FIELD REPAIR OF ALUMINUM REFRIGERATION COILS
The Aluminum Association

INTRODUCTION

Aluminum is a popular material for refrigeration units because it has high heat conductivity, high corrosion resistance, and it can be repaired using standard procedures for aluminum.

The best methods for making field repairs of punctures in aluminum refrigeration coils, for example are the conventional metal-repair “Standbys” - soldering and welding and the now-familiar adhesive bonding. All are accomplished using simple procedures, properly applied to a clean aluminum surface.

The term refrigeration units or refrigerator coils as used in this report refers to the all-aluminum coils and connecting lines in air conditioners and refrigerators.

Because of its high operating efficiencies, ease of maintenance and overall economy, aluminum is also used in many interior and exterior refrigeration cabinet applications.

Regardless of the type of break or puncture, any aluminum component can be repaired in minimum time using the basic information and equipment discussed in this Aluminum Repair Section.

GENERAL CONSIDERATIONS

Repairs of punctures or other similar damage in aluminum coils may be made by soldering, adhesive bonding or welding, either in the field or in the shop, depending upon the various factors discussed in this repair section, and also upon the procedure chosen as most satisfactory by the individual repairman. When accessible, the repair may be made in place.

For all repairs on pressurized aluminum refrigeration components, standard evacuation, flushing and dehydration procedures must be followed prior to making the repair. These affect operator safety and system function and are necessary regardless of the metals used in the components.

When it is necessary to remove an aluminum component which is connected to a copper part with a special, non-corroding copper-to-aluminum transition joint, disconnecting usually can be done with the standard repair tools, without disturbing the transition joint itself.

Since the aim in any repair job is to restore original function and strength (and sometimes original appearance) as nearly as practicable, the repairman tries to change the undamaged areas around the puncture as little as possible. For example, a puncture in aluminum refrigeration tubing rarely, if ever, would be repaired by brazing, as this process involves heating rather large areas of the aluminum to nearly its melting point, and holding the temperature at that level until the brazing filler material melts and bonds to the tubing. This combination of temperature and time anneals the aluminum in a far greater area than the immediate vicinity of the repair, thus reducing the strength of the tubing.
TIG welding, on the other hand, may be a good choice to accomplish the same type of repair, even though it produces even higher temperatures than brazing. Welding temperatures are of course always above the aluminum’s melting point. This apparent paradox actually is not contradictory.

The difference is that with TIG welding, the heat is highly concentrated, so that the repair may be accomplished in seconds. The total quantity of heat put into the part being repaired, even at the higher temperature, is much less than with the slower brazing process. The heat-affected area is therefore also much smaller.

Either soldering or adhesive bonding also may be used to repair tube punctures and similar damage to aluminum refrigeration coils. These repair methods are particularly useful when the holes are relatively small, although they are not limited to small holes. Larger openings also may be closed using soldering or adhesive bonding, with the aid of reinforcing patches made of the correct aluminum alloy and curved to lie flat on the section to be repaired.

**PATCH ALLOYS**

Since 3003 alloy is almost always used for refrigeration coils, it is first choice for repair work; however, alloys 1100 and 5005 also are satisfactory. All of these alloys are suitable for either soldering or welding, as well as adhesive bonding.

The thickness of the patch should be equal to or slightly greater than that of the metal being patched. Patch size need be no greater than 1/4” beyond the edges of the opening to be covered.

**BASIC PRECAUTIONS**

A suitable curved patch of 3003 alloy maybe obtained by cutting and slitting a section of spare aluminum refrigeration tubing of slightly larger diameter, or of the same diameter if the size of the hole permits a snug fit to be obtained.

It is of primary importance, however, that all surfaces be thoroughly cleaned before either adhesive bonding, soldering, or welding is attempted. Detailed cleaning information is given in the “Soldering” section that follows.

The solders, adhesives and welding rods suggested herein for field repairs all have proven chemically compatible with commercial refrigerants.

As in repair of any refrigeration coils, care should be taken to prevent dirt, dust, water, metallic or adhesive particles from entering and remaining within the refrigeration line.

**SOLDERING**

Because most aluminum soldering fluxes are corrosive, repair soldering of aluminum refrigeration coils should be done without the use of a flux. These fluxes are all but impossible to remove when the component being repaired is in place and are difficult to remove even when the part is free of the unit. High temperature solders, which consist of 90 to 100% zinc and melt between 700 and 800°F, have good wetting action and their corrosion resistance is superior compared to the low-temperature and intermediate-temperature aluminum solders. The high-temperature types are also the strongest and least expensive aluminum solders. Depending on their composition, those recommended for refrigeration repair melt at temperatures ranging from 715 to 787°F. (See Table 75T14.)

<table>
<thead>
<tr>
<th>Composition</th>
<th>% Zn</th>
<th>% Al</th>
<th>% Cu</th>
<th>Approx. Melt Range °F</th>
<th>Wetting Ability</th>
<th>Corrosion Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>787</td>
<td>good</td>
<td>very good</td>
<td>720-740</td>
<td>715-725</td>
<td>92-95</td>
</tr>
</tbody>
</table>

Table 75T14
SURFACE PREPARATION

Remove any components that may interfere with working space around the damaged area. If finned tube is to be repaired, slit as many fins as may be required to make room for the repair, Figure 75F15A. Bend the fins back out of the way, or remove them if necessary. Carefully clean a repair area well beyond the edges of the puncture, or beyond the edges of the patch; if one is to be used. First remove any heavy deposits of dirt or grease by wiping thoroughly with a dry, clean cloth.

As is the case with other common metals, an oxide film still remains on the aluminum surface, even after rubbing briskly with a dry cloth. Aluminum oxide is harder than glass and quite transparent in the thin films that form naturally in air.

As the solder must contact the freshly cleaned metal itself, and not its oxide, it is essential that this coating be removed. This is easily done with an emery cloth of about 120 grit; moderate application of a sharp knife blade or clean, medium-toothed file will do as well. All edges of the opening also should be similarly cleaned, and usually are accessible to the point of a small knife blade.

Because new aluminum oxide begins to form immediately on freshly-scraped surfaces, either pre-tinning or complete soldering of the repair should be done promptly.

GAS FLAMES

A soft, reducing flame, Figure 75F15B, is best for soldering aluminum. This flame can be produced with proper torch adjustment when burning any of the commercial gases. However, a gasoline torch is not satisfactory, as its flame is insufficiently free of combustion products. The same equipment and controls employed for flame soldering other metals are used for soldering aluminum.

Soldering irons cannot be used. The largest is much too small to deliver the quantity of heat required by the combination of high-temperature solders and the high thermal conductivity of the aluminum.

For most aluminum refrigeration coil repair, a portable propane torch, fitted with a suitable standard air-mixing nozzle that produces a narrow cone of flame, is satisfactory. Hotter flames may be used, but extra care must be taken to limit the dwell of the flame to prevent burn through.

The temperature of a propane, or any other flame, is of course greatly increased when the gas is burned with oxygen, rather than air. Starting with the hottest-burning, and listing in descending order, commercial gases are acetylene, hydrogen, butane, propane and natural. However, as mentioned above, propane and air is usually adequate for soldering aluminum. Other choices depend upon metal thickness, size of component, operator experience, and similar factors.
TINNING

When the puncture is relatively small, the opening often is closed as the surface is tinned; in these instances the terms “tinning” and “soldering” are of course synonymous. However, because tinning is the basic essential of all successful soldering, and also because it is done as a separate operation when patches are to be applied, it is of sufficient importance to be discussed separately. Some points mentioned here will be repeated in the next section, “Soldering Procedure”.

Tinning the cleaned repair area without the use of flux is accomplished by abrading the fresh aluminum surface through a covering pool of molten solder; a thin though tightly adhering and completely covering film of oxide already will have formed since the surface was scraped.

Use a rod or stick of solder; wire solders are not stiff enough to double as a “rubbing stick”.

Apply the flame to the repair area, rubbing the solder back and forth on the cleaned surface as heating progresses. When initial melting occurs, a rounded-edge, slightly raised pool of molten aluminum will form on the surface. Heating is continued with an oscillating motion of the torch to control temperature and prevent burn through by limiting dwell of the flame.

Either one of two procedures may now be followed, depending upon the amount of oxide which may have reformed on the cleaned surface, or simply upon the personal preference and experience of the operator.

SOLDER-ROD METHOD

One method is to continue using the solder rod as an abrasive tool, Figure 75F16. Each time the relatively cool solder is rubbed across the surface of the hot base metal it breaks up and removes the newly formed aluminum oxide, which reforms behind the moving tip of the solder, until the above mentioned continuous, protective molten pool is formed. This occurs when the base metal reaches the melting point of the solder; the bare aluminum surface is then wet by continued abrasion with the solder tip in the molten pool, and there is no opportunity for the oxide to reform, since all the air is now excluded. The operator can tell that “wetting” has occurred when the “raised” molten pool flattens out.

Figure 75F16

Using the rod of solder as an abrasive tool in soldering aluminium.
BRUSH-ABRADING METHOD

The second method is to lay the solder rod aside, and while continuing to apply the flame to maintain the molten pool, abrade the surface with a glass fiber or stainless steel brush of suitable size and shape, Figure 75F17A. As with the rod, rubbing is continued until thorough wetting of the surface occurs.

Glass fiber or stainless steel brush does excellent job of “wetting” the aluminium surface by abrading and breaking up the oxide film under a pool of molten aluminium.

When the brush technique is followed from the start, base metal is heated to the boiling point of the solder. The torch is backed off to prevent overheating, but played lightly, being only applied as required to maintain the solder’s melting temperature. The tip of the solder rod is then touched to the joint area until a small pool of molten solder has formed. The solder rod is now put aside as mentioned, and the tip of the fiber glass or stainless steel brush is dipped into the molten pool and rubbed firmly across the repair surface to abrade and remove the aluminum oxide. As this is thoroughly accomplished, the solder wets the aluminum and the tinning is completed.

The bond obtained by this wetting action reduces the surface tension of the molten solder causing the pool to flatten out. If sufficient solder is present, the hole will be closed by the solder and the seal completed upon removal of the heat. Once the repair area is thus tinned, additional solder may be added if required to close somewhat larger holes, as in the previous method.

SOLDERING PROCEDURE

When tinning has been accomplished, soldering may be done at any convenient time. As in tinning, it is important to move the torch back and forth continuously, Figure 75F17B, to prevent burn-through of thin aluminum.

The torch must be kept in motion to assure even, adequate heating, but prevent burn-through.
Repair of very small holes may be completed in the tinning process itself, as previously indicated.

Slightly larger holes may require the addition of small amounts of solder, after the surface has been tinned. This usually is done in one continuous operation, without letting the tinning pool of solder solidify. To close a hole that is too large to be “automatically” closed by tinning, heat is directed onto the tip of the rod long enough to add the necessary few additional drops of solder.

If desirable for any reason, soldering may be done later by remelting the tinning so that the additional solder forms a solid bond. If some time has passed since tinning, the surface of the solder on the repair area should be rubbed bright with a dry cloth to remove any dirt deposits.

For repair of larger holes and slits, the use of a patch is recommended. This is prepared as outlined under the “Patch Alloys” and “Surface Preparation” sections. Both patch and the repair area must be cleaned and tinned for maximum strength of repair.

Soldering of patch repair proceeds when the tinned area at the repair site has been remelted and the pre-tinned patch is applied with a tong or pliers. If necessary, a small steel clamp, or a twist of wire or glass tape may be used to maintain contact of patch with tubing. Heating continues, and additional solder is added at the edges of the patch until a bead of molten solder appears along all edges. Heat is then removed and the repair is complete when the solder solidifies. The clamp must be removed to avoid concentrations of dirt and moisture which may corrode the tubing.

**PRACTICE ADVISABLE**

Those accustomed to the rapid wetting of properly prepared copper surfaces by lead/tin solders, assisted by an acid or rosin flux, are advised to try aluminum abrasion soldering a few times on scrap metal of 1100, 3003, or 5005 alloys before performing an actual repair.

**REPAIRING WITH ADHESIVES**

Single and two-part adhesive formulations also may be used for refrigeration coil repair. However, the specific adhesive compound chosen and the manufacturer’s recommendation for its use on the aluminum alloy is of vital importance to successful repair. The importance of having such information may be of equal or greater importance to adhesive bonding repair than similar information concerning the correct solder or the correct filler alloys for soldering and welding aluminum, respectively.

There are many manufacturers of commercial adhesives suitable for use with aluminum alloys. To meet various conditions of application and service, such as cure time and humidity, each manufacturer usually produces a number of different aluminum adhesive formulations. It is therefore recommended that advice be obtained from the adhesive supplier in selecting a general-purpose adhesive for repair of aluminum refrigeration components.

For the purpose of illustrating adhesive-bonding procedures now in use for the repair of aluminum refrigeration coils, the following three adhesives were tested and found satisfactory:

1. La-Co Heat-Seal Stick
2. Apoxi
3. Hysol 6-C Epoxi Patch Kit

Making repair in return bend of refrigeration coil using a single-part adhesive and heat.
SURFACE PREPARATION

A clean surface is essential to a strong adhesive bond. It is important that grease should be removed from the repair area. Thick deposits should be wiped off with a dry, clean cloth. Any remaining grease should be removed with a standard solvent, such as trichloroethylene or methyl ethyl ketone (MEK), both obtainable from the adhesive supplier. Final wiping with a dry cloth will adequately remove any dry film left by the solvent. Light scraping with a sharp, clean knife, light filing, or "sanding" with emery cloth of approximately 120 grit, completes the surface preparation for adhesive bonding.

SINGLE-PART ADHESIVES

Of the three adhesives tested, The La-Co Heat Seal Stick represents the single-formulation category previously mentioned. (See Figure 75F18.) No mixing is involved and total time required for application and curing is short, permitting return of the refrigeration unit to service in the least amount of time for the adhesives tested.

Heat is applied to the cleaned repair area with a propane torch, or similar heat source. The aluminum is quickly brought to the adhesive melting temperature (400°F). Simplest procedure is to withdraw the heat from time to time and touch the tip of the adhesive stick to the cleaned surface. When melting occurs, a quantity of the melted adhesive is transferred from the stick, adhering to the repair area of the aluminum. The adhesive stick is then laid aside.

Very moderate heating around the repair area is continued for a minute or more to speed curing. Heat must NOT be applied directly to the adhesive. When the metal component is cool, the repair is complete and the unit may be returned to service.

TWO-PART ADHESIVES

The remaining two adhesives tested both are of the two-part type and require mixing just prior to application. Both Apoxi and Hysol 6-C are applied to the clean aluminum repair area. Preheating of the metal to 400°F is not necessary. However, the temperature of the workpiece and the air around it must be 77°F or higher or these adhesives will not harden (set up) and cure.

Mixing is done on a clean piece of metal or glass, combining equal quantities of the two parts of the adhesive compound. These are usually available in tubes and squeezing out equal lengths of each, side by side, is an easy way to insure accurate proportions, Figure 75F19A.

After thorough mixing, as directed, the epoxy is applied to the repair area with a clean screwdriver or wood spatula; a splinter of clean dry shingle or similar "stick" will do nicely, Figure 75F19B.

The Hysol 6-C cures in about 24 hrs at 77°F; the Apoxi will cure in about 12 hrs at the same ambient temperature. Curing times of both epoxies can be shortened appreciably by increasing the temperature. This may be done by placing the repaired part in an oven with thermostat set to 250 to 300°F, or by placing an infra-red heating lamp a few inches away from the repair.
When openings of more than 1/32” have been closed by applying the still-liquid adhesive, it should be allowed to set up and harden before the recommended additional heat is applied to accelerate the cure. This is necessary because fresh epoxy thins with increasing temperature and may run away from the puncture, leaving a void; also, some adhesive may leak into the line. In either case, the repair would not be satisfactory.

Openings greater than 1/16” require the use of a patch plate. This should be made from 1100, 3003, or 5005 alloy sheet aluminum. The patch must be shaped to fit the repair area, curving it as necessary, and thoroughly cleaning it on all surfaces, using the previously detailed procedures.

The repair site must be cleaned over an area slightly larger than the patch, and the fresh epoxy applied to cover this entire area. The prepared patch is then applied to the epoxied area and held in place by a wrapping of masking tape. If convenient, the patch may instead be held in place with a wrapping of a piece of wire, twisted tightly. Wire or tape must be removed before the unit is put back in service, however, to avoid the collection of dirt and moisture, which may corrode the tubing.

After the adhesive has cured, remove the tape or wire. Make certain that any adhesive backing from the tape which may have adhered to the repair is also removed.

Paint the repair with aluminum paint, or a moisture-impervious epoxy paint; this will appreciably extend the life of the repair. Similar painting also is recommended for the smaller, patchless repairs described above. However, this is not as essential, except under extreme conditions. Patches are more critical in this respect, due to their abrupt edges or corners in which moisture may collect. Any paint intended for use on aluminum is suitable. Follow paint manufacturer’s directions for cleaning all aluminum surfaces to which the paint is to be applied, to obtain maximum adherence.

**TIG WELDING REPAIR**

Aluminum refrigerator coils, lines and other components can be repaired quickly and permanently using tungsten-inert-gas (TIG) welding, as it is popularly known. To avoid possible confusion, should be mentioned that this process also is called gas tungsten arc (GTA); which is the official American Welding Society designation. However, the “TIG” name, coined when the process was first developed, still appears to be most generally used.

Welding is done only on thoroughly clean surfaces. In the TIG process, all air is excluded from the molten aluminum surface by the “envelope” of inert gas emitted from the torch. The electric arc struck between the tungsten electrode and the workpiece furnishes the heat of welding.

The arc may be powered from a supply unit delivering either direct current, reversed polarity, DC (RP), or alternating current, with a high frequency component, AC (HF), the high frequency being employed to aid in maintaining the alternating current arc.

For welding the relatively thin aluminum refrigeration tubing, DC (RP) is usually the first-choice power supply, as it produces a shallow weld pool. Tubing wall thicknesses generally are in the 0.020 - 0.064” range.

AC (HF) also may be used, however, and is particularly applicable for metal thicknesses in the 0.050 - 0.125” range. Welding grade argon, for the inert gas, and pure tungsten electrode should be used with either type of power supply.

**AC (HF) TIG WELDING**

Alloy 4043 filler rod of 1/16 or 1/32” diameter is generally recommended for repair welding 3003 alloy aluminum, of which most refrigeration lines are made. The 4043 alloy rod is used for both AC and DC welding. Only new, clean filler wire, fresh from its protective package, should be used. Filler metal for welding aluminum must be free of all grease, oil and moisture. If in doubt about filler material that you must use, be sure to clean the aluminum surface to a bright luster before welding.
For making AC (HF) TIG repair welds in refrigeration coils of average thickness, the welding current is set in the range of 40-50 amperes and the argon gas flow at a rate of 20 cfh. A generally reliable rule of thumb for current setting for this type of TIG welding is roughly 1-1/2 amperes for each 0.001 IN. of metal thickness. A pure tungsten electrode either 1/16 or 3/32” diameter is generally used.

**DC (RP) TIG WELDING**

In a DC (RP) welding power setup, the negative terminal of the direct current power source is connected to the base metal, meaning the tubing or other component to be repaired. This polarity produces a wide, shallow weld pool, which is best for thin metal. Recommended settings for gas flow rates, current and voltage, and the tungsten-electrode diameters to be used to weld various wall thicknesses of aluminum refrigeration tubing, by the DC (RP) TIG process, are given in Table 75T21.

**MACHINE SETTINGS FOR DIRECT CURRENT REVERSE POLARITY DC (RP) TIG WELDING SMALL ALUMINUM TUBING**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>0.020</td>
<td>5</td>
<td>15</td>
<td>19.0</td>
<td>1/16</td>
</tr>
<tr>
<td>0.032</td>
<td>8</td>
<td>18</td>
<td>19.0</td>
<td>3/32</td>
</tr>
<tr>
<td>0.040</td>
<td>10</td>
<td>20</td>
<td>18.0</td>
<td>3/32</td>
</tr>
<tr>
<td>0.051</td>
<td>10</td>
<td>30</td>
<td>18.0</td>
<td>1/8</td>
</tr>
<tr>
<td>0.064</td>
<td>10</td>
<td>40</td>
<td>19.0</td>
<td>1/8</td>
</tr>
</tbody>
</table>

*Table 75T21*

To improve control of the molten metal when welding with DC (RP), the tungsten electrode may be sharpened to a point on a grindstone, prior to welding.

**WELDING PROCEDURES**

The following welding procedures apply to both DC (RP) and AC (HF) welding aluminum.

**SURFACE PREPARATION**

Remove any heavy deposits of grease or oil from the repair area with a clean rag. Wipe any remaining oil residues off with a clean cloth dipped in a solvent, as previously described in this aluminum repair section. Aluminum surfaces cleaned in this manner, and all aluminum surfaces originally free of oil or grease, are then ready for removal of the hard, transparent oxide film, natural to aluminum. This is accomplished by vigorous rubbing with a stiff stainless steel brush, light filing, or scraping with a blade. The repair area is now ready to be welded.
STRIKING THE ARC

A small arc-striker plate made of scrap aluminum is securely clamped in place as close to the repair area as possible. It is important that the tubing or other surface to which the arc-striker plate is clamped is also thoroughly cleaned to assure good electrical contact. Poor contact can result in arcing between plate and component causing additional damage to the system being repaired. A separate cable connected to the strike plate and to the ground lead terminal of the power source may be used as an added precaution, but a clean contact surface and firm clamping of the strike plate is still essential to prevent unwanted arcing.

The welding arc is established by drawing the electrode over the striker plate. The arc is maintained on the striker plate until the tip of the tungsten electrode becomes incandescent. The torch is then promptly moved from the strike plate to the edge of the puncture. As the torch leaves the striker plate, the arc is momentarily extinguished, but is immediately re-established at the repair site on the work piece.

This procedure provides a more stable arc from the start of welding, improves visibility during welding, and reduces or eliminates arc scars on the tubing or other base metal surface.

With the arc established, point the torch in the direction of welding. The torch should be held so that the arc is kept very short, not over 3/16" long, Figure 75F22. Longer arcs are unstable and may cause an unintended amount of melting and subsequent collapse of the tube wall, or similar burn through of other relatively thin aluminum work pieces.

CORRECT PROCEDURE FOR TIG WELDING

(top) point torch in direction of welding; with the pool formed, adjust the torch tilt to 15° to 20° off vertical; (center) add filler metal to leading edge of weld pool, not into the arc; (bottom) discontinue feeding the filler rod when bead is the desired size. Then, move the torch forward to the leading edge of the pool. Try to develop the technique of moving the torch steadily forward and adding the filler metal intermittently as the pool requires it. Be careful to keep the molten end of the filler rod within the inert gas shield. This prevents oxidation of the hot end of the filler wire.

The arc is held at one point until the base metal starts to melt. Then the tip of the filler rod is placed within the inert gas shield at the leading edge of the weld pool. If the hole is very small, the repair will be completed almost instantaneously. If the slit or puncture is relatively large, the arc is slowly moved along the broken edge while the filler metal is fed into the front of the weld puddle.

The arc is not moved rapidly. On the other hand, the arc and filler rod should not be held at one spot until an excessive quantity of filler metal build up has occurred. Also, the torch must be moved sufficiently to prevent burn-through of the thin tubing.

If the tube or other base metal melts too rapidly, stop and reduce welding current. Start again on the striker plate, proceeding as before.

If too much time passes before the base metal melts and the filler metal flow is sluggish, the amperage is too low; stop, turn the power up, then start again on the striker plate.

When the weld is complete, do not stop abruptly. Taper off and at the same time add filler metal to avoid shrinkage craters. Tapering off consists of turning the power down before breaking the arc and manipulating the filler rod so that just enough metal to
fill the crater is deposited.

All weld craters must be filled. Those missed in welding can be filled by resetting the current and striking the arc again; at the same time continue to add filler metal into the crater under the arc.

**GENERAL CONSIDERATION**

Because many of the return bends on an aluminum refrigeration unit are soldered, care must be taken to avoid melting the solder with the heat of welding, Figure 75F23), thus unintentionally opening sound joints. Such melting is easily avoided by an experienced welder. Because of the high rate of heat input in TIG welding, it is usual for the arc to be struck and the repair completed before much of the metal is hand warm. However, if protracted welding is necessary, a wet cloth may be placed on soldered joints to keep them cool.

Generally, no post-weld operations to reduce the possibilities of an in-service corrosion at the repair site are required. There is no flux to be cleaned away or neutralized since, as in abrasive soldering, no flux is used in TIG welding. Similarly no sharp corners are left on a properly welded repair; a painting is therefore generally not required to protect against standing moisture.

<table>
<thead>
<tr>
<th>Process</th>
<th>Preparation</th>
<th>Making a Repair</th>
<th>Completing the Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOLDERING</td>
<td>1. Use No flux</td>
<td>1. Remove any patch clamping to eliminate moisture-collecting ridges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Use high temperature high-zinc solder</td>
<td>2. No flux removal required since no flux is used</td>
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<tr>
<td></td>
<td>3. Keep “soft-reducing” torch flame moving for even heating</td>
<td>3. Painting not required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Obtain solder-wetting action by rubbing repair surface under molten pool with solder stick or stainless steel or glass-fiber brush</td>
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<tr>
<td></td>
<td>5. If hole not closed with this “tinning,” apply more solder, or solder pre-tinned patch over hole.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Practice on scrap if soldering aluminum for first time.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHESIVE</td>
<td>1. Evacuate, flush and dry the tubing.</td>
<td>1. Apply adhesive with clean stick</td>
<td>1. Remove any patch clamping to eliminate moisture-collecting ridges</td>
</tr>
<tr>
<td>REPAIR</td>
<td>2. Remove components as required for repair</td>
<td>2. Use heat only when specified; NEVER APPLY FLAME DIRECTLY TO ADHESIVE</td>
<td>2. Painting repair with suitable aluminum or moisture proof epoxy paint is recommended to insure long repair life.</td>
</tr>
<tr>
<td></td>
<td>3. Remove dirt, oil; scrape off oxide.</td>
<td>3. Suitable alloy patch may be held in place with a clamp or tape</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. If hole size needs patch use 3003, 1100, or 5005 alloy.</td>
<td>4. Allow time for cure as specified by manufacturer.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Prevent dirt or moisture from entering line.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. If two part adhesive used mix as directed.</td>
<td></td>
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<tr>
<td></td>
<td>7. If adhesive requires heat use propane/air or similar torch.</td>
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<td></td>
</tr>
<tr>
<td>TIG WELDING</td>
<td>1. Evacuate, flush and dry the tubing.</td>
<td>1. No flux is used.</td>
<td>1. No flux removal required, since no flux is used</td>
</tr>
<tr>
<td></td>
<td>2. Remove components as required for repair</td>
<td>2. Strike arc on small scrap plate clamped next to repair area.</td>
<td>2. Painting not required.</td>
</tr>
<tr>
<td></td>
<td>3. Remove dirt, oil; scrape off oxide.</td>
<td>3. Transfer arc to repair.</td>
<td>3. Transfer arc to repair.</td>
</tr>
<tr>
<td></td>
<td>4. If hole size needs patch use 3003, 1100, or 5005 alloy.</td>
<td>4. Point torch in direction of welding, at about 20° off vertical</td>
<td>4. Painting not required.</td>
</tr>
<tr>
<td></td>
<td>5. Prevent dirt or moisture from entering line.</td>
<td>5. Keep arc short; about 3/16”.</td>
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</tr>
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<td></td>
<td>6. Use TIG Welder with DC (RP) or AC (HF) power supply; argon gas; 1/16-3/32” pure tungsten electrode; 4003 alloy filler rod.</td>
<td>6. Add filler at leading edge of weld pool.</td>
<td></td>
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<td>7. Move torch sufficiently to prevent burn-through.</td>
<td></td>
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