Lockheed

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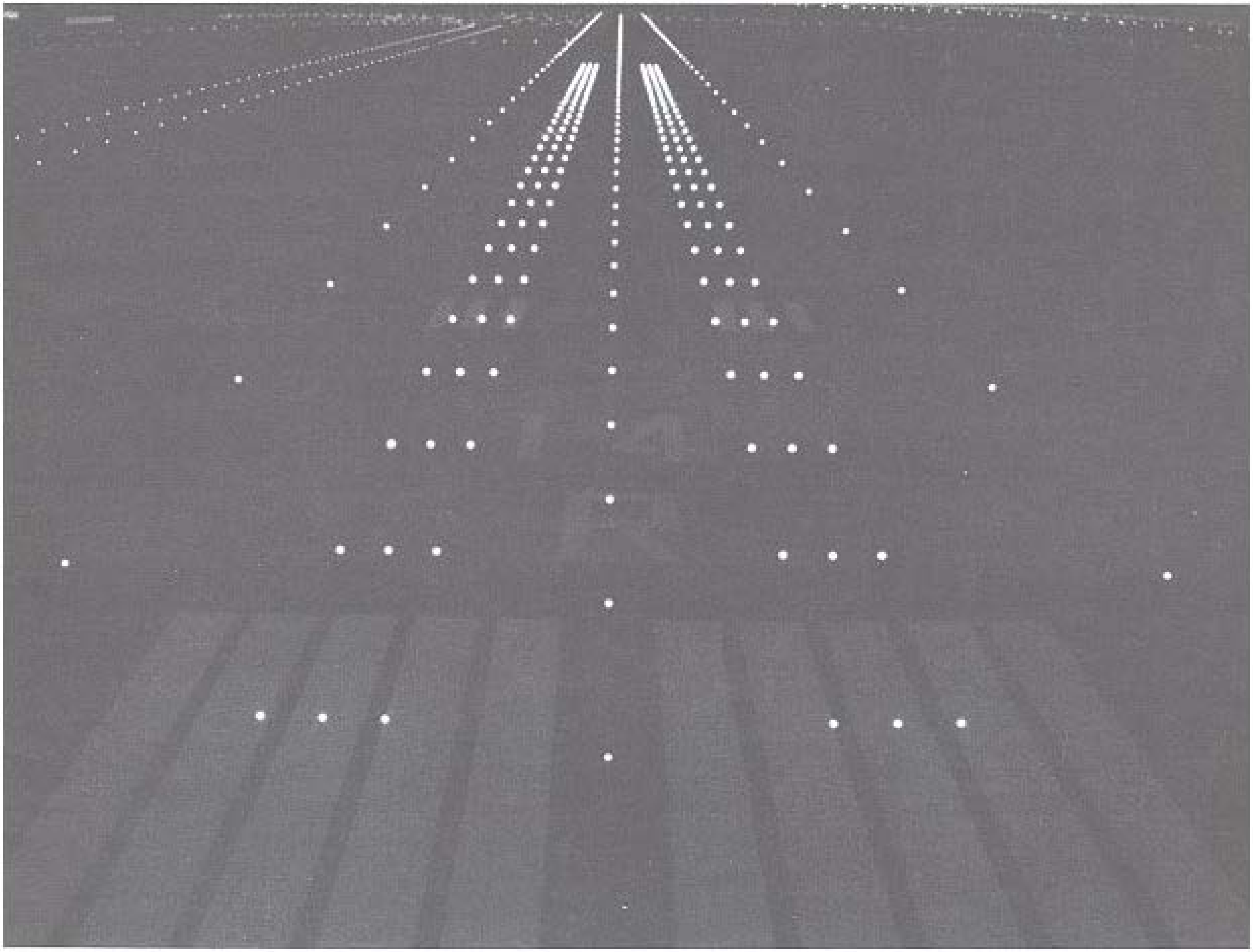
service news

A SERVICE PUBLICATION OF LOCKHEED-GEORGIA COMPANY, A DIVISION OF LOCKHEED CORPORATION



Hercules Flight Training Center

Lockheed
Service News

A SERVICE PUBLICATION OF
LOCKHEED-GEORGIA COMPANY
A DIVISION OF
LOCKHEED CORPORATION

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Vol. 12, No. 2, April – June 1985

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Back: A KC~l30H flown by the U.S. Marines performs an aerial refueling demonstration for Colombian Air Force A-375.

PAUL FRECH

Focal Point

Partners for Progress

We at Lockheed have a proud tradition of partnership. Almost 70 years ago two brothers, Allan and Malcolm Loughead, pooled their talents and their resources to form what won would become known as the Lockheed Aircraft Company. Sixteen years later another partnership, this time headed by Robert E. Gross, restructured the company and brought into being the organization that is todays Lockheed Corporation.

In the pioneer days of aircraft manufacturing, partnership offered both the strength of mutual enterprise and a way to share the risks, financial and otherwise, that were a constant threat to the future of the fledgling industry. Today, aerospace has matured into a vast and highly sophisticated giant, and the concept of partnership has evolved to play a new and enhanced role. Cooperative efforts have emerged as an efficient and productive way of bringing together the unique expertise of selected organizations within the industry to achieve a common goal. What that goal is can be summed up in one word: value The purpose is to provide the aerospace customer with the best in state-of-the-art products and services at the lowest possible cost.

There is no other industry where the demonstrated potential for advancement through cooperative effort holds so much promise as it does in the aerospace industry, and I can think of no better example of what this kind of partnership can yield in practical terms than the new Hercules Flight Training Center described in this issue of Service News.

In building this remarkable new facility, Singers Link Flight Simulation Division and the Lockheed-Georgia Company have established an ultra~modern training center which can offer both military and civilian Hercules aircraft operators the ideal way oi meeting their flight training requirements. The capabilities of the center and its staff are second to none in quality. yet highly cost-effective at the same time.

We are very proud oi the Hercules Flight Training Center and of the kind of cooperative endeavor that it represents. The building is new. and thr technology its simulator represents is the latest and the best. But I take particular satisfaction in the knowledge that this facility also contains a full measure of something that is not news the Lockheed tradition of providing our customers with the greatest possible value for every investment in our products and services.

Paul Frech
President

PRODUCT SUPPORT LOCKHEED-GEORGIA COMPANY MARIETTA, GEORGIA 30063

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Hercules Flight Training Center

One of the first large-scale uses of flight simulation was in World War II. The Link trainer, named after its inventor and by today's standards a relatively simple device, was used in pilot ground school for training in simulated instrument flight conditions and radio navigation. Flight simulators have evolved over the years into replicas of flight decks or cockpits based on individual aircraft types with specific handling characteristics built-in.

Modern flight simulators satisfy a definite need in the field of flight training because they allow flight training to take place with no risk to an aircraft or personnel. The cost is also lower than if all training were conducted in an aircraft, although actual flight time in the aircraft cannot be dispensed with altogether,

To provide the benefits of state-of-the-art flight simulator training for crews of C-130H, C-130H-30, and L-lOO-30 aircraft, Lockheed-Georgia Company has teamed up with the Singer Company's Link Flight Simulation Division in the construction and operation of a new Hercules Flight Training Center. The best, most comprehensive Hercules aircraft aircrew training available in the world will be conducted in this new facility.

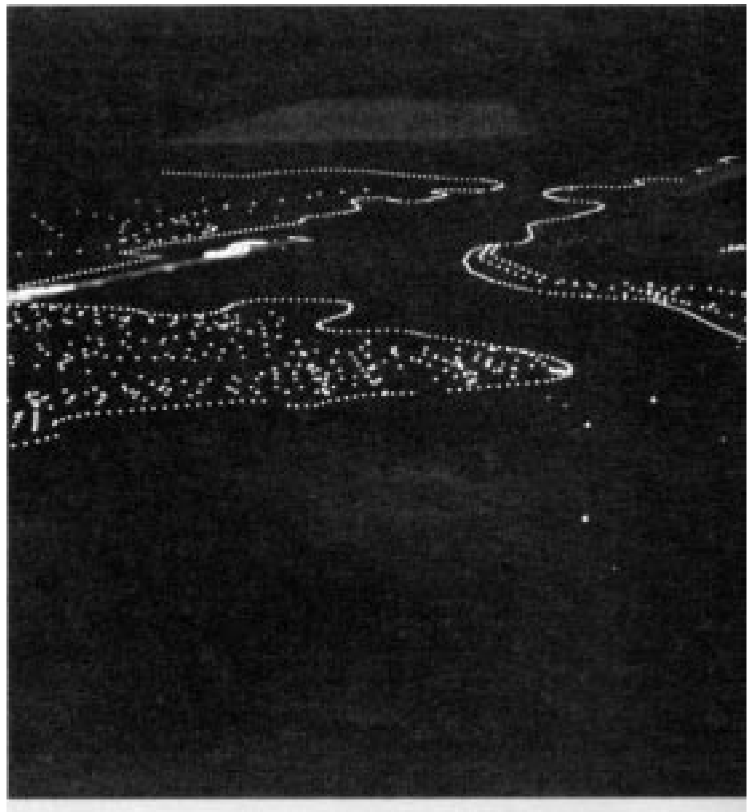
The simulator is built in Binghamton, N.Y. by the Link Simulator Division of the Singer Company. It features the first microprocessor-driven visual system: IMAGE II, built in England by Link-Miles. The IMAGE II system presents quite a realistic visual display and has won approval for the simulator by the Federal Aviation Administration as a "visual simulator".

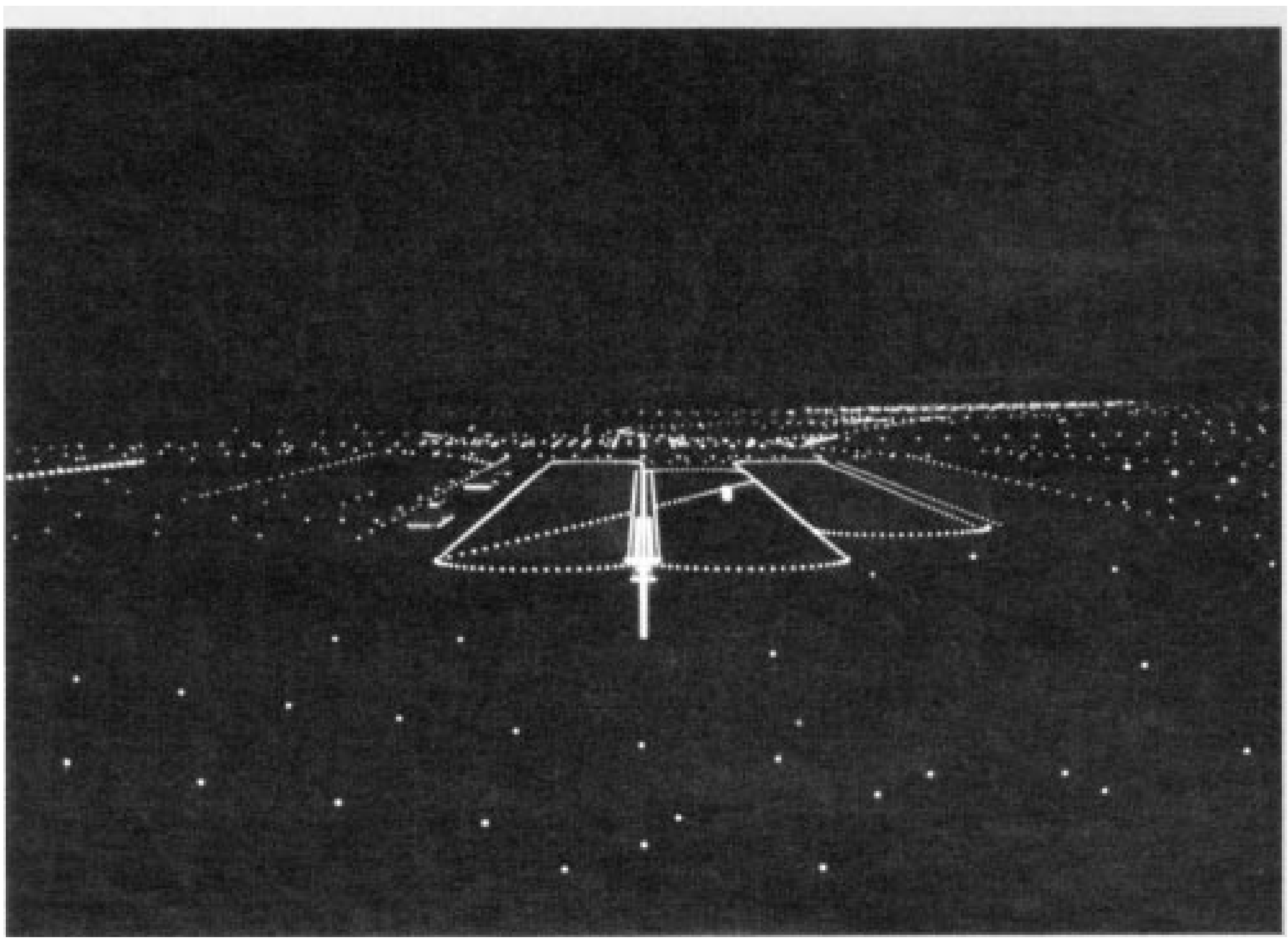
The trainee crew aboard the simulator sees a dusk/night presentation of computer-generated color scenes representing the view from the cockpit in simulated taxi, cross-country, circling approach, and landing procedures. During simulated flight in the vicinity of the airport, the view includes:

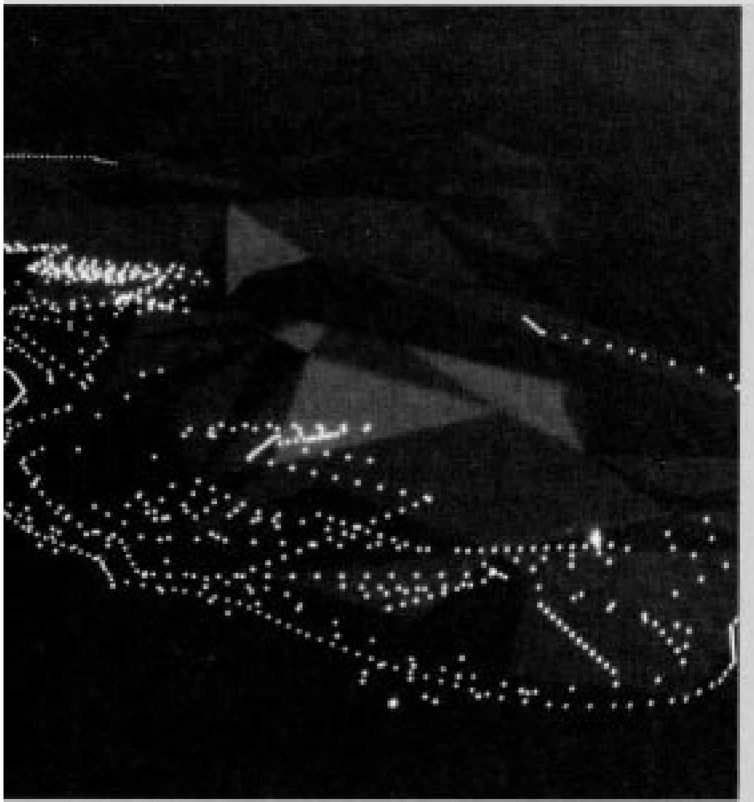
- The whole airport area and all significant features.
- The area surrounding the airport (depending on visibility and aircraft altitude).
- Ground and airborne traffic, both static and moving.
- The horizon, under clear conditions.
- Environmental surfaces, runway markings, landmarks, etc.
- Runway and approach lighting.
- Weather conditions that vary from clear to completely obscured.

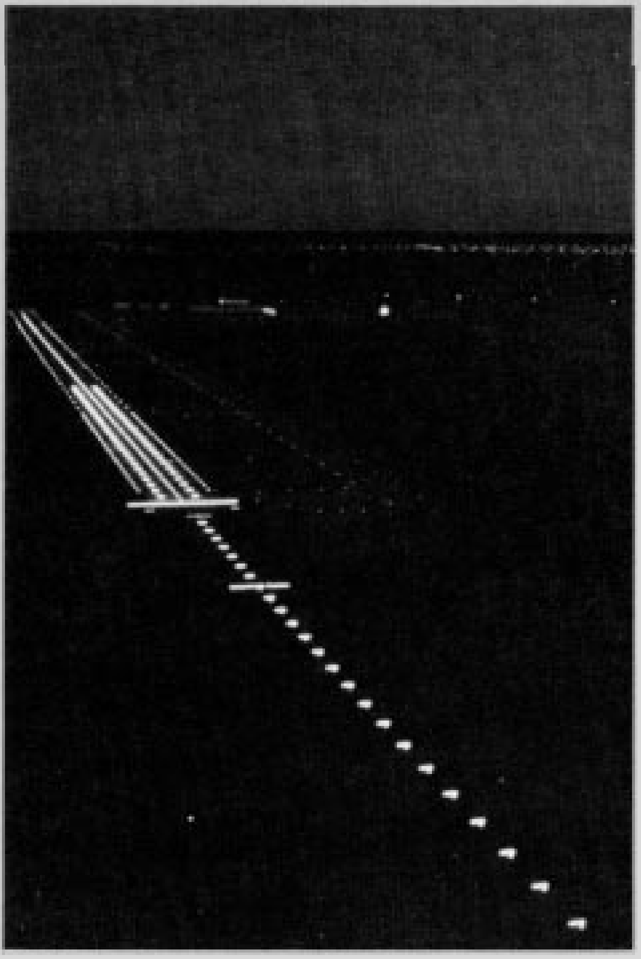
Away from the airport area, urban lights and other navigational features may be seen.

The Hercules aircraft's flight station is duplicated in detail on the simulator. Flight conditions such as









pitch, roll and yaw rotation as well as surge, heave, and sway are simulated by a six-degree of freedom motion system. This feature provides the physical sensations of the various flight maneuvers for the flight crew.

The characteristics or "feel" of the aircraft's controls are duplicated to enhance the effectiveness of the training. Changes in the amount of movement and force on the controls as a function of aircraft acceleration, velocity, configuration, center of gravity, and weight give realistic feedback to the pilot.

Flight crews can practice maneuvers in the Hercules simulator which may present certain risks when accomplished improperly in the airplane, such as:

- Flight with flight control boost off.
- Stalls.
- Rejected takeoffs.
- Three-engine takeoffs.
- Two-engine landings.
- Engine failure at takeoff.

- Maximum effort takeoff and landings.
- Limited visibility approaches.

Certain hydraulic, electrical, and other system failures that cannot be effectively demonstrated in the aircraft can be demonstrated in the simulator under a variety of simulated weather conditions. If the student encounters a problem with a particular maneuver or procedure, the situation may be frozen at that point, and the solution and alternatives explained without flying back into position to start the maneuver again. Turbulence, icing conditions, high crosswinds, instrument and night flying conditions are realistically simulated and are practiced as required by the schedule or as student need dictates. Simulator flight training allows more efficient use of instruction time because there are no weather delays, maintenance delays, refueling of the aircraft, preflight inspection, air traffic control delays, or ground operation delays.

Simulator flight training is not only a more efficient form of training but it is a more economical form of training as well. The students require less flight time in the simulator to perfect the same sequence of maneuvers and the cost per hour for operating the simulator is significantly less than what it costs to operate the aircraft.

For the instructors, there are two compact panels equipped with three CRTs and two keyboards that allow complete control of all aspects of the training situation. The onboard location of the instructor stations allows an over-the-shoulder view of the pilot and flight engineer actions and cockpit instruments. The instructors have over four hundred discrete and variable malfunctions available for their use in simulating failures of aircraft systems. Initial positioning of the simulator with the desired environmental conditions, fuel and cargo loads, pre-programmed malfunctions and performance monitoring is selected by the instructor. It is possible to record and play back selected maneuvers in the simulator to allow student scrutinization of their own actions and enhance learning. In addition, the instructor may select specific data relative to the simulator training session that may be printed on a computer printout for use as a training aid and as a means of evaluating the trainees' progress.

For complete information on the new Hercules Flight Training Center, contract:

Manager
Hercules Flight Training Center
605 Franklin Road
Marietta, Georgia 30067, USA
TELEX: 42642 LOCKHEED MARA
Telephone: (404) 424-3646

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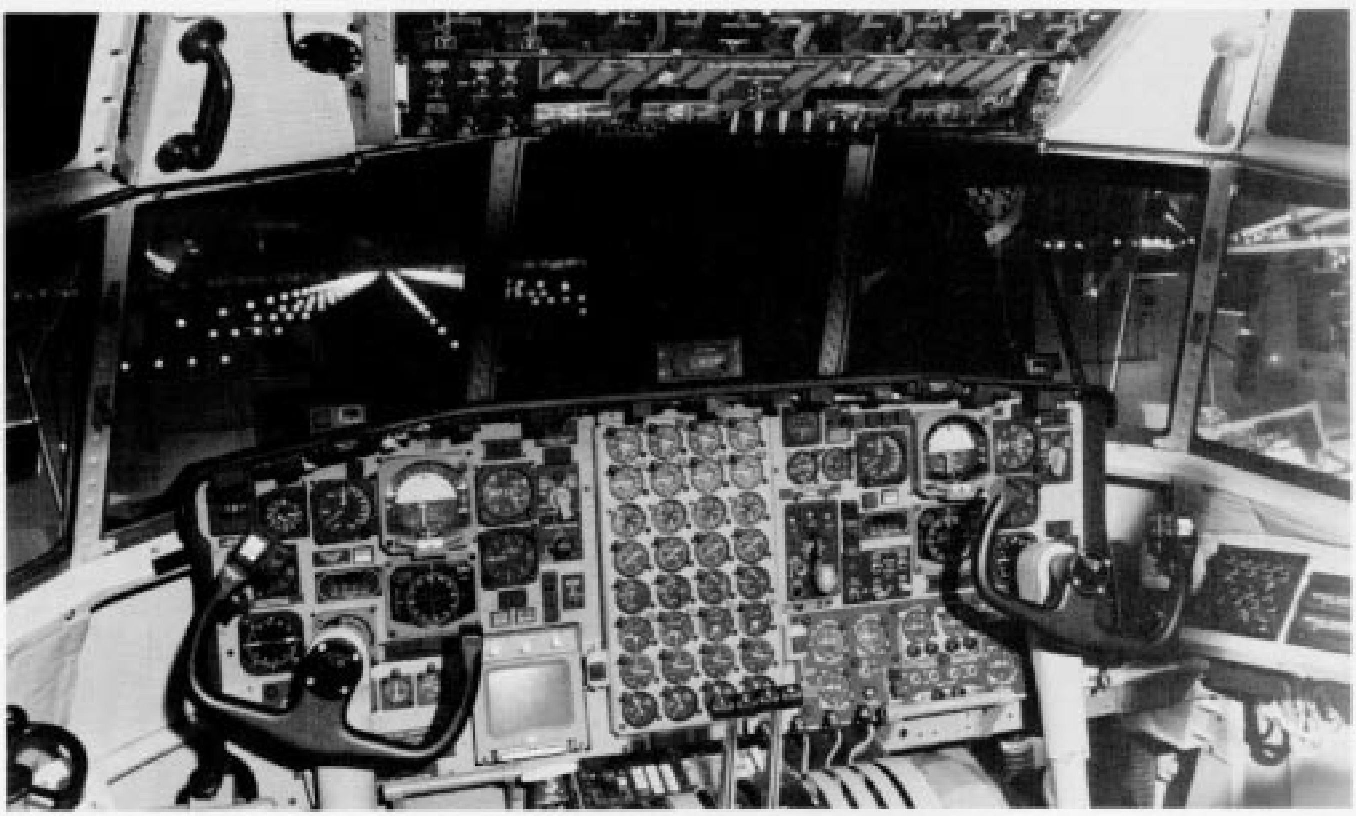

ENGINE PERFORMANCE CALCULATOR KIT

A new **method** of engine performance measurement has been developed by **Allison Gas Turbine Division** for use with the Series III turboprop engines such as the 501-D22A, T56-A-15, and T56-A-15 LFE engines. This new method involves the use of a hand-held calculator for determining engine performance on the ground instead of using one of the published engine performance charts, which are often difficult to read and subject to miscalculation. The new method is easier to perform and much more accurate.

The new method developed by Allison uses a Hewlett-Packard model 41CV programmable calculator equipped with a P/N 82104A card reader, and a set of magnetic cards, part numbers 23006772-1, 23006772-2, and 23002987, on which engine parameter curves have been recorded. To do an engine performance check using the calculator, the operator enters the outside ambient temperature near the engine, the pressure altitude where the check is being done, and engine power either in inch-pounds of torque or in degrees Celsius TIT, and the calculator will display the engine performance percentage.

Allison does not specify a particular interval for engine performance checks, but they do suggest that a performance check be accomplished and recorded after installation of a new or newly overhauled engine. This will establish a baseline to which subsequent checks can be compared, and allow engine operating trends to be recognized. The use of the hand-held calculator will greatly facilitate setting up a series of accurate performance checks.

Lockheed has assembled a kit which contains all the items necessary to accomplish an engine performance check by this method. Besides the 41CV calculator, 82lC4A card reader, and magnetic cards mentioned earlier, the kit contains a model 450-AKT digital thermometer, and a part number HPS-AP-K-316E-IZSMP thermocouple probe unit (see figure), both manufactured by Omega Engineering Incorporated, and a set of instructions, part number 3403157-l. The part number of this kit is 3403157. The kit will be listed in the next revision of the Illustrated Tool and Equipment Manual, SMP 515E.

For quotations or purchase of the kit, contact:

Lockheed-Georgia Company
Supply Sales and Contracts Dept.
Department 65-11, Zone 451
Marietta, Georgia 30063
Telephone (404) 424-4214
TELEX 542642

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SOLID-STATE OIL QUANTITY TRANSMITTERS

by **J. A. Oda,** *Electrical Design Group, Project Engineering*

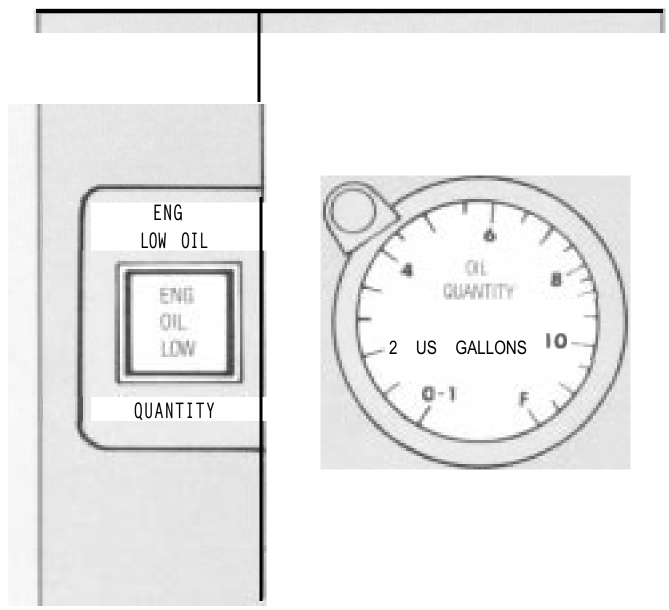
The Hercules aircraft has been updated with many technological improvements over the years, a fact which has helped maintain this remarkable airplane as the world's most versatile airlifter. One such improvement is the use of solid-state microprocessors to provide engine oil quantity level signals to the engine oil quantity indicators.

Dataproducts New England's Aerospace Division is currently supplying the solid-state oil quantity transmitters (see Figure 1) for installation on all new Hercules aircraft. The indicators in the aircraft flight station are not affected by this change.

A brief explanation at this point will help clarify the operation of these new solid-state transmitters. The heart of the system is a length of small-diameter, nickel-alloy wire used as a sensing element in the solid-state transmitter probe housing. The microprocessor, located in the upper end of the transmitter (Figures 1 and 2), pulses current in very small increments through the wire, heating the wire and thereby increasing its resistance. The microprocessor measures the resistance change and is able to calculate the temperature increase of the nickel wire by using data on the temperature coefficient of nickel, which is stored in its memory.

When the sensing element is immersed in engine oil, the temperature increase is substantially reduced. The amount of temperature change is dependent upon the total mass of the nickel wire, its specific heat, and the percentage of the element that is immersed in oil. The microprocessor calculates the unknown variable, the energy loss from the portion of the element that is immersed, and sends the appropriate signal to the indicator.

The solid-state unit is also different from the old design in that it posesses automatic self-test features.



WARNING LIGHT & OIL QUANTITY GAUGE

When power is applied to the system, the transmitter tests the indicator, the low oil light circuits, the drive circuits of the transmitter, the transmitter electronics, and the sensing element's continuity.

The self-test is observed on the appropriate indicator for each engine. This feature is not available on the float-type oil quantity transmitters and deserves further explanation. When electrical power is applied to the system with the appropriate circuit breakers closed, the indicator pointer will drive to the "F" mark and hold for approximately one second. The pointer will then swing to the "O-l" mark and the low oil warning light will illuminate. This will also be observed for about a second. Then the low oil light will extinguish and the pointer will drive in one, two, or three increments to the actual oil level quantity. Since each transmitter is capable of

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illuminating the low oil light, power may be applied to each unit individually to check for proper self-test upon initial power application.

It should be noted that since this unit is a form, fit, and function replacement of the float-type unit, a combination of the two types of transmitters may occur on any particular aircraft. It is important to remember that under this condition there will be a difference in indications upon initial power application because of the solid-state unit's self-test feature.

Once the self-test is completed and the system is indicating the oil quantity, the indicator pointer may occasionally be observed to be swinging a small amount (+/-1/2 gallon) on either side of the indicated quantity. This is a designed-in search mode and should be considered as normal operation when it is observed.

If a self-test is interrupted for some reason, or power is removed from the system during normal operation, a 30-second wait is required before the transmitter's microprocessor will reset. After this interval, power may be reapplied for a normal power-on self-test.

The solid-state transmitter also tests the engine oil quantity indicating system continously during any power-on condition. Should a fault develop in the probe, the low oil light will blink. Should the transmitter find a fault in its own circuits, the low oil light will illuminate steadily and the indicator pointer will drive to off-scale full and remain there.

Although the solid-state oil quantity indicating system transmitter is designed to be a "form, fit, and function" equivalent of the older float-type unit it supersedes, during engine servicing some differences may be noted between the oil quantity readings obtained with a solid-state transmitter and those given by float-type units or

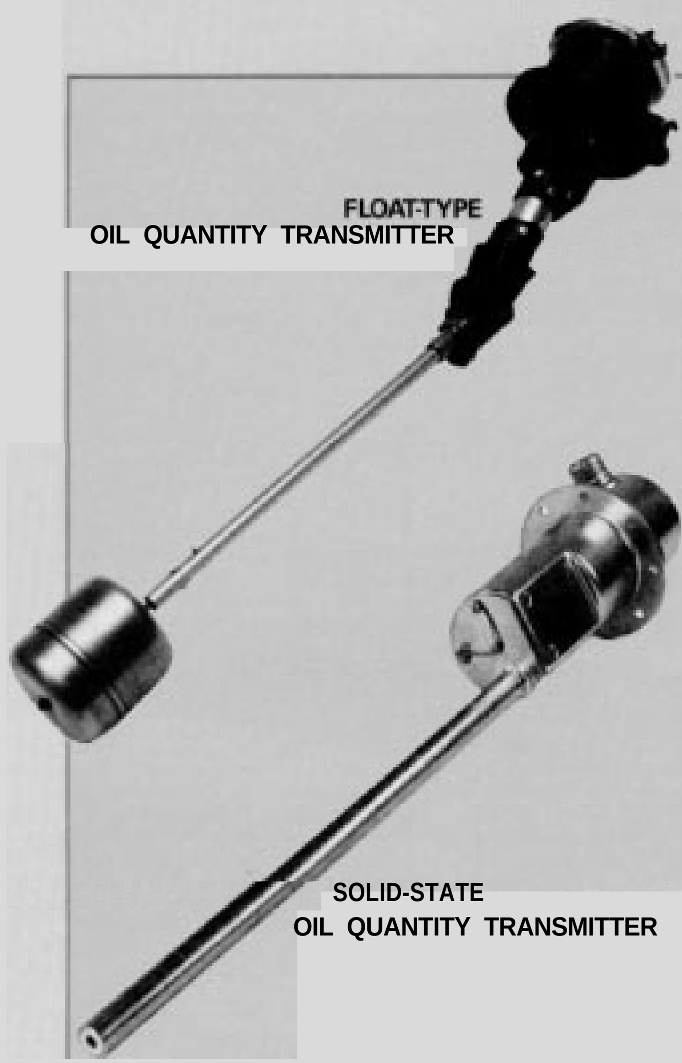

Figure 1.

the oil tank dipstick.

This is a result of the relative internal positions of the oil tank dipstick and the transmitter probe, which are

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shown in Figure 2. The figure also shows approximately where the oil supply in the tank would be located at zero degrees roll-the aircraft wings level. Both the solid-state transmitter and the float-type transmitter are calibrated in accordance with design specifications to match the readings of the tank dipstick at zero degrees of roll. But the physical locations of the components that actually measure the oil in the two types of transmitters have some important consequences for the operation of the system.

The float-type transmitter incorporates a float that measures the oil level close to the dipstick, a point which is some distance from where the transmitter is installed. As the degree of roll varies from zero (because of an unlevel ramp, for example), the dipstick and the float transmitter readings remain about the same.

The solid-state transmitter is installed at the same location as the float-type transmitter, but it also takes readings there. This means that the solid-state transmitter is measuring the oil level near the side of the tank that is opposite from the dipstick. This arrangement, which is necessary to meet the requirement of complete interchangeability with the old unit, will yield oil quantity indicating system readings that are in good agreement with the dipstick as long as the wings are level, in other words, at zero degrees roll.

But any condition that will affect roll, such as parking ramps that are not level, unequal fuel loads in the wings, possibly even wind conditions, can produce oil quantity readings that do not agree. When measured on the ground, the difference between the values shown by a solid-state oil quantity transmitter and the dipstick of the same engine may differ by as much as 2.25 gallons with up to 2 degrees of roll and still be considered within tolerances.

The operation of the oil quantity indicating system is not affected by such factors in normal flight, and it is in flight where the advantages of the new transmitters become most apparent. From a practical standpoint, the tank dipstick should be used for determining ground servicing requirements, while the solid state transmitter can be considered a "remote dipstick" for all normal flying operations.

The Dataproducts New England manufactured solid-state oil quantity transmitter is hermetically sealed, making it virtually immune to the detrimental effects of dust, sand, salt air, oil, humidity, and altitude. With self-test features, built-in fault codes, and continuous monitoring of system integrity, the DNE solid-state oil quantity transmitter offers Hercules aircraft operators enhanced performance from the engine oil quantity indicating system.

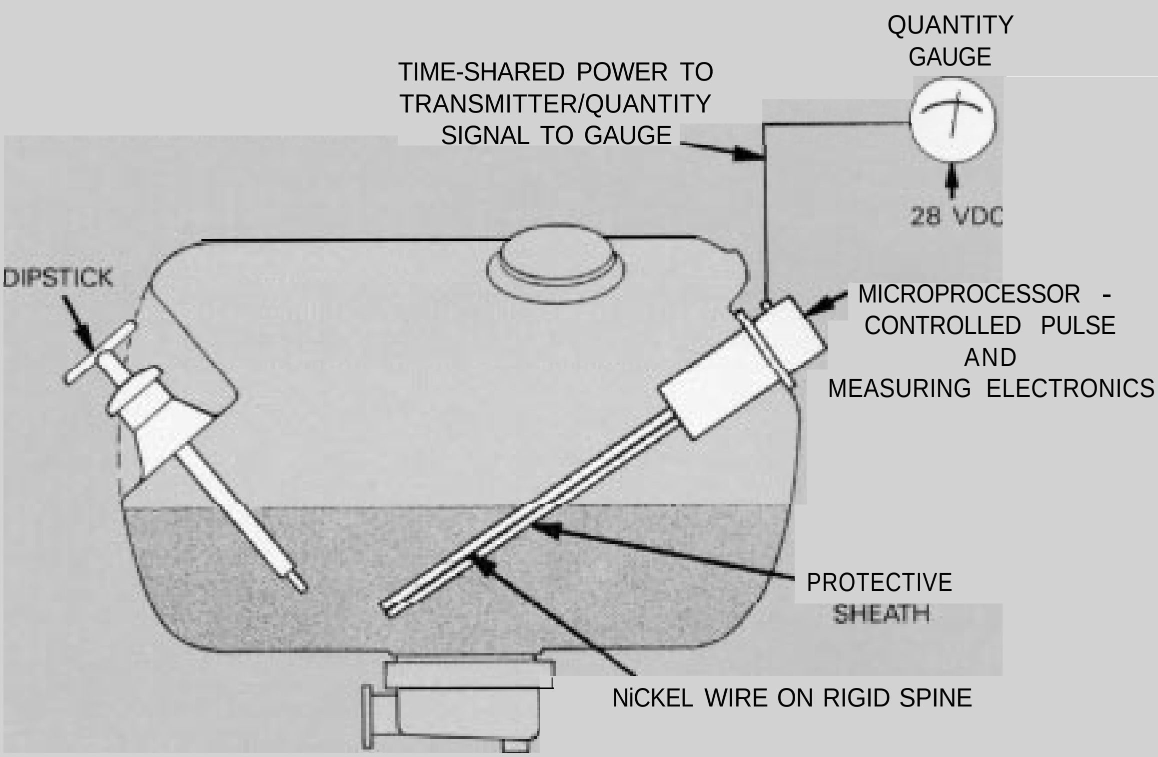

Figure 2. SOLID STATE OIL QUANTITY TRANSMITTER TANK INSTALLATION.

Lockheed Introduces AVWASH

by **Al Harcarik**, *Group Engineer, Lockheed-California Co.*
Raymond E. Yearty, *Supply Sales Planner, Sr., Lockheed-Georgia Co.*

Figure 1.

Today most aircraft are cleaned in the conventional manner using cold water, detergents, a sponge, and a brush. However, conventional washing techniques have the following disadvantages:

- Excessive material costs due to high consumption of cleaning compound and water,
- Excessive labor costs due to high manhour requirements,
- Aircraft surface deterioration caused by harsh brush effects, and
- Inadequate cleaning resulting in corrosion.

Aside from the benefit of an enhanced physical appearance, and aircraft with a clean exterior surface provides the following economic benefits:

- Increased service life due to improved corrosion resistance.
- Early detection of surface cracks, leaks, and worn parts,
- Increased fuel efficiency due to reduced aerodynamic drag, and
- Reduced fuel consumption due to lower weight.

In an effort to provide these benefits while lowering the operator's costs, Lockheed began a study of aircraft cleaning equipment. The result of that study is the introduction of the Avwash Cleaning System (P/N 1310858-101, NSN 4940-Ol-157-8614BP) shown in Figure 1.

Avwash is a self-contained mobile cleaning system, requiring only an external water source. It is designed to economically clean a variety of aircraft, machinery, mobile and stationary equipment, floors, and any surface subject to dirt, oil, grease, or other contaminants. This system cleans on contact by rapidly disintegrating and dissolving surface contaminants by means of a high

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energy (high pressure, 1000 PSI, and high temperature, 2OO'F/93'C) spray of water and cleaning compound. This provides for thorough cleaning of the surfaces with less scrubbing, resulting in more effective corrosion prevention and less surface deterioration.

When compared with conventional methods of washing an aircraft, the savings in cleaning compound, water, manpower, and time derived from using the Avwash System are evident. Figure 2 illustrates the savings which can be achieved on a Hercules type aircraft using Avwash.

By following the operating manual provided with the system, a crew of three can wash an aircraft the size of the Hercules in approximately three hours. This is accomplished by having two men operating spray guns while one man operates and monitors the system controls.

The cleaning compounds recommended for use with the Avwash System are nontoxic, have no dangerous fumes, are economical (formulated for use in a 50 to 1 dilution), and contain corrosion-inhibitor additives.

As well as being a cleaning system, Avwash can easily be adapted to perform other functions, including: deicing, anti-icing, chemical decontamination, hi-density foaming, and wet sandblasting. These conversions can be accomplished by substituting specially designed modules for certain svstem components, in order to provide the desired capability.

SAVINGS IN	NUMBER OF AIRCRAFT				
	5	10	25	50	100
Labor (Manhours)	2145	4,290	10,725	21,450	42,900
Cleaning Compound ($)	5850	11,700	29,250	58,500	117,000
Water (Gallons)	585,000	1,170,000	2,925,000	5,850,000	11,700,000

NOTE: **Based on 13 washes per year per aircraft, three (3) hours cleaning time per aircraft, and cleaning compound at $3.00/Gal.**

Figure 2.

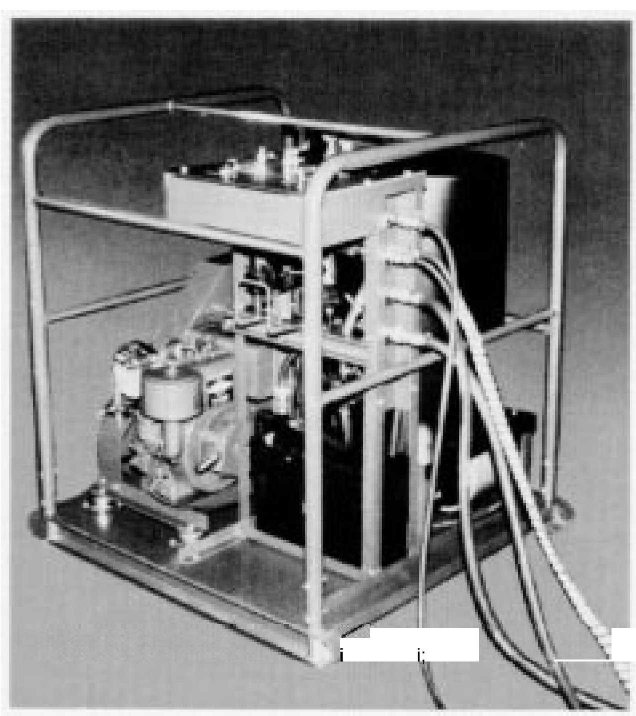


Figure 3. **DECONTAMINATION, DEICING, & CLEANING SYSTEM (P/N 1310847-101)**

One such derivative is the Decontamination, Deicing, and Cleaning System (P/N 1310847-101) shown in Figure 3. This is a mobile unit which in addition to these functions can be used as an internal jet engine washer as well as a personnel shower. It will draw water, glycol, detergent, liquid decontamination agents, and diesel fuel from any available source.

The Avwash system and its derivatives represent a significant advancement in the area of aircraft maintenance. Designed to reduce both labor and material costs associated with aircraft washing, this system provides superior cleaning capability. It's mobility, simplicity of operation, and ability to conserve water and other valuable resources makes it ideal for both remote and main operating bases.

If you would like additional technical or procurement information about the Avwash system, please direct inquiries to the Manager, Supply Sales and Contracts Department, at the following address:

Lockheed-Georgia Company
Supply Sales and Contracts Department
Department 65-11, Zone 451
Marietta, Georgia 30063
Telephone (404) 424-4214
TELEX 542642

A QUICK FIX FOR A HANGING DOOR

by John Walters, Staff Engineer

Occasionally we receive reports from Hercules aircraft operators of aft cargo doors failing to lock in the open position during in-flight door operation. On the ground, an operational check of the aft cargo door often fails to duplicate the in-flight write-up. This leaves the maintenance technician in the unenviable situation of having to troubleshoot a problem he cannot duplicate. The most common course of action then is to try out some things to see if they will help. Unfortunately, in this particular case the efforts to remedy the problem may ultimately do more harm than good, and the underlying problem will still be left unresolved.

The usual practice after an initial in-flight cargo door operation malfunction is to sign off the write-up if an operational check by the maintenance technician is found to be satisfactory. If the cargo door continues to fail to lock open during in-flight operation, one of two things is usually done which may appear to solve the problem. One fix is to shorten the cargo door actuator by adjusting the rod end; the other is to lower the uplock assembly. These two procedures are often done even when it has been previously determined that the aft cargo door system is rigged in accordance with the ramp and aft cargo door section of the maintenance manual. Let us see why these two actions should not be undertaken in an attempt to correct this kind of in-flight aft cargo door malfunction.

First, by shortening the cargo door actuator, undue stress can be transmitted to the actuator attach point on the cargo door or aircraft structure. This could lead to cracking and failure of the attach points if the increased stress is maintained.

If the second approach is chosen, lowering the uplock, care must be taken to ensure that the required 108-inch clearance between the ramp floor and the cargo door is maintained when both are in the open position. If the lob-inch clearance is not maintained, a loadmaster might unwittingly try to push a normal-size load through too small an opening, possibly damaging the cargo door.

When these two approaches to getting the door to lock during in-flight operation fail, some maintenance organizations have even removed and replaced the whole door in an attempt to solve the problem.

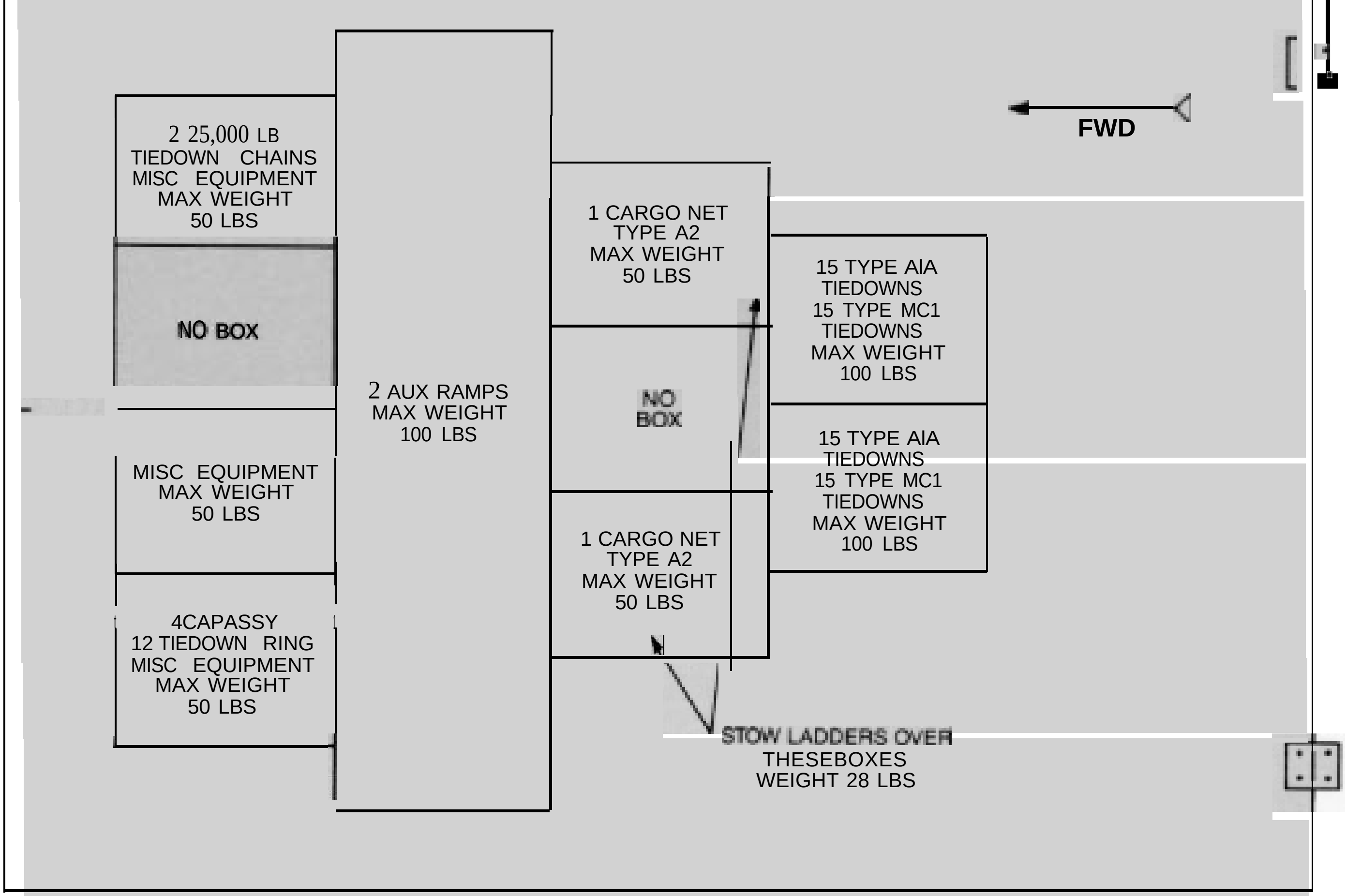
None of these corrective actions need be used for the type of in-flight malfunction that we have described. The solution is likely to be much simpler. When a cargo door operates on the ground in accordance with the maintenance manual, but does not lock open during in-flight operations, the problem is usually too much weight on the cargo door.

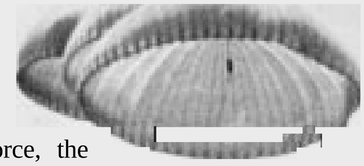
The reason that the door does not open completely and lock in flight is because of an extra force that acts in the opposite direction from the actuator trying to open the door. This added force is caused by an air load, which in effect tries to pull the door down when the aircraft is in flight. Since the air load cannot be eliminated, another means of reducing the downward force on the door must be found.

Figure 1 illustrates a typical Hercules aircraft aft cargo door and the storage compartments located on it. When both auxiliary ramps and both paratroop door ladders are stowed, and all stowage boxes are loaded to their maximum allowable weights, a total of 578 pounds of equipment is stored on the door. This weight – in particular the way it is distributed – plus the weight on the door, the force needed to overcome the door snubber (installed on most Hercules aircraft built since 1972), the force needed to engage the uplock, and the force caused by the air load during flight combine to require a pressure of more than 3300 psi to open and lock the door during flight. Since the auxiliary hydraulic system only provides 3000 psi, it is obvious why a heavily loaded cargo door cannot lock open during flight. Even on Hercules aircraft without a snubber installed, the pressure required to open and lock a fully loaded aft cargo door in flight is approximately 3270 psi.

When the aircraft is sitting on the ground, the cargo door is subjected to all the forces just mentioned ex-

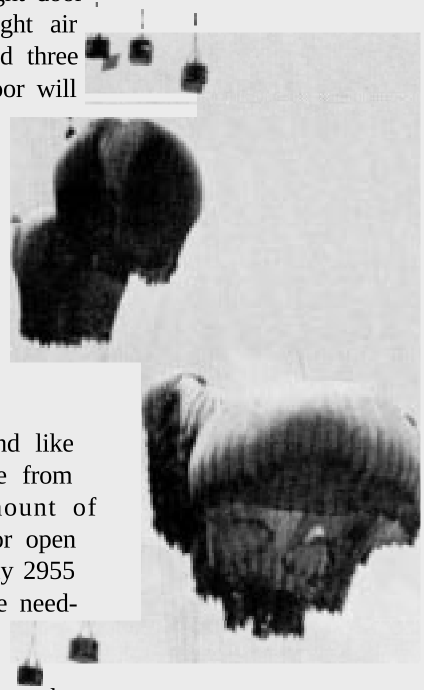
Figure 1. **AFT CARGO DOOR.**

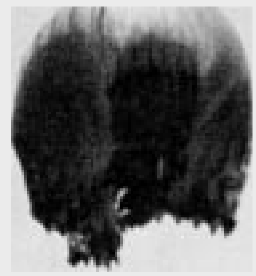




cept for the air load. Without the air-load force, the pressure required to open and lock the door on aircraft with a snubber is approximately 2400 psi, less for aircraft without a snubber.

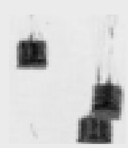
The obvious solution to the problem is to remove enough weight from the cargo door during in-flight door operation to counteract the effect of the in-flight air load. If all the equipment stowed in the forward three stowage boxes is removed, the weight on the door will





be reduced by 150 pounds. This may not sound like much, but this weight coupled with its distance from the cargo door hinge line reduces the amount of hydraulic pressure needed to lock the cargo door open in flight from more than 3300 psi to approximately 2955 psi. On airplanes without a snubber, the pressure needed is less than 2900 psi.

The information that we have just related about the pressures needed to open and lock the aft cargo door under different conditions is based upon functional tests performed by Lockheed during the early 1970's. As a result of these tests, Lockheed started installing a decal on each of the forward three stowage boxes starting with Hercules aircraft LAC 4682. This decal reads "STOWAGE BOX TO BE EMPTY DURING IN-FLIGHT OPERATION OF THE AFT CARGO DOOR?



In an effort to further emphasize the importance of unloading these stowage boxes when the aft cargo door is to be opened in flight, Lockheed will include instructions to this effect in future editions of the appropriate technical manuals. A recommendation will also be made that similar information be included in upcoming revisions of the affected military technical orders.

Making certain that the forward stowage boxes are empty will help ensure that the aft cargo door will lock properly in the open position during in-flight door operation. One of the first questions that maintenance should ask when debriefing a flight crew that has reported an in-flight problem with the aft cargo door is whether the forward stowage boxes were emptied prior to door operation. This may save a lot of troubleshooting time and needless maintenance to a perfectly rigged aft cargo door.

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Lockheed-Georgia Company

CUSTOMER SERVICE
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