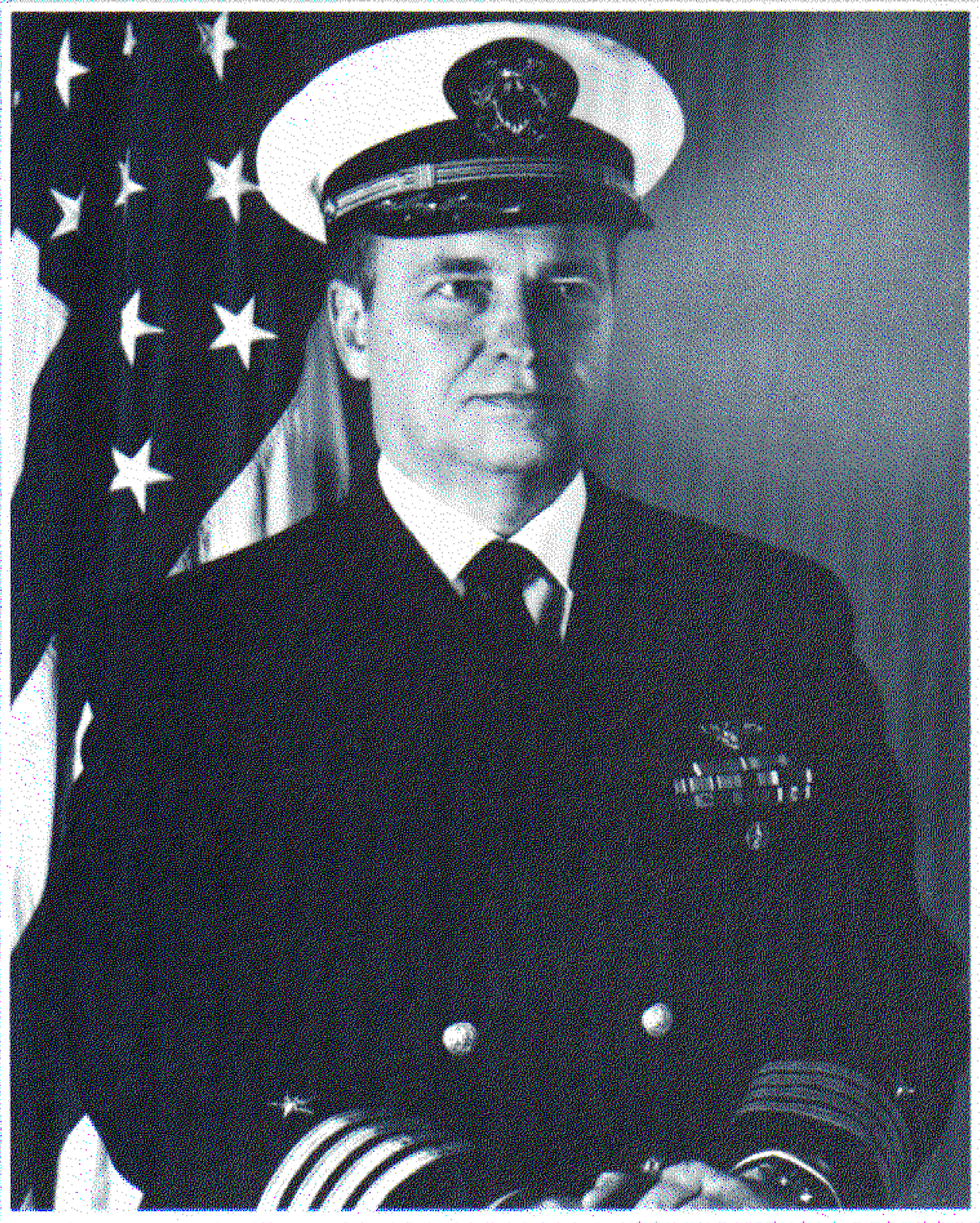
ORION

service digest

issue 27 april 1973

LOCKHEED · CALIFORNIA COMPANY



Captain J. Roger Farrell

Captain Grover M. Yowell

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FRONT AND BACK COVERS Seven years ago, in June 1966, the **Mad Foxes** of VP-5 swapped their venerable SP-2 Neptunes for the latest development in Lockheed ASW aircraft, the P-3 Orion. Since then the squadron has continued to demonstrate the capability that has made it a mainstay of Fleet Air Wing Eleven.

After sharpening their skills with the P-3, the **Mad Foxes** began a six-month deployment to Sangley Point, Republic of the Philippines, in June 1967. Despite a heavy schedule that entailed more than 9000 flight hours in support of our efforts in Viet Nam, they returned to their home port of Jacksonville the winner of the CNO Safety Award.

In 1968 VP-5 participated in Operation Springboard, participated in a joint Anti-Submarine NATO training exercise, and completed a deployment to the Mediterranean area. This year marked a high point in the history of VP-5, as they made a clean sweep

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of the awards available to East Coast Navy Patrol Squadrons. In one competitive cycle PATRON FIVE won the CNO Maintenance Award, the CNO Aviation Safety Award, the Battle Efficiency "E," and the Captain Arnold J. Isbell Trophy for Excellence in ASW. The squadron was also mentioned for the Admiral Areligh Burke Award, further proving their all-around capability.

The following year found the **Mad Foxes** participating in Springboard '69 and in a fleet exercise called Exotic Dancer II, after which they deployed to Bermuda/Argentina and operated from bases throughout the North Atlantic. In 1970, VP-5 deployed to Sigonella, Sicily and was able to again capture the CNO Safety and Maintenance Awards.

1971 was also an active year for PATRON FIVE, including a split deployment between Rota, Spain and Lajes, Azores, participation in RIMEX 2-72, and transition to the DIFAR equipped P-3A(D) Orion. They were awarded the Battle Efficiency "E" in August 1971, marking the **Mad Foxes** as the leading Atlantic Fleet Patrol Squadron.

Last year VP-5 celebrated the completion of ten years of accident-free flying, a record unparalleled by any other Atlantic Fleet Patrol Squadron. Their commitments took them again to Sigonella, from which they maintained ASW and surface surveillance over the Mediterranean, and participated in National Week and Dawn Patrol exercises.

On 12 January 1973, **CDR F. L. Woodlief** assumed command of PATRON FIVE, and by so doing became the first Naval Flight Officer in the history of Naval Aviation to command an aviation patrol squadron. The **Mad Foxes** are presently on deployment, and upon their return will transition to the computerized "Charlie" model of the P-3 Orion.

Notable among those who have served with VP-5 are **Capt. J. Roger Farrell** and **Capt. Grover M. Yowell**. Capt. Farrell, NAVAIR P-3 Project Manager, was the Commanding Officer of VP-5 between 1967-1969 when the **Mad Foxes** swept the Atlantic Fleet Patrol Squadron Awards. Capt. Yowell, Naval Plant Representative at Lockheed-California Company, ranged the North Atlantic, Caribbean, and Mediterranean with VP-5 between 1950-1953 when the squadron won two consecutive Battle Efficiency "E's."

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Contents

INTEGRAL FUEL TANK MAINTENANCE

editor WAYNE CRADDUCK
assistant editor LUCILE HEMANN
art and production by DEPARTMENT 84-23

FOREWORD

Six years ago we presented an article on Integral Fuel Tank Maintenance in Orion Service Digest, Issue 15. Since then there has been a considerable amount of input from the fleet on this subject, enabling a more extensive and perceptive treatment by Joseph C. Placentine, Engineer, Navy Product Support Assurance, Dept. 66-31. Special assistance in preparation of this article was provided by R. V. Bold, Senior Design Specialist, and J. V. Fisher Jr., Structures Designer, P-3 Structures Design, Dept. 75-21; and by I. C. Haus and B. Silverman, Senior Research Specialists, Materials and Processes, Dept. 74-52.

Presentation of this article is part of a program by Lockheed-California Company's Navy Logistics Support to assist the Navy in maintaining the integral fuel tanks of their P-3 aircraft. Also included in this program are periodic visits to operational squadrons by a Lockheed integral fuel tank maintenance specialist to provide on-the-spot training, render assistance, and relay the latest information to you, our customer. In addition, a video cassette training film is presently under preparation by our Navy Maintenance Training Department.

INTRODUCTION

Integral fuel tank repair is an unscheduled variety of maintenance and specialized work in which true proficiency is acquired through practice. Experienced tank seal crews are not always available, especially to squadrons operating from deployed bases, thus when the need for tank maintenance arises it is often necessary to assign the task to personnel who have little or no previous experience. Working without the specialist's skills and equipment, inexperienced personnel are doubly handicapped, and a minor leak repair some times becomes a major maintenance problem under field conditions.

The difficulties attending most field repairs can be avoided if the personnel assigned have a general knowledge of P-3 wing structure, understand the properties of sealants and the particulars of preparing and applying them, and if they then adopt a careful methodical approach in analyzing and resolving tank seal problems.

This article will provide line crewman with a personal reference source of information summarizing tank sealant repair data, emphasizing the principal points of care to exercise and methods to employ in restoring the integrity of the integral fuel tanks.

Integral Fuel Tank Maintenance

by Joseph C. Placentine
Engineer, Dept. 66-31

INTEGRAL TANK STRUCTURE

The upper and lower wing skins each consist of nine integrally stiffened planks; the wing box front and rear beam webs are the tank fore and aft walls. With the exception of the tank bulkheads and ribs used to support the wing flap, landing gear, and nacelle structure, the interior members are generally attached with H-clips to the integral stiffeners of the upper and lower wing skins. This arrangement minimizes the number of seams and fasteners penetrating the tank. All faying surfaces and fasteners are coated with uncured catalyzed sealant just prior to assembly. As described in detail later, many steps of the assembly process are deliberately redundant to ensure that every potential leak point is well covered. Figures 1 through 5 show views of the wing integral fuel tank structure during assembly.

PROTECTIVE COATINGS After all required fabrication, cleaning, and chemical processing operations have been performed, all detail parts comprising the interior surface of the integral fuel tanks (including the center wing tank) are finished in detail prior to assembly (and sealant application) with one coat of MIL-C-27725, Type 2, Class B Corrosion Preventive Compound.

A second coat of MIL-C-27725, Type 2, Class B, containing a contrasting color is applied in detail to the lower skin panels, lower beam spar caps, lower rib caps, and both sides of tank divider rib assemblies at wing stations (W.S.) 65 and 221. The second coat is applied after the first coat has air dried for 1/2 hour minimum to 4 hours maximum.

The total thickness of each cured coating is between 0.0008 and 0.0012 inch except for parts which are complex in shape from a painting standpoint, such as channels, tee's, hat sections, flanged parts, etc. The average dry film thickness for these complex parts is 0.0008 to 0.0015 inch with no reading less than 0.0005 inch or greater than 0.0020 inch. Blue-Green Dye is added to the MIL-C-27725, Type 2, Class B Corrosion Preventive Compound in the ratio of 1 oz/gal where a second coat is required.

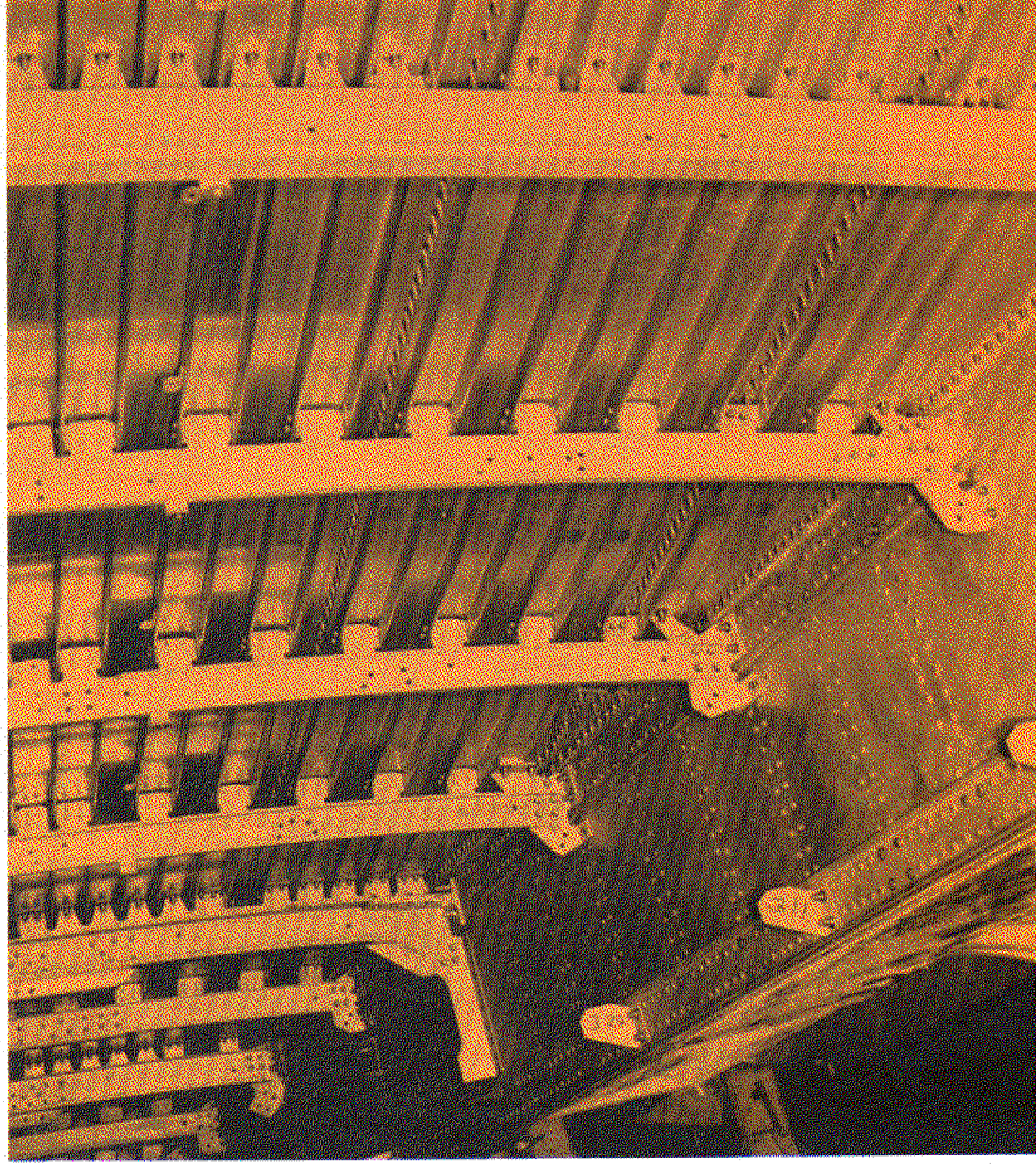
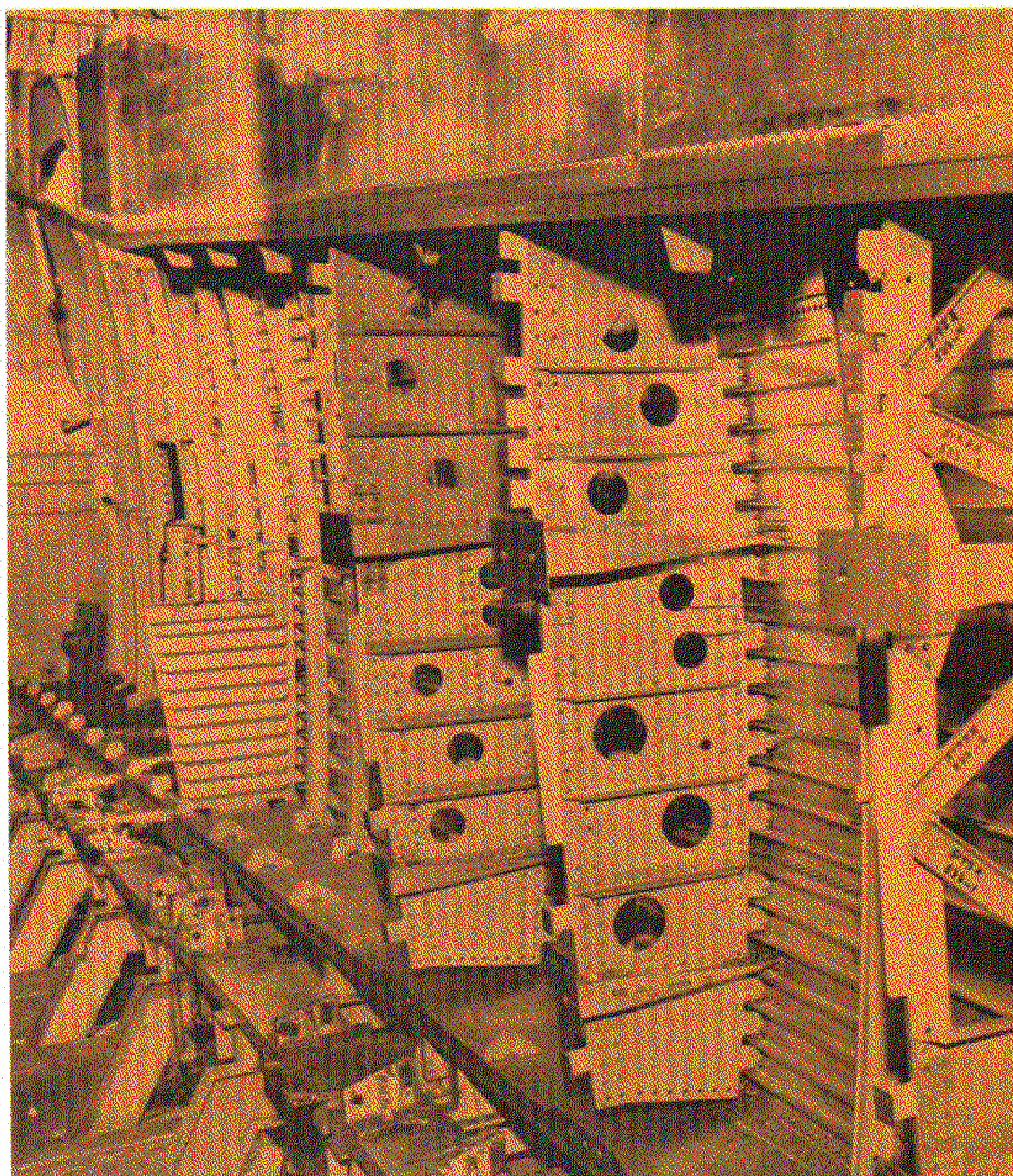


Figure 1. Typical Box Beam Web that Forms the Fore and Aft Walls of the Tanks. Except for those noted in the text, ribs are attached to wing plank risers by "H" clips shown here.

Figure 2. Wing Lower Surface Integrally Stiffened Planks form the Bottom Surface of the Tanks. Wing ribs and tank bulkheads are shown installed.



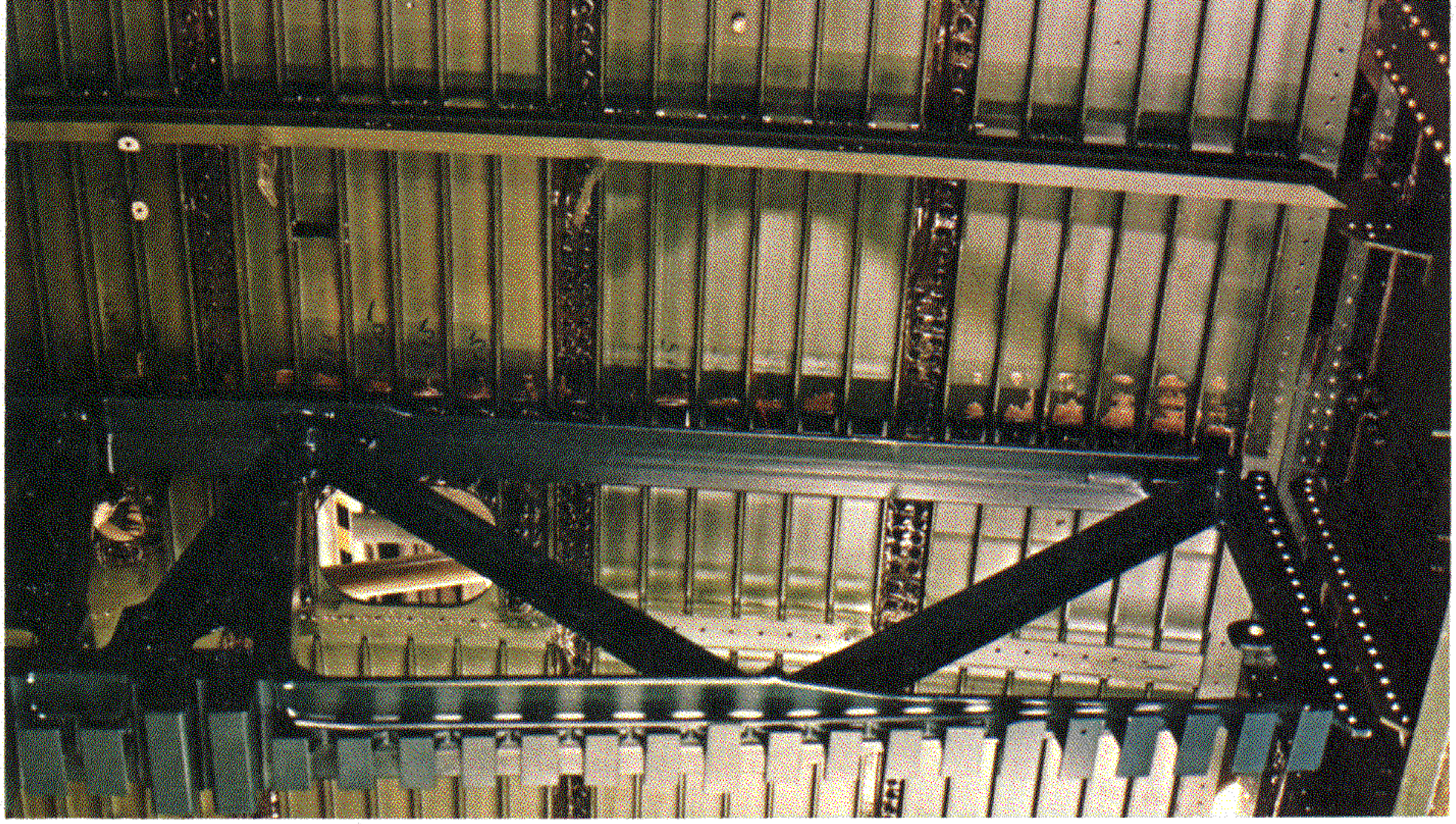


Figure 3. Main Landing Gear Outboard Rib and Wing Upper Surface Integrally Stiffened Planks

MIL-C-27725 compound should not be applied to tank surfaces as a field fix.

SEALING COMPOUNDS Lockheed is currently using a polysulfide-type polymer liquid rubber sealing compound, varying the viscosity and application time to suit specific purposes. This material cures by chemical reaction to the consistency of solid rubber when mixed with a catalyst accelerator in the correct proportion. The base material and the catalyst are always of contrasting colors. This provides a visual aid in determining the proper dispersion of the catalyst throughout the base material during the mixing operation as evidenced by a uniform color of the mixture.

Table 1 lists the sealing materials, the protective coating, and the cleaners now in use at Lockheed for initial assembly work as well as quick repair kits, protective coatings, and cleaners used for field repair. These sealants, when correctly mixed and applied to a properly cleaned area, will provide a dependable, adequate seal. They can be used to repair any sealant installed by Lockheed, provided the deteriorated portion of the previously applied sealant is completely removed.

Types The MIL-S-8802 Class B-2 and A-2 (LCM 40-2180, Types I and II) materials have an application life of 1 to 3 hours. The Class B-2 is a heavy viscosity sealant used for injection and fillet sealing in voids, holes, and along structure seams and joints. The Class A-2 sealant is a brushable material used for sealing fasteners, such as rivets and bolts. The MIL-S-8802 Class B-1/2 and Class A-1/2 (LCM 40-1218, Types I and II) sealants are quick repair materials and have an application life of 15 to 45 minutes. Class B-1/2 is a heavy viscosity sealant and Class A-1/2 is brushable. Commercially available Product Research Corporation (PRC) PR 1435 sealant can be used for repairs at ambient temperatures down to 45^{o}F. It has a work life of only 15 minutes at 70^{o}F. There is no Lockheed or Military Specification for this material.

The MIL-S-8784 Class B and Class A (LAC C-40-769, Types I and II) materials have an application life of 1 to 3 hours. They are a low adhesion (2 lbs/inch max.) version of MIL-S-8802 and are used to seal contact surfaces of components which are not permanently installed.

The LCM 40-2121, Types I and II are extended work-life versions of MIL-S-8802 Class B-2 and Class A-2 but do not have a military specification number. (See Table 1.) The application time limit of Type I is 10 hours and the assembly time limit is 20 hours (including the application time limit). Type II has an application time limit of 24 hours and an assembly time limit of 80 hours (including the application time limit). Both Type I and Type II are used only on faying surfaces, and chemical curing of these materials takes place within the required time subsequent to the exclusion of air during the assembly process. Since air interferes with the curing of LCM 40-2121, any uncured sealant at the edges of the faying surfaces (due to squeeze-out) must be completely removed to prevent its interfering with the proper curing of either fillet and/or brush-coat materials which are applied later.

The MIL-C-27725 coating used in production is a two-part polyurethane material which requires mixing before application. All the internal tank structure detail parts have one coating; however, one additional coating of MIL-C-27725 is applied to the bottom surfaces of the tank structure detail parts for additional protection. See the section, "Protective Coatings", for more detailed data on this subject.

WARNING

Avoid all skin contact with MIL-C-27725 polyurethane coating during application. Chemicals used in its manufacture are poisonous and can be absorbed through the skin. Use precautionary measures such as protective hand cream, rubber or plastic gloves, aprons, and a full-face, air-supplied respirator. Remove and launder all clothing contaminated by these chemicals as soon as possible. In case of accidental skin contact with polyurethane, wash the affected area immediately with soap and water. When applying polyurethane, ventilate the area as described under the "Safety Precautions" Section of this article. When application is made by either brush or spray gun, wear an air-supplied respirator and cover all parts of the body.

Mixing The different brands of base sealing compounds included under the military specifications vary in color. The catalyst is of a contrasting color. A light colored base material and a dark colored catalyst are preferred because definite streaks of color are evident until the sealing compound and catalyst are thoroughly blended. At the factory where large quantities are used, the sealant is mixed by an automatic-metering, mechanical mixer. When this type of mixer is not available, the heavy fillet-type (Class B) sealant is mixed on a flat glass plate so that the thorough blending of the base and catalyst can be checked easily.

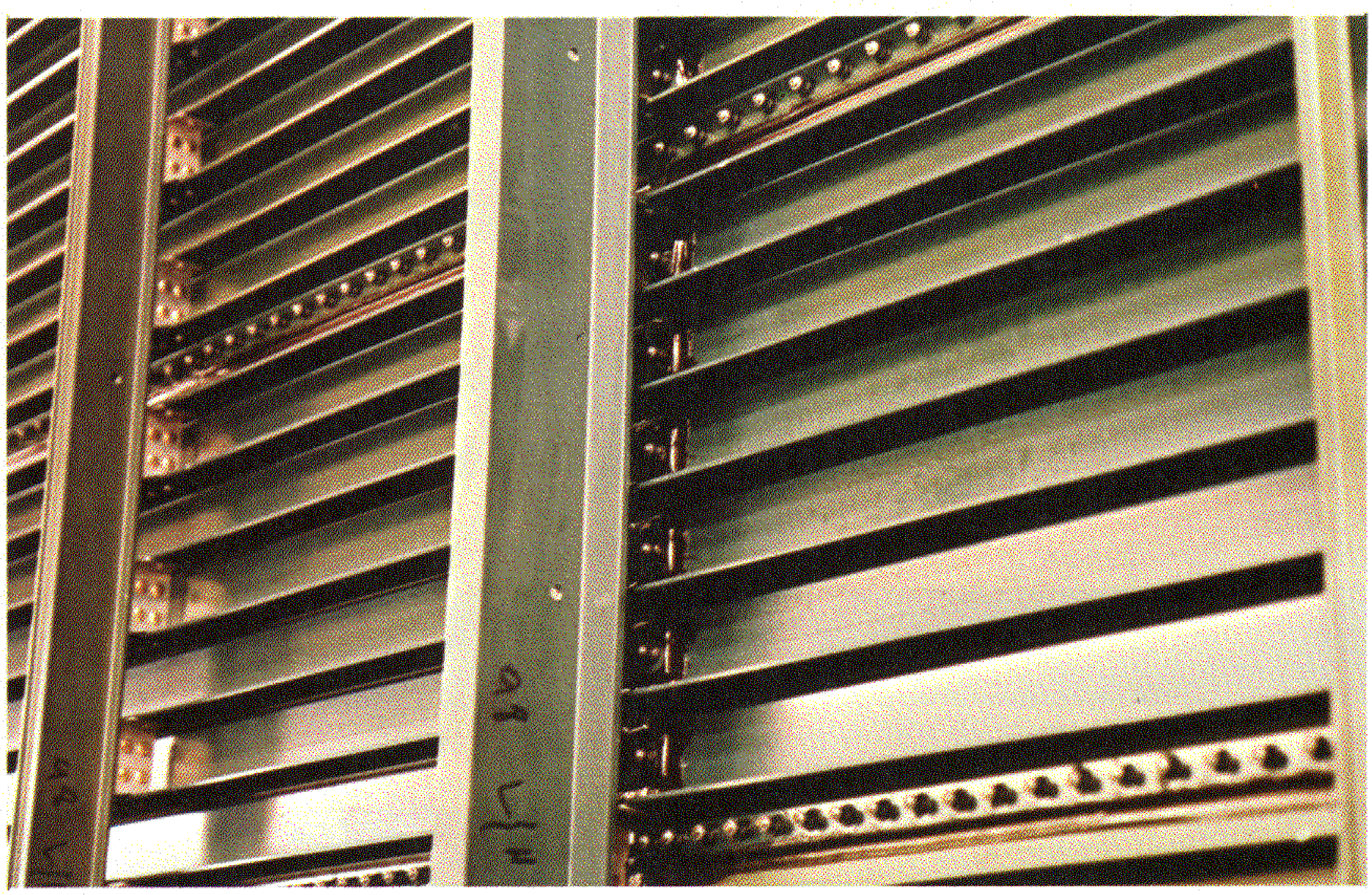


Figure 4. Wing Upper Surface Integrally Stiffened Planks Form the Upper Surface of the Tanks. Ribs are attached to wing plank risers by "H" clips shown here.

Table 1. Materials Used in Production Sealing and Service Maintenance of Integral Fuel Tanks

PROTECTIVE COATING, LEAK DETECTORS, AND CLEANERS					
MATERIAL DESCRIPTION	MATERIAL SPEC*	APPLICATION TIME	DRYING TIME	VENDORS	USABLE MILITARY SPECIFICATIONS
BRUSHABLE PROTECTIVE COATING FOR TOUCH-UP OR FIELD REPAIRS	LAC-40-781 TYPE I		2 HRS. @ 77°F (25°C) PLUS 6 HRS. @ 120°F (49°C)	3 M CO. **EC-776R PRODUCTS RESEARCH CO. **PR 1005R	MIL-S-4383
DICHLOROMETHANE TECHNICAL, USED FOR THINNING LAC-40-781				QUALIFIED PRODUCTS LIST	MIL-D-6998
LEAK DETECTOR, SOAP-LIKE FLUID USED ON EXTERNAL SEAMS AND FASTENERS TO DETERMINE LEAKS WITH FUEL TANK UNDER 3 PSI AIR PRESSURE.	LAC C-31-215			TURCO PRODUCTS INC. TURCO 598	
LEAK TEST COMPOUND, NON-CORROSIVE BUBBLE SOLUTION USED FOR DETECTING LEAKS.					MIL-L-25567
CLEANERS, CHLORINATED TYPE USED AT FACTORY FOR CLEANING WAX TYPE CONTAMINANTS FROM TANK SURFACES TO BE SEALED.	LAC-32-337			TURCO PRODUCTS INC. NO. 657 DELCO CHEM. CORP. NO. 2083 LEEDER CHEMICAL CO. NO. 885	
DRY CLEANING SOLVENT, USED FOR LEAK CHECK AND GENERAL CLEANING AT FACTORY.	P.D. -680 TYPE II			QUALIFIED PRODUCTS LIST	
CLEANER, PETROLEUM BASE, USED AT THE FACTORY FOR REMOVING GREASE AND OIL FROM TANK SURFACES TO BE SEALED.	LAC-32-367			DELCO CHEM. CORP. NO. 2064 KELITE PROD. CO. KUL LEEDER CHEM. CO. NO. 500L	
METHYL ETHYL KETONE	TT-M-261			QUALIFIED PRODUCTS LIST	
AROMATIC NAPHTHA (USED IN CLEANING SOLVENT MIXTURE).	TTN-97 TYPE I GRADE B				
ETHYL ACETATE (USED IN CLEANING SOLVENT MIXTURE).	TT-C-781				
ISOPROPYL ALCOHOL (USED IN CLEANING SOLVENT MIXTURE).	TT-1-735			FEDERAL STOCK NUMBER 6810-223-2726 (5 GAL.)	
RED DYE MIXED WITH JP-4 OR ISOPROPYL ALCOHOL FOR INJECTION LEAK DETECTION	DYE RED "O" (SOLVENT RED NO. 27)			FEDERAL STOCK NO. 6820-559-3248	
FLUORESCENT DYE MIXED WITH JP-4 OR ALCOHOL FOR INJECTION LEAK DETECTION	ZYGLO ZL-2				
PETROLATUM, USED ON EXPOSED AREA OF ACCESS DOOR SEALS TO PREVENT SEIZURE.	W-P-236				

SEALING MATERIALS

MATERIAL DESCRIPTION	MATERIAL SPEC*	APPLICATION LIFE @ 77°F (25°C) AND 50% RELATIVE HUMIDITY	CURE TIME 77°F (25°C) AND 50% RELATIVE HUMIDITY	VENDORS	USABLE MILITARY SPECIFICATIONS
SEALING COMPOUND (FILLET AND INJECTION) USED FOR FILLETING ALONG SEAMS AND JOINTS AND FOR FILLING GAPS AND VOIDS BY INJECTION WITH A PRESSURE GUN.	LCM 40-2180 TYPE I	1 TO 3 HOURS	48 HOURS	PRODUCTS RESEARCH CO. PR7301K (PR-1422B-2) SEMCO DIVISION OF PRODUCTS RESEARCH CO. SEMKIT FSN 8030-753-5005	MIL-S-8802 CLASS B-2
SEALING COMPOUND (BRUSHABLE) USED FOR SEALING RIVETS, BOLTS AND ALL FASTENERS.	LCM 40-2180 TYPE II	1 TO 3 HOURS	48 HOURS	PRODUCTS RESEARCH CO. PR 7401K (PR-1422A-2) COAST PROSEAL & MFG. CO. PROSEAL 890-A-2 3M CO. EC-1675-A-2 SEMCO DIVISION OF PRODUCTS RESEARCH CO SEMKIT FSN 8030-753-5009	MIL-S-8802 CLASS A-2
SEALING COMPOUND (QUICK REPAIR FILLET) USED IN SERVICE REPAIRS FOR FILLETING ALONG SEAMS OR JOINTS AND FOR FILLING GAPS OR VOIDS.	LCM 40-1218 TYPE 1	15 TO 45 MINUTES	12 HOURS	PRODUCTS RESEARCH CO. PR5601K(PR-1422B-1/2) 3M CO. EC-1675-B-1/2 **COAST PROSEAL & MFG. CO. PROSEAL 890B-1/2** SEMCO DIVISION OF PRODUCTS RESEARCH CO. SEMKIT FSN 8030-753-5004	MIL-S-8802 CLASS B-1/2
SEALING COMPOUND (QUICK REPAIR, BRUSHABLE), USED IN SERVICE FOR ALL MINOR REPAIRS TO SEALANT COATING OVER RIVETS AND FASTENERS.	LCM 40-1218 TYPE II	15 TO 45 MINUTES	12 HOURS	PRODUCTS RESEARCH CO. PR5701K(PR-1422A-1/2) 3M CO. EC-1675-A-1/2 COAST PROSEAL & MFG. CO. PROSEAL 890-A1/2 SEMCO DIVISION OF PRODUCTS RESEARCH CO. SEMKIT FSN 8030-753-5008	MIL-S-8802 CLASS A-1/2
SEALING COMPOUND (QUICK REPAIR, BRUSHABLE OR FILLET). USED IN SERVICE FOR MINOR LEAKS OF ALL TYPES.		15 TO 45 MINUTES	24 HOURS	PRODUCTS RESEARCH CO. PR5801(PR-1435)	
SEALING COMPOUND (FAYING SURFACE). USED IN PRODUCTION ASSEMBLY, APPLIED TO ALL FAYING SURFACES (PRIOR TO INSTALLING FASTENERS) TO PREVENT SEAM LEAKS AND ALSO DETER CORROSION. CAUTION - USE ON FAYING SURFACE ONLY	LCM 40-2121, TYPE I OR II, CLASS B-12 LCM 40-2121, TYPE I OR II (FOR LARGE ASS'Y)	10 HOURS APPLICATION TIME AND 20 HOURS ASSEMBLY TIME 24 HOURS APPLICATION TIME AND 80 HOURS ASSEMBLY TIME	14 DAYS 6 DAYS @ 77°F PLUS 24 HRS. @ 120°F OR 3 DAYS @ 77°F PLUS 48 HRS. @ 120°F	PRODUCTS RESEARCH CO. PR1431G, TYPE I PR1431G, TYPE II	NONE
SEALING COMPOUND (LOW ADHESION) APPLIED TO CONTACT SURFACES OF SYSTEM COMPONENTS WHICH ARE NOT PERMANENTLY INSTALLED.	LAC C-40-769 TYPE I	1 TO 3 HOURS	24 HOURS	PRODUCTS RESEARCH CO. PR-1301HT-K(PR-1301, CLASS B) COAST PROSEAL & MFG. CO. PROSEAL 712	MIL-S-8784 CLASS B
SEALING COMPOUND (BRUSHABLE, LOW ADHESION). USED FOR PURPOSES GIVEN ABOVE.	LAC C-40-769 TYPE II	1 TO 3 HOURS	24 HOURS	PRODUCTS RESEARCH CO. PR1301BT-K(PR-1301, CLASS A)	MIL-S-8784 CLASS A
FIELD REPAIR KIT, FOR EXTERNAL SEALING OF FUEL LEAKS IN FASTENERS		30 MINUTES		SEMCO DIVISION OF PRODUCTS RESEARCH CO. FIELD REPAIR KIT 400 A-1 FSN 5180-450-6925	
OYLTITE-STIK, FOR TEMPORARY QUICK REPAIR OF MINOR LEAKS ON EXTERIOR SURFACES				LAKE CHEMICAL CO. FSN 8030-953-5841	

*KITS OF SEALANT RECEIVED FROM STOCK MAY HAVE CHANGE LETTERS SUCH AS "A", "B", "C", ETC., AFTER THE BASIC SPEC. NO. MERELY TO REFLECT THE LATEST REVISION TO THE SPECIFICATION BUT DO NOT SIGNIFY A DIFFERENCE IN THE COMPOUND FROM A SERVICE STANDPOINT.

**THE LETTER "R" AFTER THE NUMBER INDICATES THAT THE SEALANT HAS BEEN DYED RED FOR EASIER IDENTIFICATION OF REPAIRED AREAS.

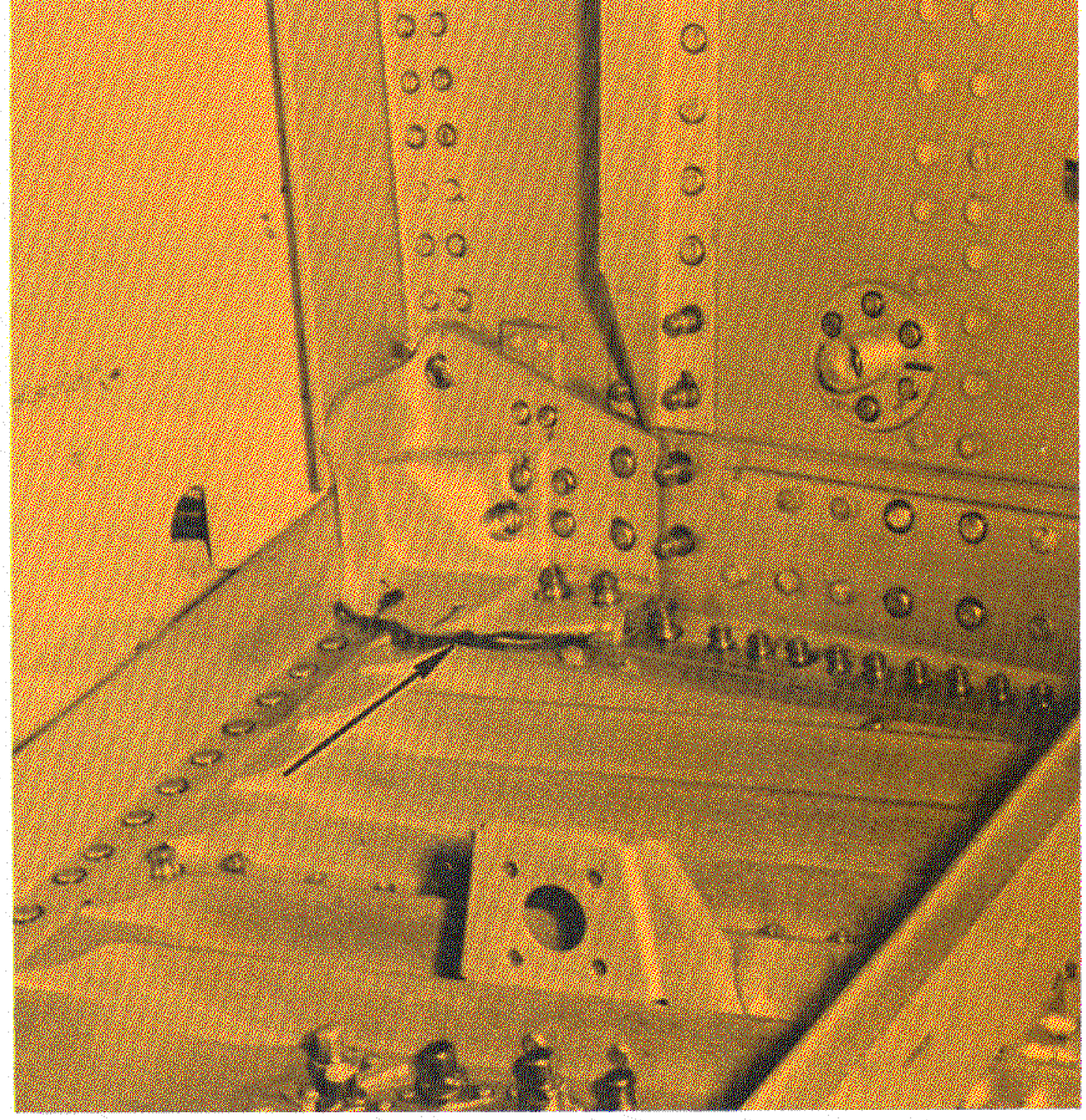


Figure 5. Corner Sealing

For service repairs, the sealant suppliers provide the correct proportions of base compound and catalyst in kit form. It is suggested that the 1/2-pint kit be kept in stock as this amount usually suffices for repairing the average leak. Good results are dependent on adherence to the following basic mixing rules:

"Do's and Don'ts" When Mixing Sealants

- **DO** follow all kit instructions implicitly.
- **DO** mix all the catalyst and the base compound in the kit, regardless of how little sealant will be required.
- **DO** scrape all the base compound from the lid and from under the rim of the can into the mixture. This is a comparatively simple task if the rim is cut away with a household type can-opener as shown in Figures 6 and 7.
- **DO** scrape all the catalyst into the base compound can. *Unless all the catalyst is added, the sealant will not cure properly and will not have adequate fuel resistance.* If more than the recommended catalyst is added, the sealant will cure, but its flexibility and elongation properties will be seriously impaired.
- **DO** stir the mixture slowly by hand, using a flat mixing paddle, for 3 to 6 minutes. Stirring the mixture rapidly will cause it to heat and will introduce air bubbles which may burst later and result in pinhole leaks.
- **DO** stir the mixture thoroughly until the catalyst and base compound are completely blended and free from a marbled appearance. All the mixture must be completely uniform in color.
- **DON'T** try to economize by mixing part of the catalyst and part of the base compound that comes with the kit. This will only result in an ineffective repair.
- **DON'T** intermix similar sealing materials supplied by different manufacturers.
- **DON'T** intermix different types of sealing materials supplied by the same manufacturer.

Application Life The period during which the mixture of the catalyst and base compound retains a consistency suitable to its particular use (for example, brushing, filleting, or injection sealing) is called *application life.* Brush material is usable until brush marks no longer flow out when it is applied to rivets and bolts. Fillet and injection materials are usable until the sealant becomes rubbery and sticks to the application gun rather than to the surface of the tank.

The application life of a sealant varies with the relative humidity, the ambient temperature, and the temperature of the mixture. Assuming that the mixture is being used at an ambient temperature above 77°F (25°C) and 50% relative humidity, the application life of the sealant is shorter than that listed in Table 1; below 77°F (25°C) and 50% relative humidity, the application life is longer. The relative humidity has a distinct effect on the application life of the mixed sealant, but only within the range of 70° to 120°F (21° to 49°C). For each 15% increase in relative humidity over 50% at any temperature between 70° and 120°F, the application life of the mixed sealant is reduced by approximately one-half. Conversely, for each decrease of 15% relative humidity under 50%, the application life is nearly doubled. The relationship of temperature, relative humidity, and application life is easier to understand if one bears in mind that the sealant cures by chemical action; it does not harden through evaporation.

Cure Time The length of time required for the sealant to set up after application is the *cure time.* This depends on the initial application life, the ambient temperature, temperature of the material, temperature of aircraft structure, and the relative humidity. The cure time is roughly about 10 times the application life, provided the air temperature and relative humidity do not vary. (See Table 1.) If, during the cure time, the air temperature is increased 12°F (6°C) over the 77°F (25°C), the sealant will cure in approximately one-half the time listed in Table 1. Raising the temperature an additional 12°F to 101°F (38°C) will cure the sealant in about one-fourth the time listed in Table 1. *Below 65°F (18°C), the sealant will not cure, but will merely become tacky and remain in that state until exposed to higher temperatures.* After exposure to suitable temperatures, the sealant will cure properly.

When a low ambient temperature delays or prevents curing or when accelerated curing is desirable, circulate filtered hot air through the tank until the sealant has cured.

Storage Limitations for Kits Most manufacturers specify a maximum of 6 months shelf-life for an unopened container when it is stored at a temperature

Figure 6. Remove Rim of Base Compound Container for Easy Access to Contents

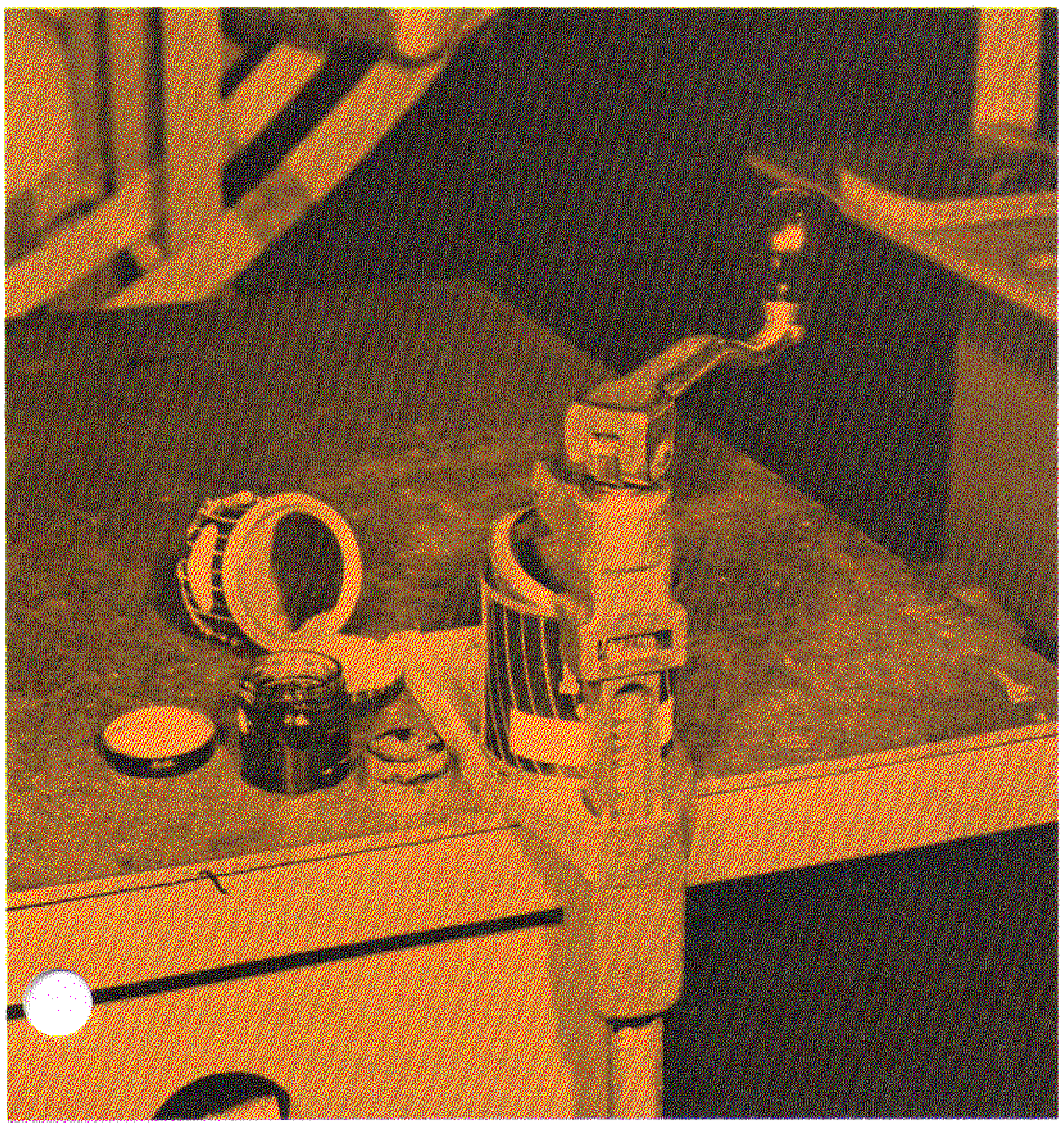


Figure 7. Scrape All the Catalyst into the Base Compound Can and Stir Mixture Slowly by Hand

below 80°F (27°C). However, this time can be extended considerably if the kit is stored in an area maintained below 60°F (preferably at or near 40°F).

Naturally, the best practice is to use materials still current under the manufacturer's shelf-life specifications. Should an emergency arise in which an aircraft is considered unsafe for flight due to fuel leaks and currently dated kits are not available, check one of the outdated kits with this procedure:

1. Open the catalyst portion of the kit and check the contents for evidence of lumps or general hardening.

2. If the catalyst appears to be uniformly fluid, mix the sealant as directed and make a 2-inch wide by 1/8-inch thick test application to a properly cleaned aluminum surface.

3. Cure the sealant as outlined in Table 1 and check that the sealant attains a hard rubber-like surface. If the catalyst has lost its chemical properties the sealant will remain soft and tacky. Cut a 1-inch wide strip from the center of the test specimen and check for adhesion by pulling the sealant away from the metal. Continue to pull until the sealant pulls apart. Sealant with good adhesion qualities will pull apart before it pulls away from the metal strip.

4. If the results of Step 3 are normal, the remainder of the kits with the same batch number (stamped on the container) can reasonably be expected to serve their intended purpose.

FUEL TANK SEALING AT THE FACTORY Chemical cleaning and degreasing of all interior fuel tank surfaces is a very important key to the successful application of sealing compounds. Production specifications require the removal of all grease, oil, adhesive residue, tape, organic finishes, pencil marks, and fingerprints before any sealing materials are applied.

Any foreign matter is first removed with brush, spray gun, or clean rags using LAC 32-337 cleaner, 1-1-1 Trichlorethane, or Methyl Ethyl Ketone (MEK), TT-M-261, and then the area is flushed with LAC 32-367 petroleum base cleaner to remove all traces of grease or oil. To avoid redeposit of oil or grease, the tank surface is wiped dry with clean, soap-free rags and hot-air dried at 120°F to 140°F for a period of 6 hours before sealing operations start.

Faying surface sealant is utilized on all mating surfaces of the wing primary structure that forms the integral fuel tanks. These include all added doublers, angle clips, pump brackets, electrical and plumbing fittings, and other accessory equipment permanently mounted through the primary skin, rib, or web structure.

Any one of the following sealing compounds, LCM 40-2121 Type I or Type II, LCM 40-2180 Type I, or LCM 40-1218 Type I is used as a faying surface sealant. The compound is first applied to one mating surface and the desired thickness is obtained by smoothing the sealant with the comb shown in Figure 8. Then the parts are mated and fasteners installed.

The type of sealant used depends upon the total time that will be required to install all of the necessary fasteners. As stated previously, curing time is directly related to ambient temperature and relative humidity and is considered when selecting the faying surface sealant from the list given in Table 1. The time specified is for ambient conditions of 75°F at 50% relative humidity, and is the *maximum* time that is allowed to elapse between the mixing operation and the completion of the assembly work.

All Hi-Lok fasteners are installed with sealant applied under their countersunk heads and to their thread areas prior to installing the fastener collars. A sufficient quantity of sealant is applied to the faying surface and around the fasteners to ensure a full seal as evidenced by squeeze-out of the excess sealant. Where LCM 40-2121 sealants are used, the squeeze-out excess is removed prior to subsequent fillet or brush sealant application. Air interferes with the chemical curing action of this sealant, making it necessary to remove the excess squeeze-out so that it will not interfere with the curing of the fillet and/or brush sealants applied later. Excess sealant is removed with a scraper (Figure 9) fabricated from approved materials and then cleaned with LAC 32-337 cleaner as shown in Figure 10. The following sealing methods are employed.

1. **Fillet Sealing.** LCM 40-2180, Type I or LCM 40-1218, Type I sealant is applied to the edges of all seams, flanges, angles, gussets,

doublers, and fittings with a fillet gun equipped with a 1/8-inch interchangeable nozzle opening. To ensure application of an even fillet along these places, the gun is held at a 45-degree angle and moved evenly along the seam in the direction in which the nozzle is pointing as depicted in Figure 11. Immediately after each charge of the fillet gun is applied, the mechanic uses a small aluminum spatula to force the sealant into the seams and joints, work out the air bubbles, and taper the fillet edges.

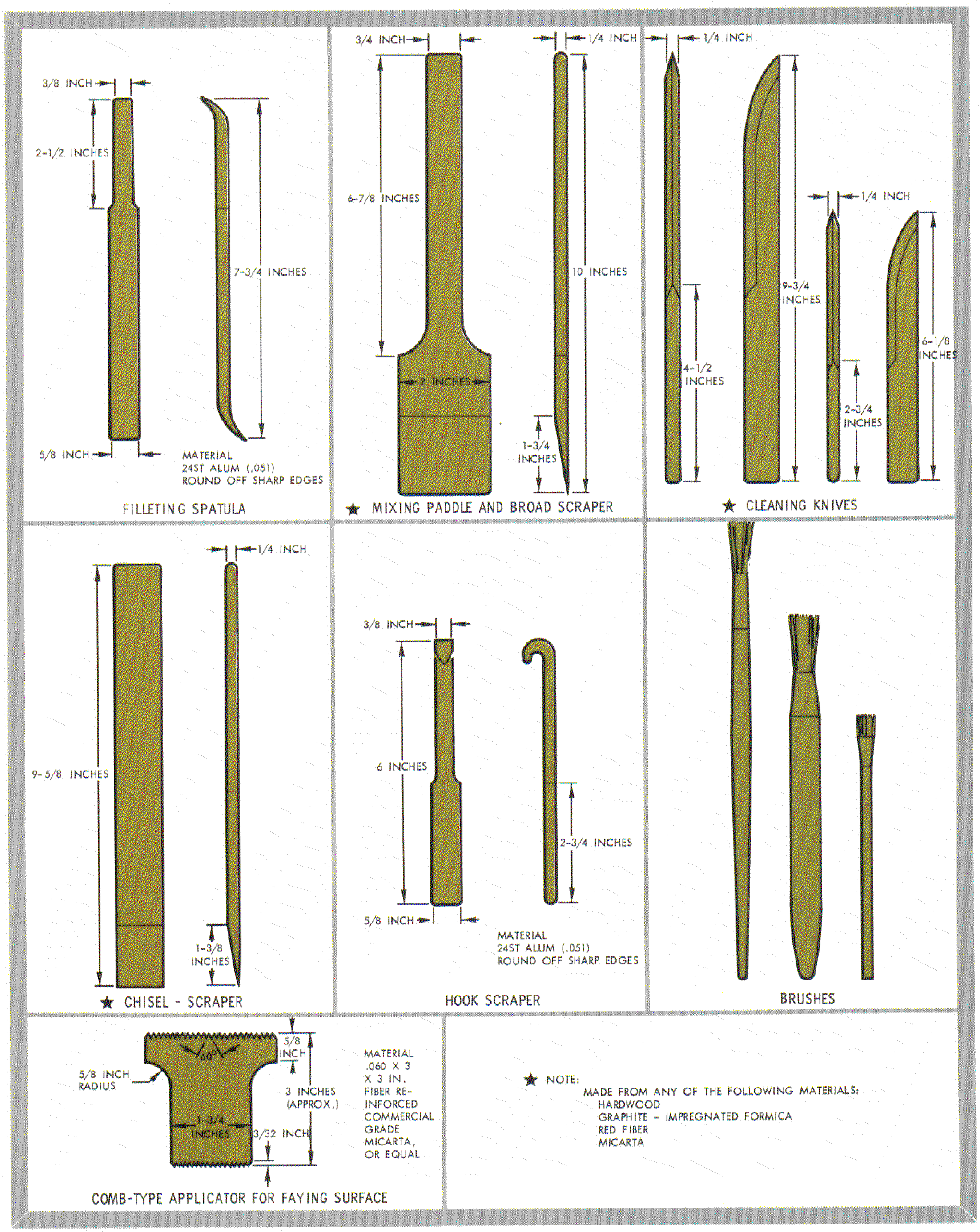


Figure 8. Hand Tools for Sealant Removal and Application

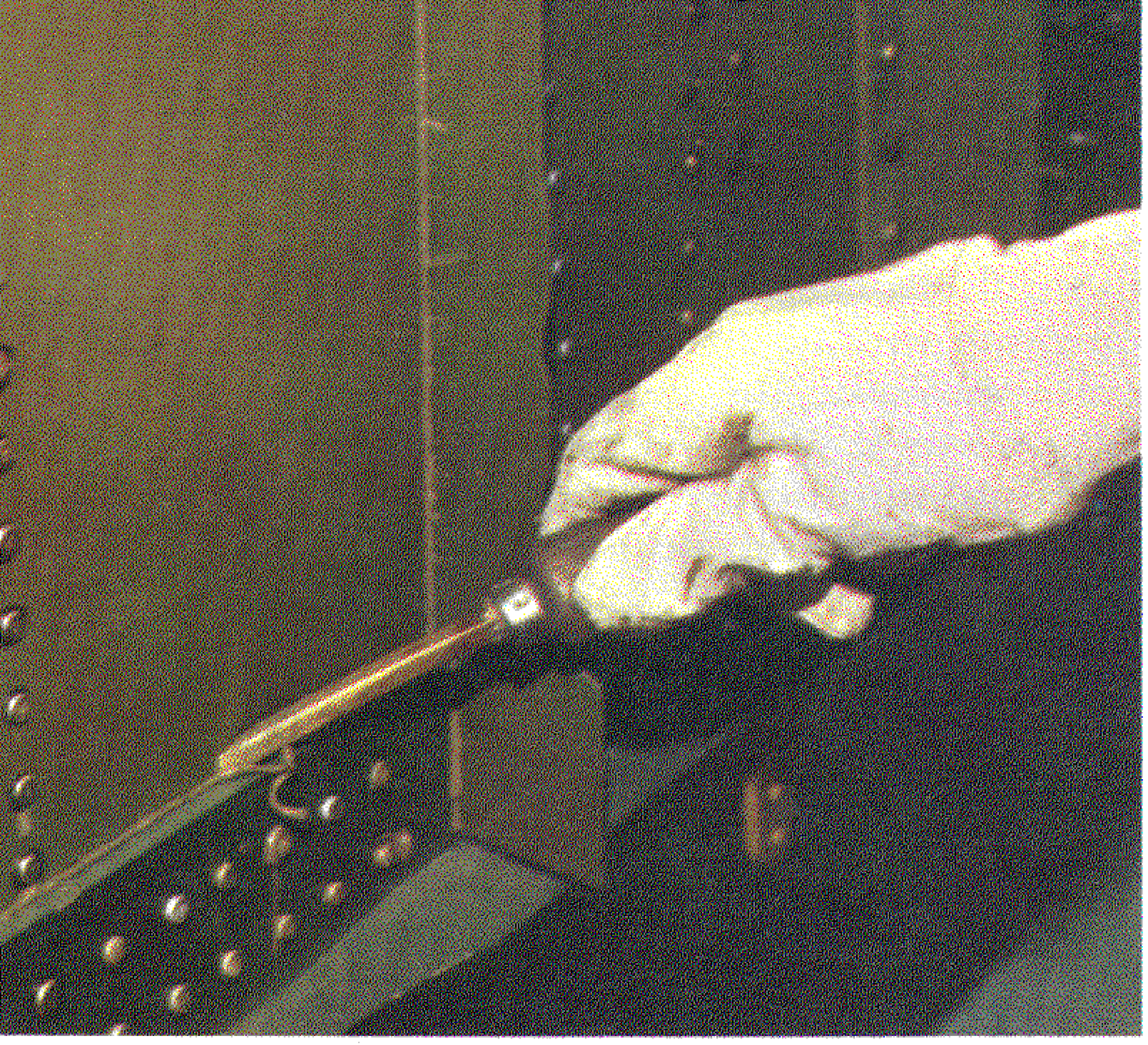
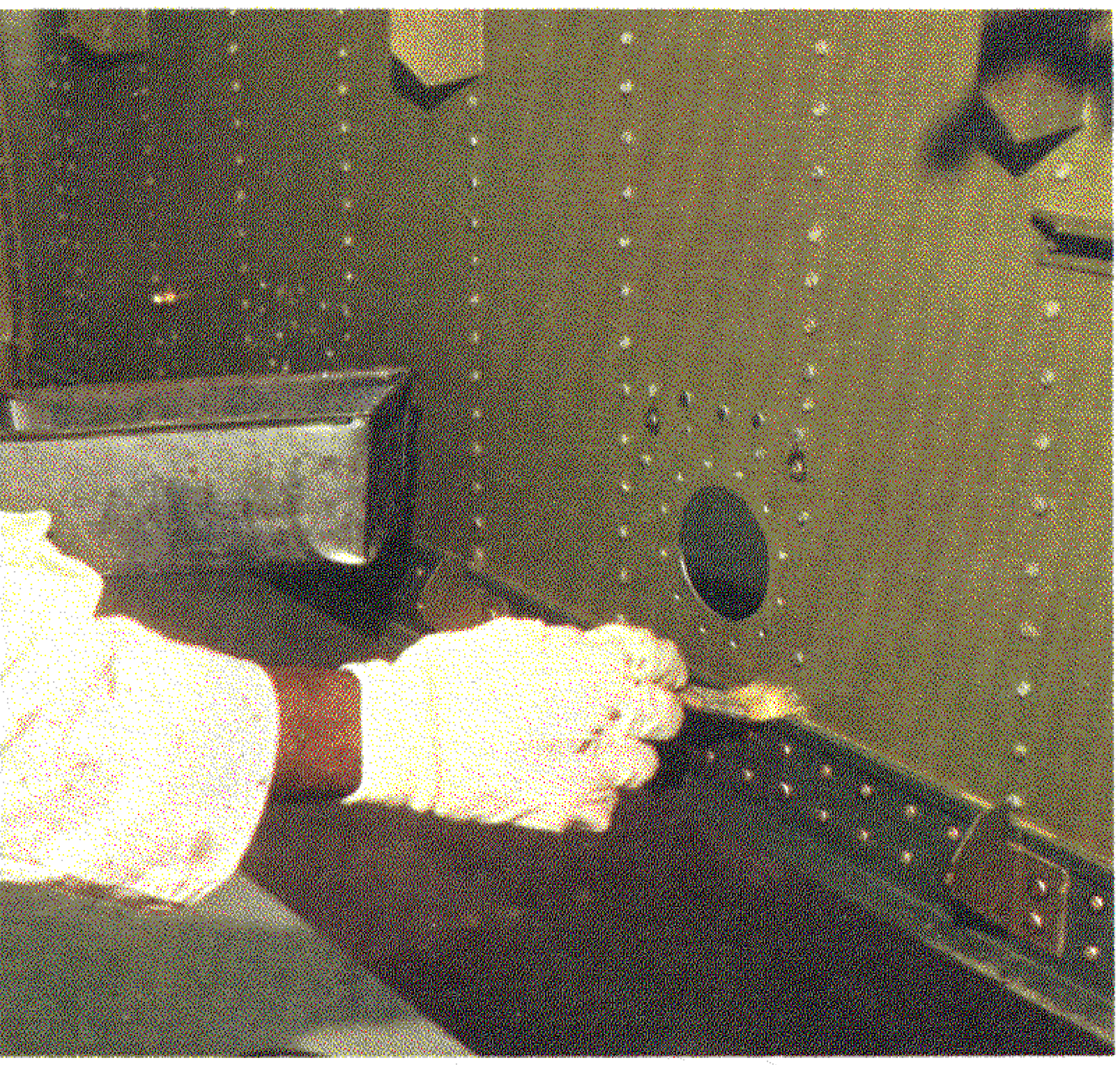


Figure 9. Excessive Sealant is Removed with a Scraper

Figure 10. Clean Fillet Area with LAC 32-337 Cleaner



2. **Brush Sealing.** When the fillet sealant has cured to a non-tacky condition, a brush coat of LCM 40-2180, Type II sealant is applied over the fillets, seams, rivets, nuts, and bolts (Figure 12), and it too is allowed to become tack-free. Then a second coat is applied and cured as noted in Table 1.

3. **Injection Sealing.** Injection sealing forces the air from all structural cavities at jobbles, spacers, and fittings and replaces it with sealant. Sealant is injected with a high pressure injection gun until it emerges from all openings interconnected to the cavity.

4. **Corner Sealing.** All corner seals at bulkhead intersections are packed with faying surface sealant at the time the corner plates are installed.

Soak Checks The tanks are soak checked with Stoddard Solvent for 4 hours and after a no-leakage test is passed, the plumbing lines are installed. All mechanical seals and gaskets used with plumbing lines and other system components are checked by pressure-testing the tanks with air at 3 psi.

After the wings are attached to the airplane and final sealing completed, a 6-hour fuel-soak check is made. When this check has been successfully completed, the aircraft proceeds into the ground checkout portion of flight test where engine power runs provide an effective shake test of the sealed tanks. The tanks are again checked for leakage following production flight test. Finally, after the acceptance flight and just prior to delivery, the tanks are given a 4-hour soak check on the ground.

FUEL TANK LEAKS

CAUSES OF LEAKS Failures of both the original and the repaired sealant are generally due to one of the following causes:

1. **Blisters.** These may be caused by air bubbles or cleaning solvents entrapped in the sealant. Expansion of the air in the blister at altitude, plus the flexing of the wing structure or an extreme increase in temperature, can rupture the blister and thus open a channel through the sealant.

2. **Ruptures.** Continual excessive flexing of the wing structure during flight, rough landings, or during rapid taxiing over rough terrain with a heavy fuel load can cause ruptures in sealant.

SAFETY PRECAUTIONS

Improper use of materials and equipment in the fuel tanks could result in injury to personnel and damage to the aircraft. Therefore, Lockheed recommends conscientious observation of the following safety rules while investigating leaks and making repairs:

1. Be certain that the airplane is electrically grounded and that the fuel pumping gig is bonded to the aircraft.
2. Use only air motors that have been bonded to the aircraft for all drilling operations. If a vacuum cleaner is used to clean tank interiors, it must be bonded to the aircraft and be of an air-driven type. Wear wing socks or gym shoes when working inside tanks.
3. Use only explosion-proof electrical equipment in the area.
4. Use only explosion-proof lights and flashlights inside the tank.
5. Have fire extinguishing equipment readily available.
6. Before entering a tank, circulate fresh, filtered air through the tank for at least 30 minutes. A venturi-type air remover at the filler well and filtered air forced through the access panel in the wing lower surface will serve the purpose. The purging will be more effective if the residual fuel in the low spots in the tank is mopped up or removed with an air-driven vacuum cleaner (FSN 7910-632-9840 or equivalent) after the preliminary purging. *Supply fresh filtered air continuously while personnel are working in the tank.* Air from a compressor should not be used unless it has passed through a filter that will remove all impurities, particularly water and oil.
7. Station a man outside the fuel tank to be responsible for the safety of the man working inside. *Under no circumstances should a man be allowed to enter or remain inside a tank, even for a few minutes, without being in constant visual or aural contact with his "observer."*
8. Always wear an air-supplied respirator in regions where concentration of fumes is greater than 500 parts per million.
9. Use clean, lint-free cotton rags and wear proper explosion-proof clothing free of exposed steel buttons or belt buckles when working inside the tanks.
10. Remove all loose items from pockets — especially the breast pocket — before entering the tank.

Figure 11. Application of Filleting Compound With Gun

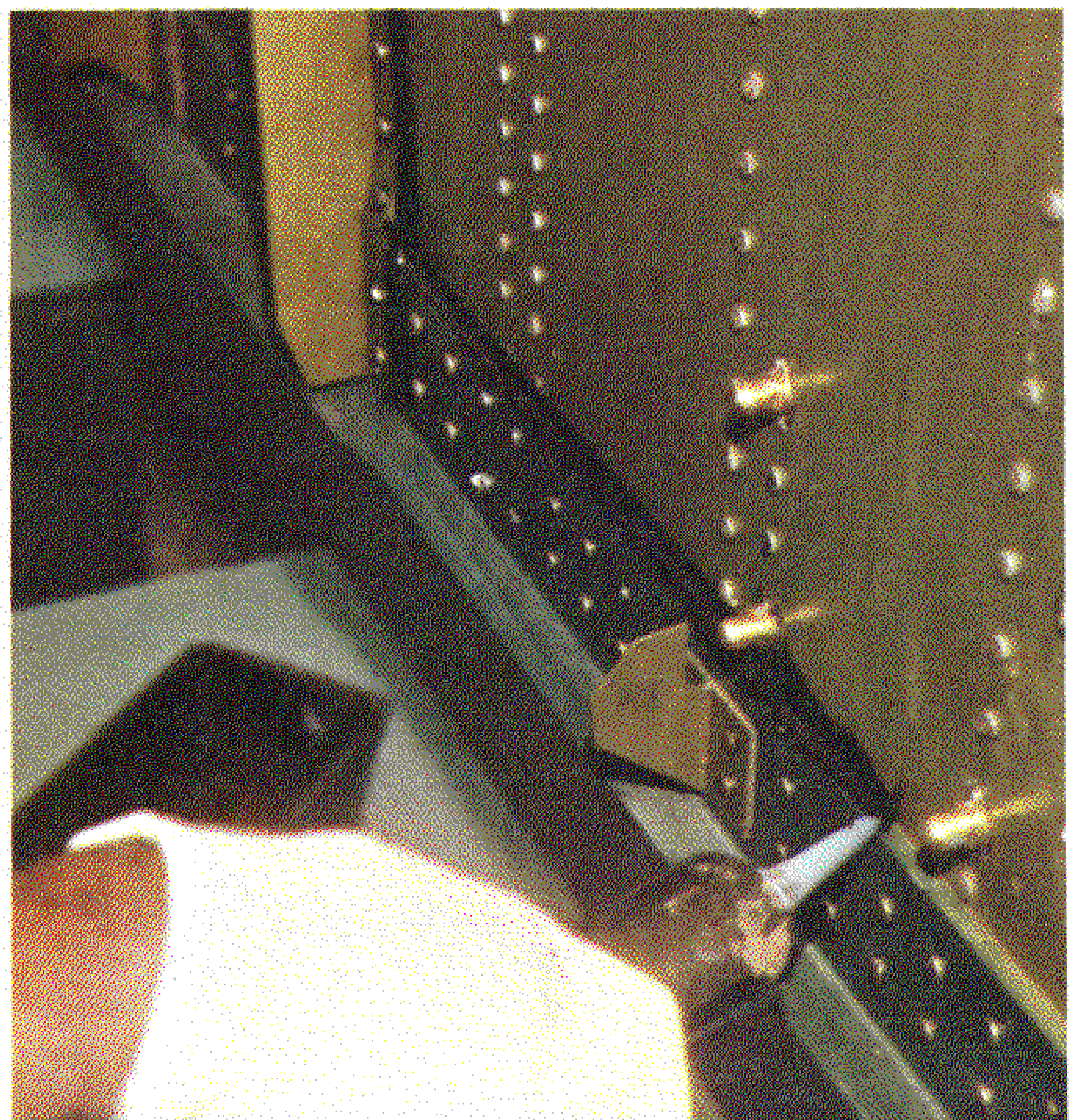
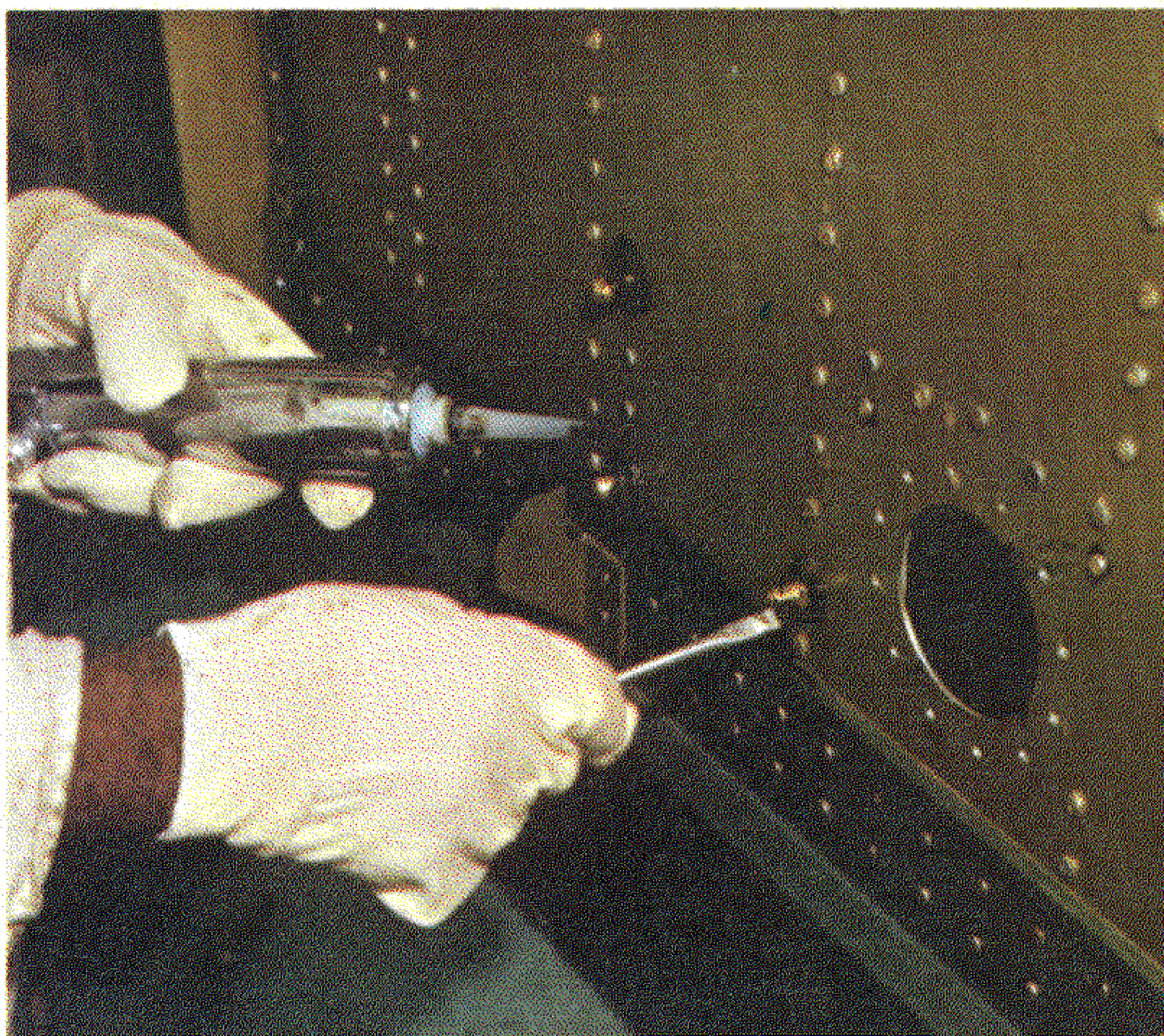


Figure 12. Apply Brush Coat of LCM 40-2180 Type II Sealing Compound Over Fillets, Seams, Rivets, Nuts, and Bolts



3. **Voids or Omissions.** Leaks will result if sealant is omitted from difficult access areas or if it is not thoroughly worked into all voids along seams and joints.

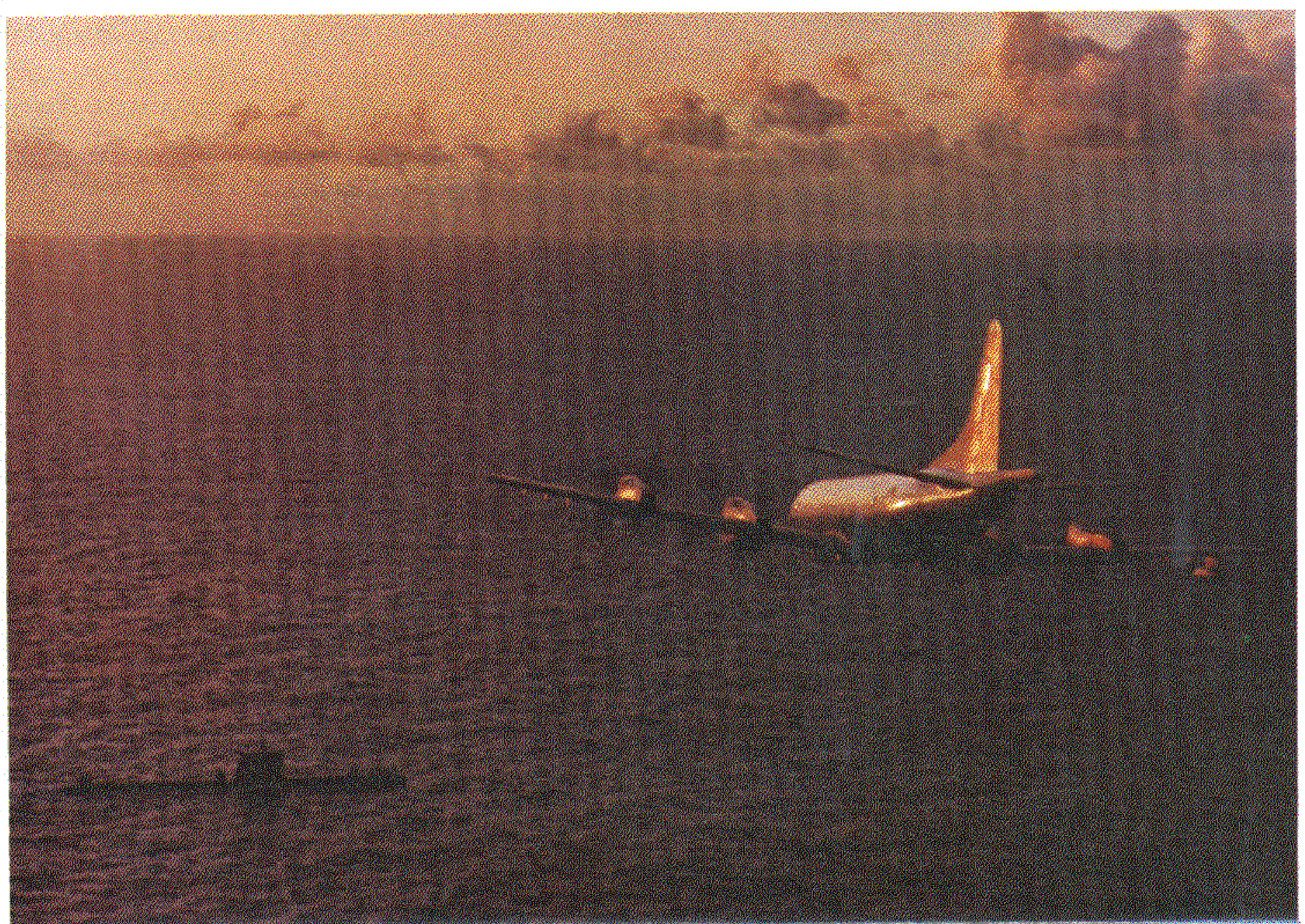
4. **Poor Adhesion.** Sealant will not adhere to structure if it is applied over dirt, grease, soap film, oil film, or entrapped moisture.

5. **Pinholes.** Brush sealant, if not thoroughly worked around each rivet or fastener, may break as the sealant cures and the break may not be detected. In service, fuel will extract unmixed accelerator material from the sealant if the accelerator and base compound are not completely blended. Also, rapid mixing of accelerator and base compound can introduce small air bubbles into the sealant. The bubbles may rupture and cause pinhole leaks.

6. **Deterioration.** Improper proportions of base compound and accelerator can affect the quality of the sealant. Too much accelerator for the amount of base compound used results in loss of sealant flexibility at low temperatures. If too little accelerator is used, the sealant will not have the required resistance to fuel. The sealant will deteriorate and will appear chalky and powdery or will crack when flexed, even at room temperature.

7. **Dry Fuel Tanks.** When fuel tanks remain dry for extended periods, the sealant and the mechanical gaskets and seals will dry out and fuel leaks may result. For this reason, if an aircraft is to be out of service for 10 days or more, each tank should contain at least 50 gallons of fuel. The fuel vapor will help to preserve the sealant that is not actually in contact with fuel. Inactive fuel systems must be handled in compliance with NAVAIR 15-01-500, Section IV.

8. **Dome Nuts.** Sealant failures that occur in the area of dome nuts are usually due to the installation of the wrong type screw, use of excessive pressure on screw installation tools before screw head is seated, or use of excessive pressure on screw removal tools after screw head unseats. Long screws puncture the cap or rupture the sealant before the head is seated. Faulty screw threads or incorrect thread type or thread count can cause the nut to rotate and rupture the cap and sealant. Excessive tool pressure can cause the screw to push the nut away from its mounting and break the sealing surface. Also, screws that have been dipped in sealant—in contrast to coating only the underside of the head—may force the cap off the nut by hydraulic action.



9. **Uncured Sealant.** If the sealant has failed to cure properly for any reason (inadequate cure time or temperature, outdated shelf-life, improper storage, etc.), it will deteriorate when in contact with fuel.

RECORDING LEAKS Determination of the specific location of each leak is necessary for the record of the individual aircraft and is also useful to Lockheed Engineering as information on sealant and system performance. The following data should be recorded:

1. Location of All Leaks
   a. Wing (left, right, or center), and tank (inboard or outboard).
   b. Wing Surface (upper, lower, front beam, aft beam).
   c. Inboard/Outboard Location (W. S. if appropriate).
   d. Fore/Aft or Up/Down Location (if appropriate).

2. Additional Information Regarding Location of Specific Leak Sources
   a. Access Doors – Function of door (fuel pump access, pilot and float vent valves access, main access, lower access, fuel probe).
   b. MLG Trunnion – Which MLG (left or right), which trunnion (inboard or outboard), which bolts (trunnion fitting or cap), forward or aft bolts.
   c. MLG Uplock – Which uplock (left or right), inboard or outboard side of uplock, lower or upper bolts.
   d. Dome Nuts – Function of nut (fillet, access door or other device fastener; if fillet – which one, fuselage upper, fuselage under-belly or nacelle; if nacelle – which one, which wing surface and whether on inboard or outboard side of nacelle), nut fore and aft location relative to wing forward beam.
   e. Stores Fittings – Which store station; fore and aft location (forward, mid or aft); inboard, middle or outboard hole.

LEAK INSPECTION The type of area where a leak occurs partially determines how soon it must be required. Any leak in a confined area can be a safety hazard.

Confined Areas It is particularly important from a safety standpoint to make a careful inspection for seeps and leaks in confined areas. Fuel leaks originating in such areas should be repaired prior to the next flight. Confined (closed) areas are:

1. Wing front spar and leading edge
2. Nacelles above the wing
3. All fillet-enclosed areas (nacelle, fuselage, and lower fuselage-to-wing fillet)
4. All Tank 5 (center wing) surfaces except the lower surface not covered by the lower fuselage-to-wing fillets.

Open Areas Stains and seeps in the following designated open areas do not require repair prior to the next flight. Open areas are:

1. Wing rear spar and trailing edges outboard of the fuselage
2. Nacelles below the wing
3. Main Landing Gear (MLG) wheel well (including landing gear fittings)
4. Wing upper surfaces outboard of the fuselage that are not covered by a fillet or a nacelle
5. Wing lower surfaces outboard of the fuselage that are not covered by a fillet.
6. Tank 5 lower surface not covered by the lower fuselage-to-wing fillets

The MLG wheel wells and the nacelles below the wing, even though somewhat enclosed, have sufficient exchange of air so that fumes from stains or seeps will not accumulate sufficiently to present a flight safety hazard.

TYPES OF LEAKS A fuel leak is classified according to the quantity of fuel escaping. Fuel leak classes are:

1. **Stain.** A stain is the slowest leak. It is characterized by a discoloration around fasteners or seams and is caused by a very slow fuel seepage which dries as it meets the air. A stain should be wiped off; if it does not reappear within one hour, its location should be recorded and periodically inspected (unless it occurs in a confined area as described above, in which case it should be repaired prior to the next flight). If a stain occurs in an open area, repair is not required until the aircraft is removed from service for other maintenance that requires tank entry.
2. **Seep.** A seep is a heavy stain which, when wiped off, reappears within one hour. This type of leak should be recorded and inspected frequently for increased activity. If it occurs in an open area, repair is generally not required until the aircraft is temporarily removed from service for other maintenance that requires tank entry. If it occurs in a confined area it should be repaired prior to the next flight.
3. **Heavy Seep.** A heavy seep recurs immediately after being wiped off. If it occurs in an open area, it should be repaired at the earliest convenience without disrupting operational commitments; if it occurs in a confined area it must be repaired prior to the next flight.
4. **Dripping and Running Leaks.** A dripping leak is a continuous flow of fuel which wets a limited area and then drips off the air craft. A running leak is a continuous running of fuel caused by a definite break in the sealant. The source is usually easy to locate. These leaks should be repaired immediately and must be repaired prior to the next flight.

LEAK SOURCE ANALYSIS

Armed with a basic knowledge of P-3 wing construction and the properties of tank sealants, the technician can analyze the leak, then methodically approach the problem of locating the fuel exit point and trace the leak to its true source (or sources). Thorough and careful planning cannot be over-emphasized, because repairing leaks singly is time-consuming and costly. Consequently, tanks should also be inspected for additional leaks so that repairs can be made with only one entry into the tank. Furthermore, the true sources of all leaks should be located *before* repairs are begun. Careful application of the subsequent leak detection procedures can assist the technician in finding the true sources of fuel leaks, effect the best possible repair, and provide a lasting, leak-free tank.

LEAK DETECTION METHODS Either the Talcum Powder or the Paper Test detection method may be employed to determine the exact leak exterior exit point.

1. **Talcum Powder Method.** After a visible fuel leak has been detected and before the tanks are defueled, accomplish the following procedures to localize the leak on the tank exterior:

   a. Mark the area of leakage and classify according to type of leak.

   b. Study wing structure and sealing illustrations to determine possible leak paths.

   c. Strip fillet seals from suspected leak paths. Since paths may be interconnected, finding one path wet does not necessarily eliminate the others.

CAUTION

Red talcum powder is for external use only and should not be mixed with fuel as a dye.

   d. Provide a container of red talcum powder and a thick-bristled camel hair brush for dusting the powder on suspected leak sources. Have plenty of clean cotton cloths available.

   e. Wipe off leak area thoroughly using three or four changes of absorbent cotton cloths. Blow out all seams and corners with compressed air. Use air hose with a 100 psi maximum pressure and keep the nozzle at least 1/2 inch away from sealant or structure to prevent damage to the

sealant. The air should be completely dry.

f. Dust area with talcum powder immediately.

g. The first trace of fuel will cause the talcum to turn bright red. This change of color will spread rapidly.

h. Keep dusted area under constant observation in order to pinpoint the exact point of exit. Note the first sign of change in color of the talcum.

i. Continue to observe the area for an adequate period of time to determine the sequence in which different areas become wetted.

j. When the point of exit has been determined, mark it and wipe up the talcum, being careful not to remove the mark.

2. **Paper Test Method.** In a procedure similar to the talcum powder method, torn paper may be used to detect leaking fuel. As in the talcum powder method, strip any environmental seals from the suspected leak paths. Blow and evaporate fuel from the seams and crevices of the leak area with an air gun. Slowly move the fuzzy edge of torn paper along the suspected leak area. The paper will readily absorb fluid and give a good visual indication of the presence of any fuel. Mark the external leak point.

DETERMINING WHICH TANK IS LEAKING No attempt should be made to repair the leak until it has been determined which tank is leaking. Fuel leaks which appear near the common boundary of two adjacent tanks may originate in either tank. The following procedure may be used to determine which tank is leaking.

1. Defuel the outboard tank.

2. After allowing a short time for residual fuel to drain, check for leak stoppage. If the leak has stopped, the outboard tank is leaking.

3. If the leak continues, defuel the inboard tank and fuel the outboard tank. If the leak stops, the inboard tank is leaking. If the leak continues, either both tanks are leaking or residual fuel is giving the indication.
4. If residual fuel is suspected of giving the indication, defuel the outboard tank. (Both tanks are now defueled.) After all residual fuel is drained from both tanks, the leak will stop.
5. Fuel the inboard tank first. If no leak indication appears, the outboard tank is leaking.
6. If a leak indication is obtained, defuel the inboard tank, wait for leak to stop, then fuel the outboard tank. If leak indication is obtained, both tanks are leaking.
7. Defuel and purge the leaking tank for entry.
8. Analyze possible leak paths from the leak exterior exit point, through the seal plane, to the tank interior. (Refer to the following paragraphs on Leak Path Analysis for detailed instructions.)
9. Thoroughly inspect the area of the tank where the leak path analysis indicates the internal leak point is located.
10. Depending on the complexity of tank structure in the area of the leak, use one or more of the methods given in the section on Leak Tests to locate the leak source inside the tank. The methods are listed in the order in which they should be performed.

LEAK PATH ANALYSIS Leak path analysis is one of the most important steps performed in fuel system repair. Repair without finding the source and exit point of a leak is useless, as this type of repair is only temporary.

The seal plane is the barrier that prevents escape of the fuel from the tank. When this seal plane is penetrated, the faying surfaces of all structure on the other side of the seal plane become wet. The wetted area extends in all directions from the point of penetration until it is stopped by an injection, faying surface, or pre-pack type hidden seal. Fillet seals act as sides of a channel formed in the structure through which the fuel will flow. Since there are no seals on the other side of the seal plane, any fuel that has penetrated the seal plane will leak out at the point of least resistance. For example, a row of fasteners in the channel may be wet, but the leak will appear at only one fastener due to the looseness of the fastener at that point. If the leaking fastener were sealed, then the fastener having the next least resistance will leak, and so on. Leak path analysis will show the fuel path from the point of seal plane penetration to the exit point.

After the leak is localized on the tank exterior, the next step is to study the structure and sealing of the suspected area, utilizing the appropriate data from the aircraft technical manuals. Construct cross-sectional views to locate the seal plane. Study these views and trace all potential leak paths from the external leak point to the tank interior, assuming failure of sealant at various locations. This will define the area of the tank in which the leak source or sources will be found.

The area where the bubble or dye appears when locating the interior leak point should indicate the true point of seal plane penetration, except in the case of failure of a hidden seal. In many cases the failure of an injection, pre-pack or hidden type of seal will allow fuel to enter and travel within the structure and appear at a point distant from the leak source. Repairing the apparent leak area where the bubbles or dye appear, and not the failed hidden seal, may result in a "fix" which will have to be redone frequently until the true point of penetration of the seal plane is located. To prevent this situation, a fuel leak should be thoroughly analyzed for all possible leak paths between external and internal appearance points.

Purging Before tank leak repairs can be performed the fuel tanks must be defueled, then purged. Follow the precautions listed in the section on safety.

Purging is accomplished by ventilating the tank with fresh air, usually with the aid of venturi air movers and blowers. The venturi air mover should be placed over the vent or other suitable opening, attached with tape, anchored with shot bags, and must be grounded to an approved ground on the airplane. The blower must also be grounded to an approved grounding rod. The air mover and the blower should be started prior to placing the open end of the duct into the tank. This allows any

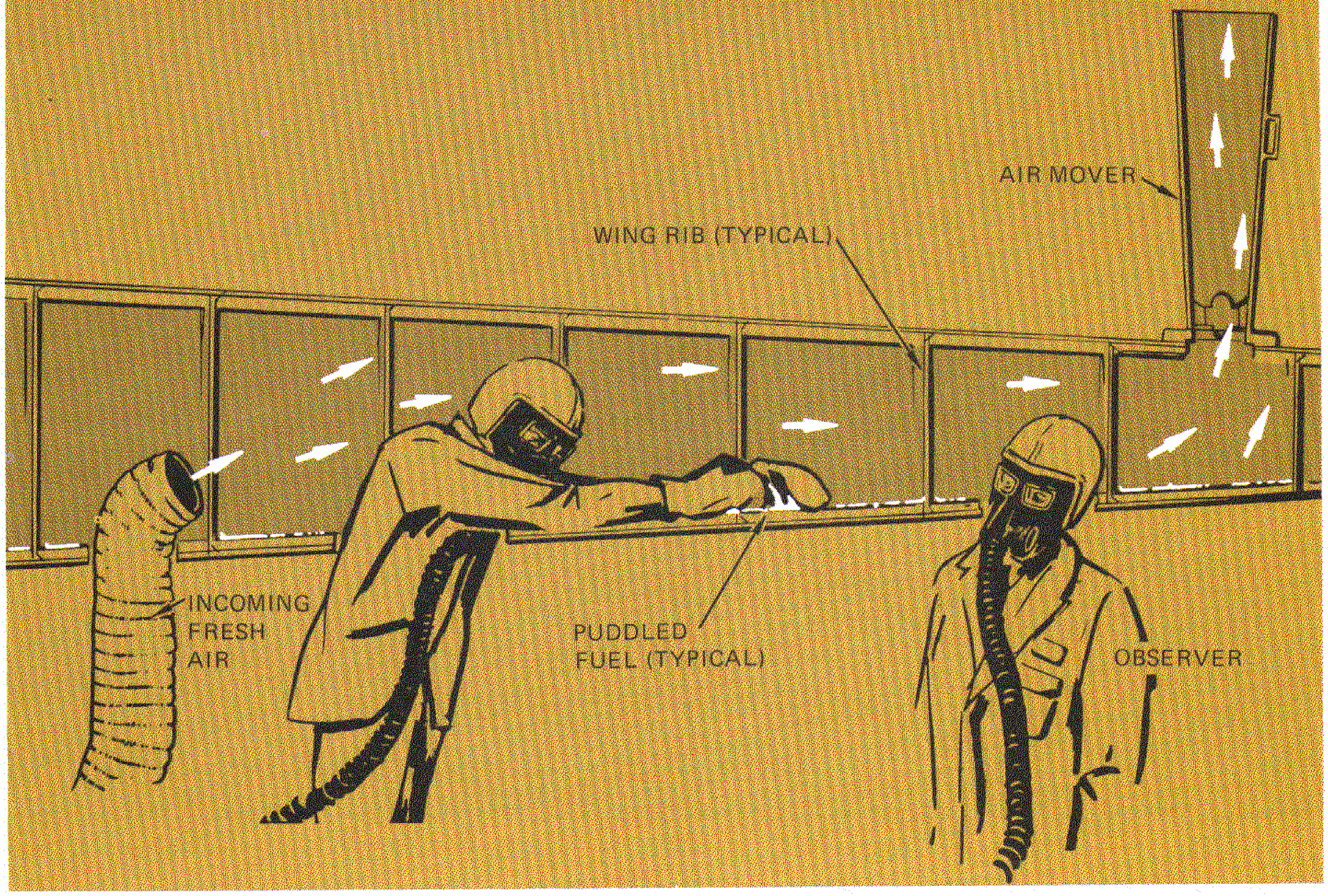


Figure 13. Removing Residual Fuel and Depuddling Wing Fuel Tanks

dust and dirt to be ejected from the blower before it is attached to the tank.

To expedite purging residual fuel, puddles may be removed with absorbent lint-free cloths and an air-driven vacuum cleaner. Depuddling is extremely hazardous since it requires entry or partial entry into the tank to remove the fuel. For maximum safety, personnel must work at least in pairs, regardless of which method is used – complete or partial entry.

After all puddled fuel has been removed from the tank, the tank must be purged to obtain the safety standard of 500 parts per million fuel-air ratio condition. To achieve this the tank must be ventilated for at least 30 minutes. The duct can then be removed from the tank opening, the blower and air mover stopped, and the tank checked with a combustible gas indicator to ensure that the atmosphere inside the tank is at the minimum safety standard. In the event the reading does not meet the safety standard, the blower should be started (before inserting the duct into the tank), tank purging continued for an additional 15 minutes, and a repeat check made with the gas indicator. If practical, additional venturi air movers and air blowers may be used to decrease the purging time.

See Figures 13, 14, and 15 for typical air blower installations, safety equipment, and techniques used for purging.

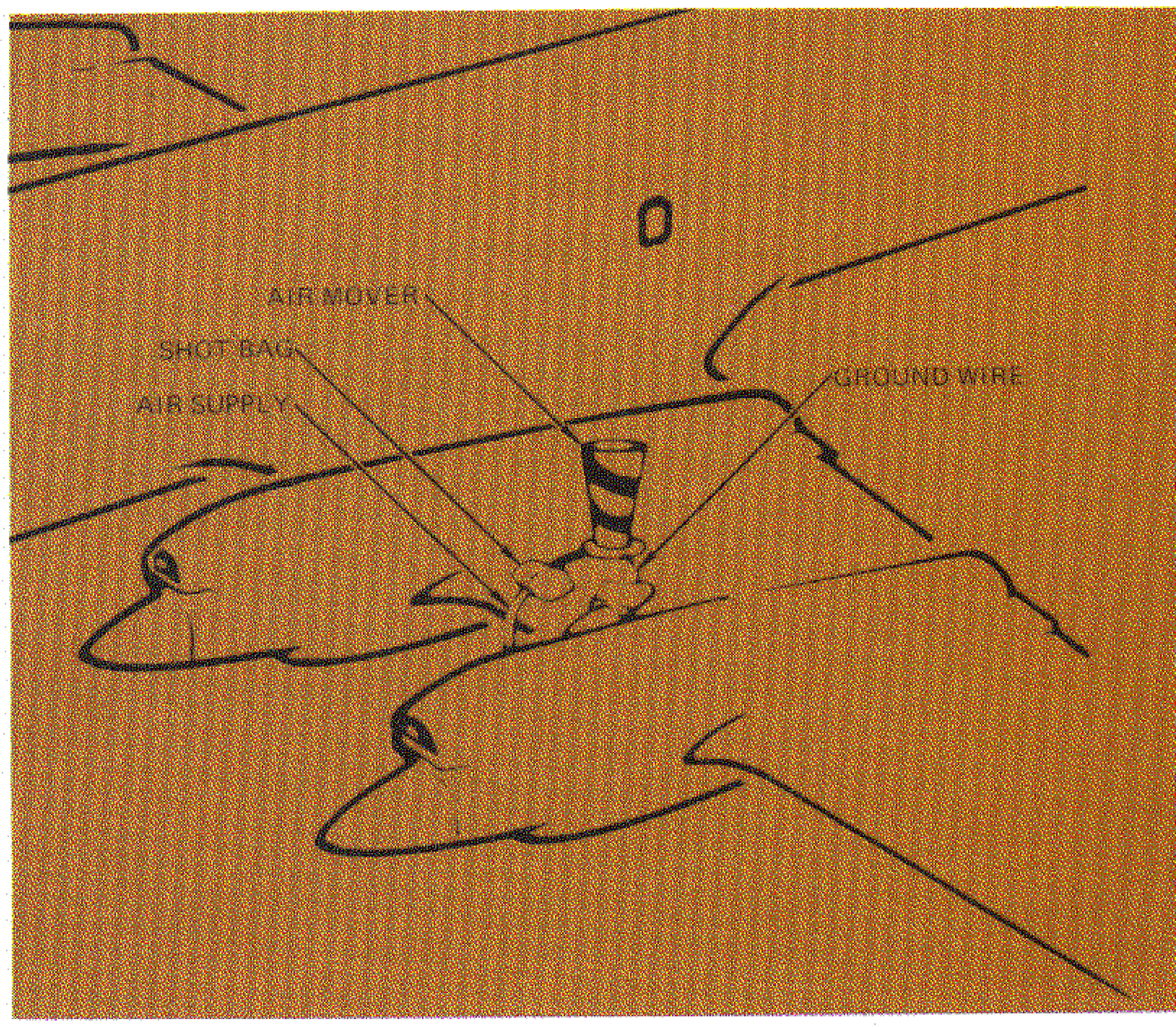


Figure 14. Air Mover Installed on Wing Fuel Tank Opening

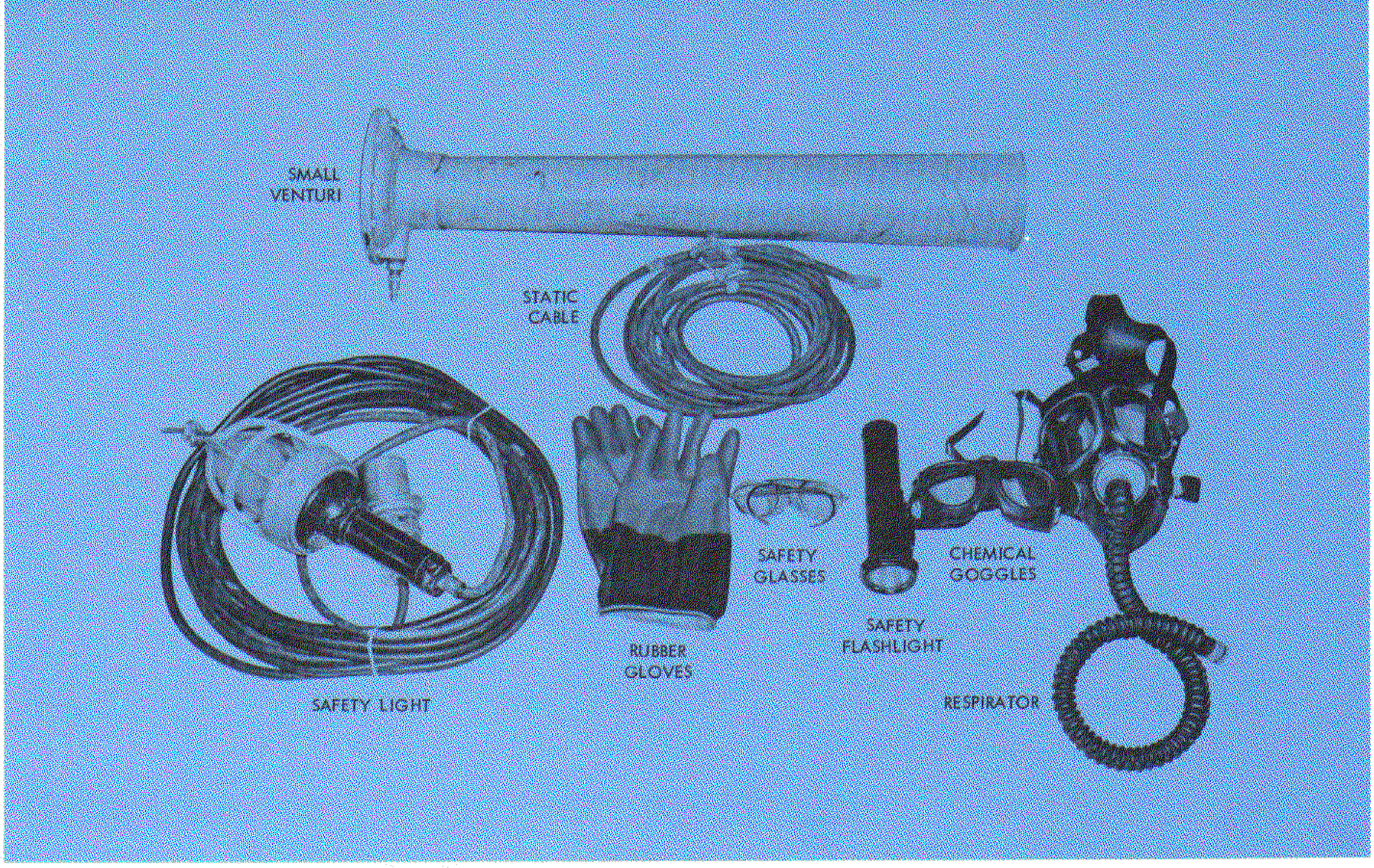


Figure 15. Typical Safety Equipment Used in Connection with Tank Sealing and Repair

Inspection of Tank Interior Entry into the fuel tank requires extreme caution. Proper explosive and toxicity readings must be obtained prior to entry. Observe the Safety Precautions previously presented.

After leak path analysis, thoroughly inspect the interior of the tank in the area suspected to contain the leak source. The following inspections will help to reveal a leak source.

1. Inspect the leak area carefully for defective sealant, loose fasteners, cracks, air bubbles, or loose fillets. Use mirrors to inspect areas which are not otherwise completely visible.
2. Inspect locations where injection seals have been installed to provide continuity of fillet seals.
3. Inspect the topcoat for breaks, tears, scuffs, or nicks in tanks. Fuel will penetrate any break in the topcoat film and cause the base sealant to deteriorate to the point where an edge of the structure is bare, thereby resulting in a leak. A chalky material under the cracked topcoat will indicate leaching of the sealant. All leached sealant should be removed and replaced with properly prepared sealant, MIL-S-8802.
4. Inspect fillet seals for adhesion. Check fillets suspected of poor adhesion by applying compressed air (100 psi maximum) with an air gun placed approximately 1/2 inch from the fillet. (See Figure 16.) This check will loosen a fillet which has poor adhesion. Cut a section through the loose fillet and strip it off by pulling it away from the structure. Continue to strip the fillet until it breaks apart. A fillet with poor adhesion will pull away from the tank structure rather than pull apart. (See Figure 17.)
5. Inspect for cracks, distortion, and corrosion of the tank structure and for loose fasteners.
6. Visible defects in sealant or the structure are not necessarily the true source of a leak. Continue the visual inspection until the entire suspected leak area has been carefully examined. Mark all defective sealant.
7. During inspection of sealant for deterioration, watch closely for the following characteristics:

   a. Excessive shrinkage
   b. Loss of luster or discoloration
   c. Loss of elasticity

NOTE

To test sealant for elasticity, press firmly with a blunt metal punch of not less than 3/16-inch diameter. If sealant gives and returns to its original state, it is good; if sealant breaks and holds its compressed position, it is defective.

d. Crumbling Sealant

e. Loss of cohesive strength

If any of the conditions described in the preceding paragraphs are found in the sealant, remove and replace the sealant.

Leak Tests The following approved tests may be used to find a leak source in an integral fuel tank. Two men are required, one inside and one outside the tank.

1. **Air Hose and External Bubble Test.** If the external leak point has not been isolated, perform the following test.

   a. One man applies the bubble solution to the wing external surface in the area surrounding the leak exit point.

CAUTION

Arrange a system of tapping signals for communication between the two men to indicate when the air pressure is to be applied and shut off, and when repeated testing of an area is desired. Repairmen should wear goggles for eye protection both inside and outside the tank.

   b. The man inside the tank applies air pressure to the wing internal surface in the area corresponding to that in which the leak appeared outside. The air used should be filtered and the hose capable of delivering air at 90 to 100 psi. Place the air hose 1/2 inch from the sealant.

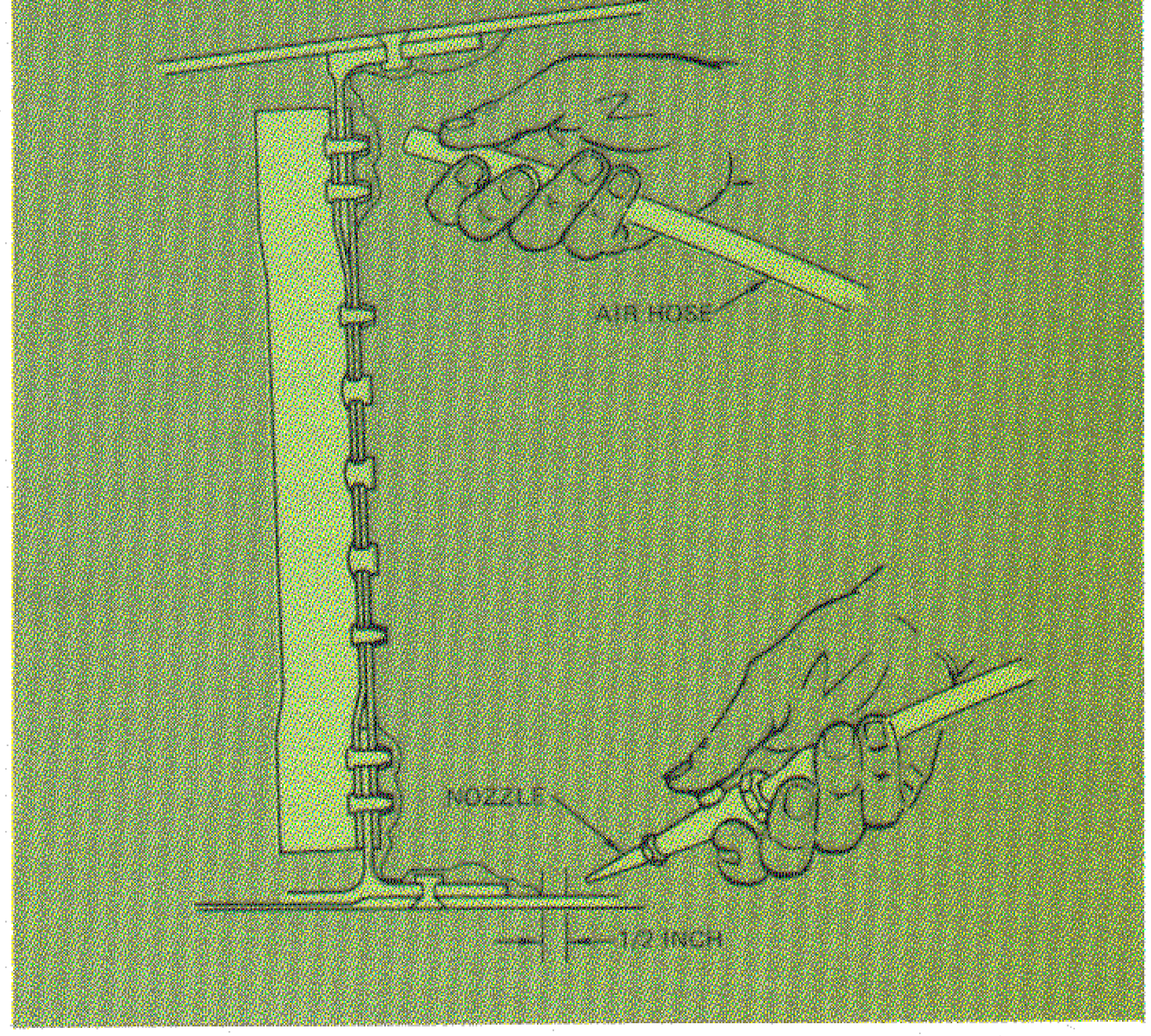


Figure 16. Checking Sealant for Adhesion

Figure 17. Remove All Deteriorated, Blistered, or Non-Adhering Sealant

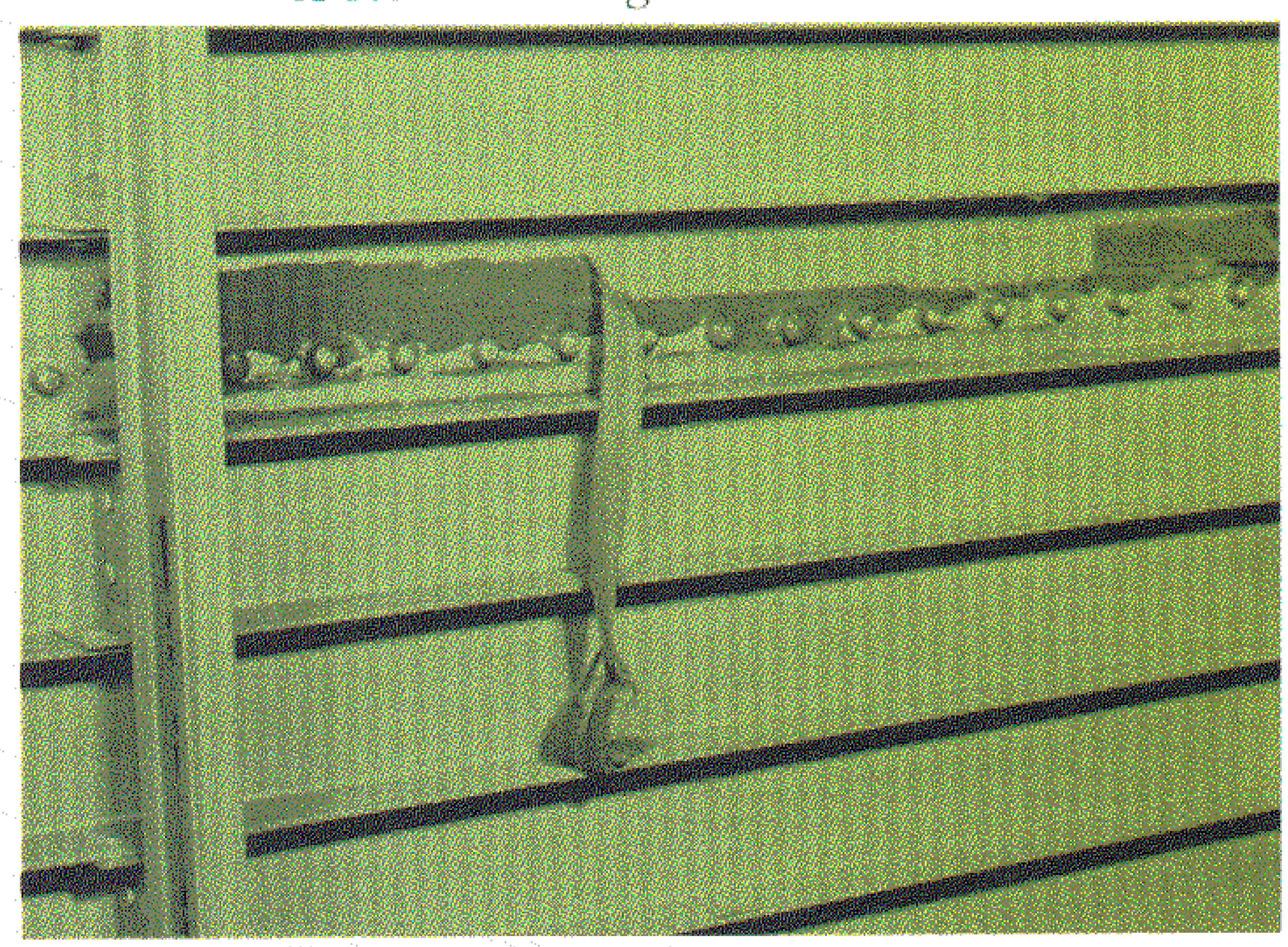
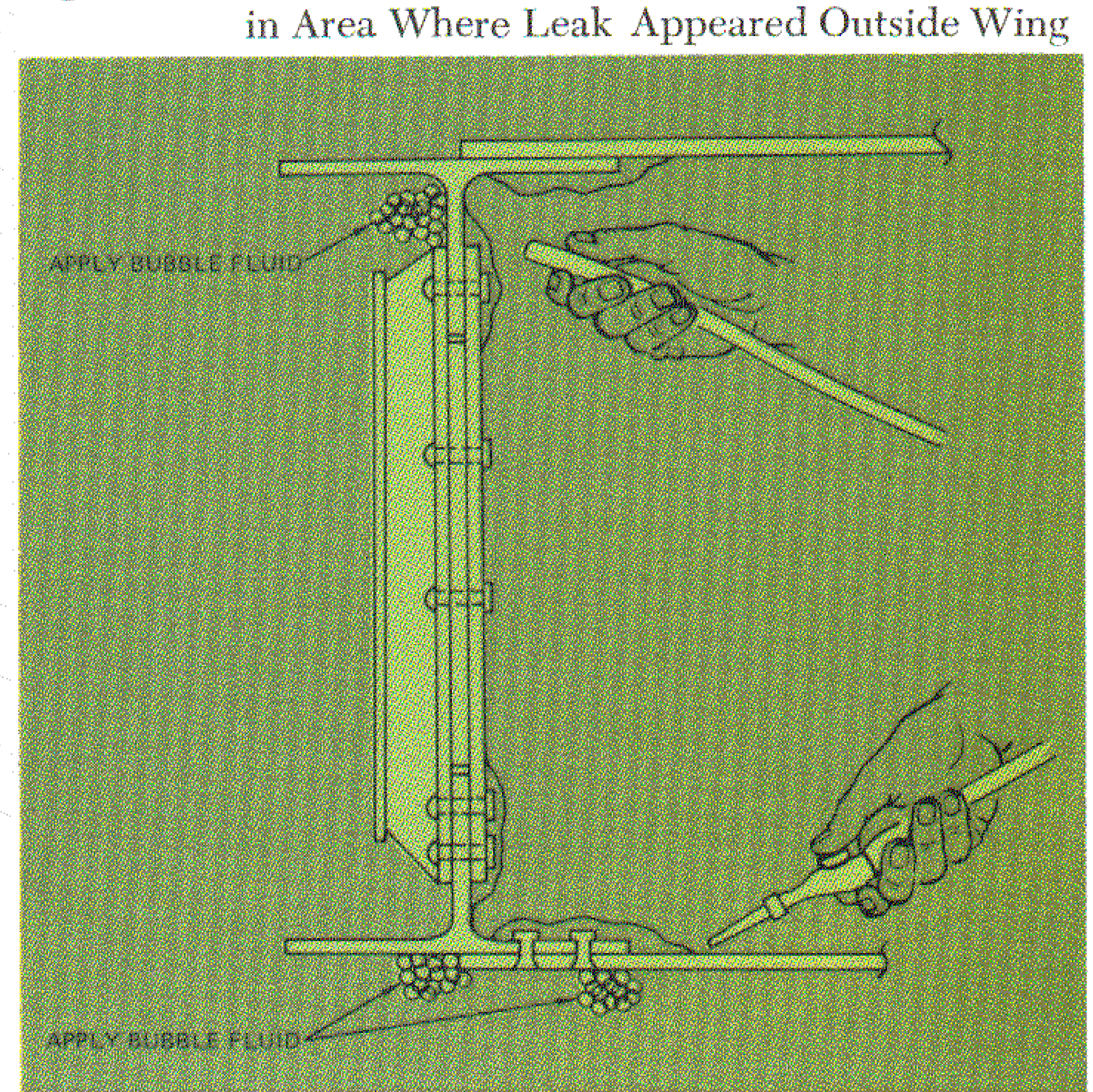


Figure 18. Apply Air Pressure to Wing Internal Surface in Area Where Leak Appeared Outside Wing



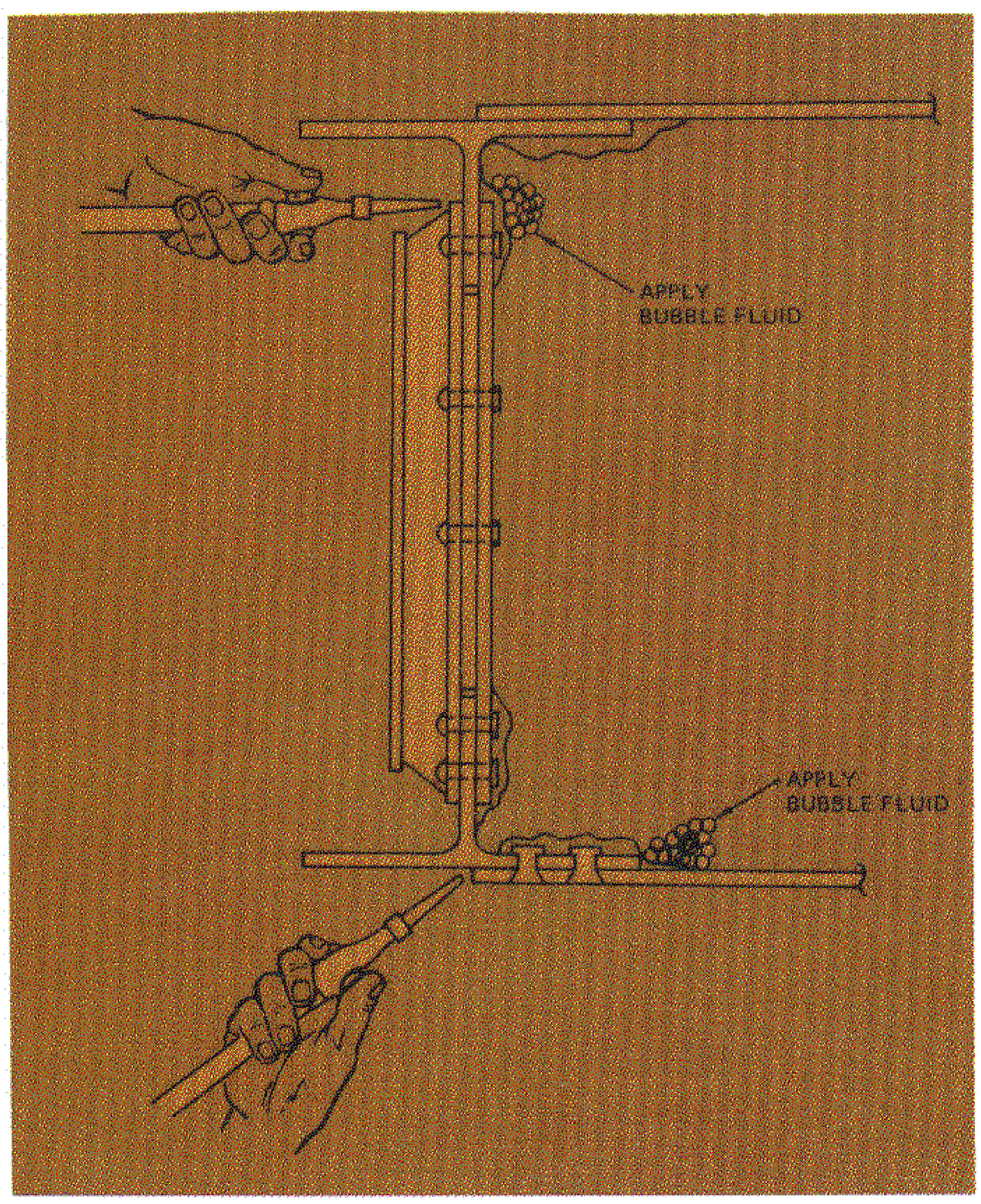
c. When bubbles appear at the leak point on the wing exterior surface (Figure 18), the man outside notifies the man inside to mark the spot where the air was applied. Continue this procedure until all suspected areas have been inspected, because some leaks may have more than one entrance point. The man outside marks the leak exit point.

d. Recheck the marked inside area by covering it with bubble solution and applying air pressure from the outside.

e. After completing the bubble check, wash the solution from the interior and exterior surfaces with water and dry with lint-free cloths. Be sure all areas to be repaired remain marked after the bubble solution has been removed.

If the leak source has not been located using the *External* Bubble Test, proceed with the *Internal* Bubble Test.

Figure 19. Apply Air Pressure to Wing Exterior Surface in Area Where Leak Appeared to Detect Leak Source Inside the Tank



2. **Air Hose and Internal Bubble Test.** If the leak source has not been definitely isolated by visual inspection, it may be revealed by the application of a bubble solution to the inside of the tank and of compressed air from the tank exterior surface at the leak exit point. This procedure requires the services of two men, one outside and one inside of the tank area. (See Figure 19.)

a. One man enters the tank and applies a noncorrosive bubble solution to the areas of the interior surfaces of the tank where leakage is suspected.

CAUTION

Arrange a system of tapping signals for communication between the two men to indicate when the air pressure is to be applied and shut off, and when repeated testing of an area is desired. Repairmen should wear goggles for eye protection both inside and outside the tank.

b. The man outside of the tank applies air pressure to the leak exit point on the wing exterior surface. The air hose and supply should be capable of delivering compressed air at approximately 90 to 100 psi. Care should be taken to keep the air hose approximately 1/2 inch from the structure. A pressure box may be used to locate small leaks which require air pressure for longer periods of time.

c. As the air pressure is applied to the leak exit point, the man inside the tank applies the bubble solution to the suspected area of the wing interior surface (Figure 19), watching for the telltale bubbles.

d. If bubbles are observed, mark the spot inside and outside of the tank, and continue the test until the entire area has been completely inspected.

e. Recheck the suspected spot by applying bubble solution on the leak exit point on the wing exterior surface, then applying air pressure to the suspected location on the wing interior surface.

f. After completion of the test, wipe the bubble solution from the interior and exterior of the tank surfaces with a damp cloth. Be certain that the tank structure and seals are completely clean and the point of leak is properly marked.

If the internal bubble solution method does not expose the leak source, employ the dye injection method of leak detection.

3. **Dye Injection Method**. This leak detection method consists of injecting dyed JP-4 fuel through the leak exit point on the wing external surface to the leak source inside the tank by use of a leakage tracing device FSN-4940-928-4698, pressure-vacuum cup, and hose as shown in Figure 20. This method may also be used with fluorescent dye and an ultraviolet light for locating the leak source inside the tank. The leakage tracing device can supply controlled air pressure and serve as a vacuum source. The double cup assembly has a vacuum segment to inject dye into the leak path. A "hollow bolt" may be installed in place of a leaking fastener to force dye into the leak path. A plastic vacuum cup provided with the leakage tracing device is used to confirm a sealant repair or to check under head-sealed fasteners by pulling air or dyed fuel back through structure and into the plastic container.

The following procedure is used to accomplish the dye injection method of leak detection:

a. Remove any materials that may remain from previous performance of another leakage detection method.

b. Connect the double cup assembly to the leakage tracking device as shown in Figure 20. The hose from the cup outer segment connects to the vacuum source and the inner segment hose connects to the pressure source.

c. Mix dye and fill the pressure container. Suggested dyes are a mixture of one part Zyglo ZL-2 or Red Dye and ten parts JP-4 fuel. Black light, portable explosion-proof, FSN 6635-969-4172, should be used in the detection of flourescent dye.

CAUTION

The leakage tracing device should be as close to the double cup as is practical to minimize pressure errors.

d. Attach the double cup assembly to the outer wing surface of the aircraft.

NOTE

Any irregularities in the wing surface that could cause leakage around the injection cup should be sealed with putty. If zinc chromate putty is used, it is advisable to apply masking tape on the wing surface first to prevent staining the wing by the putty. Do not cover leak exit point with tape.

e. Apply an air pressure of 4 psi to the dyed-fuel pressure tank segment of the double cup assembly. Bleed air from the dyed-fuel tank and hose by opening the clamp on the double cup assembly until dyed fuel is ejected, then close the clamp.

f. Check for dyed-fuel vapor ejection from the air ejector. Any dyed fuel leaking from the cup inner segment will be sucked down the outer cup segment hose and blown out of the air ejector. No leakage is permissible.

g. After ensuring compliance of all tank entry safety precautions, enter the tank and observe suspected leak area for indications of dye. When fluorescent dye is used, an explosion-proof ultraviolet light will be required to detect dye in the tank.

h. Continue the dye pressure application as long as required to force the dyed fuel to travel the complete leak path.

NOTE

Monitor the dye container gauge and equipment to ensure a pressure of 4 psi.

i. When the dye appears inside the tank, mark the point of appearance and close the flow valve.

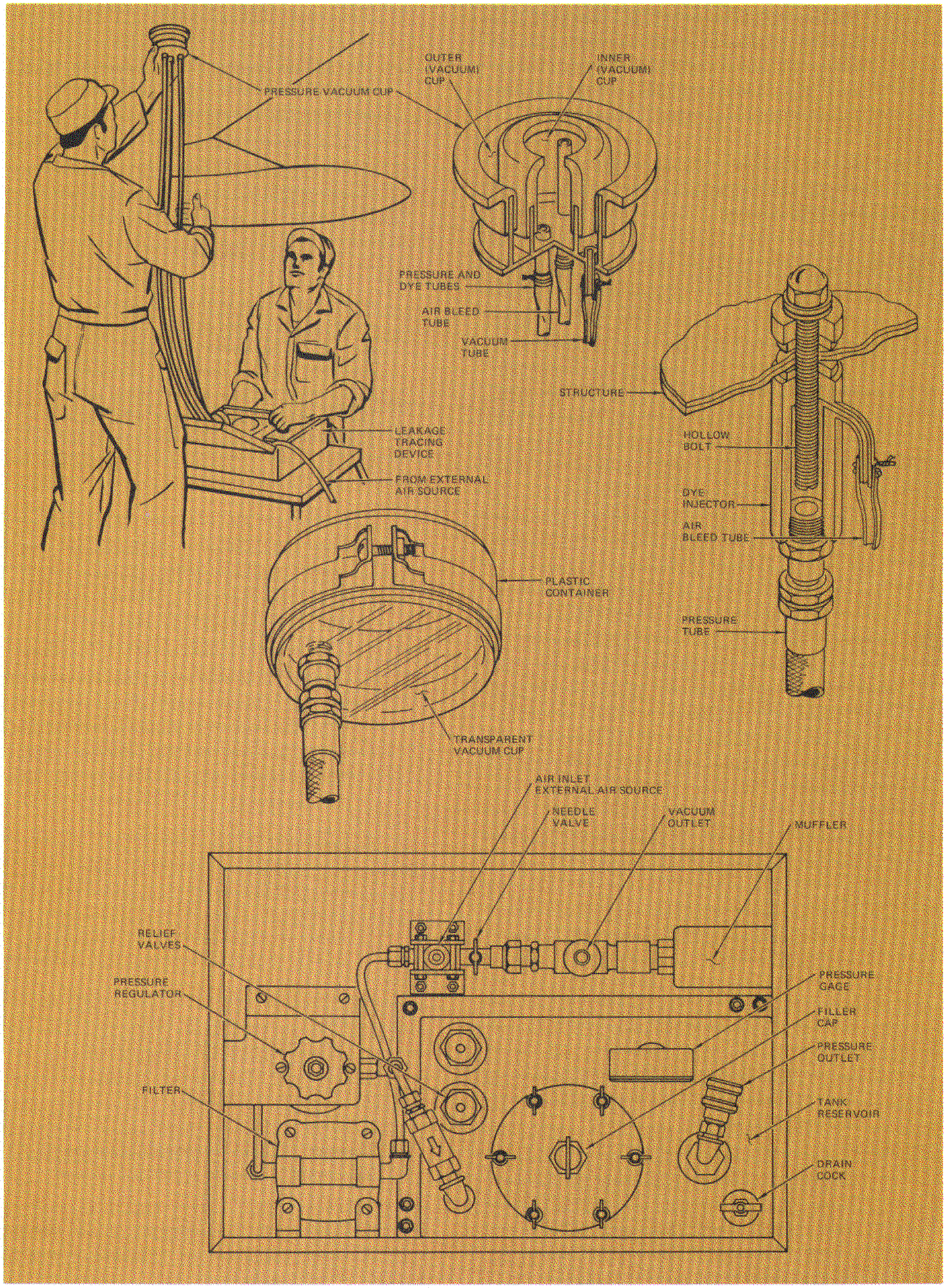


Figure 20. Leakage Tracing Device FSN 4940-928-4698 and Accessories

j. If the double cup assembly is not able to force dye through the external leak point and the external leak point is a fastener, the fastener can be removed and the dye injected by the "hollow bolt" shown in Figure 20. The hollow bolt method forces the dye solution between the mating surfaces of the structure along the leak path and out the leak source in the tank. After the leak path has been determined, remove the hollow bolt and replace the fastener.

WARNING

Use of JP-4 fuel as a tracing medium may cause hazardous vapor to exist in the test equipment following use of the unit. This condition requires special storage, handling, and isolation of the unit from flame or possible sources of sparks.

LEAK REPAIR PROCEDURES

TANK REPAIR In general, all leaks should be permanently repaired inside the tank as soon after discovery as practicable. However, under certain circumstances and conditions a temporary external repair may be made if it is considered safe to operate the aircraft until regularly scheduled maintenance is possible. During these repair procedures the tank repair specialist should observe all safety precautions outlined previously.

External or Temporary Repairs The decision to make a temporary repair should be based upon safety considerations as determined by the location of the leak exit point and the amount of leakage. It is recommended that temporary repairs be kept to an absolute minimum and inspected frequently.

Two repair methods are available – use of Field Repair Kit 400 A-1 or of an Oyltite-Stik. With either method the fuel tank exterior must be cleaned thoroughly in the area of the leak.

1. Field Repair Kit 400 A-1 (FSN 5180-450-6925) consists of various shaped patches and a device for holding the patch to the tank exterior until it adheres to the surface. Repair may be accomplished in 30 minutes.
2. Oyltite-Stik (FSN 8030-935-5841) is used on flush external fasteners that are leaking by working the compound into the countersink around the fastener head. Use of this compound for temporary repair of MLG trunnion cap bolt leaks is described later in this article.

Internal or Permanent Repairs All internal repairs on sealant are permanent and should improve on the original sealant in the surrounding area. To make permanent internal repairs proceed as follows:

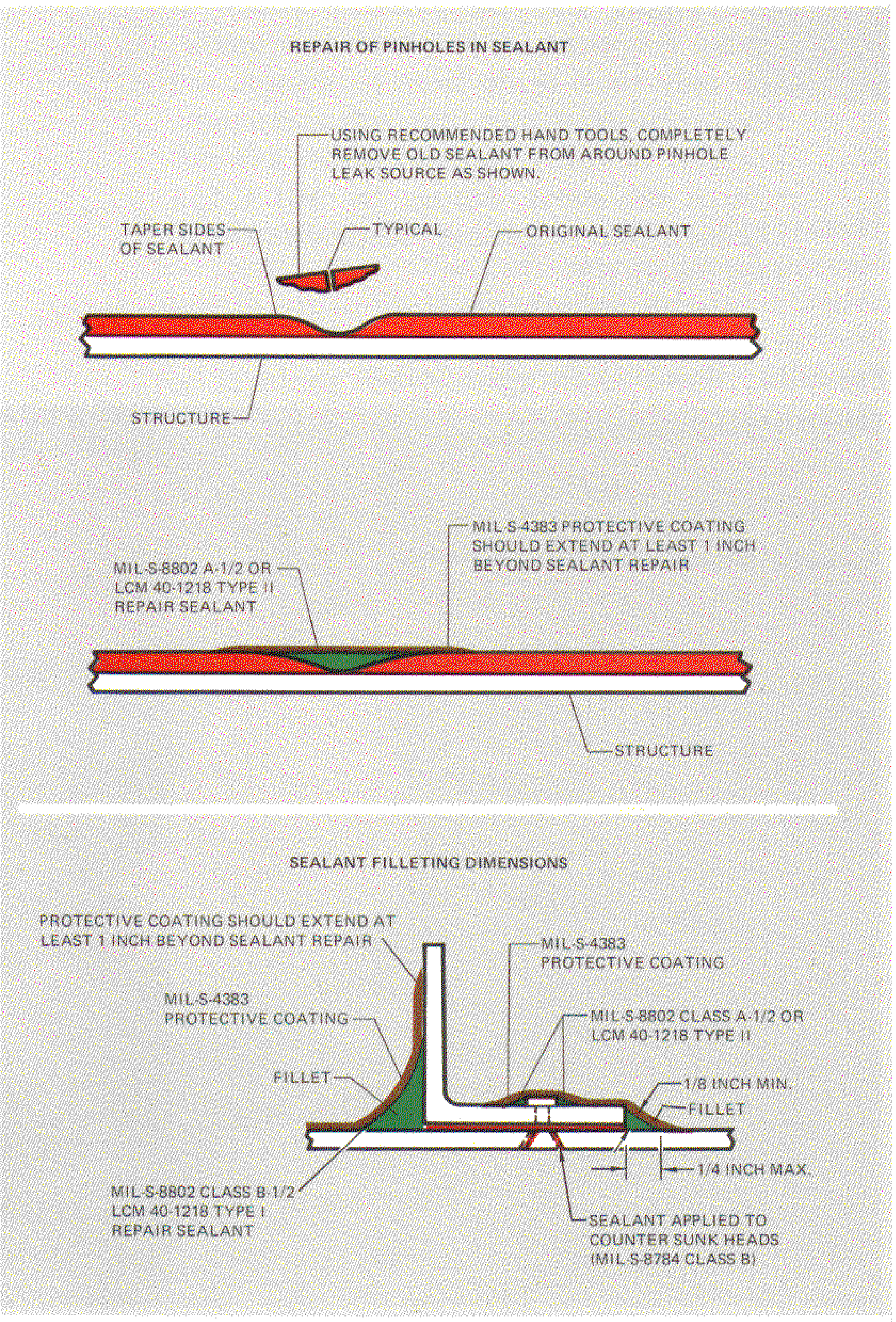
1. Remove all deteriorated, blistered, or non-adhering sealant around the leak source. (See Figure 21.) Deteriorated sealant is chalky in appearance and tends to crumble. Use only tools made from hardwood, red fiber reinforced phenolic, soft aluminum, micarta, or other material which will not scratch the metal, damage the MIL-C-554 chemical film or generate static electricity. (See Figure 8.)

Figure 21. Removing Defective Sealant

2. Taper the edges of the good sealant around leak sources (such as pinholes, etc.). This is done so that the repair sealant can be forced into the cavity without entrapping air in the repair area.

3. Remove all leak detector fluid, dirt, grease, etc., in the area with clean, grease-free, lint-free rags dampened with clean solvent, preferably MEK. Do not spill MEK or apply it too freely, as it will attack good sealant and cause new leaks. Wipe the area until it is free of MEK, and then rinse twice with the cleaner mixture cited in Table 2. Wipe thoroughly after each mixture application and then allow the cleaner to evaporate until the area is completely dry. The important thing is that all foreign material and fluids must be completely removed. Do not apply the sealant over any moisture. Air should be forced through the leak exit point until any remaining fluid has been completely evaporated from the leak channel.

Figure 22. Typical Sealant Repairs



4. Use quick repair sealant MIL-S-8802 Class A-1/2, Class B-1/2 or LCM 40-1218 Type II for service repairs. The 1/2-pint kit will suffice for most repairs.

5. Heat or cool the base compound as required to maintain the temperature of the sealant at about 75°F.

6. Mix the accelerator with the base compound as described under "Sealing Compounds". Mix slowly to avoid whipping in air bubbles. Stir until the two materials are thoroughly blended. This should take approximately 5 minutes. Note that mixed quick repair sealant has a short application life (Table 1) and should be applied immediately or the material will become too rubbery to adhere to the repair surface.

7. Apply a small amount of quick repair brushable sealing compound with a stiff bristle brush as an adhesion coat to the clean repair area. To ensure good adhesion, rub the material on the structure with a rotary scrubbing motion. For repairs requiring only brush material, immediately apply a second brush coat approximately 1/32-inch thick over the initial adhesion coat. Typical sealant repair dimensions are shown in Figure 22. Work the sealant in thoroughly so that no air will be entrapped.

8. For larger repairs requiring the quick repair fillet sealant, apply an adhesion coat of brush sealant as described in the preceding step. Allow a 15-minute air-drying period before applying the fillet sealant.

9. Use a spatula of the type depicted in Figure 8 to smooth the filleting material. The material must be worked into place to squeeze out any trapped air and then must be tapered out so that it fairs smoothly with the original sealant and the tank structure.

10. This final step applies to repairs made with both the brush and fillet quick repair sealants. When the quick repair sealant is no longer tacky, thoroughly cover the repair with a brush coat of MIL-S-4383 Buna-N protective coating. After a 15-minute air-drying period, apply a second brush coat. Both protective coats should overlap the original sealant and cover coat by at least 1 inch. Air-dry the fuel tank for 30 minutes before installing the access doors. Discard all unused accelerated sealant.

11. Before installing the access doors, make one last check for tools or other foreign objects that might have been left inside the tank. It is wise to count tools before and after repairing tank sealant.

12. Wipe off all fuel and leak detector residue from the wing exterior surface so that it will not be mistaken as evidence of new leaks, then fill the tank with fuel. A fuel soak check lasting 1 hour is adequate for test after repair, and a 15-minute engine run provides an adequate shake test.

TABLE 2

Aromatic Naphtha Type I Grade B TT-N-97	5 parts
Ethyl Acetate TT-E-751	2 parts
Methyl Ethyl Ketone TT-M-261	2 parts
Isopropyl Alcohol TT-I-735	1 part

ACCESS DOORS The fuel tank access doors are part of the wing primary structure. As such, part of the shear loads carried by the integrally stiffened wing panels are also imposed on the access doors, causing them to flex to some extent. Unless the doors, seals, surrounding structure, and attaching hardware are maintained with care, this flexing will cause fuel leaks. For this reason a close manufacturing tolerance must be maintained between the door attaching holes and the relatively large number of attaching screws. Occasionally this close tolerance makes it difficult to install the screws. As a consequence, the dome nuts can be forced away from the attaching surface (resulting in fuel leakage) when the screws are started into the dome nuts by force.

In an effort to reduce or eliminate leakage problems in this area, some maintenance practices are presented which will facilitate the effective sealing of doors.

Removal and Inspection of Access Doors Remove any paint and/or sealant from all Phillips screw recesses with a pointed tool to ensure proper Phillips tip-screw engagement. After the screw recess has been cleaned, remove the access door screws with an air-driven impact wrench fitted with the correct size Phillips tip (in good condition).

Some screws may be too tight to break loose with an impact wrench, in which case a large T-handle with the correct size Phillips tip may be used. One man should hold the T-handle in alignment and apply pressure, while another man turns it with a wrench to loosen the screw. Exercise care when applying pressure to the screw. Excessive pressure may cause the dome nut to be forced away from the tank's interior surface, and may also unseat the nut within the dome shell when the screw begins to turn.

If the recess on the screw head is stripped, use a small punch to make an indentation in the screw head on both sides of the recess. Position a small punch in these indentations, then tap the punch with a light hammer to rotate the screw.

Check the dome nuts for damage or separation from the surrounding structure, and inspect the sealant around the dome nuts for cracks, deterioration, or other defects. Replace any damaged dome nuts, apply two brush coats of sealant, then cover coat the dome nuts and the rest of the inside surface of the door frame with Buna-N as required. A typical access door opening in the wing structure (showing sealed nuts) is shown in Figure 23.

Figure 23. Typical Access Door Opening Showing Sealed Nuts on Door Frame

Installation of Access Door Seal Inspect the molded door seal for defects (generally, replacement of the seal is necessary). If replacement is necessary, proceed as follows:

1. Select a seal that is free of storage deterioration checks and is even and smooth, particulary where the ends are joined together.
2. Remove the old seal from the door groove and thoroughly clean the door frame down to bare metal. Clean the door mating surface but do not remove protective coating unless it is damaged.
3. Lay the new seal in place in the groove and check for proper fit. If the seal is too long or too short (as evidenced by pulling at the corners or bunching), reject the seal. The seals are manufactured with a 2 percent stretch required during installation. Prestretch the seal around its entire length until it will rest in the groove.
4. The flat attaching surface of the door seal must be installed evenly in the groove as follows:

   a. Wash the groove and the back of the new seal with MEK.

   b. After the MEK has evaporated, apply a thin coating of Buna-N to the groove and to the flat side of the seal that contacts the groove. Allow the Buna-N to dry until tacky, then press the flat side of the seal into the groove.

   c. Smooth the seal into the groove so that the seal edge does not project over the edge of the groove. If the edges of the seal are allowed to extend outside the groove, they will hold the door away from the frame and prevent achievement of a leakproof seal.

   d. Clean the exposed portion of the seal with a clean lint-free cloth lightly dampened with MEK. Allow the MEK to dry completely.

Installation of Access Doors Before installing the access door, check that the contact surfaces of the door and door frame are free of dirt, sand, oil, or sealant that would prevent an effective seal. The door frame should be cleaned to bare metal and should not be cover coated.

Screw Length Determination New screws of the correct specification must be used to reinstall access doors. If it is necessary to reuse some of the old screws, inspect them carefully for damaged threads, shanks, or stripped recesses. Damage of any nature is cause for rejection. Before installing the screws, check that they are the correct length for the particular application. The screw must be of sufficient length for the thread to protrude entirely through the nut. If a chart showing screw lengths is not available, use the following procedure to determine the correct screw length.

Two wires are required to perform this procedure. One wire should have a small 90-degree bend sufficiently short to permit insertion through the nut, but long enough to grasp and seat the nut firmly against the wing plank surface. The other wire should be straight.

Grasp and seat the nut against the wing plank inner surface with the bent wire. Measure the distance from the wire bend to the door frame exterior surface. Add the door thickness (exclusive of the seal) to determine the minimum possible screw length. The screw must be sufficiently short so that the non-threaded portion of the shank will not bottom against the thread.

Hold the nut against the wing plank inner surface with the bent wire. Gauge the distance from the door frame exterior surface to the first thread of the nut with the straight wire. Add the door thickness (exclusive of the seal) to determine the unthreaded shank maximum length. The screw also must be sufficiently short so that the threaded end will not unseat or puncture the dome shell.

Gauge the distance from the door frame exterior surface to the dome shell inner surface with the straight wire. Add the door thickness to determine the maximum permissible screw length. A 1/32-inch clearance must be provided for each of the three above determinations to permit application of specified torque without bottoming the screw.

Nut Self-Locking Feature Repeated installation of screws may cause the self-locking feature of the nut to become ineffective. To check this feature, thread an NAS 428-4-20 hex head bolt into the nut by hand. If it can be threaded by hand, replace the nut.

Installation Before placing the door in position, apply a light coat of petrolatum (VV-P-236) to the exposed area of the seal, and apply a light coating of LAC C-40-769 (MIL-S-8784) low adhesion sealant to the countersunk portion of each screw hole to inhibit corrosion. Do *not* use Buna-N, paint, or any other such material on the screws. A hand screwdriver should be used to start the screw into the dome nut. Avoid striking the screwdriver with the hand or exerting excessive pressure in an attempt to start the screw into the nut.

After the screws are started by hand, they may be tightened with a properly adjusted impact wrench or an air-driven screwdriver. Tighten the screws in the sequence shown in Figure 24 so that the access door will be drawn evenly into place.

Special Instructions If unusual difficulty is experienced in obtaining a leakproof access door, especially on the outer wing, the operator may use the method described in this paragraph to effect a temporary repair until such time as a permanent repair can be made. This method is essentially the same as outlined above, except that low adhesion sealant LAC C-40-769 Type I is used between the contact surfaces in lieu of a seal. The door frame contact surface should be cleaned down to bare metal and the door surface cleaned down to the protective paint. Buna-N should not be applied to either surface. The low adhesion sealant should be applied the full width of the contact area on *one* surface only. The door should be installed and the screws tightened while the low adhesion sealant is still wet. The excess sealant that emerges around the access door should then be completely removed. The tank is not to be refueled for at least 4 hours after the door has been sealed in this manner.

This plan has been used in service with considerable success but should only be authorized when absolutely necessary as the door may be difficult to remove. When it is used, make certain that the aircraft records reflect this information.

MAIN LANDING GEAR INBOARD TRUNNION CAP BOLT LEAK REPAIR The main landing gear attachments are fastened to the wing with trunnion bolts, and their faying surfaces are sealed at the factory during installation. (See Figure 25.) The bolt presently used on the main landing gear inboard support fittings is P/N 729125-101. This bolt replaces P/N 728420-3 (9Z5306-806-9223). If fuel leaks occur at the main landing gear inboard support fitting cap bolt, obtain the P/N 729125-101 bolt and P/N MS29513-113 packings (shown in Figure 26), then perform the following procedure. Note that there may be no necessity to defuel the aircraft in order to perform this repair.

1. Remove the inboard support fitting cap bolts and cap.

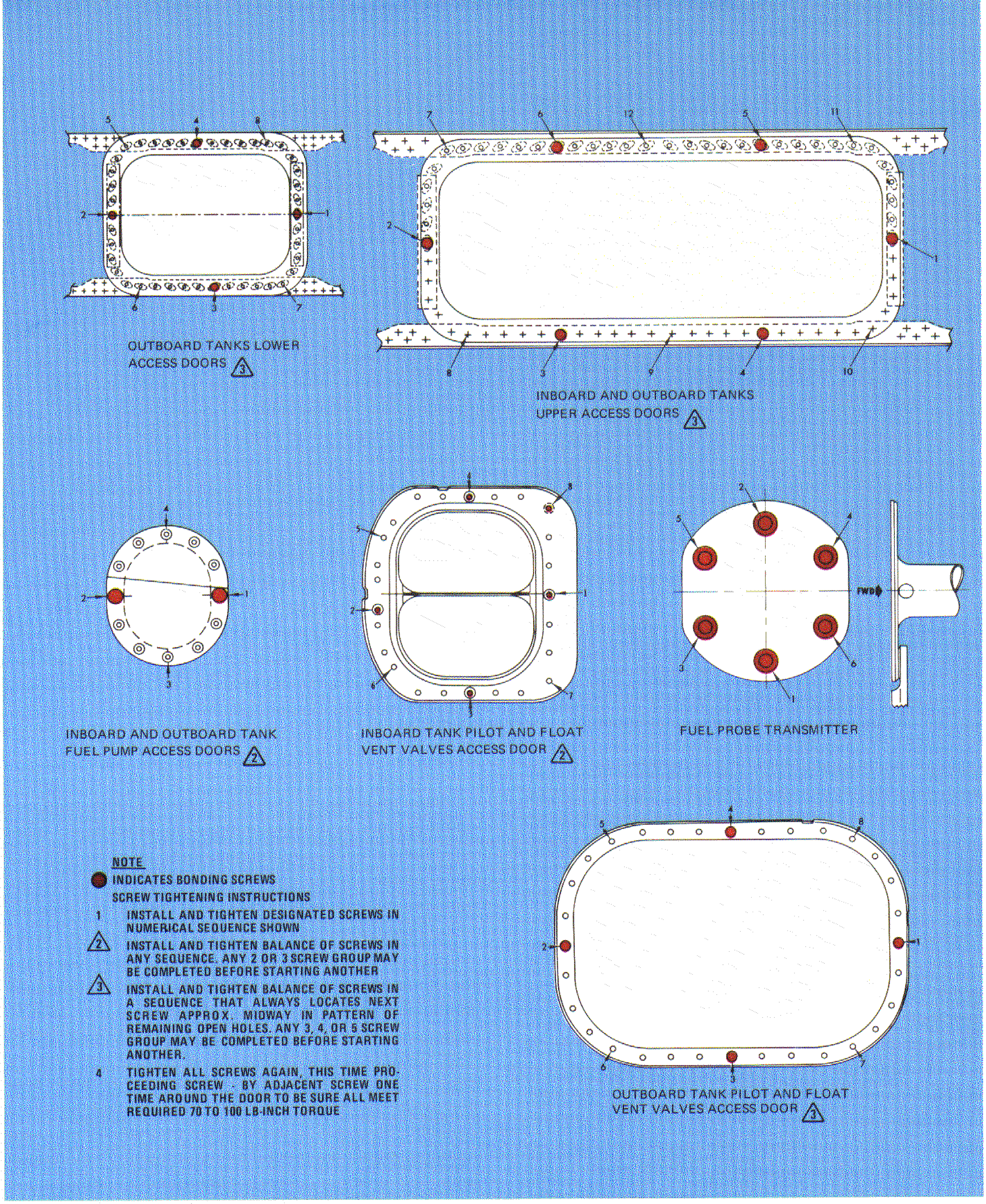


Figure 24. Access Door Screw-Tightening Sequence and Instructions

2. Thoroughly clean all existing sealant from the support fitting and the fitting cap holes through which the new bolts will be installed. Use LAC-32-337 cleaner or MEK (TT-M-261) and scrape the surfaces with wood or micarta scrapers.

3. Ensure that all holes and surfaces are smooth, clean, and free of existing sealant.

4. Treat all bare metal with Alodine, MIL-C-5541.

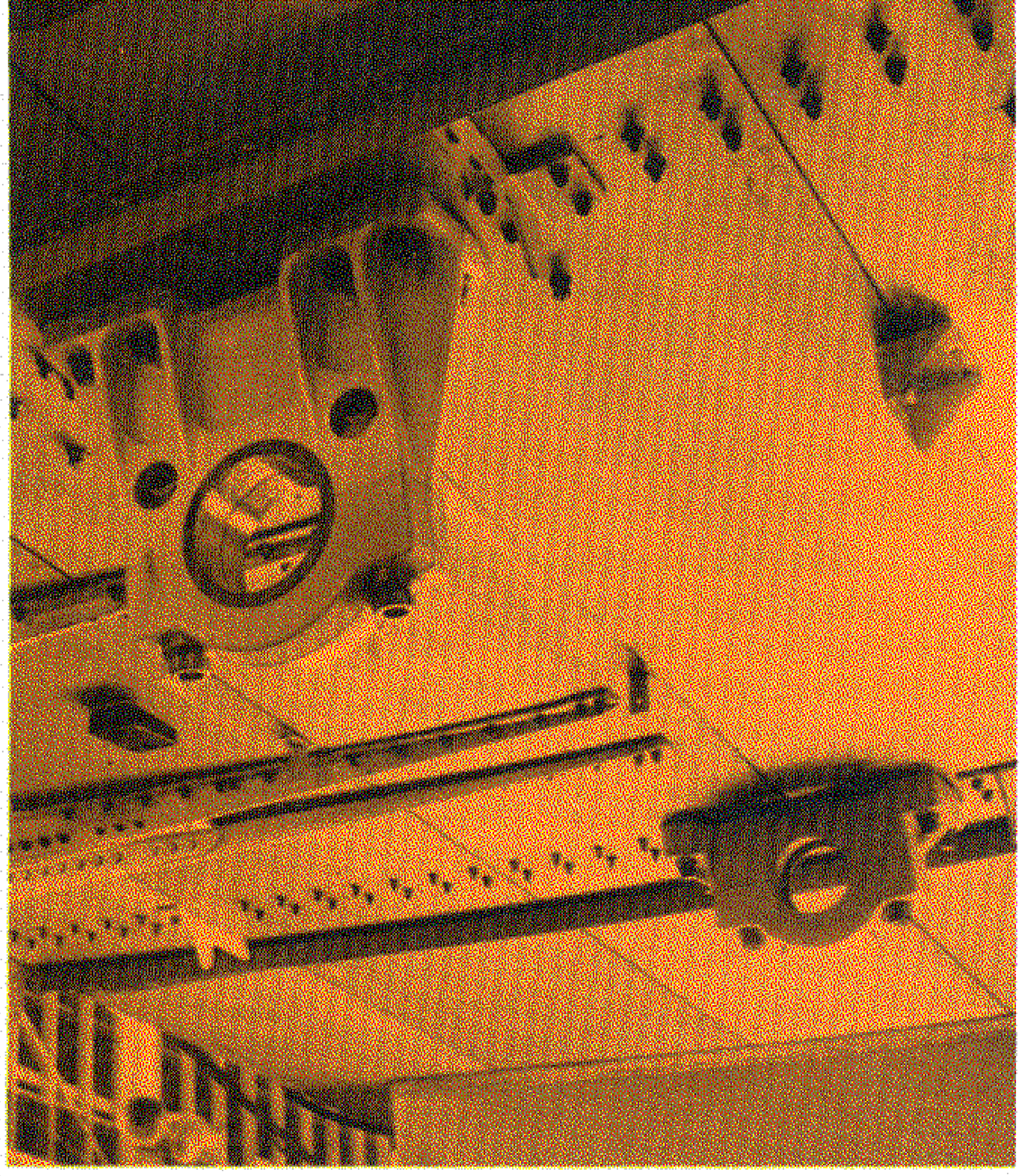


Figure 25. Main Landing Gear Attachment Fittings with Faying Surfaces Sealed

5. Install washers on bolts and apply lubriplate, 130AA, to shank of bolt from the head to the packing groove nearest the head.
6. Coat the support fitting cap with grease, MIL-G-21164, in the area where the trunnion bearing fits.
7. Install the new bolts in the support fitting cap.
8. Coat the packing with lubriplate and install in the packing groove nearest the bolt head.
9. Coat the other packing groove with lubriplate and install the packing.
10. Coat the rest of the bolt shank, excluding the threads.
11. Install the support fitting cap and bolts as shown in Figure 26. Apply 1100-1300 pound-inches of torque to the bolts.
12. Lockwire the cap bolts with MS20995C47 lockwire.

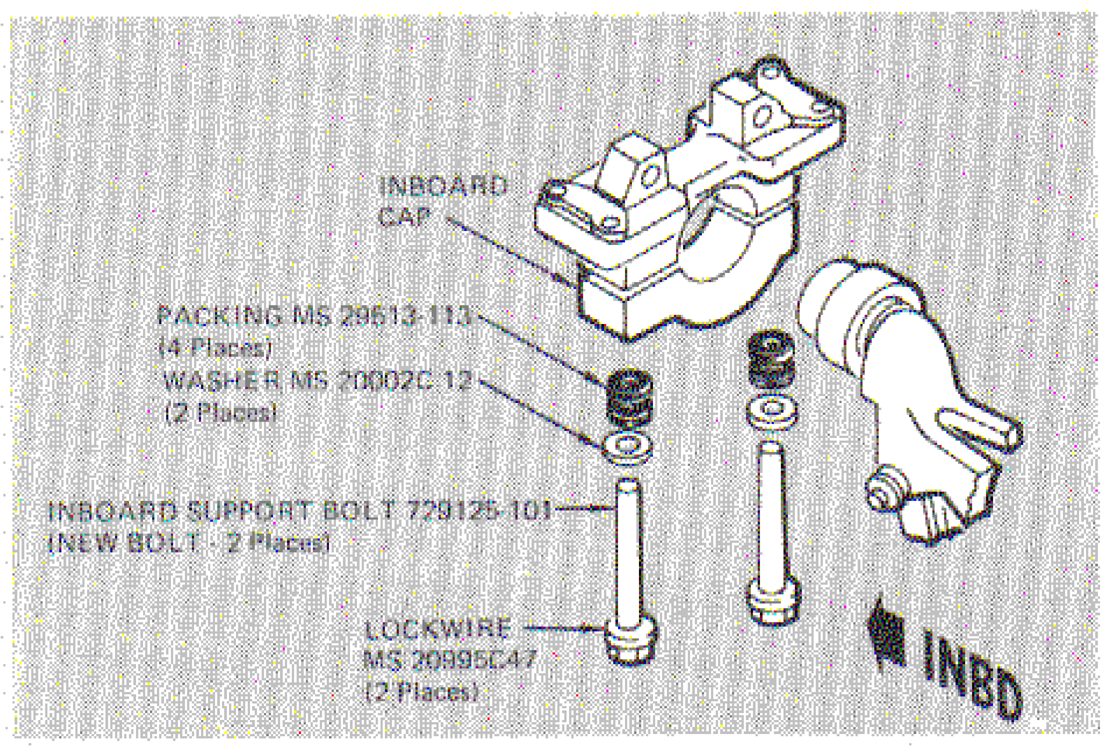
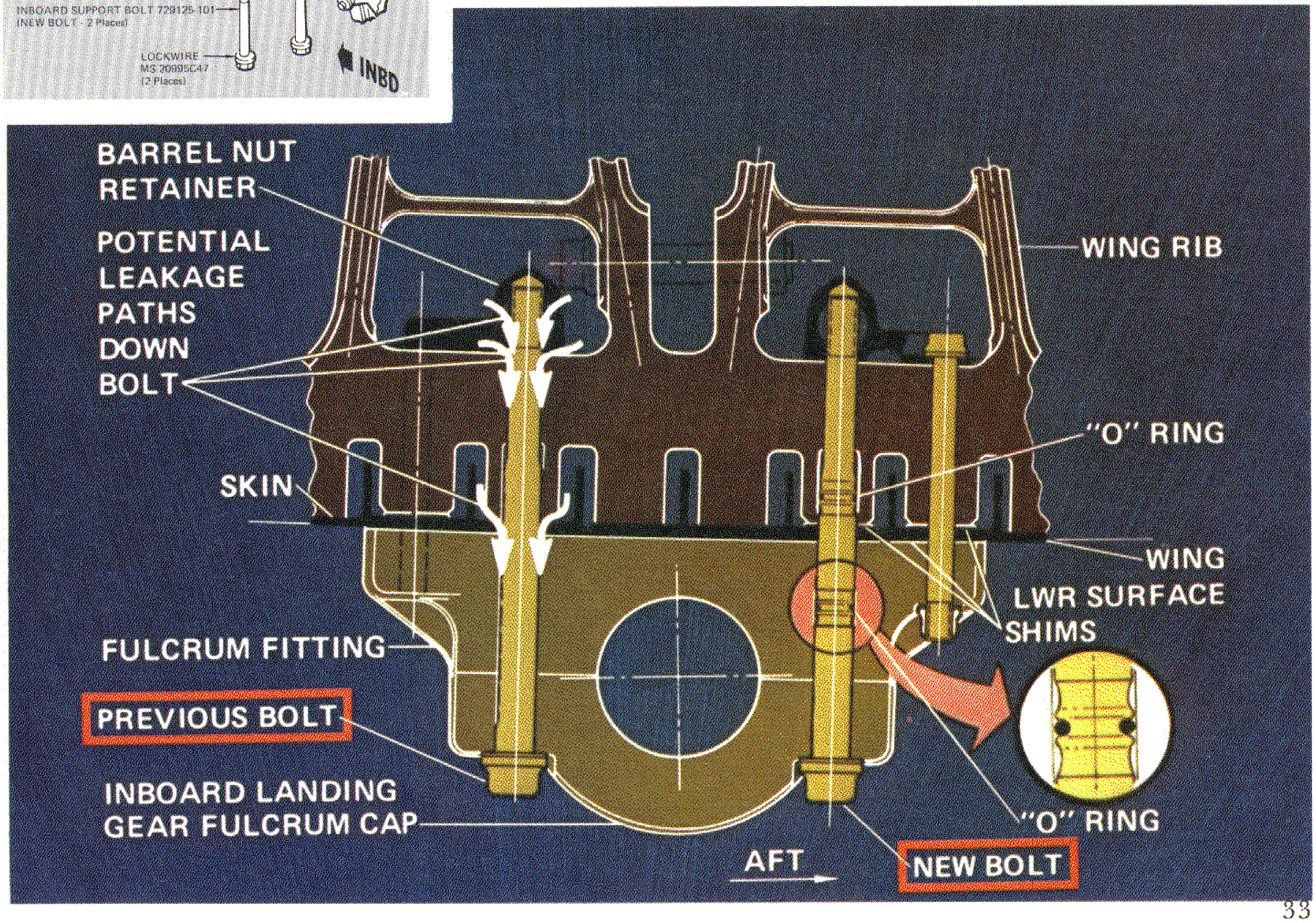


Figure 26. Main Landing Gear Trunnion Bolt Installation Showing Previous Bolt (P/N 728420-3) and New Bolt (P/N 729125-101)



Inboard Trunnion Cap Bolt Temporary Repairs If existing bolts P/N 728420-3 must be used, some success has been attained in service with a temporary repair that consists of installing the inboard trunnion cap bolt wet with sealant. It entails injecting sealant into the barrel nut cavity, the barrel nut, and into the entire bolt hole from the trunnion cap, through the trunnion fitting and skin plank, through the MLG rib, to the tank interior. After the sealant is injected, install the trunnion cap bolt. During installation of the bolt, hydraulic action forces the uncured sealant into the tank, fills the leak path, and replaces any good sealant displaced by the uncured sealant. Be certain to use only MIL-S-8802 sealant, preferably Class B-1/2. *Low adhesion sealant, MIL-S-8784, must not be used.* Incomplete removal of fuel from the leak path by the aforementioned hydraulic action on the sealant may make this repair temporary.

Another temporary repair occasionally employed is to remove the trunnion cap bolt, coat it with sufficient Oyltite-Stik to stop or minimize the leak, then reinstall the bolt. Both this method and the previous one may be used without defueling the tank.

Permanent Repair Using P/N 728420-3 Trunnion Cap Bolt, and For All Other Trunnion Fitting Bolts If trunnion bolt P/N 729125-101 is not available, it will be necessary to use the existing trunnion cap bolt (P/N 728420-3). If this is the case, or if a leak occurs at any other trunnion support fitting bolt, perform the following procedure:

1. Defuel and purge the affected wing tanks.
2. Determine the leak source by the appropriate Leak Source Analysis method. If the leak appears to be at a trunnion bolt, remove the bolt to facilitate application of leak source analysis techniques. Do not disturb the attachment of the upper trunnion support fittings to the wing. If these interfaces must be resealed, take care to maintain the original shim orientation. These fittings are jig-located during installation, and the shims are step-peeled accordingly.
3. Remove the sealant in the area of the leak source. If the barrel nut cavity of an inboard trunnion cap bolt is involved on earlier P-3 aircraft, remove and discard the sealing plug discs installed during production on these aircraft. Do not disturb the barrel nut cavity sealant unless it is suspect. Clean the bolt hole and bolt with solvent; clean the area from which sealant was removed with solvent (refer to Table II). Blowback with pressurized air to dry solvent from the leak path.
4. Use a fillet gun to inject sealant into the bolt hole until the sealant protrudes inside the tank at the leak source, and until the barrel nut and cavity (if at an inboard trunnion cap bolt) are completely full of sealant. Install the bolt immediately while the sealant is wet.
5. Smooth out sealant inside tank that appears as fillet along joints or around nut retainers. Add enough fillet sealant on joints to assure a quality fillet.
6. Allow fillet sealant to air dry for a minimum of 2 hours at over 70°F, then apply a brush coat of sealant over all fillet sealant repairs and over fasteners and nuts as required, extending coating 1 inch past the repair over the old sealant. Also brush coat any bare metal which resulted from removing the old sealant. Allow sealant to cure.
7. Apply protective coating.
8. Vacuum and clean tank. Close the tank.
9. Refuel with dyed fuel for static soak test.

NOTE

A fuel soak check lasting 1 hour is adequate for test after repair, and a 15-minute engine run provides an adequate shake test.

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