

SERVICE NEWS

A Publication of Lockheed Martin Aeronautical Systems

A SERVICE PUBLICATION OF
LOCKHEED MARTIN
AERONAUTICAL SYSTEMS

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Vol. 22, No. 2, April - June 1995

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Cover photographs by John Rossino.

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Focal Point

In Support of the Hercules Operator



Mike Fortenberry

The Hercules has enjoyed an outstanding history of over 40 years, something everyone associated with this aircraft should be proud of. In many ways the C-130 Hercules is unique, but as anyone who has ever worked with airplanes understands, an aircraft's operation and performance are totally dependent on the programs set up to support it. In this, the Hercules is no different.

In 1978, a small group of dedicated individuals created an organization intent on developing electronic ground support equipment specifically for Lockheed aircraft. This organization evolved over the years to become the Lockheed Martin Electronic Support Equipment Engineering Department. Today, we not only continue to build the very best in electronic support equipment, but we are also able to offer our professional services to Hercules customers in other areas, including the design and development of electronic flying hardware, avionics repair, aircraft battery servicing, and the development of aircraft wiring formboards.

Aircraft operators today face economic and technological challenges that were unknown a decade ago. As budgets tighten, owners and operators increasingly find that they cannot afford the luxury of paying high prices to outside contractors for maintenance services. The economic advantages of doing maintenance work in-house, whenever possible, are becoming more and more apparent. At the same time, modern electronic systems are getting more complex, and require more sophisticated test equipment and more highly skilled technical personnel to maintain.

The Electronic Support Equipment Engineering Department is in a position to offer our customers several options for solving this dilemma. The first is our line of highly automated test equipment. Our philosophy is to manufacture portable, software-driven, automatic test equipment that tests the equipment for which it is designed thoroughly, but is at the same time convenient and straightforward to use. In this issue of *Service News*, Scott Lavender describes a new test set for checking encoding altimeters and altitude alerters. This microprocessor-based tester is an excellent example of a design that combines sophisticated troubleshooting efficiency with ease of operation.

A second option is our expert repair service. The Electronic Support Equipment Engineering Department includes a group that specializes in avionic component overhaul and repair, as well as precision calibration of customer equipment. These expert engineers and technicians have the resources to ensure the quickest possible response time, whether the repair is routine or AOG. Our large inventory of spare parts allows us to offer unusually rapid turnaround time, and continuous on-site quality assurance inspection ensures that all work is performed to the highest quality standards.

The third option we make available to customers is our wide range of capabilities as a full-service organization. It is our business to offer to you the broadest possible spectrum of problem-solving knowhow, and this is an area where we think we excel. Elsewhere in this issue, Don Coia describes in more detail some these capabilities and a few of the services we can provide.

Dedicated to the support of the C-130 and all of Lockheed's aircraft, we constantly strive to be sensitive to the needs of each of our customers. Although the Electronic Support Equipment Engineering Department has grown considerably over the years, its overall goals have not changed. The same vision seen in 1978, to support the customer with professional services and quality products, remains the underlying objective of each individual within our department today.

Sincerely,

Mike Fortenberry, Manager
Electronic Support Equipment
Engineering Department

PRODUCT SUPPORT LOCKHEED MARTIN AERONAUTICAL SYSTEMS

J. L. GAFFNEY — DIRECTOR

FIELD SUPPORT	SUPPLY SUPPORT	TECHNICAL PUBLICATIONS	RM&S DESIGN	CUSTOMER TRAINING
J. D. Adams	J. L. Bayley	G. M. Lowe	H. D. Hall	S. S. Clark

Setting the Hercules

PARKING BRAKE !



by **Michael R. Jones**, Aircraft Design Engineer, Senior
C-130 Flight Controls Department

The function of the parking brake system on the Hercules aircraft is to hold the aircraft in position for short-term parking. Proper setting of this system is extremely important to prevent the aircraft from rolling prior to installing wheel chocks after flight and during post-maintenance engine runs. If the aircraft is to be parked for longer periods of time, wheel chocks must be used. The appropriate maintenance manual should be consulted for complete information on proper wheel chock usage.

The parking brake T-handle is located in front of the pilot's seat and to the right of the pilot's foot rest. When the handle is pulled, a flexible cable pulls a pawl plate into a detent in the brake control levers to lock the pedals in a brakes-on position. With the brake control levers locked in this position, and the anti-skid switch in the ON position, a solenoid in the anti-skid valve will be deenergized to block the return port of the anti-skid valve. This ensures that the hydraulic pressure required by the parking brake will be maintained for a period of time after power is removed from the aircraft to allow for the placement of wheel chocks.

Some Hercules operators have reported incidents where their aircraft have rolled after having set the parking brake. Subsequent investigations of these events have revealed that the parking brake was not properly set.



Setting the Parking Brake

In order to set the parking brake properly, a particular set of steps is required:

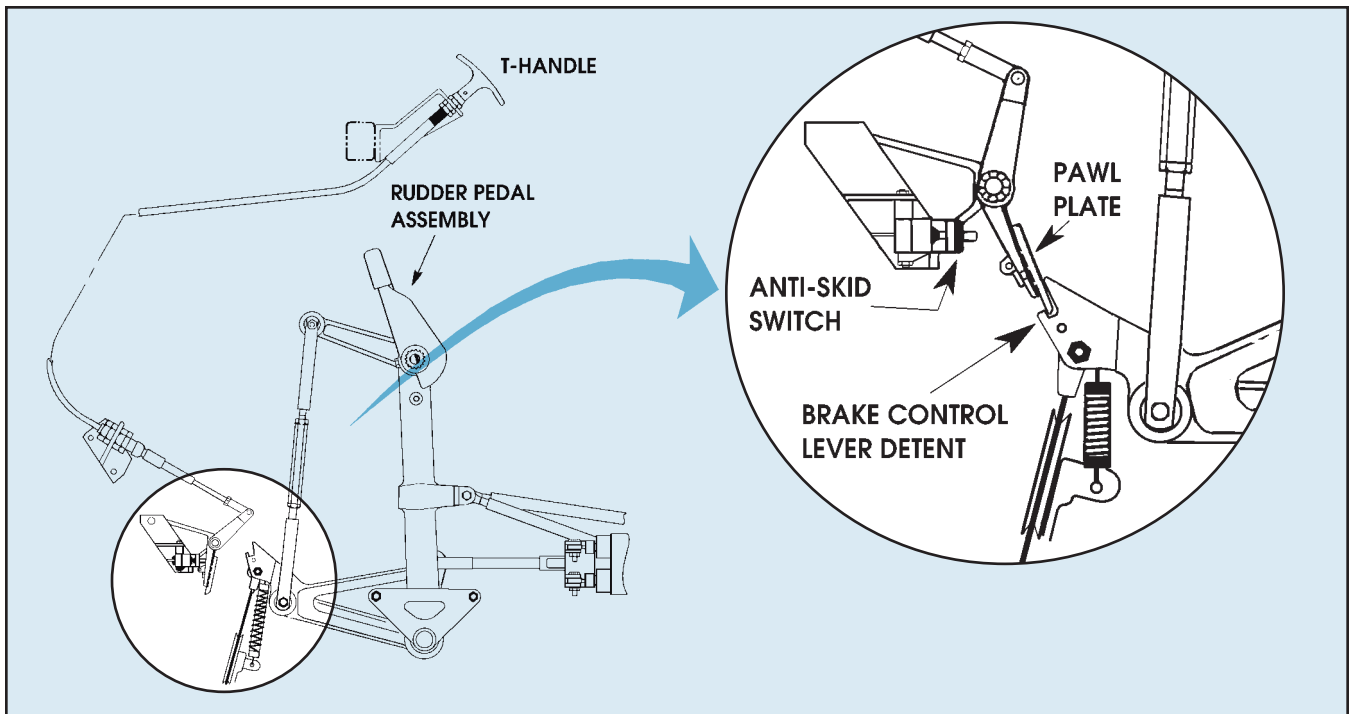
1. Ensure that the auxiliary hydraulic pump is

switched on and that the auxiliary and emergency brake system gages read approximately 3000 psi.

2. Place the emergency brake selector switch in the EMERGENCY position.
3. Fully depress the toe section of the rudder pedals. Monitor the emergency brake system pressure gage for a momentary dip in pressure as the parking brake is applied.
4. Pull the parking brake T-handle to its stop.
5. Slowly release the brake pedals while continuing to pull on T-handle.
6. Verify that the parking brake is set by lightly pressing on the toe section of the rudder pedals. If the brake is properly set, the pedals will have a solid feel and resist the toe pressure; if it is not, they will depress easily and spring back to the “brakes off” position.

These steps must be followed *exactly* to ensure that the pawl plate engages the detent in the brake control levers. If these steps are not followed, it is possible for the pawl plate to miss the detent and rest on the lip of the detent.

The parking brake control assembly, with brake mechanism disengaged, and (right) engaged.



Should this occur, there may be a false sense that the brakes are set, when in reality they are not. One result can be that the parking brake will later release inadvertently. Another possibility under these circumstances is that the solenoid valve which blocks the return port of the anti-skid control valve will fail to deenergize. Unless the hydraulic pumps happen to be operating, the pressure in the braking system will then soon bleed down, allowing the aircraft to roll.

Verifying Brake Engagement

Remember that the most important step in setting the parking brake is to check for proper engagement by applying light pressure to the toe section of the rudder pedals. The presence of solid resistance to the effort to depress the pedals confirms that the brakes are correctly set. Never attempt to verify parking brake engagement by tapping on the T-handle. This can result in damage to the parking brake flexible cable.

Application of the parking brake in the Hercules aircraft is basically a straightforward procedure that achieves positive, reliable results. Rigorous adherence to the steps described above will give the parking brake a chance to do the job it is designed to do, and avoid the potentially costly consequences of suddenly finding an unsecured aircraft in motion on the ramp.

Mike Jones may be reached at 770-494-3343.

A New Multi-Purpose Test Set:

The Encoding Altimeter/Alerter Analyzer



Courtesy Wyoming Air National Guard

by **Scott T. Lavender**, *Senior Electronics Engineer*
Electronic Support Equipment Engineering Department

The integrity and accuracy of both the encoding altimeter and altitude alerter are essential to the proper flight operations on board many versions of the Hercules aircraft. The digitally encoded altitude data output provided by the encoding altimeter is used by IFF and ATC systems and by some area/inertial navigation systems. The coarse and fine synchro signal outputs representing the current barometric altitude of the aircraft are used by the altitude alerter which controls the altitude select mode of the flight director. It is therefore vital that these altitude signals be tested and verified to ensure the proper operation of the other dependent systems.

Lockheed Martin Aeronautical Systems has developed a new, multifunction test set for testing the encoding altimeter and altitude alerter used on C-130E and C-130H aircraft. The Encoding Altimeter/Altitude Alerter Analyzer, PN ES125030-1, is designed for use on board the aircraft and in the shop environment in conjunction with such typical ancillary equipment as a calibrated air pressure source and digital voltmeter.

Multifunction Capabilities

When used for testing the encoding altimeter, the test set converts the encoded altitude Gray code into a usable binary code that drives a five-digit display representing altitude in feet. The operator can then compare the analyzer's display with the actual altimeter to determine if the altimeter is functioning and to evaluate its accuracy. The coarse and fine synchro outputs are converted with synchro-to-digital circuitry and displayed as degrees with 0.1 degree resolution. The user can select which synchro signal, coarse or fine, is displayed.

As an altitude alerter test set, the operator sets the desired altitude on the alerter. The operator can then change the simulated altitude on the test set in 10-foot increments. Circuitry within the test set performs a digital-to-synchro conversion, and outputs both the coarse and fine synchro signals to the alerter. Functional testing is performed by stepping the test altitude from above and below the set altitude while monitoring the alerter output.

This test set can also be used as an analyzer. In the analyzer mode, the test set serves as the source of encoded altitude. This operator-controlled, encoded altitude signal allows the testing of all aircraft systems that require encoded altitude independently of an altimeter or static pressure source.

The Encoding Altimeter/Altitude Alerter Analyzer Test Set is supplied with all the cables necessary for interfacing with the following components:

ALTIMETERS

- B451521002 518-28007-204
- B451521003 518-28007-921
- B451521004 518-28007-923

ALTITUDE ALERTERS

- 540-25100-004
- 540-25100-005

An additional cable is included for connecting the test set to the aircraft when it is being used as an ana-

lyzer. Cables are also provided for connection to both shop and aircraft power.

Further Information

For further information concerning this test set, please contact:

(U.S. Government)
 Lockheed Martin Aeronautical Systems
 Customer Supply Business Management
 Dept. 65-11
 Marietta, GA 30063-0577
 Telephone: 1-770-494-7529
 Fax: 1-770-494-7657

(International and Commercial)
 Lockheed Aeronautical Systems Support Company
 P.O. Box 121
 Marietta, GA 30061-0121
 Telephone: 1-770-431-6664
 Fax: 1-770-431-6666

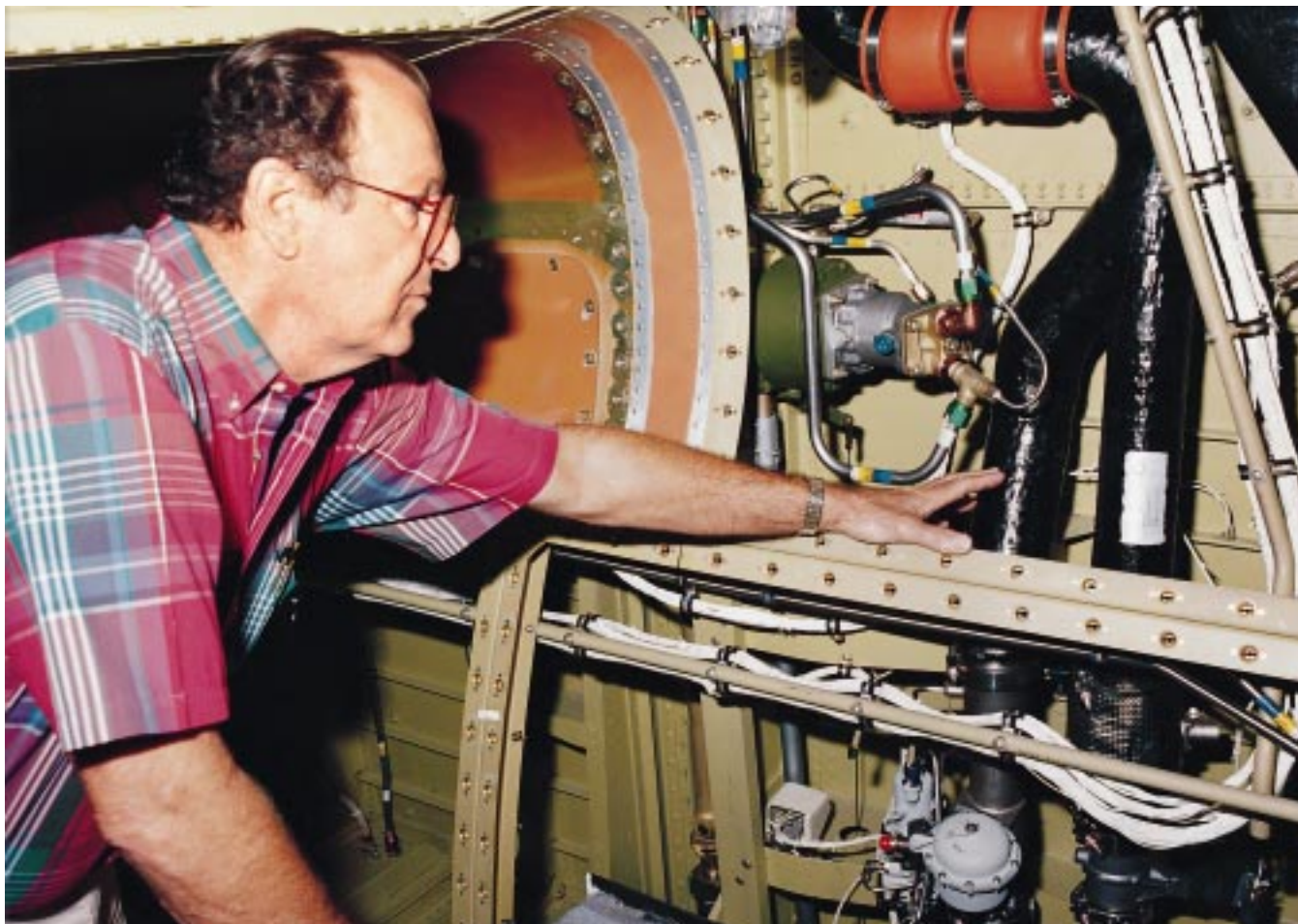
Scott Lavender can be contacted at 770-916-2642.

The Encoding Altimeter/Alerter Analyzer, PN ES125030-1



Bleed Air Duct Corrosion

by **Dave Jefferies**, Staff Engineer
Structural Integrity Engineering Department



Several important systems of the Hercules airlifter, including the engine starting system and the environmental control system, depend upon compressed air for their operation. These pneumatically powered systems can be supplied by the APU/GTC or from ground sources before the main engines are started. During normal operation with the engines running, however, these same systems are powered by hot compressed air which is “bled” (hence the term bleed air) from the 14th stage of the engine compressors.

Operating Parameters

Each engine can provide approximately 155 pounds of air flow per minute at 635F and 125 pounds per square inch of gage pressure. The combined output of the four engines is more than enough to supply all the pneumatic requirements of the airplane.

In the mid-1970s, a bleed air regulator and shutoff valve was added in each nacelle. The purpose of these valves is to reduce the operating pressure in the bleed air ducting system. During wing and empennage anti-icing operation, the regulation mode of these valves can be overridden to provide the higher bleed air pressures and temperatures that are required.

Duct Design

As can be seen from the foregoing, the bleed air ducts are exposed to significant amounts of both heat and pressure, and must therefore be strongly constructed, free of leaks, and well insulated. In the Hercules aircraft, these ducts have typically been made of stainless steel tubing covered with insulation and encased in an integral phenolic fiberglass shell. This design has historically provided a highly satisfactory combination of



Weakened by corrosion, this duct ruptured under pressure. strength, light weight, and durability that are required for this type of application.

Bleed Air Ducts

The bleed air sources in the engine nacelles are connected to the pneumatic systems and to each other by insulated metal ducts. The most significant sections of the ducting are as follows:

1. The bleed air manifold. This is the main duct which extends across the front beam of the wing and interconnects the bleed air outlets from the engine compressors. This main duct also supplies air to the wing anti-icing system.
2. Ducting routed forward from the bleed air manifold to the flight station air conditioning.
3. Ducting routed aft from the bleed air manifold to the empennage anti-icing system.
4. Ducting routed through the right wheel well to the cargo compartment air conditioning system and underfloor heating system.
5. Ducting routed through the left wheel well and on down to the APU and the ground high-pressure air connection.

Duct Failures

Sudden rupture of a bleed air duct has the potential to cause significant damage to the structure, wiring, and cables in the area adjacent to where the break occurs. There is also the possibility of the loss, or partial loss, of functionality in important systems such as the environmental control system and the anti-icing systems.

The bleed air system installed in C-130 aircraft has performed satisfactorily for many years. In the mid-1980's, however, Lockheed began receiving reports of sudden bleed air duct failures from the field. Although the number of cases was small, Lockheed Field Support and Engineering personnel immediately focussed their efforts on finding the cause of these incidents.

These studies soon produced clear indications about the origin of the problem. In all cases of duct failure that have been subjected to metallurgical examination at Lockheed Martin, the cause has been traced to corrosion sites along the welded seams of the stainless steel tubing used for fabrication of the duct.

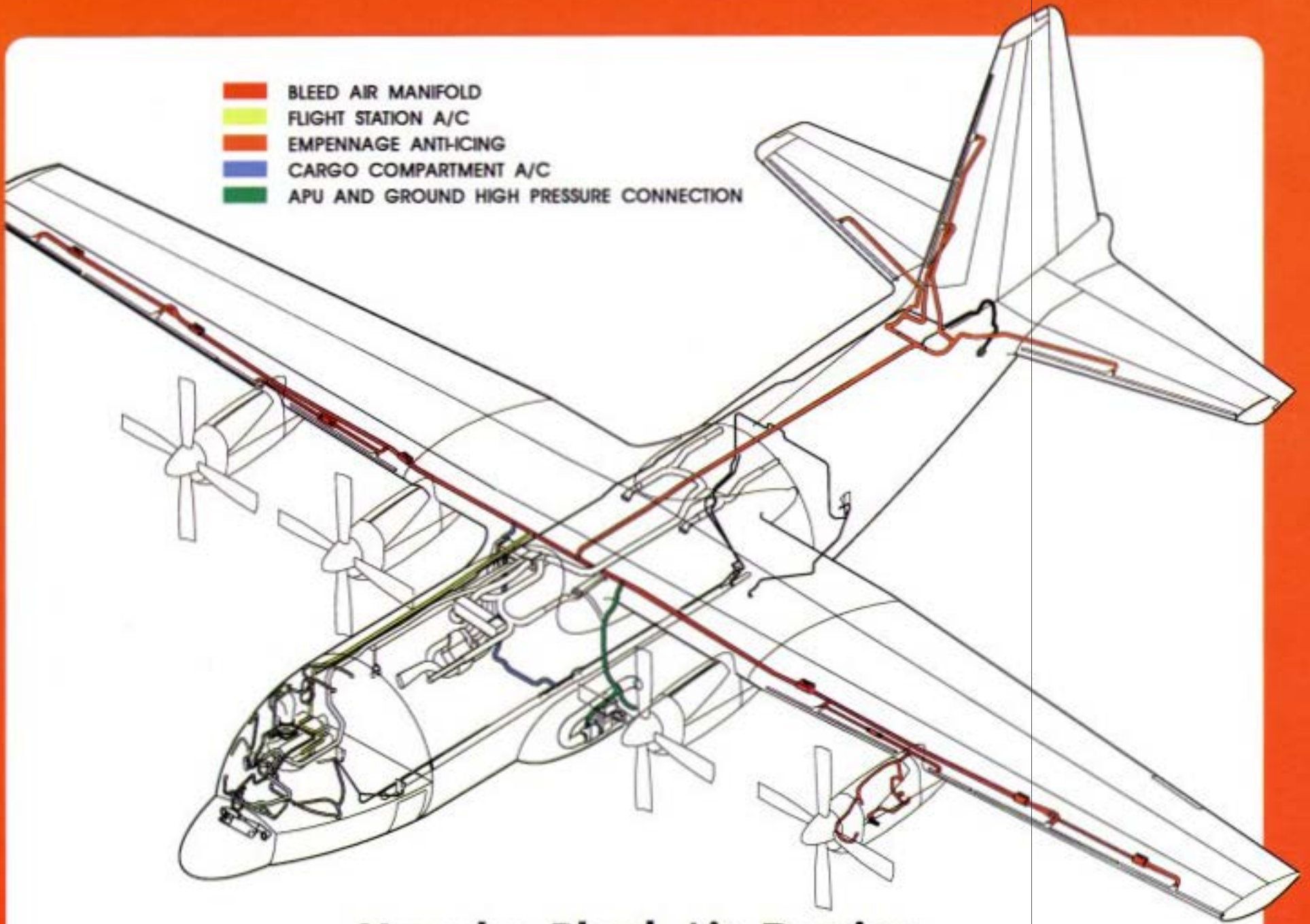
Duct Redesign

In order to eliminate any potential for future duct corrosion, Lockheed redesigned the high-pressure ducting using Inconel 625 in lieu of the type 321 stainless steel. These Inconel ducts were incorporated into production aircraft Lockheed serial numbers LAC 5271, 5276, and 5283 and up, and are now available for replacement ducting on previously delivered aircraft.

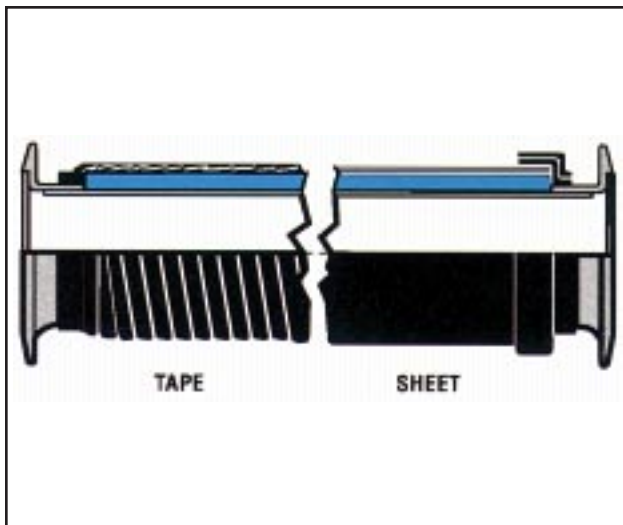
Maintenance Actions

Lockheed Martin Engineering has developed two options to assist operators in maintaining the integrity of the bleed air ducting on delivered aircraft. One option provides for the systematic inspection of the stainless steel bleed air ducts at specified intervals. The second option is a combination of duct replacement using the new Inconel 625 ducts and periodic inspection of the remaining type 321 stainless steel ducting.

These inspection requirements and replacement Inconel ducts for delivered aircraft are published in Service Bulletin 382-36-5/B2-637, which applies to FAA-certified aircraft and military C-130 aircraft purchased directly from Lockheed Martin. The inspection



Hercules Bleed Air Ducting



The application of insulation and insulation covering to bleed air ducts.

procedure for the ducts requires removal of the phenolic fiberglass shell and insulation shown in the illustration above.

The shell and insulation must be removed to gain access to the external surface of the stainless steel duct to permit a thorough visual inspection. The need for this access is dictated by the fact that the corrosion sites identified in previous cases of duct failure clearly began on the exterior surface of the stainless steel tubing.

Complete procedures for bleed air duct insulation removal and inspection are all contained in the service bulletin. Operators are encouraged to report their inspection findings to the factory to help provide as broad a data base as possible on this subject. Lockheed Martin Engineering will continue to evaluate these findings and issue appropriate revisions to the service bulletins when justified.

The U.S. Air Force has addressed the question of bleed air duct corrosion by issuing a technical order requiring the replacement of certain ducts while retaining their current inspection requirements. This order, TCTO 1C-130-1397, is applicable to certain C-130 aircraft purchased by the USAF, either directly or under the FMS program.

A Note on Parts Listings

A complete listing of the available replacement Inconel duct part numbers, aligned with the 321 stainless steel part numbers, is contained in the latest available revision of Service Bulletin 382-36-5/62-637.

The operator should establish a list of the ducts that are actually installed on his aircraft, either from the applicable IPB or directly from the aircraft. He may then determine if an Inconel replacement duct is available by consulting the listing provided in Service Bulletin 382-36-5/82-637.

When requesting a price quote from Lockheed Martin for Inconel ducts by part numbers, the correct selection of the replacement ducts can be verified if the operator also submits the listing of the stainless steel ducts on his aircraft.

Attention to these procedures will help avoid delays and confusion in assisting operators with their orders. Lockheed Martin retains records of the delivered configuration of each aircraft; however, the current configuration status may differ due to operator-installed modification or part replacements.

To order Lockheed Martin-approved bleed air ducts, please contact the following:

(U.S. Government)

Lockheed Martin Aeronautical Systems
Customer Supply Business Management
Department 65-11
Marietta, GA 30063-0577
Telephone: 404-494-7529
Fax: 404-494-7657

(International and Commercial)

Lockheed Aeronautical Systems Support Co.
P.O. Box 121
Marietta, GA 30061-0121
Telephone 404-431-6664
Fax 404-431-6666

The author and *Service News* wish to extend special thanks to Doug Hamilton of Lockheed Martin Engineering for his valued advice and assistance in the preparation of this article. We also wish to thank Dave Wetzel, who appears in the illustration on page 7. Photographic support was provided by Rita King.

For operator assistance, please contact Dave Wetzel, Lockheed Aeronautical Systems Support Co., 770-431-6551 (voice) or 770-431 6556 (fax).

Electronic Support Equipment Engineering

by **Don Coia**, Lead Engineer
Electronic Support Equipment Engineering Department

During modifications and updates to the famous C-130 Hercules and other Lockheed Martin aircraft, many different types of problems can arise. Typical problems encountered by the aircraft manufacturer in connection with electronic equipment upgrades include testing and integrating the updated equipment in a laboratory environment, interfacing the new systems with existing aircraft systems, and effi-

cient design, fabrication, and functional testing of new wire harness assemblies for use in installing these systems into the aircraft.

To maintain Lockheed Martin's reputation for the quality and the supportability of its aircraft, it is important to identify the electronic support equipment that is needed to sustain the new systems at all maintenance levels as soon as the decision to incorporate them is made. For customers who do not have repair capabilities, or who choose to farm out their maintenance work, it is also necessary to identify qualified repair facilities able to service their installed equipment when needed.

Providing Solutions

For solutions to many of these aircraft problems, Lockheed Martin does not have to look further than a few miles down the road from its huge airframe production facility in Marietta, Georgia, where the C-130 is assembled. The Lockheed Martin Aeronautical

Repairing an AC generator control panel, using the PN 3402749-5 test set.



Systems Electronic Support Equipment Engineering Department, located on nearby New Market Parkway, not only designs and produces electronic support equipment, but is also a valued team member experienced in providing expert solutions for problems encountered during aircraft system upgrades and modification.

Led by Mike Fortenberry (please see the Focal Point article, page 2 of this issue), the Department offers unique expertise in the following areas:

- **Electronic Support Equipment**
- **Electronic Equipment Design**
- **FAA Certified Repair**
- **Aircraft Wire Harness Layouts**

The AP-105/FD-109 Integrated System Test Set: C-130 field level.



Our department's capabilities in these areas benefit significantly from its close, ongoing relationship with many different aircraft operators worldwide. Engineers from our department regularly travel to customer facilities to demonstrate equipment and experience firsthand the individual customer's and unique aircraft or equipment maintenance problems. Let us take a closer look at the scope of our organization's capabilities.

Electronic Support Equipment

The Electronic Support Equipment Engineering Department designs and fabricates test equipment to analyze and diagnose electrical and electronic systems on the C-130 and other Lockheed aircraft at all maintenance levels: organizational, intermediate, and depot. From the very first Hercules to the state-of-the-art C-130J, these test sets support every version of this versatile airlifter with the professionalism, expertise, and quality that has always been a trademark of Lockheed Martin Aeronautical Systems products. The Department's capabilities also extend well beyond the production of individual test sets, and include the ability to provide our customers with complete avionics maintenance complexes.

The quality and timeliness of the test equipment we manufacture is further enhanced by the comprehensive knowledge gained by our engineers during the development phases of the various models of the C-130. When new versions of the Hercules aircraft reach the customer, all new test sets required, as well as any upgrades needed for existing test sets, will be ready and available. The current development of new test equipment for the C-130J is a good example of this, and it leads us to our next topic.

Electronic Equipment Design

During the development of new versions of the C-130, or upgrades of previous versions of any Lockheed aircraft, there are often requirements for system hot mockups for engineering and system integration labs. The Electronic Support Equipment Engineering Department has designed, updated, and fabricated such mockups for many versions of the C-130, including every electrical and electronic system being incorporated in the C-130J. The department has also been responsible for the design and fabrication of system development labs for upgrades of the P-3 and S-3 aircraft.

The integration of new systems sometimes requires that special new electronic boxes be designed. The Department's engineers provide the expertise and capability to design the required circuits, and build production-quality equipment in time to meet aircraft assembly or modification schedules. The Threat Warning Lamp Driver Unit and the ALE-47 Bypass Inverter are examples of devices which were developed to perform specific functions in conjunction with current C-130 defensive systems. Currently, an audible fire warning unit is being developed to provide C-130 pilots with an audible warning notification in their headsets in case of an engine fire.

Repair

All Hercules electrical and electronic systems are important, and some are truly critical. For more than 35 years, Lockheed Martin's engineering departments have maintained programs that specifically address the repair and testing of aircraft parts in support of Lockheed Martin aircraft. The repair capabilities we offer include virtually every electrical and electronic component used on our aircraft, ranging from intercom systems to critical power generation and distribution systems. Radar, navigational, instrument landing systems (ILS), and radio communication systems are also fully supported.

As a certified FAA repair facility, the Department maintains the expertise and resources needed to service all types of components and equipment. This includes everything from basic troubleshooting to complete "reverse engineering" redesign to accomplish repair or replacement of obsolete parts. The Department specializes in providing the state-of-the-art testing, engineering expertise, and professional technical support needed in today's demanding aircraft environment.

Wire Harness Layouts

During the production of the C-5B, the need arose for laying out wire harness formboards quickly and efficiently. Acknowledged as experts in printed circuit layouts, the Department was tasked to develop a computerized process for formboard layouts. The process which was developed met all requirements while greatly cutting development time and cost.

In recent years, many enhancements have been incorporated to keep abreast of layout form-

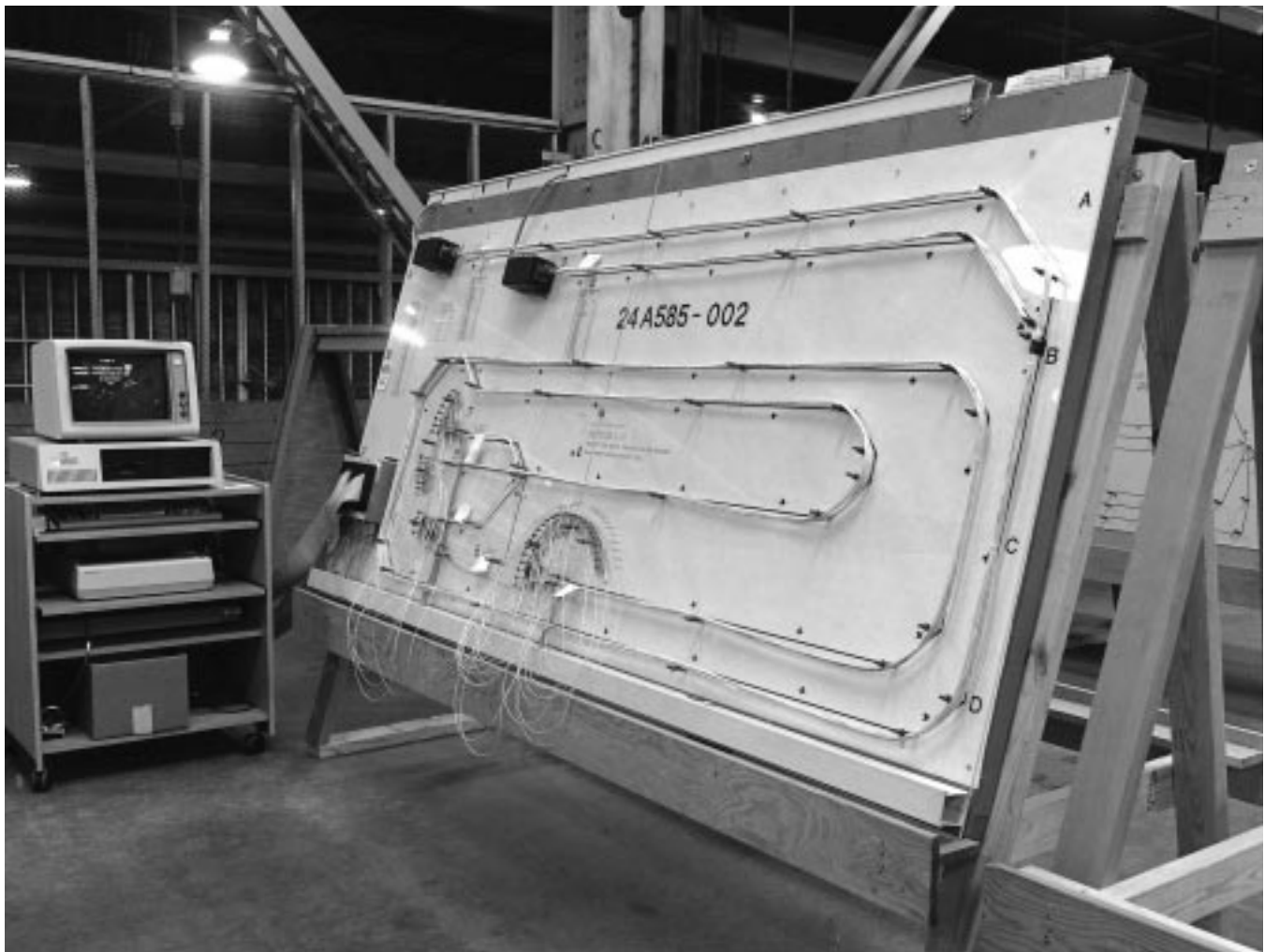
board manufacturing needs. These include the automation of a functional test program for testing assemblies and developing a process by which boards could be reconfigured quickly for use with different assemblies. Since the inception of our program, we have designed thousands of layouts for the C-5B and C-130 aircraft. Thanks to our organization's efforts in this area, the time, space, and budget requirements for the production of aircraft wire harness assemblies have been significantly reduced.

The Synergy of Expertise

Each of the four areas of expertise within the Electronic Support Equipment Engineering Department complement one another to create an efficient, knowledgeable, and uniquely synergistic organization. With the knowledge gained from our experience in the repair sector, the department is able to design better test sets and associated manuals. The knowledge gained from designing and fabricating test sets improves designs for special electronic hardware and hot mockups for system

The PN ES125051 Instrumentation Test Set: multi-aircraft, organizational level.





C-130 CADAM-designed formboard with automated testing.

development labs. Automated formboard stations benefit from the knowledge gained from test equipment designs and experience with the various models of Lockheed Martin aircraft. In turn, our overhaul and repair capability benefits from the ready availability of quality test equipment in our facility.

With the invaluable partnership that has been developed with you, the customer, the Electronic Support Equipment Engineering Department offers unique engineering and servicing capabilities that incorporate the high quality standards expected from Lockheed Martin Aeronautical Systems. For cost-effective and timely solutions to your particular aircraft needs, we stand ready to help! Please do not hesitate to get in touch:

Lockheed Martin Aeronautical Systems
Electronic Support Equipment Engineering Dept.
2211 New Market Parkway, Suite 112
Marietta, GA 30063

Our telephone numbers are as follows:

Telephone: 770-916-2631

Fax: 770-916-2641

Speaking of Telephones —

The area code for most Lockheed Martin telephones in the Atlanta area, including those at the Marietta facility, is being changed to 770. Between 1 August and 1 December, 1995, either the old 404 code or the new 770 code may be used. After 1 December, however, only the 770 code will be effective. Please keep this in mind when contacting Lockheed Martin offices.

Lockheed Classics:



The EC-121 Constellation

*by Terry Linehan, Service Analyst
Lockheed Aeronautical Systems Support Company*

Wing Span - 123'

Length - 116'2"

Height - 24'9"

Gross Weight - 152,500 lbs.

Empty Weight - 93,000 lbs.

Power Plants - Four Curtis-Wright

R3350-42 reciprocating engines

Max. Speed - 295 knots

Cruising Speed - 190+ knots.

Service Ceiling - 27,500'

This aircraft, a variant of the Lockheed Super Constellation, was operated by the U. S. Navy and, together with the similar USAF RC-121, provided the early warning radar screen around the Arctic during the height of the Cold War. The main detection equipment was housed in two large radomes, one below the center section, and the other on top of the fuselage. The “Connie” was uniquely suited for this mission because its tall landing gear provided adequate ground clearance for the lower dome. In addition, by increasing the height of the triple fin and rudder configuration, the designers were able to offset the stubborn directional stability induced by the large upper radome. The EC- and RC-121s, which performed their vital mission faithfully for more than 20 years, were gradually phased out of service in the late 1970s.

Photo courtesy of Robert E. Herndon
Terry Linehan may be reached at 770-431-6594.

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Aeronautical Systems

Customer Training Systems Department
Lockheed Martin – LMAS
Marietta, GA 30063-0601

