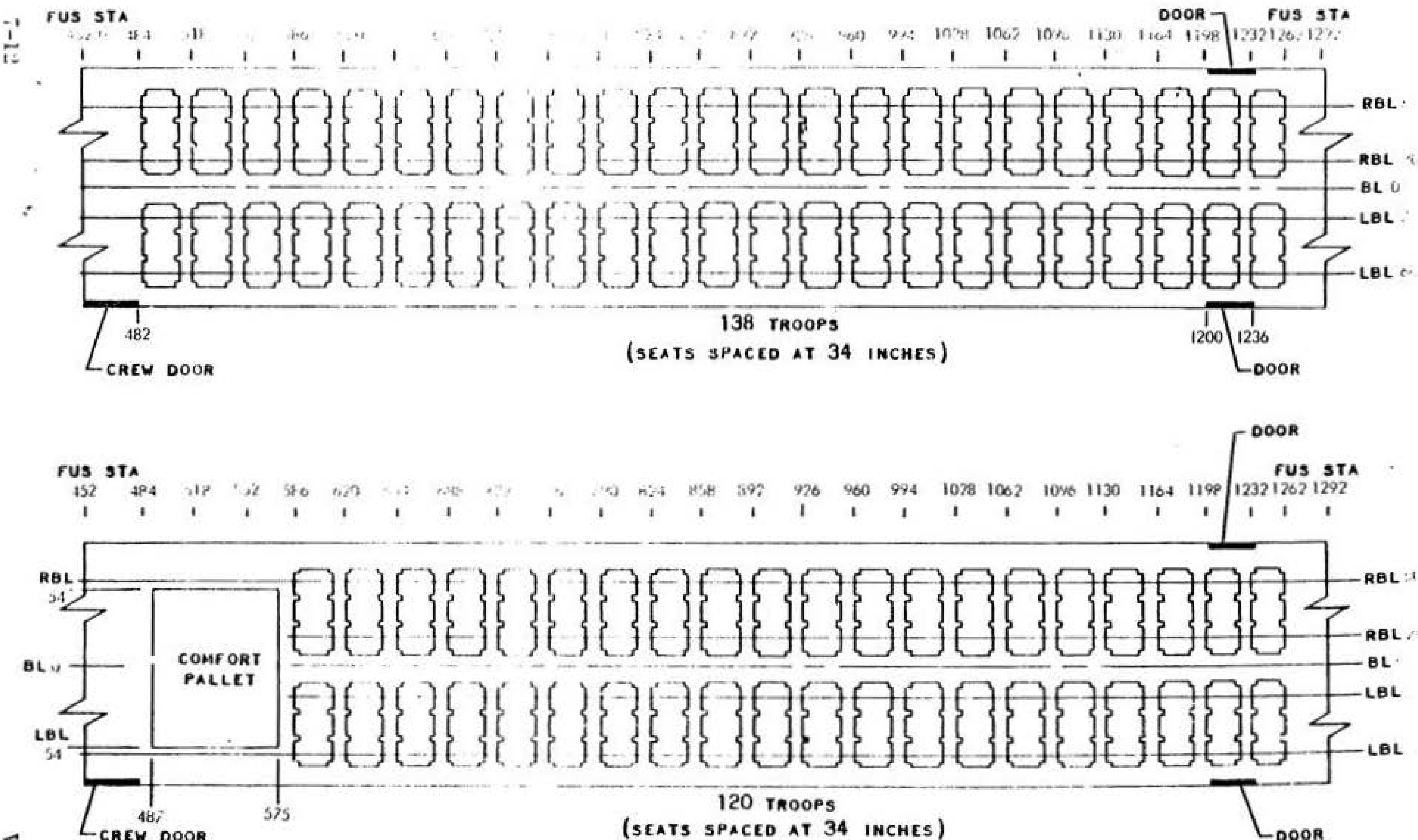
To meet the various requirements as a heavy logistic transport aircraft, the StarLifter was designed to accomplish many types of missions. It can be used as a cargo carrier. It has an aerial delivery system which gives the capability of air dropping ground support and emergency equipment wherever it is needed. By the use of kits, it can easily be converted to a troop carrier with various configurations. In the minimum amount of time, it can be equipped for a paradrop mission or with use of different equipment be converted for the evacuation of up to 80 litter patients with seats for 24 attendants.

RIGID PASSENGER SEATS.

The four continuous seat tracks in the cargo compartment floor allow rapid installation and removal of rigid, aft facing three man seats. Without a comfort pallet, a maximum of 46 seats can be installed which can carry 138 passengers. Forty seats with a comfort pallet can accomodate 120 passengers.



RESTRAINT ANGLE LIMITS



RIGID PERSONNEL SEAT ARRANGEMENT

The seats are installed in rows of two units abreast (six seats) with a minimum of 34 inches center to center from front to back. There is a 23 inch aisle down the center of the aircraft. A suggested seating arrangement is shown, but this may be varied according to the need at the time of installation. Each seat incorporates metal trays, ash trays, foot rests, container for life preservers and anti-exposure suits, and a six position reclining mechanism. The cargo document gives detailed information on the installation, removal, and stowage of seats.

TROOP SEATING.

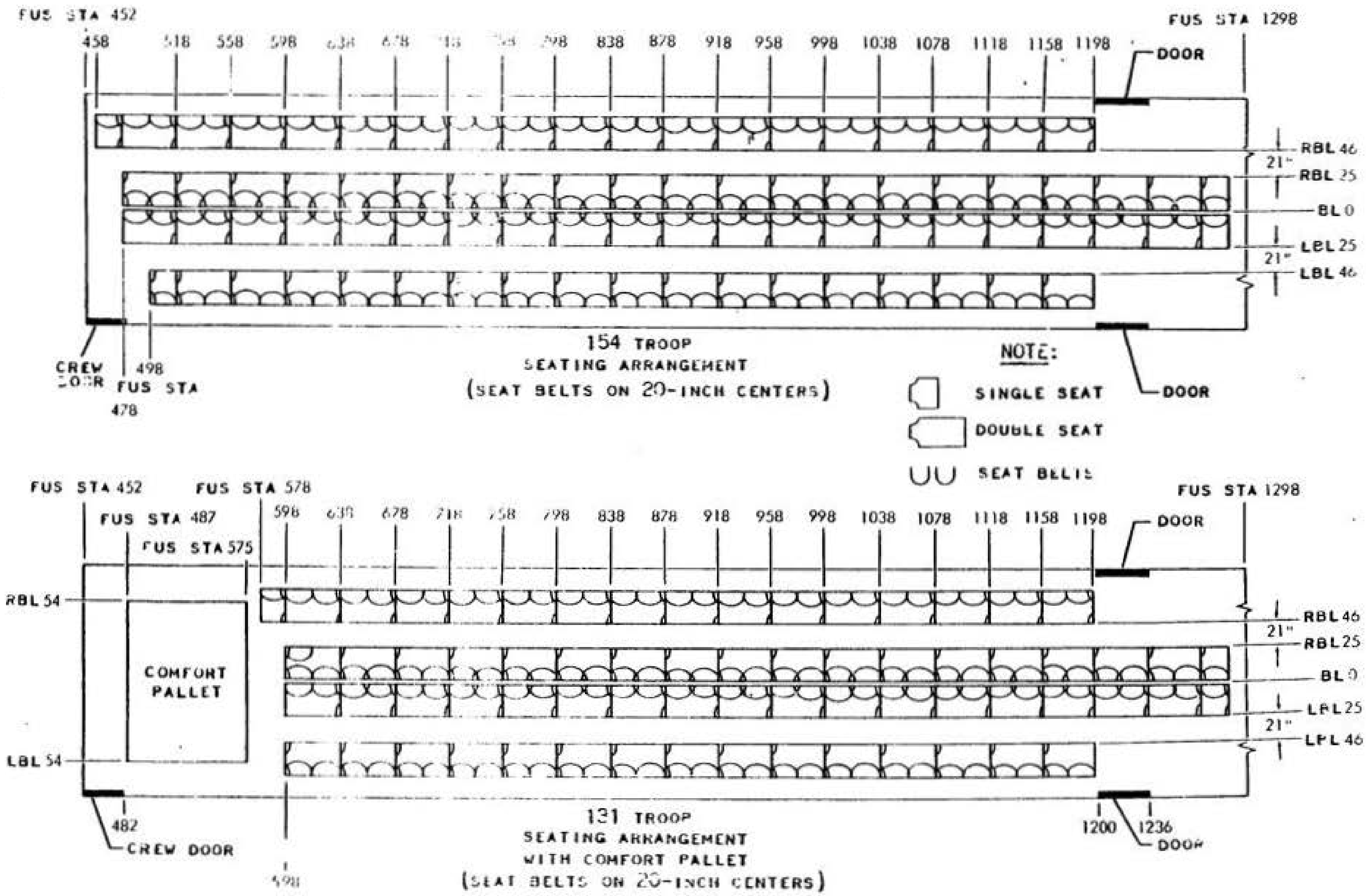
Various seating arrangements using canvas or rigid seats are possible. The seats are not part of the equipment permanently installed on the aircraft. Canvas seats ready for installtion are contained in kits. Rigid seats must be obtained separately.

The maximum number of troops that can be accomodated by utilizing kit No. 1 and 2 is 154. Kit No. 1 provides one row of inboard-facing seats along each side of the cargo compartment. Kit No. 2 provides two rows of back to back outboard facing seats down the centerline. The seat bottoms in each row are zipped together to form four continuous rows of seating space. Fittings in the kits permit seat belts to be attached on 20 inch centers for ground troop transport. Kit No. 3 contains the stanchions needed to support the centerline seats. It is not necessary to install the maximum number of seats contained in either kit. Varying numbers can be installed to meet the seat capability required by different missions.

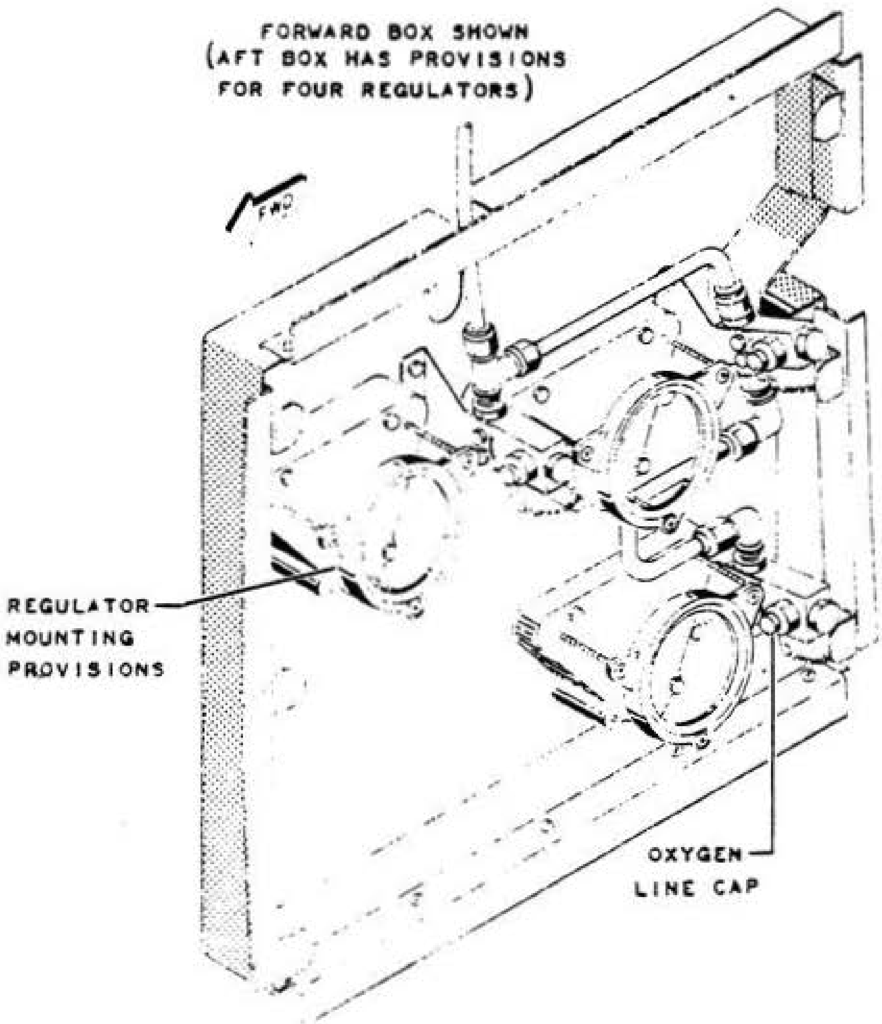
LITTER PROVISIONS.

The cargo compartment can be equipped to carry up to 80 litters in tiers of three or four litters each. This configuration provides space for up to 24 attendants or troops in side facing canvas seats. Fittings and sidewall stanchions needed to equip the aircraft for carrying the litters are contained in kit No. 4. Centerline stanchions for supporting the center litters must be obtained from Kit No. 3. Canvas seats and seat fittings are contained in Kit No. 1.

Therapeutic oxygen provisions are available for connecting seven hospital-type oxygen regulators. The regulator boxes are mounted in two areas along the right side of the cargo compartment where they are convenient to all litters. This provision is incorporated in Kit No. 6.



CANVAS TROOP SEAT ARRANGEMENT



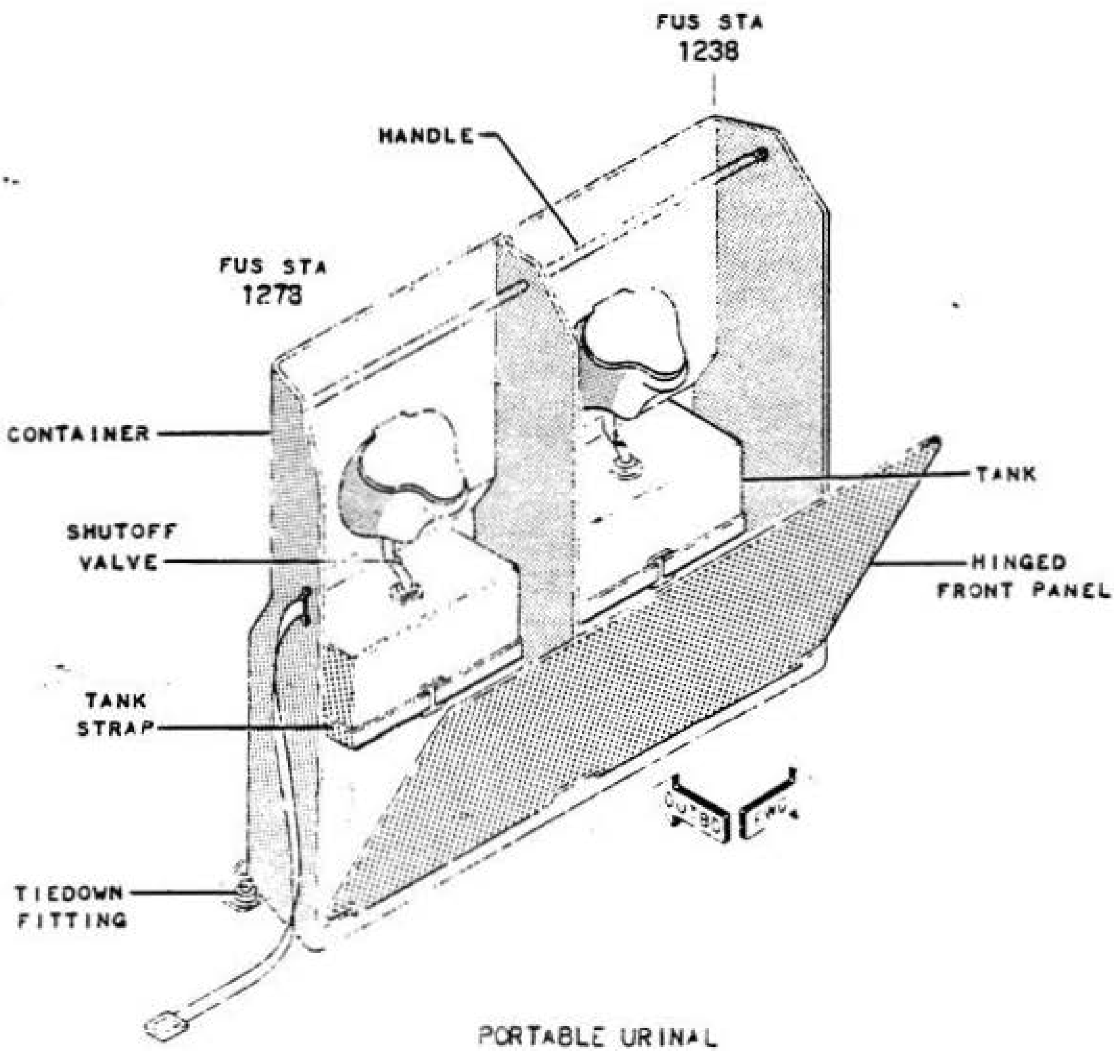
THERAPEUTIC OXYGEN PROVISIONS

COMFORT PALLET PROVISIONS.

Provisions for installing a palletized confort station are located at the forward end of the cargo compartment. The pallet is installed in the same manner as other palletized cargo. The unit contains toilet and galley facilities for passengers when long distance missions are being flown. The necessary electrical and waste removal provisions for connecting the comfort pallet are permanently installed at the forward end of the cargo compartment.

CARGO COMPARTMENT CUTAIN.

A cargo compartment cutain is carried on board the aircraft as loose equipment. This consists of five sections and may be installed at FS 1292 to reduce air flow

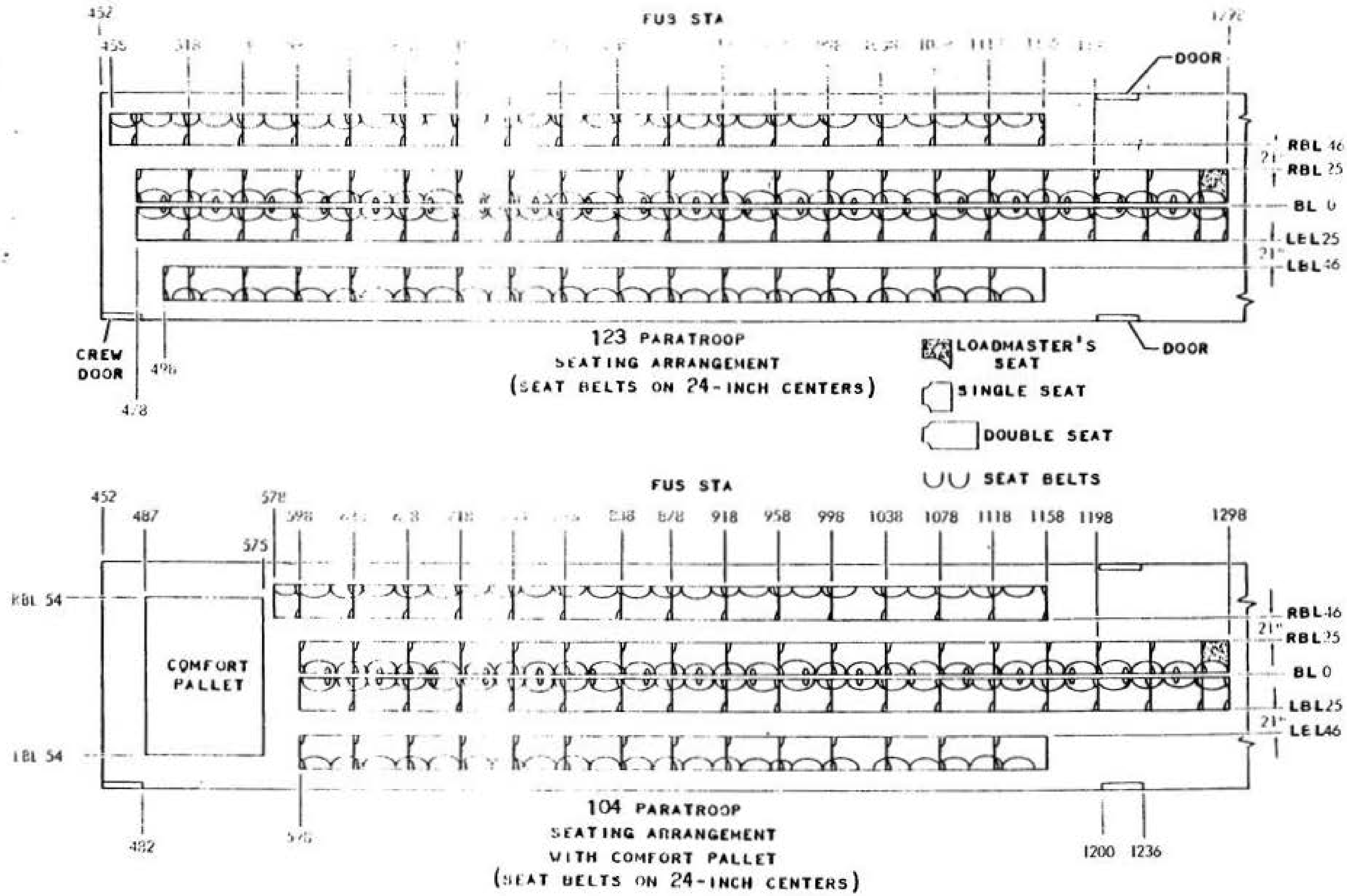


PORTABLE URINAL

in the cargo compartment and add to personnel comfort. When not in use, the curtain may be rolled and tied either at the top or each side or completely removed and stowed in the stowage bag on the right side of the cargo compartment.

PARATROOP DROP.

Components necessary to equip the StarLifter for a paratroop drop mission are contained in configuration kits. When these provisions are incorporated, paratroops can be dropped simultaneously from both personnel doors or over the ramp. The kits provide two optional seating arrangements, 104 personnel with comfort pallet or 123 without the comfort pallet.



PARATROOP SEAT ARRANGEMENT

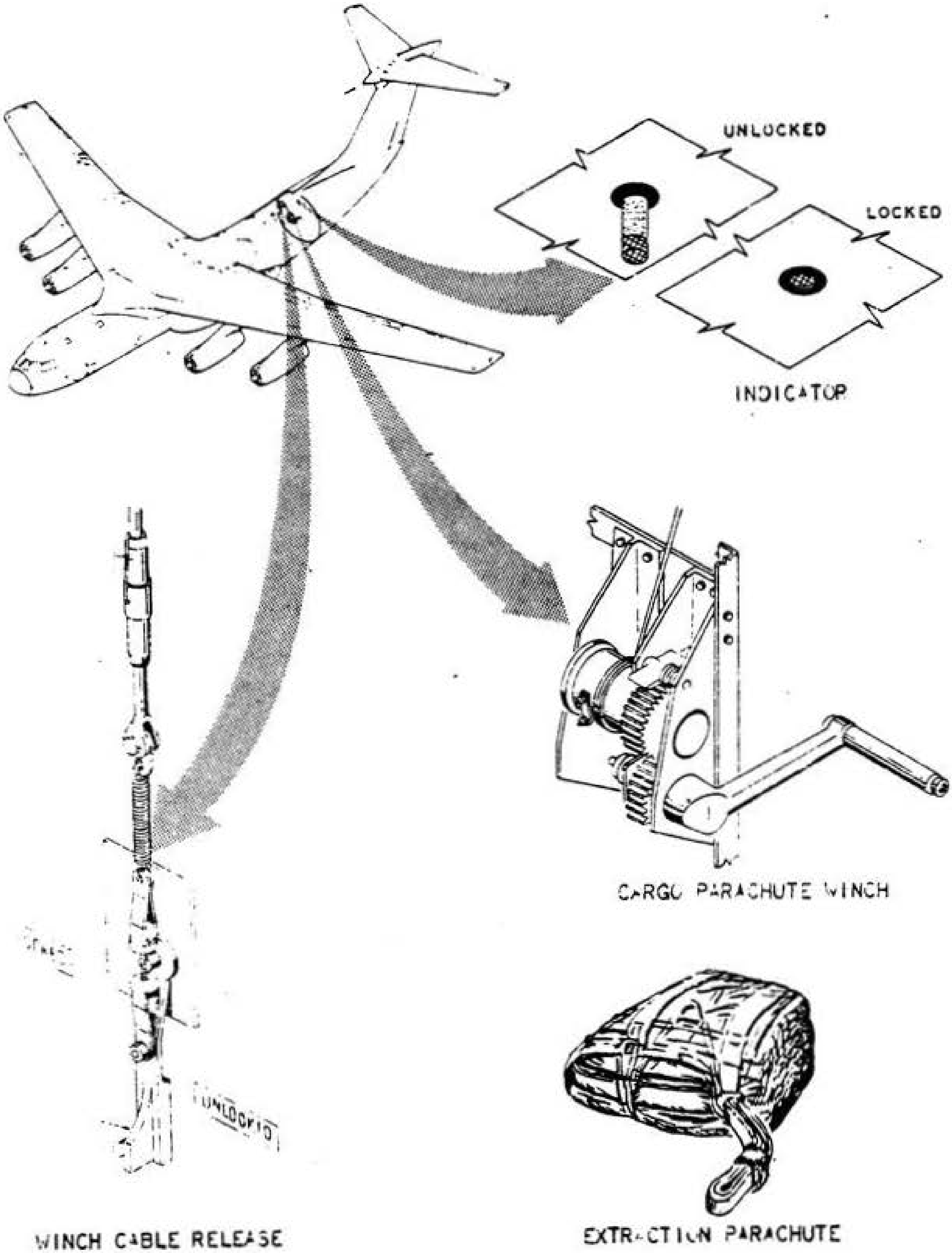
Three kits are necessary to obtain maximum capacity. Kit No. 1 contains 55 side wall mounted canvas seats with necessary hardware and seat belts for mounting. Kit No. 2 contains 68 centerline mounted canvas seats. Included in the kit are the static line anchor cables and retriever winches, electrically actuated air deflector door, jump platforms, and a static line retriever bar. Kit No. 3 contains the stanchions needed to support the cneterline seats.

AERIAL DELIVERY SYSTEM.

For routine air drops, bulk cargo or wheeled vehicles are loaded on conventional 108 inch platforms varying in length from eight to 24 feet in four foot increments.

Prior to loading the platforms, calculations must be made to determine where the platforms must be positioned. This is to assure that the aircraft CG limits are not exceeded. The extraction parachutes are installed in parachutes holders. With the aid of a hand winch, the parachutes in the holders are drawn up into the extraction support housing. The extraction mechanism is recessed in the overhead between FS 1338 and 1358. The housing contains an ADS manual arm switch, an uplock mechanism, and an electro mechanical release mechanism. In ADS operation, the loadmaster manually arms the extraction parachute release mechanism from his station in the forward end of the cargo compartment. Normal release of the parachute is made by the pilot, copilot, or navigator. In an emergency, the loadmaster can manually release the parachute from his station. Before release the restraint devices in the rails may be set to apply the correct amount of resistance to each platform. Airdrops of two 35,000 pound platforms in multiple passes are possible, or as many as seven 10,000 pound loads can be extracted.

The loading document contains detailed instructions for the loading of the ADS cargo and for setting up associated ADS equipment to ensure a safe and dependable delivery. Carefully planning and strict adherence to procedures outlined are essential if the full capability of the aerial delivery system is to be realized.


UNLOCKED
LOCKED
INDICATOR
CARGO PARACHUTE WINCH
UNLOCKED
WINCH CABLE RELEASE
EXTRACTION PARACHUTE