Lockheed

VOL. 9, NO. 1, JANUARY—MARCH 1982

# service news

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

## Propeller Blade Care

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Lockheed

# SERVICE NEWS

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

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Cover: A USAF C-130H over the North Carolina Coast.

Sand and sea are a popular combination for warm weather relaxation, but no holiday for the exposed metal parts of an aircraft. Propeller blades, for example, have to absorb a lot of punishment whenever the environment includes sand, dust, and salt air. The blades can take it, but they need your help. This issue features guidance from the manufacturer on maximizing propeller blade service life under adverse operating conditions. USAF photo by MSgt Robert J. Carr.



BOB STEWART

# Focal Point

## THE SUPPORTING CAST

The production of the Hercules aircraft is supported by a cast of thousands. We in Materiel are part of this supporting cast. Our role takes form during, and sometimes before, the aircraft design is complete. The raw materials of the airframe structure, together with paint, fasteners, avionics, landing gear, propellers, engines, and whatever else is required to provide function and give life to the Hercules, are all procured by Materiel. Our primary requirement is that every purchase be a quality product that will perform the necessary function for which it is designed. When quality and performance arc certain, our next challenge is assuring a reasonable price and delivery to a schedule that will ensure the availability of each aircraft when it is needed by the customer.

In order to achieve these goals, we utilize approximately 6500 suppliers worldwide and make purchases presently valued at $350 million a year. An undertaking of this size and complexity represents a significant day-in, day-out performance challenge. It requires close and continuing contact with all suppliers so that any delays, shortages, or other problems that may affect delivery schedules are identified as they materialize and, when necessary, a plan of action formulated to protect the interests of our customers. The effective working relationships we establish with suppliers and manufacturers throughout the world serve to strengthen the operational support capability Lockheed is able to offer each and every Hercules aircraft operator.

Another day-to-day task is gathering and compiling appropriate technical information from suppliers and making it available to our Product Support people. This ensures that the myriad components each aircraft contains can be serviced in accordance with approved procedures endorsed by the individual manufacturers.

Our suppliers often collaborate with us in providing supplementary maintenance data designed to help our customers maximize the service life of a particular part of the aircraft system. An example of this kind of cooperative effort can be found in this issue of Service News magazine. The article "A Guide to Propeller Blade Care" is authored by William Hack of the Hamilton Standard Division of United Technologies. His contribution of this sound technical advice in his area of expertise is concrete evidence of the spirit of mutual commitment to the customer's success that is a fundamental part of the relationship between Lockheed and its suppliers.

We know that our suppliers take intense pride in their contribution to the Hercules airplane. Pride in this great airlifter is a contagious thing!

Sincerely,

Bob Stewart

R. D. Stewart, Manager
Major Subcontract Procurement

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*by* William Hack, Service Engineering
*Hamilton Standard Division of United Technologies*

The propeller blades of Hercules aircraft are still being pursued by a very old enemy. The culprit is corrosion, and the two will be natural foes as long as aluminum propeller blades exist. The struggle against corrosion is one that Hercules aircraft operators should always win. But some C-130 and L-100 owners report that corrosion has literally taken the edge in their fight to prevent propeller blade damage. They describe severe examples of leading edge deterioration, such as "cracking," "splitting," and "delamination."

### The Winning Strategy

What can be done to avoid such problems? The strategy is simple: a firm commitment to preventive maintenance. Propeller blades lose ground in their life-


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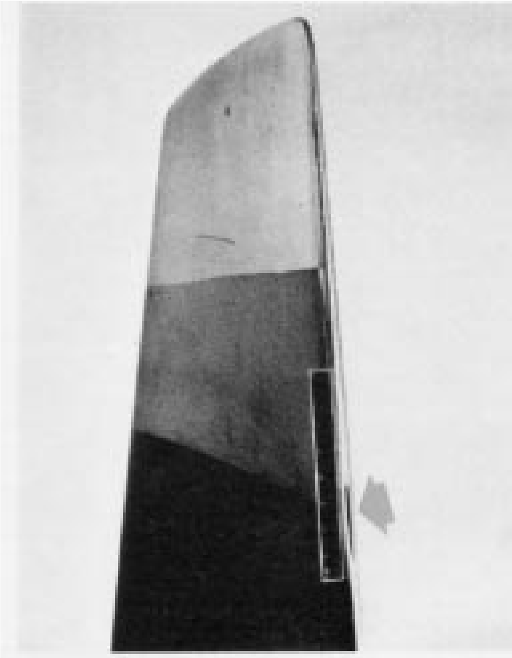


The 3-inch long "split" in this blade leading edge was caused by corrosion.

long struggle against erosion and corrosion every time propeller blade maintenance procedures are relaxed.

Preventive maintenance is particularly important in the case of the propeller blades that are installed on Hercules aircraft. The reason is the unique versatility of these famous airlifters. Propeller blades take a beating whenever aircraft operate from unprepared fields, in sandy or dusty climates, or in the vicinity of salt water. These are the kinds of harsh operating environments in which the Hercules aircraft excels, but they are also very hard on propeller blades.

Even in the most favorable climates, propeller blades are constantly being worn and pitted by sand, dirt, and water. Should this be a problem? Not at all. The blades are designed to withstand this kind of treatment -but only if they are properly inspected and maintained. There is not much that can be done about exposure to rough runways or a salt water environment, but it is possible to greatly extend the service life of propeller blades used under such unfavorable conditions. That is what this article is all about: achieving maximum propeller blade life through improved care.



Please note, however, that the material contained in these pages is intended only to support and illuminate the information in the applicable maintenance manuals. Always consult the authorized technical publications before undertaking any maintenance activities in connection with your Hercules aircraft.

Experience has shown that good maintenance practices can hold corrosion of blade leading edges to a tolerable minimum in almost any operational situation. This is an easier job to do when the factors involved in the normal progression of blade wear are well understood.

**Propeller Blade Wear Limits**

In the development stages of any new, propeller-driven aircraft, the propeller manufacturer always conducts ground and in-flight propeller stress surveys. These surveys empirically measure the strength and durability of the propeller blades designed for use with the aircraft in question. The overriding consideration in the initial blade design is safety, and for this reason propeller manufacturers are very conservative when it comes to establishing rework limits, overhaul standards, and determinations of blade structural integrity.

There is good reason to respect the propeller manufacturer's technical ability and follow his advice on maintaining not only a propeller's internal components, but the blade surfaces as well.

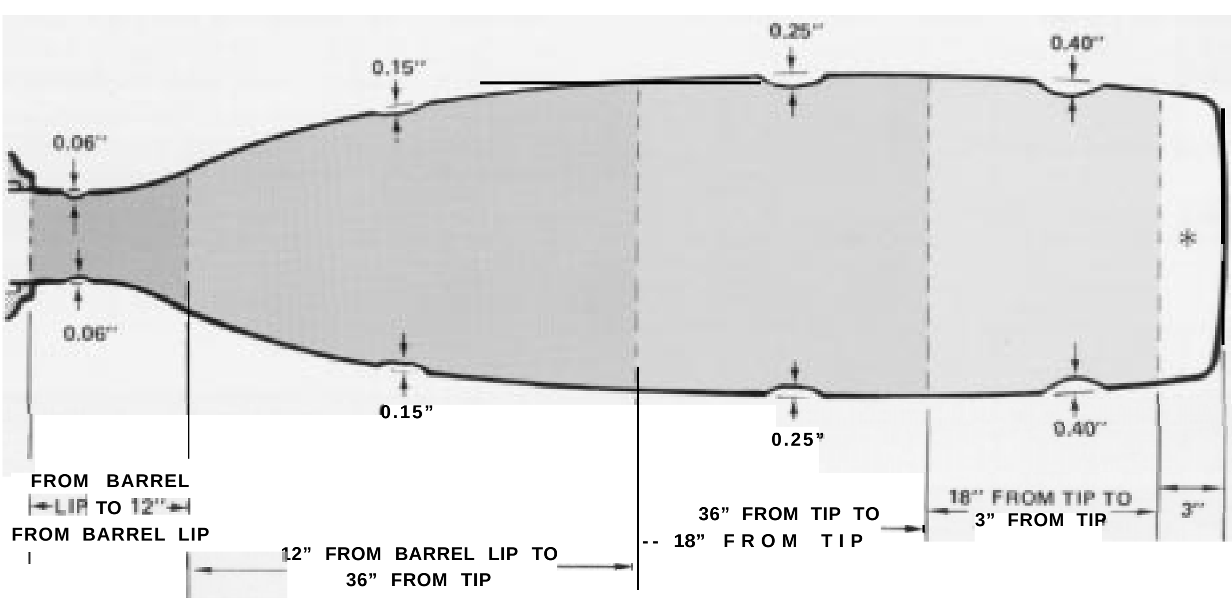
The effort to develop service limits is long, arduous, and expensive, and the manufacturer recognizes that a once-efficient airfoil will have to be sold as scrap when its wear limits have been exceeded. The values ultimately established offer the maximum possible service life consistent with safe operation. After all, the propeller manufacturer wants the blades to endure just as much as the aircraft operator does. His reputation for building a quality product will not be enhanced by selling the user another propeller or blade prematurely.

**How Blade Damage Occurs**

Propeller blades are no different from any other metal structures that are subjected to repeated mechanical stresses. They will deteriorate unless they are properly inspected and maintained. In the course of normal operation, the propeller blade leading edges take the brunt of the externally applied stresses — principally impingement of solid particles on the rotating blades. The effects of this impingement show up in the form of abraded and eroded leading edge surfaces.

In areas where there are corrosive substances in the atmosphere, particularly in locations that are near salt

**Maximum depth of rework allowed on propeller blade leading and trailing edges**




* AREA TO BE FREE OF DAMAGE. EROSION TO BE DRESSED OUT AS NECESSARY.



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water, the effects of corrosion will greatly add to the mechanical deterioration of the blades. Operations from unimproved runways, and from runways that are not regularly swept clear of dust, sand, and foreign objects will accelerate the rate of environmental damage.

The leading edge "splitting" reported by some Hercules aircraft operators starts with minor pitting of the blade leading edges, caused by the impact of heavier-than-air particles like sand or dirt. Such mechanical damage can even be traced to the hydraulic forces of water drawn into the propellers as the airplane is taxied on wet surfaces, to say nothing of the effects of precipitation encountered in flight.

As these pits on the leading edges increase in number and become deeper, they serve as pockets in which corrosive materials can accumulate. The presence in these pits of salts from sea water or other alkaline substances sets up conditions which are highly damaging to stressed aluminum alloys. The result is corrosion along the grain boundaries of the aluminum alloy from which the propeller blades are forged. This condition is known as intergranular corrosion.

While this process is taking hold, the blades continue to be stressed in the course of normal operation. As the stress cycles accumulate, the individual pits will tend to develop into microscopic holes which penetrate into the blade structure. If the pits are so close together that they produce what are actually lines of leading edge damage rather than isolated pits, splits or cracks will form in the blade leading edges. If a leading edge crack progresses to the point where it undermines the damaged aluminum above it, a tiny piece of blade will flake off — and possibly cause damage or injury.

**The Maintenance Challenge**

It is clearly very important that propeller blades not be allowed to deteriorate to the point where damage of this kind can occur. The applicable dimensional limits, operational restrictions, and repair and overhaul standards must be strictly observed.

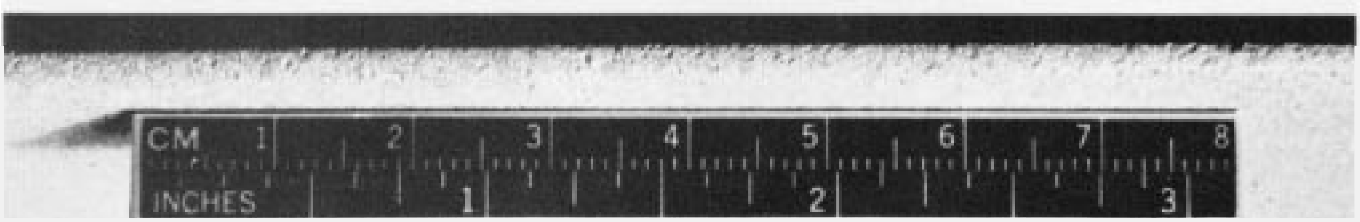
Unfortunately, this amounts to yet another challenge for maintenance organizations, which are typically short on manpower, equipment, and supplies, but long on flight schedule commitments. Under such circumstances, it is easy to understand why propeller blade maintenance does not always receive top priority.

Training is a key step out of this dilemma. An effective program of preveptive maintenance conducted by well-trained personnel can save a great deal of time, as well as money and propeller blades. Furthermore, such a program almost always attracts the enthusiastic support of aircrews. Made aware of an ongoing preventive maintenance program and given a little additional information, the aircrews can provide extra sets of trained eyes to assist in the effort to discover blade damage in its initial stages.

**Blade Inspection and Clearing**

Proper inspection of the blades by maintenance personnel is essential. The propeller blades should be inspected daily for obvious damage like deep scratches, cracks, gouges, burns, bends, and especially leading edge corrosion. Note that this is not the proper time to stand back and rely exclusively on keen vision. Cracks can look like fine scratches from a distance. Pull the blades through (by turning them clockwise as seen from the aft side of the engine) and inspect them from a distance of no greater than two feet. As a rule of thumb, when a leading edge has abraded to the point where it resembles coarse sandpaper such as number 60 grit, it is time to file, or dress down, the leading edge surface. This is accomplished by removing the leading edge pits and erosion-roughened surface metal by filing and sanding. It is important that this action not be delayed, since the longer it is put off, the better chance corrosion has of doing damage.

**This blade leading edge is in need of rework. Note coarse surface texture.**



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Daily inspection is only half of an effective maintenance action plan. The missing half is a proper cleaning procedure. When the aircraft is being operated in environments that are potentially damaging to the blades — rough runways, sand or dust in the atmosphere, near salt water — the blades should be washed regularly with clean fresh water, allowed to dry, and then coated with a very thin film of clean, petroleum-base engine oil or MIL-H-5606 hydraulic fluid. Avoid using synthetic oils for this purpose. If these products come in contact with parts of the aircraft structure, they may damage the paint.

A suitable calendar interval for this procedure will depend upon the aircraft's operational requirements, the total operating environment, and previous experience with blade damage. Performing the cleaning procedure every seven days will normally be adequate to prevent blade damage. However, this interval may be shortened or lengthened, depending upon the severity of the corrosive influences in each particular operating area.

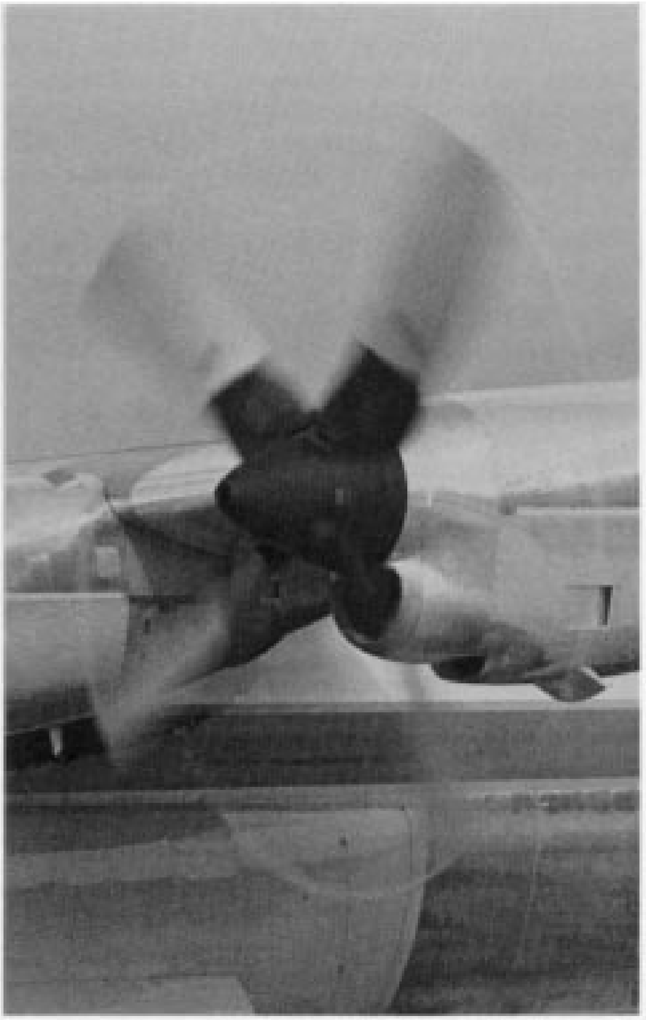
**Reworking the Leading Edge**

If a blade inspection does in fact reveal a leading edge that resembles coarse sandpaper, what kind of tools will be needed to repair the damage? The recommended equipment for repairing propeller blade leading edge damage consists of an assortment of suitable files and emery cloth. The files should include a 14-inch Vixen file, a 14-inch fine mill file, a half-round number 0 cut file, and a half-round number 2 cut file — or the equivalents. A small hand grinder with soft abrasive wheels can also be used.

After the eroded or corroded areas have been removed from the blade leading edge with the files, the file marks should be polished out with number 120, 240, and 320 dry emery cloth, as required. When the final polishing has been completed, a IO-power magnifying glass, penetrant remover, penetrant developer, and a dye penetrant solution are used to examine the rework.

When blade rework is to be undertaken with the propeller mounted on the aircraft, it is usually best to file the blade when it is in the horizontal position, at ground idle blade angle, and with the leading edge up. The only acceptable method of removing damage is by physically doing it with a file or hand grinder. No approach which merely covers up or conceals the damaged area should ever be employed.

Hercules **aircraft are at home in the toughest operating environments, but the props sometimes take a beating.**



**Even on the ground, rotating blade tips encounter water droplets and suspended solid particles at nearly 500 mph.**



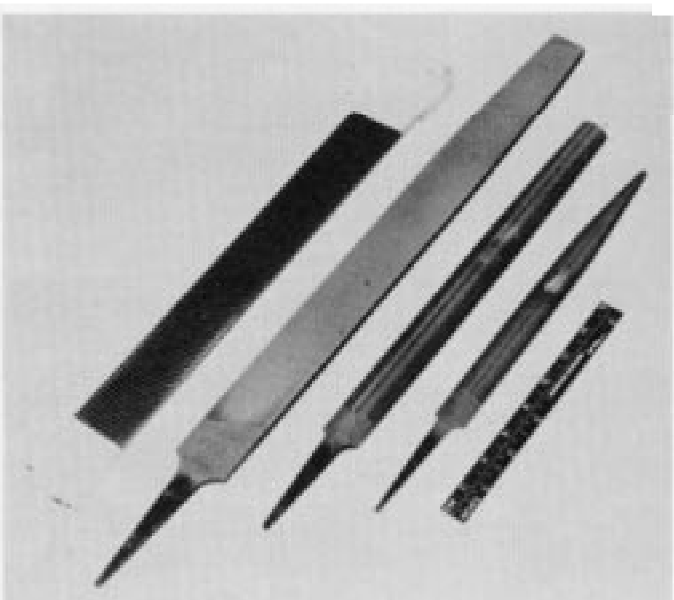
Using the appropriate file for the amount of material that will have to be removed, rework the leading edge in a direction parallel to the long axis of the blade. The surface should be dressed by removing all visible erosion and pitting. It should then be checked for corrosion cracks that may penetrate to a greater depth. If cracks'exist, it is advisable to cross file the damaged area to determine whether the depth of the rework will fall within the permissible limit for local repairs.

Most blade erosion and corrosion occurs within about 18 inches of the blade tip. In this area, the maximum depth for local rework is 0.400 of an inch. It may be apparent after cross filing that the damage depth exceeds this limit. If this is the case, the blade should be removed from service and returned to the overhaul facility.

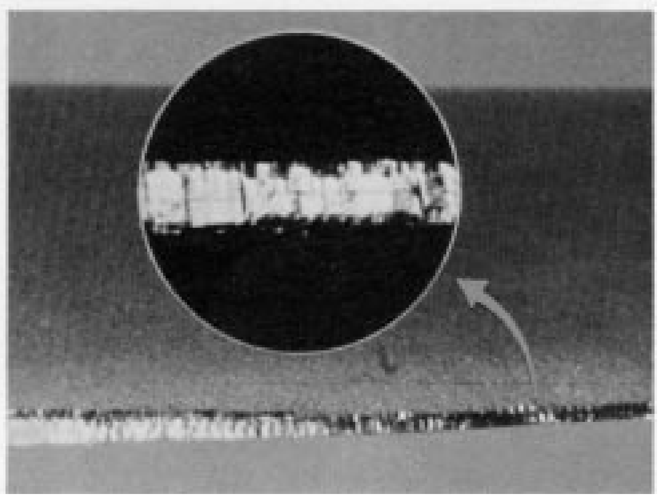
### Checking for Hidden Corrosion

After dressing the damaged area, the depth of the rework can be determined by placing a straightedge along the leading edge of the blade and measuring with a vernier caliper or 6-inch rule. Use a IO-power magnifying glass to ensure that enough material has been removed to get rid of any deep-seated intergranular corrosion.

The surest way to check for hidden corrosion cracks is to perform a dye penetrant check on the leading edge. First, clean the leading edge surface with penetrant remover and wipe it clean with a dry cloth. Next, apply the dye penetrant solution to the leading edge, using clean cotton swabs.



**Left: A set of files like this would serve for most blade leading edge repair projects undertaken in the field.Below: This propeller blade leading edge has been cross filed to determine the depth of rework required. Note the thin line of deep-seated intergranular corrosion still present.**



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Allow the penetrant to dry for a minimum of twenty minutes to a maximum of two hours. After the penetrant has dried for the specified time, remove the dye from the surface with penetrant remover. Finally, spray penetrant developer on the leading edge and allow it to remain for 15 minutes. This will bring out any of the dye which has penetrated into hidden corrosion cracks. The dye — usually red in color — will easily be seen against the white color of the developer and will appear as thin and slightly wavy lines. Red lines that are very straight or parallel with other lines are most likely file marks that have not been completely removed by polishing. It is the presence of irregular lines that indicates intergranular corrosion and the need for additional filing.

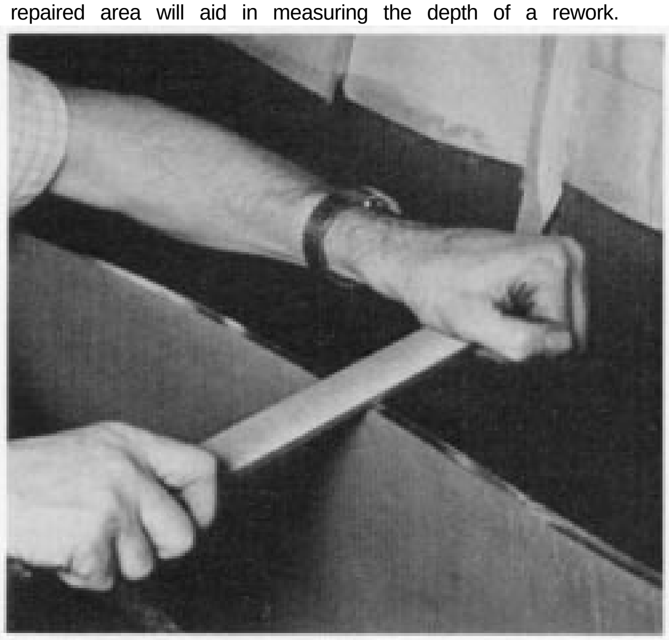
### Restoring the Edge

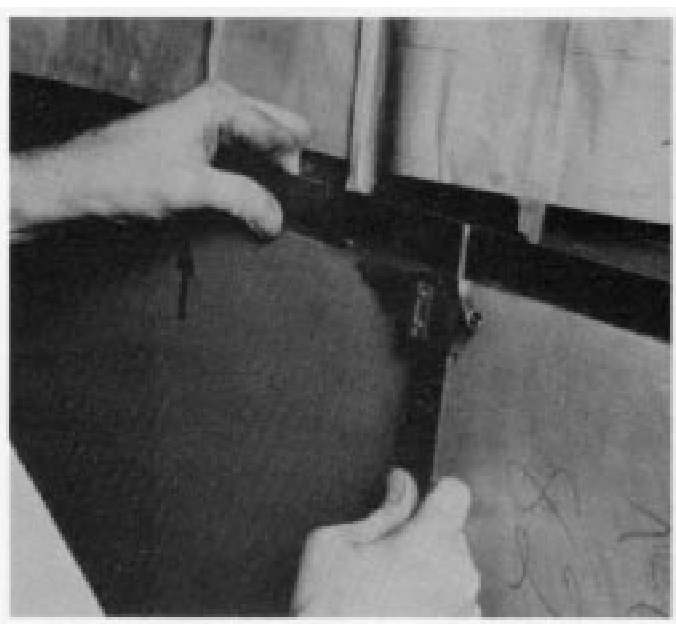
When all of the erosion pits and corrosion cracks have been removed, the leading edge will probably contain flat spots with sharp edges and have the general appearance of a roller coaster along its length. If left as is, this configuration would only tend to increase the likelihood of future erosion and corrosion by offering a large, flat area for particles to impact the leading edge.

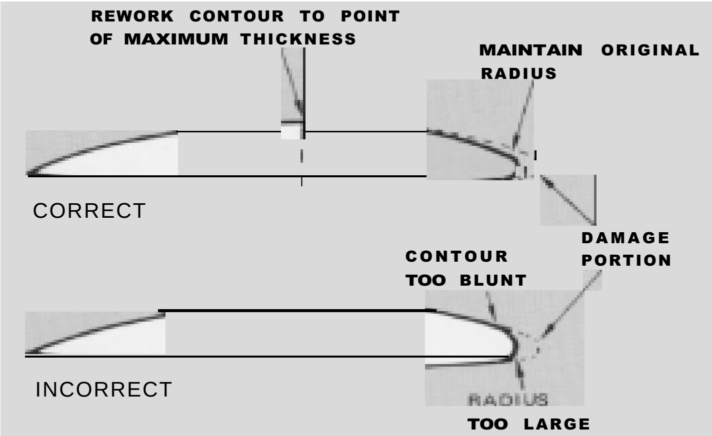
Such problems can be prevented by blending the reworked area in with the original blade edge surface. The idea is to form a smooth-shaped depression whose long dimension measures not less than ten times the depth of the rework. For example, if the total depth of the rework is 0.250 inch, the length of the shallow, saucer-shaped depression must be at least 2.5 inches.

Performing a dye penetrant check will determine if all corrosion cracks have been removed.

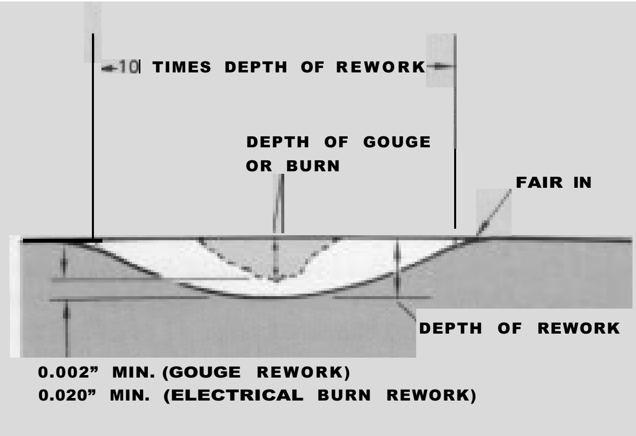
Below left: Filing is normally done in a direction parallel to the long axis of the blade. *Right:* A straightedge held across the repaired area will aid in measuring the depth of a rework.








Rework of leading edge.

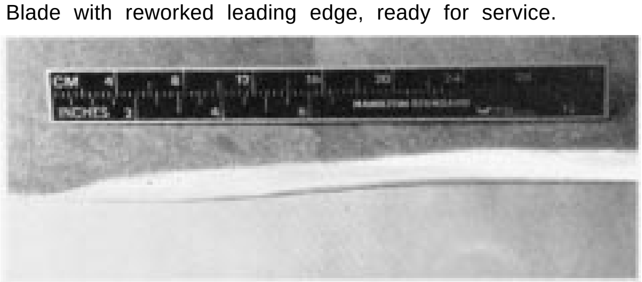



Example of local rework.

In carrying out this part of the rework procedure, always be sure that the ends of the depression are smoothly blended in, or faired, with the leading edge.

Now the "bluntness" of the repaired area of the leading edge must be eliminated and the original radius restored. Using the appropriate file, start removing metal at approximately the thickest section of the blade and work the file forward over the leading edge camber. Remember that the goal of leading edge repair is to remove all of the damage while leaving as much of the blade metal in place as possible. Work carefully and avoid abrupt changes in leading edge contour. The contour or radius of the reworked leading edge should resemble its original shape with no trace of bluntness. When the proper shape has been restored, remove all signs of tool markings with emery cloth.

Blade with reworked leading edge, ready for service.




**Blade Repairability**

Hercules aircraft maintenance personnel sometimes ask if it isn't possible that so much material will be removed in the process of making local repairs that a blade will become unusable. The answer is in theory, yes; in practice, probably not. Hamilton Standard Overhaul and Parts Catalog P5056 gives the procedure for locating blade stations and the minimum allowable blade widths for each station, but this information is not normally needed for routine blade maintenance in the field. The likelihood is that a blade will be removed for the next scheduled overhaul before it becomes unserviceable because of rework.

Here is why: When a propeller blade leaves the overhaul facility, blade width is measured to ensure that it has sufficient stock to last the entire overhaul cycle. The width dimension is figured so that the leading edge may be periodically filed, or dressed, with sufficient blade stock remaining to apply the maximum depth of local rework. During the next overhaul cycle, blade width will be measured again to determine if there is enough blade stock remaining to last another entire overhaul cycle. Experience has proven that only very rarely does a blade go below minimum width between overhaul cycles.

Let's look at an example. Suppose the overhaul facility found it necessary to reduce a blade to its minimum width of 17.96 inches at the 66-inch blade station. Is this blade really going to make it through an entire overhaul cycle? It would take exceptional circumstances and severe damage to prevent it from doing so.

Even a blade that has been reworked to its minimum acceptable width at any station is released to the operator with the assumption that it may become necessary to apply the maximum depth of local rework at that station. That is the way width dimensions are designed. In our example, the full maximum depth of rework (0.400 inches) could be applied at the 66-inch station without jeopardizing blade strength and integrity. Only alternate blade stations may be reworked below their minimum widths, but the probability of receiving a blade that will require the maximum-depth rework at a station already at minimum width is quite remote.

Proper blade inspection, cleaning, and repair require a relatively small investment in time and manpower. The payoff is a safe, efficient airfoil that will give a full life of service. Remember that there is no redundant system for a propeller any more than there is for an aircraft wing. Take care of it! On the next maintenance check or preflight walk around, look at those blades more carefully. Their longevity depends on the quality of your maintenance.

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