Lockheed

service news

VOL. 10, NO. 1, JANUARY—MARCH 1983

The "City of Marietta"

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

Lockheed

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

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CONTENTS

Cover: The "City of Marietta," the first advanced model C-l 30H to be delivered to the Air Force Reserve, overflies the city of Atlanta (see story at right and additional photos on back cover).

A Milestone for Airlift Modernization

October 4,1982 was a special day in Marietta, Georgia. On that day, the 14th Air Force's 94th Tactical Airlift Wing, which is headquartered in Marietta, received the first new Hercules aircraft ever to be delivered directly to an Air Force Reserve unit. The factory-fresh, advanced model C-l 30H, one of six that have since been acquired by the 94th TAW, was named the "City of Marietta" in honor of the unit's hometown.

In the picture above, Lockheed-Georgia President Robert B. Ormsby, Jr. marks the occasion by presenting a ceremonial key to 14th Air Force Commander Major General James E. McAdoo (since promoted to vice commander of the Air Force Reserve).Other dignitaries participatingin the ceremony are (left to right) 94th TAW Commander Brigadier General Alan C. Sharp (now commander of the 14th Air Force), Marietta Mayor Robert Flournoy Jr., Assistant Secretary of the Air Force Tidal McCoy, Georgia Senator Mack Mattingly, and Georgia 6th District Congressman Larry McDonald.

The fact that Marietta, Georgia, happens to be the hometown of the Lockheed-Georgia Company helped make the event special for us, but a great deal more than just local pride was involved. The acquisition of these updated, technologically refined airlifters represents a significant milestone in the Air Force Reserve's ongoing tactical airlift modernization program. The 94th TAW now joins some forty other Air Force Reserve and Air National Guard unitsthatflythe Lockheed C-130 Hercules. Together, theycomprisethe backbone of the nation's Air Reserve Forces transport fleet, ready and able to deliver the goods whatever the airlift requirement.

We extend our congratulations to all who serve with the 94th TAW and wish them every success as they move into a new era of airlift operations.

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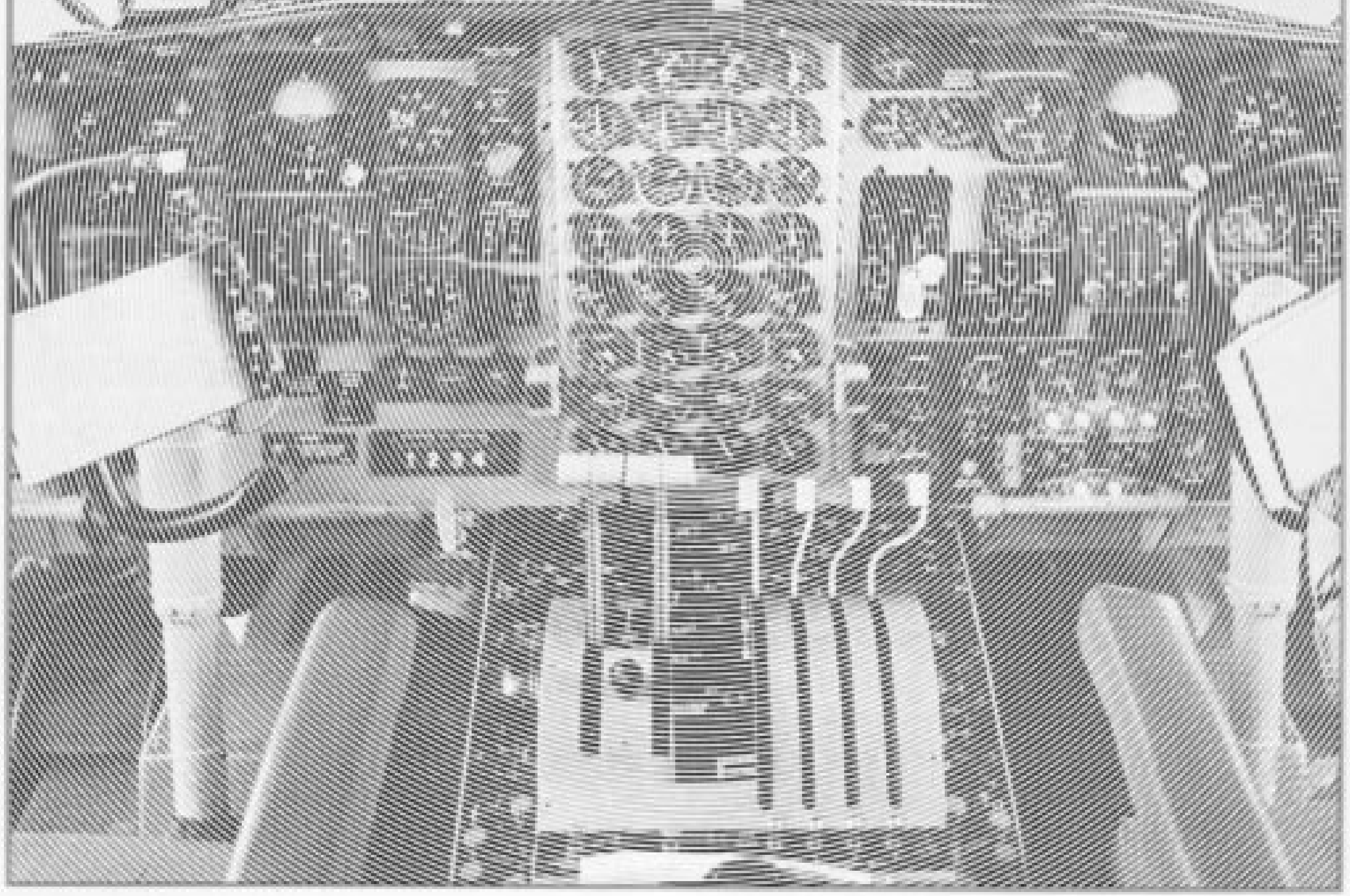
Fire on the Flight Deck

by Herb L[illegible]tze, Aerospace Safety Engineer, Senior
[illegible], Staff Engineer

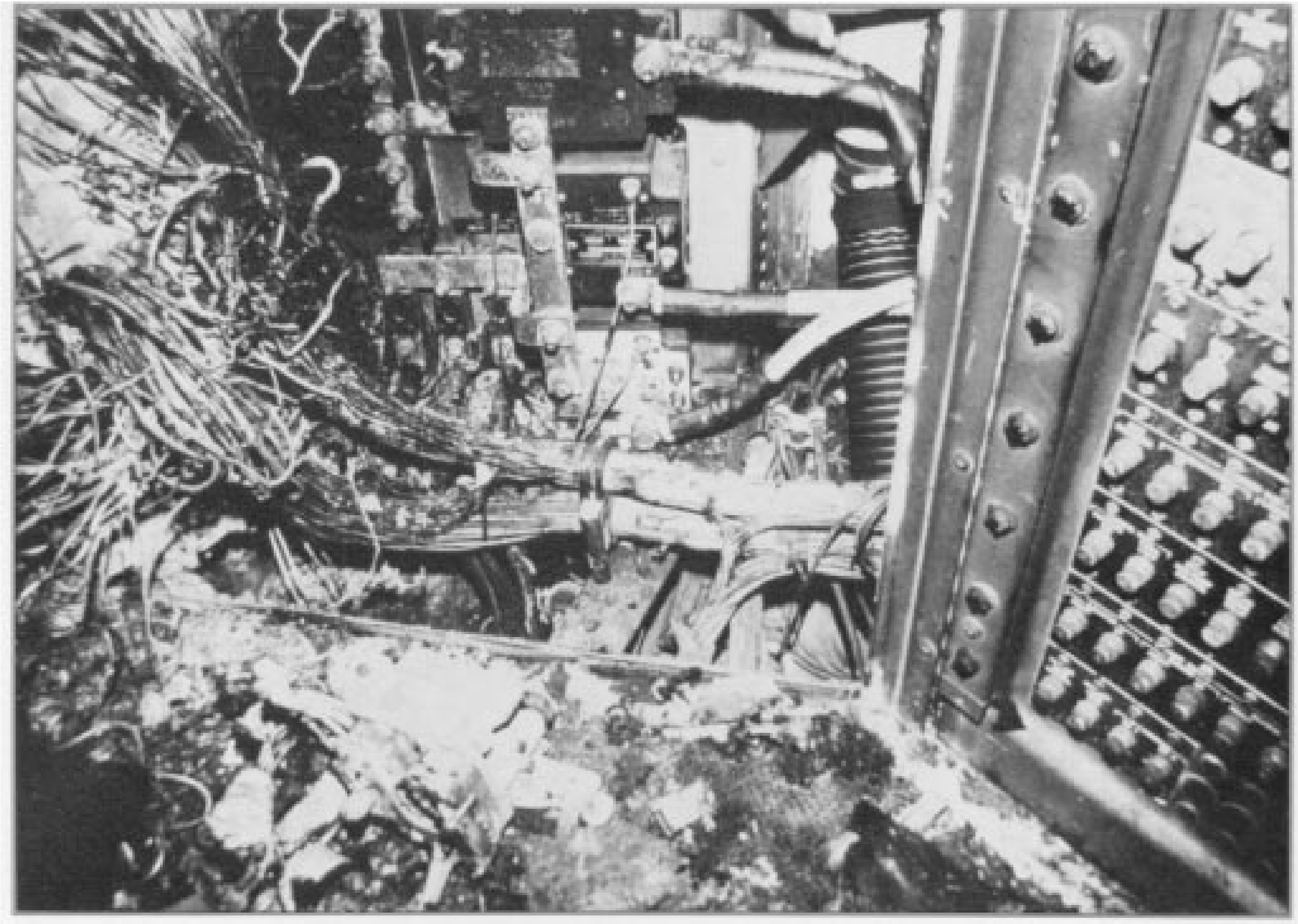


Of all emergencies encountered by flight crews, few are likely to attract the full attention of everyone present more quickly than a flight station fire. Certainly in no other flying situation is there greater need for timely and appropriate crew response – and a generous portion of plain, old-fashioned good luck.

Most of us are familiar with Murphy's Law, that wry commentary on the apparent perversity of things in general and products of high technology in particular. The principal tenet of this facetious effort to describe the methodology of misfortune is that if anything can go wrong, it will. Two "corollaries" which may be said to derive from this "law" are that every solution breeds a new problem,, and that if there is a possibility of several things going wrong in a given situation, the one that will cause the most damage will be the one to go wrong.

Murphy's Law and its corollaries seem to have had special applicability in connection with the unfortunate circumstances surrounding a recent Hercules aircraft mishap. Let us take a close look at just what happened in this case, and at the seemingly innocent action that paved the way to what could have been a full-blown disaster.

It was a bright winter day. Checklists were being accomplished as the aircraft moved out of the parking area toward the runway for an early morning functional check flight following an extended maintenance layup. All seemed to be in order. Suddenly, smoke was seen inside the flight station near the copilot's side windows. Flames appeared, and then a heavy, blowtorch-like fire shot toward the copilot's instrument panel from the vicinity of the copilot's side circuit breaker panel. The flames in-



Figurel. The aftermath. A well-intended effort to solve a minor problem ultimately yielded this scene of destruction.

creased in intensity as the aircraft was stopped and crew members made an emergency evacuation. Fire and crash equipment operators on the scene were able to save the airplane, but the flight station area sustained heavy damage (Figure 1).

Post-mishap investigation and analysis revealed that there had been an extensive rehabilitation effort in the airplane during the maintenance layup. The refurbishing work included a thorough repaint of the flight deck. To facilitate the repainting process, many cockpit furnishings and hardware items were either removed from the airplane entirely or placed far enough out of the way to protect them from beingunintentionallypainted. Among those items moved "out of the way" was an externally braided flexible tube in the oxygen supply system (Figure 2) that is used to recharge the copilot's MA-l portable oxygen unit.

There is a small opening, about 3.5 inches by 2.5 inches in size, on the forward side of the copilot's essential DC bus on certain aircraft. With a little ingenuity, it is possible to fit the flexible oxygen filler tube through this opening. And this was the solution to the cockpit painter's dilemma of where to place the tube to avoid inadvertent painting. Figure 3 shows the flexible filler tube pushed through the opening at the top of the forward end of the DC power distribution area. Notice that the filler nozzle is hanging down like a pendulum near the bus bar, and that the filler tube is resting on top of a rigid, oxygen-filled supply line (Figure 4).

So far, there is nothing obviously amiss in the arrangement. And in fact, as long as the airplane remained stationary in the maintenance shop and without electrical power, there was no trouble. Unfortunately, when the painting work was finished and it came time to return the aircraft to service, no one remembered to pull the flexible tube back out of the distribution panel and return it to its retaining clip.

This was a serious oversight, but there was still ample opportunity to save the situation. Although looking to see that the flexible oxygen filler tube is correctly secured *is* not a specific preflight checklist item, confirming that the pilot's and copilot's MA-l portable oxygen bottles are

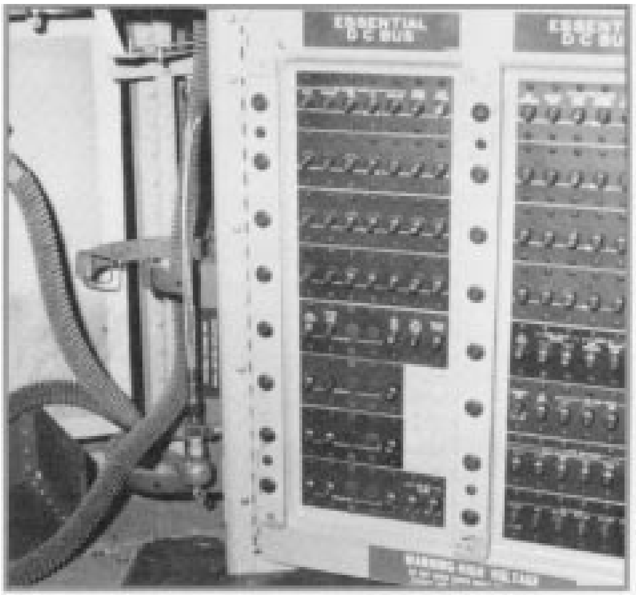


Figure2. The oxygen filler tube in normal stowed position. Note nearby bracket for copilot's MA-l oxygen bottle.

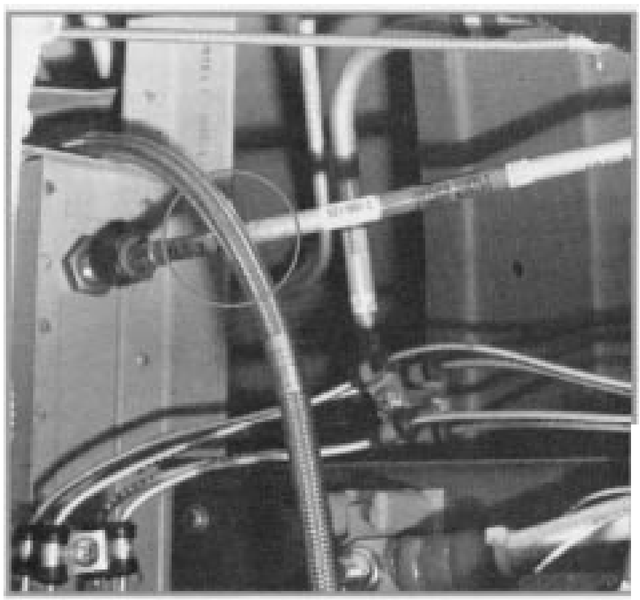


Figure 4. The electrical fire started where the metal braiding of the filler tube rested against a rigid oxygen line.

properly serviced is. Had these units been serviced or checked carefully, it is likely that the absence of the filler tube from its usual position would have been noted. This evidently did not happen, however, and the flexible oxygen line remained where the painter had put it, casually stuffed behind the electrical distribution panel.

The stage was now set for calamity, for it was at this point that the effects of Murphy's Law took over. Running true to form, the earlier solution to the painter's problem itself became a problem, and when the trouble started, what went wrong did so in the worst possible way.

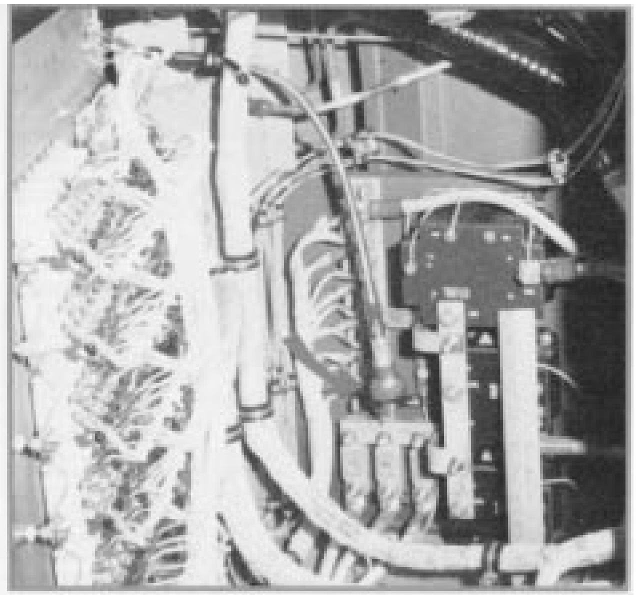


Figure 3. A solution that bred a problem: this reconstruction shows how the filler tube was left in the accident aircraft. The nozzle (arrow) hangs free near a bus bar.

When the aircraft began moving into position for its functional test flight, the pendulum motion of the nozzle end of the flexible filler tube during taxi caused the nozzle to touch the bus bar behind the copilot's side circuit breaker panel, creating a short to ground at the point where the flexible tube contacted the rigid, oxygen-filled line. The rigid oxygen line then started to melt and quickly developed a leak. The result was a rapid sequence of smoke, flame, and then an oxygen-fed blowtorch fire.

In this case, the aircraft's location – on the ground, near fire trucks – coupled with the rapid crew response, prevented injuries and mitigated the effects of the damage. The results of this sort of event in flight can only be hypothesized, but the risks appear to be very high indeed.

How ironic that an honest attempt by maintenance people to find a convenient solution to their problem of keeping a flexible oxygen line from being painted also provided the genesis of a new and highly hazardous problem for the operator!

Engineering review is currently in process to block unwanted access to Hercules aircraft power distribution areas, but hardware alone cannot provide total protection against the consequences of innovative "solutions" to transient problems that fail to take all possible risk factors into account.

No matter how clever the idea, real ingenuity always includes keeping safety job priority number one. It's the only proof against the inexorable workings of Murphy's Law.

Keeping the Pressure On

by John Walters, Staff Engineer

A change was made to Hercules aircraft wiring starting with Lockheed serial number LAC 4637 which keeps the "up" solenoid of the landing gear selector valve energized anytime the landing gear control handle is in the up position (Figure 1). Previously, the up solenoid deenergized as soon as all three landing gear up position indicator switches were actuated (Figure 2). At about the same time that the wiring change was made on new production aircraft, Lockheed issued Service Bulletins 82-380 and 382-064 to allow commercial and foreign military customers to modify their Hercules aircraft to the new wiring configuration. Subsequently, Warner Robins Air Logistics Center issued TCTO 1 C-130-1065 to retrofit all United States Air Force C-130s (except A-models, which were not affected). Like most changes, there were advantages and disadvantages associated with changing the wiring. Let us examine Lockheed engineering's analysis of the wiring change, and why it was concluded that there

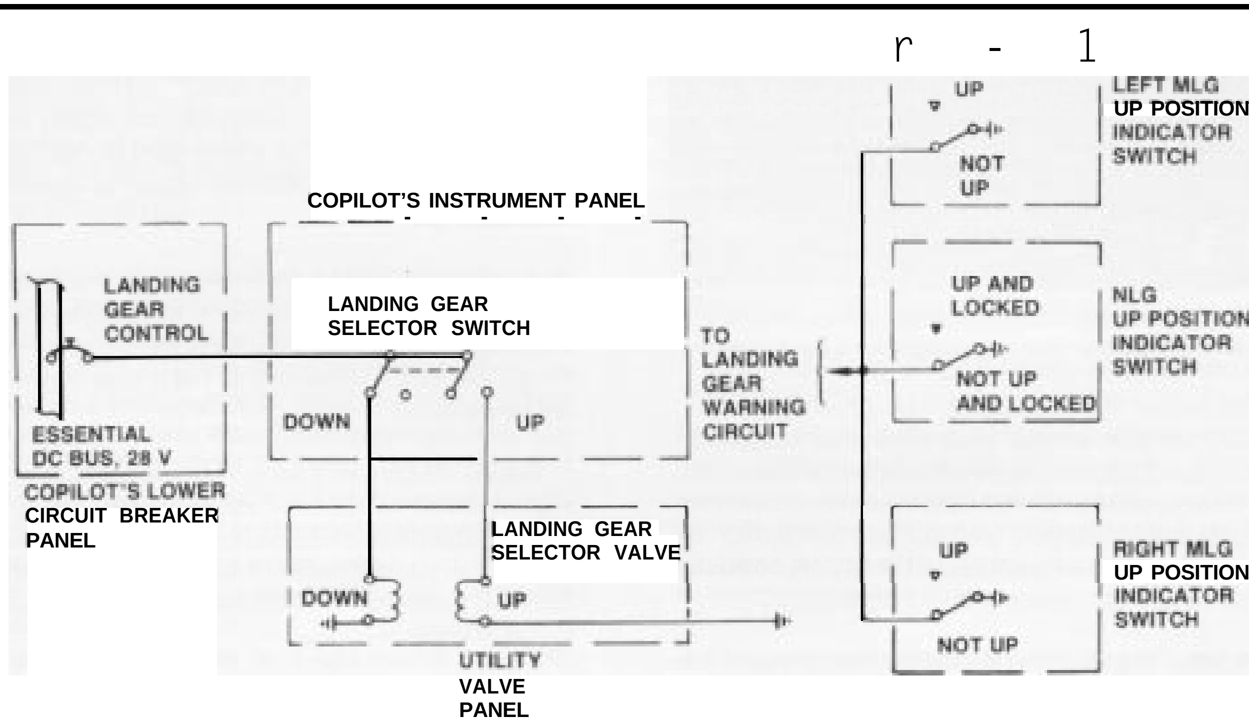


Figure 1. Landing gear control wiring diagram for Hercules aircraft LAC 4637 and up, and earlier Hercules aircraft incorporating Service Bulletins 82-380 or 382-064, or TCTO 1 C-l 30-l 065.

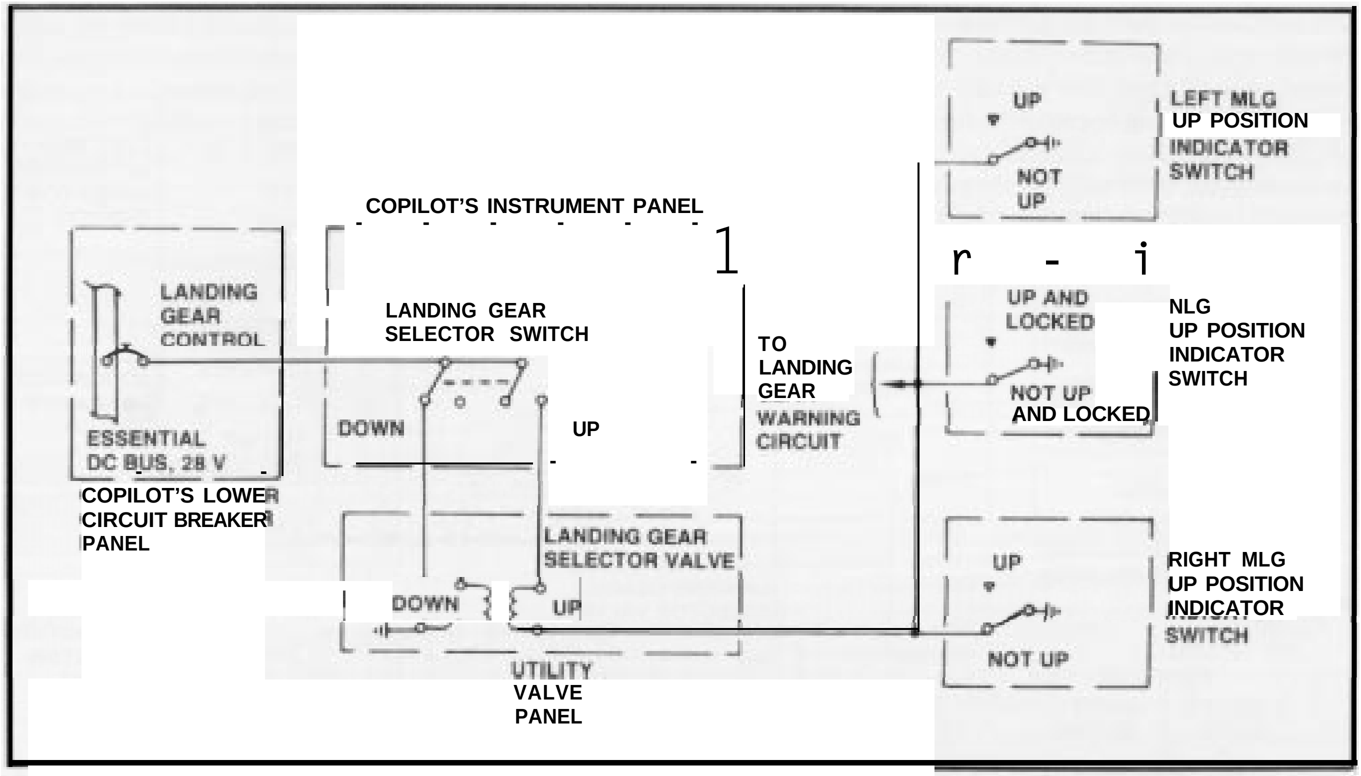


Figure 2. Landing gear control wiring diagram for unmodified Hercules aircraft built prior to LAC 4637.

were more advantages to the change than disadvantages.

Advantages

The first advantage of changing the wiring is that the nose landing gear indicator "blip" (momentary in-transit indication) associated with the main landing gears' reaching the up position is eliminated. The blip is caused by a pressure spike that occurs when the landing gear selector valve returns to the neutral position and the up solenoid deenergizes. A brief discussion of the circumstances that cause the blip in airplanes with the old wiring configuration (also refer to Figures 3,4, and 5) will be instructive at this point.

When the landing gear control handle is raised after takeoff, the nose landing gear is usually up and locked before the main landing gears reach the up position (Figure 3). As soon as the main landing gears reach the up position, the up solenoid is deenergized, causing the valve spool of the landing gear selector valve to shift to the neutral position (Figure 4). In the neutral position, utility system pressure is blocked at the selector valve and both the gear-up and gear-down ports are opened to the return line. This dumping of gear-up pressure causes a momentary pressure spike to bounce off the return line check valve poppet (attached to the return port of the landing gear selector valve) and back up the nose landing gear down line. This forces the nose landing gear uplock to unlock momentarily (Figure 5). As soon as the uplock is unlocked, the nose gear up position indicator switch provides a ground to reenergize the selector valve up solenoid and relock the nose gear uplock. This momentary unlocking of the nose landing gear uplock is the blip that shows up on the nose landing gear indicator as a momentary in-transit indication.

The United States Air Force eliminated the blip on their C-130s by putting a restrictor in the nose landing gear uplock line (TCTO lC-130-884) to dampen the pressure surge (Figure 6). The disadvantage that Lockheed engineering sees with this approach to solving the problem is that it has the effect of slowing the unlock operation of the uplock during normal nose landing gear extensions. Unfortunately, this can aggravate a nuisance condition that was already associated with nose landing gear extension operations, as we shall presently see.

Maintaining continuous gear up hydraulic pressure on the landing gears allows the nose landing gear uplock time to unlock fully before the nose landing gear actuator drives the gear down against the jaws of the uplock. Prior to the wiring change, the landing gear selector valve deenergized as soon as all three gear up position indicator switches were actuated. This allowed pressure in the lines to bleed off, which caused the nose landing gear to settle in the uplock. Since the nose landing gear uplock and the nose landing gear actuator are not sequenced, Lockheed

Previous Page Table of Contents Next Page

engineering found that when gear down is selected, the nose landing gear will start to extend before the uplock has fully unlocked. This causes a high download on the uplock jaws and rapid spring-back when the uplock does release, along with considerable vibration and noise. If a restrictor is added to the uplock unlock line, as was done on USAF C-130s, the unlocking operation is further slowed down, which aggravates the situation. By keeping the up solenoid continuously energized with the gear handle up, the nose landing gear never settles in the uplock unless hydraulic pressure is lost. This allows the uplock time to unlock before the gear reaches the uplock jaws during extension.

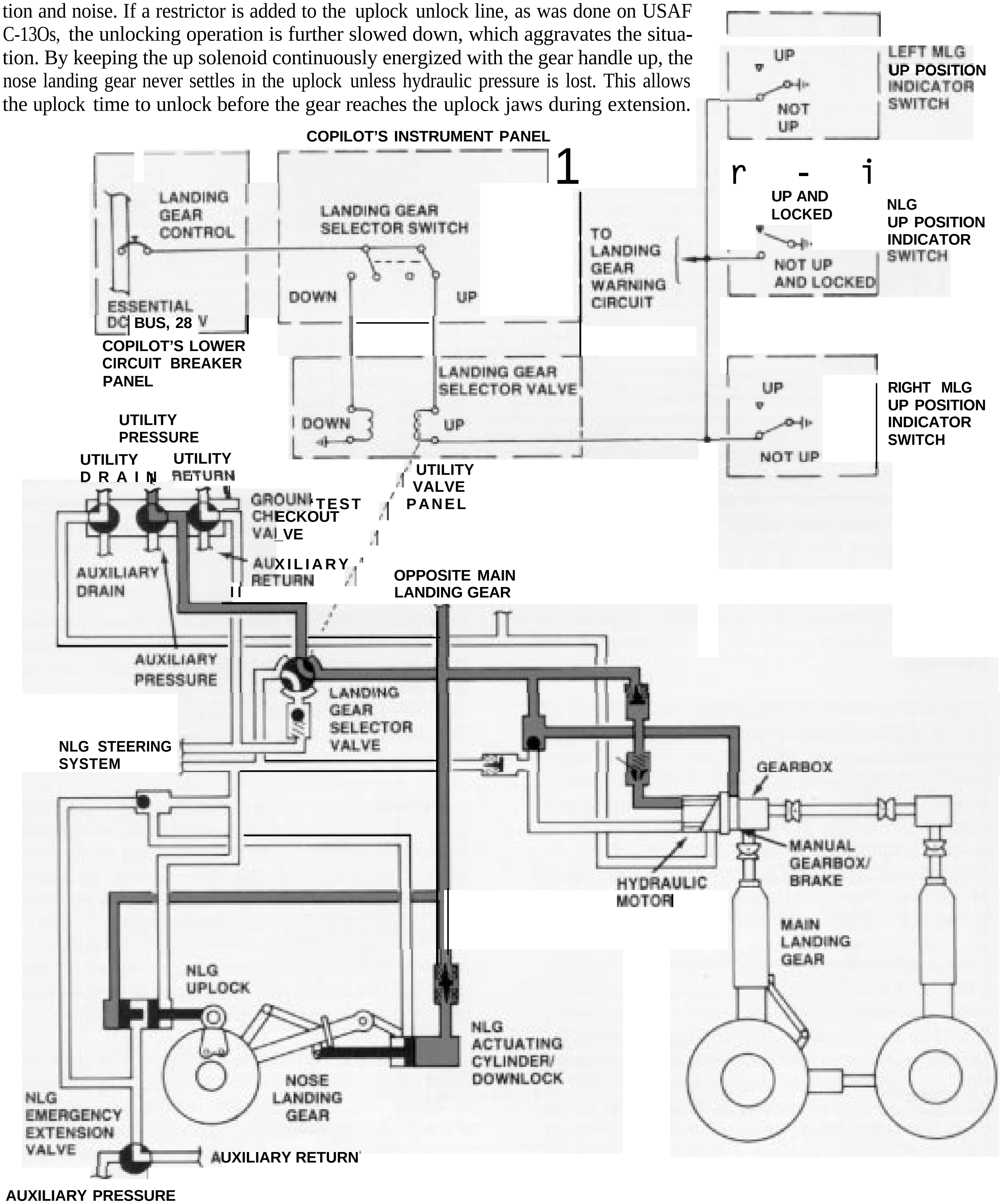


Figure 3. Nose landing gear up and locked; main landing gears still in transit (old wiring configuration).

Previous Page Table of Contents Next Page

A third advantage to the wiring change we have been discussing is that the main landing gear gearbox brakes operate half the number of cycles previously required. Since the up solenoid is always energized with the gear handle up, the brake never sets when the gear retracts unless hydraulic pressure is lost. Previously, the brakes would lock the main landing gears in the up position when the up solenoid valve deenergized. With the wiring change, the hydraulic pressure holds the main landing gear up.

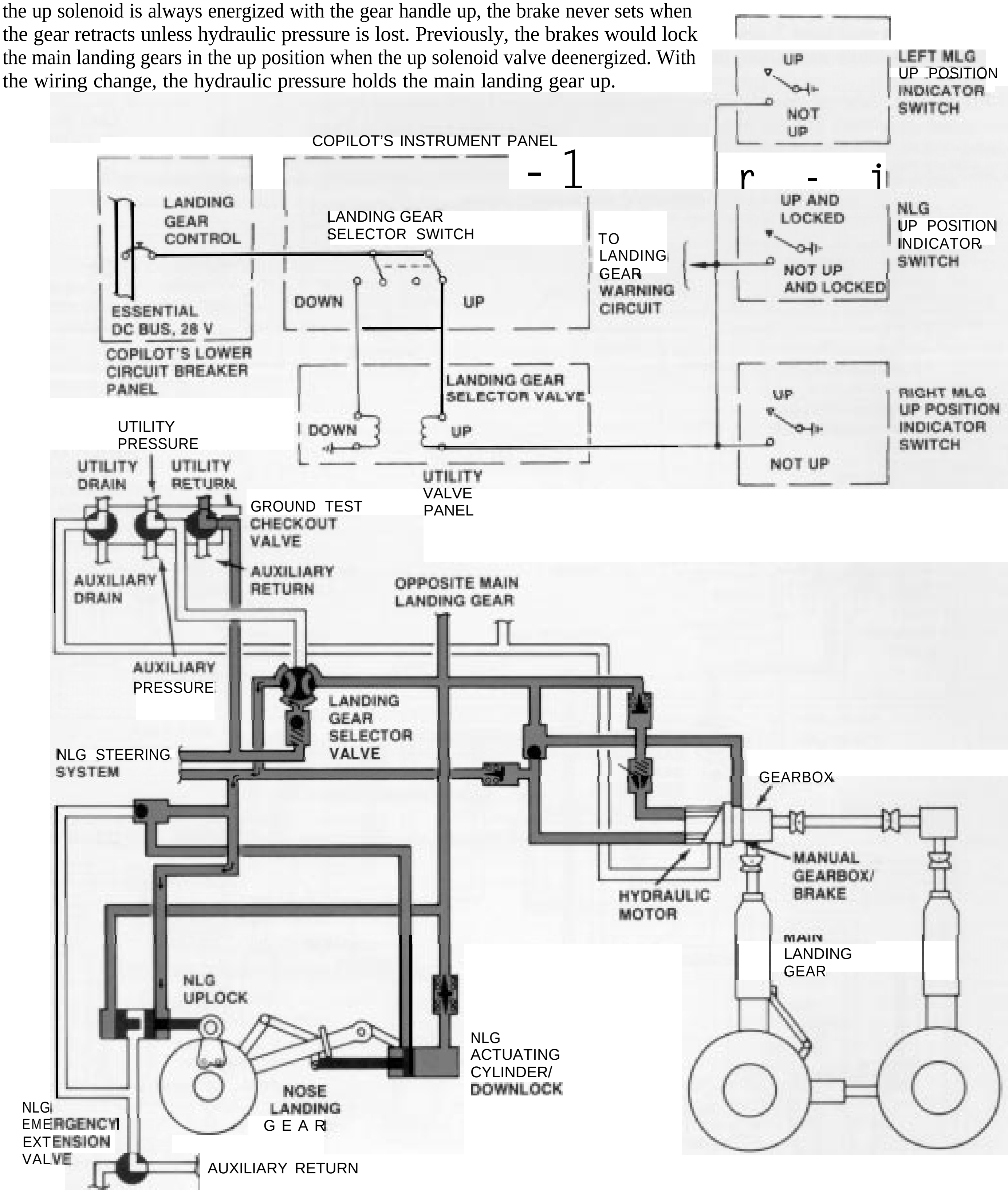


Figure4. Nose landing gear up and locked; main landing gears up. As the landing gear selector valve returns to neutral, a momentary pressure spike is transmitted through the nose landing gear down line (old wiring configuration).

Disadvantages

Some operators have asked whether the constant application of hydraulic pressure when the gear is up (Figure 7) does not result in a disadvantage by exposing the wheel wells to continuously pressurized lines and increasing the likelihood of leaks.

The concern about continuously pressurized lines in the wheel wells seems to be unwarranted since there are currently numerous other continuously pressurized lines already there; the wiring change adds but a few more. As far as leaks are concerned, a few USAF units have reported that hose failures have increased since implementa-

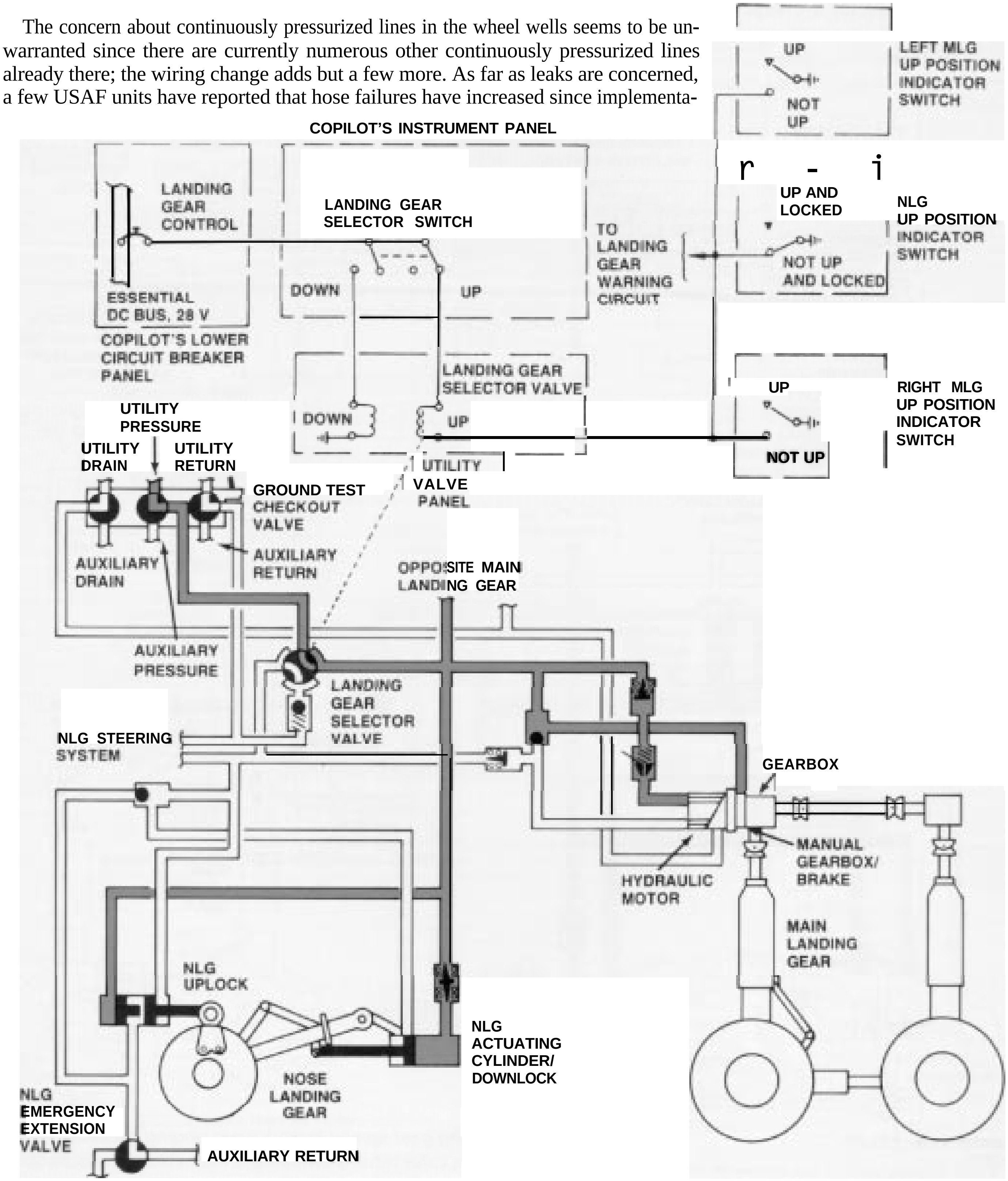
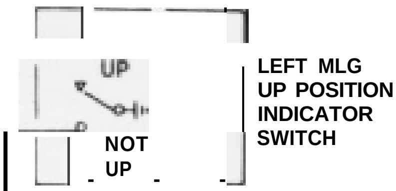


Figure 5. The pressure spike shown in Figure 4 causes the nose landing gear to unlock momentarily.

tion of the wiring change; however, the available evidence does not support the contention that hose failures are caused by the application of a steady 3000 psi pressure on the lines. Tests have indicated that flexing of the hoses with each application of pressure will result in a greater fatigue rate and cause hose failure sooner than continuously applied pressure.

The most likely explanation of the reported hose failures is simply that the hoses are getting old. Currently, USAF manuals do not specify a periodic change of hydraulic hoses; they are visually inspected and changed only if they appear bad. Unfortunately, visual inspections usually cannot detect weakened hoses that are about to fail internally.



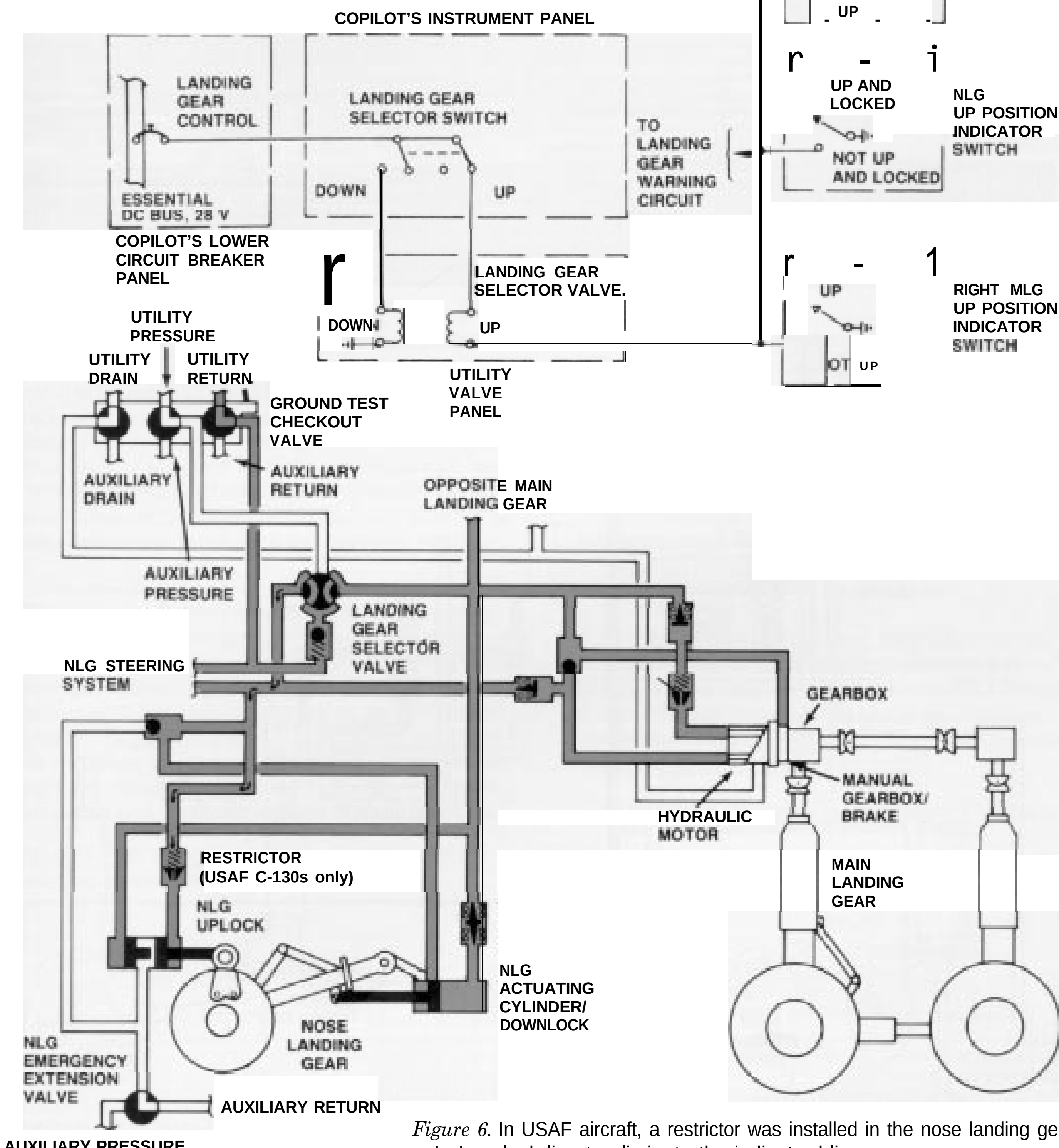


Figure 6. In USAF aircraft, a restrictor was installed in the nose landing gear uplock unlock line to eliminate the indicator blip.

Many, if not all, modifications to existing aircraft systems represent efforts to eliminate or at least ameliorate disadvantages that experience has shown to be present in a particular system as originally designed. Often the result is a tradeoff in which the good and bad features of one approach must be weighed against the good and bad features of another. It is not at all unusual to find an honest difference of opinion among those involved as to which is preferable.

In the present case, Lockheed engineering has concluded that the wiring change to keep the landing gear up solenoid energized at all times offers significant advantages that clearly outweigh any possible problems which might result from this modification.

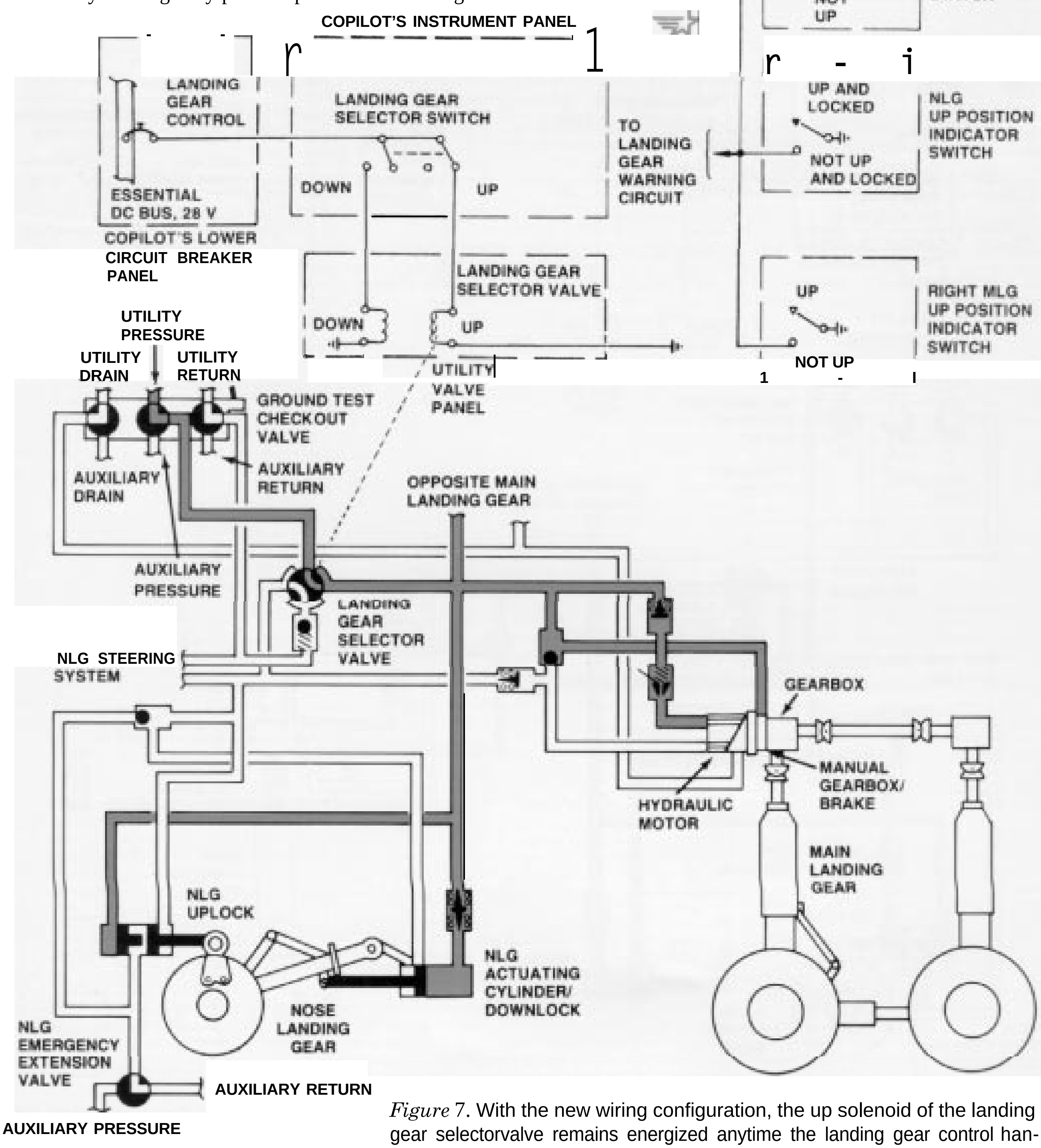
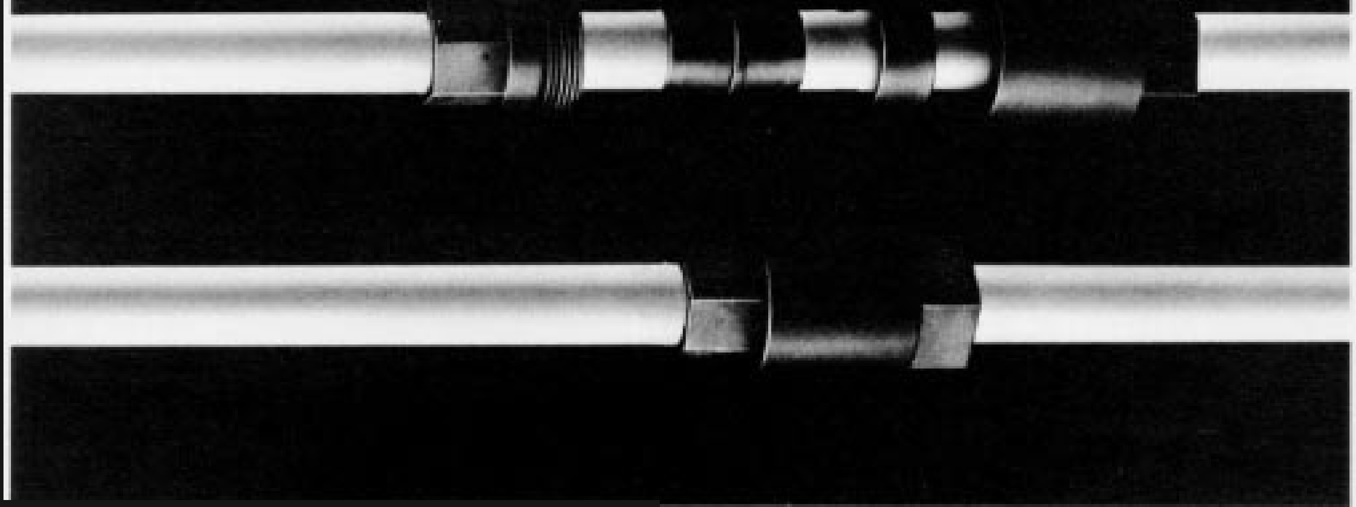


Figure 7. With the new wiring configuration, the up solenoid of the landing gear selectorvalve remains energized anytime the landing gear control handle is up; the hydraulic lines remain pressurized.

Previous Page Table of Contents Next Page

Meet the "H" Fitting



A simple and reliable repair procedure for aircraft tubing is being evaluated by Lockheed and will be recommended for use on all Lockheed-Georgia built airplanes, including the Hercules aircraft. A special fitting of a new design, known as an "H" fitting, makes this procedure possible. It is produced by Sierracin/Harrison of Burbank, California, and it accomplishes essentially the same mechanical connection as the "Permaswage" type that is approved in T.O. I-lA-8 for repair of tubing leaks.

The main difference between the two is that the "H" fitting assembly includes a coupling and nut arrangement that performs the identical function as the hydraulic actuator used in the Permaswage installation. Both are used to swage the union or connecting piece to the ends of the tubing. After the installation is complete, the Permaswage hydraulic actuator is removed. The coupling and nut of the "H" fitting are not removed from the tubing, but they are small enough to fit into confined areas that would not permit even the temporary application of the Permaswage actuator. Another convenience is that two ordinary open-end wrenches are all that is needed to tighten the "H" fitting coupling and nut for the swaging action, whereas accessory equipment must be available to operate the hydraulic actuator required for the Permaswage repair fitting.

A cross section of the "H" fitting assembly is illustrated in Figure 1, which shows the positions of the parts before installation is complete. Figure 2 shows the union swaged permanently to the ends of the tubing.

Once the installation is complete, the connector is structurally independent of the tightness of the coupling and nut. However, except when the union is to be inspected, the coupling and nut should be kept tight enough to prevent the outer parts of the connector from moving around on the tubing.

These fittings are especially useful when a hydraulic

Figure 1. "H" fitting components in position for the swaging action.

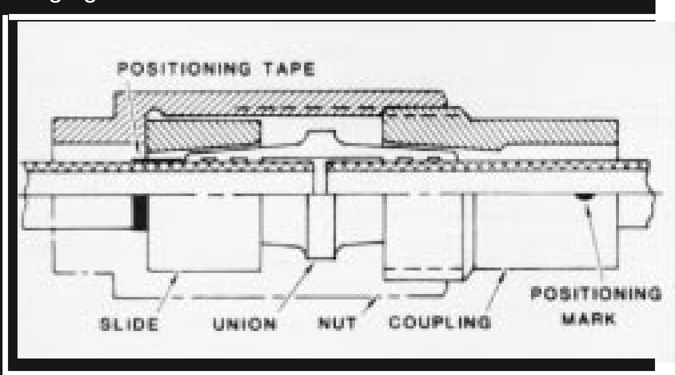
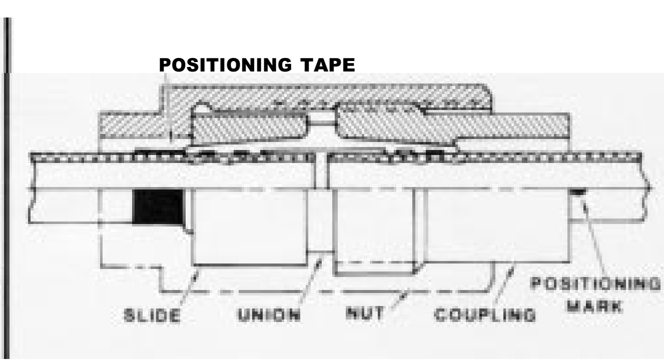


Figure 2. "H" fitting assembly after completion of swaging.



line springs a small leak or a section needs repair. They are recommeded by the manufacturer for repairs of tubing in other systems as well, except the oxygen system (until tests prove compatibility). These "H" connections have withstood the same tests that are required of other tube fittings, such as those specified in MIL-F-18280 for flareless-type fittings.

A small defect will require a simple square cut through the tubing at the point of damage, allowing the fitting assembly to be slipped into position over the free ends. A single repair fitting will cover a relatively small area, as specified in the instructions for that tube and fitting size. Longer or curved sections to be replaced will require an "H" fitting at each end. Figure 3 illustrates some of the situations that occur and the approach in repairing each one.

Lockheed plans to offer tubing repair kits for the C-5 and C-141 as well as for the Hercules aircraft. A kit will include an appropriate quantity of the fittings in all of the tube sizes for the particular airplane in question. The kit will also include a tool case containing a tube cutter, deburring tool, and fitting installation instructions (Figure 4). The fittings are compatible with all tubing alloys. If need be, one of these fittings could even be used to repair damaged tubing on ground equipment, provided its pressures do not exceed normal aircraft pressures.

The new method is envisioned as a definite benefit when rapid repairs are needed. It can be valuable as an immediate tube repair that will allow flying a Hercules aircraft safely to its destination with a minimum of delay. With the right size fitting, wrenches to match, a tube cutter, deburring tool, tape, and a felt tip marker, a Hercules crew member can make the repair on the spot.

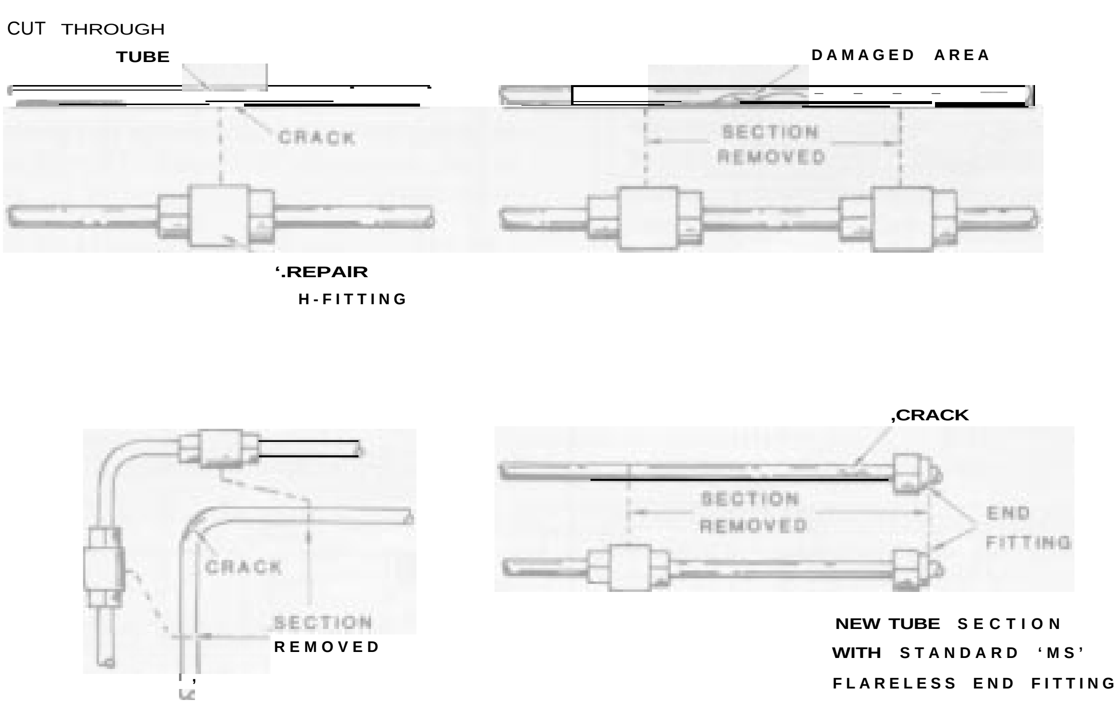
Here is a brief summary of the advantages offered by the "H" fitting tube repair method.

- No special equipment or technique is necessary for anyone experienced in general aircraft maintenance.
- Tubing in confined areas can be repaired if there is enough working room to cut and deburr the tubing.
- Most tool boxes already contain at least some of the tools necessary for the "H" fitting installation, such as open-end wrenches, electrician's tape, a felt-tip marker, and so forth.

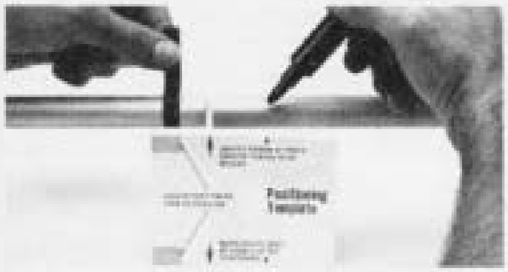
Recommendations have been made to have the "H" fitting repair procedure authorized for inclusion in all applicable aircraft technical orders, and prescreening activities have been initiated for stocklisting the fittings with national stock numbers. We hope that this information will help introduce this repair procedure to interested maintenance personnel and others who like to keep up with the state of the art of aircraft maintenance.

Lockheed's proposed "H" fitting tube repair kit for the Hercules aircraft is identified by part number 3402592-l.

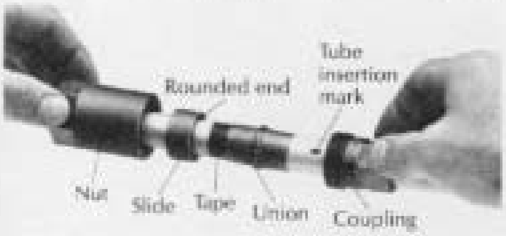
Figure 3. Typical "H" fitting repair installations.



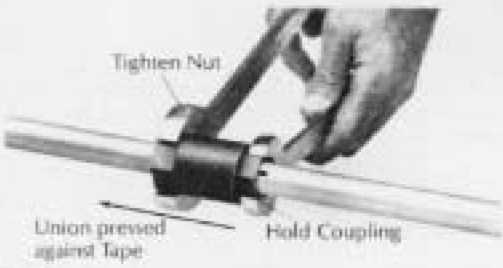
Installation Procedure



PREPARE TUBES: Remove the burrs from the tube ends. The maximum allowable gap between the ends is 0.250 inch. Position the arrow on the template in the center of the gap. Wrap tape opposite the shaded area. Mark a dot on the tube opposite the template dot.

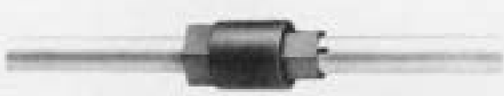


POSITION COMPONENTS: Position the fitting components onto the tube ends with the union against the tape.



TIGHTEN ASSEMBLY: Start the nut onto the coupling and tighten with the union against the tape. Continue tightening until a great torque increase is felt as the slide and coupling bottom against the union. Check for visibility of the mark.

INSPECT JOINT: Back off the nut and ensure that the slide and coupling are bottomed against the shoulder of the union. The union must contact the tape, and the edge of the coupling must intersect the tube mark.



RETIGHTEN: Retighten the "H" fitting assembly.

Figure 4. "H" fitting installation instructions.

The kit will include the following items:

PART NUMBER	QTY	DESCRIPTION
6766	1	Tool case
36011V04	8	"H" Fitting (1/4" Tube)
36011V06	8	"H" Fitting (3/8" Tube)
36011V08	6	"H" Fitting (1/2" Tube)
36011V10	4	"H" Fitting (5/8" Tube)
36011V12	4	"H" Fitting (3/4" Tube)
36011V16	4	"H" Fitting (1" Tube)
6767	1	Tube Cutter
6768	1	Deburring Tool

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Previous Page Table of Contents Next Page

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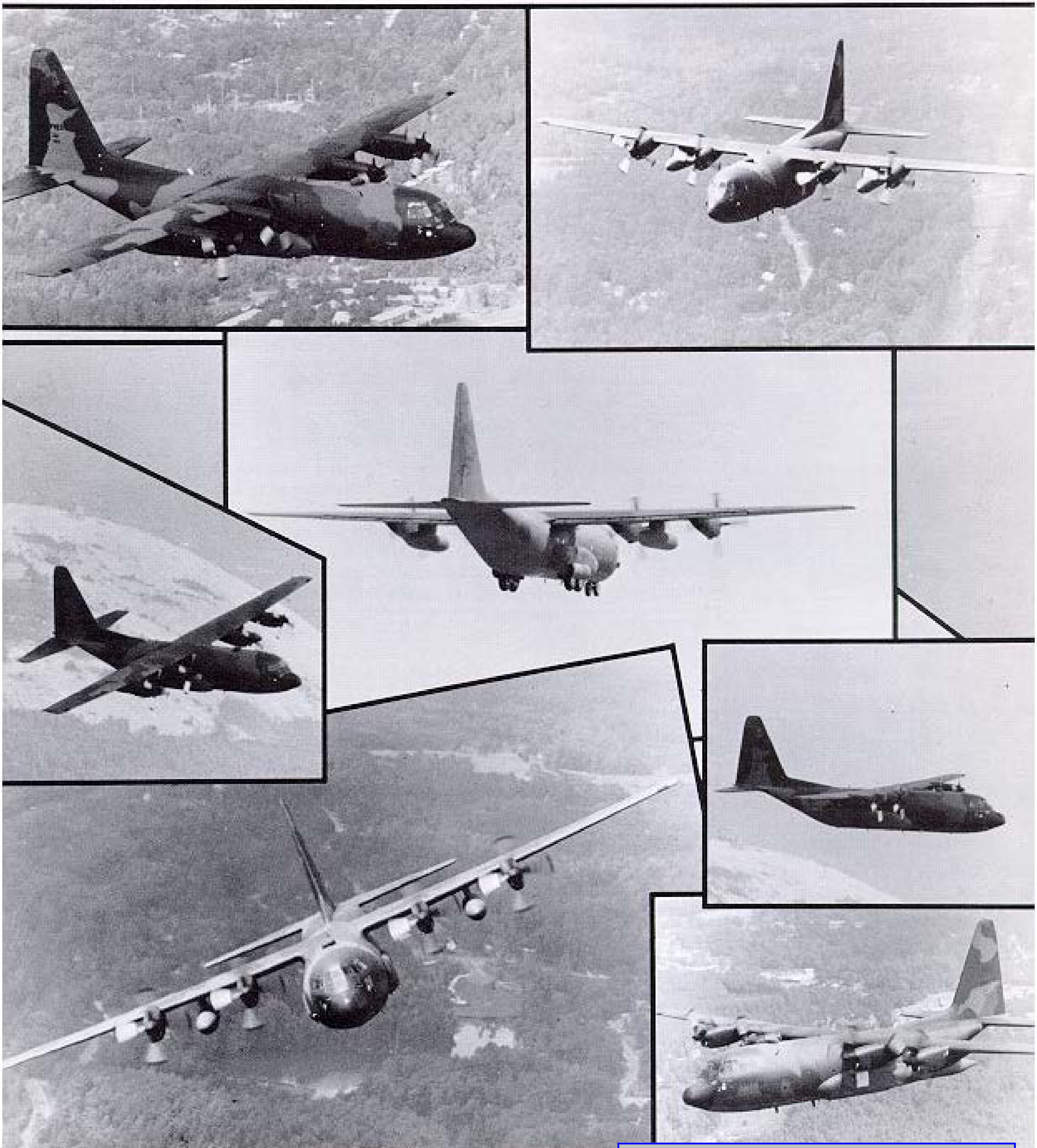

Previous Page Table of Contents Next Page