ARMY POLYTECHNIC SCHOOL

DEPARTMENT OF LANGUAGES

APPLIED LINGUISTICS IN ENGLISH PROGRAM

TITLE:

"INCIDENCE OF MANUAL-SOFTWARE APPLICATION FOR TEACHING TECHNICAL ENGLISH AND C-130 AIRPLANE SYSTEMS TO STUDENTS OF SECOND LEVEL MECHANICAL AERONAUTICAL CAREER AT ITSA", DURING PERIOD MARCH - JUNE – 2007

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QUITO - ECUADOR

APPROVAL SHEET

We, Lic. Marcos Morales Director and MSc. Maricela Madrid Co-director are pleased to certify that the Research Project under the Title ***"Incidence of Manual-Software Application for Teaching Technical English and C-130 Airplane Systems to Students of Second Level Mechanical Aeronautical Career at ITSA, during March - June – 2007 ",*** developed by Juan Raúl Sánchez Santillán and Edwin Stálin Tulchán Asimbaya, who have finished all the subjects in Applied Linguistics in English Program of the Army Polytechnic School has been studied and verified in all its parts, and performed under our guidance and supervision, so its presentation and oral sustaining are authorized at the corresponding University Instance.

Lic. Marcos Morales	**MSc. Maricela Madrid**
Thesis Director	**Thesis Co-Director**

ACKNOWLEDGMENTS

To The Army Polytechnic School, where we received knowledge and academic support. To our professors guides Lic. Marcos Morales and MSc. Maricela Madrid for their constant support to carry out our project. We acknowledge several people who gave us their help and support to complete this work. We thank the personnel contacts we made during this project have been extremely rewarding. Most importantly, we acknowledge the tremendous love and support of our family, wives and children. They provided help and understanding throughout

DEDICATION

To memory of my Mother who is always with me in all my ways. To my wife, daughter and son, that have been my support and the reason of all I am, and to my partner and friend Stalin, who shared with me this important stage of my life.

JUAN

To my wife and son, because they were my inspiration to carry on this work and they were who helped me to go ahead with patience and love, to my partner and friend Juan, who shared with me these facets of my university studies.

STALIN

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ABSTRACT

This research is made by two parts, in the first part the Manual-Software that contains elemental information in Technical English about the main system of the C-130 aircraft, systems as Generalities, Engines, Pneumatic System, Flight Controls, Electrical System, Fuel System and Propeller.

In each of these Chapters we have general information basically concepts, illustrations, first diagrams and so on. In other words, this Manual contain the knowledge in Technical English that the students of mechanical aeronautical in the Aeronautical Technological Superior Institute must have about C-130 Airplane before finishing the period of training and going to the squadron of the Ecuadorian Air Force as airmen and mechanics.

This Manual-Software was applied in the ITSA about three months in order to improve the teaching-learning process, thus, in the future the Ecuadorian Air Force will have more qualified personnel to carry out the mission to flight with security.

After this period, the students were evaluated both in Technical English and Systems of the C-130 Airplane. In this period of practicing we realized the evaluation by means of a survey about the acceptation of this Manual-Software as a new resource in order to improve the teaching-learning process of technical English in the ITSA and in the Ecuadorian Air Force. It was applied to the students of mechanical aeronautical career who received the instruction.

The results of the evaluation were that, the information included in this Manual-Software is the most important about the systems of the C-130 Airplane, the methodology used in order to teach was very effective, the software with the interactive graphs and the visual information with the help of in focus is very comprehensible.

This work and application was elaborated seeking information of several manuals that conform the process of Operation and Maintenance. It is necessary to continue doing the same work with the rest of squadrons of the Ecuadorian Air Force in order to get in the future the best Technological levels.

INTRODUCTION

Since the creation of Ecuadorian Air Force with the acquisition of several squadrons of airplanes, the maintenance of these airplanes different involved problems, considering that the all Documents, Technical Orders, Manuals, Service Bulletins, Amendments, Directives and so on are edited in English Language.

Then, it was necessary to create a School for preparation of Airmen where the knowledge of English is elemental to translate and interpret Manuals and realize the maintenance of these airplanes.

The present project has as main objective to improve level in the teachers and in the students about Technical English and C-130 airplane guided to obtain new generations with superior knowledge in English and mechanical in order to benefit to the Ecuadorian Air Force.

The Commandant of C-130 squadron, who, knows about our study in the Army Polytechnic School, gave us a disposition in order to improve the teaching-learning process. Since then we have worked in the Manual-software with the most important information of this airplane that the students must know in the ITSA to avoid the troubles that today the airmen have as Technical English as Mechanical. That's why we created this Manual-Software and put in practice in the ITSA.

In this Manual-Software we concentrate the elemental information over the main systems that the students of mechanical must know in order to put in practice when they finish their academic study and work in the C-130 squadron, because in the future the teaching process will be with a software in English that contains graphs with animation, tables, symbols, vocabulary and the theory that explain all the process in each system.

We are sure that after the application of this proposal and with its respective evaluation of mechanical aeronautical career in the ITSA with quality of information, teaching method of Technical English, our search and our work will be the beginning of new investigations in order to realize other projects alike to benefit other squadrons of our Institution.

RESEARCH THEME

"INCIDENCE OF MANUAL-SOFTWARE APPLICATION FOR TEACHING TECHNICAL ENGLISH AND C-130 AIRPLANE SYSTEMS TO STUDENTS OF SECOND LEVEL MECHANICAL AERONAUTICAL CAREER AT ITSA", DURING PERIOD MARCH - JUNE – 2007

PART ONE

RESEARCH PROBLEM

1.1. Problem Identification.

The Aeronautical Technological Superior Institute and The Language School were created to form mechanical aeronautical technicians with an excellent potential, this profession carries out in its adequate installations and with highly qualified teachers' staff.
The mechanical aeronauthical career, since its creation, doesn´t have an adecuate didactical resourse to the teaching-learning process, it has provocating a technical term unknowledge of thr C-130 aircraft main systems. Besides, this fault provocates an insecurity and unknowledge in the students during their daily activities.

For that reason, it was necessary and convenient the application in the ITSA to the students of mechanical aeronautical career a C-130 Airplane Technical English Manual - Software, in order to increase the theoretical-practical knowledge as students as professors in this area.

When the airmen pass out of the Aeronautical Superior Technological Institute and arrive to the C-130 squadron, they have several troubles in Technical English by the translation of Manuals, Directives, Amendments, Service Bulletins unique certificate documents to do the maintenance, also problems in the knowledge of systems and use of tools.

These problems are solvented after years with courses of systems in the airplane but the Technical English is difficult to continue studying by several reasons in the Institution, resulting impossible in the majority of the cases. This is a problem that must be corrected during the formation period of the airmen with the use of this Manual-Software, speciallly to the C-130 Aircraft mechanics.

1.2. Problem Setting.

This manual contains the description of the activities that the students must accomplish in function of their specialty at ITSA.

How does the fault of the C-130 airplane Technical English manual - software impact in the mechanical aeronautical career students' teaching-learning process at the Aeronautical Technological Superior Institute?

- There is an inadequate didactic resource for the teaching-learning process of the students and professors at ITSA.

- Discontinuity in the process of ESL, learning.

- Students have Technical English blank spaces, because there is a quantity of manuals to study, doing impossible for the teachers to classify the best knowledge for the students.

1.3. Variable Working Out

Independent Variable

“C-130 Aircraft Technical English Manual – Software”

Dependent Variable

“The improvement of Teaching - Learning process of Technical English and C-130 Airplane Systems”

1.4. Objectives

1.4.1. General Objectives.

- To determine the level of acceptation about Manual-Software of Technical English and C-130 Airplane systems of the students of mechanical aeronautical career at ITSA during, March-September 2007.

- To improve the level of acquisition of knowledge in order to develop the technical-practical level of the students that tomorrow will be the airmen that will realize the maintenance of the C-130 airplanes.

- To evaluate the improvement of the application of the proposal.

1.4.2. Specific Objectives.

- To apply the C-130 Aircraft Technical English Manual – Software in the students of second level in order to seek its acceptation as main tool of instruction by the ITSA.

- To realize surveys to the students who received the instruction with this Manual – Software in order to evaluate the level of incidence in the students about the acquired knowledge

- To establish new methods and procedures to improve this process of learning-teaching at ITSA.

- To evaluate the theoretical-practical improvement of the students as Technical English as Systems of C-130 Airplane, during the application of this Manual – Software.

1.5 Justification.

Nowadays the technical education has increased because; in many countries there has been an effective development of the technology in different areas. This activity is the principal reason because students decide to study a technical career which provides all the knowledge to carry out an efficient work. In recent years it has become in one of the best choices for the professional future.

English is the principal language which provides technical information, for all over the world, in different areas, especially of the aeronautical field, that is because the students must know everything about this activity.

The Aeronautical Technological Superior Institute as an institution that gives education in the aeronautical career, doesn't have an actual and modern resource that permits to facilitate the improvement of the students and professors teaching-learning process of this Institute.

With the application of a C-130 airplane Technical English Manual - Software, in the learning of the mechanical aeronautical career, students will be very significant to motivate to put in practice their new knowledge. With the information introduced in this Manual – Software about C-130 airplane will establish new methods will be established to improve and grow through the technical-professional field.

PART TWO
THEORETICAL FRAME

2.1. Theoretical and Conceptual Focus.

A phenomenon occurs where there is an inadequate function, like the fault of a Technical English Manual-Software in the mechanical aeronautical career at the ITSA.

This phenomenon can evolve and be affected by the fault of a Manual-Software for the learning of the students in the aeronautical field.

Besides, in the future this phenomenon can be very difficult to control in the mechanical aeronautical career because the students do not obtain the adequate knowledge level or skills in their speciality and during their daily activities as technicians.

The instruction of C-130 Manual-Software and an effective methodology will help the teaching-learning process in the future. In this period of practice, we could demonstrate that this Manual-Software is a principal tool in order to solve in part the problems about this theme in the ITSA and the Ecuadorian Air Force.

2.2. Hypothesis System

2.2.1. Working Hypothesis

The application of C-130 Airplane Technical English Manual –Software will improve the teaching-learning process of the mechanical aeronautical students in the Aeronautical Technological Superior Institute.

2.2.2. Null Hypothesis.

The application of C-130 Aircraft Technical English Manual –Software will not improve the teaching-learning process of the mechanical aeronautical students in the Aeronautical Technological Superior Institute.

2.2.3. Alternative Hypothesis.

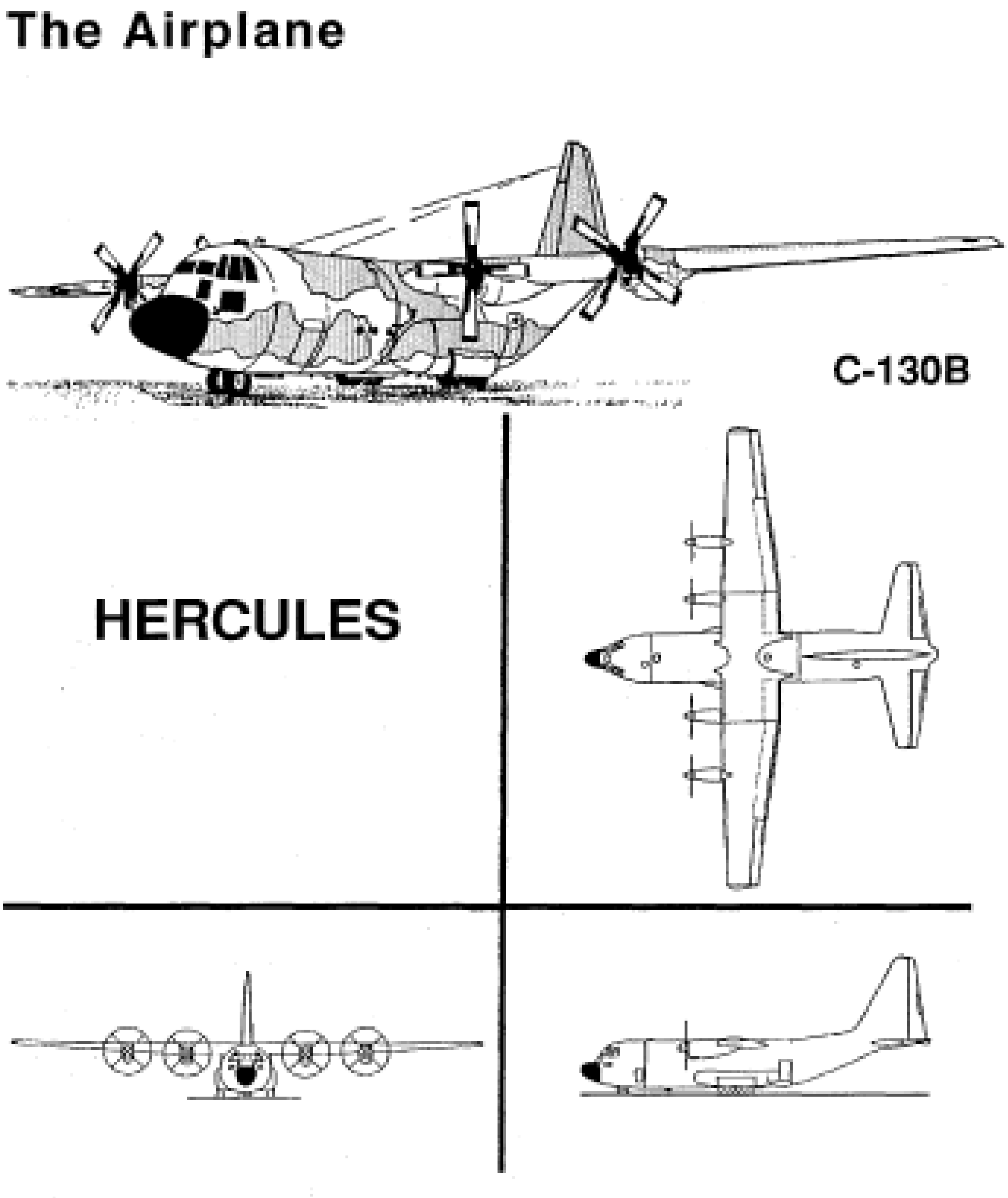
The application of another method or the use of C-130 Aircraft Flight Manual where the resources as visual aids, multimedia, will help the students to reinforce the knowledge to learn new words or phrases of Technical English and systems more effectively.

2.3. Structure.

CHAPTER 1 C-130 AIRPLANE MANUAL-SOFTWARE

This Manual and software were created thinking in the improvement of learning-teaching process of the students at ITSA, besides this resource is an interactive computer based on training software which uses the following parts:
Photographs
Graphs/Illustrations/Diagrams
Macromedia flash video and audio
This Manual-software contains the most important information about the main systems that conform the C-130 Airplane, in other words contains:
Generalities, Standard symbols, Engines, Pneumatic system, Electrical System, Flight Controls and Propeller. Here we concern all the information that students must know during the training period about the C-130 Airplane in order to work in this squadron without problems when a learner finishes this course in the ITSA.
We were students in this Institute before and we had several troubles as in Technical English as in the maintenance of the C-130 Airplane by the lack of knowledge specially in the systems for that reason our project was created thinking in the improvement of quality of information during the training period in order to work with major security and with the latest technology.

THE AIRPLANE
GENERALITIES

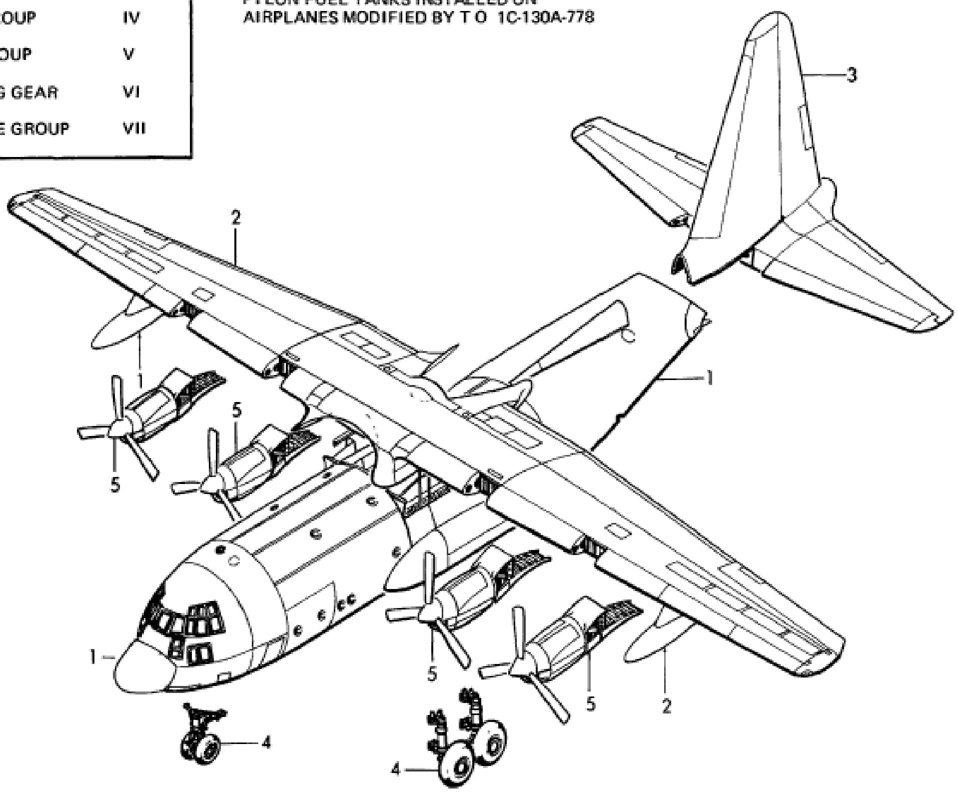


1.1 THE AIRPLANE.-The Lockheed C-130 is an all-metal, high wing, long-range, land-based monoplane. The fuselage is divided into the cargo compartment and the flight station. It can be fully pressurized and air conditioned both in flight and on the ground. The mission of the airplane is to provide rapid transportation of personnel or cargo for delivery by parachute or by landing. The airplane can be used as a tactical transport carrying 92 ground troops or 64 paratroops and equipment, and can be readily converted in ambulance or aerial delivery missions. When used as an ambulance, the airplane can carry 72 litters. There are provisions for normal life raft storage to accommodate 80 persons for over water flights. The C-130 can land and take off on short runways, and it can be used on landing strips such as those usually found in advance base operations.

INDEX	NOMENCLATURE	SECTION
1	FUSELAGE GROUP	III
2	WING GROUP	IV
3	TAIL GROUP	V
4	LANDING GEAR	VI
5	NACELLE GROUP	VII

NOTE

PYLON FUEL TANKS INSTALLED ON AIRPLANES MODIFIED BY T O 1C-130A-778



1.1.1 PROPULSION. - Power is supplied by four Allison T56 turbo-prop constant-speed engines. Each engine drives a four blade Hamilton Standard hydromantic constant-speed, full-feathering, reversible-pitch propeller.

1.1.2 AIRPLANE DESCRIPTION. - The principal dimensions of the airplane are:

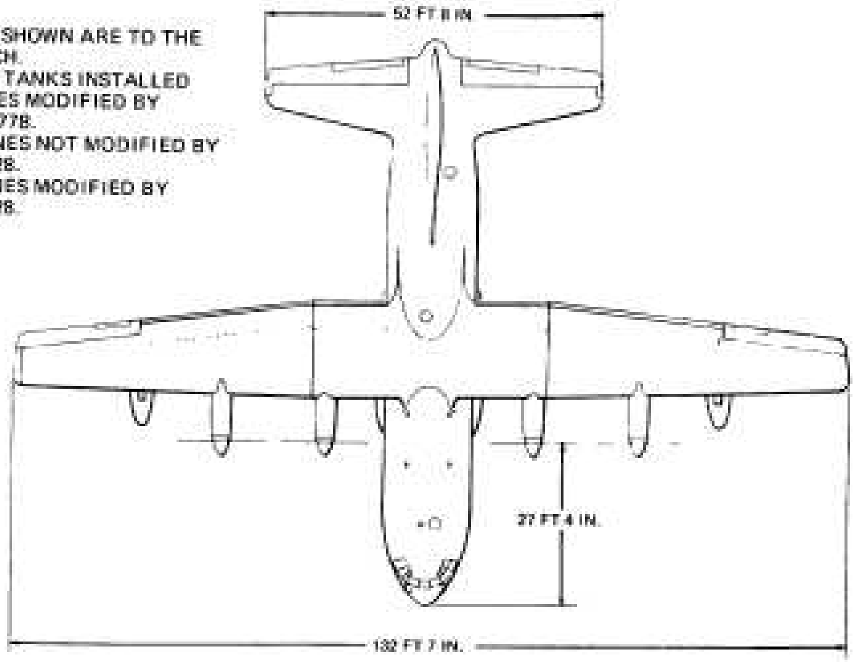
Wing Span	132 feet 7 inches
Length	97 feet 9 inches
Height	38 feet 3 inches
Stabilizer Span	52 feet 8 inches
Cargo Compartment Length	41 feet
Width (Minimum)	10 feet 3 inches
Height (Minimum)	9 feet
Maximum Gross Weight	155,000 pounds

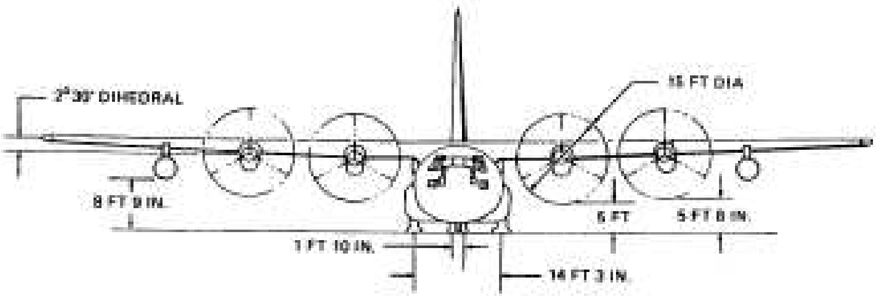
NOTE

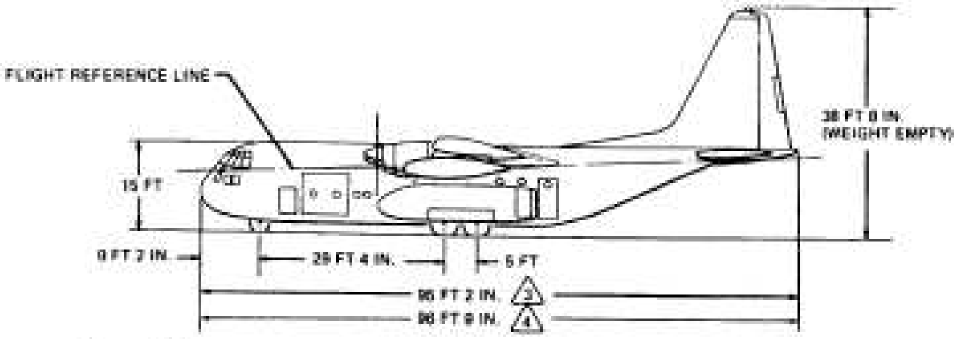
1. DIMENSIONS SHOWN ARE TO THE NEAREST INCH.
2. PYLON FUEL TANKS INSTALLED ON AIRPLANES MODIFIED BY T.O. 1C-130A-778.

△3 ALL AIRPLANES NOT MODIFIED BY T.O. 1C-130-728.

△4 ALL AIRPLANES MODIFIED BY T.O. 1C-130-728.

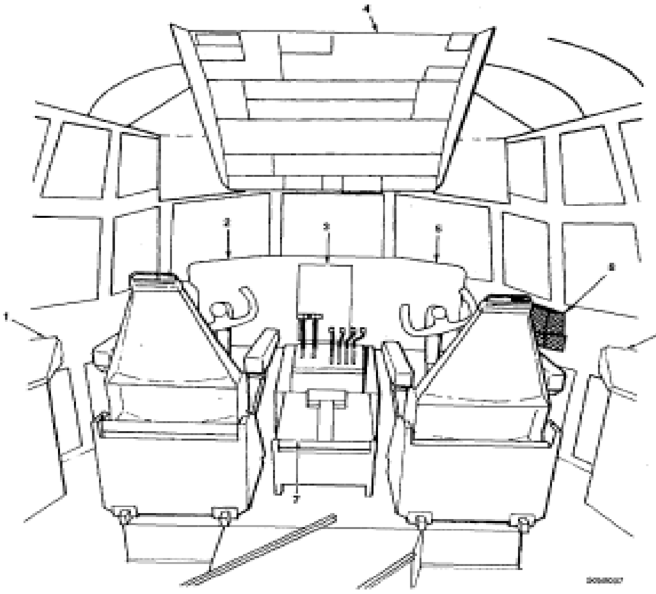






1.1.3 CREW. - Crew stations are provided for a pilot, copilot, engineer and navigator. The pilot and copilot are seated on left and right sides, respectively, of the control pedestal in the forward section on the flight station. The navigator is seated facing outboard behind the copilot on the right side of the flight station. The engineer is seated in the center of the flight station, behind the control pedestal.

Flight Station Forward (Typical)



NOTE

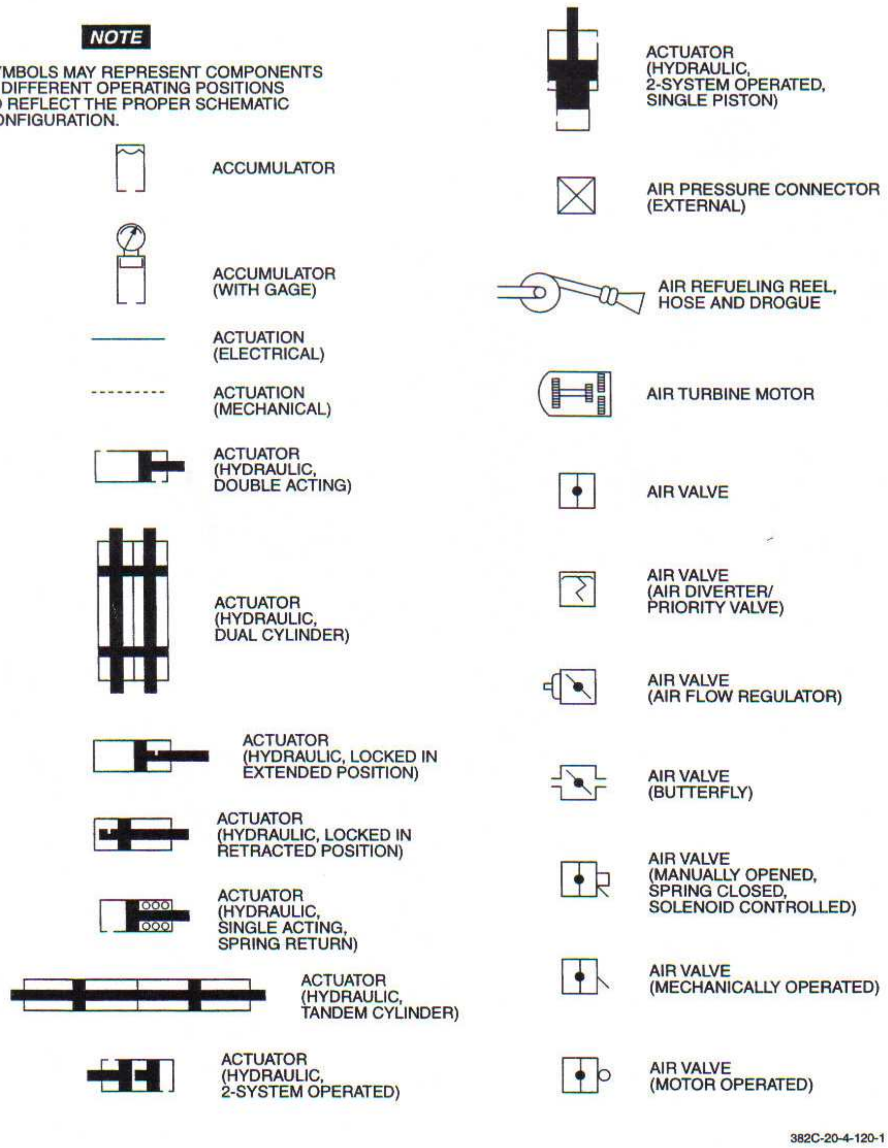
⚠ AIRPLANES MODIFIED BY TO 1C-130-1073 AND TO 1C-130-1076.

1. PILOT'S SIDE SHELF
2. PILOT'S INSTRUMENT PANEL
3. ENGINE INSTRUMENT PANEL
4. OVERHEAD CONTROL PANEL
5. COPILOT'S INSTRUMENT PANEL
6. COPILOT'S SIDE SHELF
7. FLIGHT CONTROL PEDESTAL
8. ⚠ COPILOT'S RIGHT SIDE PANEL

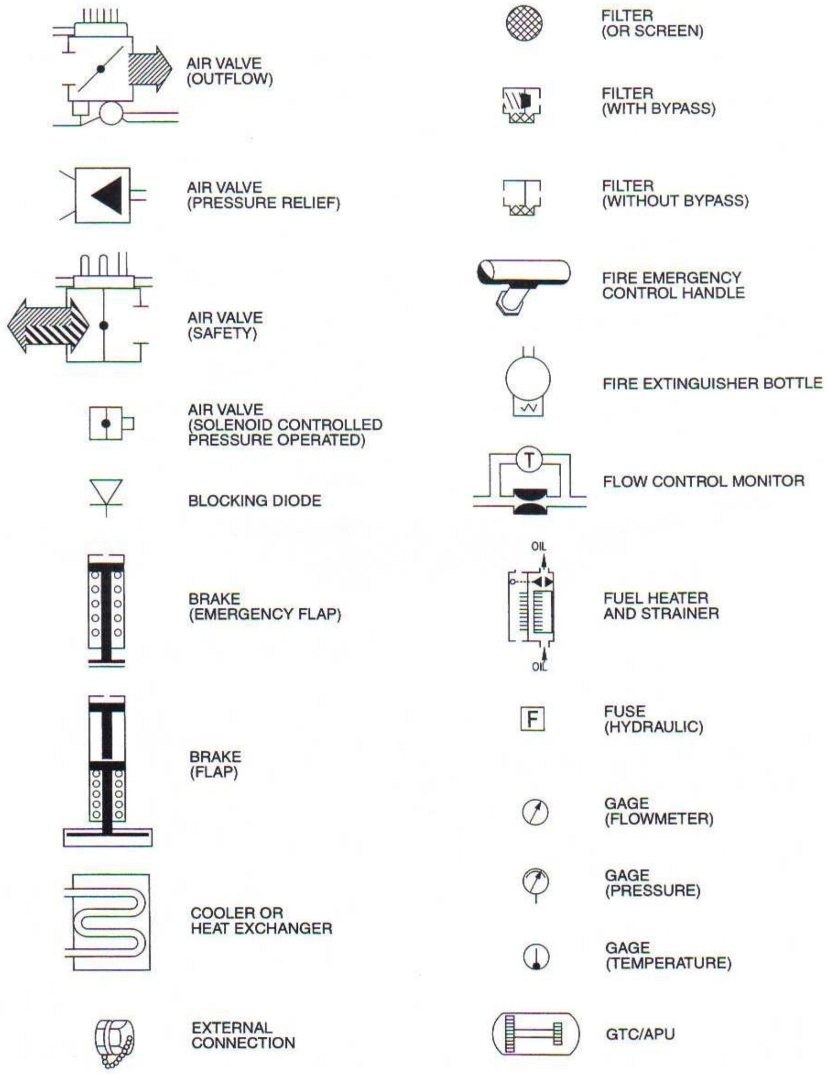
STANDARD SYMBOLS.

Standard symbols are used in schematic diagrams to the maximum extent practical. The standard symbols are identified and described as below.

Standard Symbols



Standard Symbols



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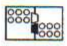
Standard Symbols

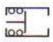

VALVE
(PRESSURE RELIEF)


VALVE
(PRIORITY)

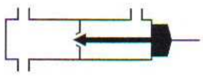

VALVE
(SNUBBER)


VALVE
(SOLENOID CONTROLLED, PNEUMATICALLY REGULATED SHUTOFF)


VALVE
(SOLENOID OPERATED SHUTOFF)


VALVE
(SURGE DAMPING)


VALVE
(TEMP CONTROL)


VALVE
(TEMPERATURE DATUM)


VALVE
(THERMAL RELIEF)


VALVE
(1-WAY CONTROLLABLE RESTRICTOR)


VALVE
(1-WAY FLOW REGULATOR)


VALVE
(1-WAY RESTRICTOR)


VALVE
(2-WAY CHECK)


VALVE
(2-WAY FLOW REGULATOR)


VALVE
(2-WAY RESTRICTOR)


VALVE
(2-WAY SHUTTLE)


VALVE
(3-WAY, 2-POSITION SELECTOR)


VALVE
(4-WAY, 2-POSITION SELECTOR)


VALVE
(4-WAY, 3-POSITION, TRAIL CENTER SELECTOR)


VENTURI


WING (EXT TANK) BREAK COUPLING

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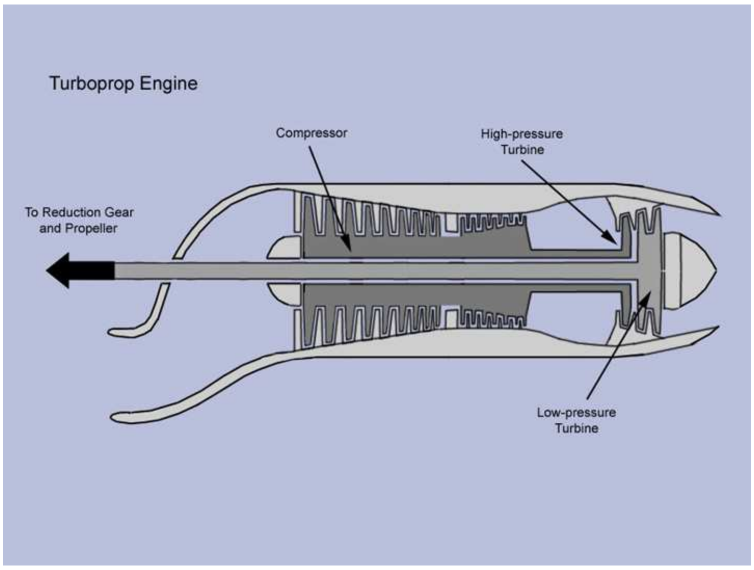
1.2 ENGINES. The airplane is powered by four T56-A-15 turboprop engines. A characteristic of the turboprop is that changes in power are not related to engine speed but to turbine inlet temperature. During flight, the propeller maintains a constant engine speed; this speed is known as the 100 percent rated speed of the engine and it is the design speed at which most power and best overall efficiency can be obtained. Given the above, power changes can be effected by changing the fuel flow. An increase in fuel flow causes an increase in turbine inlet temperature and a corresponding increase in energy available at the turbine. The turbine absorbs more energy and transmits it to the propeller in the form of torque. The propeller then, in order to absorb the increased torque, increased blade angle, thus maintaining constant energy RPM. Turbine engine consume several times the amount of air per horsepower that reciprocating engines do, and are much more responsive to conditions at the engines air inlet. Air temperature and the pressure at the engine air inlet determines air density which, at a constant RPM, determines the power output for a given turbine inlet temperature (given fuel flow). The 8weight of air (pounds per second) entering the engine is the main factor affecting the torque produced at the constant turbine inlet temperature. Assuming a constant inlet pressure, when free air temperature drops, engine power output goes up. During take off on a cold day the torquemeter indicator must be closely monitored to avoid exceeding engine power limits. Conversely, with increasing air inlet temperature, power output is reduced. As a rule of thumb, an estimated one percent power gain or loss occurs for each degree (centigrade) of temperature change below or above NACA standard day conditions.



T56-A-15 Engine

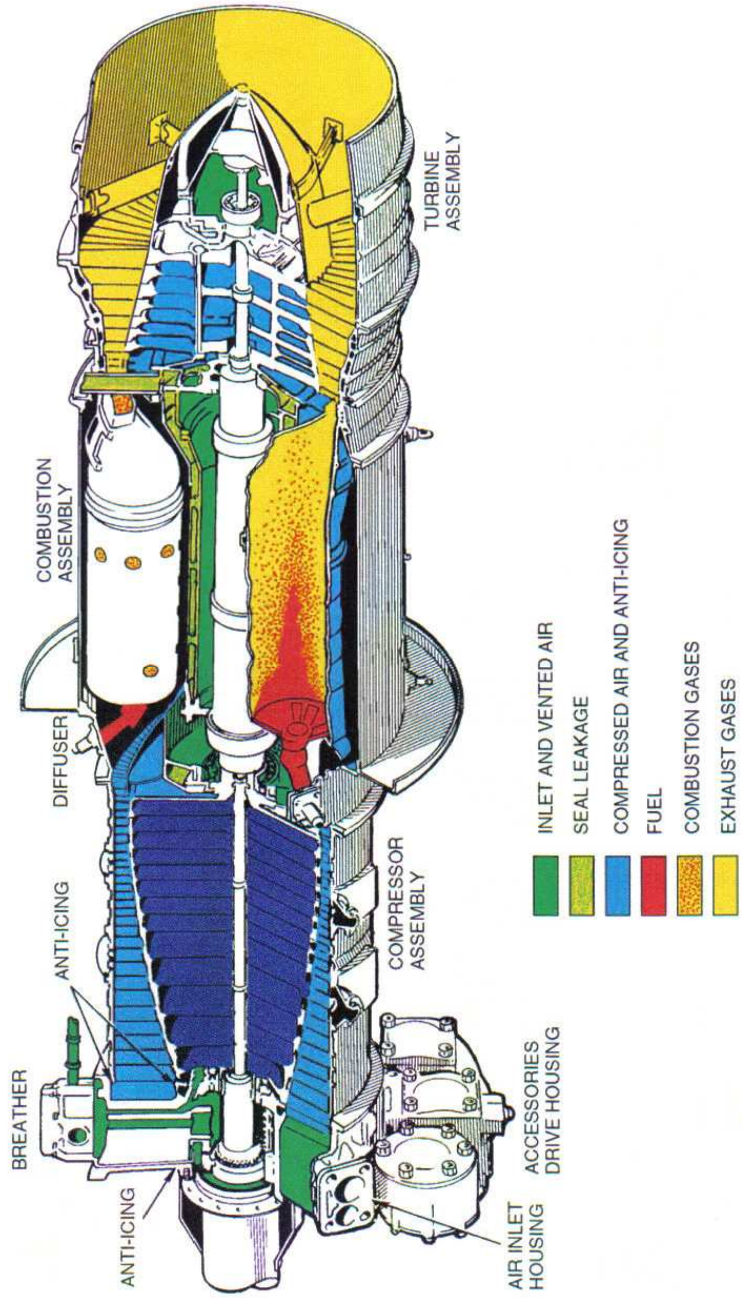
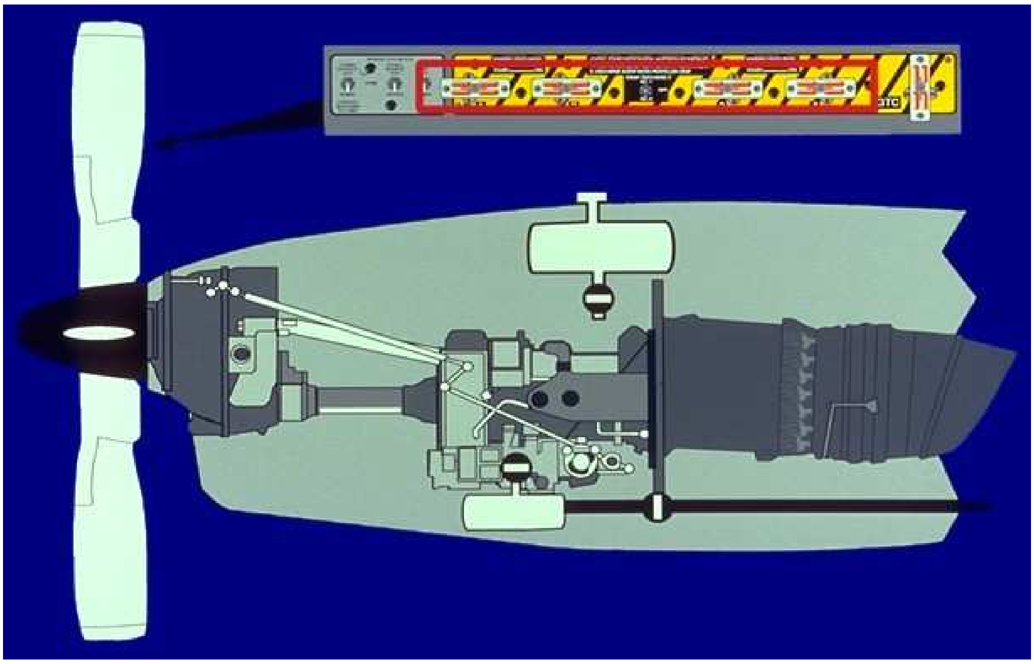


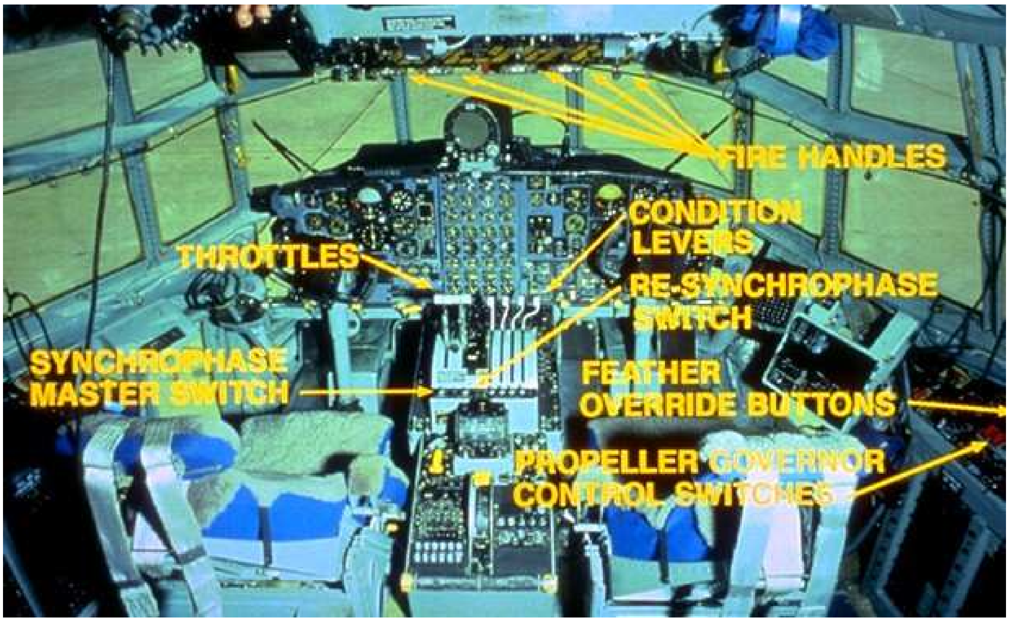
Figure 1-5.

1.2.1 TURBINE INLET TEMPERATURE (TIT). - The most critical feature of any gas turbine engine is its turbine inlet temperature (TIT). The strength and durability characteristics of the combustion and turbine section materials limit this temperature. Turbine inlet temperature is an indication of the stress level in the engine, and is a determining factor in establishing rating and guarantees. The higher the turbine inlet temperature, the move efficient the engine; therefore, temperature tolerances are maintained as close as possible to the safe temperature limits of the materials involved.



1.2.2 DEFINITIONS OF ENGINE RATINGS.-The static, standard-day, sea level, take-off rating of the engine at 100 percent RPM (13,820) is 4,910 equivalent propeller SHP; 4,591 propeller SHP plus 319 ESHP resulting from jet thrust. The propeller shaft and does not include any accessory loading that is normally required when the engine is installed in the airplane. The normal allowance for reduction gear assembly and accessory losses is 100 SHP. Therefore, the installed propeller SHP is 4,491. The maximum allowable torquemeter indicated power is 19,600 inch-pounds. This is equivalent of 4,200 SHP plus 100 SHP allowance for gearbox and accessory losses, or a total of 4,300 SHP. The following engine ratings are based on turbine inlet temperature rather than torque, which will vary with air temperature and pressure.

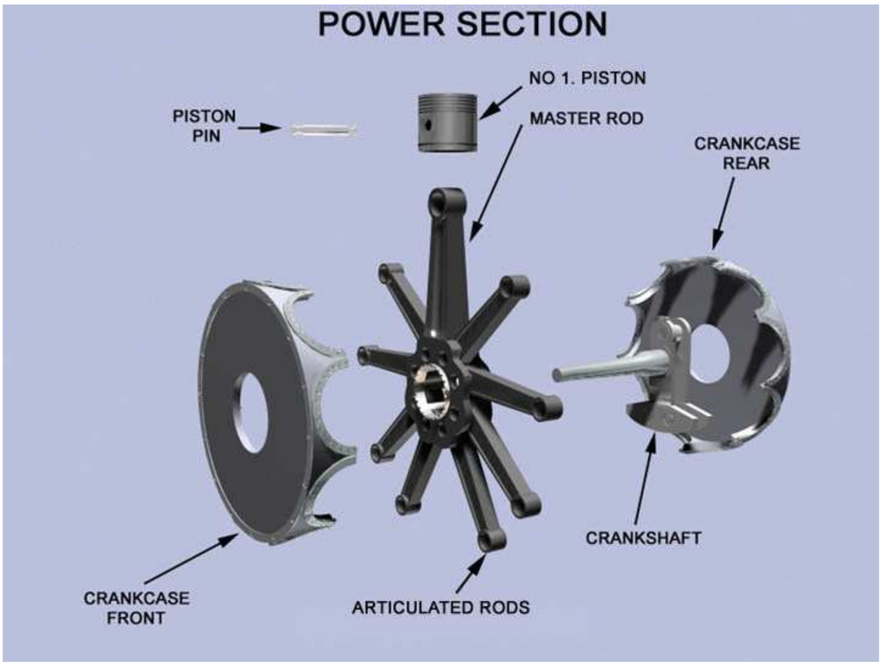
Take-Off Power (Maximum)
Take-off power is the power available at 1,083 grades centigrade TIT or 19,600 inch-pounds of torque, whichever occurs first. This power is available for all take-offs, and may be used for a maximum of 5 minutes where it is required to clear obstacles in the take-off flight path. However, it is recommended that any TIT between 1,049 grades centigrade and 1,083 grades centigrade inclusive be limited to a 5-minute duration.



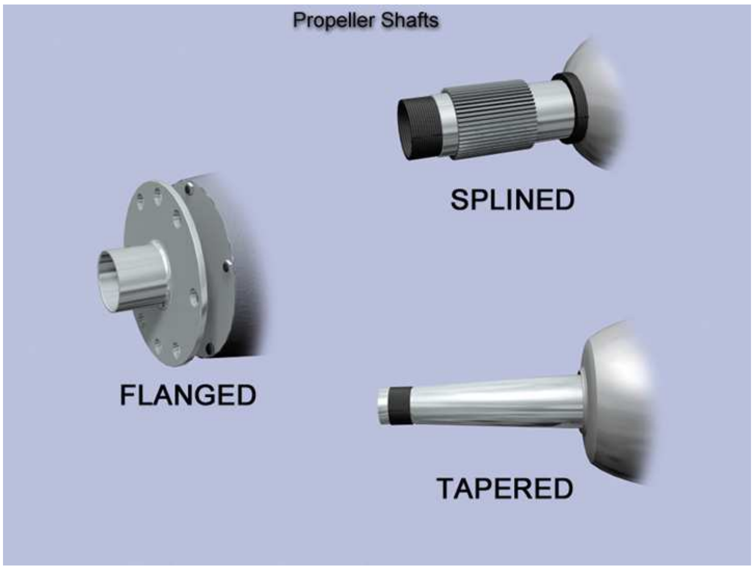
Military power
Military power is the power available at 1,049 grades centigrade TIT or 19,600 inch-pounds of torque, whichever occurs first, and may be used for a maximum of 30 minutes in flight. This power is available for emergency use. However, it is recommended that any TIT between 1,011 grades centigrade and 1,049 grades centigrade inclusive be limited to a 30-minute duration.

Maximum Continuous Power
Maximum continuous power is the power resulting when operating the engine at 1,010 grades centigrade TIT (or 19,600 inch-pounds of torque, whichever occurs first), and may be safely used for continuous operating conditions.

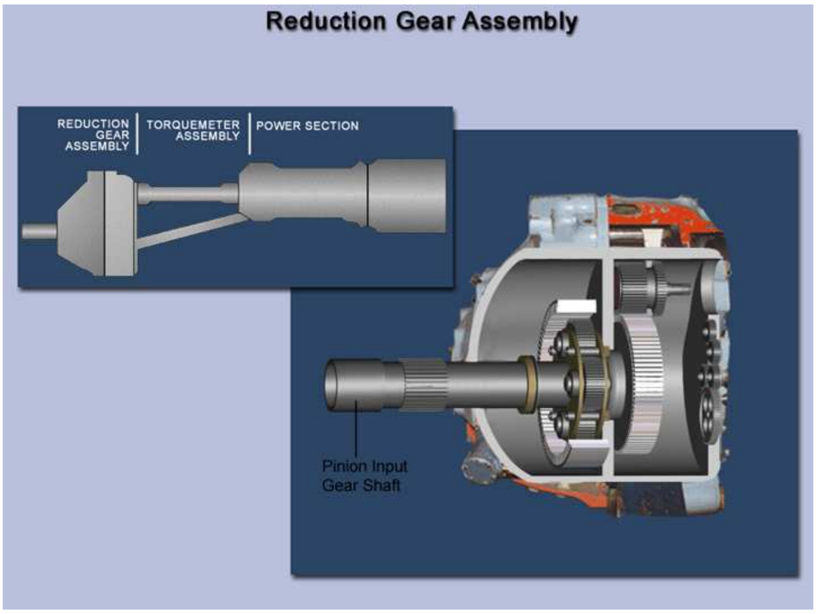
1.2.3 POWER SECTION.-The power section of the engine has a single-entry, 14 stage, axial-flow compressor: a set of 6 combustion chambers of the through-flow type: and a 4-stage turbine. Mounted on the power section are an accessories drive assembly and components of the engine fuel, ignition, and control systems. Acceleration bleed valves are installed at the 5th and 10th compressor stages. A manifold at the diffuser bleeds air from the compressor for airplane pneumatic systems. Anti-icing systems prevent accumulation of ice in the engine inlet air duct and the oil cooler scoop. Inlet air enters the compressor and is progressively compressed through the 14 stages of the compressor. The compressed air (at approximately 125 PSI, 600 grades F) flows through a diffuser into the combustion section. Fuel flows into the combustion chambers and burns, increasing the temperature and thereby the energy of the gases. The gases pass through the turbine, causing it to rotate and drive the compressor, propeller, and accessories. The gases, after expanding through the turbine, flow out a tailpipe.

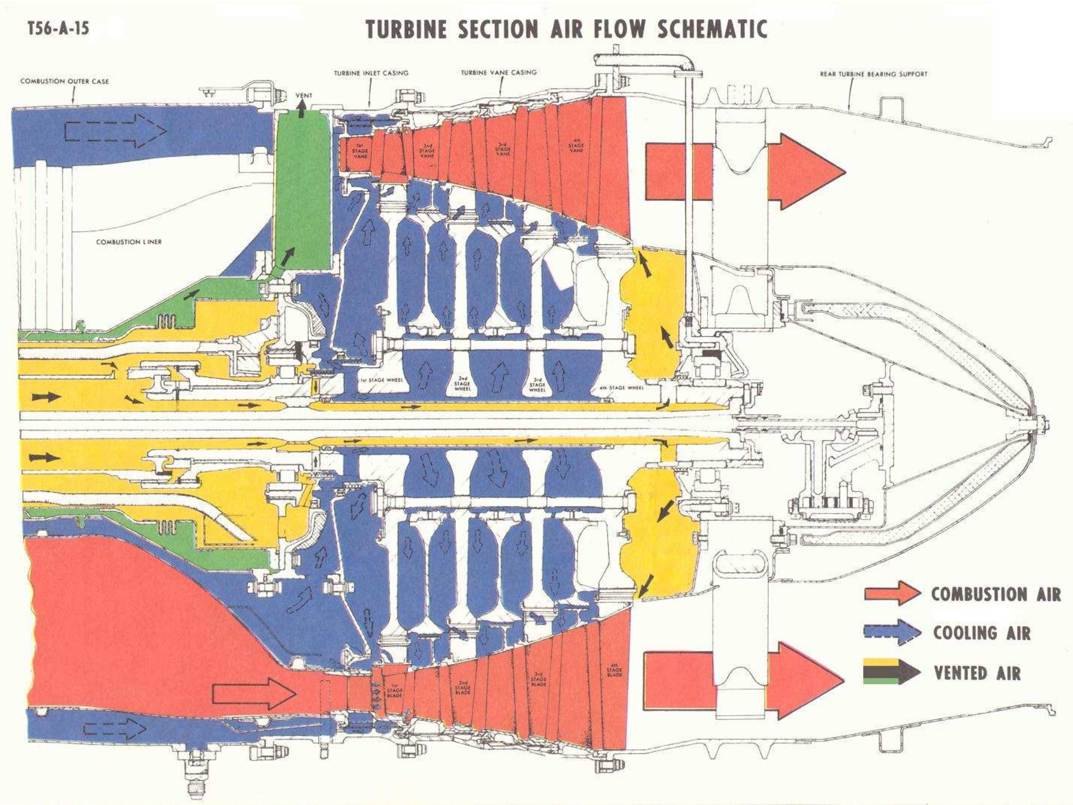


1.2.4 EXTENSION SHAFT ASSEMBLY.-The extension shaft assembly consists of two concentric hafts and torquemeter components. The inner shaft transmits power from the power section to the reduction gear. The outer shaft serves as a reference so the torsional deflection of the loaded inner shaft can be detected by the magnetic pickups of the indicating systems.



1.2.5 REDUCTION GEAR ASSEMBLY.-The reduction gear assembly contains a reduction gear train, a propeller brake, and engine negative torque control system, and a safety coupling. Mounted on the accessory drive pads are the engine starter, an AC generator. The reduction gear has an independent dry-sump oil system supplied from the engine oil tank. The reduction gear train is in two stages, providing and an overall reduction of 13.54 to 1 between engine speed (13,820 RPM) and propeller shaft speed (1,021 RPM). The propeller brake, engine negative torque signal system, and safety coupling are described in the following paragraphs.



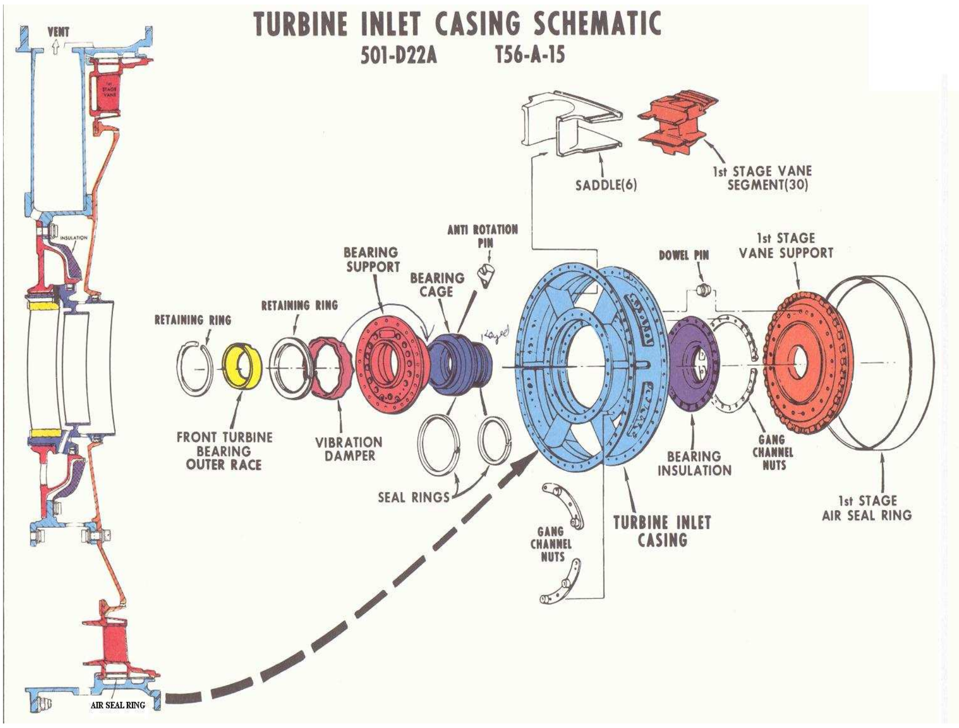


Propeller Brake

The cone-type propeller brake acts on the first stage of reduction gearing. During engine operation, the brake is held disengaged by gearbox oil pressure when RPM exceeds 23 percent, and is engaged below this speed. As engine speed is reduced and oil pressure drops, the braking surfaces are brought into contact by spring force to help slow the propeller to a stop. Helical spines are provided between the starter shaft and the starter gear on the outer brake member causing the brake to disengage when starting torque is applied during starting. The brake also engages to stop reverse rotation of the propeller.

Negative Torque Signal (NTS) System

The NTS system provides a mechanical signal to limit negative torque. Negative torque is encountered when the propeller attempts to drive the engine. If not relieved, this condition creates a great amount of drag, causing the airplane to yaw. The NTS system consists of an actuating mechanism housed partly within the reduction gear assembly and a partly in a signal assembly in the propeller valve housing. The NTS system operates when negative torque applied to the reduction gear exceeds a predetermined value of – 1,260 (-600) inch-pounds. A ring gear is the moved forward against springs as a result of the torque reaction generated through helical spines. In moving forward, the ring gear pushes a plunger through the nose of the reduction gear assembly. The plunger pushes against a cam in the signal assembly to actuate control linkage connected to the propeller valve housing. When a negative torque signal is transmitted to the propeller, the propeller increases blade angle to relieve the condition except when the throttles are below the FLIGHT IDLE position. When the throttles are below FLIGHT IDLE, a cam moves the actuator away from the NTS plunger and renders the system inoperative. This is necessary to prevent a propeller from receiving a possible negative torque signal at high landing speeds when the throttles are moved toward reverse. If the negative torque is sufficiently reduced, the signal mechanism returns to normally by springs acting on the ring gear.

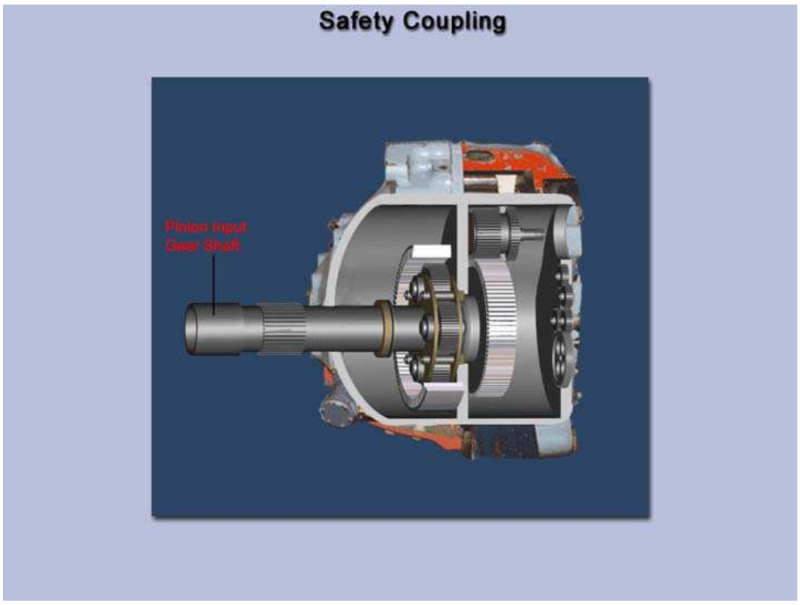


NOTE

Normal operation of the NTS system does not commit the propeller to feather. However a malfunctioning NTS system may completely feather the propeller or cause 2the engine to stall/flame out.

Safety Coupling

The safety coupling is provided by decouple the power section from the reduction gear if negative torque applied to the reduction gear exceeds approximately 6,000 inch-pounds, a valve much higher than that required to operate the NTS system. Because of its higher setting, the safety coupling backs up the NTS system to reduce drag until the propeller can be fathered. The safety coupling connects the engine extension shaft to the pinion of the first stage of reduction gears. The safety coupling consists of three members. An outer member is attached to the extension shaft; an inner member is attached to the pinion; and an intermediate member is engaged to the outer member by straight teeth and to the inner member by helical teeth. Reaction of the helical teeth tends to force the intermediate member aft out of engagement when negative torque is applied; and the members disengage if approximately -6,000 inch-pounds torque is reached. While disengaged, the two members are forced together by springs so that the teeth ratchet. The teeth can thus be damaged; therefore, the engine should not be continued in operation after decoupling.



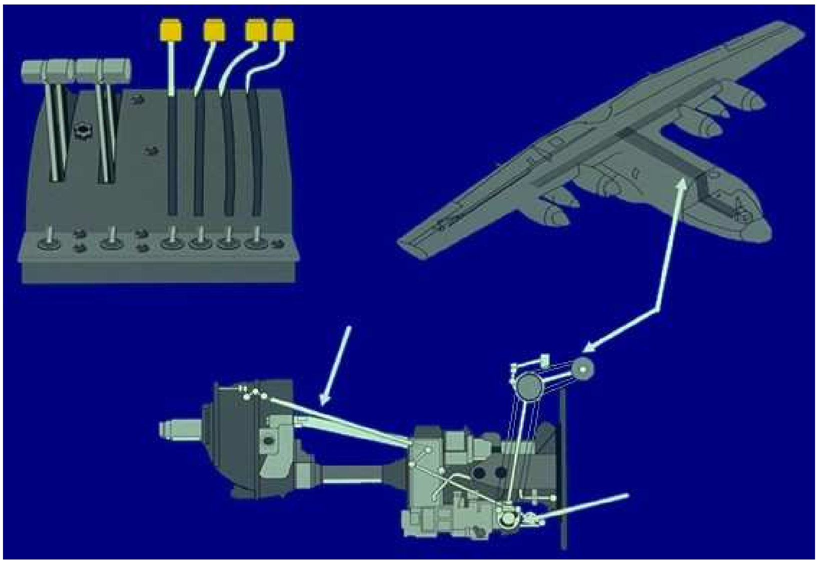
1.2.6 ENGINE FUEL AND CONTROL SYSTEM.-The turboprop engine consists of the same components as the turbojet engine except that a propeller and a reduction gear are added. A turboprop engine turbine extracts more energy from the gas stream that a turbojet engine. This is necessary to drive not only the compressor and the accessories, but also the propeller. Since most of the gas stream energy is absorbed by the turbine, the jet action, while still effective, is reduced considerably. A reduction gear is used because the turning speed of the power until is too high for use with a propeller. In flight the engine operates at a constant speed which is maintained by the government action of the propeller. Power changes are made by changing fuel flow and propeller blade angle rather than engine speed. An increase in fuel flow caused an increase in turbine inlet temperature (TIT) and a corresponding increase in energy available at the turbine absorbs more energy and transmits it to the propeller in the form of torque. The propeller, in order to maintain governing speed, increase blade angle to absorb the increase torque. TIT is a very important factor in the control of the engine. TIT is directly related to fuel flow and consequently to power produced. It is also limited because of the strength and durability of the combustion and turbine section materials. The control system schedules fuel flow to produce specific TIT and to limit those temperatures so that the temperature tolerances of combustion and turbine section materials are not exceeded. The fuel system consists of fuel filters, a fuel pump, a hydro mechanical fuel control in series with an electronic temperature datum control system, and six fuel nozzles. Operating with the fuel system is the ignition system, the starting fuel enrichment system, the bleed air system, and the propeller. Changes is power setting are effected by the throttle which is connected to the fuel control and the propeller through a mechanical coordinator. During ground operation, changes in throttle position mechanically affect both the fuel flow and the propeller blade angle. In flight, changes in throttle position mechanically affect fuel flow and the propeller governor regulates blade angle, maintaining constant engine speed.

Basic Hydromechanical Fuel System

The basic hydromechanical fuel system consists of a throttle, a coordinator, a low-pressure fuel filter, a dual-element fuel pump, a hydro mechanical fuel control, and six fuel nozzles.

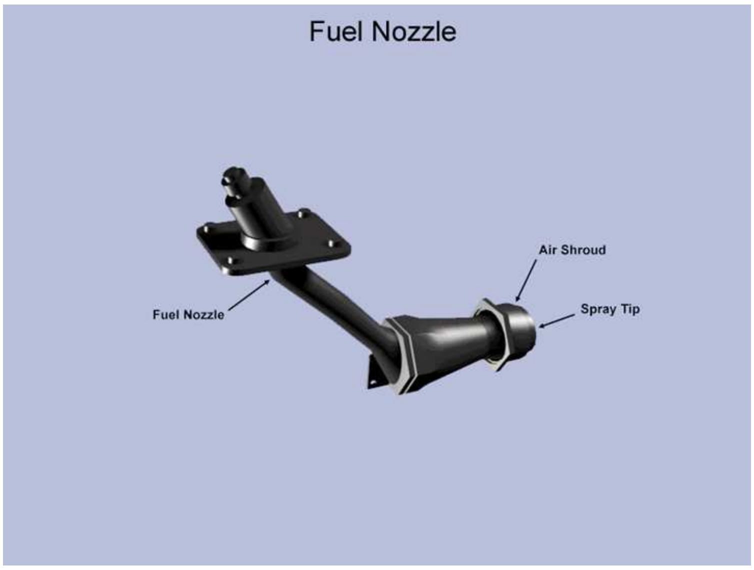
Throttles, Coordinator, and Propeller Control linkage

The coordinator is a mechanical discriminating device which coordinates the throttle, the propeller, the fuel control, and the electronic TD system. Movements of the throttle are transmitted to the coordinator by cables and, in turn, to the fuel control and the propeller by a series of levers and rods. A potentiometer in the coordinator provides signals to the TD system. Propeller blade angle is scheduled by throttle position from MAXIMUM REVERSE to FLIGHT IDLE. For throttle settings between FLIGHT IDLE and TAKEOFF, the propeller is governing. Throttle movement in this range serves primarily to change fuel flow.



Fuel Control and Fuel Nozzles

Fuel flows from the fuel pump to the hydromechanical fuel control. The control is sensitive to throttle position, air temperature and pressure at the engine inlet, and engine speed. The engine speed function of the fuel control maintains engine speed in the taxi range and limits engine speed in the flight range if the propeller governor fails. Governors' action is controlled by flyweights that respond to engine RPM. The control will start to reduce fuel to the engine at approximately 103.5 percent RPM. The fuel flow schedule maintained by the fuel control provides satisfactory operation of the engine throughout its entire range. Fuel metered by the control is equal to engine requirements plus an additional 20 percent, which is for the use by the temperature datum valve. With the TD control valve switch in NULL, the excess fuel provided by the fuel control is constantly bypassed by the temperature datum valve to the fuel nozzles and into the combustion liners, where it is burned.



Manifold Drip Valve

The solenoid-operated manifold drip valve located at the bottom of the fuel manifold allows the manifold to drain when the engine is not operating. The valve is spring-loaded open, and is solenoid-closed. During starting and to 16 percent RPM, the speed-sensitive control opens the ignition relay to energize the valve solenoid and close the valve. At 65 percent RPM, the speed –sensitive control opens the ignition relay to deenergize the valve solenoid, but manifold pressure holds the drip valve closed. To prevent fuel from dripping into the combustion chambers when the engine is shut down, the valve opens when pressure in the manifold drops below 10 PSI to allow the fuel to be drained overboard.

Electronic Temperature Datum Control System

There are a total of eighteen thermocouple probe assemblies mounted around the turbine inlet case. The thermocouple probe is positioned in the gas path at the inlet of the first stage turbine vanes. The thermocouple assemblies are thermoelectric devises which generate a specific voltage proportional to the temperature of the gas path. Each thermocouple assembly contains two independent junctions. One junction of each thermocouple assembly is connected in parallel to adjacent thermocouple assemblies by the thermocouple harness. This results in two independent temperature sensing circuits, containing eighteen junctions each. One circuit provides a signal to the TIT indicator on the flight deck while the other provides a signal to the temperature datum amplifier. The total signal generated by each circuit is then averaged by the respective receiving until (TIT indicator or Temperature Datum Amplifier). In most cases degradation of an individual thermocouple assembly would affect each circuit equally. The indicating signal will be lower (3.5 to 22 grades centigrade) than that actual temperature experienced by each thermocouple sensing element.

CAUTION

Thermocouple failure will supply an inaccurate signal to the TIT indicator or the temperature datum amplifier or both simultaneously resulting in erroneous engine instrument indications and possible damage to turbine blades.

The temperature datum control together with the coordinator potentiometer, temperature adjustment network, a turbine inlet temperature measurement system, and the temperature datum control system. The system compensates for variations in fuel heat value and density, engines, and control system characteristics. The temperature datum control is furnished actual turbine inlet temperature signals from a set of thermocouples and is furnished desired turbine inlet temperature signals by the throttle through the coordinator potentiometer and the temperature adjustment network. The control compares the actual and the desired turbine inlet temperature signals.

Acceleration Bleed Air Valves

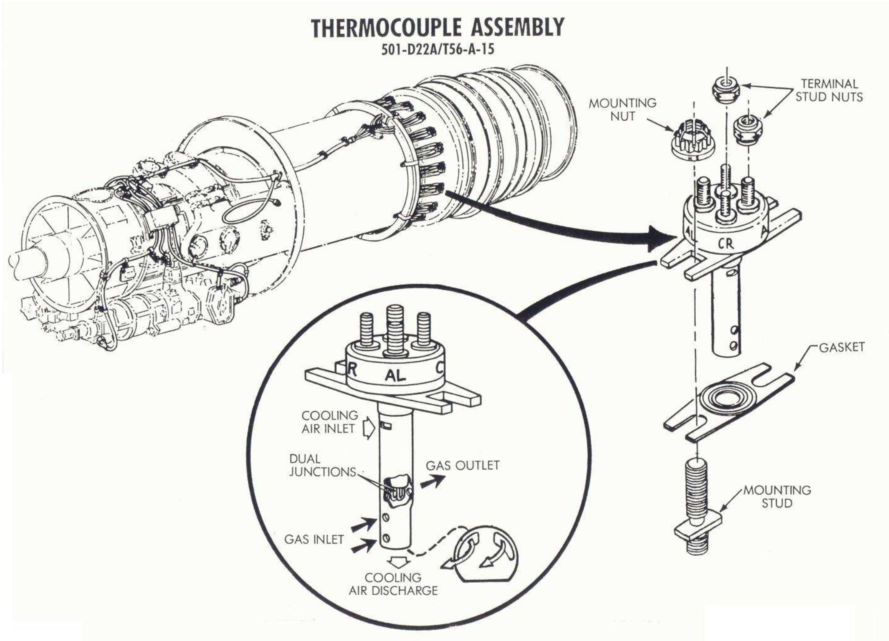
The bleed air valves on the fifth and tenth stages of the compressor are provided for compressor unloading during starting and while the engine is operating in the low peed ground idle range. These bleed valves remain open only when engine speed in below 94 percent RPM. The fifth and tenth stage bleed air valves are automatic in operation and are actuated by 14^{th} stage compressor air pressure through an engine-driven speed sensitive valve assembly.

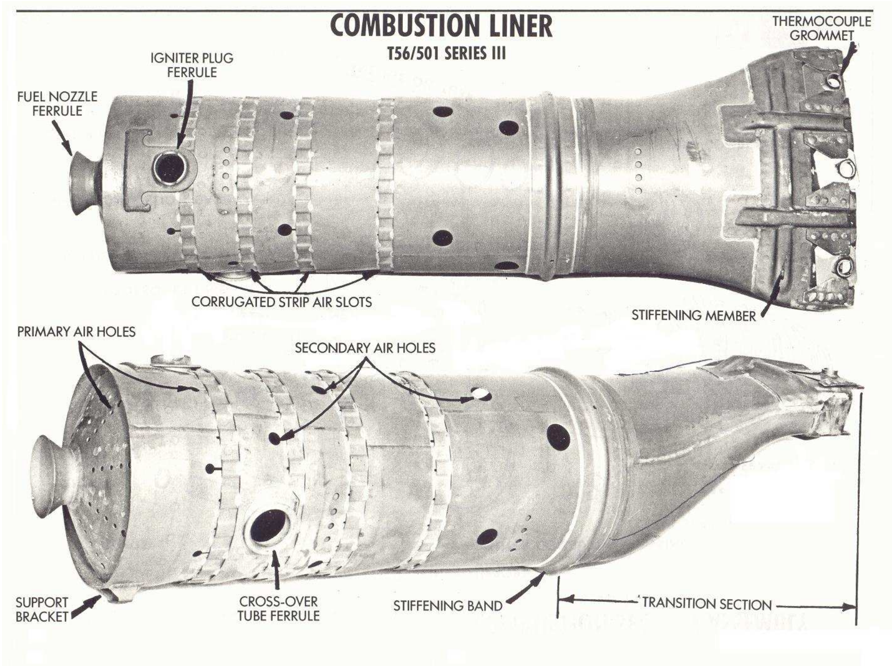
Starting Fuel Enrichment System

The enrichment system consists of a bypass line in which are mounted a solenoid valve, a pressure switch, and the engine fuel enrichment selector switch. The valve is opened by the speed-sensitive control through the ignition relay when engine speed reaches 16 percent RPM during starting when the engine fuel enrichment switch is ON. While open, the valve allows pump discharge fuel to flow around the metering section of the fuel control to add to the metered flow from the fuel control. After fuel pressure in the manifold reaches approximately 50 PSI (gage), the manifold pressure switch opens to deenergize the valve, which then closes.

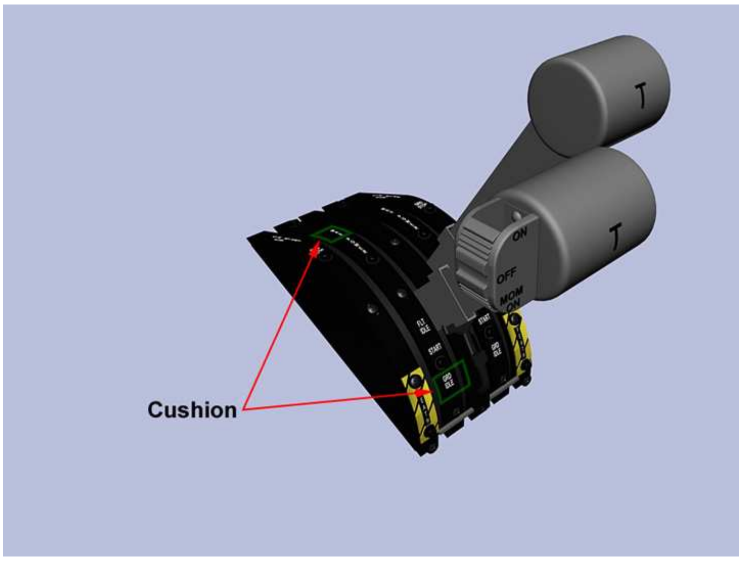
1.2.7 STARTING SYSTEM.-An air turbine starter until drives the engine for ground starts. This starter until consists of an air driven turbine section, a clutch, and a reduction gear section of the engine. Air for driving the starter can be supplied by the auxiliary power unit, by an operating engine, or by an external air source. The air is routed through the bleed air system and the engine bleed air regulators. When the respective bleed air regulator is opened, air in supplied to the starter regulator valve. When the engine ground start switch is actuated, the starter regulator valve opens (when its solenoid is energized) and allows airflow into the starter turbine section. Releasing the energize ground start switch will deenergize the regular valve. On airplanes, the START VALVE OPEN light will extinguish within approximately 15 seconds after release of the starter switch, indicating that the starter valve is closed. Each engine starting circuit is electrically interlocked with the corresponding engine oil fire shutoff valve control circuit. This renders the starting circuit inoperative unless the fire handle is pushed in and the FIRE SHUTOFF VALVES OIL circuit breaker is engaged.

1.2.8 IGNITION SYSTEM.-The ignition system is a high-voltage, condenser-discharge type, consisting of an exciter, two igniters, and control components. The system is controlled by the speed –sensitive control through the ignition relay which turns it on at 16 percent engine RPM and off at 65 percent engine RPM during starting.


THERMOCOUPLE ASSEMBLY
501-D22A/T56-A-15
MOUNTING NUT
TERMINAL STUD NUTS
CR
GASKET
R
AL
C
COOLING AIR INLET
DUAL JUNCTIONS
GAS OUTLET
GAS INLET
COOLING AIR DISCHARGE
MOUNTING STUD

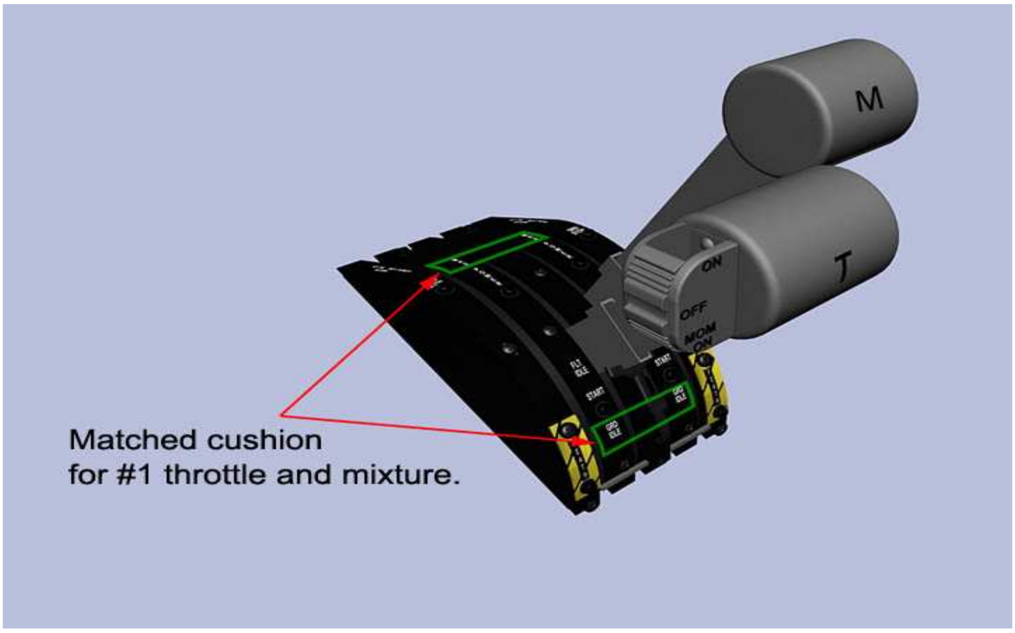

COMBUSTION LINER
T56/501 SERIES III
THERMOCOUPLE GROMMET
IGNITER PLUG FERRULE
FUEL NOZZLE FERRULE
CORRUGATED STRIP AIR SLOTS
STIFFENING MEMBER
PRIMARY AIR HOLES
SECONDARY AIR HOLES
SUPPORT BRACKET
CROSS-OVER TUBE FERRULE
STIFFENING BAND
TRANSITION SECTION

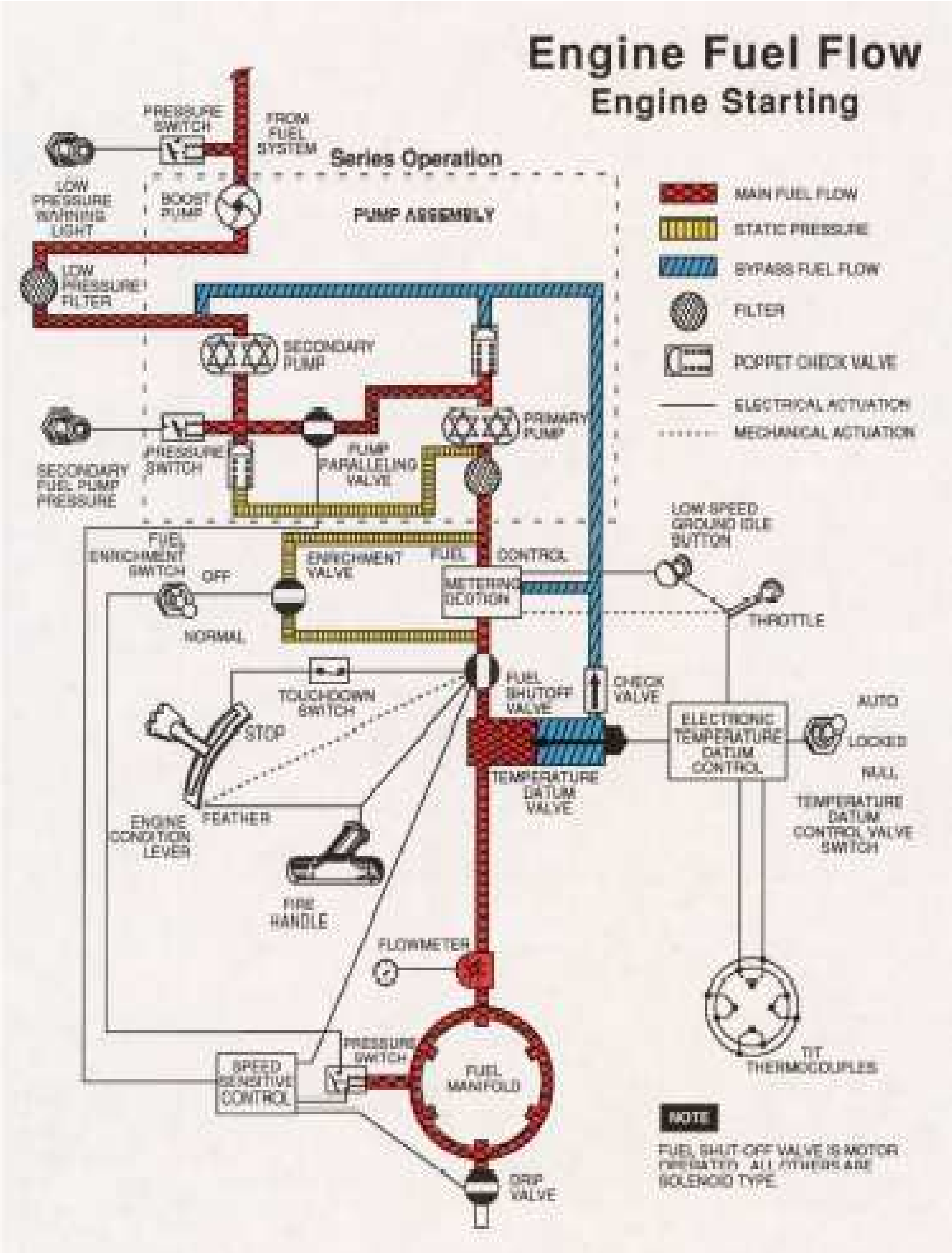
1.2.9. ENGINE CONTROLS.-Engine control in the flight range of operation is based on regulation of engine speed by propeller constant-speed governing and control of torque through regulation of fuel flow. Note that the throttle acts only as a fuel control. It exercises on direct control over the propeller, which is controlled entirely by the propeller governor to regulate engine speed and to limit the low blade angle. The throttle does select the rate of fuel flow. The fuel control regulates the rate of increase and decrease of fuel metering for acceleration and deceleration.



Throttles

The throttles are quadrant-mounted on the flight control pedestal. Throttle movement controls engine operation by positioning propeller control and by positioning controls to select the rate of engine fuel flow. Throttle movements are mechanical linkage to an engine-mounted coordinator. The coordinator transmits the movement through mechanical linkage to the propeller and the engine fuel control, and it also actuates switches and a potentiometer which affect electronic TD control system operation. Each throttle has two distinct ranges of movement, ground and flight, which are separated by a stop. Both ranges are used for ground operation, but the ground range, the throttle position selects a propeller blade angle and a corresponding rate of fuel flow. In the flight (governing) range, throttle position selects a rate of fuel flow to produce a schedule turbine inlet temperature; and the propeller governor control propeller blade angle. The throttles have the following four placarded positions.


M
T
ON
OFF
MOM ON
Matched cushion
for #1 throttle and mixture.



Engine Fuel Flow
Engine Starting
Series Operation
PRESSURE SWITCH
FROM FUEL SYSTEM
LOW PRESSURE WARNING LIGHT
BOOST PUMP
PUMP ASSEMBLY
LOW PRESSURE FILTER
SECONDARY PUMP
PRIMARY PUMP
PRESSURE SWITCH
SECONDARY FUEL PUMP PRESSURE
PUMP PARALLELING VALVE
MAIN FUEL FLOW
STATIC PRESSURE
BYPASS FUEL FLOW
FILTER
POPPET CHECK VALVE
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
LOW SPEED GROUND IDLE BUTTON
FUEL ENRICHMENT SWITCH
OFF
NORMAL
ENRICHMENT VALVE
FUEL CONTROL
METERING SECTION
THROTTLE
TOUCHDOWN SWITCH
FUEL SHUTOFF VALVE
CHECK VALVE
STOP
ELECTRONIC TEMPERATURE DATUM CONTROL
AUTO
LOCKED
NULL
TEMPERATURE DATUM VALVE
TEMPERATURE DATUM CONTROL VALVE SWITCH
ENGINE CONDITION LEVER
FEATHER
FIRE HANDLE
FLOWMETER
PRESSURE SWITCH
SPEED SENSITIVE CONTROL
FUEL MANIFOLD
TIT THERMOCOUPLES
DRIP VALVE
NOTE
FUEL SHUT-OFF VALVE IS MOTOR OPERATED. ALL OTHERS ARE SOLENOID TYPE.

1.2.10 MAXIMUM REVERSE.-(0 degrees coordinator travel). Reverse thrust at zero airspeed is equal to approximately 30 percent of static take-off power. Reverse thrust at 100 KIAS is equal to approximately 60 percent of static take-off power.

1.2.11 GROUND IDLE.-(Approximately 18 degrees coordinator travel) is a detent position. This position sets blade angle for engine starting.

1.2.12 FLIGHT IDLE.-(34 degrees coordinator travel) is the transition point between the ground and flight (governing) ranges. A step in the quadrant limits aft travel of the throttle at this position until the throttle at this position until the throttle is lifted.

1.2.13 TAKE-OFF.-(90 degrees coordinator travel) is the maximum power position.
The throttle quadrant is also divided into two unmarked ranges with respect to control of the electronic temperature datum control system. The crossover point is at 65 degrees coordinator travel, at which point the switches in the coordinator are actuated. Below this point the electronic temperature datum control system can limit turbine inlet temperature. Above this point, it is controlling turbine inlet temperature.

Throttle Friction Knob
A friction knob on the throttle quadrant adjusts the amount of friction applied to the throttles to prevent creeping or accidental movement.

Engine Condition levers
Four pedestal-mounted engine condition levers are controls for engine starting and stopping and propeller feathering and unfeathering. The levers actuate both mechanical linkages and switches which provide electrical control. Each lever has four placarded positions: RUN, AIR START, GROUND, STOP AND FEATHER.

Temp Datum Control Valve Switches
Four Temp Datum (TD) control valve switches are mounted on a panel at the aft end of the engine control quadrant. Each switch has AUTO LOCKED, and NULL position. The switch positions are used as follows:
The AUTO position permits normal operation of the electronic temperature datum control system by applying single-phase, AC power to the amplifier from the AC instrument and engine fuel control bus.
The LOCKED position may be set when the throttles are in temperature-controlling range to provide a fixed percentage correction on the metered fuel flow throughout the engine operating range, and will permit the fuel control to

compensate for changes in ambient temperatures in order to maintain a symmetrical shaft horse-power at flight idle.

The NULL position removes AC power from the control system amplifier; and the TD valve, receiving no control signals, returns to its null position so that it does not correct the fuel flow according to turbine inlet temperature. The TD valve brake is released by 28-vol DC power. The NULL position of these switches is used to deactivate the electronic temperature datum control systems when erratic electronic fuel scheduling is suspected or when the engines are not operating.

Starting Control System

The starting control system automatically controls fuel flow and ignition during ground and air starts. The automatic control of the starting control system has a speed-sensitive control and a speed-sensitive valve, which are engine-driven and performs the following functions:

At 16 percent RPM- the fuel shutoff valve in the engine fuel control is opened, the ignition relay is energized completing circuits to the ignition exciter, the engine fuel pump paralleling valve closes, if selected the fuel enrichment valve opens, and the manifold drip valve closes.

At 65 percent RPM-ignition system is deenergized, fuel pump paralleling valve is opened to returns pumps to series operation, manifold drip valve is deenergized (it is then held closed by fuel pressure).

At 94 percent RPM electronic temperature datum control system is switched from start limiting to normal limiting the TD valve take capability changes from 50 to 20 percent, and the speed-sensitive valve opens to allow 14th stage bleed air to force the 5th and 10th stage acceleration bleed valves closed.

Engine Ground Start Switches

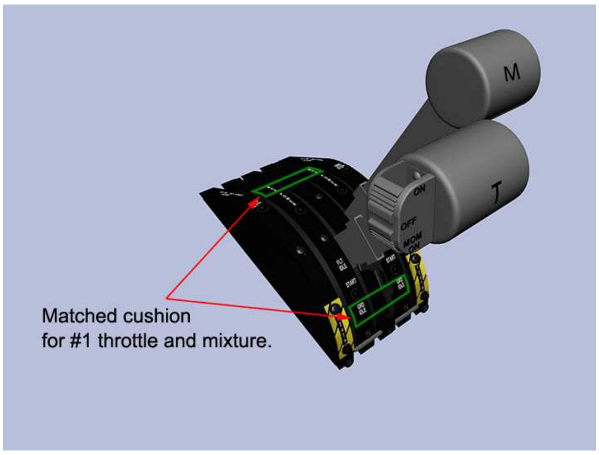
Four engine ground start switches are located on the engine starting panel on the overheat control panel. Each switch is used to open the start air regulator valve to permit operation of the starter. A pushbutton switch is used on H1 airplanes and a spring loaded toggle switch is used on H2 airplanes. Holding the engine start switch in, or placing the switch to the START position opens the starter regulator valve to permit bleed air from the bleed air manifold to drive the engine starter turbine. The engine ground start switch should be released at 60 percent engine RPM. Each engine starting circuit is electrically interlocked with the corresponding engine oil fire shutoff valve control circuit. This renders the starting circuit inoperative unless the fire handle is pushed in and the oil fire shutoff valve circuit breaker is engaged.

Engine Fuel Enrichment Switches

The engine fuel enrichment switches are located on the engine starting panel. They are toggle switches with NORMAL/NORM and OFF positions. In NORMAL/NORM, each switch allows the engine switch enrichment valve to be controlled by the speed-sensitive control and manifold pressure switch during the starting. The OFF position is provided to permit deactivating the fuel enrichment system for any engine.

1.2.14 ENGINE INSTRUMENTS

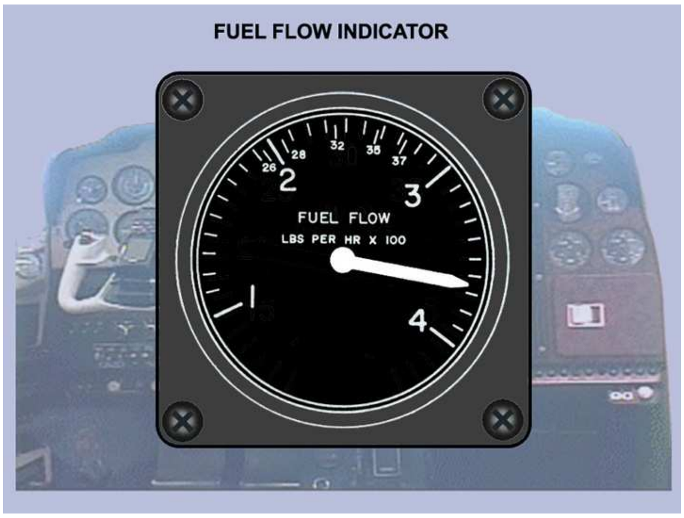
Torquemeters. Each of the four torquemeters indicates torque in inch-pounds, and can indicate either positive or negative torque.



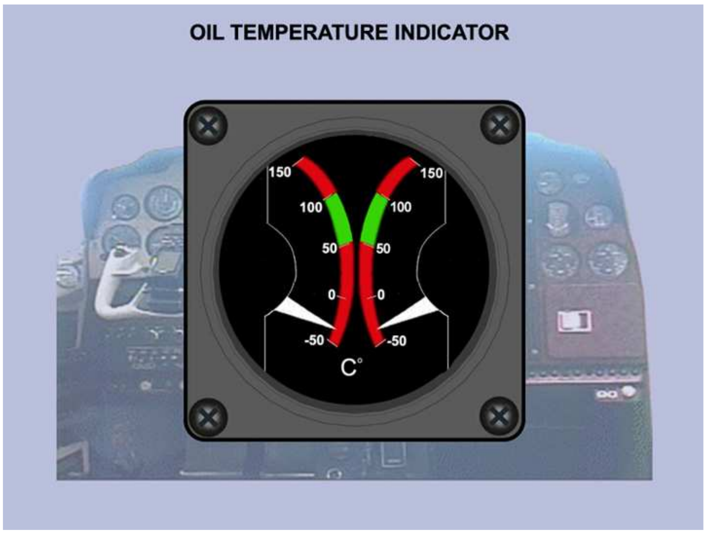
Tachometer. Each of the four tachometer indicates engine speed in percent of normal engine RPM. Normal RPM (100 percent) equals 13,820 engine RPM. A vernier dial on each indicator makes it possible to read RPM accuracy to less than 1 percent. The tachometer system has a separate engine-driven tachometer generator mounted on the accessory drive pad of the reduction gear assembly of each engine. The tachometer is not dependent upon the airplane electrical system for operation.

Turbine inlet Temperature Indicators. Each of the turbine inlet temperature indicators indicate temperature sensed by thermocouples in the engine turbine inlet casing. Each indictor registers temperature in degrees centigrade and contains a vernier scale graduated in degrees.

Fuel flow Indicators. Each of the four fuel flow indicators indicates flow in pounds per hour. Flow is measured at the point where it enters the manifold on the engine. A single fuel flow power supply unit, which powers all fuel flow transmitters, receives 28-volt DC power from the essential DC bus.



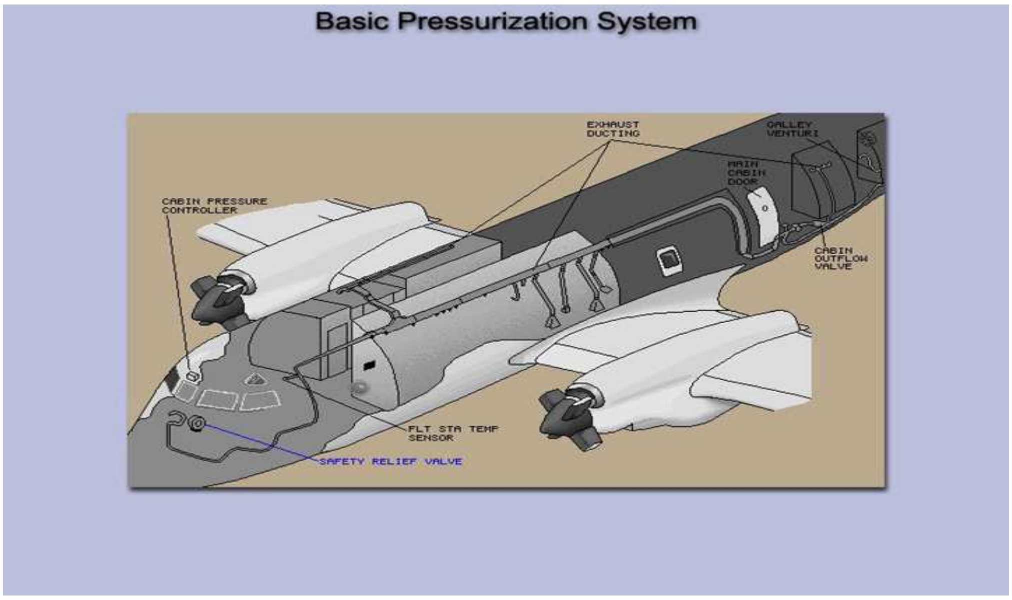
Oil Temperature Indicators. The four electrical-resistance type oil temperature indicators indicate oil temperature in the engine oil inlet lines.



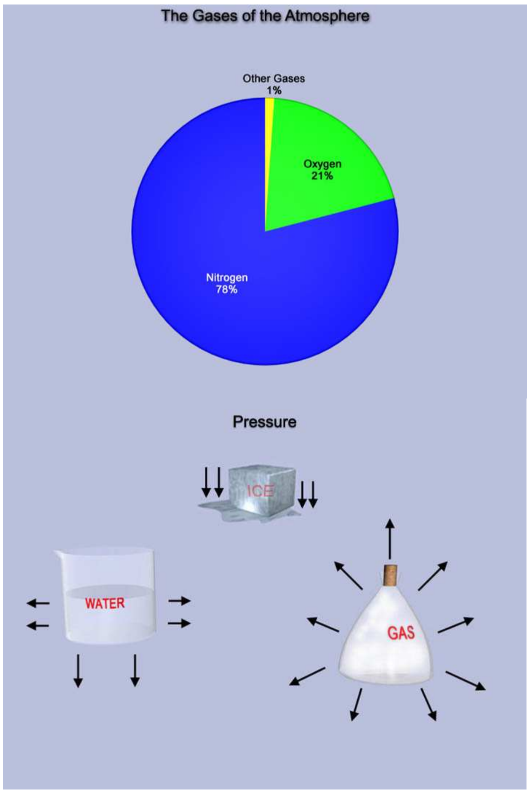
Oil pressure Indicators. Four dual oil pressure indicators indicate oil pressure for both the engine power sections and reduction gear assemblies. The rear needle marked G on each indicator shows reduction gear assembly oil pressure; and the front needle marked E indicates engine power section oil pressure.

1.3 PNEUMATIC SYSTEM

1.3.1 BASIC PNEUMATICS.-Pneumatics systems of the c-130 use air as a source of power to accomplish such tasks as cooling, heating, pressurization removal. In considering these tasks, it is helpful to review some basic principles regarding pneumatics.



1.3.2 GENERAL.-Pneumatics is a branch of physics which deals with the physical properties of gases. In a pneumatic system, there must be a compressor, a reservoir to store the gas in the compressed state, a distribution system to direct the compressed gas to the point of use, and a method for using the gas to do work. Familiar applications of pneumatics are show in the diagram below.



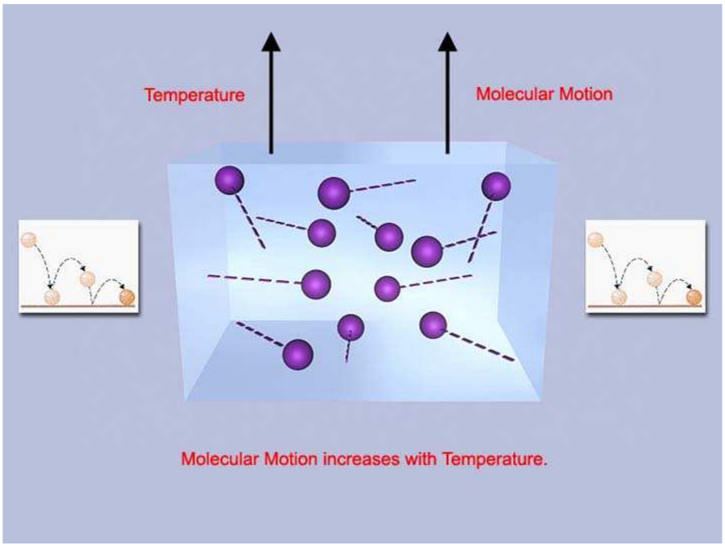
1.3.3 CHARACTERISTICS OF GASES.-Air are the gas used in the c-130 pneumatics systems because it is plentiful and can be compressed easily, and is required for life survival. A gas, like a liquid, is a fluid. A fluid is a substance which can be moved about easily and takes the shape of its container. A gas, in addition to having the above properties, tends to expand indefinitely. This means that the molecules of a gas are widely separated, and are confined only by the size of the container.

Each molecule of gas has weight and is always in motion. The velocity of the molecule is proportional to its temperature. As the molecules move they collide with each other, creating a force called pressure, if more collisions occur, more pressure is created. Pressure can be further defined as force per unit of area and is usually expressed in pounds per square inch psi.

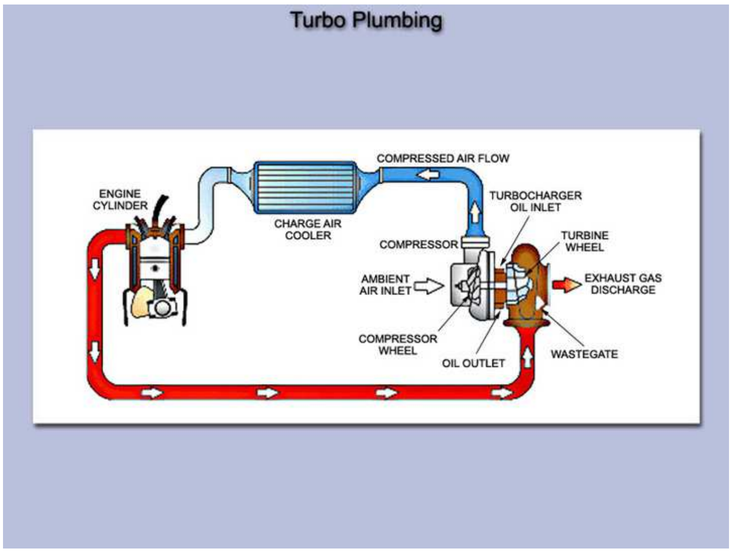
An increased in the number of molecular collisions may be brought about in different ways; for example, confine a quantity of gas in a container and then reduce the volume of the container. The molecules are then closer together and collide more often. Another example is increasing the temperature of a confined quantity of gas. This action causes an increase in the molecular movement, and the increased molecular motion results in an increase in the number of molecular collisions.

As more molecular collisions occur, energy in the form of heat is produced. This heat is called the heat of compression. When pressure is increased, temperature increases proportional. When pressure is decreased, temperature decreases proportional.

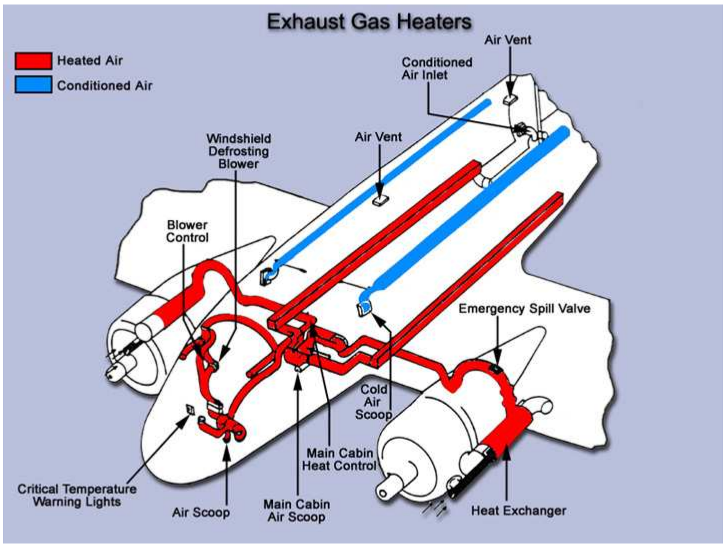
When the force used a gas is double, the volume occupied by the gas is reduced by approximately double. The pressure is approximately doubled. The pressure increase continues only until the pressure equals the compressing force.



1.3.4 GAS FLOW.-A gas flow from a point of high pressure to a point of low pressure; therefore, there must be a difference in pressure to create the flow.



When a gas flows through a duct, there is a definite relationship between the velocity of the gas and the pressure exerted on the ducts walls. If the duct diameter decreases, the velocity increases and the pressure decrease. The reverse is also true. A duct which uses this relationship between pressure and velocity is called a venture.



1.3.5 PRESSURE GAGES.-Pressure in a container or system is determined by uses of a gage. There are many types of gases but the ones used in the pneumatic systems will normally be either the bourdon or aneroid types.

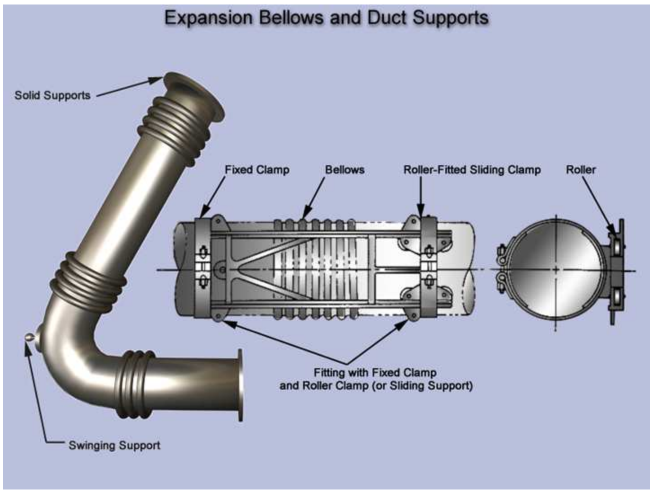
The bourdon pressure gage primarily consists of a flattened tube assembly bent in an arc, with a pressure inlet on one end. A link assembly connects to a spring and sector gear which in turn connects to a rotating gear and shaft which actuates a needle. A dial face graduated in increments indicates pounds per square inch. The instrument is enclosed in housing and fastened to the container or system at a pressure point. This type of gage usually does not consider atmospheric pressure. Some gages use an aneroid or bellows for indicators. Other uses for aneroid include barometers, rate of climb indicators, altimeters, and compensators. The aneroid-type gage usually consists of a sealed bellows.

1.3.6 BELLOWS AND ANEROIDS.-The bellows is used to measure relatively low pressure. An instrument bellows consists of a metal cylinder. It is usually made of spring brass or phosphor bronze. The sides of the cylinder are corrugated to increase flexibility. The bellows is sealed, or has a tube connected to one end. The bellows expands or contracts as pressure changes.

If the pressure around a sealed bellows increases, the bellows contracts. If the outside pressure decreases, the bellows expands. Expansion or contraction will continue until the inside and outside forces are equal.

1.3.7 PRESSURE BELLOWS.-With no pressure change at the pressure port of a bellows, the ends remain stationary. If pressure is increased on the inside of the bellows, the ends move apart. The movement is a measure of the pressure difference (differential) between the inside and outside of the bellows. If the pressure inside is reduced, or made less than the reference pressure outside, the

bellows contracts. The movement of the bellows can be transmitted to a pointer through a gear system or through a combination of levers.
The bellows is sometimes used to actuate a switch for a warning system. If pressure decreases, the switch closes to complete the circuit, and turns on the warning light.

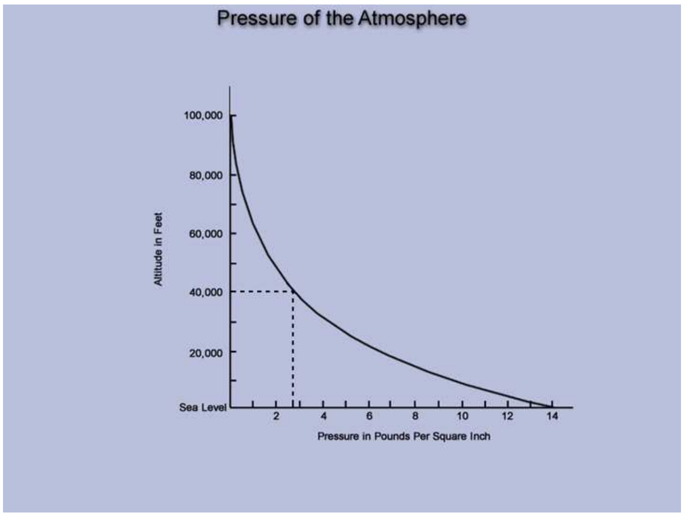


1.3.8 ANEROIDS.-In an aneroid, the bellows may be filled with an inert gas, or be completely evacuated, then sealed. The word aneroid is taken from the Greek and means "without water." A barometer that measures pressure without the use of liquids such as mercury or water is called an aneroid barometer. The aneroid is the basis for most aircraft altimeters.
The principles of operation for the aneroid are the same as for the pressure bellows. A decrease in atmospheric pressure causes the ends to move outward and the reverse happens during an increase in atmospheric pressure.

1.3.9 CHARACTERISTICS OF THE ATMOSPHERE.-Since air is the gas used in the pneumatic systems of the aircraft, some of the characteristics of the earth's atmosphere must be considered.

The atmosphere is the mass of air surrounding the earth. It is composed of a mixture of several different gases. Nitrogen makes up 78 percent and the atmosphere. Another 21 percent of the air is oxygen. The remaining gases are present in such small quantities that are not important here.

Each module of air has weight and is therefore attracted by the earth's gravitational pull. This pull causes the air to exert a force on the earth. The force is called atmospheric pressure. Altitude and changing weather conditions greatly affect atmospheric pressure.



The National Aeronautics and Space Administration (NASA) have arbitrarily chosen certain atmospheric conditions at sea level are as follows:

- Atmospheric Pressure – 14.73 PSI (29.92 in. Hg)
- Temperature – 59º Fahrenheit (15º Centigrade)
- Weight if Air – 0.0765 pound per cubic foot

Under these conditions, the relative humidity is 36 percent.

These values are used often in computing information on the engines, air conditioning system, etc.

Since most of the atmosphere is held near the surface of the earth, atmospheric pressure decreases at higher altitudes. At an altitude of 8.000 feet, atmospheric pressure is only 10.92 PSI, or 22.23 in. Hg. At 18.000 feet, the atmospheric pressure is 7.34 PSI, which is about one-half the atmospheric pressure at sea level. Atr 36.000 feet, atmospheric pressure is 3.30 PSI, or about one fourth the pressures at sea level. Atmospheric pressure is, therefore, approximately halved with each 18.000 foot increase in altitude.

Under standard lapse rate conditions, the temperature of the air decreases approximately 3.5 degrees Fahrenheit every 1.000 feet of altitude. This decrease continues up to approximately 36.000 feet, where the temperature is about 67 degrees Fahrenheit. Above 36.000 feet, the temperature changes very little until an altitude of approximately 65.000 feet is reached. At that altitude, the temperature begins to increase.

Several terms used throughout this volume are defined below:

- Air- A combination of gases consisting by volume of 21 percent oxygen, 78 percent nitrogen, and 1 percent of several other elements including carbon dioxide, hydrogen, ozone, argon, neon, krypton, and helium. This percentage holds true regardless of altitude or pressure.
- Compression – Packing more of a substance into a given container, or decreasing the volume of the confining container.
- Humidity - the amount of moisture in the air (usually given in percentage).
- Isobaric – A constant barometric pressure.
- Fluid – A substance which presents little resistance to forces trying to change its shape. Both liquids and gases are fluids.
- Gas – A fluid having the property of definite expansion.
- Pneumatics – The branch of physics which deals with the physical properties of gases, particularly air.
- Pressure – force per unit of area. Pressure is usually designed as pounds per square inch (PSI).
- Volume – the cubic magnitude of a container.
- Absolute pressure – pressure which is measured from a reference point of zero pressure (complete vacuum). Absolute pressure is designed PSIA and is equal to atmosphere pressure plus gate pressure.
- Gas pressure – pressure inside a container which is measured by a gas. Gases are usually calibrated to indicate zero when exposed to atmosphere pressure. Gate pressure is designed PSIG.
- Differential pressure – the difference between two pressures acting on opposite sides of a surface.
- Air flow – the weight of air, in pounds, flowing by a given point in given period of time. Air flow is measured in pounds per minute (PPM).
- Nasa standard day conditions – atmosphere conditions set up by the national aeronautics and space administration. The conditions are as follow.

Atmosphere pressure: 14, 73 PSI or 29.92 inches of mercury (in. HG):

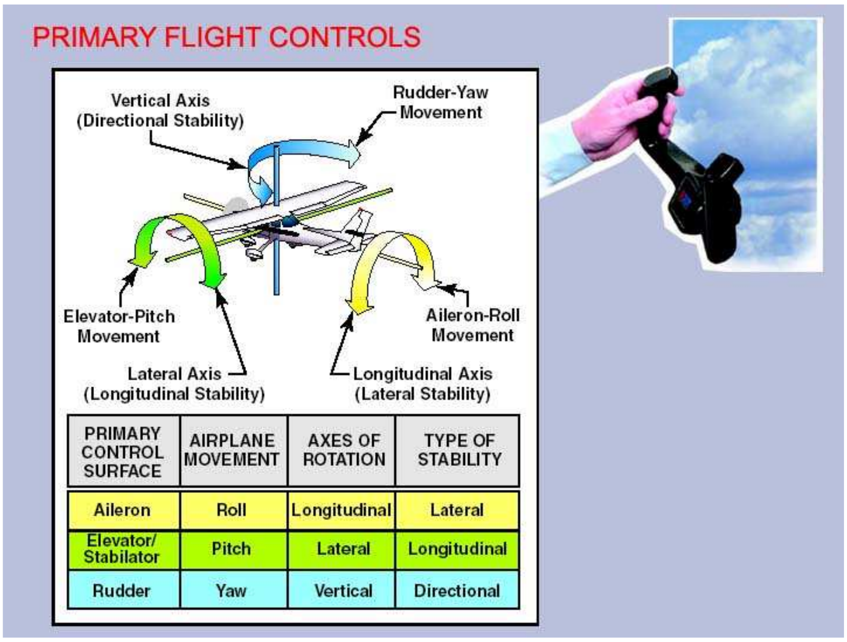
Temperature: 59 grades f (15 grades C).

Weight of air: 0.0765 lb per cubic ft.

1.4 FLIGHT CONTROLS

1.4.1 FLIGHT CONTROLS SYSTEM.-The flight controls include the main surface control system, which are aileron, rudder, and elevator systems, the trim tab control systems and the flaps control system. The main surfaces are controlled by mechanical systems which hydraulic boost. The trim tabs are controlled by electrical control systems. The autopilot, when operating, controls the main surfaces and elevator trim tabs. The flaps are operated by hydraulic pressure.

1.4.2 MAIN SURFACE CONTROL SYSTEMS.-The main surfaces (ailerons, rudder, and elevators) are controlled by mechanical control systems, consisting of cables, pushrods, bellcranks, and torque tubes. Hydraulically driven booster units provide most of the force required to move the surfaces. The booster units are driven by hydraulic pressure supplied simultaneously by the booster and utility hydraulic system, each of which serves to power one portion of the booster units. System operation is such that failure or malfunction of any component of either system in any booster unit will allow normal function of the other system powering the same unit. A loss of hydraulic pressure in either hydraulic system results in a corresponding loss in the booster unit, and a proportionate loss of power to operate the unit. The airplane maybe controlled with complete loss of booster unit power by the use of trim tabs and engine power, plus coordinate increased efforts of the pilot and copilot. Solenoid operated shutoff valves in each surface control system can be actuated by switches on the control boost switch panel at the flight station to shut off supply pressure to either portion of the systems. The valves are spring-loaded and will open when de-energized (control boost switches in the ON position). A booster off warning light for each switch is also powered by the solenoid shutoff valve switch and will illuminate when the switch is in the OFF position. An autopilot servomotor is cable-rigged to each booster unit to substitute for manual control during autopilot operation. Electrical power for operation of the booster shutoff valves is supplied from the essential DC bus through the aileron, elevators, and rudder shutoff valves circuit breakers on the copilot’s lower circuit breaker panel.



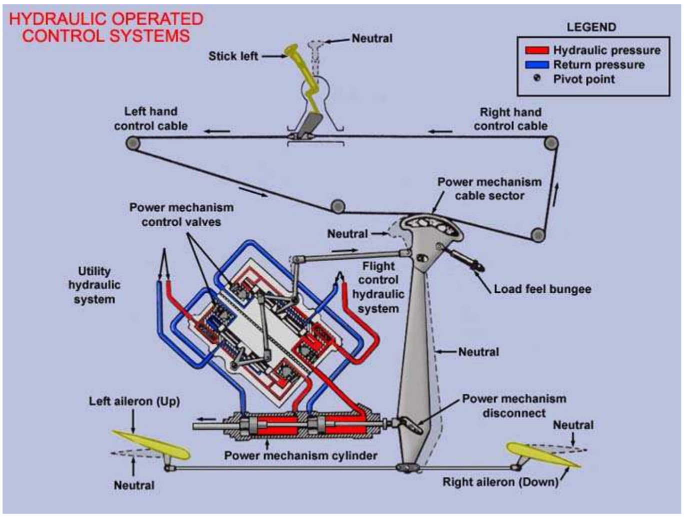
PRIMARY CONTROL SURFACE	AIRPLANE MOVEMENT	AXES OF ROTATION	TYPE OF STABILITY
Aileron	Roll	Longitudinal	Lateral
Elevator/ Stabilator	Pitch	Lateral	Longitudinal
Rudder	Yaw	Vertical	Directional

1.4.3 RUDDER BOOSTER ASSEMBLY.-The rudder booster assembly is a single tandem-type hydraulic actuating cylinder which furnishes most of the force to actuate the rudder. During normal operation, fluid supplied at approximately 3.000 PSI pressure is routed by solenoid-controlled, normally de-energized diverter valves through pressure reducer valves in each of the systems; and from there at a pressure of approximately 1.300 PSI, to the rudder booster assembly. This system pressure produces desirable characteristics of sensitivity and surface travel for normal in flight operation. Movement of the flap lever from the retracted (UP) position to approximately the 15% position or beyond will energize the solenoids of the diverter valves, actuating the valves in such a manner that the pressure reducers are bypassed thereby permitting supply fluid at approximately 3.000 PSI pressure to reach the booster assembly. This doubles the available actuating force and gives desirable characteristics of sensitivity and surface travel at low airspeeds such are encountered in take-off, landing, flight traffic patterns, troop drops, and cargo drops where flaps are used. The diverter valves are powered from the essential DC bus through the rudder high boost circuit breaker located on the copilot's lower circuit breaker panel.

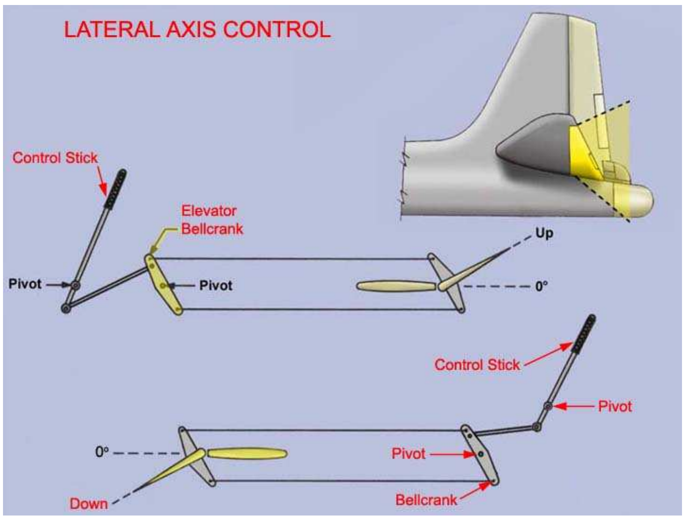
1.4.4 AILERON BOOSTER ASSEMBLY.-The aileron booster assembly is a single tandem-type hydraulic actuating cylinder which furnishes most of the force to actuate the ailerons.

During normal operation, the booster assembly is furnished fluid at approximately 3.000 PSI from both the booster and utility hydraulic systems.

During normal operation, the booster assembly is furnished fluid through pressure-reducers at approximately 2.050 PSI from both the booster and utility hydraulic systems.



1.4.5 ELEVATOR BOOSTER ASSEMBLY.-The elevator booster assembly has dual actuation cylinders connected to the booster assembly output power lever that operated the elevator control surfaces. The actuating cylinders operate simultaneously by 3.000 PSI pressure supplied by the booster and utility hydraulic systems, each of which power one actuating cylinder.



1.4.6 SURFACE CONTROL SYSTEM CONTROLS

Control Columns and Wheels

Control columns and wheels installed at the pilot's and copilot's stations to operate the aileron and elevator surface controls are of the conventional type. Mechanical linkage actuates the hydraulically powered booster unit control valves and servomotors for each of these surface controls. Pushrods (elevator) and a chain and cable arrangement (ailerons) connect the control column to bellcranks and torque tubes which are mounted under the flight station beneath the pilot's and copilot's seats. From there, dual sets of steel cables continue the elevator linkage as far as the pressure bulkhead at the extreme rear of the cargo compartment and the aileron linkage to the rear face of the center section wing rear beam web. From these points pushrods and bellcranks pick up the motion and transmit it to the booster unit control valves and servo units.

Control Wheels

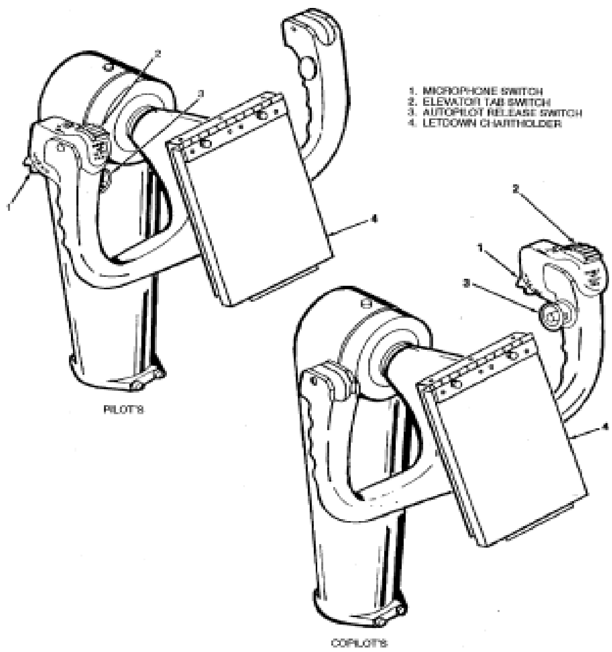


Figure 1-53.

Surface Control System

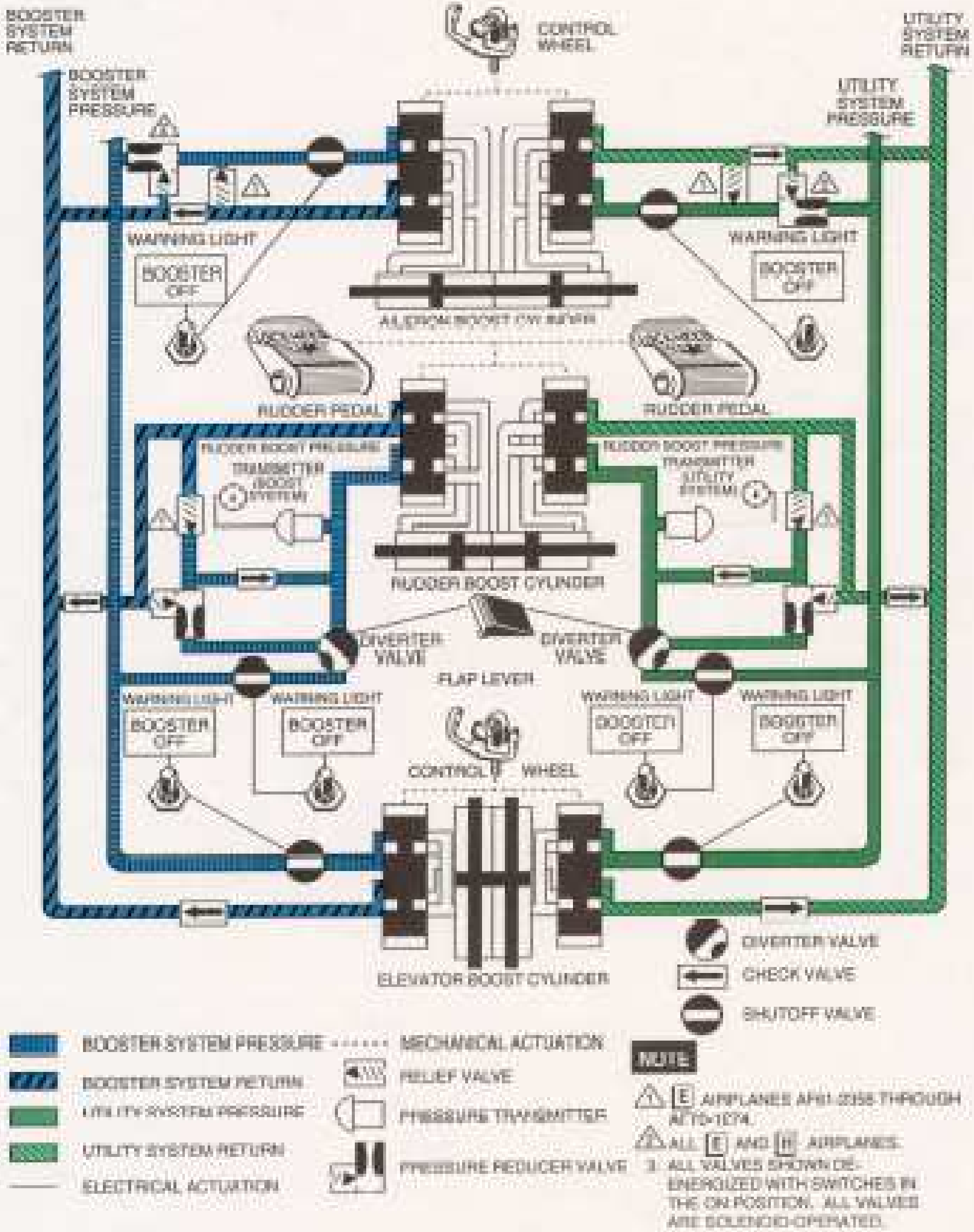


Figure 1-53.

Rudder Pedals and Adjustment Levers.

Rudder pedals are of the conventional type. Each pair of rudder pedals can be adjusted individually by unlocking the rudder adjustment lever and pushing or releasing the spring loaded pedals to the desired position. The rudder pedals are used to operate the rudder booster when hydraulic power is available, and to operate the rudder manually when hydraulic power is not available. Toe pressure on the rudder pedals actuates the brake during either normal or emergency braking.

Control Boost Switches and Warning Lights.

28V	ESS DC	CP LOWER

(SHUTOFF VALVES)
BOOST AND UT (ELEVATOR)
BOOST AND UT (RUDDER)
BOOST AND UT (AILERON)

1.4.7 TRIM TAB CONTROL SYSTEMS.-Trim tabs are provided on the control surfaces to aid the trimming the airplane during flight. Lateral trim is obtained through operation of a trim tab on the left aileron. A ground adjustable tab is located on the right aileron to compensate for any Inherent unbalance about the longitudinal axis of the airplane. Nose-up and nose-down trim is obtained through operation of the trim tabs on the elevators, one trim tab on each elevator control surface. Minor directional control for yaw conditions is obtained by operation of the rudder trim tab. The elevator trim tab normal system is inoperative for manual control when the autopilot is engaged. The autopilot elevator servo will function only when the elevator tab switch is placed in the NORMAL position. All trim tab actuators are driven by 115-volt, single-phase, AC motors, except during emergency operation when the elevator trim tab actuator is driven by a 28-vol DC motor.

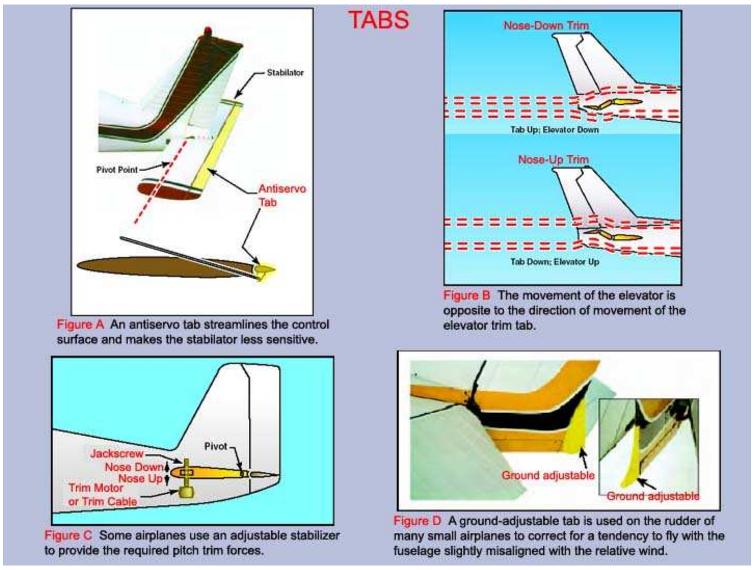


Figure A An antiservo tab streamlines the control surface and makes the stabilator less sensitive.

Figure B The movement of the elevator is opposite to the direction of movement of the elevator trim tab.

Figure C Some airplanes use an adjustable stabilizer to provide the required pitch trim forces.

Figure D A ground-adjustable tab is used on the rudder of many small airplanes to correct for a tendency to fly with the fuselage slightly misaligned with the relative wind.

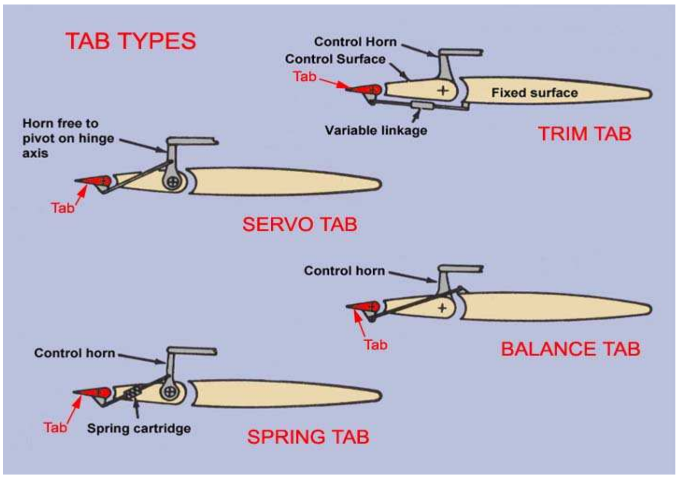
Trim Tab Systems Controls.

Trim tab controls consist of switches for control of the tab actuators and a power selector switch to select emergency operation of the elevator tabs.

AILERON AND ELEVATOR TRIM TAB SWITCH.

28V	ESS DC	CP LOWER
AILERON TAB CONTROL		
115V 10	ESS AC	P SIDE
AILERON (TRIM TAB)		

An aileron and elevator trim tab switches is located on the trim tab control panel of the flight control pedestal. It is a recessed, five-position (NOSE UP, NOSE DOWN, OFF, LOWER LEFT WING, LOWER RIGHT WING) toggle switch, with all switch positions other than the OFF (center) position upon release of the switch. When the switch is held in the LOWER LEFT WING or LOWER RIGHT WING position, the trim tab on the left aileron control surface is actuated by a tab motor to trim the airplane laterally. When the switch is held in the NOSE UP or NOSE DOWN position, the elevator trim tabs are actuated by a tab motor to drive the tabs down or up. When the switch is in the OFF (center) position, the electric motors that actuate the trim tabs are de-energized.



1.4.8 ELEVATOR TAB SWITCHES.-An elevator trim tab switch is located on the outboard hand grip of each control wheel. It is a slide-type switch with NOSE UP, NOSE DOWN and center OFF positions. These two switches are connected in parallel, and either one of the switches can control the tabs. A runaway tab condition may be corrected by opposite movement of the other switch. When either of the switches is in the NOSE UP or NOSE DOWN position, a pair of dual relays is actuated to apply power to the elevator trim tab actuator. With the elevator tab power selector switch positioned to NORMAL, the elevator tabs can only be operated from the trim tab switch on the pilot's and copilot's control wheels. With the elevator tab power selector switch in NORMAL, 115 volt AC power is applied to the actuator. The elevator trim tab switches on the controls wheels are inoperative when the elevator tab power selector switch is placed to the EMER or OFF position.

SECONDARY FLIGHT CONTROLS

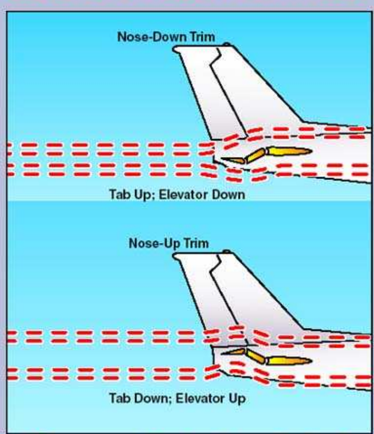


Fig. A The movement of the elevator is opposite to the direction of movement of the elevator trim tab.

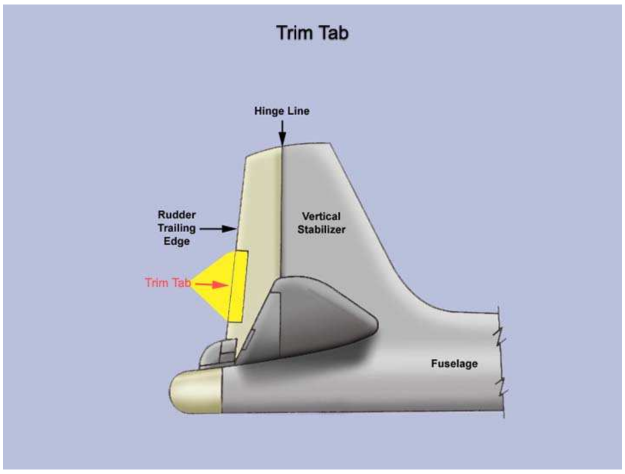
ELEVATOR TAB POWER SELECTOR SWITCH

28V ESS DC CP LOWER
ELEVATOR TRIM TAB CONTROL
ELEVATOR EMER TAB CONTROL
ELEVATOR EMER POWER
115 10 ESS AC P SIDE

An elevator tab power selector switch is located on the flight control pedestal. It is a three-position (NORMAL, OFF, EMER) toggle switch used to select the source of electrical power for operation of the elevator trim tabs. When the switch is in the NORMAL position, 115-volt AC power is supplied to a trim tab actuating motor relay for autopilot or control wheel handgrip switches operation of the elevator trim tabs. In the NORMAL position, the elevator trim tabs can be controlled only for the control wheels. When in the EMER position, the elevator trim tabs can be controlled only for the elevator trim tab switch located on the pedestal. During emergency operation, 28-volt DC power is supplied for the essential DC bus to a trim tab actuating motor that will drive the elevator trim tabs either up or down when the respective elevator trim tab control relay is energized by actuation of the trim tab control switch on the pedestal. When the elevator tab power selector switch is in the NORMAL/EMERGENCY position, the elevator trim tab control relays are powered by 28-volt DC, from the essential DC bus. When the elevator tab power selector switch is placed in the OFF position, all circuits to the elevator trim tabs are de-energized.

RUDDER TRIM TAB SWITCH

115V 10 ESS AC P SIDE
RUDDER (TRIM TAB)



A rudder trim tab switch is located on the trim tab control panel of the flight control pedestal. It is a three-position (NOSE LEFT, OFF, NOSE RIGHT) switch that controls operation of the rudder trim tab motor. The NOSE LEFT and NOSE positions are spring-loaded to return of the control switch. When the switch is in NOSE LEFT or NOSE RIGHT position, 115-volt AC power from the essential AC bus energized the rudder trim tab motor to position the rudder trim tab and trim the airplane.

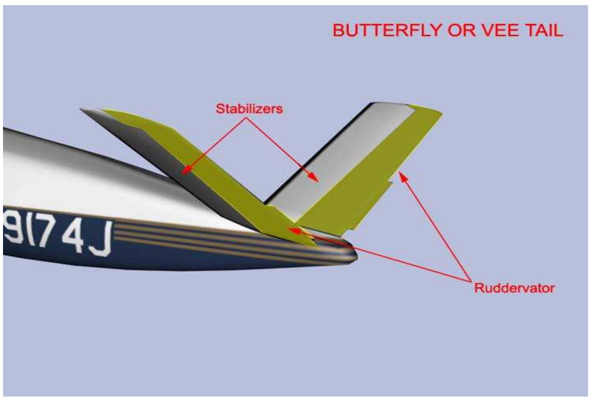
AILERON TRIM TAB POSITION INDICATOR

28 V MAIN DC AFT FUSELAGE
TABS AND FLAPS POSITION INDICATORS

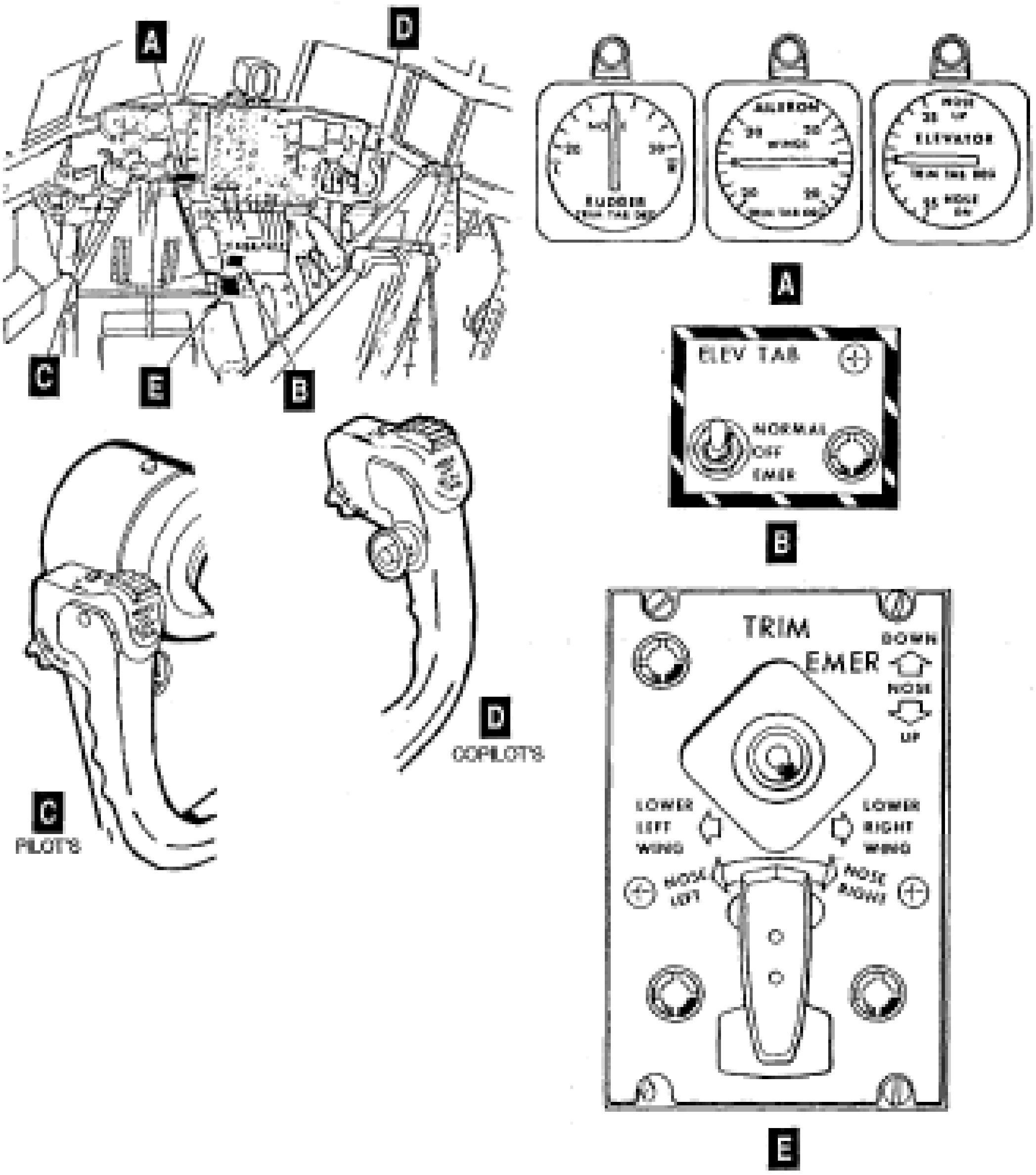
An aileron trim tab position indicator is located on the pilot's instrument panel. This indicator is connected to a transmitter mounted on the left aileron trim tab actuator and indicated to the pilot the degree of left aileron trim tab positioning relative to the aileron control surface. The indicator dial face is calibrated from the neutral position of 0 to 20 up and 0 to 20 down in 5-degree increments of left aileron trim tab travel. The needle on the indicator shows the exact angle between the aileron trim tab and the left aileron surface and the direction in which the trim will act.

ELEVATOR TRIM TAB POSITION INDICATOR

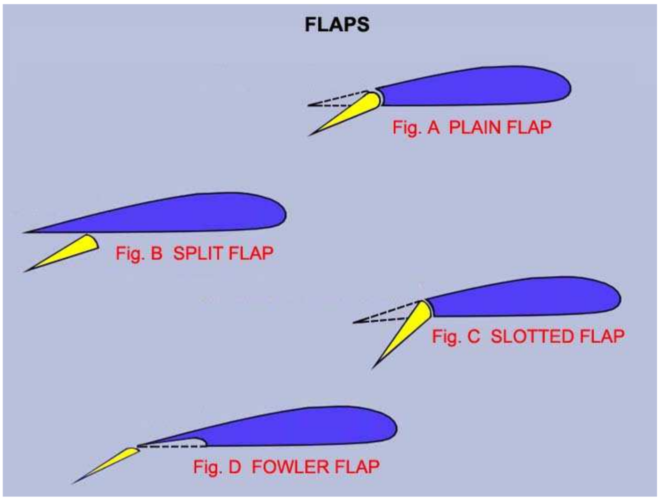
28V MAIN DC AFT FUSELAGE
TABS AND FLAPS POSITION INDICATORS
An elevator trim tab position indicator is located on the pilot's instrument panel. The indicator is connected to a transmitter mounted on the elevator trim tab rotary actuator housing and indicates to the pilot the degree of elevator trim tab positioning relative to the elevator control surface. The indicator dial face is calibrated from the neural position 0 to 25 up or down; in 5 degree increments of elevator trim travel.



Trim Tab System Controls and Indicators



1.4.9 FLAP SYSTEM.-The airplane is equipped with four flaps, consisting of an outboard and an inboard flap in each wing. The flaps are of the Lockheed-Fowler, high-lift type in which the flap motion is a combination of an aft movement to increase wing area and a downward tilting movement to alter the airfoil section to increase lift and drag. The time required for full extension of the flaps is between 8 and 15 seconds and full retraction time is between 10 and 15 seconds. When 100 percent extended, the flaps form an angle of approximately 35 degree with the wings. The flaps are operated by a reversible hydraulic motor, a cam-actuated microswitch follow-up mechanism, torque tubes, gearbox, and drive screw assemblies. Hydraulic ´pressure is directed through a check valve to the emergency flap brake valve, and the wing flap selector valve, where pressure is directed to the up or down system. The hydraulic motor operates the torque shaft selection extending outboard to the gearbox, which rotates ball bearing drive screws for actuation of the flaps. The flaps may be operated manually with a handcrank. A disk-type, spring-loaded flap brake holds the flaps in the selected position and prevents movements by aerodynamic loads. The brake is released by fluid pressure supplied to the system for operation of the flap drive motor. Emergency flap brakes are splined to the outer ends of the flap drive torque shaft to prevent unequal actuation of the flaps during normal extension and retraction of the flaps. Utility hydraulic system pressure is used for operation of the system (See figure 1-65.)



1.4.10 FLAP SYSTEM CONTROLS.-Flap system controls are provided for normal operation of the flaps. Provisions exist for manual operation of the flaps if the normal operating system fails to function.

A flaps lever is located on the aft end of the flight control pedestal. (See figure 1-7.) It is a manually actuated control lever with the lever range calibrated from UP to DOWN in increments of 10 percent. There is a detent at approximately the 50 percent position but the detent at approximately the 50 percent position but the flaps can be extended to any desired position by placing the lever at the selected percent of flap extension. The lever is attached by cables to a movable cam inside a flap control unit mounted on the center wing rear beam in the cargo compartment. Movement of this cam closes limit switches that complete a DC control circuit for the wing flap selector valve. The actuated valve directs a flow of hydraulic fluid to drive the flap motor in the selected direction. A rudder pressure diverter valve, electrically actuated by a switch on the flap control lever mechanism, controls the pressure available for operation of the rudder. Pressure available for rudder operation at flap settings from 0 to 15 percent is approximately 1,300 PSI as compared to approximately 3,000 PSI for flap setting from 15 to 100 percent. The pressure control system is provided to prevent excessive air loads at high speeds. When the selected position of the flap is reached, the limit switches open, the selector valve shuts off hydraulic flow, and a spring- loaded hydraulic brake locks the flaps in the selected position.

NOTE

The ground collision avoidance system (GCAS) is interconnected with the flap system. A switch is located on the flap control lever mechanism, at the 50 percent flap setting, to signal the GCAS computer whenever the airspeed/ altitude and flap setting are not commensurate to a take- off/ landing configuration. The 50 percent flap switch may be inhibited by placing the GCAS flap override switch to the OVRD position.

NOTE

The landing gear warning horn is interconnected with the system. When the flaps lever is set at approximately 70 percent or more with the landing gear in any position other than down and locked, the landing gear warning horn will sound; it cannot be silenced until the landing gear is down and locked or the flaps lever is retracted above 70 percent.

NOTE

The ground collision avoidance system (GCAS) (if installed) is interconnected with the flap system. The flap position transmitter provides signals to the GCAS computer.

The GCAS computer provides an aural warning when the airspeed/altitude and flap setting are not commensurate to a landing or takeoff configuration. The flap aural warning may be inhibited by momentarily pressing the flap switch on either ground collision avoidance enunciator panel to select OVERRIDE. Mode 9 cannot be overridden by the switch.

Flaps Lever Friction Knob

A flaps lever friction knob is located on the flap control quadrant. (See figure 1-7.) Turning the knob clockwise mechanically tightens the friction on the flap cables, preventing the flap lever from vibrating out of its set position.

Wing Flap Selector Valve

Awing flap selector valve (figure 3-5) is mounted on the utility hydraulic panel, forward of the left- hand wheel well. It is a solenoid- operated valve, directing the flow of utility hydraulic fluid to either the up or down side of the flap motor for normal rising and lowering of the flaps, depending on the position of the flaps lever. Override controls, consisting of two buttons marked RAISE and LOWER, are located on the selector valve for use in case of electrical failure. Pushing the button marked LOWER routes hydraulic fluid to release the flap brakes and to the gearbox drive motor to lower the flaps. Pushing the button marked RAISE routes hydraulic fluid to release the brakes and to the gearbox drive motor to raise the flaps.

Manual Operation

An emergency method of operating the flaps mechanically is provided by an extension stub shaft connected through a universal joint to the torque shaft that drives the flap screwjacks. An emergency engaging handle shifts between the hydraulic and manual drive. The extension stub shaft and the handcrank are located on the forward wall of the left- hand main landing wheel well.

Flap Position Indicator

A flap position indicator is located on the copilot's instrument panel. (See figures 1- 84 and1- 85.) The indicator is connected to a transmitter that is mounted on the flap drive control unit located on the aft face of the center wing rear beam. The indicator dial is calibrated from UP to DOWN in increments of 10 percent.

1.4.11 FLAPS ASYMMETRICAL CONTROL SYSTEM.-The flaps asymmetrical control system is designed to sense certain malfunctions in the flap drive system and actuate the emergency flap brakes to stop any further movement of the flaps.

Asymmetrical Sensing Switches

There are two asymmetrical sensing switches, one at each of the outboard flap drive gearboxes. It a torque tube in the system breaks or a coupling comes apart, the switches sense the resulting out- of- phase condition. When this occurs, DC power is routed by the switches to the emergency flap brake valve to lock the flap brakes.

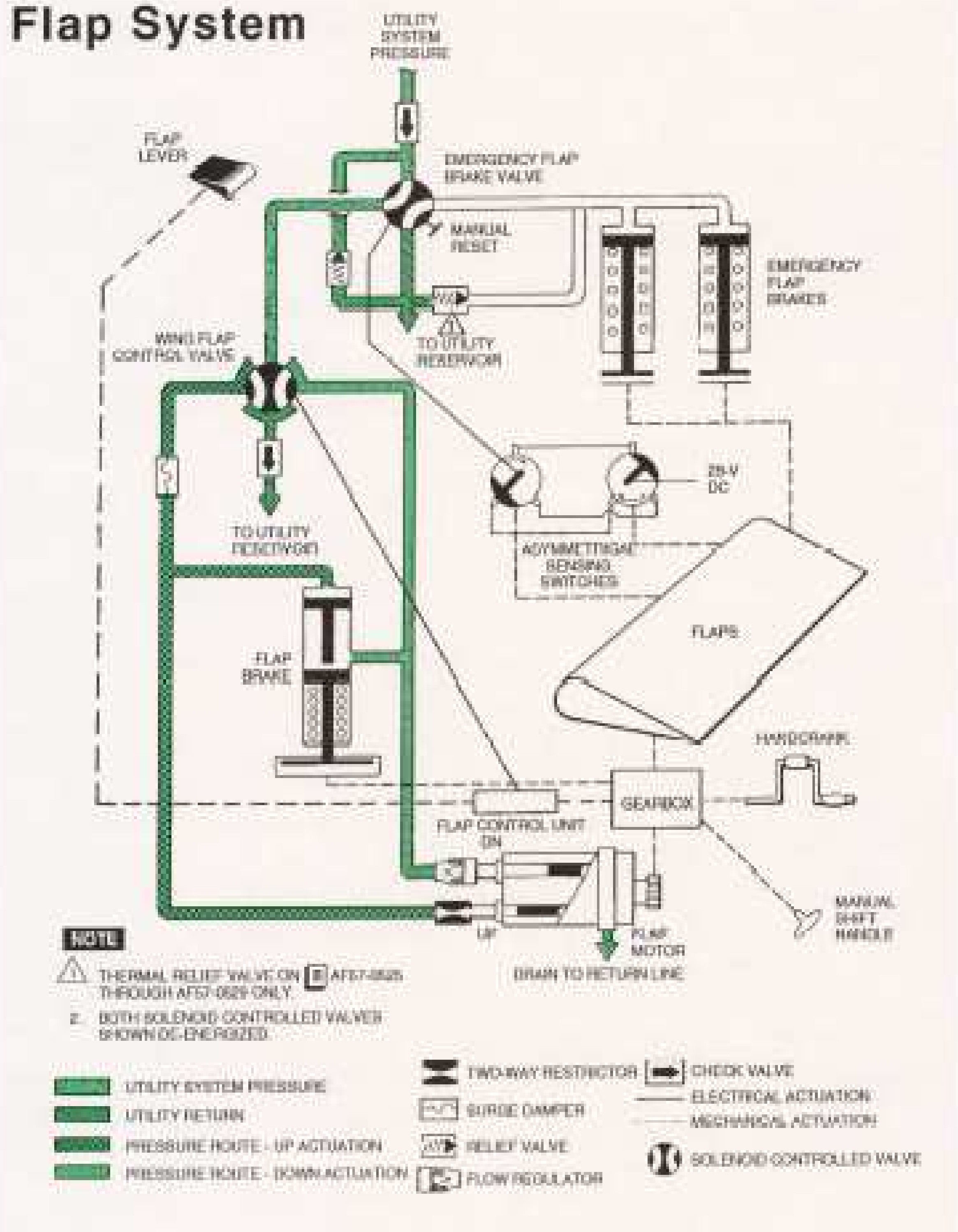
Emergency Flap Brake Valve

The emergency flap brake valve is a solenoid- operated hydraulic valve, located on the utility hydraulic panel.
In its deenergized position, hydraulic pressure passes through it to the flap selector valve. When energized by the asymmetrical sensing switches, the valve routes hydraulic fluid pressure to the emergency flap brakes and closes off pressure to the flap selector valve. The valve is equipped with a manual override. When locked by the emergency flap brakes, the flaps cannot be raised or lowered by any means until the manual reset lever is pressed. The manual reset lever resets the emergency flap brake valve and releases the emergency flap brakes.
The manual reset lever is for ground use only.

Emergency Flap Brakes

There are two emergency flap brakes, one located at each of the outboard flap drive gear- boxes. The emergency flap brakes are spring- loaded released and hydraulically applied by pressure supplied through the emergency flap brake valve. When actuated, the brakes lock the flaps, preventing any further movement of the flaps. The brakes are released by operating the emergency flap brake valve manual reset lever.

Flap System



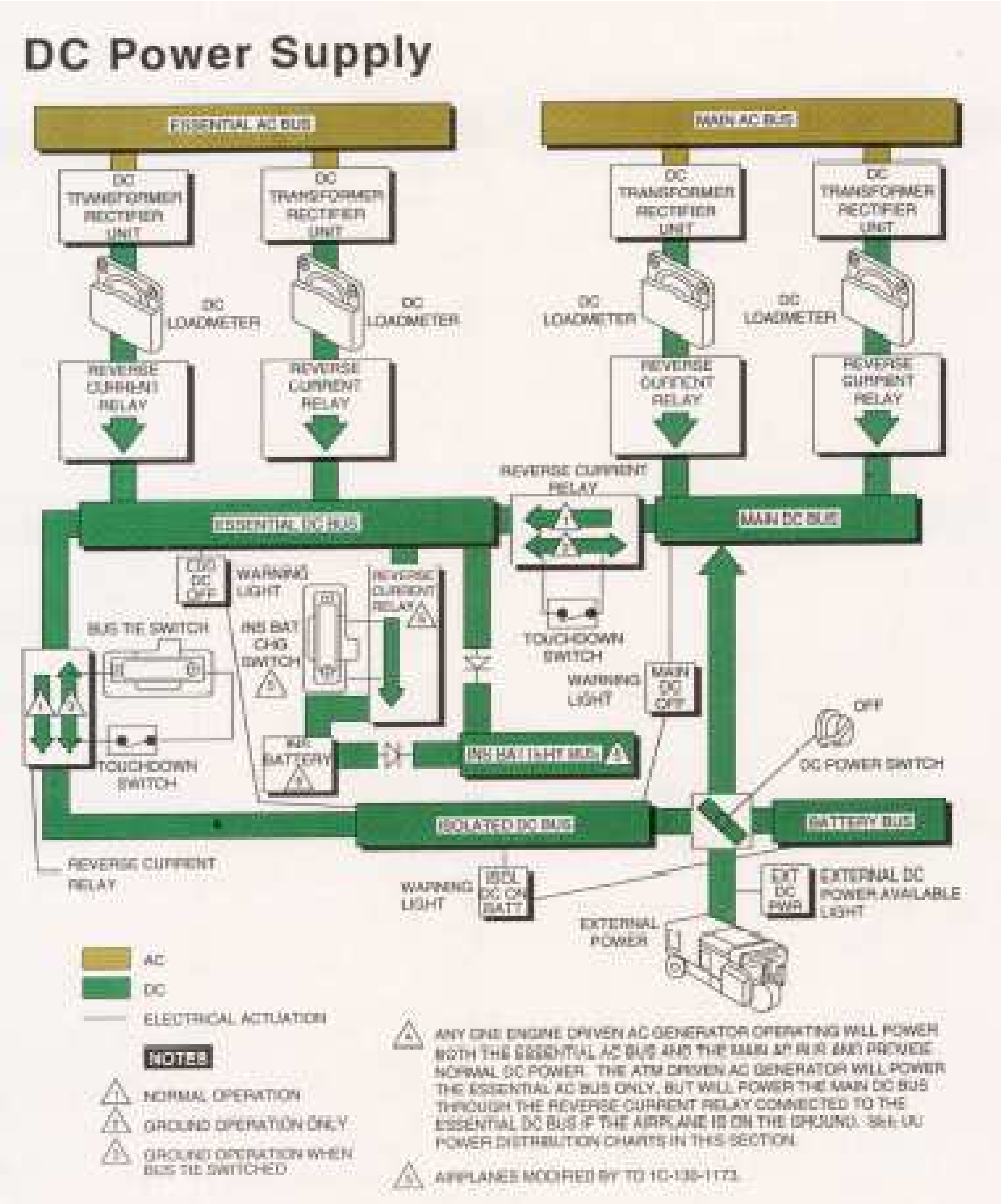
UTILITY SYSTEM PRESSURE
FLAP LEVER
EMERGENCY FLAP BRAKE VALVE
MANUAL RESET
EMERGENCY FLAP BRAKES
TO UTILITY RESERVOIR
WING FLAP CONTROL VALVE
28-V DC
TO UTILITY RESERVOIR
ASYMMETRICAL SENSING SWITCHES
FLAPS
FLAP BRAKE
HANDCRANK
GEARBOX
FLAP CONTROL UNIT
DN
UP
FLAP MOTOR
DRAIN TO RETURN LINE
MANUAL SHIFT HANDLE
NOTE
1. THERMAL RELIEF VALVE ON AF57-0525 THROUGH AF57-0529 ONLY.
2. BOTH SOLENOID CONTROLLED VALVES SHOWN DE-ENERGIZED.
UTILITY SYSTEM PRESSURE
UTILITY RETURN
PRESSURE ROUTE - UP ACTUATION
PRESSURE ROUTE - DOWN ACTUATION
TWO-WAY RESTRICTOR
SURGE DAMPER
RELIEF VALVE
FLOW REGULATOR
CHECK VALVE
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
SOLENOID CONTROLLED VALVE

1.5 ELECTRICAL SYSTEM

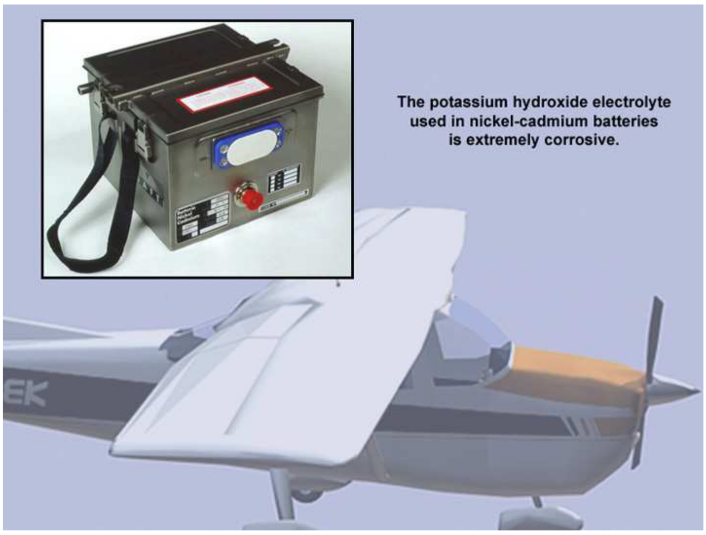
All internal electrical power for airplane use comes basically from five AC generators or from the battery. Each of the engines and the auxiliary power unit (APU) drive one 40-KVA, AC generator. Power from these AC generators is used to provide electrical power for airplane use: 28-vol DC; 200/115-vol, 400-Hz, three-phase primary AC; and 115-vol, 400-Hz, single-phase, secondary and primary AC. The four engine-driven AC generators are connected through transfer contactors (relays) to four AC buses: the left-hand AC bus, the essential AC bus, the main AC bus, and the right-hand AC bus. On airplane modified by TO 1C-130-1339 prior to TO 1C-130-1821, the four engine-driven AC generators supply (unregulated) power to four AC buses and to two avionics AC buses (essential avionics AC bus and main avionics AC bus) through two Bus Switching Systems. The avionics AC buses supply (regulated) AC power to selected avionics systems. The transfer system operates in such a manner that any combination of two or more of the engine-driven AC generators will power all four of the buses. If only one generator is operating, it will power the essential AC bus and the main AC bus.

1.5.1 DC POWER SYSTEM.-There are four buses in the DC power system: the main bus, the essential bus, the isolated bus, and the battery bus. The main and essential buses are connected through a reverse-current relay, which in flight allows current to flow from the main bus to the essential bus, but limits current flow in the opposite direction. When the airplane is on the ground, a touch down switch is actuated to complete a circuit which overrides the current limiting features of the reverse-current relay and permits current flow in either direction between the main and essential buses. The essential and isolated buses are similarly connected through another reverse-current relay which limits current flow from the isolated bus to the essential bus in flight. When the airplane is on the ground, the touch-down switch completes a circuit so than manual positioning of the DC bus tie switch overrides the current limiting features of the reverse-current rely and permits current flow in either direction between the isolated and essential buses.

1.5.2 AIRPLANE BATTERY.-A 24-volt, 21 (at 1-hour discharge rate) or 36 (at 5-hour discharge rate) ampere-hour battery is locate in a fuselage compartment forward of the crew entrance door. The battery supplies power to the battery bus and to the isolated bus. A reverse current cutout is connected between the isolated bus and the essential and the main DC buses. It normally prevents the battery from powering equipment connected to the essential and main DC buses and permits power from the essential and main DC buses to the used to power equipment connected to the isolated bus, and to charge the battery. During APU starting, the battery powers the APU starter and control circuits through the APU CONTROL circuit breaker on the pilot's side circuit breaker panel.



1.5.3 IN BATTERY.-A second 24-vol battery is installed inboard of the airplane battery. This INS battery supplies backup power to the INS battery bus when the voltage on the essential DC bus falls below that of the INS battery. The INS battery is also connected to the essential DC bus through a reverse current relay used for battery charging. When the INS battery charge switch, located on the overhead control panel, is in the ON position, the reverse current relay is energized allowing current to flow from the essential DC bus to the battery and charge the battery.



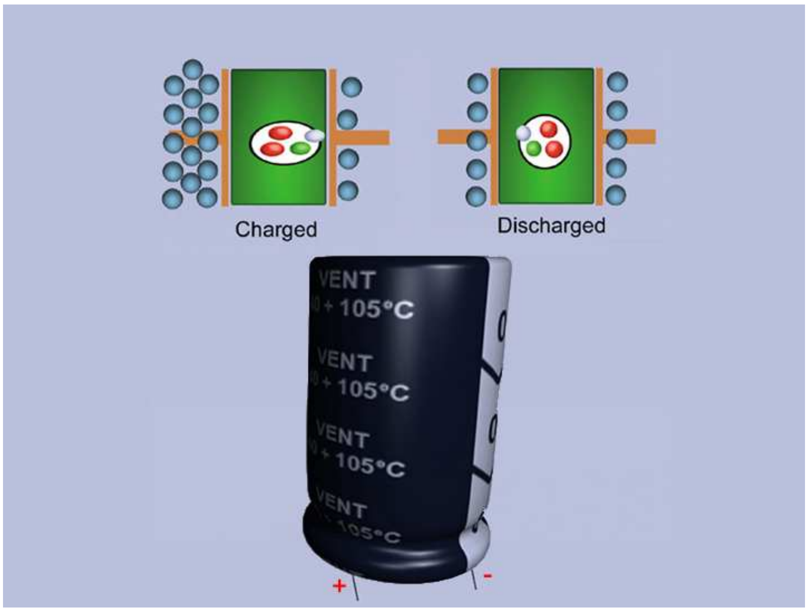
DC SYSTEMS CONTROLS

Dc bus tie switch. The DC bus tie is a two-position toggle switch which functions in conjunction with the touchdown switch. When the airplane is on the ground, the DC bus tie switch can connect the isolated DC bus and the essential DC bus for current flow in either direction. This allows battery power to feed all DC buses and circuits when the DC power switch is in the BAT position.

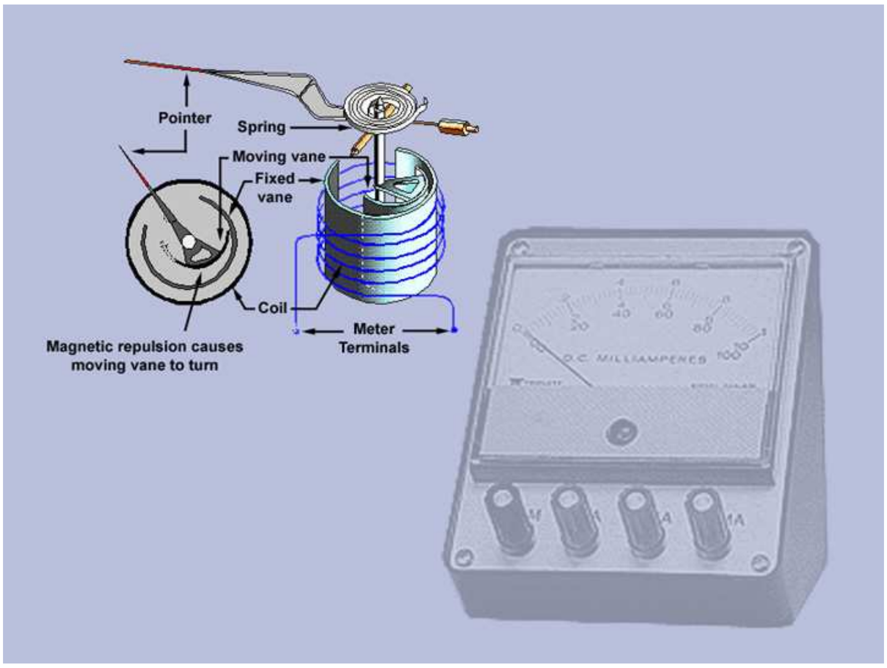
Dc power switch. The DC power switch is a Three-position, rotary-type switch. When the switch is in the EXT DC PWR position, the external power relays will close, when external power is applied in the correct polarity, to connect the external receptacle to the main DC bus. When the switch is in the BAT position, the battery relay is closed and the battery is connected to the isolated bus. This position on the switch permits power to flow from the main DC bus or the essential DC bus through the reverse current relay to the isolated bus to the charge the battery.

Dc system indicators. The DC system indicators are all located on the overhead electrical control panel and include four loadmeters, two bus off indicators, an isolated DC bus on battery indicators light on H1 airplanes, a battery discharge indicator on H2 airplanes, an external DC power available light, and a voltmeter with a bus selector switch.

1.5.4 BATTERY DISCHARGE INDICATOR LIGHT.-The BAT DISCH indicator light gives a visual indication that the isolated DC bus has become disconnected from the essential DC bus and is being powered by the battery only. The BAT DISCH indicator light is controlled only by the indicator circuit of the reverse current relay which connects the isolated DC bus to the essential DC bus.

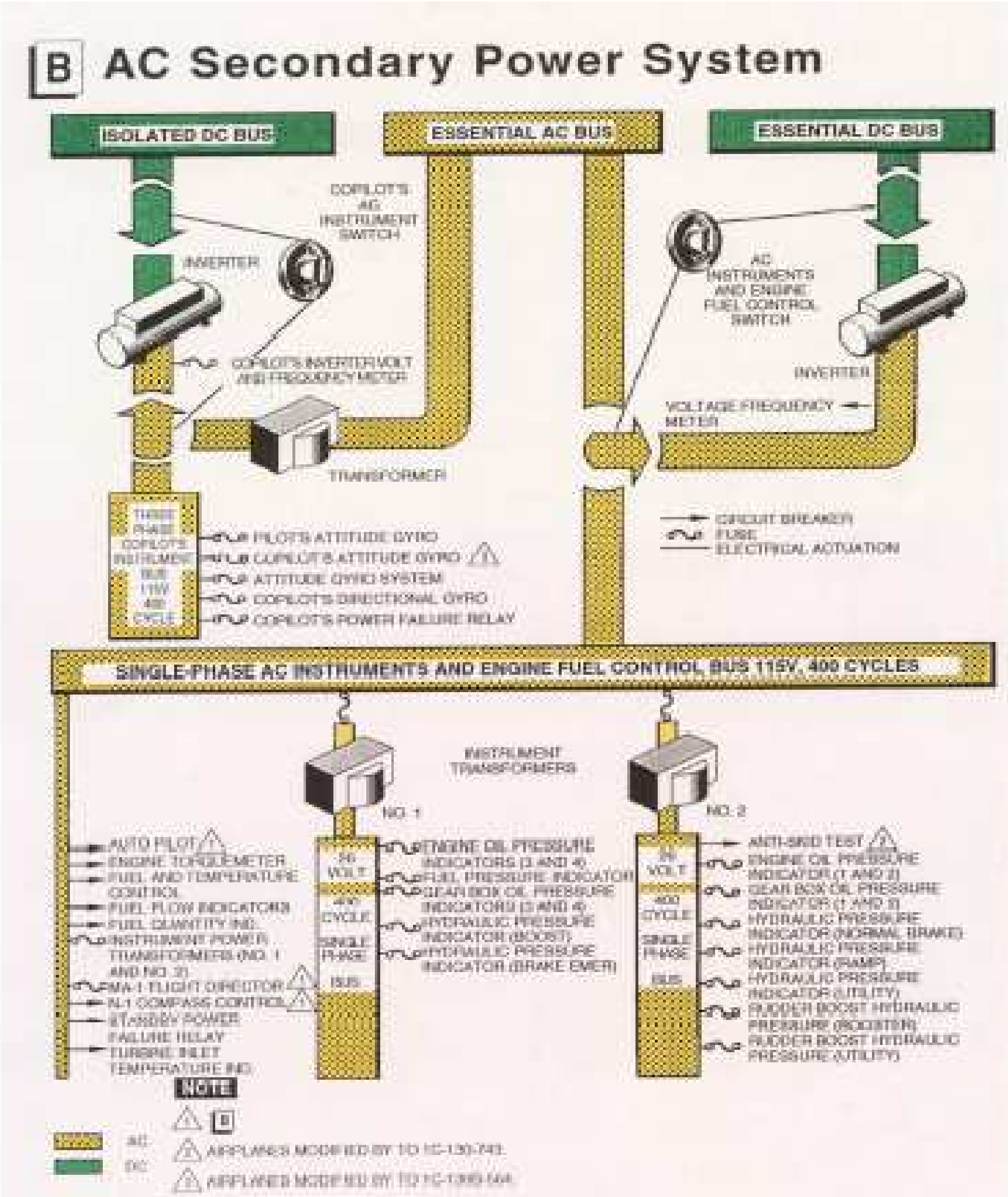


1.5.5 VOLTMETER AND BUS SELECTOR SWITCH.-The DC voltmeter located on the overhead electrical control panel is used to check airplanes/INS battery and DC bus voltages. Selection of the various battery/bus voltage indications is by means of the voltmeter switch adjacent to the voltmeter. The selector switch positions are: ESSENTIAL DC BUS, MAIN DC BUS, BAT (battery bus), INS BAT, and INS BAT BUS (INS battery bus).



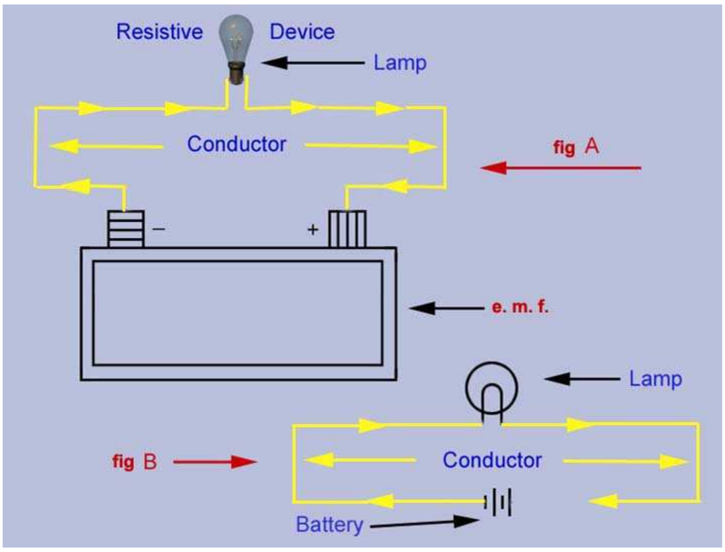
1.5.6 EXTERNAL DC POWER INDICATOR.-The EXT DC PWR press-to-test light illuminates when external DC power is connected to the external DC power receptacle in the correct polarity.

1.5.7 SECONDARY AC SYSTEM.-A 250-volt ampere inverter supplies 115-volt, 400-Hz, and three-phase power. The inverter draws DC power from the isolated bus; therefore, it can be operated from the battery during emergency conditions of flight. During normal operation power is supplied from the essential AC bus through a power transformer which converts three-phases, 115-volt, and 400-Hz power to operate the pilot's and copilot's AC Instruments.



B AC Secondary Power System
ISOLATED DC BUS
ESSENTIAL AC BUS
ESSENTIAL DC BUS
COPILOT'S AC INSTRUMENT SWITCH
INVERTER
COPILOT'S INVERTER VOLT AND FREQUENCY METER
TRANSFORMER
AC INSTRUMENTS AND ENGINE FUEL CONTROL SWITCH
INVERTER
VOLTAGE FREQUENCY METER
CIRCUIT BREAKER
FUSE
ELECTRICAL ACTUATION
PILOT'S ATTITUDE GYRO
COPILOT'S ATTITUDE GYRO
ATTITUDE GYRO SYSTEM
COPILOT'S DIRECTIONAL GYRO
COPILOT'S POWER FAILURE RELAY
SINGLE-PHASE AC INSTRUMENTS AND ENGINE FUEL CONTROL BUS 115V, 400 CYCLES
INSTRUMENT TRANSFORMERS
NO. 1
NO. 2
AUTO PILOT
ENGINE TORQUEMETER
FUEL AND TEMPERATURE CONTROL
FUEL FLOW INDICATORS
FUEL QUANTITY IND.
INSTRUMENT POWER TRANSFORMERS (NO. 1 AND NO. 2)
MA-1 FLIGHT DIRECTOR
N-1 COMPASS CONTROL
STANDBY POWER FAILURE RELAY
TURBINE INLET TEMPERATURE IND.
ENGINE OIL PRESSURE INDICATORS (3 AND 4)
FUEL PRESSURE INDICATOR
GEAR BOX OIL PRESSURE INDICATORS (3 AND 4)
HYDRAULIC PRESSURE INDICATOR (BOOST)
HYDRAULIC PRESSURE INDICATOR (BRAKE EMER)
ANTI-SKID TEST
ENGINE OIL PRESSURE INDICATOR (1 AND 2)
GEAR BOX OIL PRESSURE INDICATOR (1 AND 2)
HYDRAULIC PRESSURE INDICATOR (NORMAL BRAKE)
HYDRAULIC PRESSURE INDICATOR (RAMP)
HYDRAULIC PRESSURE INDICATOR (UTILITY)
RUDDER BOOST HYDRAULIC PRESSURE (BOOSTER)
RUDDER BOOST HYDRAULIC PRESSURE (UTILITY)
NOTE
AC
DC

1.5.8 PRIMARY AC SYSTEM.-Power for the primary AC system is supplied by five AC generators. This power supply is also used to operate the secondary AC systems and the DC system.

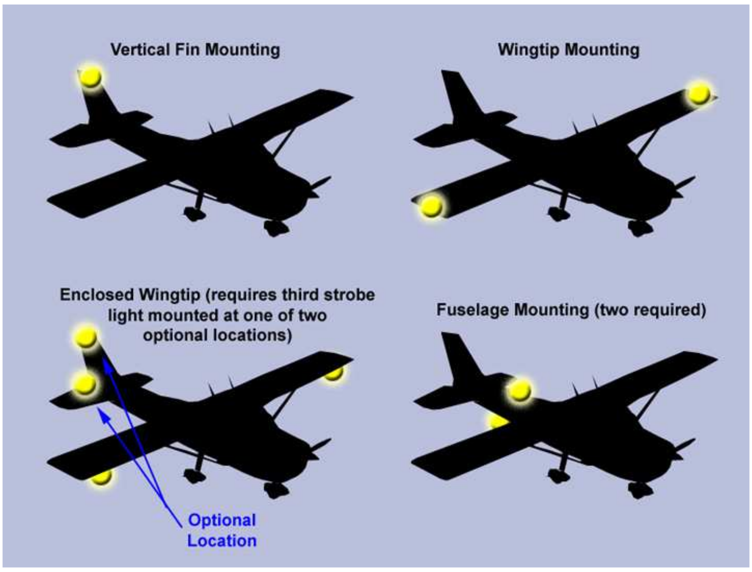


Primary AC System Controls
The AC system controls are located on the overhead electrical control panel in the flight station. The generator control units are located in racks under the flight station and are accessible from the cargo compartment.

1.5.9 GENERATOR CONTROL UNITS.-A generator control unit (GCU) is mounted on the electrical control and supply rack. The GCU replaces the voltage regulator, generator control panel, and frequency-sensitive relay. The GCU has the capability of identifying and regulating either Bendix or Leland generators, eliminating the requirement to match generator and GCU. Each GCU provide system monitoring of the generator output and controls the contactors which tie the generators to the airplane buses. The GCU provides overvoltage, undervoltage, overfrequency, underfrequency, and feeder fault protection. If any of the monitored parameters of a generator are outside the specific limits, the generator contactor is deenergized.

1.5.10 AC EXTERNAL POWER SWITCH.-A two position, AC power switch is located immediately below the No. 1 generator loadmeter on the overhead electrical control panel. The OFF position of the switch disconnects external power from the AC distribution. The EXT AC PWR position (stripe on knob aligned with the stripe on panel) connects external power to the AC distribution system.

1.5.11 LIGHTING SYSTEM.-The lighting system is composed of exterior and interior groups of lights and their controls. Receptacles are also provided on the sides of the pilot's and copilot's side shelves for connecting a signal lamp. The pilot's and copilot's instrument lights and the engine instrument lights operate on AC power and all others operate on DC power.

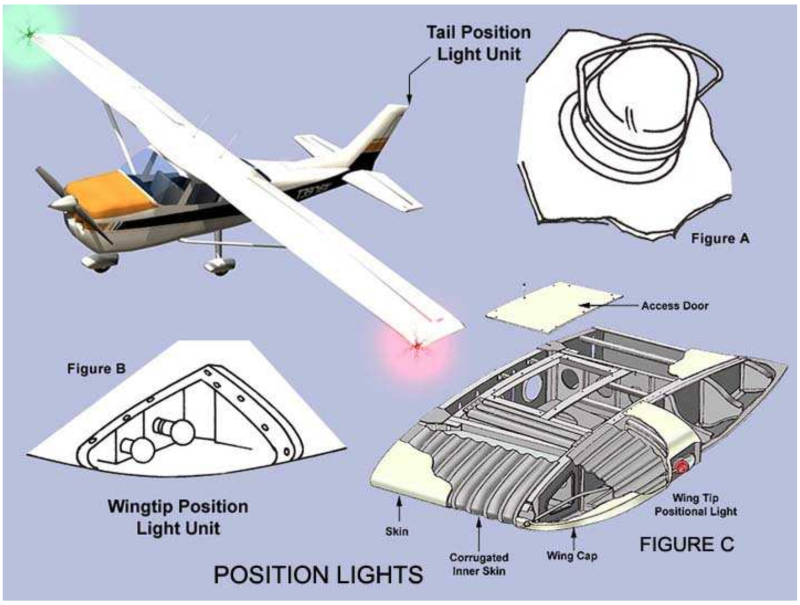


1.5.12 EXTERIOR LIGHTS

Warning. Never intentionally stare into an infrared light source. Personnel within 10 feet of an operating infrared light source should not look into the light without safety glasses/goggles with clear plastic lens. The lens should have an optical density of greater than 0.5. This should be sufficient protection from accidental exposure.

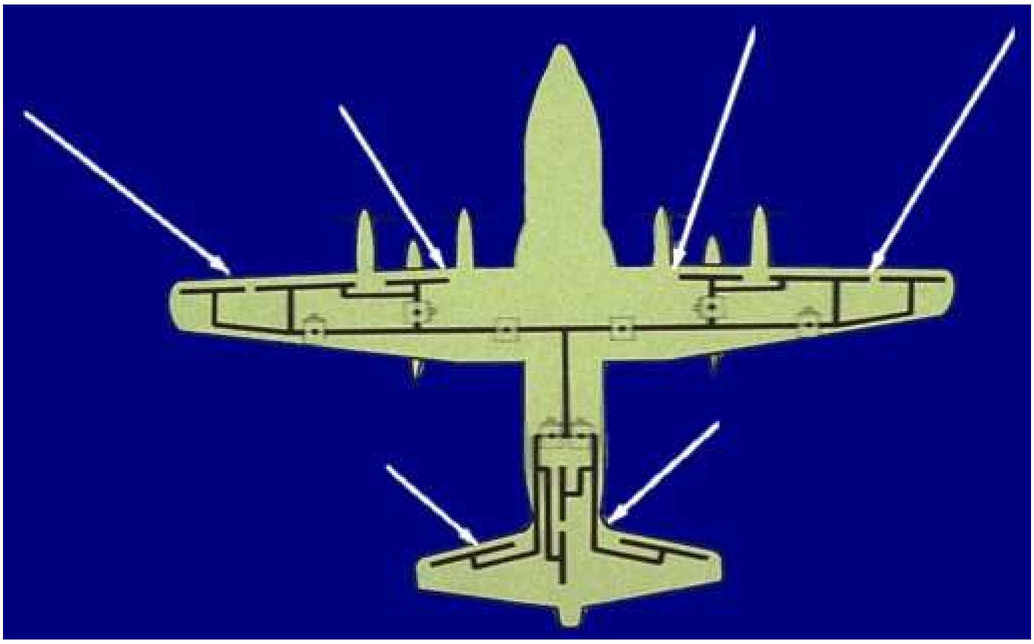
Exterior lights consist of the following.

a. One landing light on the undersurface of each wing.
b. One taxi light on each main landing gear door.
c. One taxi light on each wing tip.
d. Nine formation lights
e. Six navigator lights
f. One leading edge light on each side of the forward fuselage.
g. Two anti-collision/strobe lights.



1.5.13 INTERIOR LIGHTING.-Interior lighting consists of flight station and cargo compartment lighting. The various types of lighting, locations of light controls, power sources and locations of circuit breakers for the light circuits are listed and locations of lighting control panels

ANTY ICE SYSTEM



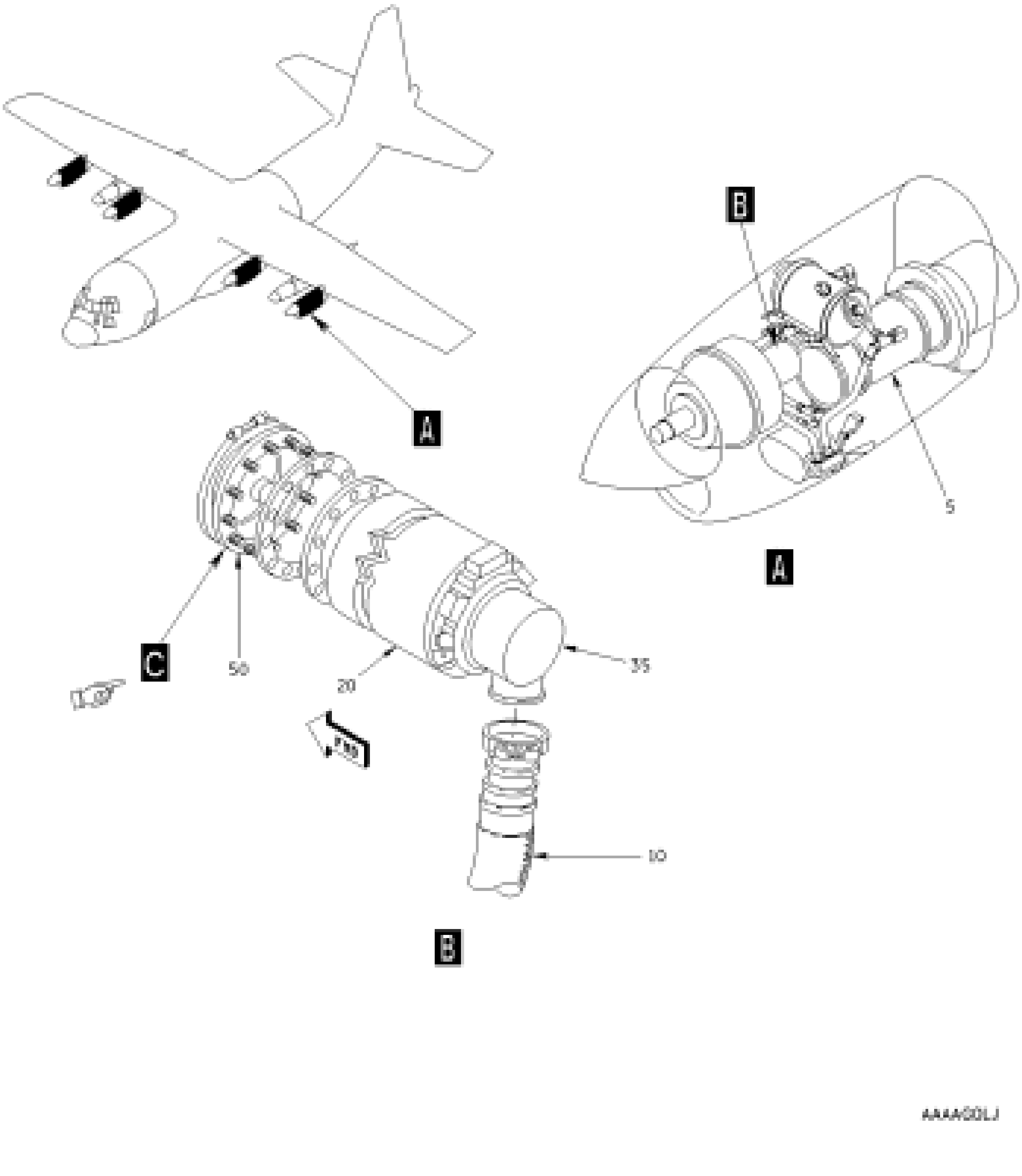
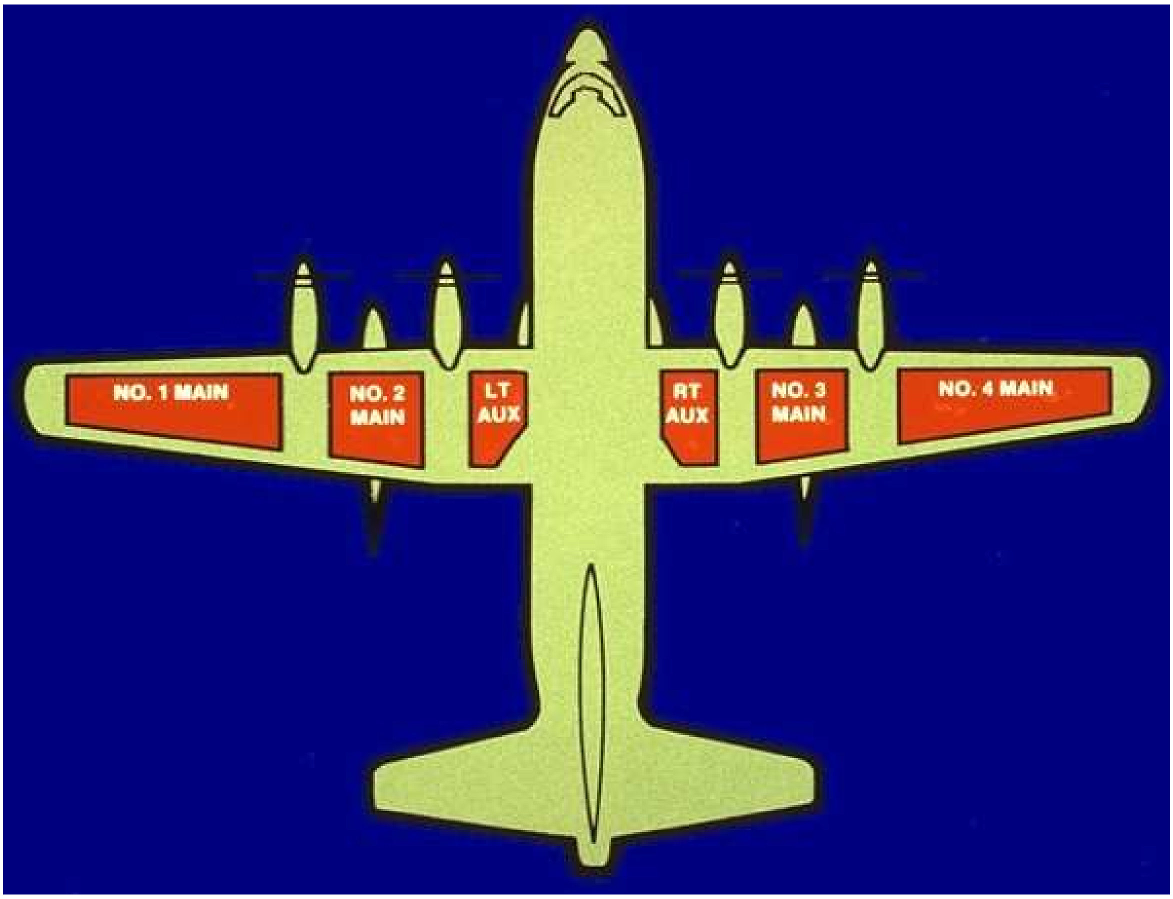


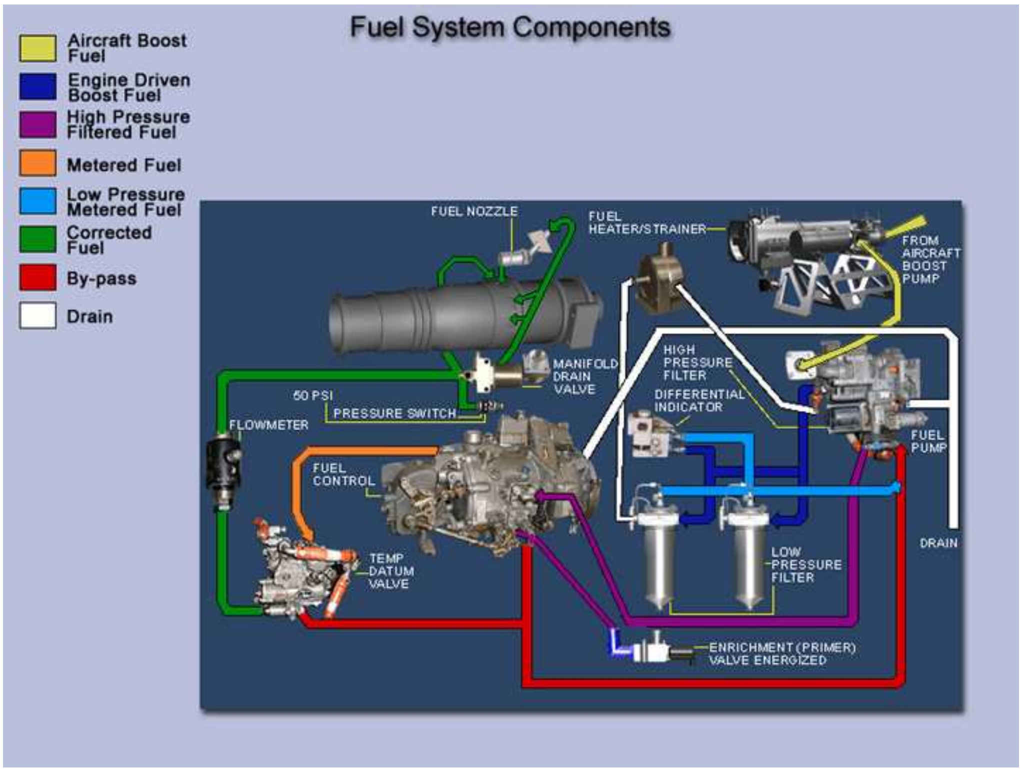
Figure 1. POWER PLANT GENERATORs (FIGURE 1 OF 2)

1.6 FUEL SYSTEM

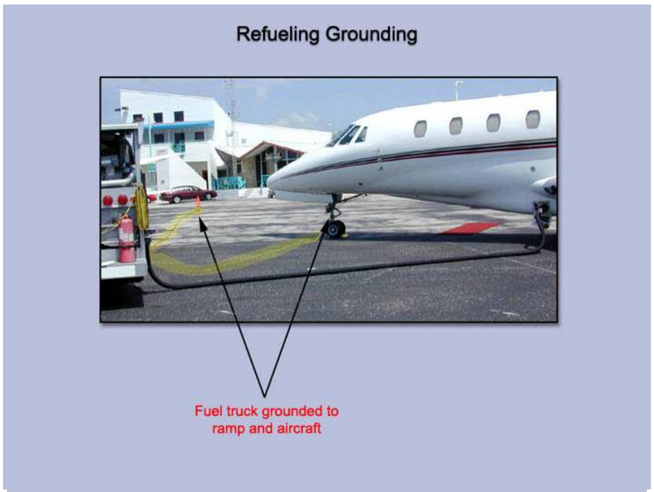
The fuel system is a modified manifold-flow type, incorporating a fuel crossfeed system, a single point refueling and defueling, and a fuel dump system.
The system provides fuel supply for the four engines and the auxiliary power unit. It is adaptable to a number of flow arrangements (figure 1-23). Fuel specifications and grads are listed in the servicing diagram (figure 1-1) at the beginning of this section. Nominal values for fully serviced and total usable capacities of the fuel thanks are shown in figure 1-24.



1.6.1 FUEL FLOW.-Each engine may be supplied fuel either directly from the main respective fuel tank or though the crossfeed manifold system from any tank. Fuel for the APU is routed directly from the No. 2 fuel tank surge box.



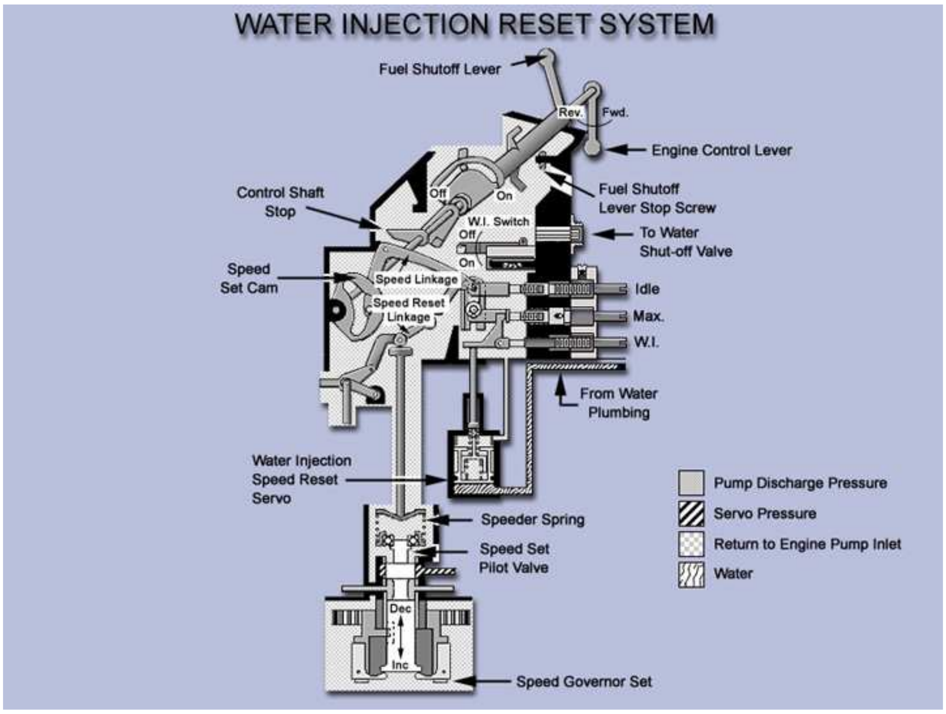
1.6.2 REFUELING AND DEFUELING.-All fuel tanks may be refueled from a single point ground refueling and defueling receptacle located in the right aft landing gear fairing. Fuel is routed from the single receptacle through the refueling manifold. Each tank has a separate supply line has a float-type shutoff valve. Refueling is controlled at the single point refueling control panel, located above the refueling receptacle. As an alternate method, the four main and two external tanks may be fueled separately through a filler opening in the top of each tank.



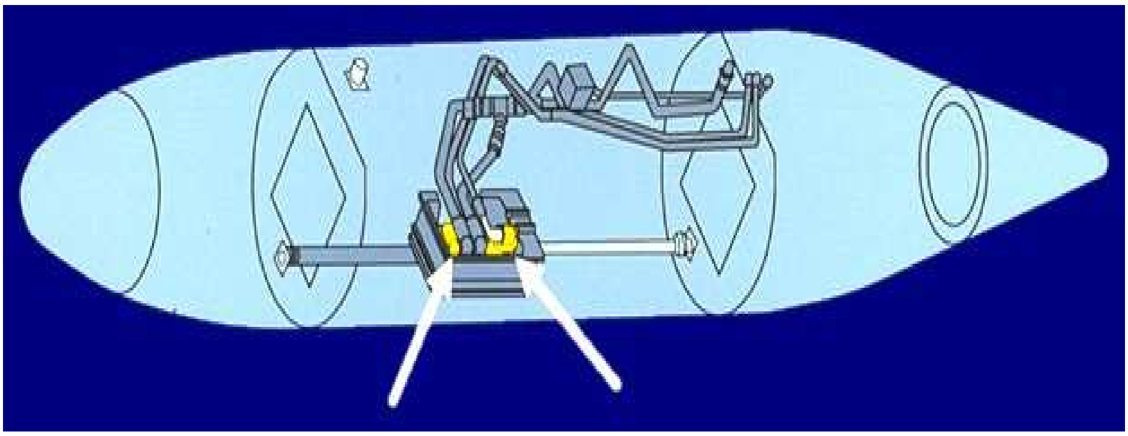
1.6.3 INTEGRAL TANKS.-There are six fuel tanks located within the wind. The number one, two, three, and four main tanks are integral and use sealed wing structure for tank walls. The left and right auxiliary fuel tanks are each comprised of units of three bladder-type cells. The three cells are interconnected to form one assembly and laced within the center wing section. Each of the six tanks has a three-phase, AC powered boost pump to ensure fuel flow.

The water removal system, located in each main tank maintains the fuel level around the boost pump when the airplane is in a nosedown attitude with low fuel level in the tank. An additional larger, three-phase AC powered dump pump is located in each main tank for fuel dumping.

1.6.4 WATER REMOVAL SYSTEM.-The water removal system provides continual water removal from the tank low points during boost pump operation. The system consists of two ejectors, a check valve, a strainer and associated plumbing in each main tank. The ejectors are connected by plumbing to the boost pump discharge line and a part of the boost pump fuel flow is routed through its nozzle. This fuel flow through the ejectors causes a differential pressure and additional fuel is drawn from between the lover wing panel rises and is ejected into the surge box. Any time the fuel boost pump I operating; the fuel will be continually stirred preventing water from settling in the bottom of the tank.



External tank fuel

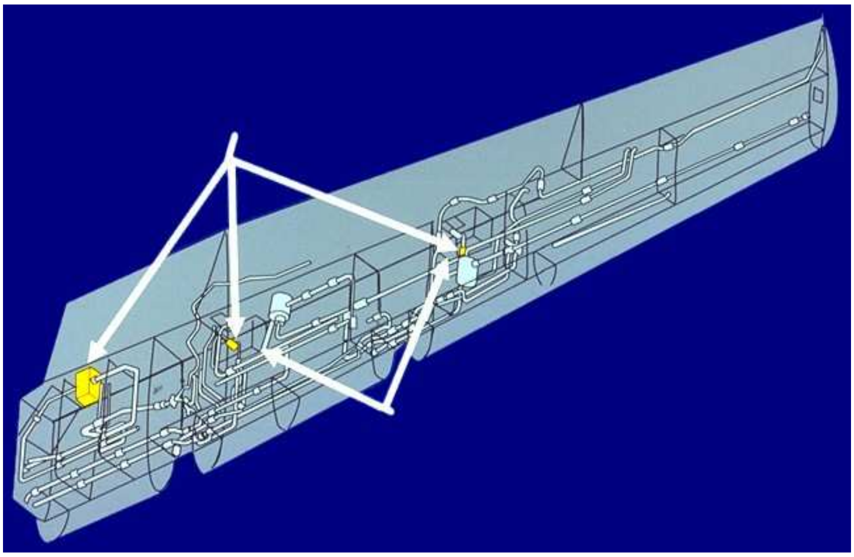


Two all-metal external fuel tanks are mounted under the wings on pylons between the inboard and outboard engines. The tanks are partially compartmented for center-of-gravity control. All fuel flows into the center compartment through check valves. A surge box in the tank center compartment contains a forward and an aft tank pump, providing dual reliability and an increased fuel dumping rate if both pumps are operated during fuel dumping. Both pumps have overriding output pressures which, under normal operation assure depletion of fuel form the external tanks before the main tanks are affected.

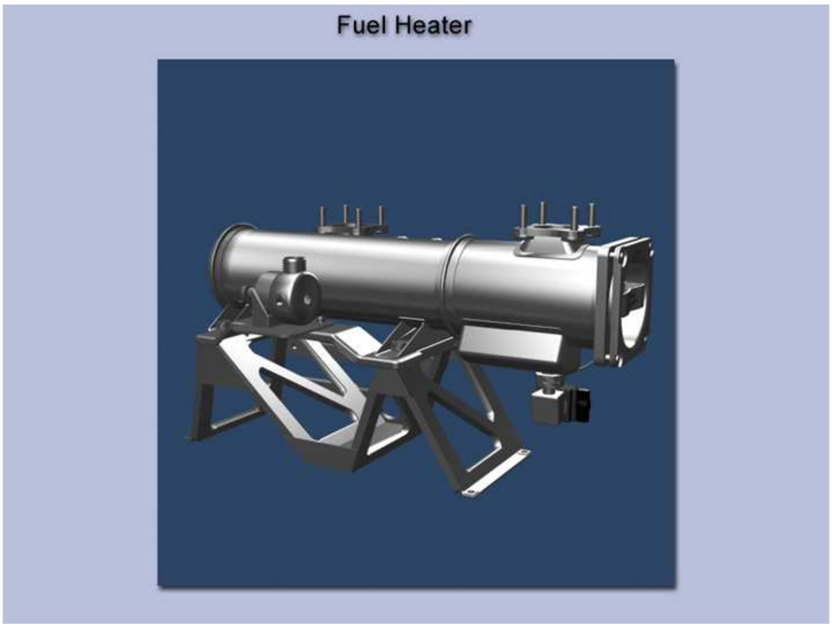
1.6.5 VENT SYSTEM.-All of the fuel tanks is vented to the atmosphere to equalize pressure at all times. The inboard tanks (No. 2 and No. 3) and the left and right auxiliary tanks have a wrap-around vent system. The wrap-around vent system permits venting for the tanks even though the airplane is not in a wing-level attitude. The outboard tanks (No. 1 and No. 4) are vented by float-controlled vent valves to prevent fuel loss overboard on the ground when the airplane is not in wing-level attitude and in flight when the wings deflect upward. Vent air leaving the tank passes through a drainbox on its way overboard. Any fuel entering the vent lines because of a change of attitude of the airplane collects in the drainbox and is returned to the tank continuously by the water removal systems in the inboard and outboard tanks and by the jet pump eductors in the auxiliary tanks. Boost pump pressure is necessary for the water removal system and jet pump eductors to operate. The outboard tanks contain a pressure relief valve which vents tank pressure directly to the jettison manifold, downstream of the dump mast shutoff valve.

NOTE.

The external tanks are vented through the spaces at the top of the bulkheads separating the tank compartments, and through the fuel vent line. The vent line runs from the forward compartment of the tank through the pylon and up into the wing trailing edge, where it vents to the atmosphere. Fuel will not fill the vent line because the tank is separated by compartments, and the line is at the top of the tank and runs upward to the wing.

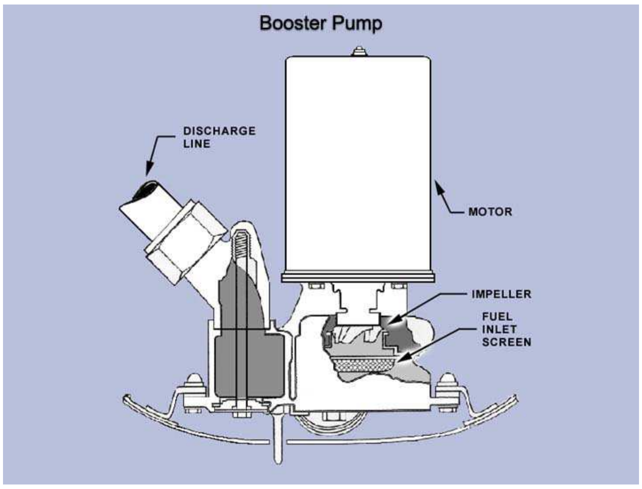


1.6.6 FUEL STRAINER AND HEATER UNIT.-A combination fuel strainer and heater is located in the right side of each engine nacelle. Heat is transferred from engine oil to the fuel in the heater unit, and the temperature is thermostatically controlled.

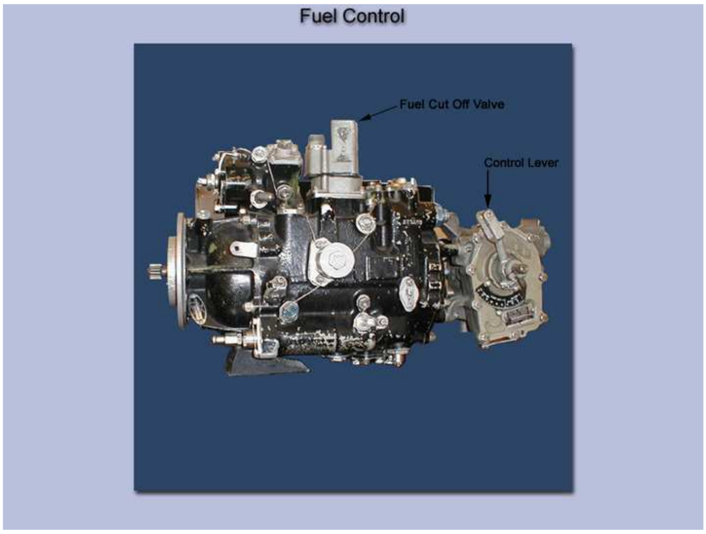


1.6.7 FUEL DUMP SYSTEM.-A fuel dump system s provided to dump all fuel overboard except approximately 2,100 pounds in each outboard main tank, 1,800 pounds in each inboard main tank, and 60 pounds in each external tank.

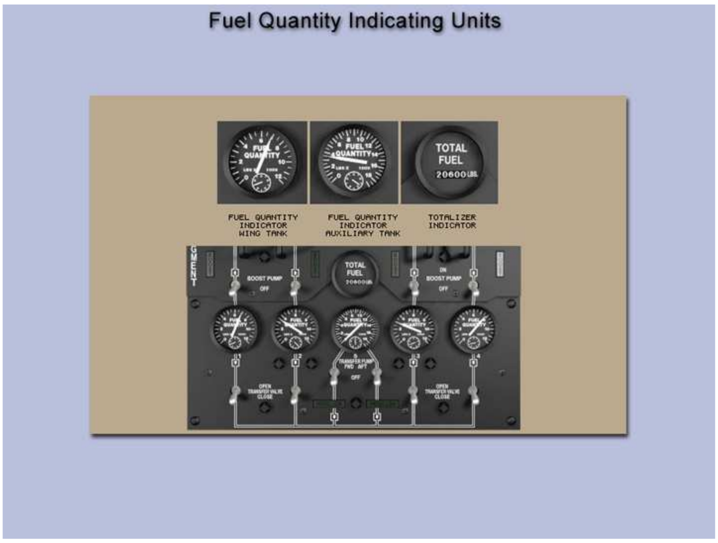
Eight two-position (OFF, DUMP) toggle switches are located on the fuel control panel. Control for fuel dump from the auxiliary tanks is through the DUMP position of the left and right auxiliary tanks is through the DUMP position of the left and right auxiliary pump switches. Control for the fuel dump from the external tanks is thought the DUMP position of the left and right external pump aft switches.

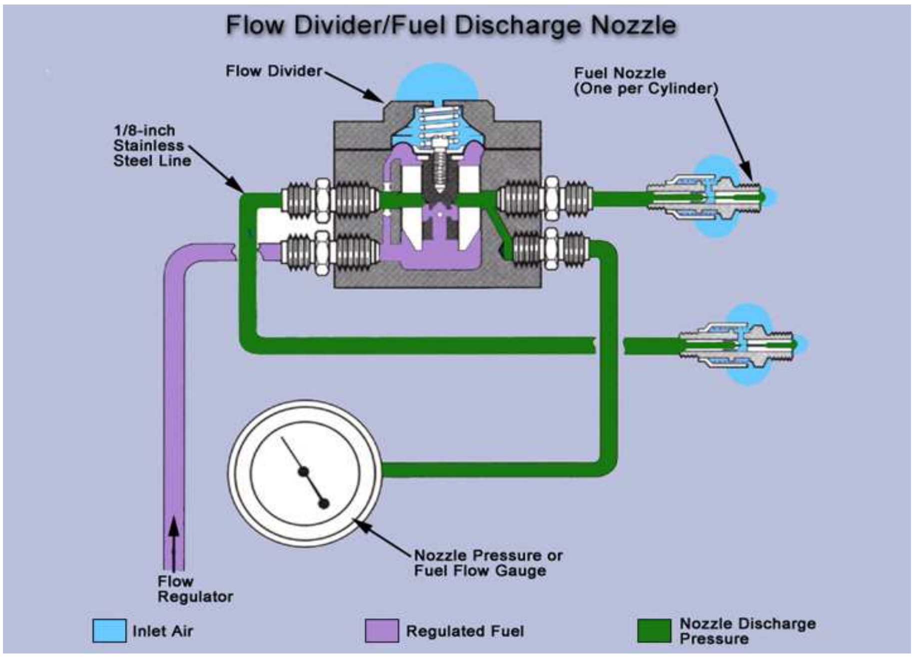


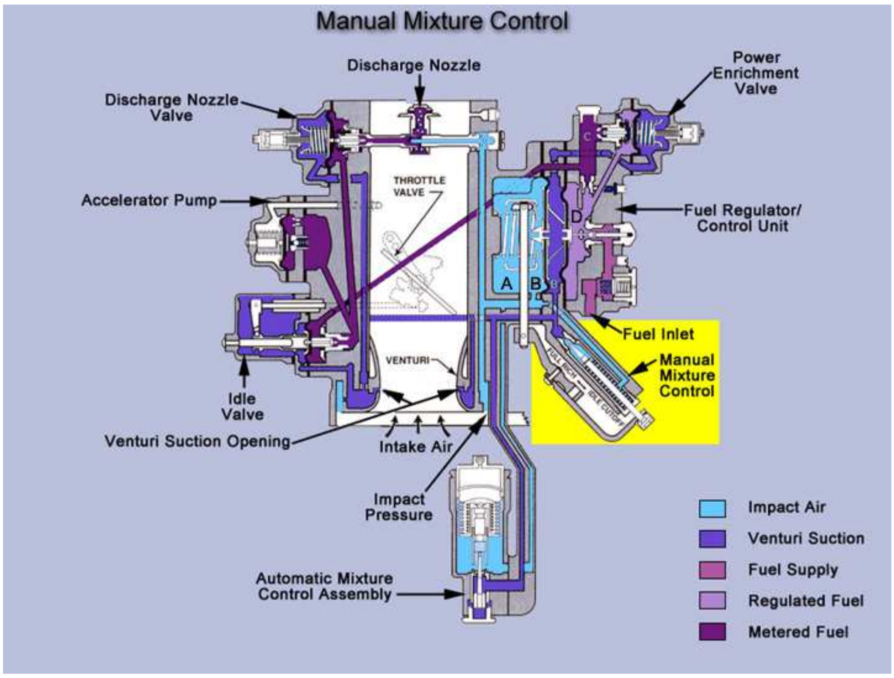
1.6.8 FUEL SYSTEM CONTROLS.-All controls for inflight management of the fuel system is located on the overhead fuel control panel. (See figure 1-25.)
Boost pump switches are located on the fuel control panel. The No. 1, 2, 3, and 4 fuel tank boost pump switches control the integral boost pumps for their respective tanks. The left and right aux tank pump switches control the pump in each of the auxiliary tanks. The external tank pumps switches control the forward and aft tank pumps in the external tanks. Moving the switches to ON place the pumps in operation to provide fuel to the crossfeed manifold.

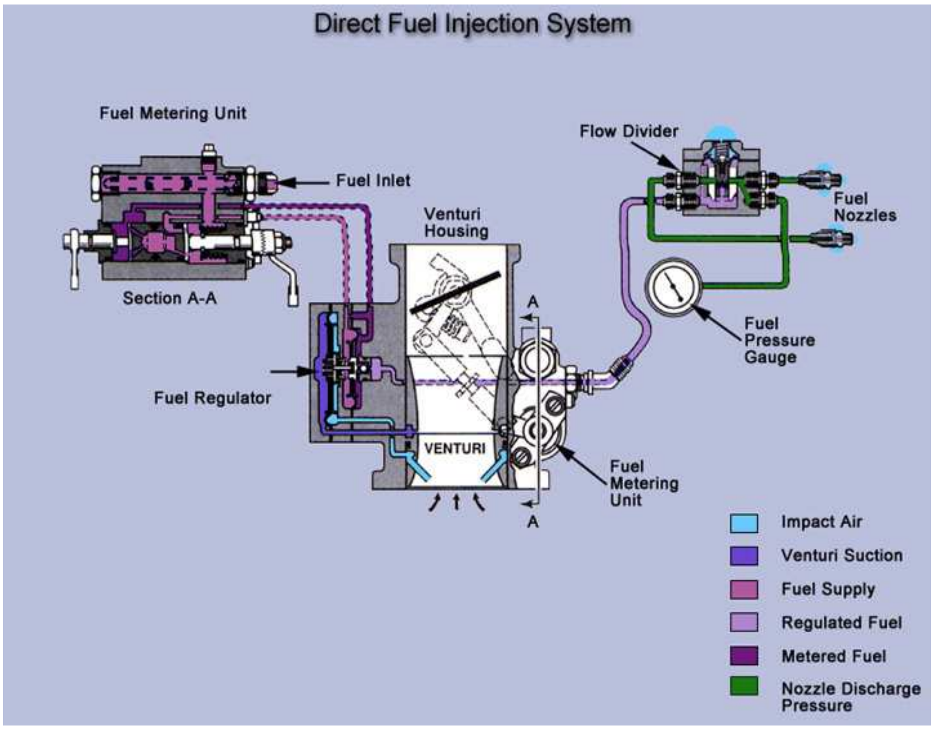


1.6.9 FUEL SYSTEM INDICATORS.-Fuel quantity indicators and warning lights are located on the fuel control panel to give the crew a continuous, visual, indication of the status of the fuel system. For additional of the status of the fuel system. For additional information on the fuel indicators, refer to ENGINE INSTRUMENTS in this section.






Manual Mixture Control
Discharge Nozzle
Power Enrichment Valve
Discharge Nozzle Valve
THROTTLE VALVE
Accelerator Pump
Fuel Regulator/ Control Unit
A
B
C
D
Fuel Inlet
Manual Mixture Control
VENTURI
Idle Valve
Venturi Suction Opening
Intake Air
Impact Pressure
Automatic Mixture Control Assembly
Impact Air
Venturi Suction
Fuel Supply
Regulated Fuel
Metered Fuel


Direct Fuel Injection System
Fuel Metering Unit
Flow Divider
Fuel Inlet
Venturi Housing
Fuel Nozzles
Section A-A
A
Fuel Pressure Gauge
Fuel Regulator
VENTURI
Fuel Metering Unit
A
Impact Air
Venturi Suction
Fuel Supply
Regulated Fuel
Metered Fuel
Nozzle Discharge Pressure

1.6.10 TOTAL FUEL QUANTITY INDICATOR.-A total fuel quantity indicator is located in the center of the fuel control panel. The indicator is electrically connected to each of the fuel tank quantity indicators, and continuously shows the total useable fuel quantity in pounds in the fuel tanks, when the single point refueling master switch is in any position other than OFF, the total fuel quantity indicator is deenergized.

Fuel Quantity Data Table

WITH FOAM IN TANKS
(ALL MLG STRUT TYPES ARE PRESSURES)

	△1 USABLE FUEL, LEVEL FLIGHT.	
TANK	**U.S. GALLONS**	**JP-8 POUNDS**
TANK NO. 1 △4	1222	8310
TANK NO. 2	1126	7657
LEFT AUXILIARY	855	5814
LEFT EXTERNAL △2	1309	8901
RIGHT EXTERNAL △2	1309	8901
RIGHT AUXILIARY	855	5814
TANK NO. 3	1126	7657
TANK NO. 4 △4	1222	8310
Total	9024	61,364

WITHOUT FOAM IN TANKS
(ALL MLG STRUT TYPES AND PRESSURES)

	△1 USABLE FUEL, LEVEL FLIGHT.	
TANK	**U.S. GALLONS**	**JP-8 POUNDS**
TANK NO. 1 △4	1288	8758
TANK NO. 2	1186	8065
LEFT AUXILIARY △2	901	6127
LEFT EXTERNAL △2	1379	9377
RIGHT EXTERNAL	1379	9377
RIGHT AUXILIARY	901	6127
TANK NO. 3 △4	1186	8065
TANK NO. 4	1288	8758
Total	9508	64,654

NOTE

ALL TANKS MAY BE FILLED TO SPR SHUTOFF REGARDLESS OF FUEL DENSITY. FUEL WEIGHTS REFLECT JP-8 AT 6.8 POUNDS PER GALLON. REFER TO TAXI AND GROUND LIMITATIONS IN SECTION V.

NOTE

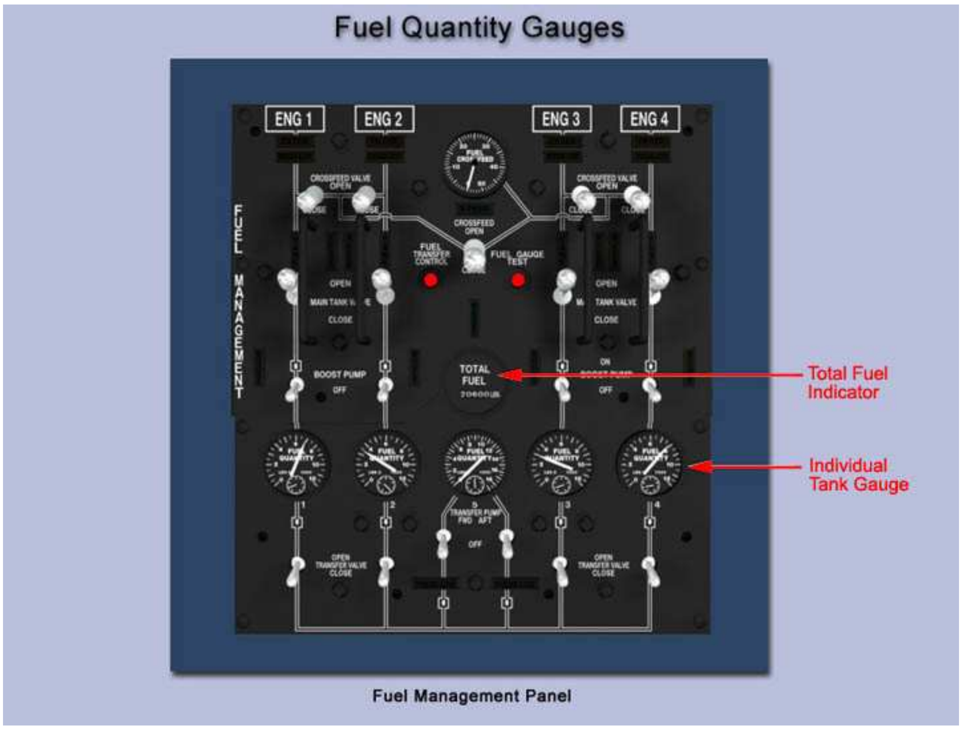
△1 LEVEL FLIGHT 3°NOSE UP ATTITUDE.

△2 IF INSTALLED.

3. ALL VALUES PRESENTED IN TABLE ARE NORMAL.

△4 WITH EXTERNAL STORES INSTALLED, THE MAXIMUM ALLOWABLE FUEL WEIGHT FOR TANK NO. 1 AND TANK NO. 4 IS REDUCED BY THE WEIGHT OF THE STORES.

Figure 1-24.



1.6.11 AUXILAR AND EXTERNAL TANK EMPTY LIGHTS.-Two auxiliary tank empty lights and two external tank empty lights are located on the fuel control panel (See figure 1-25.) If the tank pump switch associated with a given auxiliary or external tank is positioned at ON and there is no source of higher pressure to that side of the manifold, the associated tank empty light will be illuminated whenever output flow pressure is below approximately 23 PSI. Illumination of the light indicates either depleted tank quantity or an inoperative tank pump or in the case of the external tanks only. Failure of the fuel level control valve.

1.6.12 SINGLE POINT REFUELING AND DEFUELLING SYSTEM.- A single point refueling and defueling system enables all normal refueling and defueling operations to be accomplished through a single receptacle located in the aft end of the right wheel well fairing. All tanks may be serviced through the system. Controls and indicators for the system are on the refueling control panel located immediately above the receptacle. (See figure 1-26.)

When refueling, fuel enters the tanks by way of the refueling manifold, and a dual float valve in each tank shuts off the flow when the tank is filled to its single point refueling capacity. Defueling and ground tank-to-tank fuel transfer is accomplished by running the tank boost pumps and the auxiliary and external tank pumps.

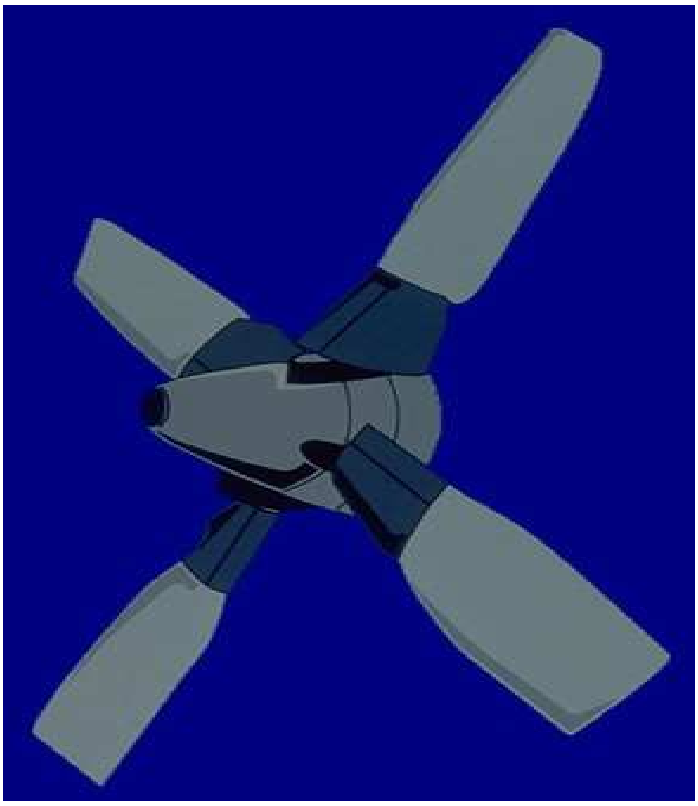
Defueling flow is through the crossfeed manifold, through the ground transfer valve to the refueling manifold, and out the single point refueling/defueling receptacle. The fuel pumps may be used for defueling.

The pumps are controlled from the flight station fuel control panel. Defueling flow, when using the dump pumps, is through the dump line to the refueling manifold and out the single point refueling/defueling receptacle. A surge suppressor is located in the refueling line to prevent damage to the fuel system components. A surge suppressor pressure gage is located behind the right air deflector door.

1.7 PROPELLER

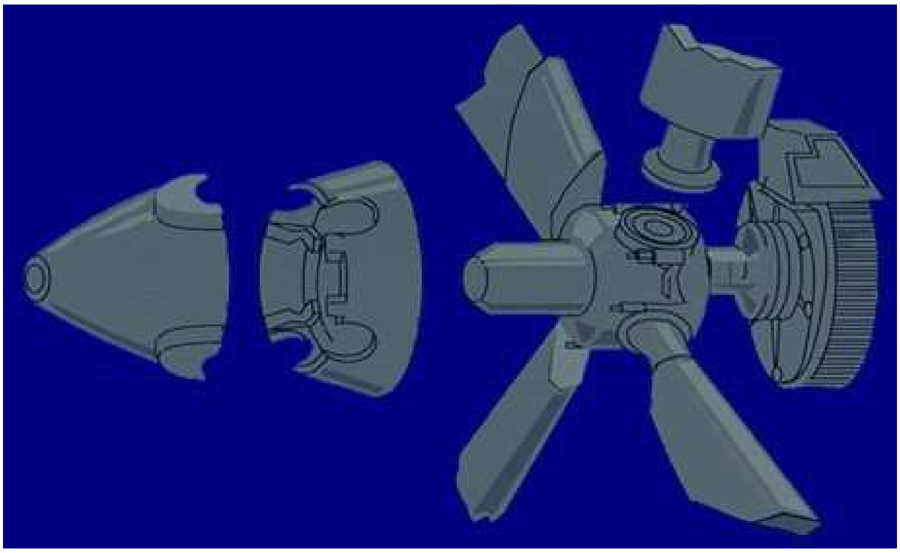
Each engine is equipped with a Hamilton Standard, four-blade, electro-hydromatic, full feathering, reversible-pitch propeller. The propeller operates as a controllable-pitch propeller for throttle setting below FLIGHT IDLE and as constant- speed propeller for throttle setting of FLIGHT IDLE or above. The major components of the propeller system are the propeller assembly, the synchrophasing system, the control system, and the anti-icing and deicing systems. The oil capacity of the pressurized sump is 6.5 quarts. The capacity of the complete system fully serviced including the pressurized sump is 26 quarts.

1.7.1 PROPELLER BLADES.-The propeller blades are of solid aluminum alloy with shanks which are partially hollow for weight reduction. The blade incorporates a fairing made of plastic foam (Lockfoam) covered with a nylon reinforced rubber material to direct the airflow into the engine. The blade gear segments, thrust bearings, oil seal, and deicing rings are located on the mounting end the blades.



1.7.2 BARREL ASSEMBLY.-The principal functions of the barrel assembly are to retain the blades within the propeller assembly, to provide the means of attaching the propeller to the engine shaft, and to transmit engine torque to the blades. The barrel assembly is made in two sections which are bolted together to retain the propeller blades. The rear half of the assembly has an extension which is machined to fit over the splined engine shaft.

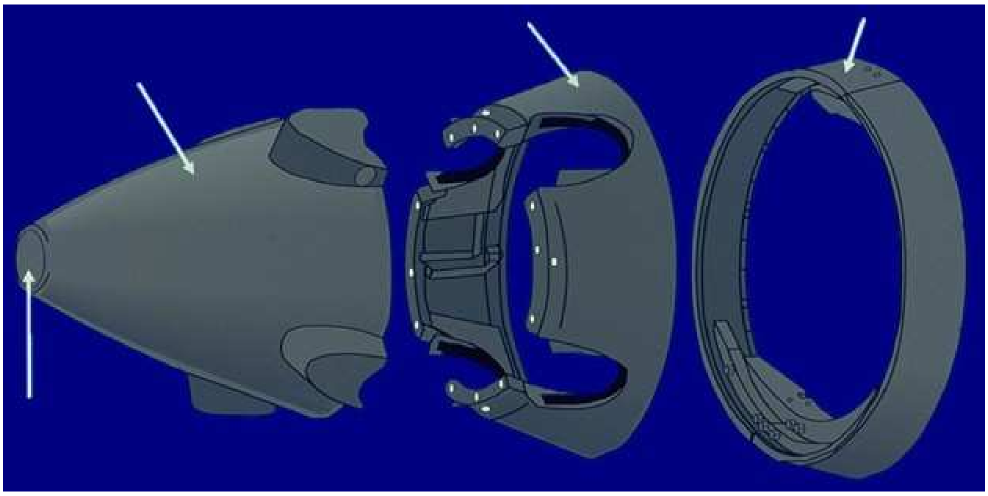
1.7.3 PITCH LOCK ASSEMBLY.-The pitch lock regulator assembly is located within the barrel assembly. Components of the pitch lock mechanism are a stationary pitch lock ratchet which is splined to the barrel, and a rotating pitch lock ratchet which is splined to the rotating cam within the done assembly. The pitch lock mechanism prevents the blades from decreasing pitch if overspeeding of approximately 103 percent RPM occurs or if hydraulic pressure is lost. The stationary and rotating pitch lock ratchet rings are held disengaged by propeller oil pressure under control of the pitch lock regulator; they are spring-loaded to engage when the pressure is lost. However, when the ratchet rings are engaged, the propeller can still increase pitch to allow feathering. When an overspeed condition is sensed by the flyweights within the pitch lock regulator assembly, oil pressure is removed to allow the pitch lock ratchets to engage and prevent a decrease in blade angle. To release the pitch lock, the overspeed must be correct to restore oil pressure, and the blade angle must increase a few degrees to disengage the ratchets. The prevent pitch lock action from interfering which normal reversing, the pitch lock ratchet rings are mechanically held apart by cam action throughout a blade angle range of a few degrees above the low pitch stop to full reverse. However, a propeller which has once locked pitch cannot be reversed, as its blade angle cannot be reduced.



1.7.4 DOME ASSEMBLY.-The dome assembly is mounted on the forward section of the barrel assembly. It contains the pitch changing mechanism and the low-pitch stop assembly. The pitch changing mechanism converts hydraulic pressure into mechanical torque. Its main parts are a piston assembly, a stationary cam, a rotating cam, and the dome shell. The piston is a double-walled assembly which fits over the two camps and inside the dome shell. The piston is held in place by rollers which ride in the cam tracks of both cams. The rear of the rotation cam is connected to the propeller blades by beveled gears. As propeller oil pressure is applied to the piston, causing it to move, the rollers riding in the cam tracks turn the rotating cam, changing the blade angle. The low-pitch stop is located in the dome and mechanically stops the piston from decreasing blade angle below approximately 23 degrees in flight. The low-pitch stop is retracted to allow lower blade angles ground operation.

1.7.5 CONTROL ASSEMBLY.-The propeller control assembly in mounted on the aft extension of the propeller barrel but does not rotate. It contains the oil reservoir, pumps, valves, and control components which the pitch changing mechanism with hydraulic pressure of the proper magnitude and direction to vary the propeller blade angle as required for the selected operation condition. The main components contained within the valve housing assembly section of the control assembly are the flyweight speed sensing pilot valve, feather valve, feather solenoid valve, and feather actuating valve. The pump housing assembly contains a scavenge, main, standby, and an electric drive, double-element, auxiliary pump. The flow of fluid from these pumps is controlled by the valves in the valve housing assembly to accomplish the desired propeller operation.

1.7.6 SPINNER ASSENBLY.-The spinner assembly improves the aerodynamic characteristics of the propeller assembly. In encloses the dome, barrel, and control assemblies. It consists of a front section, rear section, and a non-rotating afterbody assembly. Cooling air is admitted through an air inlet at the front of the spinner and passes over the dome assembly, barrel assembly, and control assembly fins and exhausts through vents in the engine nacelle.



1.7.7 ANTI-ICING AND DEICING ASSEMBLY.-The anti-icing and deicing assembly is made up of resistance-type heating elements which are incorporated on the leading edge and fairing of each blade and the entire spinner assembly for anti-icing and deicing. Continuous anti-icing heaters cover the front portion of the spinner assembly and the entire afterbody assembly. Cyclic deicing heaters cover the remainder of the spinner front section, the spinner rear rotating section, the spinner plateaus, and the blade leading edge and fairing.

Propeller Anti-Icing and Deicing System

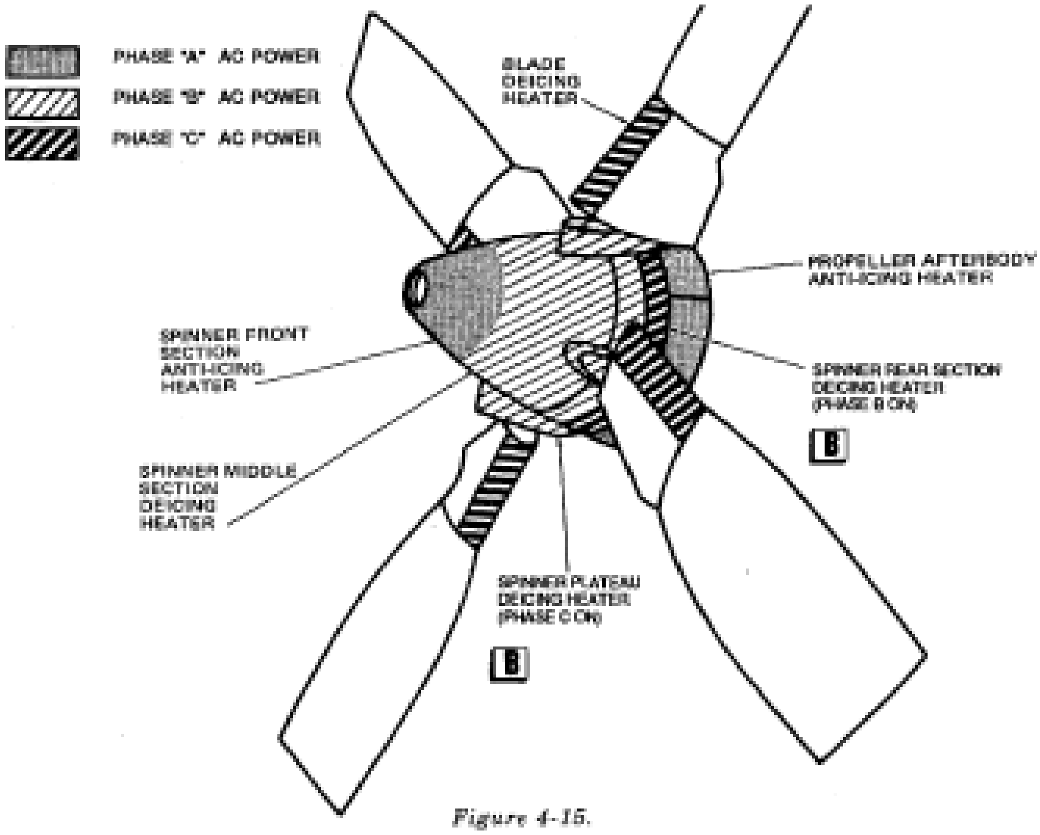


Figure 4-15.

Ice Detection Panel

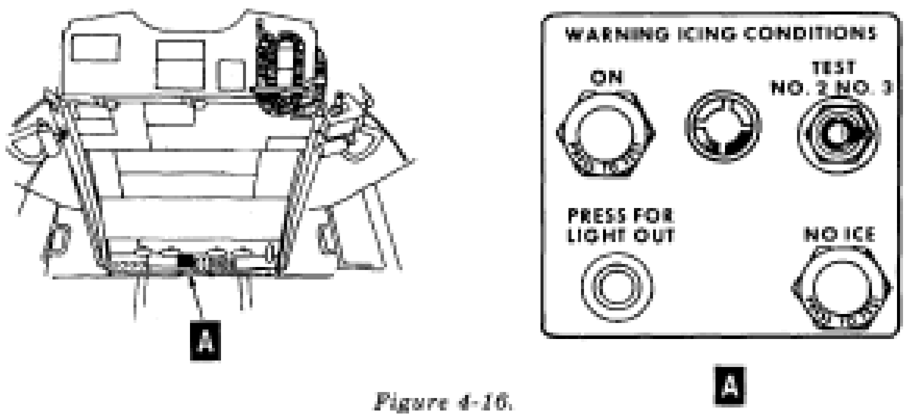


Figure 4-16.

1.7.8. PROPELLER SPEED CONTROL SYSTEM.-The speed of the propeller is controller by the propeller governing system within the flight range of the throttle lever so as to maintain a constant RPM. Within the ground range, the propeller blade angle is a function of throttle lever position. The propeller does not govern the RPM within the ground range.

Propeller Governing System

The principal function of the propeller governing system is to maintain a constant engine operating RPM. Propeller governing is accomplished by the action of the flyweight speed-sensing pilot valve. This valve is controlled by the mechanical action of the flyweights opposing the force of the speeder spring. When the propeller is in an on-speed condition, the pilot valve meters sufficient fluid to the increase pitch (forward) side of the dome assembly piston to overcome the centrifugal twisting moment and maintain the required blade angle.

Electronic Propeller Governing

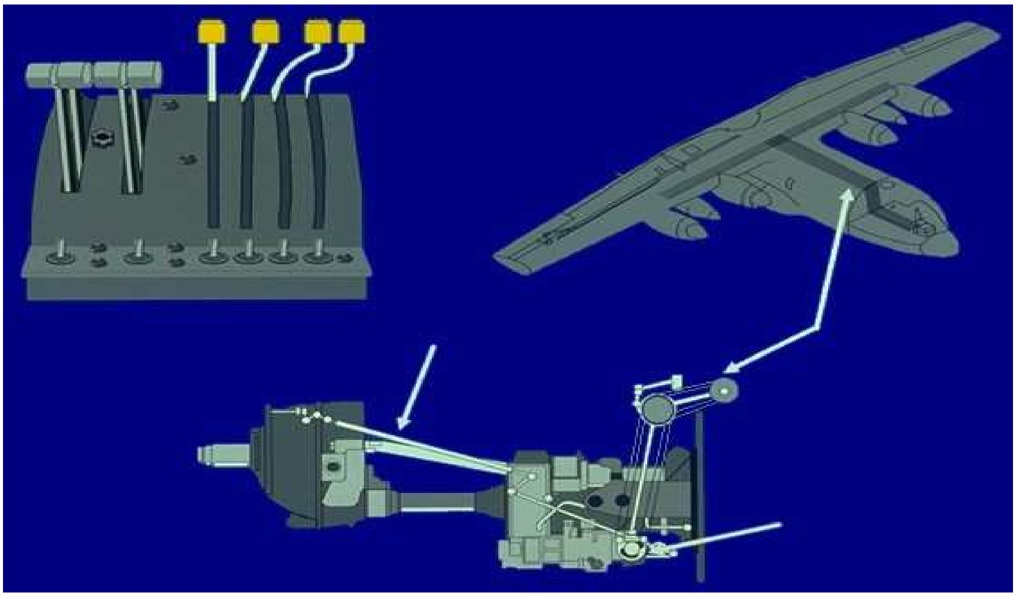
The synchrophaser electronic unit provides circuits for the following governing functions: speed stabilization (derivative), throttle anticipation, and synchrophasing. The propeller mechanical governor will hold a constant speed in the flight range but throttle changes will cause the governor to overspeed or underspeed while trying to compensate for the change in power. A stabilization circuit stabilizes the mechanical governor during these changes when the propeller governor control switch is in the NORMAL position by sending a signal to the speed bias servo control motor to change the speeder spring compression. The throttle anticipation circuit stabilizes the propeller speed during rapid movement of the throttle when the propeller governor control switch is in the NORMAL position.

1.7.9. PROPELLER CONTROLS.-Propeller controls include the throttles, engine condition levers, fire handles, a synchrophase master switch, a propeller resynchrophase switch, synchrophaser trim controls (airplanes equipped with a vacuum tube synchrophaser), propeller governor control switches, fuel governing check switches, feather override buttons and a feather valve and NTS checks switch.

Throttles

Each throttle is mechanically linked through the engine coordinator to an input shaft on the propeller control assembly. When the throttle is in the governing range, between FLIGHT IDLE and TAKE-OFF positions, the input shaft rotates with throttle movement, but has no effect on propeller speed except normal throttle anticipation and speed stabilization action. When the throttle is in the range below FLIGHT IDLE, movement of the throttle is transmitted to the speed-sensing pilot valve to increase or decrease blade angle. The maximum negative blade angle is obtained when the throttle is at MAXIMUM REVERSE.

1.7.10. ENGINE CONDITION LEVERS.-The engine condition levers serve to feather and unfeather the propellers and as engine start and ground stop control. Each lever is mechanically linked to the engine coordinator, which transmits the motion of the lever to the propeller linkage only when it is moved to the FEATHER position. When the condition lever is moved to the FEATHER position, the pilot valve is ported to increase pitch, and the feather valve moves to the FEATHER position, the pilot valve is ported to increase pitch, and the feather valve mover to the feather position. The condition lever also actuates a switch in the control pedestal, completing a circuit to the holding coil of the propeller feather override button on the copilot's side shelf. The propeller feather override button pulls in and completes circuits to energize a feather solenoid and the auxiliary pump motor.

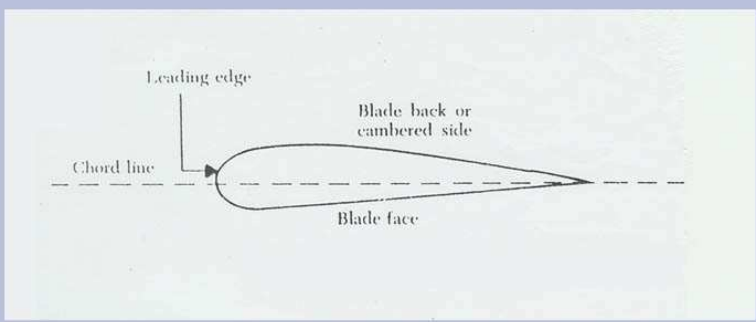


Synchrophase Master Switch

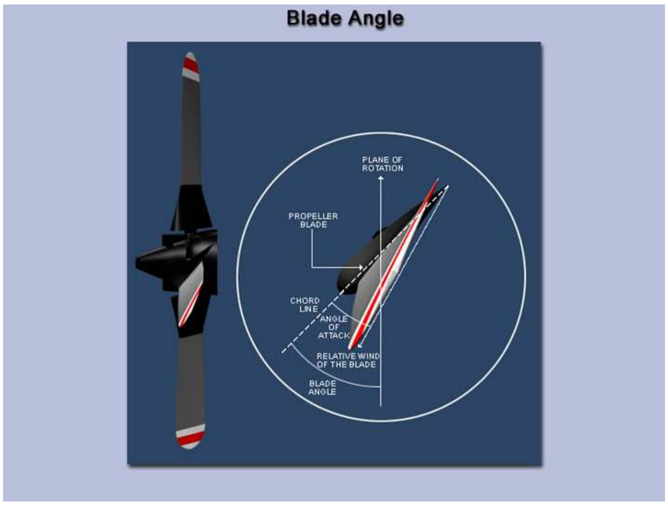
The synchrophase master switch is located on the flight control pedestal. The master switch is a three-position toggle switch. This controls the operation of the synchrophasing system and selects the engine to be used as the master. When the switch is in the ENG2 position, the No. 2 engine is selected as the master and the other propeller rotational speeds and blade phase angles are referenced to the engine. When the switch is in the OFF position, there is no synchrophasing and the propellers operate in normal governing. When the switch is in the ENG 3 position, the No. 3 engine is the master and the other propellers are referenced to this engine.

A cross section of a typical propeller blade is shown and labeled in the provided illustration. This section or blade element is an airfoil comparable to a cross section of an aircraft wing. The blade back is the cambered or curved side of the blade, similar to the upper surface of an aircraft wing. The blade face is the flat side of the propeller blade. The chord line is an imaginary line drawn through the blade from the leading edge to the trailing, edge. The leading edge is the thick edge of the blade that meets the air as the propeller rotates.

Cross Section of Blade

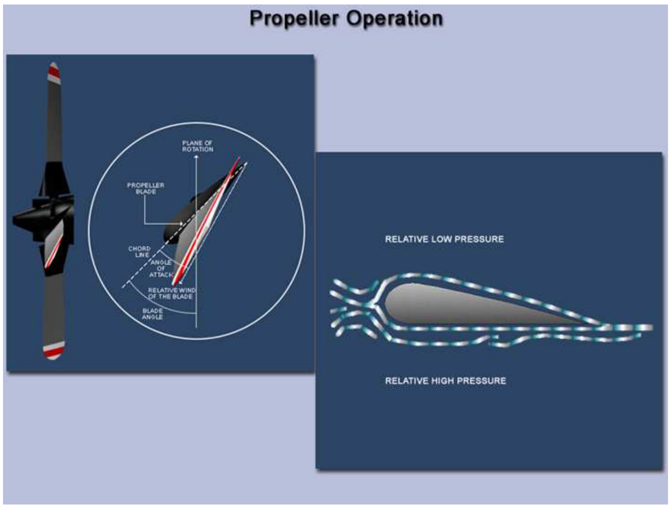


The blade angle, measured in degrees, is the angle between the chord of the blade and the plane of rotation. The chord of the propeller blade is determined in about the same manner as the chord of an airfoil. In fact, a propeller blade can be considered as being made up of an infinite number of thin blade elements. From this, each is seen as a miniature airfoil section whose chord is the width of the propeller blade at that section. Because most propellers have a flat blade face, the chord line is often drawn along the face of the propeller blade. Pitch is not the same as the blade angle, but, because pitch is largely determined by blade angle, the two terms are often used interchangeably. An increase or decrease in one is usually associated with an increase or decrease in the other.



A rotating propeller is acted upon by centrifugal, twisting, and bending forces. The principal forces acting on a rotating propeller are shown in the provided illustration.

Centrifugal Force (A) is a physical force that tends to throw the rotating propeller blades away from the hub. Torque bending Force (B), in the form of air resistance, tends to bend the propeller blades opposite to the direction of rotation. Thrust bending Force (C) is the thrust load that tends to bend propeller blades forward as the aircraft is pulled through the air. Aerodynamic Twisting Force (D) tends to turn the blades to a high blade angle. Centrifugal twisting force, being greater than the aerodynamic twisting force, tries to force the blades toward a low-blade angle.



1.7.11 HAMILTON STANDARD HYDROMATIC PROPELLERS

Description

The following description is typical of most of the various models of the Hamilton Standard hydromantic propeller.

The hydromantic propeller is composed of five major components:

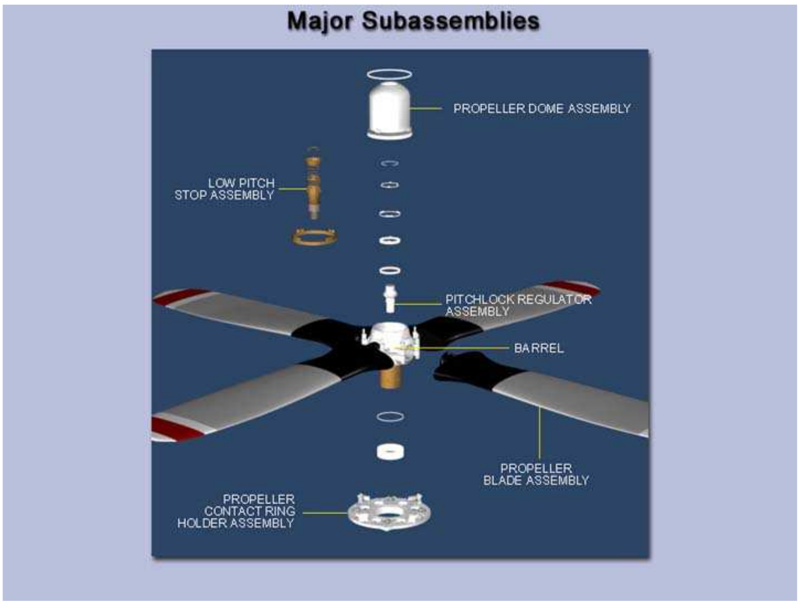
1. The hub assembly.

2. The dome assembly.

3. The distributor valve assembly (for feathering on single acting propellers) or engine shaft extension assembly (for no feathering or double acting propellers).

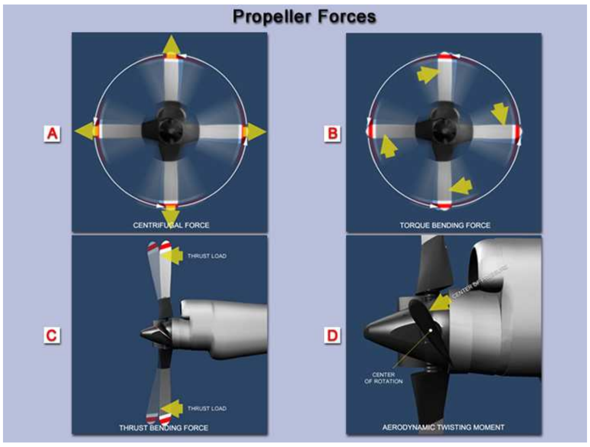
4. The anti-icing assembly.

5. Blade assembly.



Principles of Operation - Basic Propeller Control Forces

The Basic Propeller Control Forces acting on the Hamilton Standard propeller is centrifugal twisting force and high pressure oil from the governor.
The centrifugal force acting on each blade of a rotating propeller includes a component force that results in a twisting movement about the blade center line which tends, at all times, to move the blade toward low pitch.
Governor pump output oil is directed by the governor to either side of the propeller piston. The oil on the side of the piston opposite this high pressure oil returns to the intake side of the governor pump and is used over again. Engine oil and engine supply pressure does not enter the propeller directly but is supplied only to the governor.
During constant speed operations, the double acting governor mechanism sends oil to one side or the other of the piston as needed to keep the speed at a specified setting.



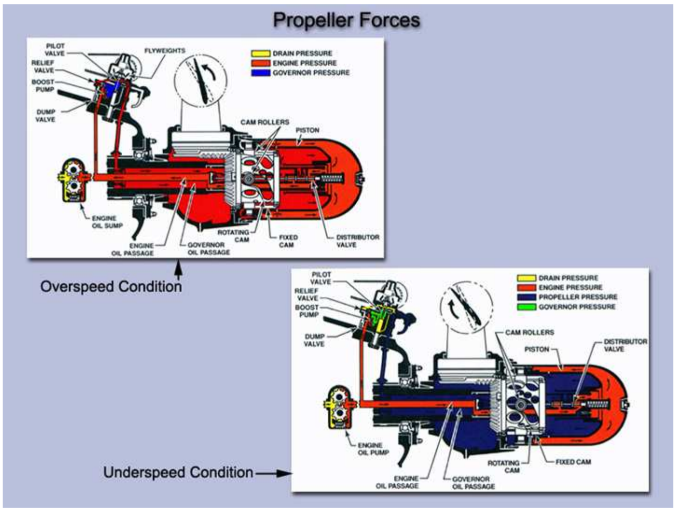
Underspeed Condition

Underspeeding results when the blades (solid black section in the illustration, Reference A) have moved to a higher angle than is required for constant speed operation (dotted line section). The arrow represents the direction in which the blades will move to reestablish on-speed operation.

When the engine speed drops below the rpm that the governor is set to, the resulting decrease in centrifugal force exerted by the flyweights permits the speeder spring to lower the pilot valve, thereby opening the propeller-governor metering port. The oil then flows from the inboard end, through the distributor valve inboard inlet, between distributor valve lands, through the valve port, and into the propeller shaft governor oil passage. From here, the oil moves through the propeller shaft oil transfer rings, up to the propeller-governor metering port. Also, it moves through the governor drive gear shaft and pilot valve arrangement to drain into the engine nose case. The engine scavenge pump recovers the oil from the engine nose case and returns it to the oil tank.

As the oil is drained from the inboard piston end, engine oil flows through the propeller shaft passage and the distributor valve ports. It emerges from the distributor valve outboard outlet into the outboard piston end. With the aid of blade centrifugal twisting moment, this oil moves the piston inboard. The piston motion is transmitted through the cam rollers (Reference B) and through the beveled gears to the blades. Thus, the blades move to a lower angle.

As the blades assume a lower angle (dotted line section in the illustration, Reference A), engine speed increases and the pilot valve is raised by the increased centrifugal force exerted by the governor flyweights. The propeller-governor metering port gradually closes, decreasing the flow of oil from the inboard piston end. This decrease in oil flow also decreases the rate of blade angle change toward low pitch. By the time the engine has reached the rpm for which the governor is set, the pilot valve will have assumed a neutral position (closed) in which it prevents any appreciable oil flow to or from the propeller. The valve is held in this position because the flyweight centrifugal force equals the speeder spring force. The control forces are now equal, and the propeller and governor are operating on the desired speed.



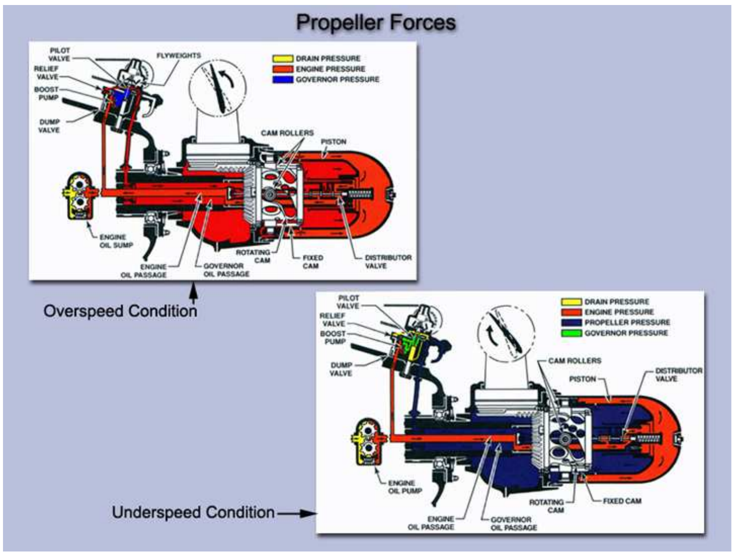
Overspeed Condition

If the propeller is operating above the rpm for which the control is set, the blades will be in a lower angle (solid black section in the illustration, Reference A) than is required for constant speed operation (dotted lines). The arrow represents the direction in which the blades will move to bring the propeller to the on-speed condition.

When the engine speed increases above the rpm for which the governor is set, the flyweights move outward against the force of the speeder spring, raising the pilot valve. This opens the propeller-governor metering port, allowing governor oil flow from the governor booster pump, through the propeller governor metering point into the engine oil transfer rings. From the rings, the oil passes through the propeller shaft governor oil passage and through a distributor valve port. From there it flows between distributor lands, to the inboard piston end by way of the distributor valve inboard outlet.

As a result of this flow, the piston and the attached rollers (Reference B) move outboard and the rotating cam is turned by the cam track. As the piston moves outboard, oil is displaced from the outboard piston end. This oil enters the distributor valve outboard inlet, flows through the distributor valve port and past the outboard end of the valve land, through the port and into the propeller shaft engine oil passage. From that point, it is dissipated into the engine lubricating system. The same balance force exists across the distributor valve during overspeed as during underspeed, except that oil at the governor pressure replaces oil at the drain pressure on the inboard end of the valve land and between lands.

Outboard motion of the piston moves the propeller blades toward a higher angle. This, in turn, decreases the engine rpm. A decrease in engine rpm decreases the rotating speed of the governor flyweights. As a result, the flyweights are moved inward by the force of the speeder spring. Also, the pilot valve is lowered and the propeller governor metering port is closed. Once this port has been closed, oil flow to or from the propeller practically ceases and the propeller and governor operate on speed.



1.7.12 Feathering Systems

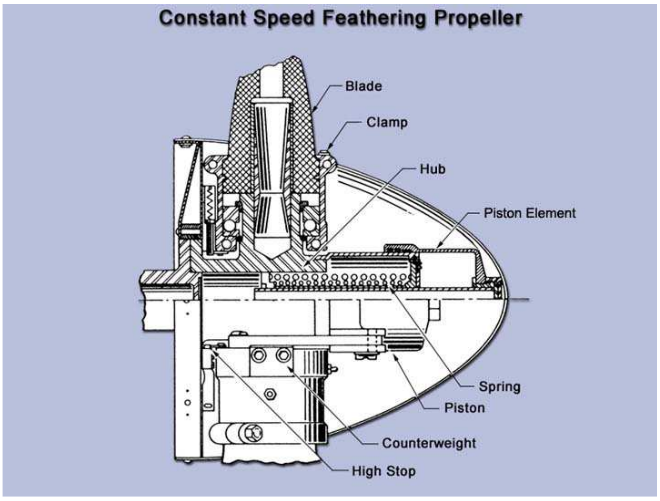
A typical hydromantic propeller feathering installation is shown in the illustration. When the feathering button switch is depressed, the low current circuit is established from the battery, through the button holding coil and from the battery through the solenoid relay. As long as the circuit remains closed, the holding coil keeps the button in the depressed position. Closing the solenoid establishes the high current circuit from the battery to the feathering motor pump unit. The feathering pump picks up engine oil from the oil supply tank and boosts its pressure if necessary. This is then sent to the relief valve setting of the pump and supplies it to the governor high pressure transfer valve connection.
Auxiliary oil entering the high pressure transfer valve connection shifts the governor transfer valve which, in turn, hydraulically disconnects the governor from the propeller. At the same time it opens the propeller governor oil line for auxiliary oil. The oil flows through the engine transfer rings, through the propeller shaft governor oil passage and through the distributor valve port. Then it flows between lands to the inboard piston end by way of the valve inboard outlet.
The distributor valve does not shift during the feathering operation. It merely provides an oil passageway to the inboard piston end for auxiliary oil and the outboard piston end for engine oil. The same conditions described for underspeed operation exist in the distributor valve. However, oil at auxiliary pressure replaces drain oil at the inboard end of the land and between lands. The distributor valve spring is backed up by engine oil pressure. This means that the pressure differential required to move the piston will be identical with that applied to the distributor valve at all times.

Feathering Operation

The propeller piston moves outboard under the auxiliary oil pressure at a speed proportional to the rate at which the oil is supplied. This piston motion is transmitted through the piston rollers operating in the inclined cam opposite the tracks of the fixed cam and the rotating cam. This is converted by the bevel gears into the blade twisting movement. Only during feathering or unfeathering is the low mechanical advantage portion of the cam tracks used. (The low mechanical advantage portion lies between the break and the outboard end of the track profile.) Oil, at engine pressure and displaced from the outboard piston end, flows through the distributor valve outboard inlet. Then it moves past the outboard end of the valve land, through the valve port and into the propeller shaft engine oil passage. From there, it is finally delivered into the engine lubricating system. Thus, the blades move toward the full high pitch (or feathered) angle.

Having reached the full feathered position, no further movement of the mechanism occurs because contact between the high angle stop ring in the base of the fixed cam and the stop lugs set in the teeth of the rotating cam. The pressure in the inboard piston end now increases rapidly. And upon reaching a set pressure, the electric cutout switch automatically opens. This cutout pressure is less than required to shift the distributor valve.

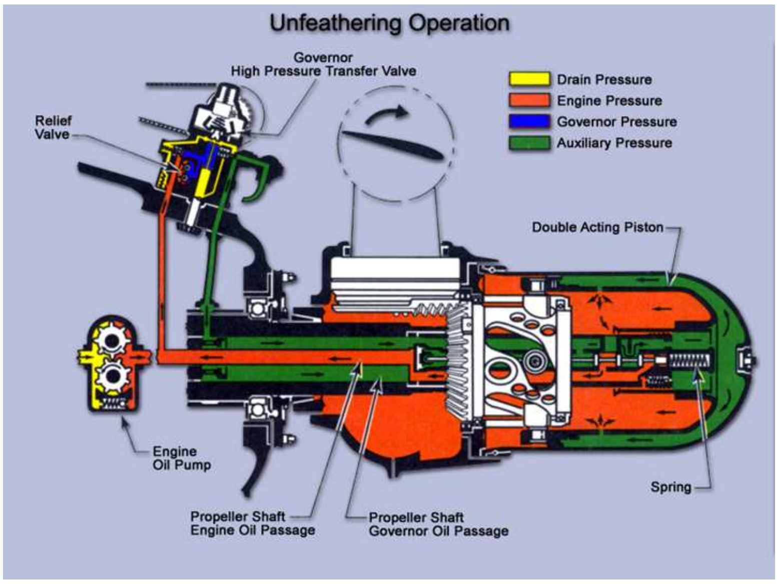
Opening the switch de-energizes the holding coil and releases the feathering button control switch. The release of this switch breaks the solenoid relay circuit, which shuts off the feathering pump motor. The pressures in both the inboard and out-board ends of the piston drop to zero. Since all the forces are balanced, the propeller blades remain in the feathered position. Meanwhile, the governor high pressure transfer valve has shifted to its normal position as soon as the pressure in the propeller governor line drops below that required holding the valve open.



1.7.13 Unfeathering Operation

To unfeather a hydromantic propeller, depress and hold in the feathering switch button control switch. As in the case of feathering a propeller, the low current control circuits from the battery, through the holding coil, from the battery, through the solenoid are completed when the solenoid closes. The high current circuit from the battery starts the motor-pump unit. Oil is then supplied at a high pressure to the governor transfer valve.

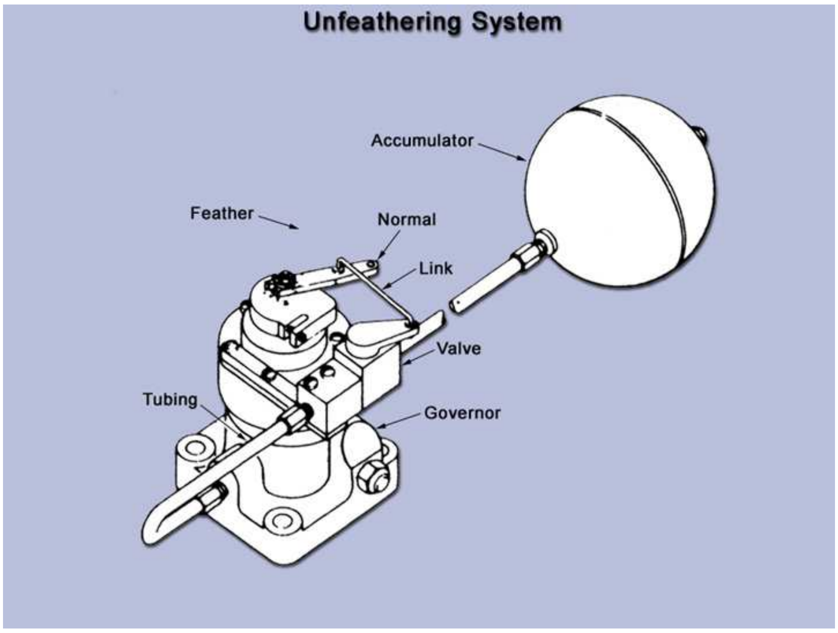
Auxiliary oil entering through the high pressure transfer valve connection shifts the governor transfer valve and disconnects the governor from the propeller line. In the same operation, auxiliary oil is admitted. The oil flows through the engine oil transfer rings, through the propeller shaft governor oil passage and into the distributor valve assembly.



Unfeathering Operation

When the unfeathering operation begins, the piston is in the extreme outboard position. The oil enters the inboard piston end of the cylinder by way of the distributor valve inboard outlet. As the pressure on the inboard end of the piston increases, the pressure against the distributor valve land also increases. When the pressure becomes greater than the combined opposing force of the distributor valve spring and the oil pressure behind this spring, the valve shifts. Once the valve shifts, the passages through the distributor valve assembly to the propeller are reversed. A passage is opened between lands and through a port to the outboard piston end by way of the distributor valve outlet. As the piston moves inboard, under the auxiliary pump oil pressure, oil is displaced from the inboard piston end, through the inlet ports and between the valve lands. Then it moves into the propeller shaft engine oil lands. Then into the propeller shaft engine oil passage where it is discharged into the engine is lubricating system. At the same time, the pressure at the cutout switch increases and the switch opens. However, the circuit to the feathering pump and the motor unit remains complete; so long as the feathering switch is held in.

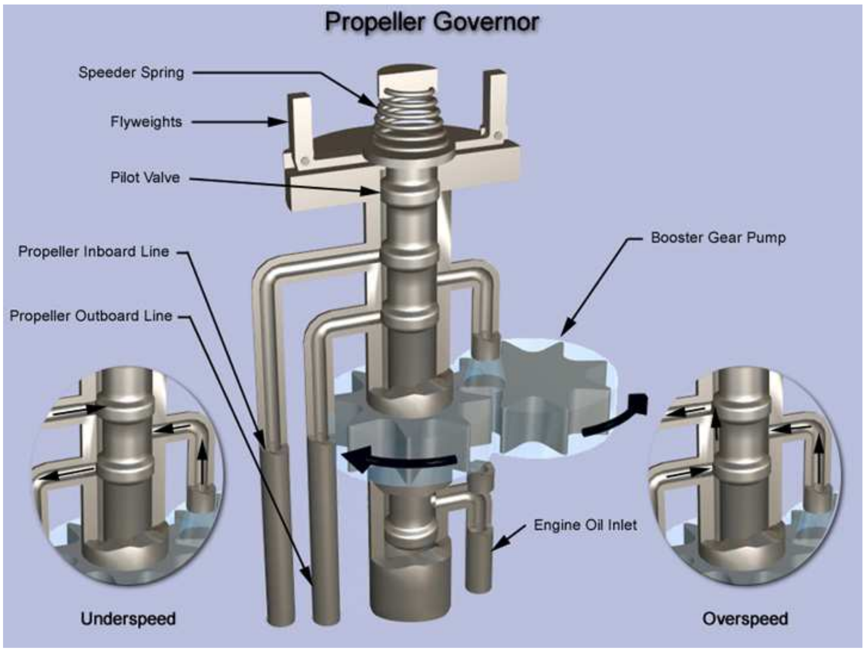
With the inboard end of the propeller piston connected to drain and auxiliary pressure flowing to the outboard end of the piston, the piston moves inboard. This unfeathers the blades. As the blades are unfeathered, they begin to windmill and assist the unfeathering operation by the added force toward low pitch. This is brought about by the centrifugal twisting movement. When the engine speed has increased to approximately 1,000 rpm, the operator should shut off the feathering pump motor. The pressure in the distributor valve and at the governor transfer valve will then decrease, allowing the distributor valve to shift under the action of the governor high pressure transfer valve spring. This action reconnects the governor with the propeller and establishes the same oil passages through the distributor valve that are used during constant speed and feathering operations.



1.7.14 Governor Mechanism

The engine driven propeller governor (constant speed control) receives oil from the lubricating system and boosts its pressure to that required to operate the pitch changing mechanism. It consists of a gear pump to increase the pressure of the engine oil and a pilot valve actuated by flyweights which control the flow of oil through the governor. Also it has a relief valve system which regulates the operating pressures in the governor.
In addition to boosting the engine oil pressure to produce one of the fundamental control forces, the governor maintains the required balance between all three control forces by metering to, or draining from, the inboard side of the propeller piston. Note in the illustration the direction of flow for the overspeed and underspeed. It maintains the exact quantity of oil necessary to maintain the proper blade angle for constant speed operation.
The position of the pilot valve, with respect to the propeller-governor metering port, regulates the quantity of oil which flows through this port to or from the propeller. A speeder spring above the rack returns the rack to an intermediate

position approximating cruising rpm in case of governor control failure.



1.7.15 PROPELLER SYNCHRONIZATION

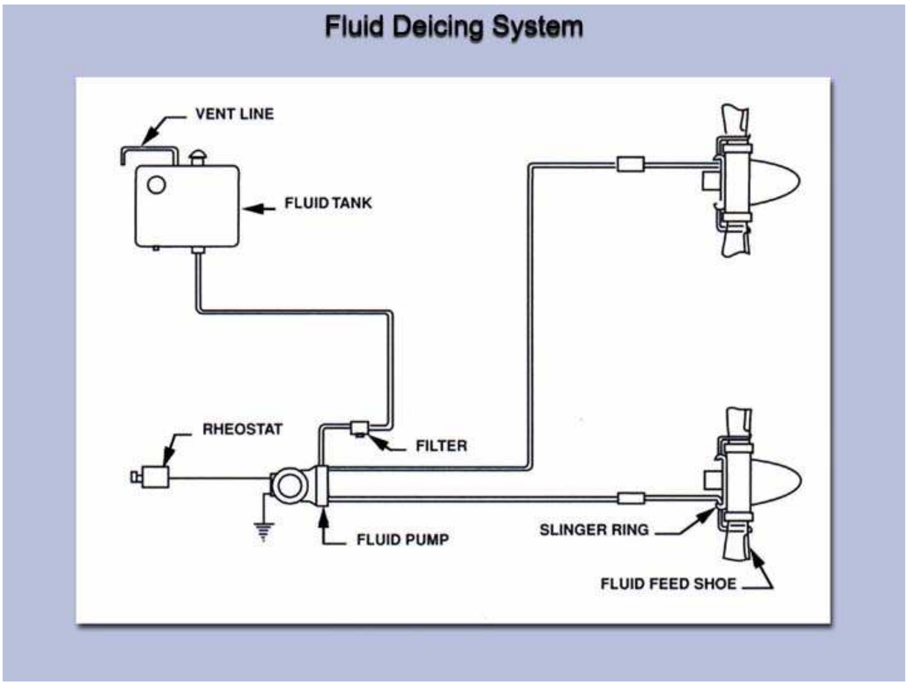
Most four engine aircraft are equipped with propeller synchronization systems. Also, most twin engine aircraft are also equipped with the same. Synchronization systems provide a means of controlling and synchronizing engine rpm. Synchronization reduces vibration and eliminates the unpleasant beat produced by unsynchronized propeller operation. There are several types of synchronizer systems in use.

Effects of Propeller Icing

Ice formation on a propeller blade, produces a distorted blade airfoil section. This causes a loss in propeller efficiency. Generally, ice collects unsymmetrically on a propeller blade and produces propeller unbalance and destructive vibration. Additionally, the extra weight of ice is to be considered.

Fluid Deicing System

A typical fluid system includes a tank to hold a supply of anti-icing fluid. This fluid is forced to each propeller by a pump. The control system permits variations in the pumping rate so that the quantity of fluid delivered to a propeller can be varied, depending on the severity of icing. Fluid is transferred from a stationary nozzle on the engine nose case into a circular U-shaped channel (slinger ring). This channel is mounted on the rear of the propeller assembly. The fluid; under pressure of centrifugal force, is transferred through nozzles to each blade shank.
Feed shoes or boots are installed on the blade leading edge because airflow around the blade shank ends to disperse anti-icing fluids to areas where ice does not collect in large quantities. These feed shoes are a narrow strip of rubber, extending from the blade shank to a blade station that is approximately 75% of the propeller radius. The feed shoes are molded with several parallel open channels in which fluid will flow from the blade shank toward the blade tip by centrifugal force. The fluid flows over the leading edge of the blade, laterally from the channels.
Isopropyl alcohol is used in some deicing systems because of its availability and low cost. Phosphate compounds are comparable to isopropyl alcohol in anti-icing performance and have the advantage of reduced flammability. However, phosphate compounds are comparatively expensive and, consequently, are not widely used.



1.7.16 PROPELLER INSPECTION AND MAINTENANCE

The propeller inspection requirements and maintenance procedures discussed in this section are representative of those in widespread use on most of the propellers described in this chapter. No attempt has been made to include detailed maintenance procedures for a particular propeller. Also all pressures, figures, and sizes are solely for the purpose of illustration and do not have specific application. For maintenance information on a specific propeller, always refer to the Applicable Manufacturer's Instructions.
Additional information may be obtained in AC 20-117 as it contains information vital to ground operation during icing conditions. This information will aid the mechanic in maintenance of the deicing system.

Propeller Inspection

Propellers must be inspected regularly. The exact time interval for particular propeller inspections is usually specified by the propeller manufacturer. The regular daily inspection of propellers varies little from one type to another. Typically it is a visual inspection of propeller blades, hubs, controls, and accessories for security, safety, and general condition. Visual inspection of the blades does not mean a careless or casual observation. The inspection should be meticulous enough to detect any flaw or defect that may exist.
Inspections performed at greater intervals of time, e.g., 25, 50, or 100 hours, usually include a visual check of:

1. Blades, spinners, and other external surfaces for excessive oil or grease deposits.

2. Weld and braze sections of blades and hubs for evidence of failure.

3. Blade, spinner, and hubs for nicks, scratches or other flaws. Use a magnifying glass if necessary.

4. Spinner or dome shell attaching screws for tightness.

5. The lubricating oil levels when applicable.

If a propeller is involved in an accident, and a possibility exists that internal damage may have occurred, the propeller should be disassembled and inspected. Whenever a propeller is removed from a shaft, the hub cone seats, cones, and other contact parts should be examined to detect undue wear, galling or corrosion.

During a major overhaul, the propeller is disassembled and all parts are inspected and checked for size, tolerances, and wear. A magnetic inspection, or another type of nondestructive test, is usually made at this time to determine whether any fatigue cracks have developed on the steel components and assemblies.

1.7.17 PROPELLER VIBRATION AND TRACKING

When powerplant vibration is encountered, it is sometimes difficult to determine whether it is the result of engine vibration or propeller vibration. In most cases, the cause of the vibration can be determined by observing the propeller hub, dome, or spinner while the engine is running within a 1,200 to 1,500 rpm range and by determining whether or not the propeller hub rotates on an absolutely horizontal plane. If the propeller hub appears to swing in a slight orbit, the vibration will normally be caused by the propeller. If the propeller hub does not appear to rotate in an orbit, the difficulty will probably be caused by engine vibration.

When propeller vibration is the reason for excessive powerplant vibration, the difficulty will usually be caused by propeller blade unbalance, propeller blades not tracking or variation in propeller blade angle settings. Check the propeller blade tracking and the low pitch blade angle setting to determine if they are the cause of the vibration.

If both propeller tracking and low blade angle setting are correct, the propeller is statically or dynamically unbalanced and should be replaced or rebalanced if permitted by the manufacturer.

1.7.18 CHECKING AND ADJUSTING PROPELLER BLADE ANGLES

When an improper blade angle setting is found during installation or is indicated by engine performance, the following Maintenance Guidelines are usually followed:

1. From the applicable manufacturer's instructions, obtain the blade angle setting and the station at which the blade angle is checked. Do not use metal scribes or other sharp pointed instruments to mark the location of blade stations or to make reference lines on propeller blades. This is needed because such surface scratches can eventually result in blade failure.

2. Use a Universal Propeller Protractor to check the blade angles while the propeller is on the engine.

1.7.19 SERVICING PROPELLERS

Propeller servicing includes cleaning, lubricating, and replenishing operating oil supplies.

Cleaning Propeller Blades

Aluminum and steel propeller blades and hubs usually are cleaned by washing the blades with a suitable cleaning solvent and using a brush or cloth. Acid or caustic materials should not be used. Power buffers, steel wool, steel brushes or any other tool or substance that may scratch or mar the blade should be avoided.
If a high polish is desired, a number of good grades of commercial metal polish are available. After completing the polishing operation, all traces of polish should be immediately removed. When the blades are clean, they should be coated with a clean film of engine oil or suitable equivalent.
To clean wooden propellers, warm water and a mild soap can be used, together with brushes or cloth.
If a propeller has been subjected to salt water, it should be flushed with fresh water until all traces of salt have been removed. This should be accomplished as soon as possible after the salt water has splashed on the propeller, regardless of whether the propeller parts are aluminum alloy, steel, or wood. After flushing, all parts should be dried thoroughly, and metal parts should be coated with clean engine oil or a suitable equivalent.

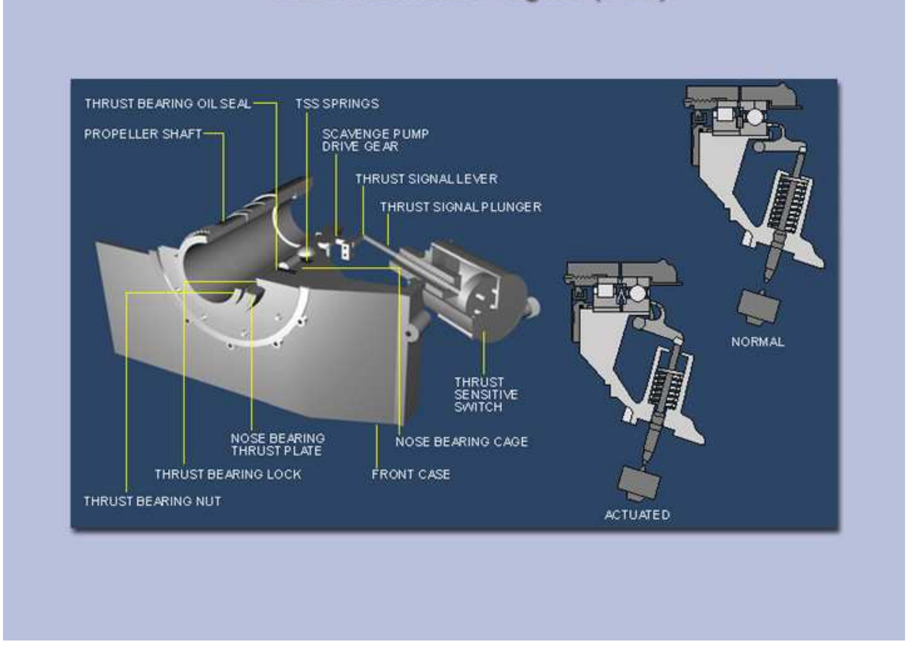
Propeller Lubrication

Hydromantic propellers operated with engine oil do not require lubrication. Electric propellers will require oil and grease for hub lubricants and pitch change drive mechanisms.
Proper propeller lubrication procedures with oil and grease specifications are usually published in the manufacturer's instructions. Experience indicates that water sometimes gets into the propeller blade bearing assembly on some models of propellers. For this reason, the propeller manufacturer's greasing schedule must be followed to ensure proper lubrication of moving parts. Grease replacement through attached pressure fittings (zerks) must be done in accordance with the manufacturer's instructions.
The oil reservoir level must be checked at specified intervals on propellers that have self-contained hydraulic units. Usually, this type of propeller must have one of the blades (generally No. 1) positioned so that the oil is visible in a sight glass on the side of the reservoir. Extreme care must be used when servicing the reservoir to avoid overfilling or servicing with the wrong specification oil.

Turboprop Propeller - Thrust Sensitive Signal (TSS)

The thrust sensitive signal (TSS) is a safety feature that actuates the propeller feather lever. If a power loss occurs during takeoff, propeller drag is limited to that of a feathered propeller. This reduces the hazards of yawing in multiengine aircraft. This device automatically increases blade angle and causes the propeller to feather.

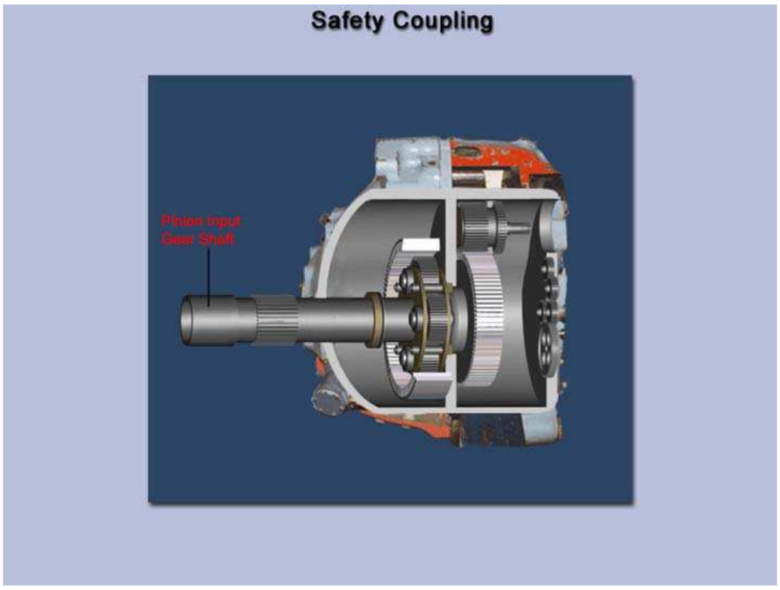
The TSS system consists of an externally mounted switch assembly on the right side of the reduction gearbox. A plunger extends into the switch from the inside of the gearbox. A spring loads the plunger against the thrust signal lever mounted inside the gearbox and contacts the outer ring of the prop shaft thrust bearing. When propeller-positive thrust exceeds a predetermined value, the prop shaft and ball bearing move forward, compressing two springs located between the thrust and rollerbearing assemblies. The thrust signal lever follows the outer ring, and the TSS plunger moves into the front gearbox. The TSS system is then armed for takeoff and automatic operation. At any subsequent time when propeller thrust decreases below the predetermined value, a spring force moves the prop shaft rearward. When this occurs, the TSS plunger moves outward, energizing the autofeather system. This signals the propeller to increase the blade angle.



Thrust Sensitive Signal (TSS)

Turboprop Propeller Safety Coupling

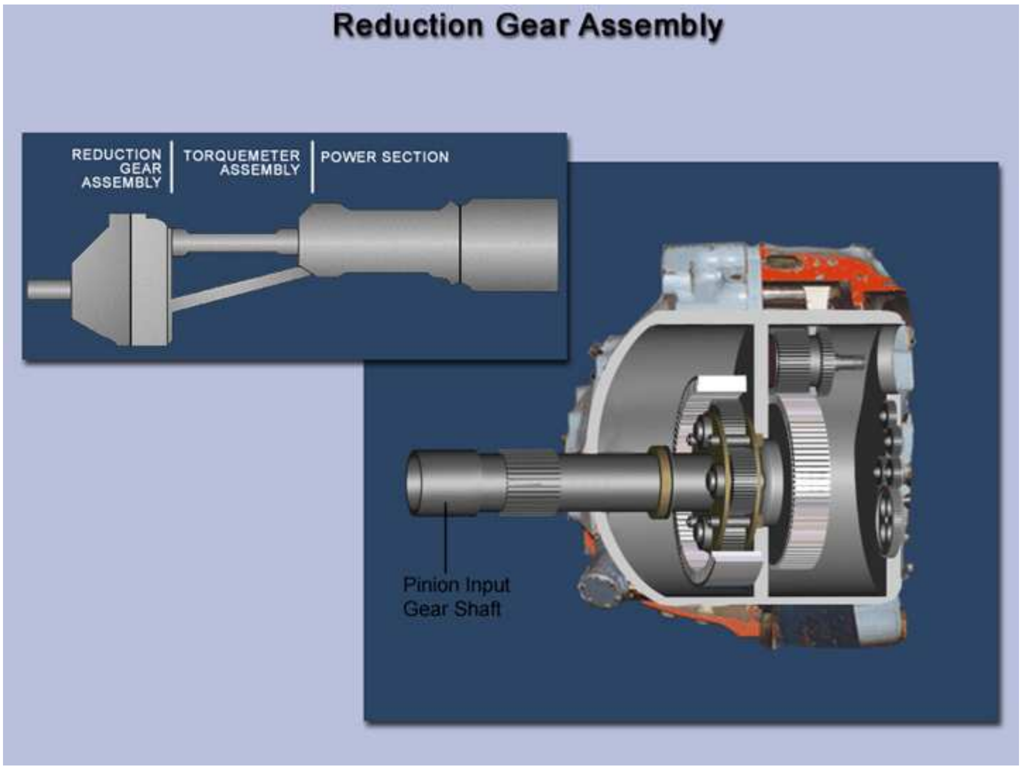
A safety coupling disengages the reduction gear from the power unit if the power unit is operating above a preset negative torque value considerably greater than that required to actuate the NTS. The coupling consists essentially of an inner member splined to the pinion shaft. It also consists of an outer member bolted to the extension shaft and an intermediate member connected to the inner member through helical teeth. This then is connected to the outer member through straight teeth.
The reaction of the helical teeth moves the intermediate member forward and into mesh when positive torque is applied. It is also rearward and out of mesh when negative torque is applied. Thus, when a predetermined negative torque is exceeded, the coupling members disengage automatically. Reengagement is also automatic during feathering or power unit shutdown. The safety coupling will operate only when negative torque is excessive.



Reduction Gear Assembly

A reduction gear assembly incorporates a single propeller drive shaft, an NTS system, a TSS system, a safety coupling, a propeller brake, an independent dry sump oil system and the necessary gearing arrangement. The propeller brake is designed to prevent the propeller from windmilling when it is feathered in flight, and to decrease the time for the propeller to come to a complete stop after engine shutdown. The propeller brake is a friction cone type, consisting of a stationary inner member and a rotating outer member which, when locked, acts upon the primary stage reduction gearing. During normal engine operation,

reduction gear oil pressure holds the brake in the released position. This is accomplished by oil pressure which holds the outer member away from the inner member. When the propeller is feathered or at engine shutdown, as reduction gear oil pressure drops off, the effective hydraulic force decreases and a spring force moves the outer member into contact with the inner member.
The power unit drives the reduction gear assembly through an extension shaft and torquemeter assembly. The reduction gear assembly is secured to the power unit by the torquemeter housing which serves as the bottom support and a pair of the struts serving as the top support. The tie struts assist in carrying the large overhanging moments and forces produced by the propeller and reduction gear. The front ends of the struts have eccentric pins, which are splined for locking. These pins adjust the length of the strut to compensate for the manufacturing tolerances on the drive shaft housing and inter-connecting parts.



CHAPTER 2: TECHNICAL ENGLISH

This Manual-Software is used during the class to the students in a visual forms, in the first place we introduced the Manual-Software, we talked about the theme that will be presented during the class, after with the help of In-focus and a computer several information are shown in order to get in the students the best idea over the function of each system the C-130 Airplane.
When the information and graphs are presented the students have different questions that the instructor must answer about the meaning of words, pronunciation, technical words an so on as about the function of each item that appears in the different graphs and diagrams.
The theory generally is explained by the instructor step by step and the students hear and look at the images shown by the in-focus.

2.1 ENGLISH AS AN INTERNATIONAL AND USEFUL LANGUAGE.

English is increasingly being used as a tool for interaction among non native speakers. Over one half of the one billion English speakers of the world learned English as a second or foreign language. Most English language teachers across the globe are non native English speakers, which means the norm is bilingualism, and not mono lingualism.
English has become a tool for international communication in transportation, commerce, banking, tourism, technology, diplomacy, and scientific research, and in this case is so important to have a clear idea about technical English related with aeronautical field.

2.2 CURRENT DEFINITIONS.

It is so essential to know different definitions about words that are used in the English education so; we are going to give the most important:
From the mid-1880s to the mid-1980s, the language teaching profession was involved in a search for “methods” or one method that could successfully teach students a foreign language in the classroom.

What is a method?

Edward Anthony (1963) said there were three hierarchical elements, ***approach, method and technique.***

Approach:

A set of assumptions dealing with the nature of language, learning, and teaching.

Method:

An overall plan for systematic presentation of language based on a selected approach.

Techniques:

Specific activities shown in the classroom according to a method and in harmony with an approach.
For example: At the ***approach*** level, a teacher could emphasize the importance of learning in a relaxed environment. Just above the threshold of consciousness. The ***method*** could resemble Suggestopedia. ***Techniques*** could include playing baroque music while reading a passage in the foreign language.
However, now, thanks to Richards and Rodgers (1982, 1986), Anthony's proposal has been renamed to ***approach, design, and procedure***. They have called this three-step process a ***method***, "an umbrella term for the specification and interrelation of theory and practice" (1982).
An ***approach*** defines assumptions, beliefs, and theories about the nature of language and language learning.
Designs specify the relationship of those theories to classroom materials and activities.
Procedures are the techniques and practices derived from one's approach and design.
Today, the concept of separate methods is no longer a main issue in language-teaching practice. Instead, we refer to methodology as the umbrella term, reserving the term method for more specific clusters of compatible classroom techniques.

2.3 CURRICULUM/SYLLABUS

Designs for carrying out a particular language program. Features include a primary concern with the specification of linguistic and subject-matter objectives, sequencing, and materials to know the needs of a designated group of learners in a defined context. (Syllabus = UK ; Curriculum = USA)

Technique: Any of a wide variety of exercises, activities, or tasks used in the language classroom for realizing lesson objectives.

CHAPTER 3 MANUAL-SOFTWARE FOR TEACHING TECHNICAL ENGLISH.

During the presentation of this Manual-Software in the ITSA to the students of mechanical aeronautical career, we could demonstrate that our project and our effort had got results. The students today wish that all classes could be presented at the same form in other words audio visual color inputs opposed to plain text and straight lecture.
When we finished the period during which the Manual-Software was introduced as new material of instruction, it helped in the process of teaching-learning process. We had the opportunity to inquiry the students who received the instruction with this Manual-Software and the result was that all students and professors were happy with the information that contains and the facility to learn with this methodology.

3.1 TECHNICAL ENGLISH

The principal aim of this Manual-Software is the improvement of students' ability to read and translate Technical orders. The groups are homogeneous according to skills and cover authentic and specific material to their field. Relevant Grammar and syntax to technical and scientific writing are considered. In addition, the course with this Manual-Software oral and written skills. Students who finished this level have completed all knowledge about systems of C-130 Airplane and have improved Technical English requirements.

3.2 TECHNICAL ENGLISH FOR MECHANICAL

Developing the ability to read and understand Technical Orders in the field of Mechanical Aeronautical. This field covers a wide range of related topics so that the students were exposed to a variety of articles dealing with subjects like: Mechanics of Materials, Thermodynamics, Fluid Dynamics, Mechanical Aeronautical Design, Friction and Lubrication. Students who study Technical English and systems of C-130 Airplane require special effort in order to increase this knowledge. The skills developed in this period were following:

a. vocabulary building through the study of word construction,
b. ability to write formal definitions of technical terms and expression,
c. ability to analyze information presented in graphs, charts, tables, etc.,

3.3 COMMUNICATIVE LANGUAGE TEACHING.

Nowadays, we teach English and specially technical English using methods in which students have the opportunity to be the main actors; on the other hand, they have to use the language to communicate but in this case they need to use the technical words to give and receive information in a good way. We present some characteristics about the communicative language teaching those are used to guide the teaching- learning process, in this way we are exploring pedagogical means for real life communication in the classroom. We are trying to have learners who developed linguistics fluency, and not just accuracy, as in the past.

3.4 METHODOLOGY.

English teaching is based in contents and in the development of the competences so, in the class we use contents related with technical topics in order to develop the process. One of the advantages to use the content is that students are interested in learning because they need it in their real life; in other words they need in their technical labs, thus they are very motivated, in this way we have a connexion between learning English and learning technical English, but we have to choose the appropriate topics according to their knowledge.

When we design a set of interesting topics, it lets to the students to develop their communicative competences in order give and receive information in different places and situations.

On the other hand, the studies' programme must have an aim to present and develop the linguistics competences through the receptive and productive skills in an integrated way, it is because students need to get information through listening and reading and then they have to write notes, complete tables, order information or they give information in a written or oral way.

Students must build up their meaningful learning based in the relation between language skills and their macro functions, the programs are directed to develop skills and some sub skills as study techniques such as:
Take notes, classify some words, and order in sequence, present hypothesis. Infer, deduce, elaborate pictures, draw some graphics of different parts in an engine, summaries, etc.

3.5 METHODOLOGY IS DEFINED AS:

1. "the analysis of the principles of methods, rules, and postulates employed by a discipline" or
2. "the development of methods, to be applied within a discipline"
3. "a particular procedure or set of procedures".
4. It should be noted that *methodology* is frequently used when *method* would be more accurate. For example, "Since students were not available to complete

the survey about academic success, we changed our methodology and gathered data from instructors instead". In this instance the methodology (gathering data via surveys, and the assumption that this produces accurate results) did not change, but the method (asking teachers instead of students) did.

3.6 METHODOLOGY INCLUDES THE FOLLOWING CONCEPTS AS THEY RELATE TO A PARTICULAR DISCIPLINE OR FIELD OF INQUIRY:

1. a collection of theories, concepts or ideas;
2. comparative study of different approaches; and
3. critique of the individual methods

Methodology refers to more than a simple set of methods; rather it refers to the rationale and the philosophical assumptions that underlie a particular study. This is why scholarly literature often includes a section on the methodology of the researchers. This section does more than outline the researchers' methods (as in, "We conducted a survey of 40 people over a two-week period and subjected the results to statistical analysis", etc.); it might explain what the researchers' ontological or epistemological views are.

Another key (though arguably imprecise) usage for methodology does not refer to research or to the specific analysis techniques. This often refers to anything and everything that can be encapsulated for a discipline or a series of processes, activities and tasks. Examples of this are found in software development, project management and business process fields. This use of the term is typified by the outline who, what, where, when & why. In the documentation of the processes that make up the discipline, which is being supported by "this" methodology, that is where we would find the "methods" or processes. The processes themselves are only part of the methodology along with the identification and usage of the standards, policies, rules, etc.

Qualitative research is one of the two major approaches to research methodology in social sciences. Qualitative research involves an in-depth understanding of human behavior and the reasons that govern human behavior. Unlike quantitative research, qualitative research relies on reasons behind various aspects of behavior. Simply put, it investigates the why and how of decision making, as compared to what, where, and when of quantitative research. Hence, the need is for smaller but focused samples rather than large random samples, which qualitative research categorizes data into patterns as the primary basis for organizing and reporting results.

Quantitative research is the systematic scientific investigation of quantitative properties and phenomena and their relationships. Quantitative research is widely used in both the natural and social sciences, from physics and biology to sociology and journalism.

The objective of quantitative research is to develop and employ mathematical models, theories and hypotheses pertaining to natural phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships.
The term quantitative research is most often used in the social sciences in contrast to qualitative research.
After we analyze several methods and apply at the ITSA, we obtained the best result with the suggestopedia method.

3.7 SUGGESTOPEDIA

Suggestopedia is one of the teaching methods developed by Bulgarian psychologist Georgi Lozanov based on the study of Suggestology. The method has been used in different fields of studies but mostly in the field of foreign languages learning. Lozanov claimed that by using this method one can teach languages approximately three to five times as quickly as conventional methods.
However, this assertion has not been proven scientifically and is impossible to verify in the absence of a scientific benchmark for learning speed using conventional methods. The foreign language educator Ludger Schiffler of the Free University of Berlin compared in a scientific experiment the effectiveness of suggestopedia with a conventional method. The experiment was conducted both for intensive learning (4 hours per day) and extensive learning (2 hours twice a week), testing six different skills. Only under intensive learning conditions suggestopedic learning showed superior results. Under extensive learning conditions suggestopedic learning showed no significant difference.
The theory applied positive suggestion in teaching when it was developed in the 1970s. However, as improved, it has focused more on “desuggestive learning” and now is often called “desuggestopedia.” Suggestopedia is the latest of the six major foreign-language teaching methods known to language teaching experts (the oldest being the grammar translation method.) The name of Suggestopedia is from the words “suggestion” and “pedagogy.”

3.8 RECENT DEVELOPMENT

Up to now, suggestopedia has been the only method working with relaxation. Mainly based on the discovery of the mirror neurons Ludger Schiffler (2003) has developed the interhemispheric foreign language learning, using gestures and the mental visualization of the gestures during the relaxation period.

3.9.PURPOSE AND THEORY

The intended purpose of Suggestopedia was to enhance learning by lowering the affective filter of learners. Lozanov claims in his website, Suggestology and Suggestopedy, that “suggestopedia is a system for liberation,” the liberation from the “preliminary negative concept regarding the difficulties in the process of learning” that is established throughout their life in the society. Desuggestopedia focuses more on liberation as Lozanov describes “desuggestive learning” as “free, without a mildest pressure, liberation of previously suggested programs to restrict intelligence and spontaneous acquisition of knowledge, skills and habits.” The method implements this by working not only on the conscious level of human mind but also on the subconscious level, the mind’s reserves. Since it works on the reserves in human mind and brain, which are said to have unlimited capacities, one can teach more than other method can teach in the same amount of time.

Physical surroundings and atmosphere in classroom are the vital factors to make sure that "the students feel comfortable and confident”, and various techniques, including art and music, are used by the trained teachers. The lesson of Suggestopedia consisted of three phases at first: deciphering, concert session (memorization séance), and elaboration.

Deciphering: The teacher introduces the grammar and lexis of the content.
Concert session (active and passive): In the active session, the teacher reads the text at a normal speed, sometimes intoning some words, and the students follow. In the passive session, the students relax and listen to the teacher reading the text calmly. Music (“Pre-Classical”) is played background.
Elaboration: The students finish off what they have learned with dramas, songs, and games.
Then it has developed into four phases as lots of experiments were done: introduction, concert session, elaboration, and production.
Introduction: The teacher teaches the material in “a playful manner” instead of analyzing lexis and grammar of the text in a directive manner.
Concert session (active and passive): In the active session, the teacher reads with intoning as selected music is played. Occasionally, the students read the text together with the teacher, and listen only to the music as the teacher pauses in particular moments. The passive session is done more calmly.
Elaboration: The students sing classical songs and play games while “the teacher acts more like a consultant
Production: The students spontaneously speak and interact in the target language without interruption or correction.

Teachers

Teachers should not act directive although this method is teacher-controlled but not students- controlled. For example, they should act as a real partner to the students, participating in the activities such as games and songs "naturally" and "genuinely." In the concert session, they should fully include classical art into their behaviors. Although there are many techniques that the teachers use, the factors such as "communication in the spirit of love, respect for man as a human being, the specific humanitarian way of applying there 'techniques'" etc. are crucial. The teachers need not only to know the techniques and theoretical information but also to understand the theory and to acquire the practical methodology completely because if they implement those techniques without complete understandings and acquisition, they could not provide learners successful results, or even could give a negative impact on their learning. Therefore the teacher has to be trained in the course that is taught by the certified trainers.

Here are the most important factors for teachers to acquire, described by Lozanov.

1. Covering a huge bulk of learning material.
2. Structuring the material in the suggestopaedic way; global-partial – partial-global, and global in the part – part in the global, related to the golden proportion.
3. As a professional, on one hand, and a personality, on the other hand, the teacher should be highly prestigious, reliable and credible.
4. The teacher should have, not play, a hundred percent of expectancy in positive results (because the teacher is already experienced even from the time of teacher training course).
5. The teacher should love his/her students (of course, not sentimentally but as human beings) and teach them with personal participation through games, songs, a classical type of arts and pleasure.

Methodology refers to more than a simple set of methods; rather it refers to the rationale and the philosophical assumptions that underlie a particular study. This is why scholarly literature often includes a section on the methodology of the researchers.

The Suggestopedia Method was used during this period, because we considering that with the Manual-Software are more easily to learn as Technical English as Systems of C-130 Airplane and in the forms as this method is employed. For that reason we obtained the better results with the students of second level of Mechanical Aeronautical Career at ITSA.

PART THREE

METHODOLOGICAL DESIGN

3.1. Research Type and Design.-

RESEARCH TYPE

- The type of research that was used during the application of this Manual-Software to the students of mechanical aeronautical career at ITSA is Descriptive and Evaluative Research, which use a method of analysis to show their characteristics and properties in a fixed form.

RESEARCH DESIGN

- Qualitative
- Quantitative
- Survey

3.2. Population and Sample.

The Aeronautical Technological Superior Institute has:
Universe – 600 students.
Population – 400 students in mechanical aeronautical careers.
Sample – 40 students in mechanical specialty.

A population is defined as a set of elements; an element is defined as the basic unit that comprises the population.
The sample is a number of elements that have to be taken for a universe and this data have to be representative of all the population.

To size of the sample depends on:

- Allowed error
- The confidence of the error
- The population characteristics, that can be finite or infinite

Some of the general formulas that let determine the samples are:

To infinite population (more than 100.000 habitants):

To finite populations (less than 100.000 habitants):

Where:

n= number sample elements

N= number of universe elements

P/Q= Probability of occurrence

Z2= critical value to the confidence value, sigma value 2, then z=2

E= allowed error

To calculate our sample we know:

N= 400

P/Q= 40/40

Z2= 2

E= allowed error 5%

$$n = \frac{N}{E2\ (N-1)} = \frac{400}{(5)\ (5)\ (400-1)} = \frac{400}{(25)\ (399)} = \frac{400}{9975} = 0.040 * 1000 = 40$$

So the sample will be of 40 students.

3.3. Fielding.

Our research will develop in the students at the ITSA of the mechanical aeronautical career during February – April 2007. Campus Latacunga, Amazonas and Javier Espinoza Avenue.

3.4. Instruments for Data Collection

The following are the instruments by which data and evidence were collected.

- A survey to students and teachers in order to obtain their subjective impressions about the application of a C-130 Airplane Technical English Manual-Software.
- To be an observer participant in the classroom and make an ethnographic record of the teaching-learning process.
- To apply the Technical English Manual-Software and evaluate the improvement of Teaching-Learning process as Technical English and Systems of C-130 Airplane.
- A survey about the acceptation of this Technical English Manual-Software as principle tool of teaching in the Institute.
- Standardized tests in order to evaluate the improvement of the four skills of Technical English and systems of C-130 Airplane in the students.

CLASSROOM OBSERVATION

Through the classroom observation, we could get information about the methodology, activities, and some other aspects of the teaching – learning process in the Aeronautical Technological Superior Institute.

- **To elaborate the survey**

During the research a questionnaire with closed and open questions was applied the same that let to know the reality that existed in view of the fault a Technical English Manual.

- **Validation of the survey**

This survey was validated through of specialties about the title or by the project consultants.

- **Application of the survey**

The survey was applied to 40 students in the mechanical aeronautical career at ITSA.

- **Collection of information**

We collected all dates in a fielding form.

- **Tabulation of the dates and procedures.**

We used methodologies and adequate statistics of information.

PART FOUR

ADMINISTRATIVE FRAME

4.1. GRAPHICAL EXPOSITION AND ANALYSIS OF RESULTS

In order to know the opinion about the acceptance of this Manual for the instruction of the students in the maintenance area of the ITSA, we prepared a survey for the 40 students of this course.

Statistics

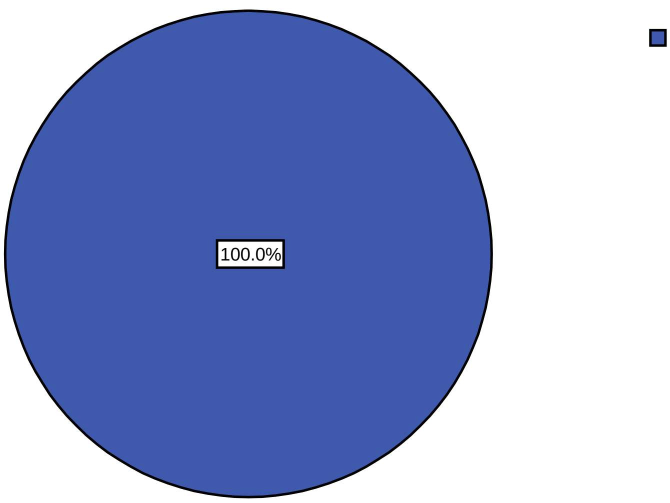
Names

Valid	40
Missing	0

Names

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	40	100,0	100,0	100,0

STUDENTS INQUIRED



ANALYSIS

In this graphic we can see that all the second semester aircraft maintenance students accepted the survey about our proposal for a Manual of Technical English of the main systems of C-130 airplane.

1. - Do you consider the applied manual is useful for teaching Technical English and the main systems C-130 Airplane?

YES ☐ **NOT** ☐

Statistics

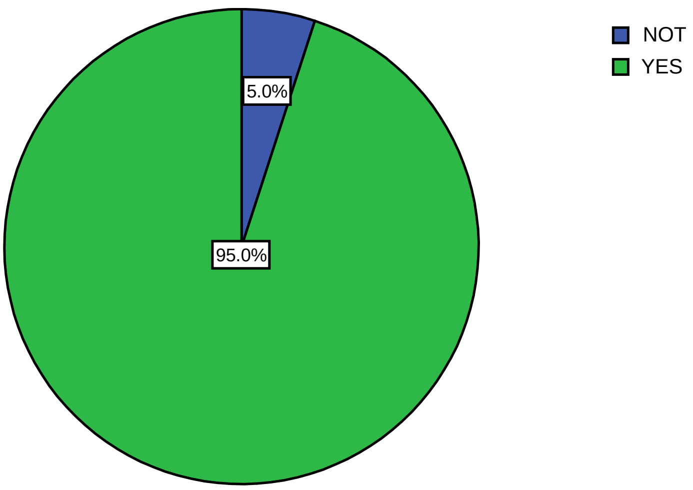
Manual will help the instruction

	Valid	40
	Missing	0

Manual will help the instruction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NOT	2	5,0	5,0	5,0
	YES	38	95,0	95,0	100,0
	Total	40	100,0	100,0	

Manual will help the instruction



ANALYSIS

In this question, 95% said that this Manual would help in learning both theoretical, and practical, aspects of Lockheed C-130 Hercules 5% of ITSA students said that this material will not help.

INTERPRETATION

We can assume from the answers to this question that most ITSA students accept this Manual and believe it will help in the instruction technical students at the Institute.

2. How important will the existence of this Manual be for both, teachers, and students, in the maintenance specialty at the Institute?

VERY IMPORTANT ☐ **IMPORTANT** ☐ **NOTHING IMPORTANT** ☐

Statistics

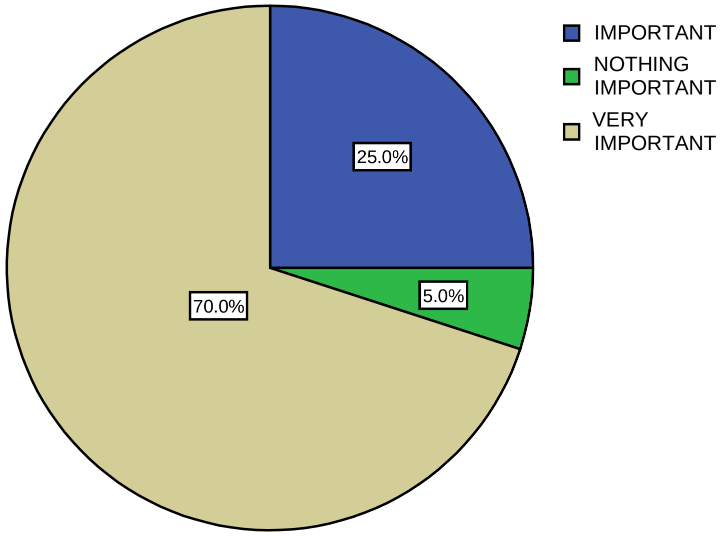
Existence of Manual in the Institute

	Valid	40
	Missing	0

Existence of Manual at the ITSA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	IMPORTANT	10	25,0	25,0	25,0
	NOTHING IMPORTANT	2	5,0	5,0	30,0
	VERY IMPORTANT	28	70,0	70,0	100,0
	Total	40	100,0	100,0	

Existence of Manual in the Institute



ANALYSIS

The 70% said that is very important this Manual at the Institute. 25% considered that this is important and the 5% say it is not important.

INTERPRETATION

Our interpretation to this question is that most students consider our research was very important for the entire Institute.

3. - Are there any maintenance or Technical English manuals for the Lockheed C-130 Hercules aircraft available to ITSA students?

YES ☐ **NOT** ☐

Statistics

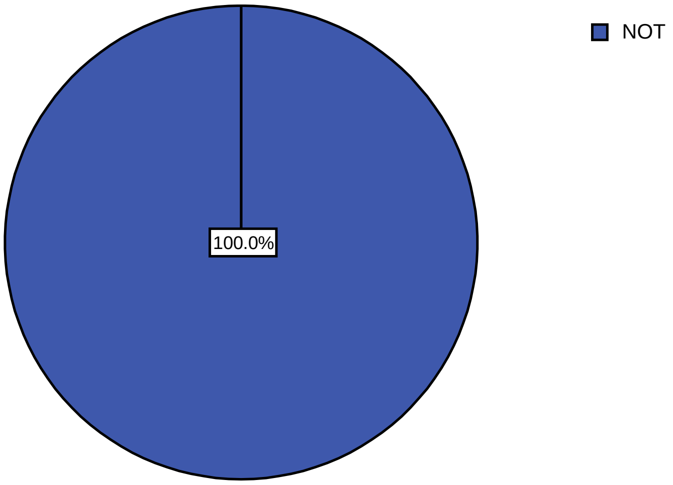
Actually there is a Manual similar

Valid	40
Missing	0

Actually there is a Manual similar

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NOT	40	100,0	100,0	100,0

Actually there is a Manual similar



ANALYSIS

In this question, 100% say that there are no theoretical, or practical, materials available at the Institute for the Lockheed C-130 Hercules aircraft or any of its systems.

INTERPRETATION

All of the students stated there is not material model at the Institute. They all believe that this manual will be very interesting for theoretical instruction of Technical English and aircraft systems.

4. - Do you believe if ITSA has any relevant materials to teach about C-130 aircraft?

YES ☐ **NO** ☐

Statistics

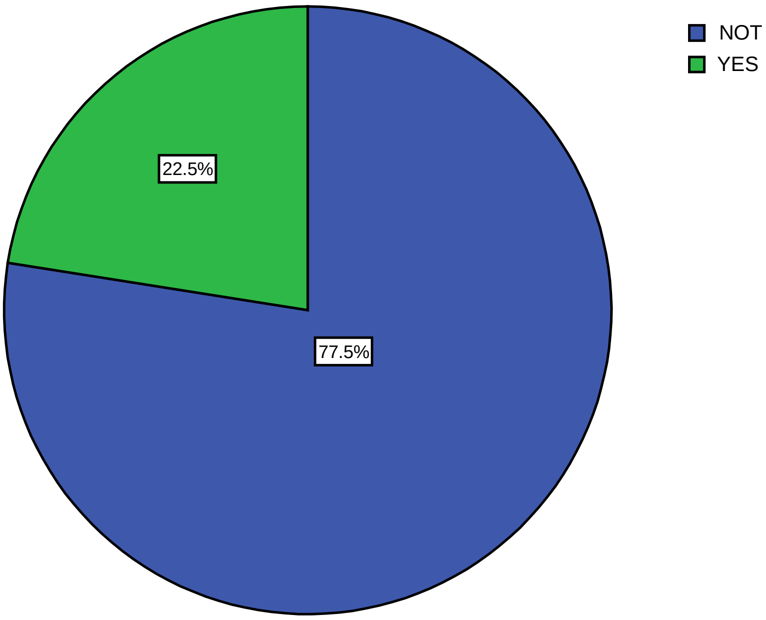
Material qualified before this manual

Valid	40
Missing	0

Material qualified before this manual

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NOT	31	77,5	77,5	77,5
	YES	9	22,5	22,5	100,0
	Total	40	100,0	100,0	

Material qualified before this manual



ANALYSIS

The 77.5% of the students said that before this Manual there were no similar materials for this purpose, and the 22.5% say that the resources are limited but the instruction is complete.

INTERPRETATION

The interpretation to this question says that before the introduction of this Manual no were no similar materials for the C-130 or any other aircraft of the Ecuadorian Air Force.

5. - Do you believe that this material will increase the technical knowledge of new airmen and help to improve the process of maintenance in the C-130 squadron?

YES ☐ **NOT** ☐

Statistics

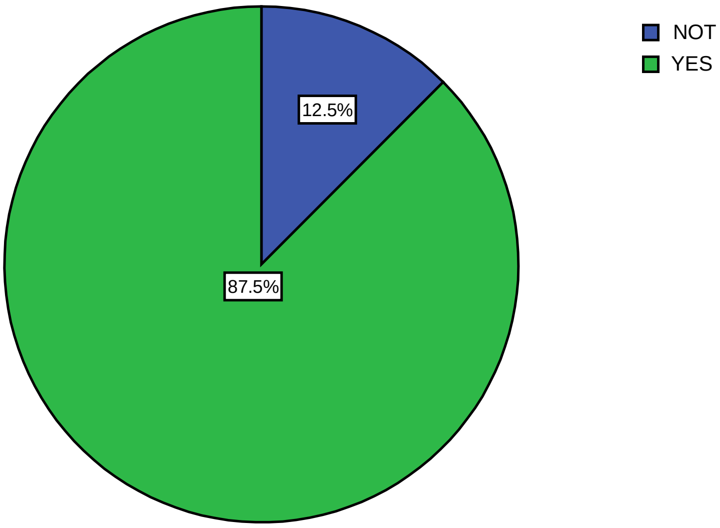
Will improve the knowledge in the students

Valid	40
Missing	0

Will improve the knowledge in the students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NOT	5	12,5	12,5	12,5
	YES	35	87,5	87,5	100,0
	Total	40	100,0	100,0	

Will improve the knowledge in the students



ANALYSIS

In this question the 87.5% of the students said that it would improve the knowledge of the students and the 12.5% say that the knowledge would not improve.

INTERPRETATION

As conclusion to this question we can say that the knowledge of the students in the technical area will improve with the use of this Manual of Technical English, concerning the main systems of the C-130 aircraft.

6. - Do you think that this Manual will help to improve the quality of work performed by technicians who learned from it?

YES ☐ **NOT** ☐

Statistics

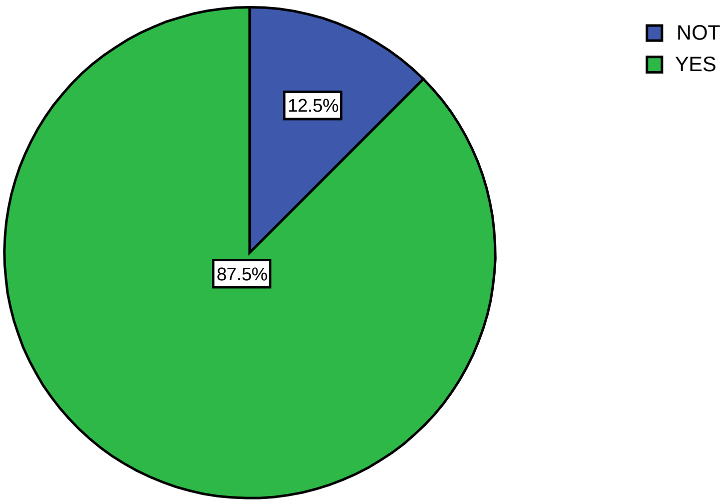
Will improve the quality of work performed by technicians

Valid	40
Missing	0

Will improve the quality of work performed by technicians

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NOT	5	12,5	12,5	12,5
	YES	35	87,5	87,5	100,0
	Total	40	100,0	100,0	

Will improve the jobs of maintenance



ANALYSIS

In this question the 87.5% of the students said that with the use of this Manual in the instruction of the students the level of technical knowledge in the maintenance of the airplanes in the Institution will improve, and the 12.5% say that the maintenance will not improve.

INTERPRETATION

We can conclude in this question that the students accept the Manual as alternative in order to improve the maintenance of aircrafts in the Ecuadorian Air Force.

7. - Do you think that it is necessary to increase some additional information to this Technical English Manual about the main systems of the C-130 airplane?

YES ☐ **NOT** ☐ **LITTLE** ☐ **A LOT OF** ☐

Statistics

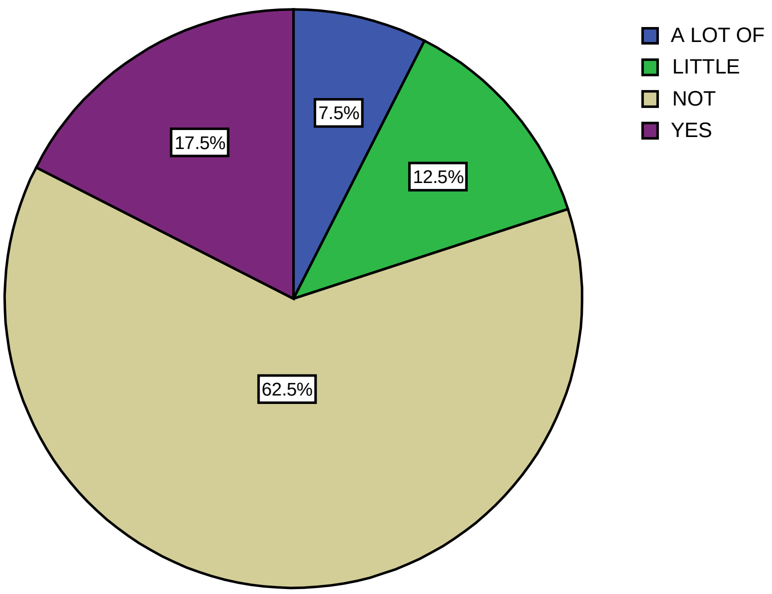
This manual needs additional information

	Valid	40
	Missing	0

This manual needs additional information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A LOT OF	3	7,5	7,5	7,5
	LITTLE	5	12,5	12,5	20,0
	NOT	25	62,5	62,5	82,5
	YES	7	17,5	17,5	100,0
	Total	40	100,0	100,0	

This manual needs aditional information



ANALYSIS

To this question the 62.5% of the students said that it is not necessary to include additional information, and 17.5% say that it is necessary to include information. 12.5% say that little information is necessary to include and the 7.5% said that the Manual require a lot of information.

INTERPRETATION

In this question most students said that the Manual is according to the necessities of the students and the Institute.

8.- Do you think that periodic evaluations using this Technical Manual is necessary to evaluate the students in aircraft maintenance or are there any other form of evaluation available?

YES ☐ **NOT** ☐

Statistics

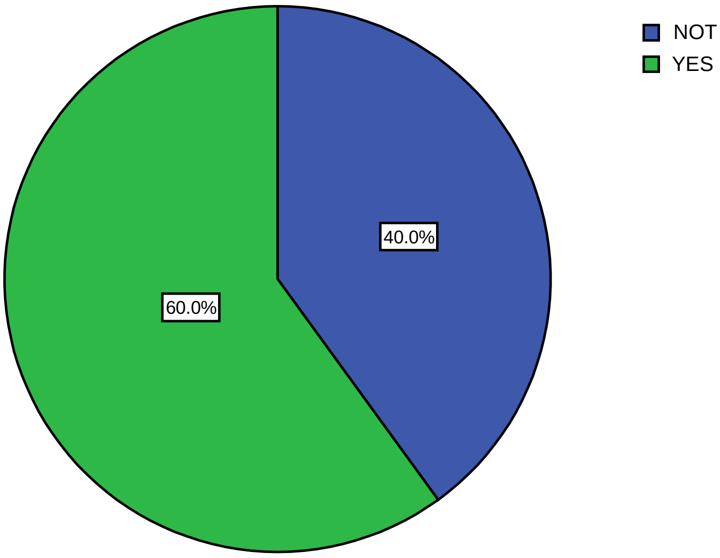
Periodic evaluations will be necessary

Valid	40
Missing	0

Periodic evaluations will be necessary

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NOT	16	40,0	40,0	40,0
	YES	24	60,0	60,0	100,0
	Total	40	100,0	100,0	

Periodic evaluations will be necessary



ANALYSIS

The 60% of the students said that it will be necessary periodic evaluations in order to determine the increase of the knowledge and the 40% say that evaluations are not necessary.

INTERPRETATION

In all courses it will be necessary evaluations in order to know the progress of the instruction, it will be indispensable to do evaluations.

9. - Is it important to apply evaluations comparing earlier teaching resources with the proposed software manual?

TRUE ☐ **FALSE** ☐

Statistics

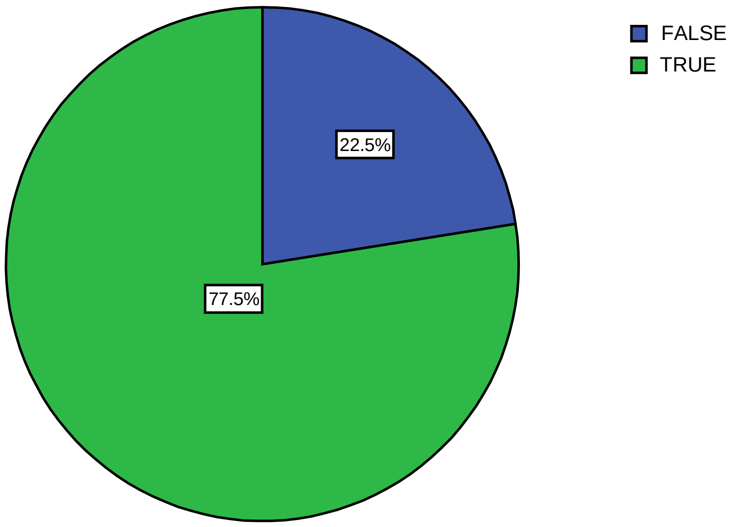
How to determine the level of knowledge

Valid	40
Missing	0

How to determine the level of knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FALSE	9	22,5	22,5	22,5
	TRUE	31	77,5	77,5	100,0
	Total	40	100,0	100,0	

How to determine the level of knowledge



ANALYSIS

In this question the 77.5% said that in order to determine the level of knowledge during the course it is necessary to evaluate and 22.5% believe that there are other methods to evaluate students on their level of knowledge.

INTERPRETATION

In other words the periodicals evaluation is the best procedure in order to know the progress during the period of class.

10. - After to know this Manual-Software and receive instruction of Technical English and systems C-130 Airplane. What is your qualification?

EXCELLENT ☐ **INTERESTING** ☐ **NOT IMPORTANT** ☐

Statistics

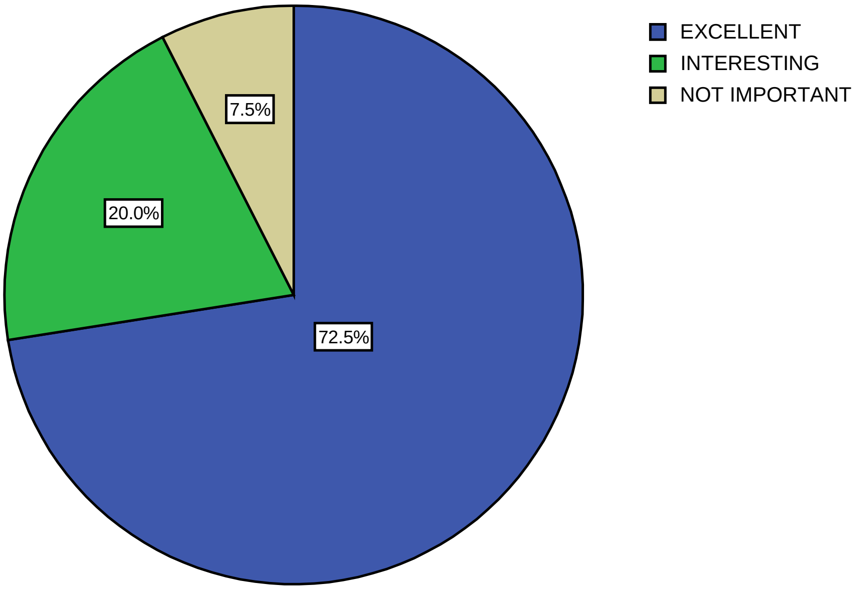
Qualification the Manual-Software

N	Valid	40
	Missing	0

Qualification the Manual-Software

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	EXCELLENT	29	72,5	72,5	72,5
	INTERESTING	8	20,0	20,0	92,5
	NOT IMPORTANT	3	7,5	7,5	100,0
	Total	40	100,0	100,0	

Qualification the Manual-Software



ANALYSIS

The last question is very important for us, the 72.5% of the students considered that the Manual is excellent, while 20% say that is interesting and the 7.5% say that the Manual is not important.

INTERPRETATION

In this question the opinion of the students to this Manual-Software according to the graph is excellent, in other words we can say that The Manual of Technical English of the main systems of the C-130 aircraft is accepted for the Institute with excellent results.

4.2. CONCLUSIONS

As conclusions over the application of C-130 Aircraft Technical English Manual-Software to the students of Mechanical Aeronautical career at ITSA during March to June, we can say.

- The Manual-Software is accepted by the students as one of the most important resource to improve the teaching-learning process of Technical English to know the main systems of C-130 Airplane.

- The information gathering in this Manual-Software is elemental but it is important in order to know the mechanical of C-130 Airplane.

- The professors and students want that this Manual-Software will be part of the Institute in the future as part of a Syllabus of instruction to the mechanical Aeronautical area.

- The methodology used in order to improve the teaching-learning process as in Technical English as Systems as SUGGESTOPEDIA with the help of in focus, pronunciation and repetition of technical words by the professor and so on it was accepted by the students who participated in an active form during all the process required to present this Manual-Software.

4.3 RECOMMENDATIONS

- This Manual-Software should be implemented for improving the teaching-learning process.

- The principal of ITSA should promote the use of this Manual-Software and the methodology for getting positive results in teaching Technical English and systems of C-130 Airplane.

- The Ecuadorian Air Force duty should be provided at least a basic level of technical English in order to be able to interpret manuals, perform tasks accurately and document their work.

BIBLIOGRAPHY

T.O. 1-C-130-2-1 General Airplane.

T.O. 1-C-130-2-1 Ground Handling, Servicing and Airframe Maintenance.

T.O. 1-C-130-2-3 Hydraulic Systems.

T.O. 1-C-130-2-4 Power Plant.

T.O. 1-C-130-2-5 Fuel Systems.

T.O. 1-C-130-2-6 Instruments.

T.O. 1-C-130-2-7 Electrical Systems.

T.O. 1-C-130-2-8 Radio Communications.

T.O. 1-C-130-2-9 Flight Control Systems.

T.O. 1-C-130-2-10 Utility System.

T.O. 1-C-130-2-11 Propeller.

T.O. 1-C-130-2-12 Landing Gear.

T.O. 1-C-130-2-13 Airplane Wiring Diagram.

T.O. 1-C-130-2-2CL-3 Aircraft Jacking.

T.O. 1-C-130-2-2Cl-4 Oxygen Servicing (Gaseous and Liquid)

T.O. 1-C-130-2-CL-5 Refueling/Defueling (Pit and Truck)

T.O. 1-C-130-2-CL-6 General Aircraft Apply External Power.

T.O. 1-C-130-4-CL-1 Engine and Propeller Run-up.

T.O. 1-C-130-4—CL-2 Engine Mobile Test Stand.

T.O. 1-C-130-4-CL-5 Engine Temperature Datum System.

T.O. 1-C-130-2-5CL-2 Fuel Maintenance System.

T.O. 1-C-130-2-4CL-2 Calibration and Test.

Technical Dictionary USAF / IAAFA.

GLOSSARY

ACCELERATION BLEED VALVES.	Válvulas de aceleración.
ACCELERATION BLEED.	Sangrado de aceleración.
ACCESORY DRIVE GEAR TRAIN.	Grupos de engranajes de los accesorios.
ACCESORY DRIVE.	Caja de impulsión de accesorios.
ACTUATING CAM.	Leva de trabajo.
AERIAL DELIVERY SYSTEM ADS.	Sistema de lanzamiento aéreo.
AFT CARGO EQUIPMENT RACK.	Soporte trasero de equipo.
AIR CONDITION CUT-OFF SWITCH.	Interruptor de cierre de aire acondi.
AIR FILTER VALVE.	Válvula de filtro de aire.
ANTI – ICING.	Antihielo, anticongelante.
ANTI SKID.	Antideslizamiento.
ASYMETRIC WING FLAP.	Asimetría de flaps.
BACKUP VALVE.	Válvula de reserva.
BALL NUT.	Tuerca de rotura.
BARREL.	Barril.
BEVEL GEAR.	Engranaje cónico.
BLEED AIR.	Aire de sangrado.
BUMPER STOP.	Detentor.
BY PASS.	Paso de desvío.
CHOCKS.	Tacos, calzos.
COMPANION FLANGES.	Pestañas de unión.
CUFF.	Puño, manguito.
DE FOGGING.	Desempañar.
DE ICING.	Descongelamiento.
DIFFUSER.	Difusor.
DIVERTER.	Desviación.

DOME.	Domo.
DRAG PIN.	Pin de guía de arrastre.
DUAL RAILS.	Rieles doble.
DUMP.	Desecho, arrojo, lanzamiento.
EDUCTOR PUMP.	Bomba de chorro.
FAIL SAFE.	Seguridad.
FEATHER VALVE.	Válvula de perfilamiento.
FILLER NECK.	Cuello de abastecimiento.
FIN STALL.	Perdida de sustentación.
FIRE HANDLE.	Manija de incendio.
FLAME OUT.	Apagón.
FLANGES.	Acoples.
GATE.	Puerta.
GEAR BOX.	Caja reductora.
GO AROUND.	Retacada.
GROUND IDLE.	Cuadrante de aceleradores.
HANDCRANK.	Manivela de mano.
HEAT EXCHANGER.	Permutador de calor.
HUB.	Tapa.
IDLE.	Relantín.
IGNITION RELAY.	Relé.
JET PUMP.	Bomba de chorro.
LOADMASTER.	Maestro de carga.
LOOP.	Circuito.
MAIN GEAR.	Tren de aterrizaje.
MASTER TRIM.	Ajuste maestro.
NACELLE PREHEAT.	Precalentamiento de la nacela.
OIL COOLER FLAP.	Aleta de enfriamiento de aceite.
PALLET.	Tarima.

PAW.	Trinquete.
PITCHLOCK.	Paso trabado.
REFUSAL.	Negación.
ROLL.	Vuelta alrededor del eje longitudinal.
RUDDER.	Timón vertical.
SHIMMY.	Oscilación.
SPACER.	Espaciador.
SPEED BIAS.	Velocidad bidireccional.
THERMOCOUPLES.	Par termoeléctricos.
TORQUE SHAFT.	Eje de torque.
UNDERFLOOR HEAT.	Calefacción del piso.
WATER SEPARATOR.	Separador de agua.
WINDMILL.	Molinete.
WRAP AROUND.	Envoltura.
YAW.	Guiñada.
ZERO FUEL WEIGHT.	Peso sin combustible.

ANNEX 'A'

ARMY POLYTECHNIC SCHOOL

APPLIED LINGUISTICS

SURVEY TO A PROJECT RESEARCH

Date: ……………………….. …………………………………………………….

Instructions: Read carefully, make an X, and please be sincere. Thank you!

1. - Do you consider the applied manual to be useful for teaching Technical English and the main systems C-130 Airplane?

YES ☐ NOT ☐

2. - How important will the existence of this Manual be for both, teachers, and students, in the maintenance specialty at the Institute?

VERY IMPORTANT ☐ IMPORTANT ☐ NOTHING IMPORTANT ☐

3. - Are there any maintenance or Technical English manuals for the Lockheed C-130 Hercules aircraft available to ITSA students?

YES ☐ NOT ☐

4. - Do you believe if ITSA has any relevant materials to teach about C-130 aircraft?

YES ☐ NOT ☐

5. - Do you believe that this material will increase the technical knowledge of new airmen and help to improve the process of maintenance in the C-130 squadron?

YES ☐ NOT ☐

6. - Do you think that this Manual will help to improve the quality of work performed by technicians who learned from it?

YES ☐ NOT ☐

7. - Do you think that it is necessary to increase some additional information to this Technical English Manual about the main systems of the C-130 airplane?

YES ☐ NOT ☐ LITTLE ☐ A LOT OF ☐

8.- Do you think that periodic evaluations using this Technical Manual is necessary to evaluate the students in aircraft maintenance or are there any other form of evaluation available?

YES ☐ NOT ☐

9. - Is it important to apply evaluations comparing earlier teaching resources with the proposed software manual?

TRUE ☐ FALSE ☐

10. - After to know this Manual-Software and receive instruction of Technical English and systems C-130 Airplane, What is your qualification?

Thanks for your collaboration and support in our research that only seeks the increase of knowledge in order to have an Ecuadorian Air Force every day more professional.

ANNEX 'B'

TEST TO THE STUDENTS DURIND THE INTRODUCTION OF THIS MANUAL-SOFTWARE

INSTRUCTIONS:
Read the following questions and possible answers very carefully. There are two types of questions contained within this examination. Read each question stem carefully, and then select the answer that you believe is correct or most nearly correct. Mark the letter of your selection for each question on the bubble sheet (answer sheet).

FIRST TEST

1. Which of the following is the procedure for a tailpipe fire prior to starter release?

   a. Shut down the engine in accordance with ENGINE EMERGENCY SHUTDOWN procedure.

   b. Place condition lever to ground stop and motor the engine with t he starter.

   c. Release the starter button and place the condition lever to ground stop.

   d. Continue the start and advance throttles to maximum power to blow out the flames.

2. In the event of an engine fire that persists after discharging the first fire bottle, what is the next action you must take?

   a. Inform the tower of the situation.

   b. Fire the remaining bottle e.

   c. Evacuate the airplane in accordance with 1C-130H-2-71JG-00-1.

   d. Isolate the wing. If condition persists, discharge the remaining bottle.

3. Which of the following is the correct procedure for a nacelle overheating during engine run?

   a. Move all throttles to ground idle and proceed with ENGINE EMERGENCY SHUTDOWN procedure for the affected engine.

   b. Move all throttles to ground idle, place the condition lever to ground stop, and motor the engine.

   c. Move all throttles to ground idle; if light goes out, no further corrective action is required.

   d. Move only the affected engine throttle toward ground idle and proceed with ENGINE EMERGENCY SHUTDOWN procedure.

4. What might happen if the Agent Discharge Switch is held in the No. 1 or No. 2 position longer than 1 or 2 seconds?

   a. May provide more extinguishing than required

   b. May cause damage to the engine

   c. May cause the fire extinguisher circuit breaker to open

   d. May discharge both bottles at the same time

5. What does a flashing red light in the fire handle indicate?

   a. High TIT

   b. Nacelle overheat

   c. Turbine overheat

   d. Fire

6. What is the corrective action for a right wheel well overheat?

   a. ATM Generator Switch OFF; ATM Switch STOP; wait 1 minute GTC Control Switch/external air OFF; wing isolation valves CLOSE.

   b. Cargo Compartment Air Conditioning and Underfloor Heating Shutoff Switches OFF; if overheat continues after 45 seconds: Engine Bleed Air Valve Switches CLOSE; GTC Bleed Air Valve Switch CLOSE; external air OFF; if bleed air valve fails to close, wing isolation valves CLOSE.

   c. Flight Deck Air Conditioning Switch OFF; if overheat continues after 45 seconds: Engine Bleed Air Valve Switches CLOSE; GTC Bleed Air Valve Switch CLOSE; if bleed air valve fails to close, wing isolation valves CLOSE.

   d. Cargo Compartment Air Conditioning and Underfloor Heating Shutoff Switches OFF; wait 1 minute; GTC Control Switch/external air OFF; right wing isolation valve CLOSED.

7. Which of the following is indicated by a steady red light in the fire handle?

   a. Turbine overheat

   b. High TIT

   c. Nacelle overheat

   d. Fire

8. In the event the wing isolation valves are CLOSED due to a cargo compartment/wheel well or wing overheat, it is recommended that they:

   a. Not be reopened unless the operator feels there is no obvious damage to the detection system or the indication was false.

   b. Be reopened to verify the indication was not false.

   c. Not be reopened as damage to the warning system may prevent detection of a subsequent overheat condition.

   d. Be reopened only if the overheat warning light stays off for 5 minutes.

9. Which is the primary exit for ground egress?

    a. Ramp and door
    b. Crew door
    c. Forward overhead escape hatch
    d. Left paratroop door

10. What is the minimum aircraft weight, in pounds, for running engines above flight idle?

    a. 95,000
    b. 105,000
    c. 115,000
    d. 120,000

11. Anytime a start malfunction occurs, in what order will the engine be shut down?

    a. Release the starter button and place the engine condition lever to ground stop, unless a specific emergency procedure dictates other action.
    b. Place the engine condition lever to ground stop and release the starter button, unless a specific emergency procedure dictates other action.
    c. Release the starter and place the throttle to ground stop, unless a specific emergency procedure dictates other action.
    d. Place the throttle in ground idle and release the starter button, unless a specific emergency procedure dictates other action.

12. If loss of engine oil pressure is indicated, what corrective action is required?

a. Move all throttles to ground idle and shut down the affected engine in accordance with ENGINE EMERGENCY SHUTDOWN procedure.

b. Move all throttles to flight idle and place the affected engine condition lever to feather.

c. Monitor all engine instruments and check the fuse for the indicator showing loss of oil pressure.

d. Move the affected throttle to ground idle and place the condition lever to ground stop.

13. What corrective action is required if a propeller low oil warning light illuminates during engine runup and RPM is fluctuating with no visible fluid leak?

a. Move all throttles to ground idle and pull the fire handle.

b. Shut down the engine by placing the engine condition lever in FEATHER.

c. Move all throttles to ground idle and place the Propeller Control Switch to mechanical.

d. Shut down the engine by placing the engine condition lever in GROUND STOP.

14. What is the first action to be taken for an AC bus off light?

a. Turn the affected generator OFF.

b. Place the Generator Control Switch to FIELD TRIP, then to ON, and continue to monitor.

c. Shut down the engine by placing the condition lever to ground stop.

d. Reset the generator and turn the generator on.

15. Which of the following is the correct procedure if a left wheel well overheat light illuminates during an engine maintenance run?

a. GTC Bleed Air Switch OFF; external air OFF; wait 45 seconds; left wing isolation valve CLOSE.

b. GTC Bleed Air Valve Switch OFF; #1 and #2 Engine Bleed Air Valve Switches CLOSED; wait 45 seconds, if overheat continues both wing isolation valves switches CLOSED, evacuate aircraft.

c. ATM generator switch OFF, ATM switch STOP, GTC control switch STOP, external air OFF, if overheat continues after 45 seconds; all engine bleed air valve switches CLOSE, both wing isolation valves closed.

d. ATM generator switch OFF, ATM switch STOP, GTC control switch STOP, external air OFF, if overheat continues after 45 seconds; #1 and #2 engine bleed air valve switches CLOSE, left wing isolation valve CLOSED.

16. The pitch lock regulator assembly prevents the blade angle from which of the following?

a. Increasing if hydraulic pressure is lost

b. Increasing if overspeeding occurs

c. Decreasing if hydraulic pressure is lost

d. Decreasing when the propeller is placed to feather

17. At what percent engine rpm is ignition energized?

a. 94

b. 65

c. 35

d. 16

18. What component in the Engine Oil System prevents the formation of ice in the fuel?

    a. Aft scavenge pump assembly

    b. Fuel heater and strainer assembly

    c. Nacelle preheat

    d. Oil cooler regulator

19. Which direction should the Pilot Microphone Switch is actuated to transmit through a selected radio?

    a. Pulled aft

    b. Pushed forward

    c. Centered

    d. Not required if hot mic is used

20. What is the preload air charge of the emergency brake accumulator?

    a. 300 psi (+ or - 50 psi)

    b. 500 psi (+ or - 50 psi)

    c. 1,000 psi (+ or - 100 psi)

    d. 1,500 psi (+ or - 100 psi)

SECOND TEST

1. What is the preload air charge of the Utility Hydraulic System accumulator?

   a. 300 psi (+ or - 50 psi)

   b. 500 psi (+ or - 50 psi)

   c. 1,000 psi (+ or - 100 psi)

   d. 1,500 psi (+ or - 100 psi)

2. When checking the aircraft battery, what is the minimum battery voltage?

   a. 26 volts AC

   b. 28 volts DC

   c. 28 volts AC

   d. 21 volts DC

3. What indication must be presented on the engine instruments upon reaching 35 percent engine rpm during start?

   a. Hydraulic pressure

   b. Secondary fuel pump operation

   c. Oil pressure

   d. Fuel pump series operation

4. Should the engine fail to light off by 35 percent rpm, you should motor the engine to approximately what percent before attempting another engine start?

   a. 15

   b. 20

   c. 25

   d. 30

5. The AC instrument and engine fuel control inverter receives power from the:

   a. Main DC bus.
   b. Isolated DC bus.
   c. Essential DC bus.
   d. Battery bus.

6. How is the wing isolation valves opened?

   a. Manually
   b. Electrically
   c. Hydraulically
   d. Pneumatically

7. What are the Auxiliary Hydraulic System normal limitations?

   a. 2,800 to 3,100 psi
   b. 2,800 to 3,200 psi
   c. 2,900 to 3,200 psi
   d. 2,900 to 3,300 psi

8. Which of the following is the primary radio you normally use to communicate with ground control during an engine maintenance run?

   a. FM
   b. HF
   c. UHF 1
   d. UHF 2

9. When inspecting the Ramp Manual Control, in what position should it be placed?

   a. 1

   b. 2

   c. 4

   d. 6N

10. Where must the throttles be set for engine starting?

   a. Feather

   b. Reverse

   c. Ground stop

   d. Ground idle

11. At what percent rpm should a start be discontinued if engine does not have ignition?

   a. 45

   b. 40

   c. 35

   d. 30

12. When performing the Engine Shutdown Checklist, which fuel crossfeed valve is normally opened to supply fuel to the GTC?

   a. One

   b. Two

   c. Three

   d. Four

13. Which hydraulic system provides pressure when emergency brakes are selected?

a. Auxiliary

b. Booster

c. Utility

d. Emergency

e.

Match the engine operating limitations in Column A with their respective numerical values in Column B.

Column A	Column B
___14. Maximum power TIT range (T56A-7)	a. 965 to 976 degrees C
___15. Maximum power TIT range (T56A-15)	b. 961 to 977 degrees C
___16. Engine oil pressure for normal ground idle	c. 1,067 to 1,083 degrees C
___17. Gearbox oil pr2essure for normal ground idle	d. 1,083 to 1,175 degrees C
___18. Maximum allowable torque	e. 19,600 inch-pounds
	f. 18,000 inch-pounds
	g. 150 to 250 psi
	h. 150 to 160 psi
	i. 50 to 60 psi
	j. 40 to 50 psi

Match the names of the Hydraulic System limitations in Column A with their respective numerical values in Column B.

Column A	Column B
___19. Normal utility hydraulic pressure psi	a. 1,000 ± 100
___20. Booster Hydraulic System accumulator preload pressure psi	b. 1,500 ± 100
	c. 2,900 to 3,200
	d. 3,200 to 3,500
	e. 2,900 to 3,300

Question Number	Correct Response	Question Number	Correct Response
1.	b	11.	b
2.	d	12.	a
3.	a	13.	d
4.	c	14.	a
5.	c	15.	c
6.	b	16.	c
7.	d	17.	d
8.	c	18.	b
9.	b	19.	a
10.	a	20.	c

Question Number	Correct Response	Question Number	Correct Response
1.	d	11.	b
2.	d	12.	a
3.	c	13.	b
4.	c	14.	c
5.	a	15.	i
6.	d	16.	g
7.	c	17.	e
8.	d	18.	c
9.	d	19.	b
10.	c	20.	c