

SERVICE NEWS

A Service Publication of Lockheed Aeronautical Systems Company



Fulfilling the Promise

Plugs and Covers

A SERVICE PUBLICATION OF
LOCKHEED AERONAUTICAL
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Covers: Capt Jeff Renner and Capt Pete Schweyher of 435th Airlift Wing were members of the first Hercules crews to airdrop relief supplies into eastern Bosnia during operation Provide Promise earlier this year. Pictured here at the 1993 International Airlift Rodeo, they represented their unit at the world's most prestigious airlift competition. Our back cover shows a general view of the many C-130s that participated in the event. Photos by Julius Alexander.

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==== Focal Point =====



O. J. Smith

R & M Engineering:
Key to Continuous Improvement

In this issue of Service News you will find several articles on new and improved items for the Hercules aircraft. Notice the diversity of the subjects: from plugs and covers to new electrical power generation components. These are representative of the ongoing effort to improve all aspects of the aircraft, and the Reliability, Maintainability Engineering Department is involved in all of them.

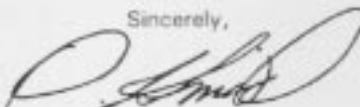
Each item of our support equipment is continually reviewed for adequacy and obsolescence, and the designs and materials are improved as needed. The updated plugs and covers featured in this issue are just a few examples of the results of our commitment

to expand and enhance our entire line of products. Others include a new engine performance calculator, an improved deicer truck, an engine scavenge oil test kit, and a cargo ramp handling dolly. The goal of all of this effort is simple: to serve Lockheed customers better.

But support equipment is only a small part of the Reliability and Maintainability Engineering story. We constantly monitor aircraft systems performance in Hercules airlifters throughout the world to pinpoint adverse trends. This allows us to provide the operational and maintenance data that forms the basis of engineering change proposals to improve these systems. We also furnish data to facilitate trade studies which select the best of several possible system candidates. Once the system is selected, the design is monitored for ease of maintenance, servicing, and inspection. Analyses are conducted to establish inspection and maintenance procedures, training needs, and support equipment requirements.

The technical data used to support the aircraft are also subject to this improvement process. New and expanded system troubleshooting procedures (fault isolation) are being developed. These procedures are constructed to not only provide positive identification of malfunctioning parts, but also wiring faults down to the single wire between identifiable test points.

This process of improving the Hercules aircraft through the application of reliability and maintainability engineering techniques is continuous. Through this process, you are assured of owning one of the most supportable airlifters in the world.

Sincerely,


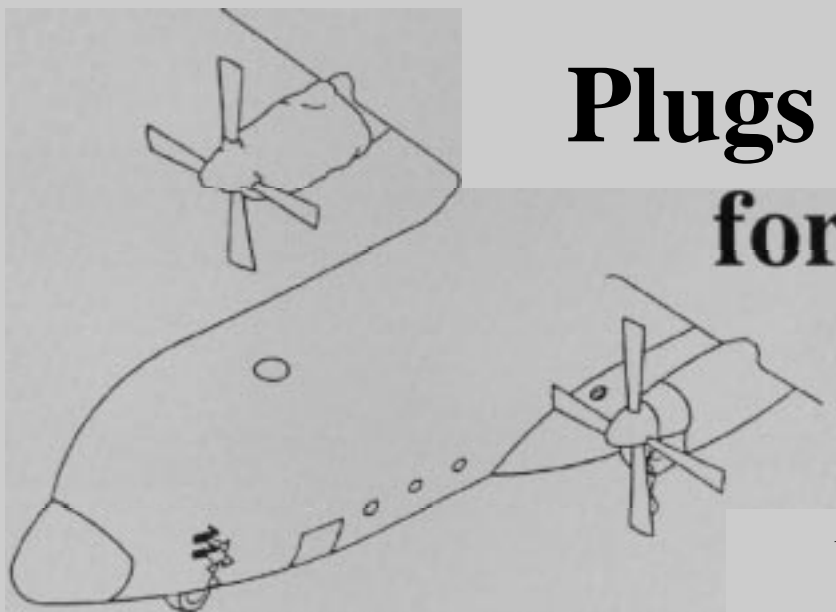
Manager
Reliability and Maintainability
Engineering Department

PRODUCT SUPPORT

LOCKHEED AERONAUTICAL
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J. L. GAFFNEY – DIRECTOR

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Plugs and Covers for Your Hercules

by Roy H. Webber,
*Product Support Engineer Specialist Sr.
Reliability and Maintainability
Engineering Department*

Dust, dirt, sand, birds, insects, and other foreign objects have no business in any kind of mechanical equipment, much less a high-tech product like a modern airplane. If allowed to get into the critical systems of the Hercules airlifter, these materials can cause all sorts of damage, and significantly increase maintenance costs.

It is for this reason that every new Hercules is supplied with a set of plugs and covers designed to keep such potential contaminants exactly where they belong—outside the airplane. Unfortunately, these valuable protective devices are often among the first items to go astray once an airplane enters service. Some get lost or are damaged by rough handling, while others gradually become unusable because of the effects of exposure to sunlight and harsh weather conditions.

Replacement plugs and covers are readily available through the normal spares channels, and they are well worth their cost in terms of increased service life for the critical aircraft components that they protect. Part numbers and a brief description of each item are given in the appropriate technical manuals.

There have been, however, a number of changes and improvements in this area in recent years. This makes a more detailed look at this type of equipment worthwhile. Note that all of the items described in the discussion below are included in the basic set of protective plugs and covers that come with each new airplane, except where indicated. The part numbers given are applicable to current-model Hercules aircraft. Operators of older Hercules should consult the authorized technical manuals for their aircraft or contact Lockheed Field Service for assistance before ordering.

APU Exhaust

All recent Hercules models are equipped with an auxiliary power unit (APU), which has an exhaust duct on the left side of the aircraft. When the APU is not running, this duct should be plugged with the PN 33 12755-1 APU Exhaust Cover Assembly (Figure 1).

Several product improvement modifications have been carried out on this part lately. Originally made from epoxy-fiberglass, in the past the cover has sometimes been difficult to insert because of its rigidity. Last year, the part was redesigned and new tooling produced to make a plug that can be inserted more deeply into the duct. Four additional saw slots were also added to the sides to improve flexibility.

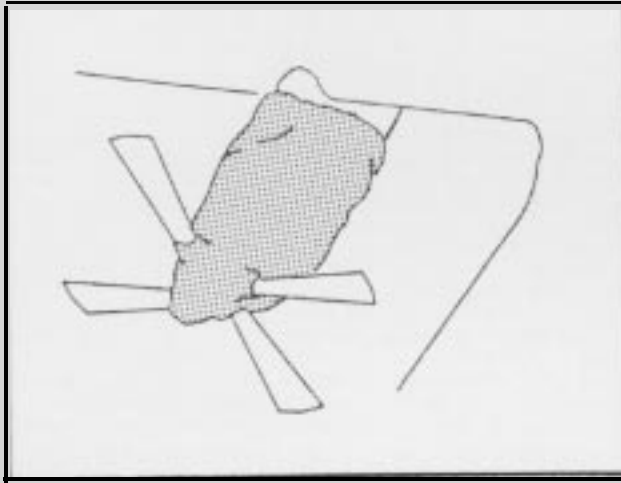
This new part proved much easier to install, and did not have a tendency to pop out after insertion as was sometimes reported with the old part. Further studies have since been undertaken and we are now using a polycarbonate plastic material to fabricate this plug. This material provides even greater flexibility and reduced manufacturing costs.

APU Cooling Air Ports

Three small air scoops and outlets are located on the underside of the aircraft below the APU. These ducts can be plugged with the PN 3402904-1 APU Cooling Air Port Plug Assembly (Figure 2). This assembly is not included as part of the standard plug set provided with new aircraft. If your Hercules is equipped with skis, the PN 3402409-3 assembly must be used.

These APU cooling air plugs are formed from red thermoplastic sheeting, and have numerous slots which provide flexibility during insertion.

Propeller Spinner and Engine Nacelle Cover



The PN 404100-1 Spinner and Nacelle Cover (shown above) is a protective device designed for use in particularly harsh environments. It is made of weather and sunlight-resistant vinyl fabric.

Engine Exhaust Pipe

The engine exhaust pipe area can be protected with the PN 3402251-3 Engine Tail Pipe Shield (Figure 3). This plug is fabricated from a red epoxy-fiberglass material that is designed to withstand the elevated exhaust pipe temperatures which could be present when the plug is inserted. A metal handle is attached to the plug for easy insertion and removal.

Lockheed is currently changing the material to a high-temperature polycarbonate plastic for this application. This change will provide a more flexible part which will be easier to install, and at the same time reduce manufacturing costs. The part number remains the same.

Engine Air Intake Ducts

Engine air inlets should be protected with the PN 3403246-1 Engine Inlet Plug (Figure 4). Older versions of this cover were fabricated from a rigid red thermoplastic sheet material that bears the trade name Kydex. Over the years, some problems have been experienced with plugs fabricated with this material. These include looseness of fit, which sometimes caused the plugs to fall out, and physical changes resulting from many hours of exposure to direct sunlight and the atmosphere. Plugs thus affected became brittle and tended to break if dropped.

Currently, Lockheed manufactures engine inlet plugs from a lightweight but rigid pink polyethylene foam that is contoured and edge-tapered to fit the inlet duct. Some early problems with this material, such as poor durability due to inadequate sunlight resistance were resolved last year when a new process was introduced in which the polyethylene foam is coated with a tough, flexible polymer. The bright red color of the polymer also improves the appearance of the product.

Proper handling and use of engine inlet plugs is essential if they are to be able to perform their intended function. To fit the plug into the engine intake duct properly, always take the time to get up on a ladder where you can reach the inlet easily; then install the plug and seat it by tapping gently around its edges. This will help avoid any possibility of the plug popping out on its own and becoming lost.

Note that a convenient rope handle is attached to each plug to permit easy removal. Be sure to make use of this handle when removing engine inlet plugs. Pulling straight out on the rope handle will do the job quickly and easily.

A red "remove before flight" streamer is also fastened to the engine inlet plug. The streamer is attached by a nylon cord, and intended to serve as a visual reminder that the plug is in place. *Do not* attempt to remove engine inlet plugs by pulling on these streamers. The streamer cord is not designed to be used in this manner and is likely to break after a few tries. This would result in the streamer being separated from the plug, which would defeat its entire purpose.

Air Conditioning Inlet and Exhaust

In current models of the Hercules aircraft, four polymer-coated rigid polyethylene foam plugs are used to protect the air conditioning ducts. Last year, the taper of these parts was changed for a better fit into the ducts. Very little force is required to seat these new plugs. Also, the same red polymer coating used on engine inlet plugs is now being applied to the air conditioning plugs.

The cargo compartment air conditioning system uses plug set PN 3403258-1 (Figure 5). This set consists of two plugs: an intake plug and an exhaust plug, tied together with a polyethylene rope.

Extra caution should be used when inserting the round exhaust plug into the cargo compartment exhaust duct. This is a round duct that extends downward from the wheel well, but it is cut at the end to a shape that approximately conforms to the exterior shape of the wheel well panels. Because the duct is not squared off at the end, there is a tendency for the plug to be inserted at an angle, with the bottom tilted outward.

Then, since the plug does not seem to insert easily, extra force is used to push the plug into the duct. This can result in a large tear in the plug surface, caused by the sharp, specially contoured edge of the metal duct.



To avoid such damage, it is very important to insert this plug in a vertical position which matches the duct angle as shown above. The sides of the plug are slightly tapered, and very little force is needed to seat it correctly. When properly seated, the bottom flat surface is almost parallel to the ground.

The flight station air conditioning system uses the PN 3403257-I plug set (Figure 6). This set also consists of two plugs tied together with a polyethylene rope.

There are, in addition, two other special plug sets available for the air conditioning inlet and exhaust ducts. These are used to adapt the aircraft inlet ducts to an external air conditioning cart. This permits positive locking of the cart's large-diameter flexible hose to the

aircraft, allowing cooling air to be introduced into the airplane's duct distribution system during maintenance or ground operations. These adapters (not pictured) are not included with the regular plugs at the time of aircraft delivery, but they can be ordered separately. The cargo compartment air conditioner plug adapter assembly is PN 3312700. The flight station air conditioner plug adapter assembly is PN 33 11849.

Pitot Tubes

Pitot tubes need shielding too. They should be protected by the PN 3338306-1 Pitot Tube Cover (Figure 7). This cover is made of cotton duck fabric, with a small cord sewed into the end to allow it to be tied to the pitot tube for greater security.

All-Around Protection

Because of its size and the wide diversity of missions it is called upon to perform, the typical Hercules aircraft leads a rugged, outdoors existence. Even in relatively moderate climates, the aircraft is routinely exposed to the kinds of environmental conditions that would quickly ruin most other types of precision machinery.

Fortunately, the Hercules is built to take it. With a little help from you to protect in its intakes, exhausts, and instrumentation apertures, nothing nature has to offer need pose a threat to a long and trouble-free service life for your aircraft.

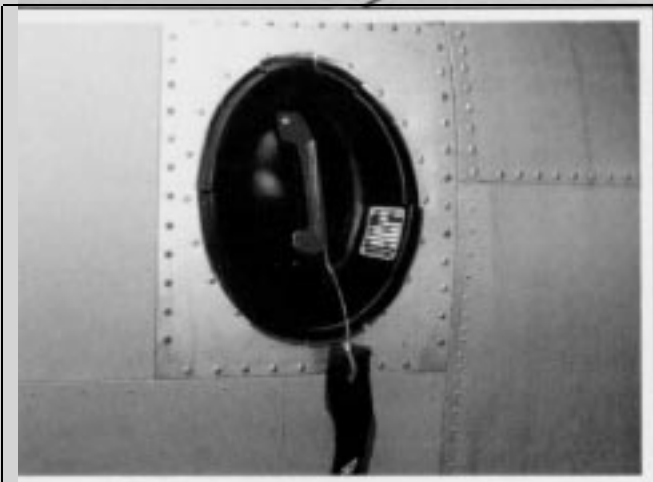
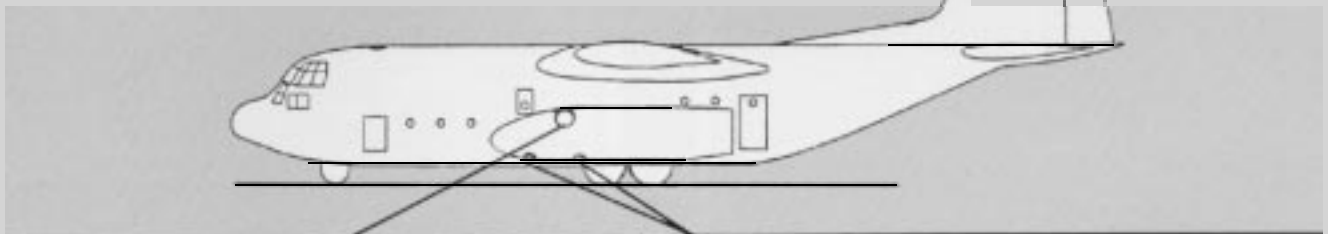


Figure 1 APU exhaust cover assembly.



Figure 2. APU cooling air port assembly.

Protective plugs and covers are used to protect the airplane from weather and foreign debris when the airplane is on the ground.

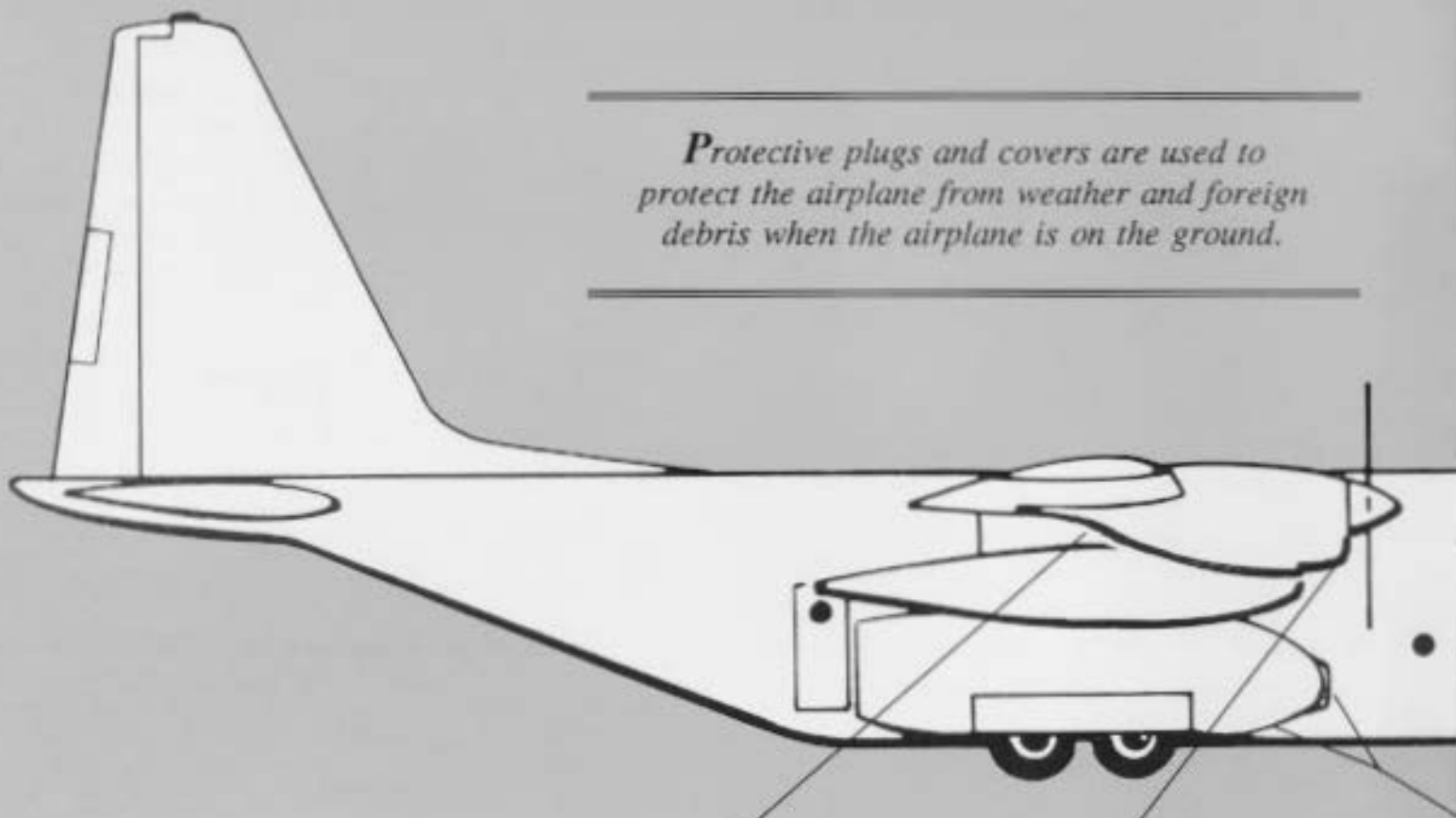


Figure 3. Engine tail pipe shield.

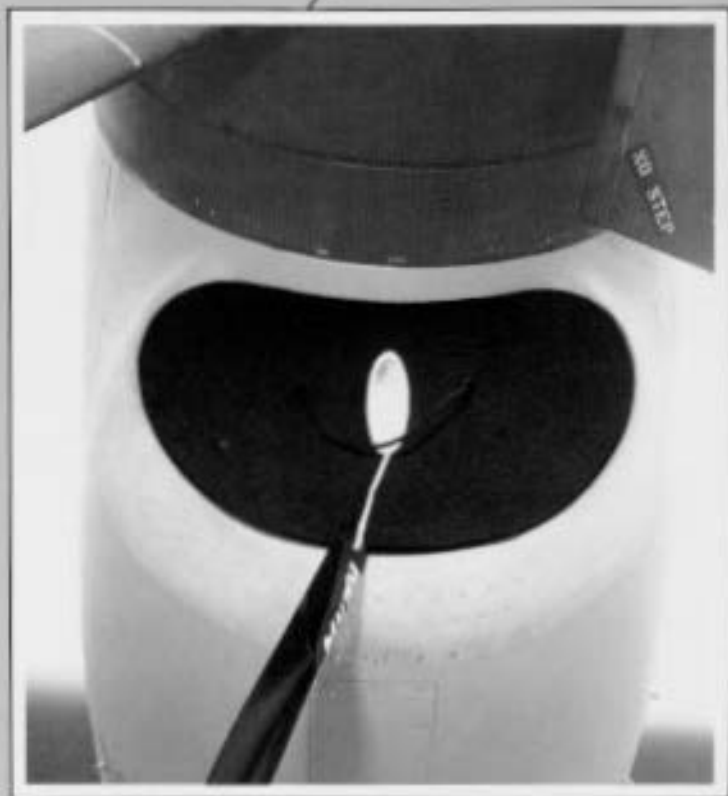


Figure 4. Engine inlet plug.

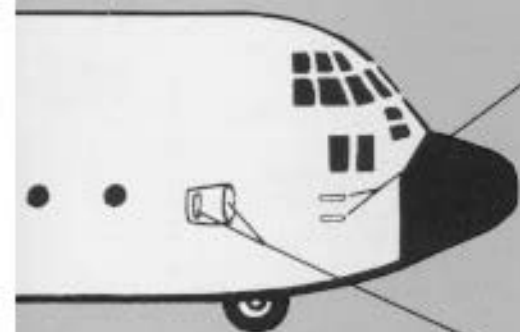


Figure 7. Pitot tube covers.

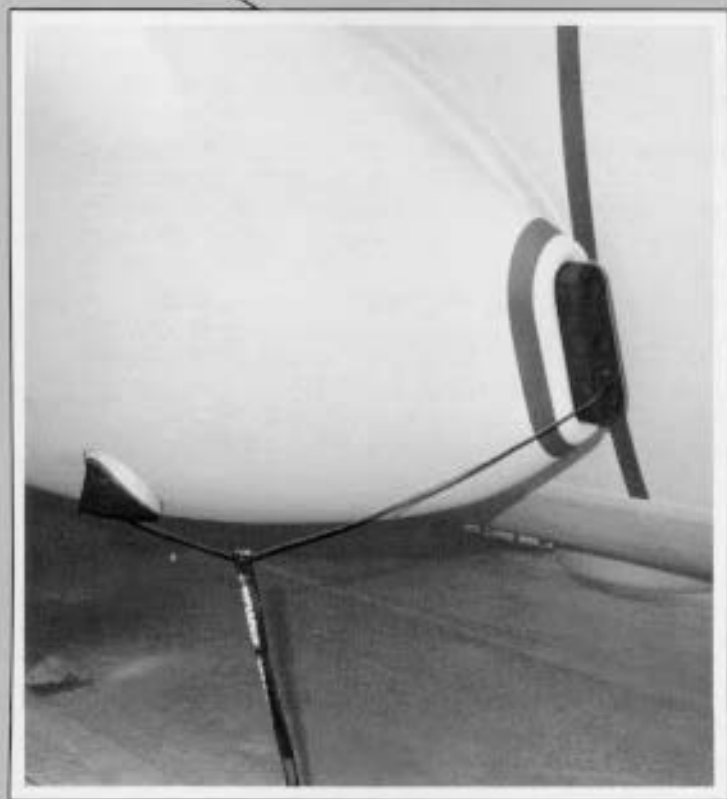


Figure 5. Cargo compartment air conditioning system plug set.



Figure 6. Flight station air conditioning system plug set.

Generator Control Unit

0 0 0 0

Truth Table Monitoring

by Norm Stevens, Training Specialist
Customer Training Systems Department



Hercules aircraft beginning with Lockheed serial number LAC 527 1 are equipped with new generator control units (GCUs), PN 697856-1. Individual GCUs replace the ensemble of components-voltage regulator, generator control or protection panel, and frequency-sensitive relay-that were previously required to control each of the aircraft's engine-driven generators and the APU generator.

GCU Capabilities - an Overview

The new GCUs provide an advanced, solid-state generator control system that offers greater reliability and lower maintenance costs, while helping to ensure that the aircraft subsystems are supplied with high-quality electrical power that meets the steady-state and voltage transient requirements of MIL-STD-704D.

These units are specifically designed to provide control and monitoring of the 40150 KVA generators installed on the engines and APU of the Hercules aircraft. They will operate automatically with either the Bendix or the Leland (GE) generator.

Each GCU monitors the permanent magnet generator (PMG) input from the main generator to determine the type of regulation to provide. If the PMG voltage is 30 VDC, the generator is a Bendix unit and the regulator for the Bendix generator PMG is selected. If the PMG voltage is 108 VAC, the generator is a Leland unit and the regulator for this type PMG is selected.

This selection is done automatically and requires no action on the part of the aircraft operator's maintenance personnel. With this feature, it is possible to operate an

aircraft with a mix of these generator types without having to match the generators to a particular voltage regulator. In addition, the units provide under- and overvoltage monitoring, under- and overfrequency monitoring, differential fault protection, and generator contactor control. GCU LED status lights are also provided to simplify system troubleshooting.

The GCUs provide continuous monitoring of the generator three-phase AC output and control the contactors which tie the generators to the aircraft loads. If any of the monitored parameters are outside limits, the affected generator contactor will be deenergized and the generator OUT light will illuminate. In most cases, the generator exciter field will also be deenergized.

A general introduction to the features of this new equipment was published in Lockheed *Service News* Volume 19, No. 2 (April-June 1992). In the present article, we will be primarily concerned with interpreting the LED truth table readout of the GCU's system monitoring and built-in-test (BIT) capabilities.

System Monitoring

The GCU's system monitoring capabilities are provided by the unit's microprocessor and internal memory. Random-access memory (RAM) provides digital storage capabilities for the LED display, system fault detection circuitry, and latching circuit logic.

When the engines and APU are not operating, all of the RAM in the GCU is cleared each time the aircraft or GCU power is cycled from on to off. Any failure codes that may be present are typically purged from memory when power is removed from the unit. When the GCU is powered up again, the GCU conducts its normal power-on system checks unaffected by previously detected faults.

During normal engine and generator operation, PMG input, generator voltage and frequency, contactor current limitation, and the feeder-fault sensing circuits are continually checked for proper operation. Should any fault be detected, the generator system will be deactivated, and an appropriate fault code will be loaded into memory and displayed on the GCU's LED status lights.

The operator may then elect to cycle the generator switch on the flight station overhead electrical control panel from ON to OFF/RESET and back to ON to restore the system. This will clear most failure codes, if the fault has been corrected. However, feeder fault, previous feeder fault, or previous BIT failures cannot be cleared by cycling the generator control switch. These faults will activate a latching circuit that prevents the system from powering up until the appropriate corrective action is taken.

System Fault Responses

Most generator system failures that occur during normal operation will result in a power-down command being issued by the GCU. At the same time, a flag is set in the system fault portion of memory. The power-down command will cause the generator line contactor to be deenergized and the generator OUT light on the overhead electrical control panel in the flight station to illuminate. Typically, the generator exciter field will also be deenergized. In all cases, however, an error code will be displayed on the GCU's LED display to indicate the cause of the failure.

It should be standard maintenance procedure to check the LED truth table before using the generator control switch to reset the system during GCU troubleshooting. Similarly, flight engineers should be encouraged to check the failure codes on the GCU prior to selecting OFF/RESET with the generator control switch. This will provide more complete information about the nature of any problems that may exist, and simplify the job of the technician who is tasked with correcting the discrepancy later on the ground.

Clearing Failure Codes

In most cases where failures codes are displayed on the LED truth table, clearing them is simply a matter of removing the fault that caused the code to be displayed and then cycling the generator control switch to the OFF/RESET position and back to ON again.

There are certain codes, however, namely those resulting from the detection of a feeder fault, previous feeder fault, or previous built-in test (BIT) failure, that represent potentially serious generator system problems. Such codes cannot be cleared by resetting the generator control switch or cycling the DC power to the GCU. These codes activate a latching circuit that prevents the system from powering up until suitable remedial action is taken. What is required in these cases is a "cold" shutdown of the affected generator control system.

In a cold shutdown, both DC input power and permanent magnet generator (PMG) voltage to the GCU are reduced to zero. This will remove the failure code, unlatch the latching circuit, and-providing the necessary repairs have been made-restore the system to normal operation. A cold shutdown can be accomplished in either of the following ways:

1. If the affected engine is running, shut it down and cycle the GCU DC power circuit breaker.
2. If the engine is not running, cycle the GCU DC circuit breaker off and back on, or cycle the aircraft DC power off and then back on.

BIT Capability

The BIT designed into the GCU allows the operator to verify that the GCU's internal built-in test circuits are performing properly. Three modules are checked during the BIT. These are the digital board, power board, and chassis components. Any failures detected during the BIT will cause an appropriate LED failure code to be displayed.

The BIT can be initiated anytime the GCU is powered and the generator control switch is in the ON position. BIT can be accomplished whether the generator is operating or not, and whether it is on line or off line. BIT it is somewhat more inclusive when the generator is off line, however.

Note that the BIT is performed only on request. One push of the guarded pushbutton switch located just above the truth table on the GCU initiates the test. The four LED indicators will illuminate for approximately 5 seconds and then extinguish if the GCU passes all the internal BIT checks. If a failure is detected, one or more of the LEDs will remain illuminated. The operator can then determine the specific failure by referring to the truth table legend on the face of the GCU.

If the generator control switch is cycled to OFF/RESET and then back to ON with a BIT failure code displayed and the generator is *not* operating (no PMG voltage applied to the GCU), a previous BIT failure code will be displayed. Power-up will then be denied because the latch set circuit has been activated. A cold shutdown will be required to reactivate the affected generator.

However, if the generator is operating (PMG voltage available to the GCU), the presence of a failure code which is displayed as the result of a BIT request will not normally keep the generator from coming on line. Nor will such a code take the generator off line if the BIT is performed with the generator control switch in the ON position.

If the BIT pushbutton is pressed a second time under these circumstances, the BIT will run again (all four LEDs will illuminate). At the end of the test, the original failure code will be redisplayed if the fault continues to exist. No code will be displayed if the problem has been corrected or was transient in nature.

BIT With Displayed System Failure Codes

Each time the GCU's BIT is initiated, it is a new test. A displayed system failure code will not be carried over to a following test. As soon as the pushbutton is pressed to start the BIT, the LED display will be cleared. Note, however, that only the display memory is erased during this test.

It is for this reason that the BIT should not be initiated after a system failure has occurred until the operator has attempted to reset the system by placing the generator control switch in the OFF/RESET position and then back to ON. If a failure has been detected and the BIT is run before OFF/RESET is selected, the failure code will be erased from display memory and disappear from the LED truth table.

However, if the BIT detects an internal GCU failure, the fault code identifying the failed module will be shown on the LED display. If no internal faults are detected, the display will go blank. To reset, the generator control switch must be cycled to OFF/RESET and then back to ON.

Similarly, running the BIT also leaves the latching circuit state unaffected. We have already noted that when a feeder fault, previous feeder fault, or previous BIT failure code is displayed, the latching circuit is set to prevent the generator exciter field from being reenergized. During the BIT, the latching circuit is checked, but if it is found already latched, it will be relatched at the end of the test.

As we have seen, however, the BIT will clear the original failure code from display memory. Unless a new failure is detected, the display will remain blank. A cold restart is necessary to restore normal operation.

GCU Failure Code Summary

0 ■■■ 3 NO FAULTS

During normal aircraft operation, all four LEDs remain extinguished. This indicates that no failures have been detected by the GCU and the system is operating properly.

It should be kept in mind that certain failure conditions can result in a blank truth table display. If the isolated DC bus voltage input to pin W of the GCU connector is less than 18 VDC, the GCU goes into a hold mode, waiting for the input voltage to rise above 18 VDC. No LED status is shown when this condition is present. The same is true when the GCU internal fuse has been blown because of incorrect generator selection (see below).

3 0 0 ■ OVERVOLTAGE

When AC voltage on one or more phases exceeds an inverse time curve of 5 volt-seconds above 130 VAC, up to a maximum of 190 VAC, the GCU will initiate a power-down command. The line contactor will then open, the generator exciter field will be deenergized, and the generator OUT light will illuminate. The generator can be reset by placing the generator control switch to OFF/RESET and then back to ON. If the overvoltage condition recurs, the GCU will trip again.

0000 UNDERVOLTAGE

If voltage on one or more phases drops to 95 VAC or below for more than 4 seconds, a power-down command will be issued: the line contactor will open, the generator exciter field will be deenergized, and the generator OUT light will illuminate. The generator can be reset by placing the generator control switch to OFF/RESET and then back to ON. If the undervoltage condition recurs, the GCU will trip again.

Note that if one or more of the three-phase sensing inputs to the GCU is open or shorted, the GCU assumes that an undervoltage condition has occurred. This will cause an undervoltage failure code to be displayed.

0000 UNDERFREQUENCY

If the frequency drops below 365 Hertz, the line contactor will open, the generator OUT light will illuminate, and the underfrequency code will be displayed on the truth table LEDs. When frequency rises above 375 Hertz again, the line contactor will close, the generator OUT light will go out, and the underfrequency code on the LED display will be extinguished. Note that the underfrequency condition is normal when the engine is operating in low-speed ground idle.

0000 OVERFREQUENCY

If the frequency exceeds 440 Hertz, the line contactor will open, the generator OUT light will illuminate, and the overfrequency code will be displayed on the truth table LEDs. When the frequency drops below 430 Hertz, the line contactor will close, the generator OUT light will go out, and the overfrequency code on the LED display will be extinguished.

It should be kept in mind that since frequency is a function of engine rpm, and the engines that power the Hercules aircraft are controlled at a constant speed, overfrequency codes are extremely rare.

0000 FEEDER FAULT

Whenever a feeder fault is detected, the GCU will initiate a power-down command and the generator OUT light will illuminate. The generator exciter field will be deenergized, and the line contactor will also be deenergized. The feeder fault condition also causes the latch set circuit to be set, which will prevent the GCU from being reset.

In this situation, the fault code is loaded into system RAM and shown on the GCU's display table. If OFF/RESET is selected with the generator control switch when the feeder fault condition is present, the GCU's LED truth table will go blank and remain that way until the generator control switch is selected back to the ON position. The truth table will then display the previous feeder fault code. The presence of this code denies power-up and the latch circuit remains set.

When a feeder fault has been detected, it requires a cold shutdown-removing all PMG voltage and DC power from the GCU-to clear system memory and reset the latch set circuit. The system will then be ready to resume normal operation. *However, the condition that caused the fault must be corrected before the generator is reactivated and connected to the bus again; otherwise, the power-down will recur.*

0000 PREVIOUS FEEDER FAULT

When a feeder fault has been detected and the generator deenergized, the LED display on the GCU will go blank if the operator selects OFF/RESET with the generator control switch. If the generator control switch is then selected back to ON, a previous feeder fault code will be shown on the truth table. With this code displayed, the latch set logic keeps the exciter field circuit open, and the generator will remain off line. A cold restart is necessary to restore normal operation.

0000 CONTACTOR CURRENT LIMIT

Display of this code indicates that the current limits to the generator line contactor or bus tie contactor have been exceeded. This condition can sometimes be traced to coil failures.

The GCU normal current rating (excluding initial pull-in current) for the generator line contactor and bus tie contactors is 3 amps continuous. Whenever more than 3.6 amps (continuous) is exceeded, the GCU goes into a pull-back mode. This will cause the micro-processor to initiate power-down, deenergizing the generator line contactor and bus tie contactor for the affected generator. The contactor current limit fault code will also be displayed. To reset, select OFF/RESET with the generator control switch.

0000 INCORRECT GENERATOR SELECTED

This indicates disagreement between the system firmware and the hardware of the GCU's logic circuitry. The presence of this failure code will deny power-up.

If the GCU selects the Bendix generator when in fact a Leland generator is installed, high PMG voltage will be established on the GCU's PMG line. However, an internal protective (fail-safe) circuit limits the PMG DC voltage to 70 volts. When the high voltage is detected, the field relay and line contactor control relay open, which isolates the GCU from the generator system. This fail-safe system is independent of the microprocessor, and will automatically reset if the internal logic reverts to a correct generator selection.

In cases where the GCU selects a Leland generator when in fact a Bendix generator is installed, an internal fuse will be blown because of excessive current draw on the transformer-rectifier unit of the GCU. This occurs because DC voltage is being applied to the primary

winding of the transformer. If the internal fuse has blown, the GCU must be replaced.

00 GENERATOR SELECT TIMEOUT

When this code is displayed, the cause is PMG output oscillation or pulsation, or internal GCU failure. The computer has timed out while trying to decide on the generator type (Leland or Bendix). This failure also denies power-up. To reset, select OFF/RESET on the generator control switch.

INTERRUPT CAPACITY EXCEEDED

This failure is caused by noise in the frequency input from the generator. The GCU senses the A-phase output of the generator and converts the sine wave to a square wave, which is used in determining the frequency. If the square wave contains excessive noise, the interrupt capacity of the microprocessor will be exceeded.

This condition is interpreted as a failure, and the GCU will initiate power-down. To reset, select OFF/RESET on the generator control switch.

0 PREVIOUS BIT FAILURE

This is the result of a previous BIT failure involving one of the 3 modules of the GCU: digital board, power board, or chassis (see below). A BIT was accomplished and an LED error code for one of the above modules was displayed.

The previous BIT failure code can only be generated when the generator is not operating (no PMG voltage applied to the GCU), and the operator cycles the generator control switch to OFF/RESET and then back to ON. The specific failure is not shown; only the fact that the GCU has failed a previous BIT.

In this condition, power-up is denied because the latch set circuit has been set. A cold shutdown is necessary to restore the system to normal operation.

DIGITAL BOARD FAILURE

This failure consists of the digital unit's inability to convert discrete and analog signals to digital signals. The circuits checked are generator selection, feeder fault, and feeder fault latch. If a problem is detected during generator operation, the failure code will be displayed, but in most cases the system will continue to function.

If the generator is not operating and a digital board failure is found during a BIT request, the fault code will be displayed and power-up will be denied. Cycling the generator control switch at this point will cause the LED display to change to the previous BIT failure code. Power-up is denied in this condition because the latch set circuit has been set.

0 POWER BOARD FAILURE

This fault consists of an AC- sensing, regulator, or frequency-sensing failure. If the generator is operating when this fault is detected, the failure code will be displayed, but in most cases the system will continue to operate.

If the generator is not operating and a power board failure is discovered in the course of running the BIT, the fault code will be displayed and power-up will be denied. Cycling the generator control switch at this point will cause the LED display to change to the previous BIT failure code. Power-up is denied in this condition because the latch set circuit has been set.

CHASSIS FAILURE

This code indicates a failure of the field relay, or the +12-volt and/or +28-volt power supply. When this failure is detected during generator operation, the GCU truth table will display the fault code, but the system will usually continue to function.

If a chassis failure is detected during a BIT request with the generator not running, the fault code will be displayed and power-up will be denied. Cycling the generator control switch at this point will cause the LED display to change to the previous BIT failure code. Power-up is denied in this condition because the latch set circuit has been set.

BIT IN PROCESS

In this case, the BIT pushbutton has been pressed, and the GCU is in the self-check mode for approximately 5 seconds. At the end of the test, all LEDs will extinguish if the test has been passed. Activation of the BIT will not interrupt the normal operation of the generator, generator line contactor, or bus tie contactor. Note that the illumination of all four LEDs also serves as a bulb check.

The author and *Service News* wish to express their appreciation to Gary Kuzkin of Leland Electrosystems Inc., for his very generous and valuable assistance in the preparation of this article.

SERVICE NEWS

Emergency Locator Transmitter

RETROFIT MODIFICATION..

by **D. C. Harrison**
Senior Design Engineer
Advanced Design Division

Since the entry of the Hercules airlifter into service, operators worldwide have employed it as a multi-mission platform in a full spectrum of environmental, geographical, and political situations. The Hercules continues to meet the challenges imposed by the performance of difficult and dangerous airlift operations, as well as conducting a wide variety of special missions.

It does not appear likely that the mission requirements of the future will be very different. Hercules aircrews will continue to find themselves engaged in relief efforts or other support roles in areas where their labors are complicated by difficult terrain, treacherous weather, political unrest, or a combination of these factors.

Not surprisingly, some of these assignments could contribute to an increase in safety risk. Because the element of safety risk can never be completely eliminated from any operation, every technological advance that can help enhance survivability in the event of an aircraft mishap deserves serious consideration.

One such technological advance is the new emergency locator transmitter (ELT) currently being incorporated as standard equipment on most new C-130H aircraft built for the U.S. military. Lockheed Aeronauti-

cal Systems Company has taken steps "to make this valuable emergency locator feature available to operators of all Hercules aircraft. A retrofit kit has been developed which allows an ELT-similar to those now being installed on new Hercules aircraft to be added to existing aircraft with a minimum of downtime and expense.

The Emergency Locator Transmitter Retrofit Kit includes an emergency locator transmitter; an externally mounted antenna, and a remote control switch installation. The system is battery-powered and has no interface with the aircraft's electrical system. In addition to all of the required wiring and hardware, each kit is supplied with a copy of Hercules Service Bulletin 82-679, which contains the instructions necessary for installing and testing the kit components.

System Configuration

Major components contained in the ELT installation are the whip antenna and its mounting assembly, the transmitter with mounting rack, the remote-control toggle switch, and the wiring required to interconnect the system's components. The locations of these components are shown in Figure 1.

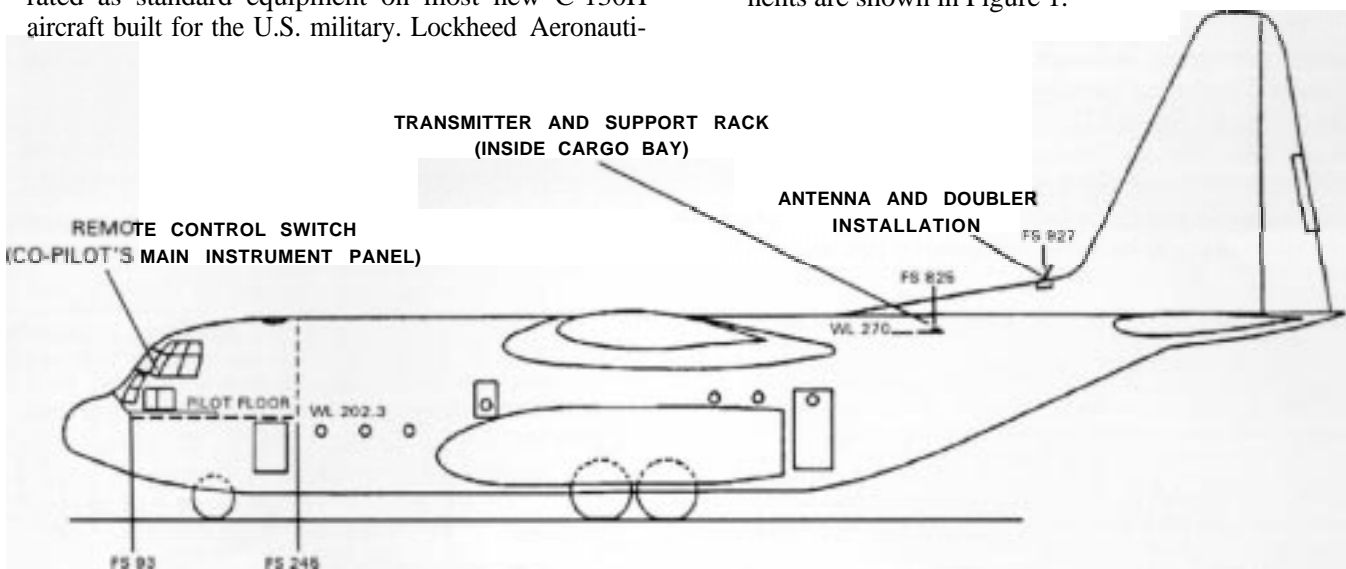


Figure 7. ELT component configuration on C-130.

The transmitter and support rack assembly mount overhead in the aft fuselage (Figure 2). The support rack positions the transmitter to face the direction of flight. This location provides easy access for installation and maintenance without interfering with cargo loading.

The whip antenna mounts on the aft fuselage dorsal fin, with a doubler between the antenna and dorsal skin (Figure 3). The doubler plate provides a template for marking the mounting hole pattern on the skin. In addition to holes needed to mount the antenna, another hole is drilled at FS 930 to accommodate a pressure feedthrough connector. Screws, lock washers, and nuts are used to secure the antenna assembly.

Any convenient location in the flight station may be selected for installation of the remote control switch. Two wires are installed along existing fuselage wire routing paths from the flight station to the transmitter (Figure 4). A coaxial cable connects the transmitter and antenna through the pressure feedthrough at FS 930. All of the necessary wire harness clamps and hardware are also provided.

System Operation

The ELT is an entirely self-contained, emergency transmitter that is powered by alkaline batteries. It operates at frequencies of 12 1.5 MHz and 243.0 MHz. The ELT is designed to start operating automatically if an impact of sufficient magnitude occurs.

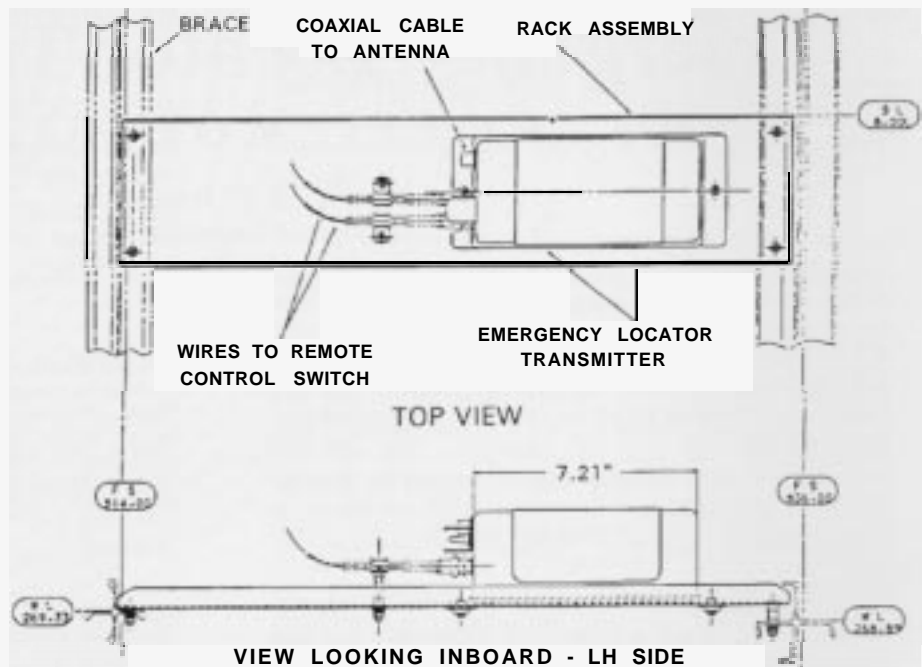


Figure 2. Transmitter and support rack.

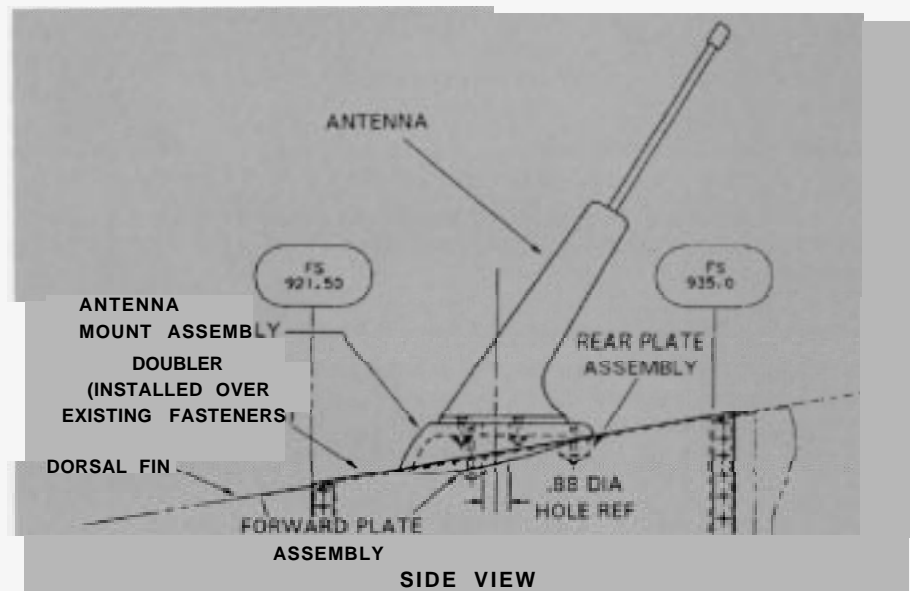


Figure 3. Antenna installation.

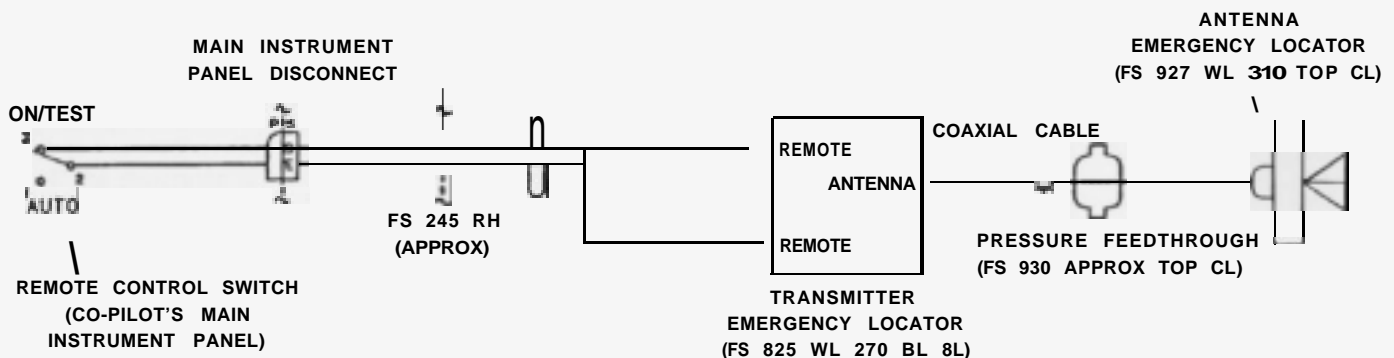


Figure 4. ELT system diagram.

For automatic operation, the ELT ON/OFF/AUTO switch located on the transmitter (Figure 5) is placed in the AUTO position. The switch must also be in this position to allow the transmitter to be operated from the remote control location.

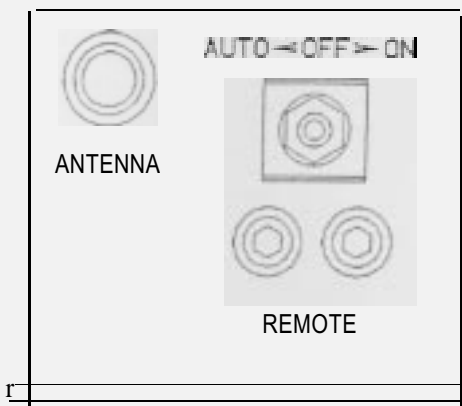


Figure 5. Transmitter front panel.

The remote control switch (Figure 6) must likewise be set in its AUTO position to permit normal system operation. This is the proper setting during flight, and allows impact forces to trigger transmitter operation automatically. The unit will activate when a 5G to 7G acceleration force of 11 to 16 milliseconds is applied along the line-of-flight axis.

The unit can also be activated manually. In general, the ELT will be operated manually only when an emergency landing is imminent. Note that when the ELT is transmitting, the signals will interfere with communications on 121.5 MHz and 243.0 MHz. If at all possible, Mayday calls for assistance should therefore be made with the normal VHF communications transmitter tuned to 121.5 MHz before the ELT operation is triggered.

The ELT is activated manually by placing the remote control switch in the ON/TEST position. The ELT will then begin broadcasting signals immediately. Note that the remote control switch is a toggle switch which must be pulled toward the operator before positioning. Alternatively, ELT operation can be initiated by setting the ON/OFF/AUTO switch on the ELT unit itself to the ON position.

In case the ELT is activated by an exceptionally hard landing, it can be deactivated and reset to the automatic mode condition by setting the remote control switch to the ON/TEST position, then back to AUTO.

System Test Procedures

To test the system, the appropriate aircraft transceiver is set to 121.5 MHz or 243.0 MHz and the remote control switch placed in the ON/TEST position. The ELT should begin transmitting. After a 1-second

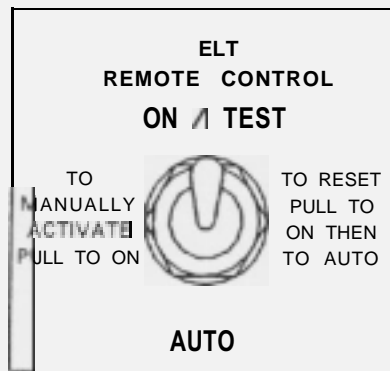


Figure 6. Remote control switch.

test period, the switch is placed at AUTO. If the ELT does not transmit while the remote control switch is in the ON/TEST position, the transmitter must be checked to verify that it is operational and that the switch on the ELT unit is correctly positioned at AUTO.

A Proven Choice

The ELT installation is recognized as an effective and valuable modification, and the retrofit kit developed for its installation ensures a quick and convenient modification. Please contact the following for further information about the Emergency Locator Transmitter Kit, and refer to PN 3341900-1:

Technical/ Engineering Information:

Lockheed Aeronautical Systems Company
Airlift Derivative Programs
Dept. 93-20
Marietta, GA 30063-0492; USA
Telephone 404-494-2793
Fax 404-494-7784

Proposal/Procurement Information:

Lockheed Aeronautical Systems Company
Customer Supply Business Management
Dept. 65-1 1
Marietta, GA 30063-0577; USA
Telephone: 404-494-7529 (U.S. government)
404-494-2 116 (commercial or international)

Service News Serialization

With the present issue, an adjustment has been made to bring the publication date into synchronization with the date shown in the magazine. This issue is being designated Vol. 20, No. 3, and the three previous issue numbers, Vol. 19, No. 4, Vol. 20, No. 1, and Vol. 20, No. 2, will be skipped.

-Ed.



Winning With the Hercules
Service News Congratulates the 1993
International Airlift Rodeo Winners:
Best Overall - 440th Airlift Wing, AFRES
Best International Team - Portugal, FAP