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

RADOME COATINGS

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Cover: The gleaming nose radome of this Hercules airlifter reflects both the scenery and the dedication of the men and women of the l64th TAW, VanNuys. Calif. This entry won the top maintenance award at the 1981 Volant Rodeo.

Focal Point

J.R. Roberts

Radome Finishes-Quality Out In Front

This issue of Service News magazine features an article containing useful information on a subject that most Hercules aircraft operators will sooner or later need to know something about-radome refinishing.

In the Lockheed-Georgia Paint Department, we take special pride in ensuring that it will be later rather than sooner. Likeevery other process or component that is used in the world's most famous airlifter, no effort is spared to make certain that the finishes on your new aircraft and the procedures used to apply them are the best the industry has to offer.

Let us take as an example a radome which must be overcoated to match a customer's paint scheme. When the new radome is brought to the paint shop to be overcoated. It IS mounted on a radome dolly rather than the airplane. This gives us easy access to all parts of the radome and allows precise control of the finishing process.

After moving the radome into position, we mask it and clean it thoroughly. The radome is then lightly sanded and wiped with solvent and clean, lint-free cotton cloths. We immediately wipe it down carefully again with tack rags to remove any remaining lint. At this point, the radome Is given a very light coat of paint, which is allowed to drv for 10 to 15 minutes. This is called a "tack"coat, which acts as a holding coat for the final application of paint.

The final coat is then applied very carefully to make sure that there is a good cover of paint, but not so much as to exceed the maximum allowed thickness of 0.002 inches. After the coating has been applied, the radome is allowed to dry for eight to ten hours before it is demasked. It then cures for another 24 hours before leaving the paint shop, The result is a radome finish that is not only attractive, but stable and durable as well,

Radome coatings, like all exterior finishes, do eventually wear out and have to be replaced. Exposure to the weather and the sandblasting effect of particulate matter in the airstream will see to that. But getting the job done right the first time gives us a special sense oi satisfaction. Quality englneenng, quality materials, and quality workmanship are, after all, what Lockheed products are all about.

Sincerely,

J.R. Roberts
Manager
Paint Department

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UPDATE ON HERCULES NOSE RADOME COATINGS

by **Joe Damiano**, Staff Engineer
Materials and Processes Engineering Department

RADOME ANTISTATIC FINISHING SYSTEMS

Several different finishing systems have been used on the nose radomes of Hercules aircraft. The selection of a particular system is determined by functional requirements or customer request. In this article we will look at some updated information on the removal, preparation, and application of the following antistatic coating systems for the Hercules aircraft's radome:

Neoprene Coating – Neoprene rain-erosion resistant antistatic coating system, conforming to MIL-C-7439, Class II.

Polyurethane Coating—Polyurethane rain-erosion resistant antistatic coating system, conforming to MIL-C-83231, Type II.

Epoxy Coating–Epoxy antistatic coating system (with or without a decorative topcoat).

Identifying Finish Systems

If you are not sure which finish system is on your radome, look for the physical characteristics which identify each system:

- The neoprene coating is black, rubbery, and relatively soft. It can be damaged by cutting into it with a thumb nail. The system is easily blistered by contact with a cotton cloth soaked with toluene. The primer coating used is almost clear, so when the coating is removed, the back side of the removed coating will appear black.

  The neoprene coating system should never be overcoated with a decorative color topcoat because solvents in the topcoat can cause blistering of the neoprene coating.

- The polyurethane coating is also black and rubbery in nature, but very tough. It cannot be damaged by attempting to cut into it with a fingernail. This system is unaffected by contact with a toluene-soaked cotton cloth. The primer coating used is red, which will be evident when the coating is removed.

  The polyurethane coating system is sometimes overcoated with a decorative color topcoat. Overcoated or not, it produces a dull, thumping sound when lightly struck with a coin.

- The epoxy antistatic coating is black and quite hard. It produces a bright, clicking sound when lightly struck with a coin. The epoxy antistatic is generally used when a nose radome requires a

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glossy topcoat. If a radome has a high-gloss white, gray, blue, etc., finish, it probably has the epoxy antistatic coating.

SAFETY FIRST

Many of the materials used in radome surface preparation and painting procedures can be hazardous. These products should be prepared and applied in strict accordance with the instructions supplied by the manufacturers. To safeguard physical health and safety, all personnel handling these substances should observe the safety procedures contained in the appropriate maintenance manuals.

Paints and strippers may contain potentially toxic industrial chemicals such as toluene, methyl ethyl ketone, xylene, and isocyanates, which are described in the following paragraphs.

Toluene

Toluene is a colorless solvent with a benzene-like odor. It is used for paints, cleaning, and as an additive to aviation fuels. This solvent is flammable, with a flash point of 45 degrees F. It must not be used in the presence of oxidizing materials.

Toluene may cause irritation of the eyes, respiratory tract, and skin. Prolonged exposure may lead to dermatitis, and breathing the vapors may cause headaches, dizziness, fatigue, and lack of coordination. Overexposure will cause collapse and possible coma. Long-term exposure to toluene can cause cell damage and may contribute to birth defects.

Methyl Ethyl Ketone (MEK)

MEK is a colorless liquid with a distinctive, fragrant odor. It is used as a solvent in nitrocellulose coatings, cements, and adhesives. The use of MEK in the presence of strong oxidizers must be avoided.

This solvent will irritate the eyes, nose, skin, and cause headache, dizziness, and vomiting. MEK is extremely flammable and must not be exposed to heat or open flame

Xylene

Xylene is a colorless, flammable liquid which is used as a solvent and a constituent of paint, lacquers, varnishes, adhesives, cements, and aviation fuels. Xylene must not be used in the presence of strong oxidizing agents.

Xylene vapor may cause irritation of the eyes, nose, and throat. Repeated or prolonged skin contact will cause drying and may lead to dermatitis. Breathing of xylene vapors may cause damage to the mucous membranes and respiratory system. Repeated exposure of the eyes to high concentrations of vapors may cause severe eye damage.

Isocyanates

Isocyanates are often used in polyurethanes and other coating materials. They are irritating to the eyes, nose, and respiratory tract. Overexposure to these substances may cause asthma-like reactions and heightened sensitivity to the material. Inhalation of vapors should be avoided. Use in well-ventilated areas and wear proper respiratory equipment.

Solvent Countermeasures

Wear appropriate protectivegloves and clothing to prevent repeated or prolonged skin contact. Wear approved eye protection to protect against splash or spills. Clothing that is wet with solvent is a hazard to the skin. Change contaminated clothing immediately. In confined spaces or poorly ventilated areas, respiratory protection devices are strongly recommended.

SURFACE PREPARATJON FOR RADOME REFINISHING

Radomes with Neoprene Coating

Remove the neoprene coating by covering the coating with felt pads or rags and saturate with MEK or toluene, or a 50-50 mixture of MEK and toluene. Maintain coverings in a saturated condition until the coating has loosened to the extent that it can be peeled off or scraped off with a hand scraper made of phenolic or plastic. If a scraper is used, avoid scratching the radome surface. Remove the residue with cloth dampened with toluene or MEK.

As an alternative, there are two paint removers which may be used in lieu of the solvent removal method cited above. These products are listed in Figure 1.

PAINT REMOVER	VENDOR ADDRESS
6581	Intex Products, Inc. p.0. Box 6648 Greenville, SC 29606
GACO S-14	Gates Engineering 100 South West Street Wilmington, DE 19601

***Figure 1. Paint Removers to Be Used* in Lieu of Solvent**

The remover should be allowed to remain on the surface until the coating has loosened as noted above, then scraped if necessary, followed by solvent cleaning. The cleaned surface should be scuff-sanded with 180-grit or finer abrasive paper, the sanding dust removed, and the surfaces solvent cleaned.

Surfaces of the laminates which have depressions, voids, or other surface irregularities should be evened out by applying a smoothing putty over the surface, followed by resanding back to the original contour. Figure 2 is a list of suggested epoxy-type filler materials.

FILLER	VENDOR ADDRESS
P-900	Koppers Co. 801 East Lee Street Irving, TX 75060 Telephone: (214) 445-0666
467-9	Sikkens Aerospace Finishes 20846 South Normandie Avenue Torrance, CA 90502 Telephone: (213) 320-6800
521X316/910X664	Desoto, Inc. Forest Lane and Shiloh Road Garland, Texas 75046 Telephone: (214) 276-5181

Figure 2. Epoxy-Type Filler Materials

These products should be prepared and applied in accordance with the instructions of the manufacturer.

The filled surfaces should be dry-sanded to the original contour of the laminate surface, followed by wet sanding with 400-grit abrasive paper. Alternatively, the excess filler may be removed with abrasive pads. If the latter method is used, it is preferable to remove the excess filler before it has completely hardened.

The smoothed surface should be examined for voids or other surface irregularities and refilled and resanded if necessary.

Radomes with Epoxy Antistatic Coating

Removal of epoxy antistatic coating must be performed by abrading with 180-grit or finer abrasive paper to a point where the laminate substrate starts to show through all over the radome. Extreme care must be exercised to ensure that fibers in the laminate are not exposed or damaged.

The sanding dust should be removed and the surfaces solvent-cleaned with clean cotton cloths wet with MEK prior to refinishing.

Radomes with Epoxy Antistatic Coating and Decorative Topcoat

Removal of decorative topcoat from epoxy antistatic coating must be performed by abrading with 180-grit or finer abrasive paper to a point where the black epoxy antistatic coating starts to show through all over the radome. Extreme care must be exercised to ensure that the epoxy

antistatic coating and the fibers in the laminate are not damaged.

The sanding dust should be removed and the surface solvent-cleaned with clean cotton cloths wet with MEK before overcoating with the decorative finish.

Radomes with Polyurethane Coating

Removal of the polyurethane coating system should be performed in accordance with the resurfacing kit manufacturer's instructions, or TO. l-l-24. After removal of the coating system, solvent-clean with MEK and clean cotton cloths.

The cleaned surface should then be scuff-sanded, cleaned, and smoothed as specified on page 4 above for radomes with a neoprene coating.

APPLICATION OF RADOME COATING MATERIALS

Neoprene Coating System

Neoprene Coating System Preparation

The coating system consists of a cement primer, a neoprene base coat, and a neoprene antistatic topcoat. These three coating materials should be prepared as specified in the manufacturer's instructions enclosed in each coating system kit. The coating system material is listed in Figure 3.

KIT NO.	VENDOR ADDRESS
23-57S	Loral Systems Group P.O. Box 548 Goodyear Street Rockmart, GA 30153 Telephone: (404) 684-7855

Figure 3. Neoprene Coating System Kit

Neoprene Coating System Application

The three coatings (primer, base coat, and antistatic topcoat) should be applied in accordance with instructions of the kit manufacturer and to the coating thicknesses specified. Spray application is recommended. Note that this coating system is not overcoatable with decorative topcoats.

Epoxy **Antistatic Coating**

Epoxy Coating Preparation

The antistatic epoxy base component must be mixed with a catalyst thinner as supplied by the vendor. Partial mixing of kits is not recommended. The liquid material must be thoroughly agitated before, while, and after adding the catalyst thinner, before pouring the mixed material from one container to another, and before each application.

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After mixing, the material must be allowed to set a minimum of one hour before use, and must be used within 24 hours after being mixed. Note that it is extremely important that all pigment is dispersed.

Figure 4 lists approved epoxy antistatic coating materials that are currently available.

EPOXY ANTISTATIC COATING	VENDOR ADDRESS
XA147A (glossy)	Koppers Co. 801 East Lee Street Irving, TX 75060 Telephone: (214) 445-0666
XA148A (matte)	
22-2686 (matte)	Sterling Lacquer Mfg. Co. 3150 Brannon Avenue St. Louis, MO 63139 Telephone: (314) 776-4450

Figure 4. Approved Epoxy Antistatic Coating Materials

It is recommended that the Koppers XA148A or the Sterling 22-2686 matte material be used in all cases except where a decorative topcoat is not to be applied and a high gloss black finish is desired.

Epoxy Coating Application

A light, wet coat should be applied around all edges or masked areas. After 5 minutes dry time, two full, wet, cross coats of the antistatic coating must be applied to the required surface with 15 to 25 minutes dry time between each cross coat. The average total dry film thickness must be 0.0016 to 0.002 inch.

Note that the pigments must be thoroughly dispersed immediately prior to spraying to provide the required antistatic properties in the cured coating.

All necessary care must be exercised to prevent application of a coating without properly dispersed components. Use a pressure or a siphon-type cup spray gun. Agitate the cup gun frequently during spray application. Placing one or two marbles in the cup will help keep the pigment dispersed during the agitation of the cup.

Cure of Epoxy Coating

The final coat must be allowed to air dry 1 to 1 1/4 hours. It may then be force-cured at 125 ±5 degrees F for 24 hours ±30 minutes. Another method is to cure at any time and temperature cycle no higher than 160 degrees F that will produce a coating meeting the surface resistivi-

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ty requirements of 2 to 200 megohms without damaging the substrate. Usually, curing at 160 degrees F for 8 hours is satisfactory.

Surface Appearance of Epoxy Coating

The cured antistatic coating, whether topcoated or not, should be continuous and free from bubbles, cracks, or blisters. It should be smooth, free from dirt, grit, or foreign matter. Scratch marks on unexposed or fay surface areas are acceptable so long as the coating satisfies the other requirements.

Decorative Topcoat on Epoxy Coating

Antistatic epoxy requiring a decorative topcoat may be overcoated with a maximum dry film thickness of 0.002 inch, and color and material as required. Pigmented coatings containing metallic particles must not be used.

The epoxy antistatic coating, when required to be topcoated, must be lightly scuff-sanded with 280-grit or finer abrasive paper to break the surface finish, after satisfactory surface resistivity readings are obtained. Sanding dust must be removed prior to topcoating by wiping with MEK and clean cotton cloths.

Polyurethane Coating System

Polyurethane Coating System Preparation

The coating system consists of a vinyl primer, a polyurethane base coat, and a polyurethane (black) antistatic topcoat. These three coatings should be prepared as specified in the instructions of the manufacturer which are enclosed in each coating system kit. The available kits are listed in Figure 5.

KIT	VENDOR ADDRESS
Class A	CAAP Company, Inc. P.O. Box 2066 Huntinglon, CT 06484 Telephone: (203) 877-0375
Class B	Loral Systems Group P.O. Box 548 Goodyear Street Rockmart, GA 30153 Telephone: (404) 684.7855

***Figure 5. Available Polyurethane* Coating Materials**

Polyurethane Coating System Application

The three coatings (primer, base coat, and antistatic topcoat) should be applied in accordance with the instructions of the manufacturer and to the coating thicknesses specified. Spray application is recommended.

SURFACE RESISTIVITY OF ANTISTATIC COATINGS

Surface Resistivity: Neoprene and Polyurethane

Surface resistivity of the applied neoprene or polyurethane antistatic topcoating will generally be 0.5 to 15 megohms when tested as described below, in the section entitled “Testing Surface Resistivity.” The testing of the neoprene coating is very sensitive and is generally done only on flat test panels, not on the radome itself.

Epoxy Surface Resistivity

The applied and cured epoxy coating should have a resistivity of **2** to **200 megohms,** tested as described below under "Testing Surface Resistivity of Antistatic Coatings." The testing should be done on the radome and not on test panels.

Coating thickness, cure temperature, and cure time affect the surface resistivity values of all antistatic top-coatings.

The thicker the coating, the higher the cure temperature, and the longer the cure time, the lower the resistivity. Conversely, the thinner the coating, the lower the cure temperature, and the shorter the cure time, the higher the resistivity of the coating.

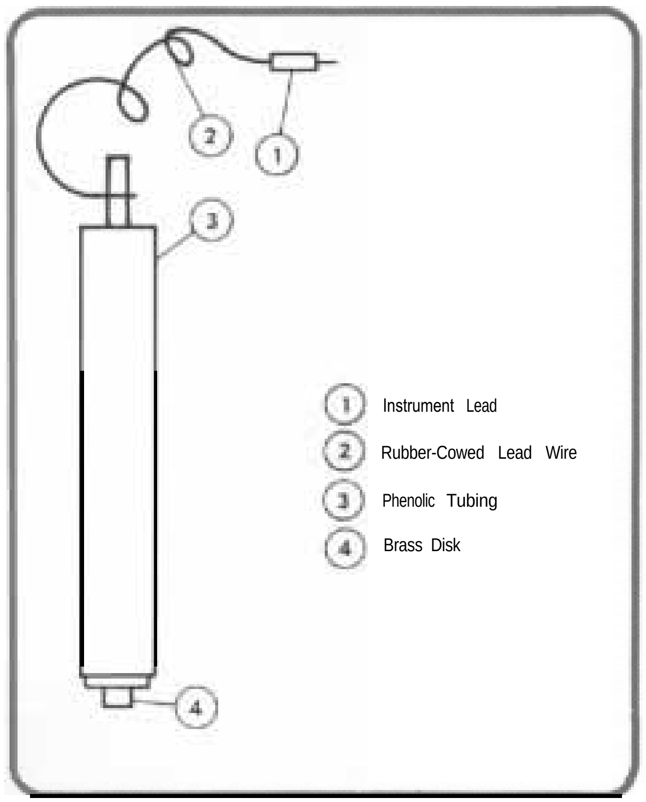
If low rcsistivity readings are encountered, the epoxy coating must be removed down to the plastic laminate surface and a new coating applied. A trace of the first epoxy coat remaining on the laminate is permissible.

If high resistivity readings are obtained, the epoxy coat may be lightly abraded, and a full, wet, cross coat of the coating applied and cured; or the radome may be rebaked at a high temperature for a longer period of time. If the resistivity reading is still out of specification limits after curing, the coating must be removed and replaced.

TESTING SURFACE RESISTIVITY OF ANTISTATIC COATINGS

Surface resistivity of epoxy antistatic coating must be determined on all parts. Measurements must be taken when the cured parts are at a temperature of between 70 degrees and 80 degrees F, and must be satisfactory before application of any decorative topcoat.

The surface resistivity is measured by holding two 3/8-inch diameter wire, spring-loaded electrodes, having a pressure capacity of 3 to 5 pounds, placed 6 inches apart on the coated surface. The spring-loaded electrodes should be similar to the test prod (probe1 shown in Figure 6.



At least six readings should be made on the coated surface of the part being tested, and each reading should meet the surface resistivity requirements. A 500-volt megohm bridge, comparable to the Standco Megohmer Model B-6, available from Herman H. Sticht Co., New York, N.Y., must be used to determine surface resistivity readings.

Surface resistivity of neoprene or polyurethane antistatic coatings should be determined as noted but only on flat test panels. The tests may beconducted on radomes if desired; however, test results may not be consistent with those obtained on flat test panels.

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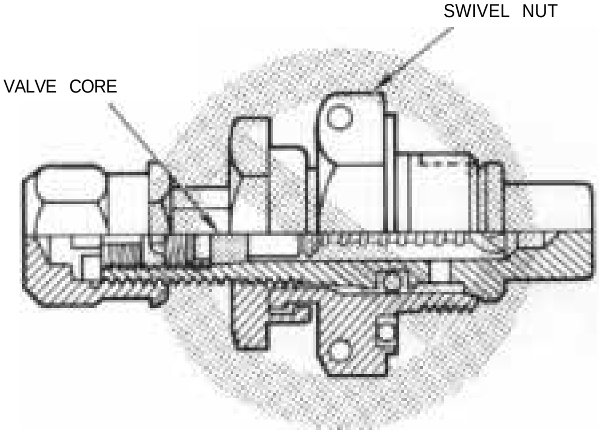
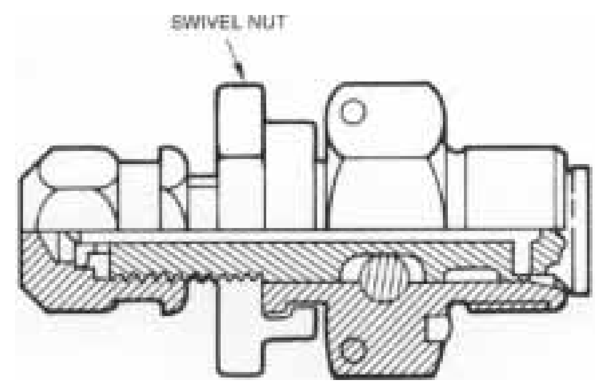
Air Charge Valve MS28889-1/-2: ACCEPT NO SUBSTITUTES



UNAUTHORIZED AIR CHARGE VALVE
PN AN6287-1
(WITH CORE)



AUTHORIZED AIR CHARGE VALVE
PN MS28889-1/-2
(WITHOUT CORE)

Commercial operators should be aware that the Air Force has advised Lockheed-Georgia of a possibly serious safety problem that could result from using a PN AN6287-I air charge valve as an alternate for PN MS28889-1 or PN MS28889-2 air charge valves.

In the Hercules aircraft, these valves can be found in a variety of places such as the MLG and NLG struts, the single-point refueling surge suppressor, and in hydraulic and brake system accumulators. Maintenance crews and supply personnel should be alert to the fact that there are NO AUTHORIZED SUBSTITUTES for MS28889-1 or MS28889-2 air charge valves.

The Air Force has issued a priority Maintenance and Safety Advisory and required a one-time inspection in order to ensure that AN6287-1 valves are removed from inappropriate applications and purged from supply stocks.

This problem has arisen as the result of the linking of NSN 4820-00-535-6483 to both the incorrect AN6287-1 valve (NSN 4820-00-800-3572) as well as the correct MS28889-1 or MS28889-2 valves in the USAF supply system. Some AN6287-1 air charge valves may therefore have been installed in applications where the MS28889-1 or MS28889-2 valves are required and for which no alternative parts are authorized.

A commercial operator who happens to obtain AN6287-1 valves from surplus and attempts to use them in place of the authorized MS28889-1 or MS 28889-2 valves risks injury to personnel, damage to equipment, and possible loss of aircraft warranty coverage.

The difference between the MS28889-1 or MS28889-2 valves and the AN6287-1 valve is that the AN6287-1 valve has a valve core similar in design to the kind used for automobile tires installed in the threaded stem of the valve assembly. In air charge valves of this type, the valve core must be removed before it is safe to loosen the swivel nut (stem nut) to release internal pressure.

A serious safety hazard can exist when an AN6287-1 valve has been used in place of an MS28889-1 or MS28889-2 valve, and maintenance personnel unaware that the AN6287-1 valve has a core try to disassemble it or release pressure by backing off the swivel nut. Backing off the swivel nut can expose the valve core threads to high pressures (as much as 3000 psi) and cause them to fail, allowing the core to be blown out at high velocity.

MS28889-1 and MS28889-2 valves are used in a wide variety of aircraft and ground equipment applications, such as struts, accumulators, pneumatic systems, support equipment, test stands, alternate mission equipment, and many other high-pressure gas-charged systems.

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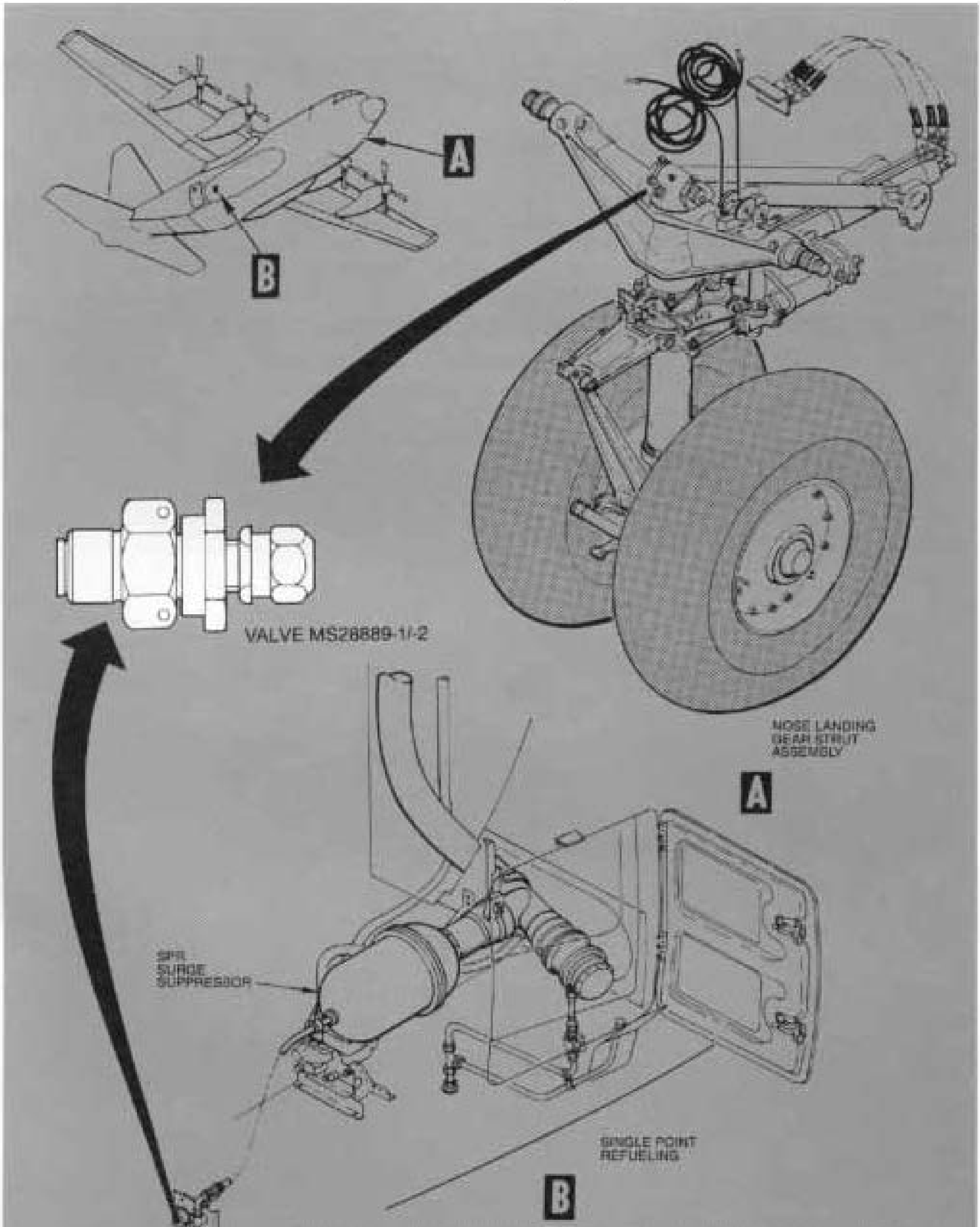


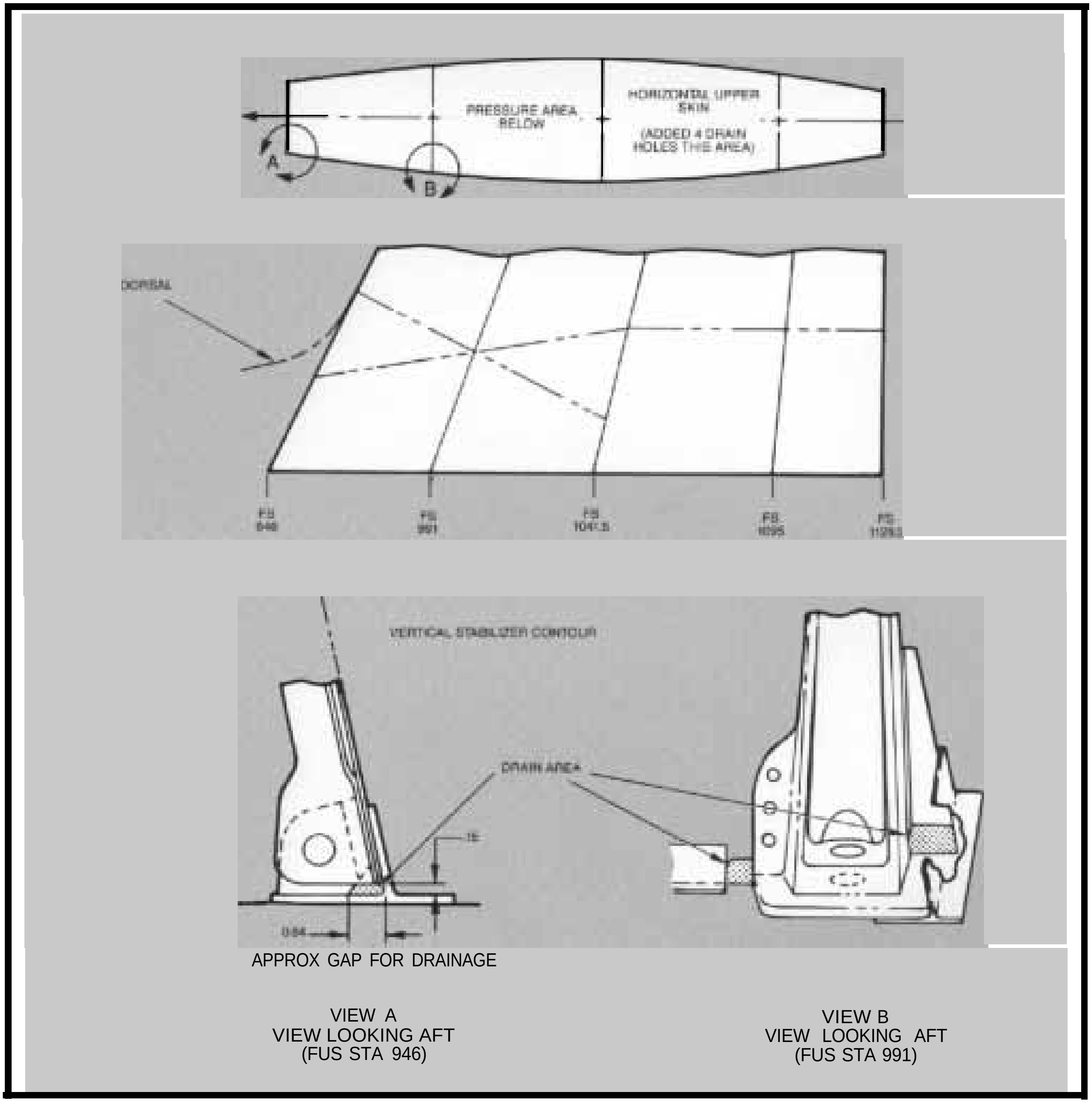
VALVE PN MS28889-1/-2 ON NLG STRUT AND SPR SURGE SUPPRESSOR

PREVENTING MOISTURE ENTRAPMENT *in the Horizontal Stabilizer*

Some Hercules aircraft operators have reported finding moisture entrapped in the horizontal stabilizer upper surface under the vertical stabilizer, in the vicinity of FS 1041.5 to FS 1096.

Figure 1 indicates areas provided for drainage of the vertical stabilizer forward of FS 1041 into the dorsal fairing. These areas should be periodically inspected to ensure drainage of any trapped water.

Figure 1. Drainage at the Base of the Vertical Stabilizer



There has also been a report of moisture in the horizontal stabilizer lower section of the Hercules aircraft. The water was discovered when access panel No. 246 on horizontal stabilizer lower surface was removed.

The horizontal stabilizer has provisions for drainage as shown in Figure 2. It is possible that the holes in question may have been clogged with debris or sealant. Lockheed-Georgia Engineering recommends that the area be inspected to ensure that the holes are open and capable of providing passage for water drainage.

Figure 2 shows the l/4-inch diameter drainage holes which are located at FS 1108, FS 1117, and FS 1129. There are also two 5/16-inch diameter holes, one located at FS 1043, and another at FS 1068. The hole at FS 1068 was added to all Hercules aircraft Lockheed serial number LAC 5070 and later.

These drain holes are considered adequate to drain the lower section of the horizontal stabilizer, assuming that the holes are kept free of debris, fasteners, or sealants.

According to Lockheed-Georgia Engineering, a design change starting with Lockheed serial number LAC 5129 will provide drainage for the vertical stabilizer through the upper surface of the horizontal stabilizer.

This will be accomplished by the addition of one drain hole through thevertical stabilizer main beam at approximately FS 1041.5, VSS 1.0, and BL 1.0, plus four dram holes through the upper surface of the horizontal stabilizer as shown **in** Figure 3.

Further drainage through the dorsal fairing has been provided on Lockheed serial number LAC 5058 and up by the addition of joggles in the stabilizer attach angle. Helpful information on improving dorsal fairing drainage on aircraft built prior to LAC 5058 can be found in Service News Vol. 13, No. 4 (October - December 1986).

Figure 2. Drain Hole Locations-Horizontal Stabilizer

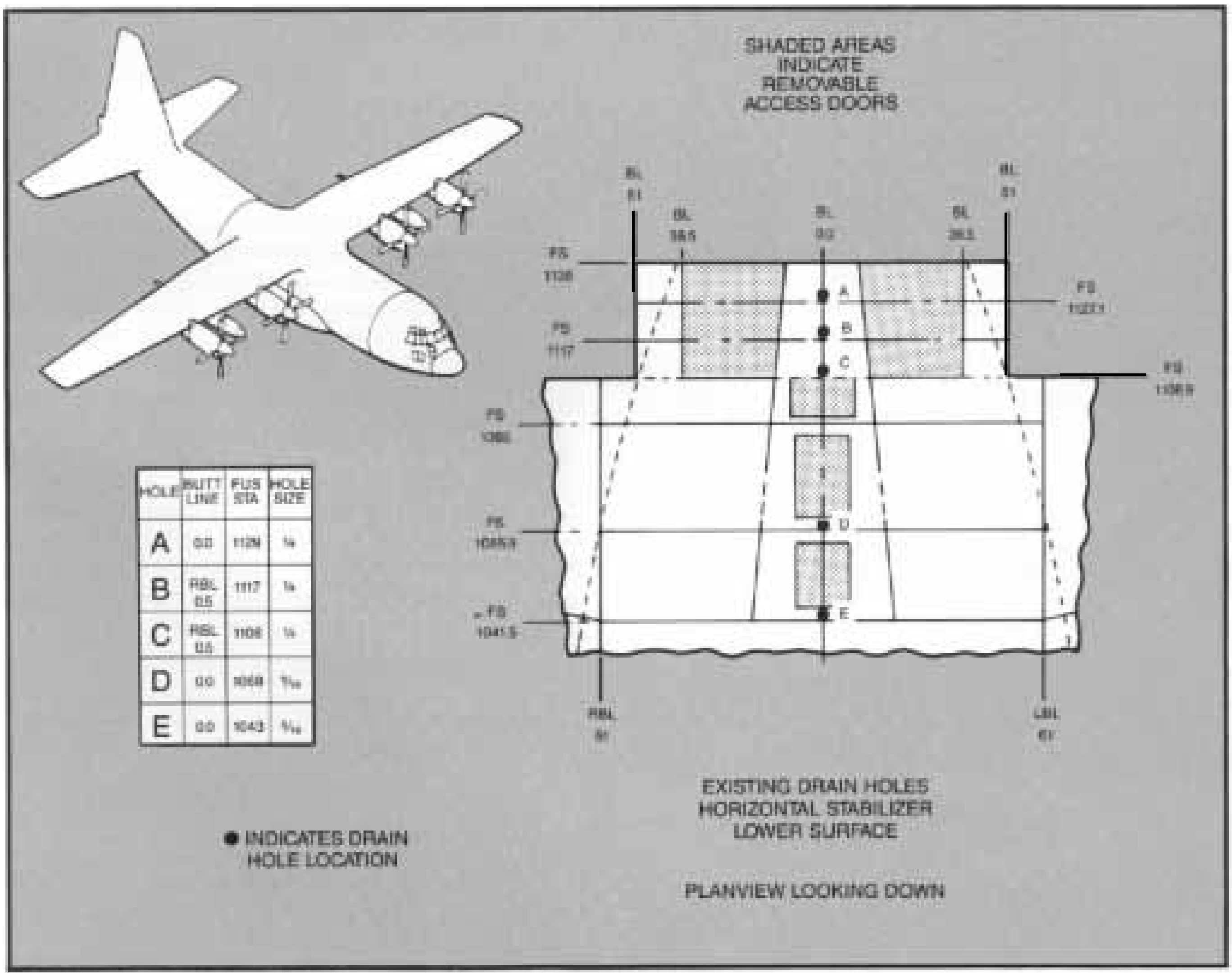
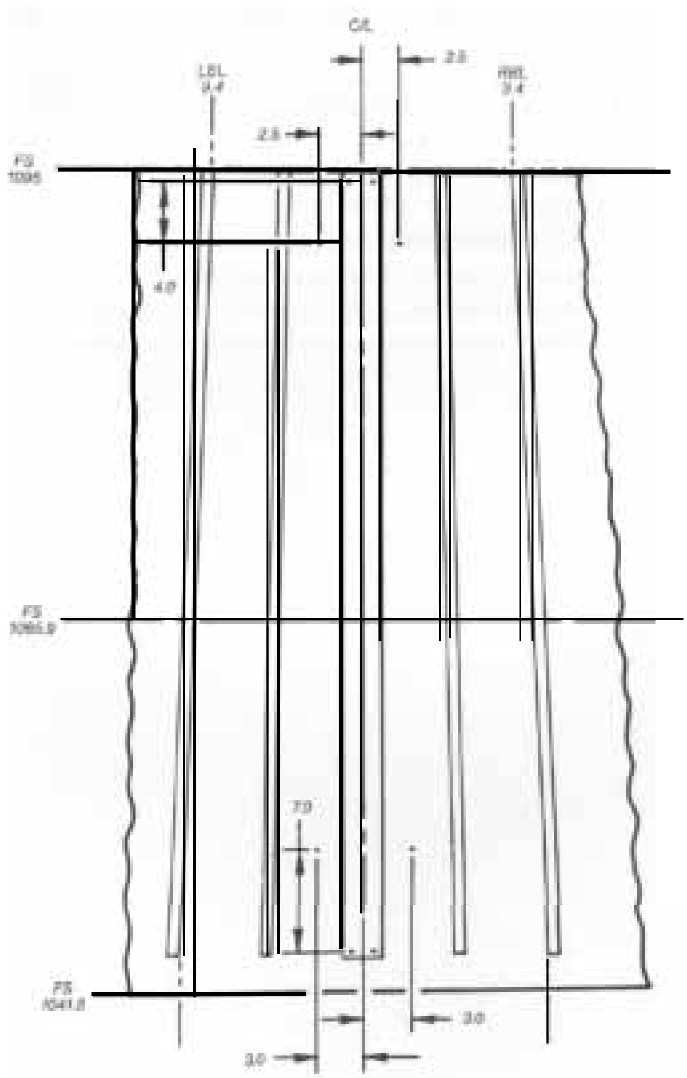


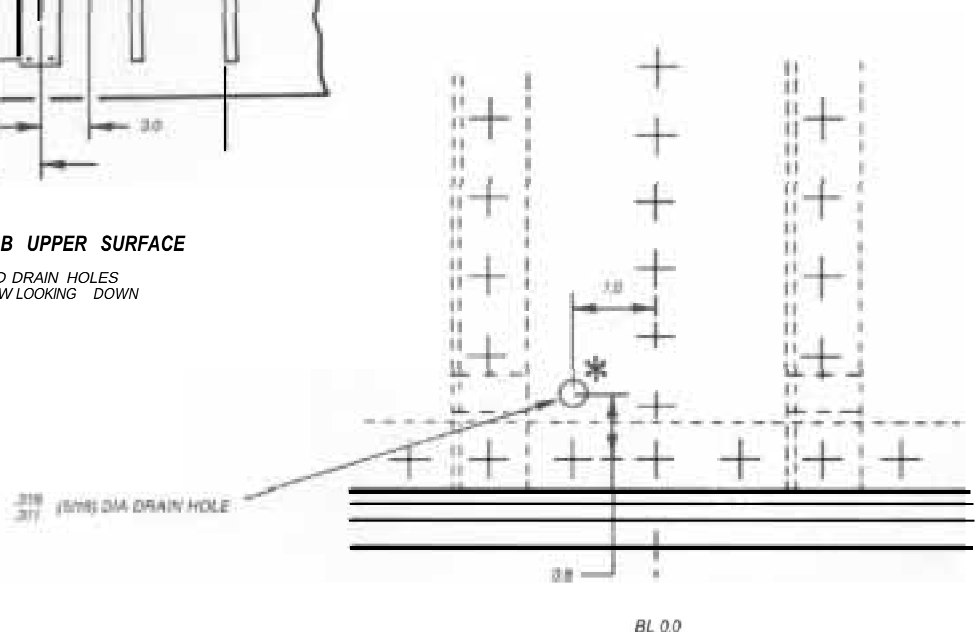
Figure 3. Additional Drainage Locations in Stabilizer



NOTE: THIS DRAIN HOLE WILL BE ADDED TO PRODUCTION AIRCRAFT. FLEET AIRCRAFT CAN BE MODIFIED TO ADD DRAIN HOLE ONLY IF VERTICAL STABILIZER IS REMOVED.

HORIZ STAB UPPER SURFACE

ADDED DRAIN HOLES
PLANVIEW LOOKING DOWN



VIEW LOOKING FORWARD
IN PLANE OF MAIN BEAM WEB

BETA SCHEDULE CHECKS: The Two-Degree Solution

by C L. Puckett, Training Specialist
Customer Training Department

There is a normal condition that exists after proper rigging of the throttle control system that sometimes causes confusion among some Hercules operators when they attempt to carry out a check of propeller beta schedule blade angles.

The condition may be described as follows: With the throttle lever placed in the GROUND IDLE detent (GROUND START on the L-100) at the flight station and the coordinator reading 18 +/-0.5 degrees, the two-step alignment pin (Hamilton Standard PN 546546) cannot be fully inserted in the propeller valve housing beta schedule rig pin hole.

It is important to recognize that this is an entirely normal situation; it is in fact an indication that the throttle control system rigging procedure has been properly carried out.

In a correctly rigged system, the two-step rig pin cannot be fully inserted into the valve housing alpha shaft cam with the throttle lever at GROUND IDLE (or GROUND START). This is because the rigging slot in the alpha shaft cam is aligned with the beta schedule rig pin hole when the alpha shaft's position corresponds to a coordinator reading of 16 +/-0.5 degrees, not 18 +/-0.5 degrees.

This means that before the alignment pin can be fully inserted in the beta schedule rig pin hole with the throttle at GROUND IDLE (or GROUND START), it is necessary to grip the propeller control intermediate linkage at the reductiongear assembly and apply sufficient pressure to move the throttle linkage toward a slightly lower coordinator reading, namely, about 16 degrees.

The checkout and adjustment procedures called out in the T.0.s and vendor documents do not at present detail this preparatory step to carrying out the beta schedule check. However, failure to make this slight adjustment to the throttle setting before starting with the beta schedule check has led to rigging problems.

Some operators, having completed a throttle system rigging checkout and finding that the two-step alignment pin cannot be inserted as expected for the beta schedule check, attempt to rerig the throttle system so that the pin will enter the slot. In doing so, they usually wind up misrigging the throttle system.

Remember that even though the throttle and propeller control systems on the Hercules aircraft are intimately related, throttle rigging and propeller system checks must be dealt with separately. Once properly set, throttle system rigging should never be disturbed to accommodate a rig pin fit that is part of the propeller system's checkout procedure.

In the case of the beta schedule check, repositioning the throttle by a small amount will allow the two-step rig pin to seat fully in the valve housing alpha shaft cam and ensure a quick and accurate determination of beta schedule blade angle settings.

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