LOCKHEED MARTIN

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Service News

A SERVICE PUBLICATION OF LOCKHEED MARTIN AERONAUTICAL SYSTEMS SUPPORT COMPANY

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Editor
Charles E. Wright, II

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Front Cover: This C-130J is being put through the paces during flight testing over Georgia.

Photographic support by John Rossino.

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Focal Point

HOC 1997

During the week of 13 - 17 October 1997, the ninth Hercules Operators Conference (HOC) was held in Marietta. Judging from the surveys of approximately 330 attendees, the conference was an overall success. Lockheed Martin is most pleased to have hosted this event and trusts each participant benefitted greatly from the proceedings.

L. D. Holcomb

Lockheed Martin is committed to continuation of the conference on a regular basis. We see the conference as a valuable forum for sharing of technical information and in-service experiences of Hercules operators. We also see the importance of having a variety of attendees to *Please turn to page 15, column 1*

HOC Co-Chairman Comments

For the last three years I have had the privilege of attending the HOC as the International Operator's Co-Chairman. The increase in representation and presentations from operators each year confirms my strong belief in the need and value for operators and Lockheed Martin in the HOC. We are all faced with shrinking budgets and possible life extensions to our C-130/L-100 fleets. Fleet support that maintains airworthiness in the face of budget cuts and life extensions will only be possible if we learn from each other. The HOC provides the only opportunity for all C-130/L-100 operators and the OEM to meet and discuss topical issues on maintenance, operations, logistics, and system upgrades.

Alex Gibbs

I urge all operators to attend and present briefings at the HOC. If a formal briefing is not possible, please attend the working groups armed with information and enter the discussions. My impression is that many of us are pursuing similar investigations and a team approach will simplify the task for all. I do not believe there is any operator who does not have a lesson for us all. Most importantly, the HOC will only *Please turn to page 15, column 2*

Troubleshooting Pressurization Problems

by Airlift Field Service Staff

Everyday wear and tear, together with the adverse effects of time and weathering, inevitably take their toll on an aircraft's structure and the components of its systems. As the flight hours and calendar years add up, it usually requires a greater maintenance effort and a more comprehensive arsenal of troubleshooting skills to keep an airplane's basic operating systems functioning like they did when they were new.

A case in point concerns pressurization systems. Probably no aircraft system is more vulnerable to the cumulative effects of age, wear, and physical damage than a modern airplane's complex - and crucial - air conditioning/pressurization system. With the passage of time, cabin leaks tend to increase in both number and volume, and pressurization equipment often declines in efficiency. The eventual result may be an airplane that starts to collect writeups because the crew is unable to obtain maximum differential pressure or maintain the desired cabin altitude above a certain flight level.

Not even the tough and reliable Hercules airlifter is immune from trouble in this area. If you happen to have a Hercules aircraft in your inventory that has begun to show symptoms of inadequate pressurization, this article is for you. In the next few pages you will find troubleshooting tips designed to help you restore full performance to a faltering pressurization system. Let's start by looking at a few basic facts about pressurization and then use them to determine what kinds of problems are most likely to be the cause of unsatisfactory pressurization performance.

The principle that underlies the use of pressurization in aircraft is the observation from elementary physics that whenever more air is pumped into a vessel than is allowed to escape from it, the pressure inside increases. As applied to high-altitude flight, the idea is to pump enough air into a more or less sealed cabin to maintain a safe and comfortable "cabin altitude" even though the actual altitude at which the aircraft is flying may be much higher. The success of this arrangement is dependent upon having the ability to maintain a certain minimum air pressure within the cabin under all operational conditions. If this cannot be done, it is either because not enough air is getting in, or too much air is getting out.

Pressurization problems are commonly traceable to one or another of several possible trouble spots, but sometimes a combination of factors is to blame. Cabin leakage is the first thing that usually comes to mind when insufficient pressurization is reported. Excessive cabin leakage may in fact be involved, particularly with older airplanes, but air leaks can be difficult and time consuming to find. Unless there is obvious damage to a seal or to the aircraft structure, it is usually best to check out some of the other possibilities first. Even where cabin leakage is somewhat greater than normal, pressurization may not become inadequate until another problem impairs the system's efficiency.

Troubleshooting the System

The two most likely scenarios are that either (1) pressurization can be obtained in the MANUAL mode but not in the AUTO mode, or (2) pressurization cannot be obtained in either MANUAL or AUTO mode. If

pressurization can be obtained in the MANUAL mode but not in the AUTO mode (scenario 1), the problem is trouble in the cabin pressure control equipment (i.e. a defective pressure controller or outflow valve). If pressurization cannot be obtained in either MANUAL or AUTO mode (scenario 2), the problem is most likely excessive cabin leakage, an insufficient amount of air being pumped into the cabin, or a combination of the two. After determining which scenario applies to your airplane, the following troubleshooting procedures may be used to help isolate the defective component(s) and/or cabin leakage locations.

Pressure Controller and Outflow Valve Check

The test equipment required is a vacuum gage (at least 0 - 15 inches of mercury with increments every 1/2 inch and a male AN #4 fitting) and a 12 inch flexible hose with male and female AN #4 fittings.

1. Apply external power to the aircraft so that 28 VDC will be available for operation of the various components.

2. Remove the fasteners holding the air conditioning and pressurization control panel and lower the panel so that you can gain access to the rear of the cabin pressure controller.

3. Pressurize the bleed air manifold, using the aircraft gas turbine compressor (GTC) or auxiliary power unit (APU).

4. Disconnect the jet pump flex line from the ATMOS 3 port located on the back of the pressure controller (Figure 1) and connect the vacuum gage to the jet pump flex line. On A-model Hercules aircraft, you may find that it is easier to connect the vacuum gage directly to the jet pump, which is located on the outflow valve (Figures 1 & 2). To do so, first disconnect the jet pump line from the aft port of the jet pump.

5. Check the vacuum gage reading. If it is greater than 5 inches of mercury (in. Hg), proceed to Step 6. If the indication is less than 5 in. Hg, clean the jet pump (bleed air) filter, if installed (Figure 1), and inspect the lines to and from the jet pump. Recheck the output of the jet pump, and if it is now greater than 5 in. Hg, go on to Step 6. If not, check the tightness of the bleed air line fitting at the jet pump and make sure that the closure of the jet pump O-ring is airtight by using a leak detector solution.

6. Reconnect the jet pump flex line to the pressure controller (or the jet pump line to the jet pump).

7. Disconnect the pneumatic relay line from the OUTFLOW VALVE port at the back of the pressure controller and attach the vacuum gage to the OUTFLOW VALVE fitting on the pressure controller (Figure 1) using the flexible hose.

8. Move the cabin altitude selector knob to the minus 1000 feet position, and position the air conditioning master switch to AUTO PRESS or AIR COND AUTO PRESS, depending on the model of Hercules aircraft you have.

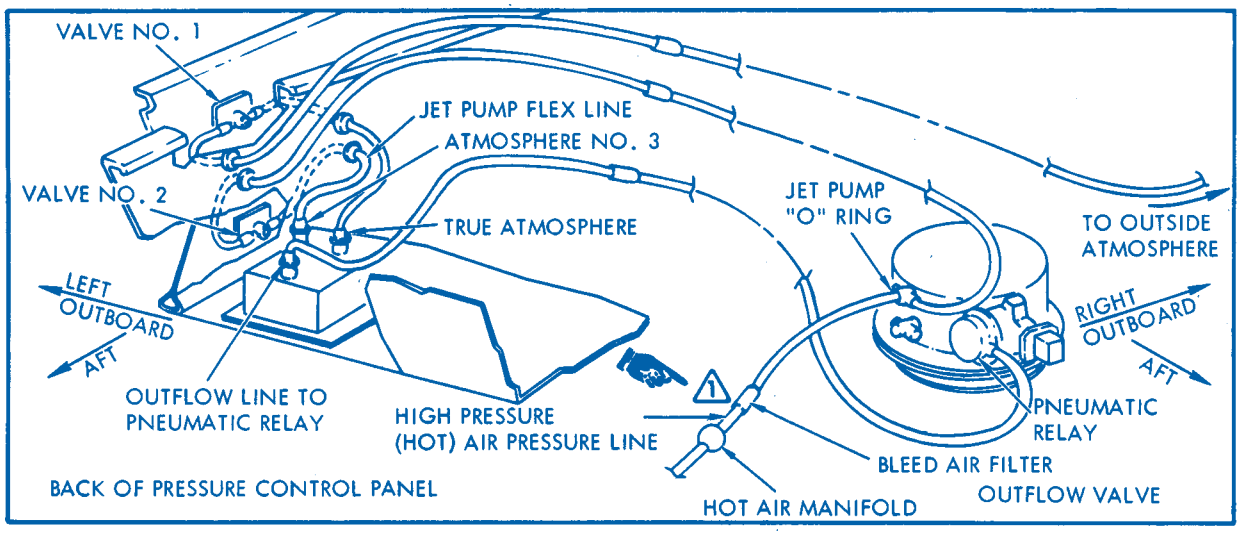
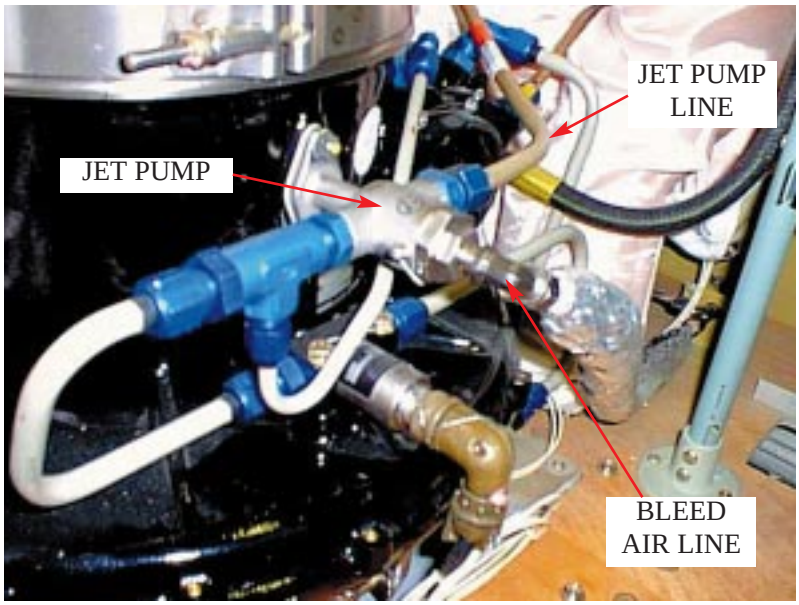


Figure 1. Cabin pressurization control components.

NOTE

1 NOT ON AIRPLANES SERIAL NO. 5022 AND UP AND EARLIER AIRPLANES MODIFIED BY SERVICE BULLETIN 382-21-13/82-552.

Figure 2. **Pressurization system outflow valve.**



9. Check the vacuum gage. If the gage indicates 0.4 in. Hg or less, proceed to Step 10. If the gage indicates 0.5 in. Hg or greater, replace the pressure controller.

10. Move the cabin altitude selector knob to 8000 feet and the rate knob to MAX. Check the vacuum indication on the gage. If the pressure is less than 1 in. Hg, replace the pressure controller. If the pressure is greater than 1 in. Hg, reconnect the pneumatic relay line to the OUTFLOW VALVE port on the pressure controller and then check the position of the outflow valve.

a. If the outflow valve is open, move the cabin altitude selector knob to minus 1000 feet; the valve should soon close. If the valve closes, the system is satisfactory. If the valve remains open, clean the pneumatic relay and repeat this step. If the valve still fails to close, replace the outflow valve.

b. If the valve is closed, clean the pneumatic relay and repeat Step 10. If the valve remains closed, replace the outflow valve.

Cabin Leakage Check

To measure the rate of cabin pressure leakage, you need to perform a cabin pressure leakage or decay check. Several kinds of leak checks are described in the various maintenance manuals dealing with the pressurization system. To pressurize the aircraft, you can use bleed air from the engines, GTC, APU, or an external compressor such as the MA-1A. The basic idea in each of these checks is to close the aircraft as tightly as possible, to pressurize it to a certain level, and then to measure how long it takes for the pressure to decay to another level of pressurization.

Lockheed Martin recommends using the following procedure when accomplishing the pressure decay check:

1. Pressurize the aircraft to above 8 in. Hg (3.93 psi) differential, using the procedures outlined in the appropriate Hercules aircraft maintenance manual.

2. Position the flight station and cargo compartment air conditioning shutoff switches, located on the air conditioning and pressurization control panel, to OFF.

3. Check pressurization decay from 8 in. Hg (3.93 psi) to 6 in. Hg (2.95 psi). Consult the appropriate technical publication to determine the minimum time allowable.

An element that should be considered when doing this test is the elevation above sea level of the location at which you are performing the test. Again, consult the appropriate technical publication for adjustments to be made for test site elevation.

If the timed pressure decay leakage test is unsatisfactory, the cabin is leaking excessively. To find where the leaks are, pressurize the aircraft to 2 to 3 in. Hg (0.98 to 1.47 psi) and inspect the fuselage door seals, exterior surfaces, and joints. Leaks can be located by feel or by using an approved liquid leak detector or soapy solution. Figures 3 and 3a (pages 6 and 7) show those areas of the Hercules aircraft which tend to leak most often. A systematic approach to finding a pressure leak in an unknown location would be simply to start at the top of the list and work down.

Inadequate Pressurization

If the timed cabin leakage test is satisfactory, but you are still having problems getting adequate pressurization, the problem must be insufficient airflow into the aircraft. Since air for pressurization comes from the air conditioning system, you must determine why this system is not delivering the proper amount of air.

There should be a strong flow of air from the ducts. If the flow is weak, check the position of the flight station and cargo compartment flow control and shutoff valves. An indicator on the side of each flow control and shutoff valve shows whether it is open or closed.

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The cargo compartment flow control and shutoff valve is designed to regulate the flow of air at 70 pounds per minute on all Hercules aircraft. The flight station flow control and shutoff valve is designed to regulate the flow at 30 pounds per minute on Hercules aircraft prior to Serial No. 4579 and 70 pounds per minute on Hercules aircraft Serial No. 4579 and later. If the flow control and shutoff valves are operating properly, but the airflow into the cargo compartment or flight station is still weak, the cause may be bleed air leaking from the affected system's heat exchanger.

Heat Exchanger Leak Check

The following check of the air conditioning system heat exchangers (flight station or cargo compartment) has been successful in solving many pressurization problems on Hercules aircraft prior to Serial No. 4579. This check is not practical for Hercules aircraft Serial No. 4579 and later since it would be necessary to remove, or loosen and turn, the cooling turbine in order to disconnect the duct between the heat exchanger and the turbine.

1. Disconnect the duct between the heat exchanger and the turbine and cap the end of the duct from the heat exchanger, using a locally manufactured leak test fitting (Figure 4, page 8).

2. Start the GTC or APU, or an MA-1A compressor (or equivalent) and turn on the air conditioning system being checked. Drive the temperature control valve to the full cold position.

3. Check for leaks by feeling for the presence of escaping hot air in the air intake scoop or exhaust. Leaks are very evident when they exist. Replace the heat exchanger if leaking is evident.

An alternate method of checking heat exchangers for leaks is available to Hercules operators who have access to the U. S. Air Force supply system. Shop air can be made to serve in place of the GTC/APU or MA-1A compressor through the use of the ground bleed air coupler assembly shown in Figure 5a (page 8). This device (NSN 4920-00-008-9402, P/N 7031321-10) can be obtained as a unit from Air Force sources. A satisfactory substitute can be locally manufactured for use with the adapter (NSN 4920-00-480-6191, P/N 7031322-01) or equivalent (see materials list, Figure 5, page 8).

The coupler assembly is intended to be attached to the external ground bleed air connection in the left wheel well. When shop air is used, the escaping air will not be hot. In addition to feeling for leaks, you may also hear the escaping air. This alternate method is a good procedure to use during an inspection.

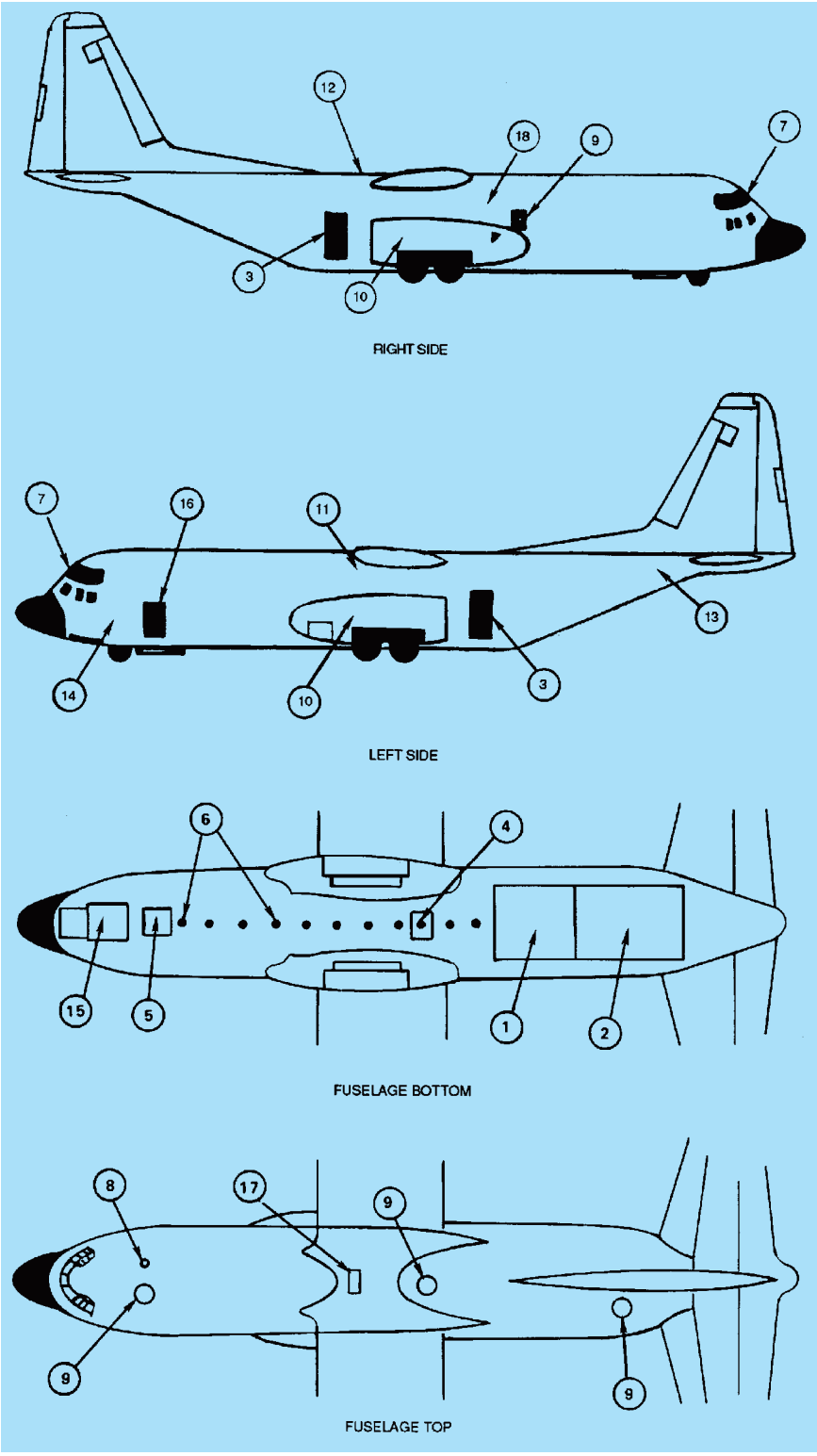
Figure 3. **Pressurization Leak Locator Chart**

INDEX NO.	NOMENCLATURE	LEAK POINTS
1	Aft Cargo Ramp	Seal Assembly
2	Aft Cargo Door	Seal Assembly
3	Paratroop Doors (2)	Seal Assembly
4	ADF Radome (if installed)	Sealant and Fasteners
5	Doppler Radome	Sealant and Fasteners
6	Flapper Valves	Seals
7	Swing Windows	Seal Assembly
8	Pyrotechnic Pistol Door	Seal Assembly
9	Emergency Exit Doors (forward, center, side, and aft)	Seals
10	MLG Inspection Windows (4) MLG Access Doors (4) MLG Attach Structure	Seals Seals Sealant and Fasteners
11	Control Cables	Seals
12	Life Raft Cables, Aileron Push Pull Rods, and Flap Torque Tube	Seals
13	Elevator, Rudder Push Pull Rods	Seal Assembly and Boot Assembly
14	NLG Inspection Window and Door	Seal Assembly
15	Nose Wheel Well Diaphragm Covers (3)	Seals
16	Crew Entrance Doors	Seals
17	Center Wing Dry Bay	Cracks, Ducts, and Conduit Sealant
18	Upper Recirculation Duct and Flapper Check Valve	Cracks

Auxiliary Vent Valve and Ducting Check

Finally, the operation of the air conditioning system auxiliary vent valves and the condition of the associat-

Figure 3a. **Pressurization Leak Locator Diagram**



ed ducting can play a role in pressurization problems. Insufficient airflow into the aircraft can be caused by a partially open auxiliary vent valve which allows air to escape through the exhaust port, or by leaky ducting. (Note: the following troubleshooting procedures apply to both cargo compartment and flight station systems. However, the cargo compartment systems typically have more problems in this area.)

The auxiliary vent valve incorporates a position indicator that shows whether the valve is open or closed. If you are trying to pressurize an aircraft and suspect that the auxiliary vent valve is not closing completely despite a CLOSED indication, feel the temperature of the air coming out of the exhaust port. If the air seems to be cooler than normal, it is likely that the valve is not fully closed.

You can verify whether or not the valve is actually closing by disconnecting the adjacent sections of ducting and examining it visually. On Hercules aircraft before Serial No. 4579, this can be done by removing flexible coupling P/N 343939-4, which connects the auxiliary vent valve to the refrigerator ram air duct assembly. On Serial No. 4579 and later, remove duct assembly P/N 3313859-1 or -9 in order to see the valve flapper.

On Hercules aircraft prior to Serial No. 4579, another possible source of leaks in this general area can be the flexible coupling P/N 343939-3 located above the auxiliary vent valve. These couplings may deteriorate and crack with age. Also, the clamps holding the flexible coupling have been known to loosen. A careful inspection of the auxiliary vent valve and related ductwork is always justified anytime insufficient airflow into the aircraft is indicated and there is no evidence that the flow control and shutoff valve is operating improperly.

There is one other point that is important enough to be worth repeating. Pressurization problems are not limited to excessive cabin leaks, faulty valves, or inefficient air conditioners. They are often a combination of deficiencies in two or more of these areas. So, if you check the cabin and subsequently find and fix several leaks, don't forget to go ahead and check the rest of the possible problem areas mentioned in this article as well. ▭

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Figure 4. **Heat exchanger leak check: Loosen upper clamp, disconnect lower clamp, rotate duct 180 degrees to install leak test fitting (shown below).**

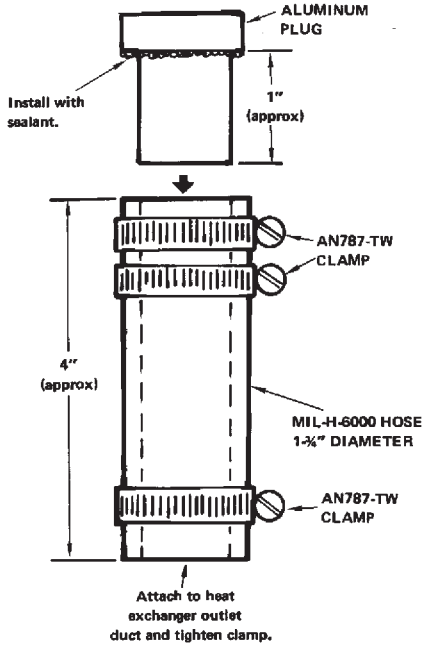
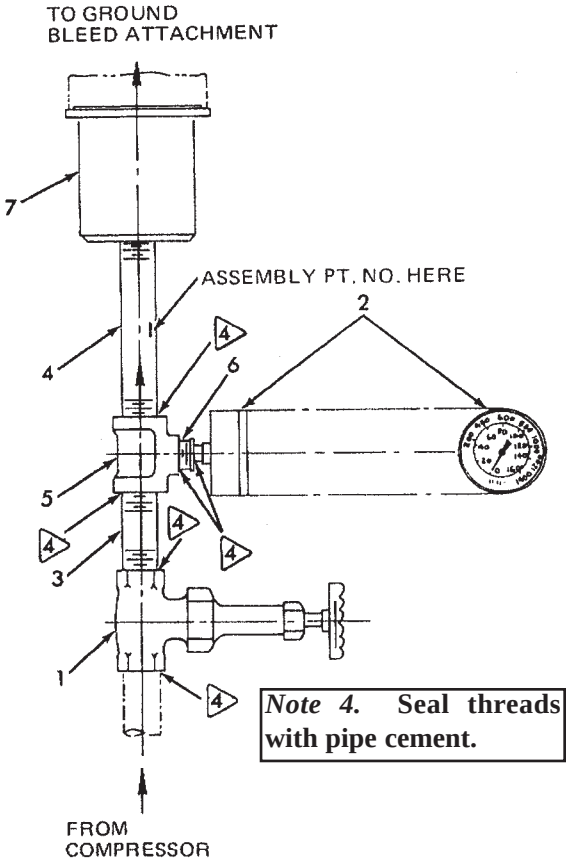


Figure 5a. **Ground Bleed Air Coupler Assembly.**



Note 4. **Seal threads with pipe cement.**

Figure 5. **LIST OF MATERIALS**

NOMENCLATURE	SPECIFICATION	MATERIAL	NUMBER (FIGURE 5a)
Globe Valve	3/4" - 250 PSI	Bronze globe and angle pattern valve	1
Air Pressure Gage	0 - 100 PSI; intervals of 10		2
Nipple	3/4" x 3"	Galvanized steel	3
Nipple	3/4" x 6"	Galvanized steel	4
Reducing Tee	1/2" on tee 3/4" on straights	Galvanized steel	5
Hex Bushing	1/2" to 1/4"	Galvanized steel	6
Adapter	NSN 4920-00-480-6191 P/N 7031322-01		7
Coupler Assembly (Complete)	NSN 4920-00-008-9402 P/N 7031321-10		

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Of technical articles

1997

continued from ***HOC 1997***

speak to the group. Therefore, we will continue the tradition of presentations by the operators, Hercules Service Centers, and major suppliers with Lockheed Martin specialists on hand to provide update information and offer advice and assistance throughout the week. To do this, we cannot overemphasize the importance of your selection of timely topics, in advance of the conference, to allow for inclusion in the agenda. It is never too early to plan your desired topic and advise us of your plans to present. Our desire is that each attendee know that the conference is open to all participants. All we request is that we be allowed ample time to review beforehand the presentation topics.

We will refine and improve the working group portion of the conference. Again, we must rely upon you, the participant, to let us know the areas and specifics for the working groups. We, therefore, request that you plan your desired topics and advise us on the survey that will be mailed to each HOC designated representative in the near future. You may also contact our offices by calling telephone: (770) 431-6543 or facsimile: (770) 431-6556.

Our best wishes to each of you throughout the year and we look forward to hearing from you.

L. D. "Dave" Holcomb,
Co-Chairman
Airlift Field Service

continued from ***HOC Co-Chairman Comments***

be supported by Lockheed Martin as long as the operators support the conference. I have attended similar conferences held by Boeing in recent years for commercial aircraft in which the OEM and operators enter the often discussed but sometimes uncomfortable "Customer Focus." Customers rarely ask easy questions. The launch of the C-130J and the major resource commitment by Lockheed Martin to the certification and initial production program has impacted post-production support in the short term. Lockheed Martin is caught between supporting over 1600 active C-130A/B/E/H and L-100 aircraft and marketing the C-130J. It is a fine line and requires operator feedback.

The C-130 is a truly amazing aircraft. As an engineer, I am constantly reminded of the brilliance of this nearly 50 year old design. With all of the computer analysis tools available today, we are still trying to analyze a design that has generally withstood the amazing variety of C-130/L-100 operations. My association with the C-130 started as a young cadet with the C-130A in 1972. I look forward to working on the C-130J-30 as they arrive in Australia over the next few years and attending the HOC to report on the experience!

Thank you for your support and encouragement over the past three years.

Alex Gibbs,
Squadron Leader
RAAF Technical
Liaison Officer

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