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# service news

## INTEGRAL FUEL TANKS

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

*Editor*
Charles I. Gale

*Associate Editors*
Daniel E. Jolley
James A. Loftin
Steve Palmer

*Art Direction & Production*
Bill Campbell

**Vol. 9, No. 4, October-December 1982**

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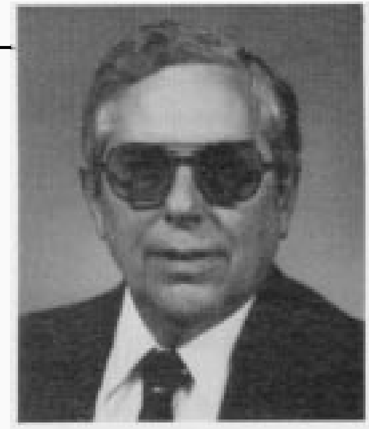
Cover: It may look like part of a bridge or the insides of a submarine to the uninitiated. but more than a few people worldwide will quickly recognize the subject of our cover picture for what it is – the inside of a Hercules aircraft integral fuel tank. In this issue, we take a close look at the way the integral fuel tanks of these famous airlifters are built today, and review the important maintenance procedures that help keep them fuel-tight and trouble-free.



## Focal Point



M.C. BILLIAS

MAKING PERFORMANCE PERMANENT

The Hercules aircraft, like most other current military and commercial airplanes, carries its fuel in integral fuel tanks. An integral fuel tank is defined as primary aircraft structure, usually wing or fuselage, that is sealed to contain fuel, as opposed to a rubberized fuel cell mounted in aircraft structure. Integral fuel tanks are the most efficient way to carry fuel, and nearly all modern aircraft utilize this type of fuel tank.

The Hercules aircraft has been in production now for over 25 years, and although its basic outward appearance has not changed very much, it is far from being the same airplane.The airframe structure and systems have been constantly improved and changed to incorporate the latest technologies. This is also true of the Hercules aircraft's fuel tanks. They represent the latest state of the art in sealing materials and processes.

The Lockheed-Georgia Company has not only kept abreast of the latest state of the art, it has advanced the state of the art in many areas of fuel tank sealing. For example, MIL-C-27725 corrosion preventive coating, MIL-S-81733 corrosion inhibiting sealant, MIL-C-83982 fluid resistant sealant, and MIL-C-83019 sealant topcoat were all developed at the Lockheed-Georgia Company and first used on the Hercules aircraft. These materials and others pioneered by Lockheed-Georgia are widely used in the aircraft industry today. We are proud of our accomplishments and continue to press forward in our efforts to develop new and better materials and processes.

Making sure that an integral fuel tank is structurally sound, carefully sealed, and protected against corrosion is only part of the story, however. Like every other part of a modern airplane, fuel tanks must be properly maintained if their full performance potential is to be realized. In day-to-day service, integral fuel tanks are subjected to a wide variety of stresses, some environmental, others operational in nature. It is vitally important that maintenance personnel be equipped to deal effectively with any fuel tank problems that may develop as a result.

This is an area where Lockheed-Georgia is uniquely qualified to help. We are prepared to offer our customers expert assistance with every aspect of fuel tank maintenance and maintenance training. The feature article of this issue of *Service News* is but one part of our program. Another is the broad range of fuel tank maintenance courses offered by the Customer Training Department. Yet another is the professional, on-site support available from a Field Service Representative.

Finally. the tank sealing specialists in the Materials and Processes Engineering Department are always at your disposal through the Customer Service organization. We share with our Lockheed colleagues in other fields of specialization a commitment to ensuring that the customer receives all of the value built into every product we make.

Sincerely,

Mike Billias

M. G. Billias, Staff Engineer
Materials and Processes Engineering



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# MAINTENANCE OF INTEGRAL FUEL TANKS

Four integral fuel tanks are standard equipment in every Hercules aircraft, two in each outer wing. They are identified, left to right, as the No. 1, No. 2, No. 3, and No. 4 main tanks (Figure 1). These tanks are integral parts of the wing structure, hence the term integral fuel tanks. They occupy the space between the front and rear beams, the upper and lower surfaces of the wings, and the bulkheads that serve as the inboard and outboard walls of each tank.

## INTEGRAL FUEL TANK SEALING

Great care is taken during manufacture to protect the tanks against future corrosion and the possibility of fuel leaks. Before assembly is begun, the aluminum parts which will make up the integral fuel tanks are sulfuric-acid anodized to reduce their susceptibility to corrosive attack. In sulfuric acid anodizing, a thin layer of inert oxides is caused to form on exposed metal surfaces. This inhibits further chemical action and helps protect the underlying material from a wide variety of corrosive influences. As further protection, MIL-C-27725 corrosion preventive coating is applied to all detail parts after the anodizing process is complete. The major structural components forming the lower surface of the fuel tanks are given a second coat of MIL-C-27725 corrosion preventive coating containing a biocidal additive immediately after application of the first coat. The MIL-C-27725 corrosion preventive coating is then heat-cured at 200°F (93.3'C) for one hour.

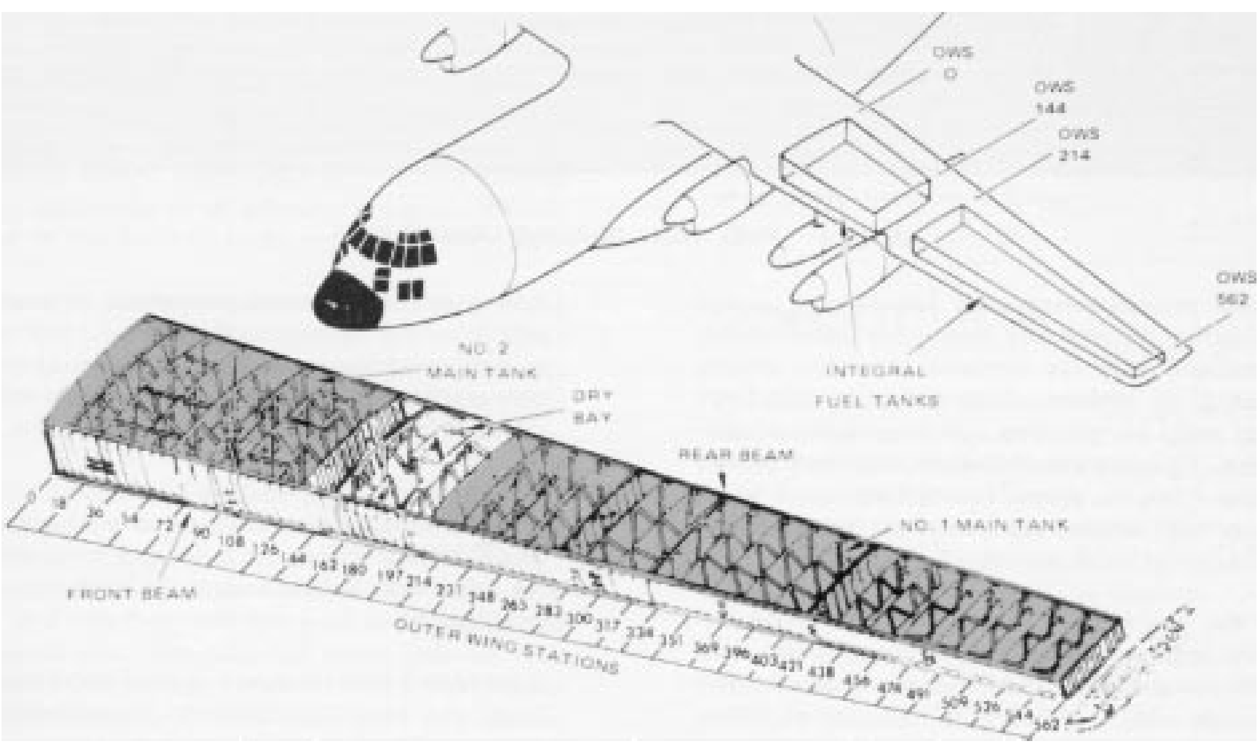


**Figure I. integral fuel tank locations – left wing.**

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| SEALING COMPOUND | | APPLICATION TIME, HOURS, LIMIT | ASSEMBLY TIME, HOURS, LIMIT (INCLUDES APPLICATION TIME) | TACK-FREE TIME, HOURS APPROX. (INCLUDES ASSEMBLY TIME) |
|---|---|---|---|---|
| SPECIFICATION | CLASS | | | |
| MIL-S-8802 | A-112 | 1/2 | NIA | 10 |
| | A-2 | 2 | N/A | 40 |
| | B-1/2 | 1/2 | I/2 | 10 |
| | B-2 | 2 | 2 | 40 |
| | B4 | 4 | 4 | 46 |
| MIL-S-81733 TYPE I | A-1/2 | I/2 | NIA | 16 |
| | A-2 | 2 | N/A | 24 |
| MIL-S-81733 TYPE II | B-112 | 112 | 1/2 | 16 |
| | B-2 | 2 | 2 | 24 |
| MIL-S-81733 TYPE IV | E-12 | 12 | 20 | N/A |
| | B-24 | 24 | 60 | N/A |
| | B48 | 46 | 166 | N/A |
| MIL-C-83019 | N/A | 3 | N/A | 4 |

Note that the application, assembly. and tack-free times of the sealing compounds above are for standard conditions of 77 +/-2°F (25 +/-1°C) and 50 +/- 5% relative humidity. Colder temperatures and lower humidity extend application and assembly times and delay tack-free times; warmer temperatures and higher humidity shorten application and assembly times and accelerate tack-free times.

**TABLE 1: FUEL TANK SEALING COMPOUNDS**

‘The next manufacturing steps are directed toward ensuring that the tanks are thoroughly sealed against fuel leakage. After the corrosion preventive coating has cured, all surfaces which are to be sealed are cleaned with an approved solvent, usually trichloroethane. The purpose of this cleaning is to remove anything - dirt, oil, grease, even fingerprints - which could prevent sealants and coatings from properly adhering to the metal surfaces.

When the wing is ready for assembly, the faying surfaces of each tank’s structural components are sealed with a 0.0l0- to 0.015-inch layer of corrosion inhibitive polysulfide sealant, MIL-S-81733. The use of sealant on the faying, or mating, surfaces prevents the channeling of fuel along the joint to a point remote from an internal leak source. This considerably simplifies any subsequent leak detection procedures. A second and very important function of the faying surface seal is to provide corrosion protection of the mating surfaces. Any moisture getting to the faying surface will leach inhibitor from the sealant to inhibit corrosion.

The application of faying surface sealant must be a carefully controlled process. Once a wing has been assembled, the faying surface seals are not accessible for any future repairs unless the basic structure is disassembled.

After MIL-S-81733 sealant is applied to the faying surfaces, the wing parts must be assembled and the fasteners installed before the expiration of the assembly time. The assembly time (Table 1) is determined by the work life of the sealant and may be

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understood in a practical sense as the time within which a joint must be completely assembled and permanent fasteners installed. All fasteners which pass into the fuel tank boundary, the area in which they may be exposed to fuel or fuel vapors, are installed wet, using MIL-S-81733 sealant.

There is a further operation which must be accomplished prior to the expiration of assembly time: injection sealing. Injection sealing consists of pumping MIL-S-8802 Class B sealant into the voids that remain in such places as the bulkhead corner fittings after faying surface sealing. These voids must be filled in order to provide a base for the fillet seals which will be applied subsequently. Injection sealing also eliminates air pockets, which could later expand and burst, possibly destroying the integrity of the tank seals in the process.

The faying surface sealant and the injection sealant are then allowed to cure, a process which can take from several days to several weeks, depending upon the ambient conditions and the exact formulation of the sealant. After curing is complete, the fuel tanks are tested by pressurizing them with air to 3.9 psi. A leak detector solution is then applied to the outside of the tanks, and any leaks found are noted and recorded for later corrective action.

After completion of the leak test, the tanks are completely cleaned in preparation for fillet sealing. Fillet seals are seals that are applied along the edges of the faying surfaces. Prior to the application of the fillet seals, the local areas to which the fillets are to be applied are cleaned with trichloroethane solvent to ensure maximum adhesion of the fillets to the corrosion preventive coating and to the exposed bead of faying surface sealant. Good adhesion is further ensured by the application of an adhesion promoter, PR147, PR148, or Pro-Seal 151, to the areas to be fillet sealed.

MIL-S-8802 Class B polysulfide sealant is used for the fillets. The fillets must be smoothed and pressed into shape with a phenolic tool or a brush lubricated with MIL-S-8802 Class A sealant within an hour of application.

After the fillets have been applied, all fasteners penetrating the fuel tank boundaries, including the base plates of dome nuts, are brush sealed with two coats of MIL-S-8802 Class A sealant. The first coat is cured to a tack-free condition prior to application of the second coat. The fillet and brush seals are then allowed to cure until they are tack-free. When they are tack-free, the tanks are again leak tested by pressurizing the tanks to 3.9 psi. Any leaks found are repaired and the test repeated. The tanks are then vacuum tested by reducing the pressure within the tanks to a value equivalent to approximately 2 psi below atmospheric pressure. Any leaks that are discovered are repaired at this time.

The tanks are then thoroughly cleaned again, and all exposed sealant in the tanks is overcoated with MIL-C-83019 fuel-resistant topcoating. The topcoating is carefully applied so that it overlaps the adjacent MIL-C-27725 corrosion preventive coating of the metal tank structure by no more than 1/4 of an inch.

After the topcoating has cured, the tanks are leak tested again, using both air pressure and fuel soaking. Each tank is tested with a full fuel load with a 60-inch head or "standpipe" to double fuel pressure. The surge box in each tank is also leak tested at this time. If any leaks are found, they are repaired and the tanks tested once more before delivery of the airplane to the customer.

As can be seen from the foregoing description of fuel tank sealing and testing procedures, no effort is spared during the manufacture of a Hercules aircraft to ensure that the customer receives an airplane whose integral fuel tanks are built to remain trouble- and leak-free for a long time. Unfortunately, fuel leaks do sometimes develop in the course of a large aircraft's service life no matter how carefully it is designed and constructed. This is due to such factors as wing deflection during hard landings and flight in turbulent weather, sealant deterioration, loose fasteners, physical damage, and corrosion.

Let us now look at some of the ways in which problems involving integral fuel tanks - typically problems with leaks - can be solved. The information below will assist the maintenance technician in classifying and recording leaks, locating the exact leak source inside a tank, identifying the cause of leakage, and determining the appropriate corrective action.

## CAUSES OF FUEL LEAKS

There are a number of reasons why leaks develop in integral fuel tanks. Some causes are quite obvious. Leaks that occur when the tanks are penetrated or the wing boxes deformed as a result of structural damage require little by way of explanation. The causes of leaks that develop in the course of normal aircraft operation can be somewhat more obscure.

No doubt the majority of leaks that occur in normal service can be traced to problems with fasteners. There are literally thousands of fasteners in the integral fuel tanks of every large aircraft, and each one is a potential leak source. To provide a good seal, a fastener must be of a specific size and properly wet-installed in a correctly prepared hole. Although a high degree of quality is demanded and achieved during manufacture, not every fastener in every airplane will perform perfectly and remain tight indefinitely.

Even if fabrication conditions were always ideal, fuel leaks would still develop. This is because sealing materials are elastic, rubber-like substances and cannot be expected to function as do stronger structural materials. Furthermore, even though modern sealants have excellent characteristics and improvements are constantly being made, there are special problems intrinsic to the chemical and physical peculiarities of sealants that can affect their long-term performance.

For example, sealants may contain blisters, and blisters are sometimes a starting point in the development of fuel leaks. A blister appears as a small bulge if it has not been broken, or as a small crater with well-defined edges if it has. Blisters can be caused by trapped air or solvents, and occasionally by gases formed during the curing process. Although they are not ordinarily a problem when sealant is new, blisters can cause trouble later on. They may be mechanically disrupted as the wings flex, or they may burst as a result of changes in atmospheric pressure during flight or high ambient temperatures on the ground.

Cracks and breaks can develop in sealant, and such cracks commonly make their existence known in the form of fuel leaks. Sealant cracks may be the result of repeated, excessive flexing of the wings during hard landings, high-speed taxiing over uneven ground with a heavy fuel load, or operation in rough air. Breaks and cracks in sealant can even be traced to the footwear of maintenance personnel who enter the fuel tanks, which is why extreme care is necessary to prevent damage whenever the tanks must be opened for maintenance. Note that physical damage to a coating of sealant may be difficult to see because breaks in these elastic materials often appear to close up once whatever caused the damage is no longer present. Unless a piece of sealant has become completely detached, close examination will generally be required to locate a break, even one that fuel seems to find quite readily.

Another cause of fuel leaks is voids or omissions in the sealant. Typically, such vacuities are difficult to find because they are often located in such places as seams and joints where they are hidden by the wing structure. Not even the use of lights and mirrors will always confirm that an unsealed cavity exists. The only way to be fairly certain that sealant is missing is to check the injection holes for evidence of extruded (squeezed-out) sealant. If any of these holes and openings lacks extruded sealant, a void or omission probably exists.

Pinholes in sealant are another invitation to fuel leaks. Pinholes may develop during curing if sealant is not thoroughly worked around tank fasteners in the course of brush sealing. Chemical problems resulting from too-rapid mixing of sealant base compound and accelerator can cause small gas bubbles which may break later and initiate leaks. Because of the small size of pinholes, they may be difficult to see. A beam of light directed almost parallel to the surface should assist in detecting them.

Aged or deteriorated sealant cannot perform its function properly and fuel leaks may develop as a result. Deteriorated sealant appears chalky or powdery and cracks easily if flexed. It may also contain pinholes. Sealant deterioration is primarily due to the long-term effects of exposure to fuel, and the process may be accelerated if a tank that has been in use is left dry for extended periods of time. This condition is uncommon in newer Hercules aircraft because the tank sealant is now normally topcoated to help protect it against deterioration of this kind.

Fuel leaks can also develop if sealant applied during repairs does not adhere tightly. If the metal tank structure is not thoroughly cleaned prior to sealant application, the sealant will not adhere properly. Dirt, grease, soap film, oil film, trapped moisture, and even fingerprints can destroy adhesion. Poor adhesion can also be the result of using sealant that is about to exceed its application life or by using sealant that has not been properly thawed after having been stored in the frozen condition.

Finally, dried-out Buna-N topcoat can cause leaks. Buna-N was applied to fuel tanks on Hercules aircraft built prior to Lockheed serial number LAC 3883. If a Buna-N topcoated fuel tank remains empty long enough for the sealant to become really dry, the topcoat tends to harden and then crack, increasing the possibility of leaks. This condition affects the whole sealing system and can be identified by the appearance of a network of cracks over the sealant surfaces. It can be prevented by coating the Buna-N topcoat in the entire tank with MIL-0-6081 Grade 1010 oil when the tank is to be left empty for a period of time.

## TYPES OF LEAKS

Fuel tank leaks are classified as belonging in one of four categories, depending on the size of the wetted area around the leak. They are, in order of increasing severity, slow seep, seep, heavy seep, and running leak. Both the type of leak and its location have a bearing on whether immediate remedial action is required or repair can be delayed until a convenient opportunity presents itself.

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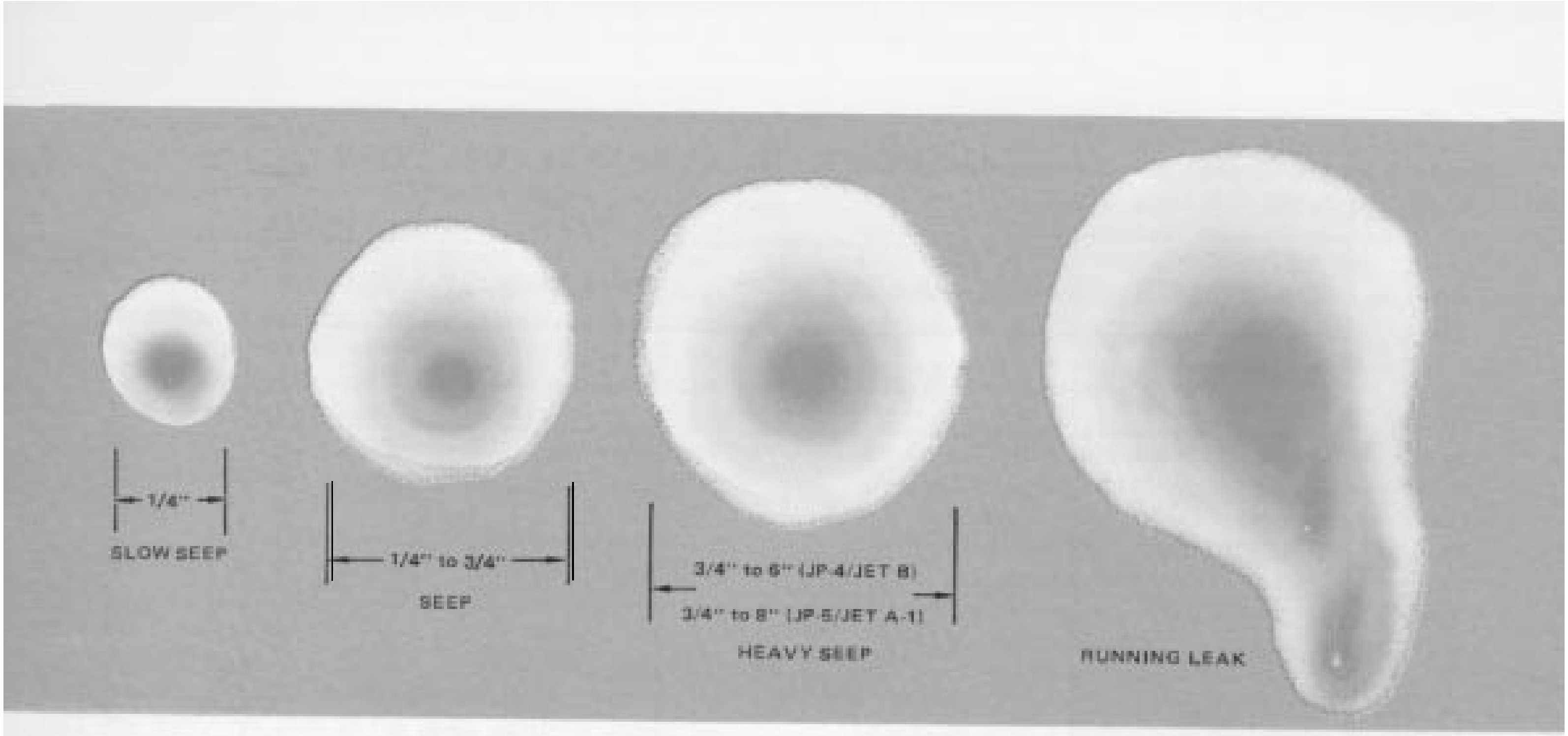



**Figure 2. Classification of leaks by size of wetted area**

An important additional consideration in classifying fuel leaks is the type of fuel involved. For one thing, fuels differ in surface tension and hence in their ability to penetrate minute openings. More important, however, "wide-cut" fuels such as JP-4 and Jet B have much lower flash points than kerosene-type fuels like JP-5, JP-8, Jet A, and Jet A-l. The difference in flash points affects just how much leakage may be tolerated in a given situation without undue danger of fire or explosion. This, in turn, influences the way some leaks should be classified. Be sure to bear in mind the importance of the kind of fuel being used when evaluating fuel leaks.

The wet area around a leak is a fairly reliable measure of its severity. To evaluate the size of this area accurately, dry the area around the leak exit point with a clean, absorbent cloth and then apply red-dyed talcum powder (Semco PR-491 or the equivalent). After waiting 6 minutes, examine the affected area again and evaluate the leak according to the following criteria (see also Figure 2 and Table 2). These guidelines reflect updated information scheduled for publication in a forthcoming revision of T.O. l-l-3, Inspection and Repair of Aircraft Integral Tanks and Fuel Cells.

A slow seep is a leak where fuel does not reappear immediately after being wiped away, and does not wet an area more than l/4 inch wide in a 6-minute period when it does reappear. This applies to all approved Hercules aircraft fuels.

A seep **is a leak** where fuel does not reappear immediately after being wiped away, but wets an area up to 3/4 inch across in 6 minutes when it does reappear. This 'applies to all approved Hercules aircraft fuels.

A 'heavy *seep* is a leak where fuel reappears immediately after being wiped away and continues to spread slowly. JP-4 or Jet B leaking from a heavy seep does not wet an area greater than 6 inches in diameter in 6 minutes and does not run, flow, or drip. JP-5, JP-8, Jet A, or Jet A-l leaking from a heavy seep does not wet an area greater than 8 inches in diameter in 6 minutes and does not run or flow. These fuels may, however, drip up to 4 drops per minute from a heavy seep.

A running *leak* is a leak in which fuel wets an area greater than that specified for a heavy seep or, as the name implies, runs, flows, or drips from the aircraft structure. Any leak where JP-4 or Jet B drips from the structure is regarded as a running leak. When kerosene-type fuels like JP-5, JP-8, Jet A, or Jet A-l drip more than 4 drops per minute, the leak must also be placed in this category.

A slow seep, seep, or heavy seep from the external surface of an integral fuel tank need not be cause for grounding an aircraft provided that the leaking fuel does not flow into an enclosed area such as the wing leading edge or a dry bay. As long as they are located in open areas, repair of these types of leaks may be delayed until the airplane is out of service for some other reason and ample time is available for fuel tank repair. On the other hand, a slow seep, seep, or heavy seep in an enclosed area must be repaired prior to flight.

| LEAK CATEGORIES | SIX-MINUTE LEAK LIMITS BY FUEL TYPES (Size of Wetted Area) | |
|---|---|---|
| | JP-4/JET B | JP-5/JP-8/JET A/JET A-l |
| SLOW SEEP | l/4 inch or less. | l/4 inch or less. |
| SEEP | From l/4 inch to 3/4 inch. | From l/4 inch to 3/4 inch. |
| HEAVY SEEP | From 3/4 inch to 6 inches without dripping. | From 3/4 inch to 8 inches, or fuel drips up to 4 drops per minute. |
| RUNNING LEAK | Greater than 6 inches, or fuel drips or runs from surface. | Greater than 8 inches, or fuel drips more than 4 drops per minute. |

**TABLE 2: FUEL LEAK CLASSIFICATIONS**

A running leak, regardless of its location, requires immediate grounding of the aircraft for fuel tank repair.

## LOCATING A LEAK SOURCE

In order to repair a fuel leak properly, the true leak source first has to be found. Simply applying some sealant inside of the tank at a location approximately opposite the leak exit point is seldom successful in solving the problem. Although the factory-installed faying surface seals are specifically designed to minimize channeling of fuel from one part of a tank to another, fuel may still find leak paths past skin splices, doublers, or spar caps. Efficient leak detection is something of an art as well as a science, and it is essential to be thoroughly familiar with wing structure as well as factory tank sealing methods before undertaking it.

When investigating a fuel leak, it is of vital importance to keep in mind that fuel tank repair is an inherently hazardous activity. The liquid fuels used for aircraft propulsion are by definition flammable and their vapors are explosive. When inhaled, particularly in enclosed spaces such as fuel tanks, these same vapors are capable of causing illness or death. As if these were not already dangers enough, prolonged contact with liquid fuel is harmful to the skin.

Be sure to observe all of the safety procedures spelled out in the applicable fuel system maintenance handbooks, and reinforce them with a generous measure of basic safety awareness and common sense. There is no reason why fuel tank maintenance cannot be made very nearly as safe as any other aircraft maintenance activity. Knowing and practicing the proper procedures, avoiding unnecessary risks, and staying alert for the unexpected are guidelines that will help ensure that safety remains priority number one no matter what the task.

There are basically five fuel leak detection methods that apply to Hercules aircraft integral fuel tanks. They are known as the fuel level method, the air bubble method, the fluid blowback method, the drilled-screw method, and the vacuum and dye method.

## Fuel Level Method

When a leak is discovered in an integral fuel tank and its source is not obvious, a good initial approach to finding it is to try locating it by the fuel level method. This method will permit you to establish the approximate level of the leak when it is in the front beam, rear beam, or tank bulkheads. The fuel level method has the virtue of great simplicity and, although less precise than some other methods, it often provides enough information about the general location of the leak source to permit it to be pinpointed later.

The fuel level method of leak location requires that the affected tank be defueled in lOOO-pound increments until the leak stops. A lOOO-pound drop in fuel quantity indicated by the flight station gages is approximately equal to a 2-inch drop on the fuel tank dipstick. When the fuel stops leaking, the level will be just below the level of the leak. This level should be noted on the dipstick. After the tank has been defueled and purged, it is often possible to find the leak source by examining the inside of the tank in the vicinity of the leak exit point at the level noted on the dipstick.

## Air Bubble Method

If the leak source eludes the fuel level method of detection, try the air bubble method. To use this leak detection method, defuel, drain, and purge the affected tank in accordance with the applicable fuel system maintenance manual. You will need an assistant to help in this case; one person to work inside the tank and the other stationed outside.

Coat the area around a suspected leak source inside the tank with a solution of specification MIL-L-25567 leak detector fluid. Approved materials include Oxy-Tee Type 1, manufactured by American Gas and Chemical Co., Ltd. of Northvale, N.J.; and F-19, manufactured by Cee Bee Chemical Co. of Downey, Calif. Have your assistant outside the tank direct a stream of air from a compressed air line regulated between 90 and 100 psi at the leak exit point. No fitting should be used on the air hose; the open end of the hose is simply held 1/2 inch from the structure while the air stream is directed against the surface. If the nature of the structure around a suspected leak exit point makes it difficult to get air to the appropriate area, special nozzles made of soft copper tubing may be fabricated to help reach these locations.

Continue to have air applied to the exit point outside the tank until the leak source has been located, as evidenced by bubbling of the leak detector solution at the leak source. Be sure to clean up the leak detector solution thoroughly before starting with repairs.

Some fuel tank maintenance specialists prefer to attack the problem from the other direction when using the air bubble method; namely, by applying leak detector solution to the outside of the tank and air pressure to the inside. Both approaches have their good points. In either case, if this method of leak detection fails to positively locate the leak source, the fluid blowback method should be tried.

## Fluid Blowback Method

The fluid blowback method of leak detection is in principle rather similar to the air bubble method, but in this case, specification TT-I-735 isopropyl alcohol is blown into the leak exit point instead of air. The point at which the alcohol shows up on the inside of the tank can then be identified as the leak source. Once again, two people will be required to perform the test.

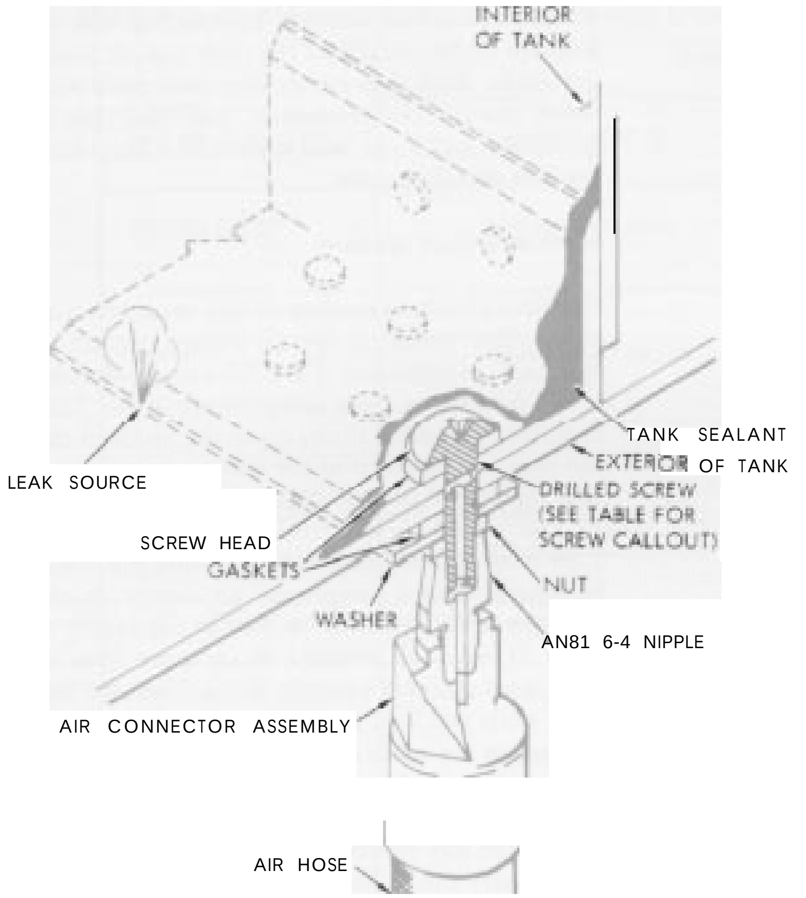
Pour isopropyl alcohol into a pressure pot which can be connected to a compressed air supply. A pressure regulator and gage must be used in the supply line in order to limit the pressure to no more than IO psi. Have your assistant blow the alcohol into the leak exit point while you look for the place at which the alcohol appears on the inside of the tank. After the leak source has been located, blow all of the residual alcohol out of the aircraft structure before attempting to repair the leak. If the leak source cannot be determined using this method, try the drilled-screw method.

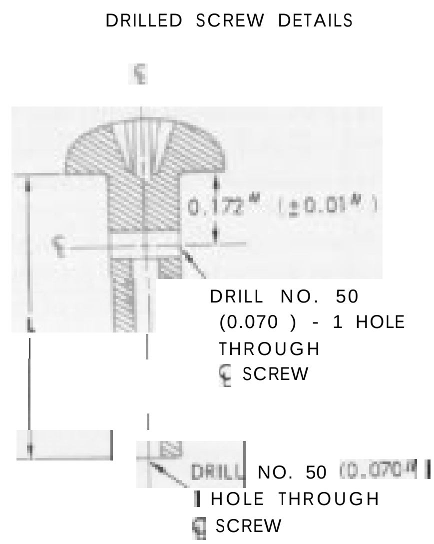
## Drilled-Screw Method

The drilled-screw method of leak detection uses a modified screw through which air or isopropyl alcohol can be injected. An AN526-series screw of the appropriate diameter and length is modified as shown in Figure 3. After the screw has been prepared, the rivet or bolt thought to be the leak exit point is removed. Then the drilled screw, gaskets, washer, and nut are installed as shown in Figure 3. Leak detector fluid is then applied to the suspected leak source area inside the tank. First try to determine the leak source, using air. Blow air through the drilled screw at a maximum pressure of 10 psi and watch for bubbles in the leak detector fluid inside the tank. If the use of air doesn't reveal the leak source, wash off the leak detector fluid and inject isopropyl alcohol through the drilled screw, utilizing the same equipment used for the fluid blowback method. Alcohol should appear at the leak source inside the tank. Remove all traces of alcohol after determining the leak source and before repairing the leak. If this method fails to find the leak source, the vacuum and dye method should be tried next.

## Vacuum and Dye Method

The vacuum and dye method of leak detection is one of the most accurate methods of locating a fuel leak source. There are two types of dyes that can be used: a




| SCREW CALLOUT TABLE | |
|---|---|
| L INCHES | SCREW PART NO. |
| 0.75 | AN526-1032R12 |
| 0.88 | AN526-1032R14 |
| 1.0 | AN526-1032R16 |
| 1.12 | AN526-1032R18 |
| 1.25 | AN526-1032R20 |
| 0.75 | AN526-832R12 |
| 0.88 | AN526-832R14 |
| 1.0 | AN526-832R16 |
| 1.12 | AN526-832R18 |
| 1.25 | AN526-832R20 |

Modify the air connector assembly, using an AN81 6-4 nipple and a nut of the appropriate size. Braze the nut to the nipple as shown and then grind it to a smooth, flat finish. Finally, tap the inside of the nipple to a depth of 0.88 inch, using a 10-32 or 8-32 size tap.

*Figure 3.* **Drilled-screw leak detection method: fabrication details.**

fluorescent dye and a colored dye. The fluorescent dye is used in conjunction with an ultraviolet light source. The colored dye can be seen with the unaided eye and can be used if an ultraviolet light is not available. The fluorescent dye is made up using one part ZL-22 Zyglo Penetrant, manufactured by Magnaflux Corp. of Chicago, Ill., to ten parts fuel. If the colored dye is to be used instead, add one ounce of specification MIL-D-81298 red liquid dye to 100 U.S. gallons of fuel. Once the dye is ready, the tank is evacuated to 1 psi negative pressure, using the procedure described in the applicable fuel tank maintenance manual. The dye is then daubed on the leak exit point, using a camel hair brush, or injected into the leak exit point, using a syringe. The dye will emerge at the leak source inside the tank and be easily seen with the aid of an ultraviolet light if fluorescent dye is used or with the unaided eye if red dye is used.

If the leak exit point is on the lower surface of the wing, application of the dye may have to be done using a plastic bag taped over the leak exit point in order to keep the area constantly covered. On the upper wing surface, a circular dam can be built around the exit point, using specification MIL-P-8116 zinc chromate putty, and filled with dye to keep the area wet.

The leak exit point should be kept wet with dye for 1/2 to 1 hour, depending on the size of the leak. The vacuum should be maintained for 1 to 2 hours. For very small leaks, it may be necessary to increase these times. If, after returning the tank to ambient pressure, it is found that no dye has penetrated to the tank interior, repeat the procedure but increase the time the tank is evacuated.

Because of the extensive preparation required and the possible damage that could result if the instructions in T.O. l-l-3 and in the Hercules aircraft fuel systems maintenance manual are not followed carefully, the vacuum and dye method of leak detection should be tried only if the four preceding methods have failed.

There is a sixth method of fuel leak detection that can be employed if none of the other procedures yield unambiguous results. This is the fuel tank pressure test, and it is described in detail in T.O. l-l-3. If this test is to be employed, remember that maximum test pressure must not exceed 3.5 psi.

## SEALANT REPAIRS

Fuel tank sealant repairs are classified as either permanent or temporary. Permanent repairs are repairs made at the leak source inside the tank and, if properly accomplished, should eliminate the leak and prevent recurrence. Temporary repairs are repairs done on the outside of the tank at the leak exit point, can be made quickly, and normally do not require defueling.

If one of the leak detection methods we discussed earlier has been used to determine the leak source inside the tank, a permanent repair should be made because the tank has already been drained and purged. If, on the other hand, time has not been taken to determine the leak source, a temporary repair can be made at the leak exit point. Temporary repairs can be justified when it is necessary to perform an urgent mission, or when the type of fuel leak, as described in the leak classification section of this article, is not bad enough to warrant grounding the airplane. Nevertheless, temporary repairs should always be replaced with a permanent repair when the airplane is grounded for other maintenance that requires entry into that tank, or during a scheduled maintenance period. Temporary repairs should be recorded on the airplane maintenance forms and referred to when performing fuel system repairs. Entries in the maintenance records should specify the location of the leak, the type of leak, and the repair method used. Charts such as the ones shown in Figures 4a and 4b can be very useful in keeping a history of fuel tank leaks and should be kept with the maintenance forms.

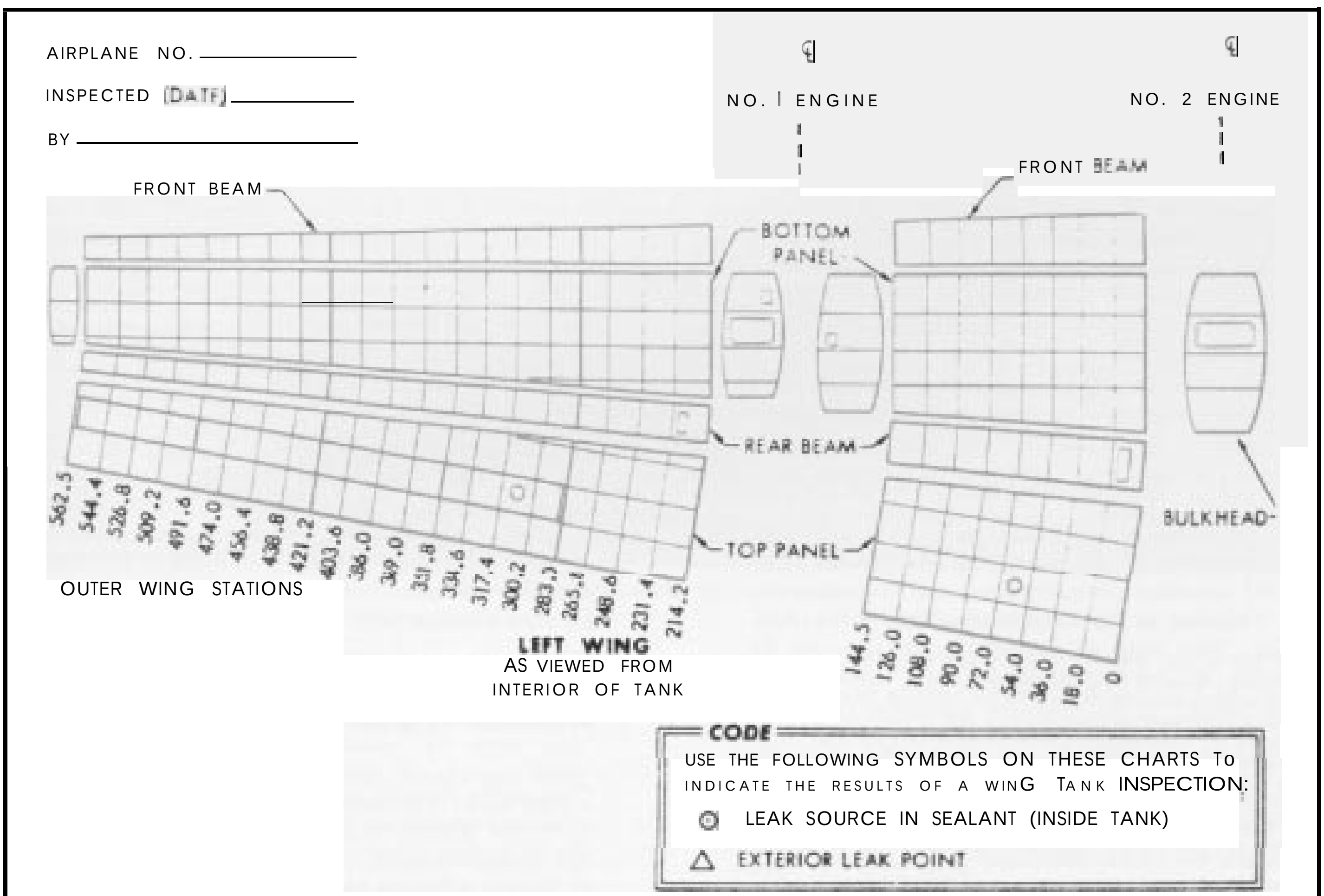



*Figure 4a.* Integral fuel tank inspection chart – left wing.

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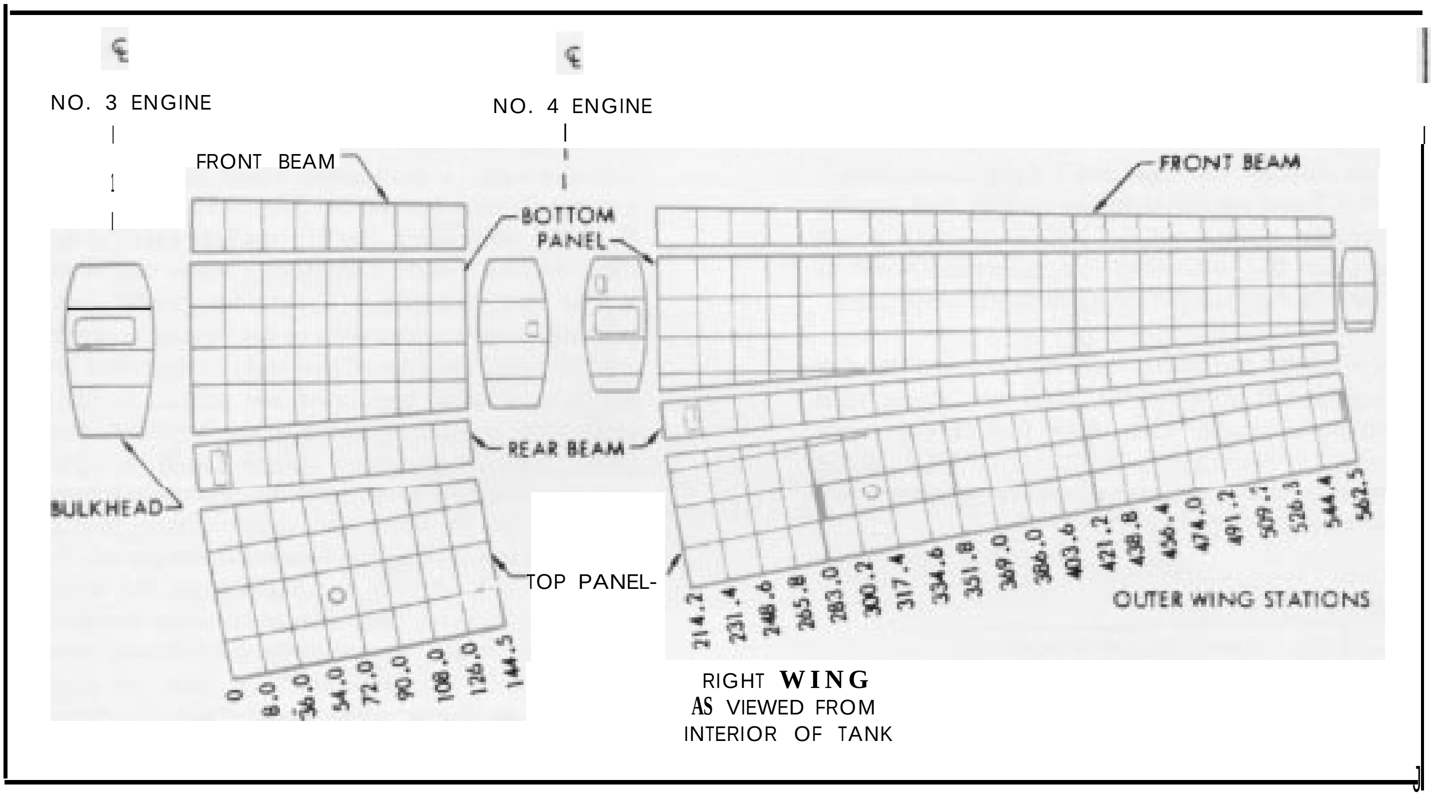



**Figure 4b. Integral fuel tank inspection chart – right wing.**

### Permanent Repairs

When the tank is entered to repair a leak, several important preliminary steps must be taken prior to actual application of sealant. First, all the defective sealant around the leak source must be removed. This removal is best accomplished by cutting away the defective sealant, using the tools shown in Figure 5. A thin film of sealant remaining on the tank structure need not be removed, provided it is well bonded to the surface. If the repair is being made in a flat area of the tank such as the tank bottom or wall, taper the edge of the sealant around the leak source to provide more surface for repair sealant adhesion. Tapering the edge of fillet repairs is not necessary if the adjoining flat surface is not affected.

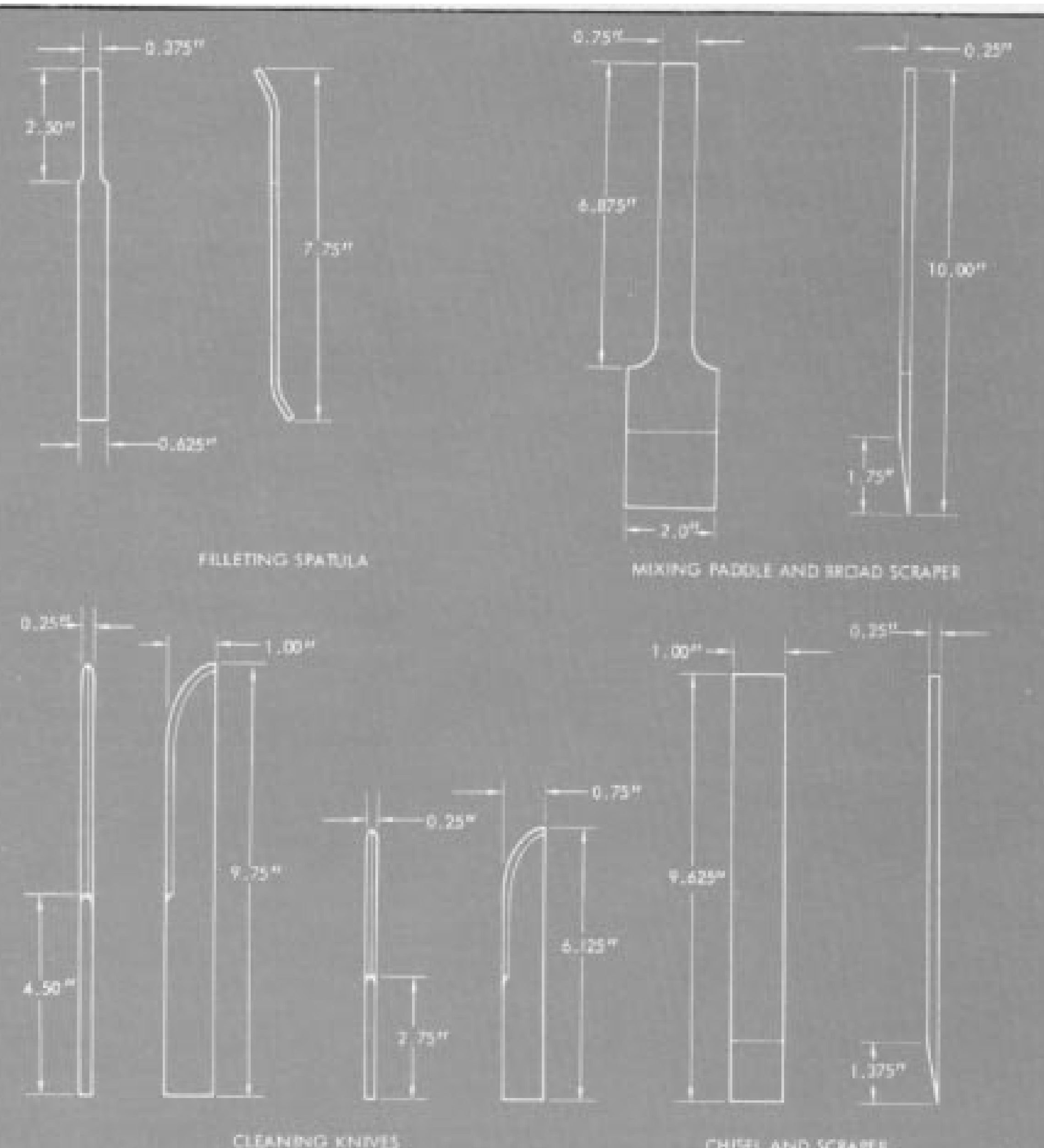
During the removal of defective sealant around a leak source, care must be taken not to damage the MIL-C-27725 corrosion preventive coating of the tank structure, if applied, or the chemical anodizing of the metal surface. Thin films of sealant can be removed by scrubbing with a rag dampened with methyl ethyl ketone (MEK). If the corrosion preventive coating is damaged or removed, it can be repaired with specification MIL-S-81733 corrosion inhibiting sealant more economically, more reliably, and more quickly than with the original MIL-C-27725 coating material. The procedure will be described later in this article. If the chemical anodizing of the metal surface has been damaged, refer to the appropriate corrosion control maintenance instructions.

After the defective sealant has been removed and the remaining sealant tapered, if necessary, the area should be cleaned using MEK, aliphatic naptha, or trichloroethane. At this time, the structure of the tank in the leak source area should be inspected. If the leak is at a fastener, the fastener should be closely inspected to determine that it is structurally sound. If there is any question as to its integrity, the fastener should be removed and replaced with a properly installed one. If a fastener is structurally defective, removing the sealant around the existing fastener and resealing it will not permanently fix the leak.

The leak source area should also be inspected for corrosion. With the advent of new sealing techniques and the use of biocidal additives in jet fuel, corrosion is not as much of a problem as it once was. Nevertheless, if corrosion is present, it must be removed in accordance with the corrosion control maintenance instructions for your airplane prior to sealant application.

### Preparation for Repairs

Thoroughly cleaning the area of the leak source prior to sealant application is probably the most important step in making a fuel tank repair. Ninety-nine percent of sealant adhesion failures are caused by improper cleaning. To ensure that your attempt to stop a fuel leak is a success, make sure the repair area is clean




The filleting spatula is usually manufactured locally, using 0.064-inch 2024-T3 aluminum alloy (round off sharp edges). The mixing paddle and board scraper, the cleaning knives, and the chisel and scraper can be made from hard, vulcanized fiber, hard maple lumber, oak lumber, or phenolic laminate.

Besides the above tools, three sizes of brushes are needed: a ½-inch round brush, a 1-inch flat brush, and a 2-inch flat brush.

**Figure 5. Hand tools for tank sealing.**

prior to sealant application. Polysulfide sealants such as specification MIL-S-8802 and MIL-S-81733 adhere well to most surfaces, provided that the surfaces have no grease, oil, dirt, soap, water, or other contaminants. If the repair area is first cleaned with water to remove leak detector solutions and other water-soluble contaminants, and then cleaned with an organic solvent such as MEK, aliphatic naptha, or trichloroethane to remove oils or greases, the sealant should always adhere to the surface after it is cured. It is important that only clean, dry rags and clean solvent be used to remove any contamination. After the solvent has been applied to the structure, use only clean, dry rags to wipe it up and do this before the solvent evaporates. Once a rag has absorbed dirt or grease, discard it and get another clean rag so that you are not merely redistributing the contamination. Continue working in this manner until the repair area is completely and truly clean.

On the early Hercules aircraft which have fuel tanks topcoated with Buna-N, the Buna-N must be completely removed from the area being repaired. Repair sealant will not adhere adequately to Buna-N. Repeated rubbing with rags soaked in MEK or methyl isobutyl ketone will remove the Buna-N. The rags must be changed frequently and only clean solvent can be used. A quick test to determine if all the Buna-N is removed is to place a drop of clean MEK on the surface and rub it with your finger. If the surface feels sticky or tacky, the Buna-N has not been completely removed. After the repair area is clean of Buna-N, application of sealant is the next step.

On later-model Hercules aircraft with MIL-C-27725 corrosion preventive coating instead of Buna-N topcoat, an adhesion promoter (PR147, PR148, or Pro-Seal 15 I) must be applied immediately after the repair area has been cleaned and prior to sealant application. The reason for the use of the adhesion promoter is that MIL-S-8802 sealant by itself will not adhere properly to the corrosion preventive coating. After application of the adhesion promoter, the surface should remain exposed to the air for at least 1/2 hour before the repair sealant is applied. Care should be taken to ensure that the applied adhesion promoter is not contaminated during the period between when it is applied and the application of repair sealant. If sealant has not been applied within 8 hours and the adhesion promoter has not been protected, the structure must be recleaned and the adhesion promoter reapplied.

After the adhesion promoter has dried for at least 1/2 hour, or after the leak source area has been cleaned of Buna-N and dried, the repair sealant can be applied. For most repairs, MIL-S-8802 Class A-1/2 brush-type or B-1/2 fillet and injection-type sealant should be used. The A-1/2 and B-1/2 sealants have a 1/2-hour application life (see Table 1).

Sometimes it may be necessary to heat or cool the sealant, the airplane, or both prior to sealant application. If the temperature of the sealant is not between 65°F and 90°F (18.3"C and 32.2"C), the temperature must be raised or lowered so that it will be in that range. If the airplane structure is not between 65°F and 120°F (18.3"C and 48.9"C), heat or cool the structure, as necessary, in accordance with the fuel system maintenance instructions.

Sealant Application

When repairing fasteners and for other small areas, two coats of MIL-S-8802, Class A-1/2 sealant should be applied. The first coat is applied using a stiff bristle brush. To ensure good adhesion, the sealant should be rubbed onto the structure, using a rotary, scrubbing motion. The second coat is applied after the first coat is tack-free.

For larger repairs, such as replacement of a fillet section, MIL-S-8802 Class B sealant should be used. Application is done with a sealing gun, if one is available, or with a spatula (Figure 5). The sealant should be worked in carefully in order to force out any trapped air, and then faired in smoothly with the original fillet and structure. Allow the sealant to cure to a tack-free condition before going on to the next step, which is topcoating.

If time is an important factor, tack-free times for sealants can be decreased by applying a tack-free time accelerator. Pro-Seal 815, manufactured by Essex Chemical Corporation's Specialty Chemicals Division in Sayreville, N. J., can reduce the tack-free time by as much as 85 percent. If the accelerator is used, the sealant must be cleaned with aliphatic naptha or trichloroethane before the topcoating is applied.

Heat can be used instead of the chemical accelerator to decrease tack-free times. Ground heaters and heat lamps are acceptable means of supplying heat. If heat is used to decrease the cure time, the temperature of the sealant should not be allowed to exceed 140°F (60°C).

After the sealant has cured to a tack-free condition, proceed with the topcoating of the repair sealant. Hercules aircraft prior to serial number LAC 3883, unless modified with new outer wings, must be topcoated with Buna-N. Hercules aircraft LAC 4314 and later, and earlier aircraft with modified wings, are topcoated with specification MIL-C-83019 topcoat (LAC 3883 to LAC 4313 were not originally topcoated). Regardless of the type of topcoat used, apply it to the clean sealant surface with a soft bristle brush. Overlap the topcoat a maximum of 1/4 of an inch over the adjacent structure. The finished coating should be 0.001 to 0.003 inch thick. After the topcoating has cured to a tack-free condition, the tank is ready for testing. The testing procedure to be used after a leak repair will be discussed later on.

**Field Repair of MIL-C-27725 Corrosion Preventive Coating**

We noted earlier that if the MIL-C-27725 corrosion preventive coating of the tank structure is damaged, it should be repaired, using MIL-S-81733 corrosion inhibiting sealant. The repair is made by first lightly abrading the area surrounding the damaged coating with a specification MIL-A-9926 abrasive pad (Scotch-Brite Pad No. 7447, manufactured by 3M Company of St. Paul, Minn.). Be careful not to penetrate through the coating to the aircraft structure. If the coating is penetrated and the anodic film on the structure is

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damaged, repair the film in accordance with the appropriate corrosion control maintenance instructions prior to making any sealing or organic finish repairs. After the area has been abraded, vacuum the tank to remove all loose particles, clean the area with MEK, and then wipe the area dry. When the area is clean, apply adhesion promoter. After l/2 hour, apply a thin coat of MIL-S-81733 Type I or II sealant by brush to provide a coating approximately 0.01 inch thick. After the sealant has become tack-free, topcoat it with MIL-C-83019 topcoating to a thickness of 0.001 to 0.003 inch. The topcoating should overlap the adjoining MIL-C-27725 corrosion preventive coating no more than l/4 of an inch. Allow the topcoat to become tack-free prior to testing the tank.

**Repair of Deteriorated (Chalking) Sealant**

During fuel tank or fuel system component maintenance or inspection, it may be discovered that some of the sealant in the tank appears to be lighter than normal and powdery in appearance. This condition is known as chalking, and it is caused primarily by long exposure to fuel. Topcoating the sealant retards chalking, but does not entirely eliminate it. To correct the problem of chalking, the chalky area should be scrubbed with a dry stiff bristle brush and vacuumed to remove the resulting dust. After all the chalk dust is removed, the area is coated with either Buna-N or MIL-C-83019 topcoating, depending on which material was originally applied.

**Testing the Tank After Permanent Repairs**

After a permanent repair has been made, the repair should be tested prior to refueling the tank. This is accomplished by performing the air bubble method of leak detection described earlier. If the test indicates that the leak path has been sealed, the tank is ready for a fuel soak check. It should be filled with fuel and allowed to stand for at least 2 hours to ensure that the leak has indeed been stopped. During this 2-hour time period, a 15-minute engine run should be performed. After the engine run and expiration of the soak test time limit, carefully inspect the area of the repaired leak and the areas around access panels on the upper and lower wing surfaces as well. If no leaks are noted, the airplane is ready to be put back in operation. If extensive repairs were accomplished, the tank should be allowed to stand for 12 to I4 hours with a full fuel load. The 15minute engine run should also be accomplished during the extended soak test.

**Temporary Repairs**

Temporary repair of fuel leaks can be made when the time factor and type of leak does not warrant opening the tank to make a permanent repair. A temporary repair should nevertheless be replaced with a permanent repair when the airplane is grounded for scheduled periodic maintenance or when other maintenance is required inside the tank. Of course, if the fuel leak cannot be stopped using one of the temporary repair methods or if the severity of the leak increases to the point where the airplane is no longer safe to fly, a permanent repair is required.

There are a number of approved temporary repair methods available to the fuel tank maintenance specialist. They are, beginning with the most effective, the aluminum foil repair method, the pressure adapter method, the CompAir D236 injector method, and the methods using directly applied compounds.

Aluminum Foil Method

The aluminum foil repair method involves using the Model 400A-1 Field Repair Kit manufactured by Semco of Glendale, Calif. (Figure 6). The kit contains aluminum patches which can be bonded with MIL-S-8802 sealant over leaky fasteners, plus the equipment needed to install them. There are flat patches for flush-head fasteners and preformed patches which fit over protruding fastener heads and collars. This method can be accomplished without defueling the fuel tank and can be done within an hour.

The first step in this procedure is to ensure that the bonding surface on the wing and the bonding surface of the aluminum foil patch to be used are clean. As in the case of permanent repairs, external temporary repair areas must also have clean bonding surfaces for proper adhesion of the sealant. Methyl ethyl ketone again is the solvent of choice to be used in cleaning both bonding surfaces. If the paint around the leaky fastener is not removed by the solvent, abrade the area around the fastener, using a fine grade aluminum-compatible abrasive paper or cloth. The area of paint removal or abrasion should cover an area around the fastener approximately l-1/2 inches in diameter. After the bonding surfaces are prepared, MIL-S-8802 Class B-1/2 sealant is applied to the patch, which is then placed over the leak. The sealant is then force-cured for approximately 30 minutes, using the heating tool and die included in the Semco 400A-1 repair kit. If the aluminum foil patch is properly applied, it can last as long as an internal permanent repair. It should nevertheless still be replaced with a permanent repair at the earliest convenient time.

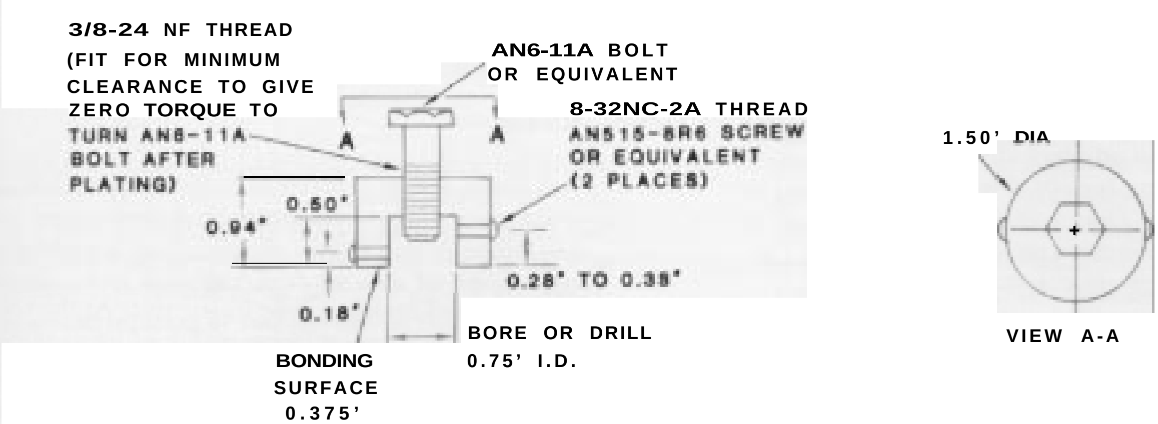
An alternative to using MIL-S-8802 with the aluminum patches is to apply the patches with an extra-fast-setting epoxy adhesive called Hardman Epoxy, manufactured by Hardman Inc. of Belleville, N. J. Hardman Epoxy sets up in approximately 10 minutes.

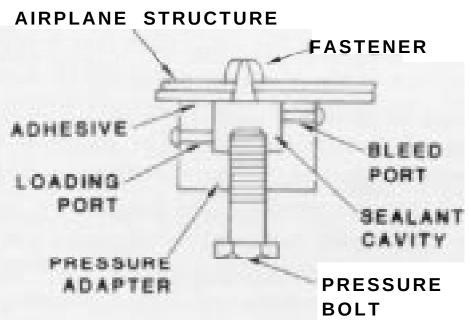

Figure 6. **Semco Model 400A-1 Field Repair Kit.**

Pressure Adapter Method

Another temporary repair method is the pressure adapter method. It uses a locally manufactured tool (Figure 7) to extrude or force sealant into a leaky fastener. The pressure adapter is cemented over the leaking fastener, using specification MIL-A-46050 adhesive. The adapter cavity is then filled with MIL-S-8802 Class A sealant. The sealant is forced into the leak path by turning a pressure bolt into the adapter. The rigid adapter installation and controlled application of pressure (by use of a torque wrench) reduces the possibility of structural damage and increases the probability of a positive seal.

To use this procedure, start by cleaning the bonding surface of the adapter with MEK and, if necessary, emery cloth. Then strip the paint around the leak area and also clean it with MEK to ensure that the adhesive will bond properly. After determining where the




**A pressure adapter for sealing leaking fasteners can be locally fabricated from 4130 steel that has been cadmium plated per specification QQ-P-41 6, Type 1 or 1 El, Class 1 or 2. or zinc plated per QQ-Z-325, Type 1 or 2. Class 2.**

**If a bolt other than an AN6-1 1 A bolt is used for the pressure bolt, ensure that the length of the threaded part of the bolt is not greater than the thickness of the adapter, i.e. 0.94 of an inch. Bolts with threads longer than 0.94 of an inch can extend beyond the bonding surface. which will dislodge the adapter and possibly damage the airplane structure.**

Figure 7. Pressure adapter: fabrication details.

adapter is to be positioned on the wing, apply specification MIL-A-46050 adhesive (Eastman 910 or Loctite Super Bonder #430) to the bonding surfaces of the wing and adapter. Now press the adapter over the leaky fastener and hold for 10 seconds. Release the adapter and allow it to remain undisturbed for 15 minutes. After 15 minutes, remove the pressure adapter loading port screw and back out the bleed port screw until one further turn will remove it from the adapter. Remove the pressure bolt to drain any fuel and then reinstall it, turning it in about 12 turns. Inject MIL-S-8802 Class A sealant into the loading port until sealant appears at the bleed port. Now tighten both the loading screw and the bleed screw and apply 5 inch-pounds of torque to the pressure bolt for 5 minutes. After this time has elapsed, remove the adapter by tapping it with a hammer and clean any excess sealant from the wing surface. Apply aluminum tape to the repair area and force-cure the sealant by heating the area for 15 minutes at 150°F (65.6”C). After 15 minutes, remove the tape and inspect to ensure that the leak is sealed.

The trick to using the pressure adapter is to get the adapter securely positioned over the leaking fastener and to contain the sealant. If the adapter is not secure, sealant will more than likely exude from between the wing structure and adapter instead of entering the leak path.

CompAir D236 Injector Method

A further temporary repair method is the CompAir D236 Injector method. This method also forces sealant into the leak path, but it can only be used on flush-type fasteners on the upper and lower surfaces of the wing. This method uses the CompAir D236 Injector Kit manufactured by CompAir Inc. of Burlingame, Calif. The CompAir D236 injector forces specification MIL-S-22473 Grade A sealant (Loctite 271) into leaky fasteners at approximately 900 psi. After the sealant is injected, the head of the fastener ‘is covered with aluminum tape and the sealant force-cured for 5 to 10 minutes with the kit heating iron. Since this method effects the same type of repair as the pressure adapter method, the repair procedure using this approach will not be discussed in detail. If the CompAir D236 Injector method is to be used, the maintenance technician can find detailed instructions in T.O. l-l-3, Inspection and Repair of Aircraft Integral Tanks and Fuel Cells.

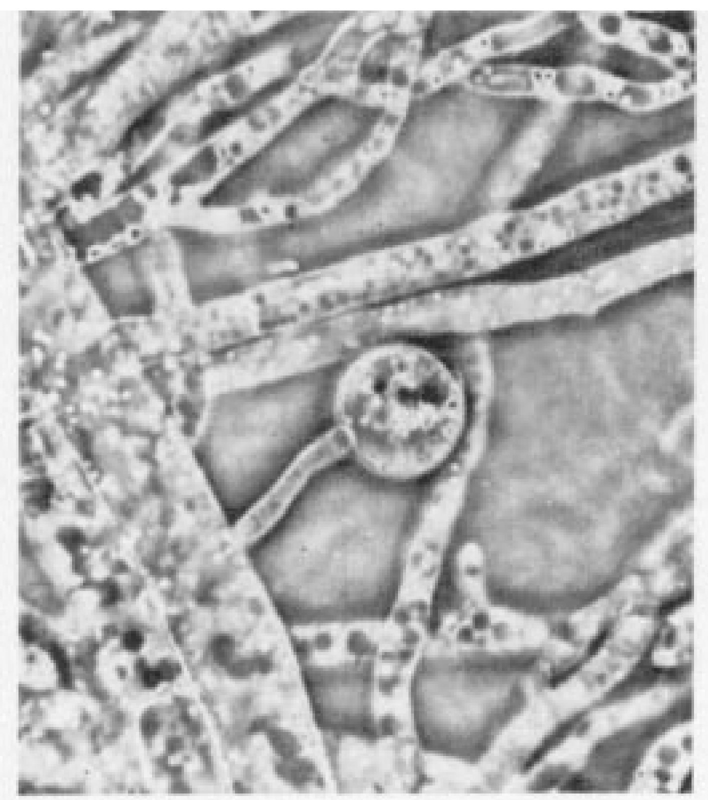
Directly Applied Compounds

Finally, some leaks can be temporarily controlled by using special non-hardening, viscous compounds that wet the surface and tend to dam the spread of fuel, or an epoxy compound that seals the leak. Two non-hardening compounds are available under the trade names Oyltite Stik and 9-L-Stop-A-Leak. Oyltite Stik is manufactured by Lake Chemical Co. of Chicago, Ill., and 9-L-Stop-A-Leak is manufactured by Nine-L Enterprises of Revere, Md. Either product is applied by rubbing the softened compound directly over the leaking fastener and adjacent structure that is in contact with the leaking fuel. If this method of repair is used, the affected area should be checked and, if necessary, recoated at each preflight and postflight inspection until a permanent repair can be made.

The epoxy compound is Epoxy Tabs Type "O," manufactured by Lake Chemical Co. of Chicago, Ill. The epoxy compound is applied to the leak area and allowed to harden. This repair material is more permanent than the two non-hardening materials.

**MICROBIAL CONTAMINATION**

We indicated earlier that fuel tank corrosion caused by microbial contamination is not quite as much of a problem today as it has been in the past. This perhaps slightly optimistic statement reflects the combined effects of progress made in the area of quality control by fuel suppliers, the improved fuel storage and handling practices now employed by operators, the widespread use of biocidal anti-icing additives, and such improvements as fuel tank water removal systems and better protective coatings and finishes.



A photomicrograph of microbial growth taken from a contaminated fuel tank.

Unfortunately, microbial contamination of fuel tanks is not the kind of problem that ever really goes away. It can be controlled, kept in abeyance, held in check, but never totally solved.

**Background**

For those whose experience in the field of fuel tank maintenance may not extend back to the time about two decades ago when the subject of microbial contamination of aircraft fuels suddenly burst upon the scene, a brief review will be instructive. At the root of the trouble is the astonishing ability of living things to carve out an ecological niche for themselves in some of the most unlikely places; to survive and multiply in environments that would at first glance appear to be totally inhospitable to life.

It had been known for some time that it was possible for certain kinds of microorganisms to metabolize - "eat" – hydrocarbon molecules very similar to those contained in aviation fuels. The problem was more theoretical than real in the days when aviation gasoline (avgas) was the standard fuel for aircraft because the grade of gasoline prepared for aviation use does not usually provide the special conditions necessary for the growth and development of these organisms.

For one thing, avgas has little tendency to mix with or absorb water, and the microorganisms that attack fuel require water. They cannot live in the fuel itself; they inhabit water that is in contact with fuel. For another, aviation gasoline contains significant amounts of tetraethyl lead, which is used to increase the octane rating of the fuel. This compound shares with other lead compounds the characteristic of being toxic to living things, including microorganisms. Its presence in avgas effectively inhibits their growth.

The situation with regard to jet fuels is different in several important ways. Jet fuels have a greater tendency to absorb and entrain water than gasoline. This can lead to a water buildup in the bottom of a tank and provide an attractive breeding ground for the kinds of bacteria and fungi that metabolize fuel. Furthermore, no lead anti-knock compounds are needed in jet fuel and none are used. The result can be a fuel tank environment that contains little to protect it from a large-scale invasion by microbial life.

This combination of circumstances set the stage for something of a fuel contamination crisis in the late 1950s and early 1960s. Prolific microbial growth suddenly erupted in aircraft fuel tanks everywhere, clogging fuel filters and pumps, and occasionally resulting in fuel starvation and engine flameout. Colonies of microorganisms attached themselves to tank structure and in some cases consumed or degraded organic fuel tank coatings such as Buna-N. Even worse, the acidic byproducts of microbial metabolism attacked the chemical finish of the metal structure of the fuel tanks and then went right on through to corrode the metal itself. In many cases, wing panels were damaged beyond repair and had to be replaced.

It was clear that immediate, vigorous remedial action was required. A major effort, coordinated by the U. S. Air Force but including all affected groups in the aerospace industry, was undertaken to control the problem. The action taken included a general cleanup and modernization of fuel storage facilities to ensure a clean, dry, and uncontaminated supply; revision of jet fuel specifications to require more stringent quality control; the development of appropriate biocidal additives to inhibit the growth of microorganisms in fuel; and a new initiative on the part of airframe manufacturers to develop better coatings and finishes to protect fuel tanks against chemical and biological attack.

All aspects of this program met with a substantial degree of success, and in the United States and most other industrialized countries this form of fuel tank contamination has in general remained under control. But the very nature of the problem demands constant vigilance. The microorganisms that contaminate fuel supplies and cause the associated damage in aircraft fuel systems are found virtually everywhere on the planet. Any relaxation in the use of the procedures that have proven effective in keeping the threat of-microbial contamination at bay can bring on a recurrence of the problem.

## Preventing Fuel Tank Infestation

There are four basic rules that will go a long way toward keeping your aircraft fuel tanks free of microbial contamination and the damage it can cause. First, use a biocidal additive in the fuel. An anti-icing additive meeting specification MIL-I-27686 has the desired biocidal properties and is approved for continuous use in Hercules aircraft engines. Second, always keep the fuel tanks as free of water as possible. The key to accomplishing this is to make sure that the fuel being used always comes from a clean, dry, well-filtered supply. Third, drain any accumulated water from aircraft fuel tanks each day, using the tank condensate drains. Finally, inspect integral fuel tanks on a periodic basis and be sure to maintain the integrity of each tank's internal protective coating system.

## Fuel Tank Sterilization

Operations in remote areas where the fuel supplies may be of uncertain origin can lead to microbial contamination despite the best of intentions. When it is established that the fuel tanks are infested with microorganisms, the tanks should be cleaned and decontaminated as soon as possible.

This involves first cleaning the tanks with a solution of warm water and an alkaline, water-base cleaning compound meeting specification MIL-C-25769. After the tanks have been cleaned, they must be sterilized to kill the microbial infestation. The procedure which is presently detailed in the authorized maintenance manuals includes spraying the interior of each tank with a solution of denatured alcohol (specification MIL-A-6091) and water. The alcohol used in this method of decontamination is 95% ethyl alcohol by volume, and a great care must be taken when using it. At this concentration ethyl alcohol can burn or explode, and breathing the vapor for an extended period of time can result in illness or death. For decontamination work done at the factory, Lockheed currently uses a 50% solution of specification TT-I-735 isopropyl alcohol, which has been found to be effective, less expensive, and safer.

After the fuel tanks have been decontaminated, they should be inspected for evidence of corrosion damage. If any is found, it must be removed in accordance with the procedures given in the applicable corrosion control maintenance manual.

**In the brief space** of less than one human lifetime, the aircraft fuel tank has evolved from a simple container crudely wired within a wooden fuselage to an integral part of basic airplane structure and the major component of an intricate system of pumps, valves, filters, and pipes. As fuel systems have become more elaborate, and the demands made upon them in terms of capability and reliability continually greater, fuel system design and fuel system maintenance have required ever higher levels of expertise and dedication.

The integral fuel tanks of today's Hercules aircraft represent a unique combination within the aerospace industry of proven design augmented by constantly advancing technology. They are built by engineering and manufacturing specialists who have as their goal total product performance, not only on delivery, but through the years. In partnership with the maintenace specialists in the field who share this commitment, that goal is not just within reach, but a day-to-day reality.

service news

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