

**DEFINITION.** Soldering is the process of joining two or more metals together at a temperature lower than the melting points of the metals.

**MATERIALS USED.** There are two basic materials used in the formation of a solder joint; the flux which cleans the surfaces of the metal to be joined and the solder itself, which forms a permanent and continuous metallic connection.

**FLUX.** Surfaces of component leads form a thin layer of tarnish or oxidation when exposed to the air. This oxidation appears as a dark discoloration on normally bright tin or silver plated parts. Cleaning the leads with an abrasive brush or solvent only partially removes this layer and will not by itself, permit formation of a good solder joint. Flux must be used to more completely clean the metal surfaces. In actual use, the flux melts and flows when heated before the solder penetrates the oxide layer and cleans the surface.

In electrical/electronic soldering, only rosin liquid or rosin core solder is permissible. Acid, chloride, or organic base fluxes are prohibited because their residues are corrosive and difficult to clean.

**SOLDER.** There are two basic types of solder: soft and hard.

**SOFT SOLDER.** This is the type used on 99% electronic wiring.

It is an alloy consisting primarily of tin (chemical symbol Sn), lead (Pb), and occasionally silver (Ag). Depending on the proportions of these metals, the solder will turn to liquid at temperatures ranging from 360° up to 690°F. Lower temperature solders consisting of tin and lead are used for most applications. High temperature solder consists of silver and lead, and is used where high heat ranges are encountered (around engines, etc). Typical alloy compositions are specified by number, i.e., 60/40 would be 60% tin and 40% lead or 63/37 would be 63% tin and 37% lead. 63/37 is also called eutectic because it goes from solid to liquid at exactly 361°F.

GENERAL INFORMATION	Soldering
	SECTION 3-1

**HARD SOLDER.** This type of solder is also known as brazing alloy. It is an alloy of silver that melts at temperatures ranging from 700° to 1600°F. It is not to be confused with silver solder, described above, which is soft. Hard solder finds limited and specialized use in aircraft primarily on thermocouple leads. Because of the high heat required to flow hard solder, it is usually applied by resistance equipment or torch.

**FORMS.** Solder is used in two major forms: wire and bar. Wire solder, as is obvious from the name, resembles bare solid wire and comes both with and without a flux core. Bar solder is the type that comes in small, heavy ingots. These bars do not contain flux but must be used in conjunction with a liquid flux. Bar solder is used to load solder pots and flow solder machines.

**THE IMPORTANCE OF CLEANLINESS.** In the vast majority of cases, faulty soldering joints can be traced to inadequate cleaning of the components before soldering. The presence of excessive oxidation, grease or dirt will not permit the solder to flow and "wet" the surface completely. The result can be an unacceptable joint that has high resistance, poor mechanical strength and breaks easily.

The soldering work area should be kept clean and well organized. Components should be stored in sealed bags or containers and cleaned thoroughly before soldering. Soldering iron tips should be well tinned at all times.

SOLDERING EQUIPMENT SELECTOR	Soldering
	SECTION 3-2

**SOLDERING IRONS.** There are two types: Conduction and temperature controlled. Typical conductions are:

- 20 Watt Iron. Miniature soldering of printed circuits, soldered modules, and small components. Takes 1/8 in. shank diameter tips. Produces tip temperature of 600°-650°F.
- 30 Watt Iron. Printed circuit boards, and large components up to 22 AWG wire. Takes 3/16 in. shank tips. Produces tip temperature of 700°-800°F.
- 40 Watt Iron. Large components, 26 to 18 AWG wiring. Takes 1/4 in. diameter tips. Produces tip temperature of 850°-950°F.
- 60 Watt Iron. 22 AWG and up wiring. Takes 1/4 in. diameter tips. Produces tip temperature of 900°-1000°F.

The other type, temperature controlled,

- Produces the tip temperature by using a tip of the desired shape but with a built-in control for the temperature. The tips will be rated and marked with the temperature range i.e., 600°F, 700°F, 800°F etc. Selection of the tip will be by the intended application
- Is controlled by fixed shape tip and a built-in controller which permits dialing in of the temperature desired. In this case, only the tip is changed.

**SOLDERING TIPS.** Three of the most commonly used tips are:

- Short Taper Chisel. Intended primarily for PC board work.
- Long Taper Chisel. For general work: point to point wiring, terminal/contact soldering.
- Conical Bevel. Resembles a chopped off cone. Primarily for PC board work.

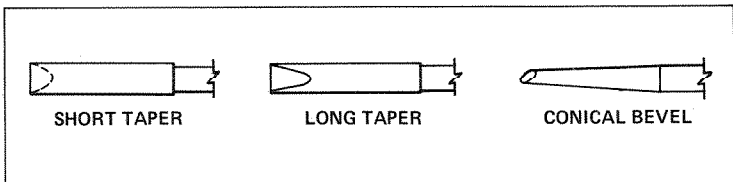


FIGURE 3-1. SOLDERING IRON TIPS

SOLDERING EQUIPMENT SELECTOR	Soldering
	SECTION 3-2

RESISTANCE SOLDERING UNITS. Intended application of resistance units is for tin/lead and silver soldering wire to contacts/terminals.

**CAUTION**

Do not use on current sensitive components such as diodes, transistors, integrated circuits.

**CONTROL UNITS**

- Low Wattage, 0-120W. For 30 to 18 AWG wiring
- Medium Wattage, 125-250W. For 20 to 8 AWG wiring
- High Wattage, 250-1000W. For 10 AWG and larger wiring

There are two basic types of electrodes; metallic & carbon. The metallic electrodes are supplied in twin or single handpieces. The carbon electrode is supplied as a twin handpiece. Application is as follows:

- METALLIC ELECTRODES.** For general small work. Tips may be custom shaped to fit work.
- CARBON ELECTRODES.** For large, heavy work. May be ground to suit work.
  - Twin Electrode Handpiece. Use where parts are easily accessible.
  - Single Electrode Handpiece. Has two separate leads available in two types: common with alligator clip, electrode in holder.

**SOLDER POT.** For dip soldering and tinning. Maintains solder in liquid state. Recommended for any volume tinning job.

**WAVE SOLDERING MACHINE.** For automatic soldering of printed circuit boards. (See MEPS-6600-20, 33000-866 and MEPS-33000-907).

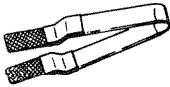
\*NOTE: Temperature controlled irons are preferred for Printed Board soldering according to application, i.e., Printed Board or terminal lug soldering.

**SOLDERING IRON HOLDER**



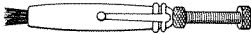
Holds iron while hot. Has guard to prevent burns to operator or wire insulation. Usually has water moistened cellulose sponge attached to base for cleaning soldering iron tip.

**LEAD CLEANER**



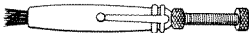
Resembles large tweezers. Has layer of copper braid on jaws. Used to clean component leads (resistors, diodes, etc) to remove oxidation/tarnish before soldering.

**FIBERGLASS ERASER**



For cleaning PC board conductors, contacts/terminals. Stiffness of bristles may be adjusted.

**STAINLESS STEEL ERASER**



For use as above but for tougher cleaning jobs. Must be used with caution to avoid removing platings or conductor surfaces on PC boards.

**BRASS BRISTLE BRUSH**



Also known as suede brush. Used to clean hot soldering iron tips. Also useful for cleaning rows of terminals/contacts.

**FIGURE 3-2. SOLDERING ACCESSORIES (SHT 1 OF 2)**

NATURAL BRISTLE BRUSH



Stock item known as acid brush. Used with solvent to brush clean components before and after soldering.

HEAT SINK



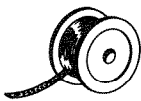
Typical resemble tweezers. Clamp onto component leads to draw off heat during soldering to protect heat sensitive components.

SOLDER REMOVING BULB



Used in desoldering. Bulb is squeezed and slowly released to create sucking action on heated, molten solder.

SOLDER REMOVING BRAID



Available in small rolls. Flat tinned copper braid is laid against joint and heated with soldering iron to draw off all or some solder.

SOLDERING AID



Like a pencil but all fiberglass. Has slot for lead bending. Used as probe and cleaning tool.

NOTE: Never use a lead pencil in place of this tool.

FIGURE 3-2. SOLDERING ACCESSORIES (SHT 2 OF 2)

SOLDER, FLUX SOLVENT SELECTOR	Soldering
	SECTION 3-4

## SOLDER

Sn 60 Wire Solder with  
RMA Core

Most frequently used solder for interconnect wiring. Contains RMA (Rosin, Mildly Activated) flux core in center of tin/lead wire. Use small diameter (0.022") for small work, large diameter (0.056") for heavier work. Composition: 60% Sn, 40% Pb.

Sn 63 Wire Solder with  
RMA Core

For use in hand soldering printed circuit boards. Composition: 63% Sn, 37% Pb.

Ag 2.5 or Ag 5.5 Wire  
Solder with RMA Core

Specialized composition for soldering high temperature components. Use only when directed. 2.5 or 5.5% Ag, remainder primarily Pb.

Sn 60 Bar Solder

Available in small ingots for use in loading solder pots. For tinning components to be soldered with Sn 60 wire solder. Use in conjunction with RMA liquid flux.

Sn 63 Bar Solder

Available in small ingots to load wave solder machine. Composition is "eutectic" meaning that, when heated, it goes from solid to liquid without passing through plastic or mushy stage.

NOTE: Chemical symbols: Sn = Tin, Pb = Lead, Ag = Silver

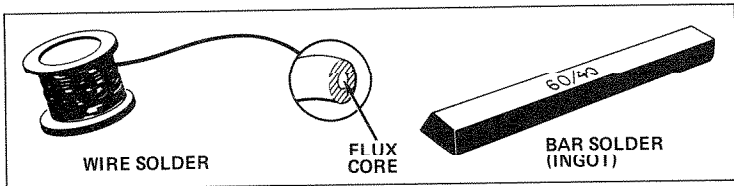


FIGURE 3-3. WIRE AND BAR SOLDER

SOLDER, FLUX SOLVENT SELECTOR	Soldering
	SECTION 3-4

## FLUX

<p>Mildly Activated Rosin MIL-F-14256D Type RMA</p>	<p>Available as core in wire solder or liquid form. Use prior to dip soldering/tinning or when solid (no core) wire solder is used. Store in air tight container (contact vial with plastic top). NOTE: Thin with Isopropyl Alcohol or approved flux thinners.</p>
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**CAUTION**

RMA is the only type of flux permissible on electrical/electronic assemblies. Acid, chloride or bromide fluxes in core solder, paste, or liquid forms is strictly prohibited.

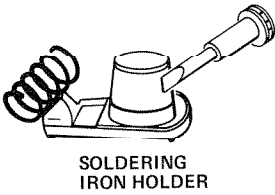
<p>Silver Solder Paste</p>	<p>For high temperature silver soldering of thermocouple connections only. Use with special silver composition solder. After use, clean thoroughly.</p>
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## SOLVENT

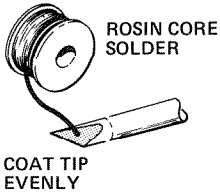
<p>Isopropyl Alcohol</p>	<p>For brush cleaning before and after soldering. Use with natural (not synthetic) bristle brush. May be used to thin out liquid RMA flux. Store in safety container.</p>
<p>Moore M-14</p>	<p>Solvents for cleaning printed circuit board assemblies. Use for dipping or brushing assembly.</p>
<p>Freon TMS or TE</p>	<p>For vapor degreaser machine or inline cleaner. Cleans any electronic assembly.</p>

Do not use FO-321, M-14 or Freon TE to thin RMA flux. Use only isopropyl alcohol or approved thinner for thinning RMA flux.

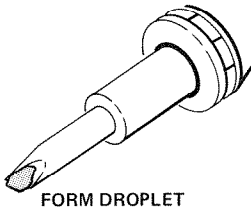




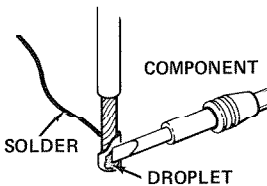
1. Place iron in holder and plug into 110 VAC grounded (3-prong) outlet.
2. Let iron come up to operating temperature.
3. When hot, wipe tip on water-moistened cellulose sponge to remove oxidation.



4. After wiping, apply rosin core solder immediately. Coat tip completely.  
NOTE: If solder beads up and does not form a uniform coating, clean per TIP MAINTENANCE.
5. If idling for lengths of time, re-tin tip periodically.

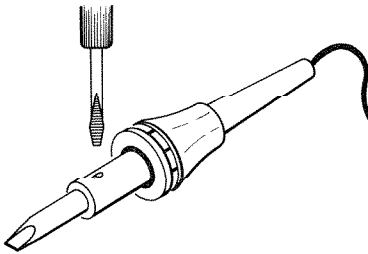


6. To solder apply small amount of solder to tip to form droplet. This will permit maximum heat transfer to components.

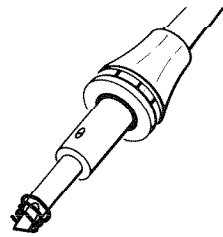
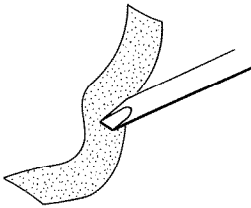


7. Apply tip to component. Apply solder to joint, not soldering iron tip.
8. Before replacing iron in holder, apply a small amount of solder to tip to maintain tin.

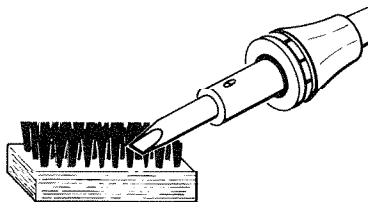
FIGURE 3-4. TINNING OF SOLDERING IRON TIP

*TIP REMOVAL*

Periodically loosen set screw and remove tip. Clean scale from shank and heating element, using 100 grit or finer emery cloth. NOTE: Keep setscrew tight at a times to assure maximum heat transfer.

*CLEANING A COLD IRON*

1. Gently polish tip to dull silver color with 100 grit or finer emery cloth.  
NOTE: a. Don't overpolish as this will remove iron plating.  
b. Never file a plated tip. (Grumman stock tips are all plated.)
2. Replace tip in element and tighten set screw.
3. Before heating, wrap a short length of rosin core solder around tip.
4. Plug power cord into outlet.
5. While iron is heating, flood tip completely with solder.

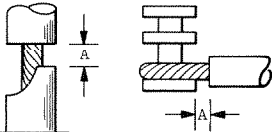
*CLEANING A HOT IRON*

To clean excessive oxidation when iron is already hot, rub with brass bristle brush (suede brush) and tin. If it fails, let cool and clean as above.

FIGURE 3-5. MAINTENANCE OF SOLDERING IRON TIP

NOTE: Keep entire Work Area Clean

WIRE



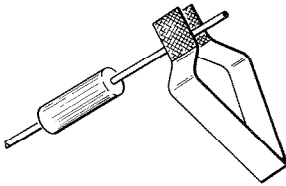
GAP A = MINIMUM: 1/32"  
MAXIMUM: 1/16" OR  
TWICE THE INSULA-  
TION DIAMETER.  
WHICHEVER IS  
GREATER

Strip the wire. Strip length should allow conductor to be exposed between solder joint and insulation when complete.

(Dim. A)

NOTE: Wire may be overstripped and dressed to size later.

COMPONENT LEADS

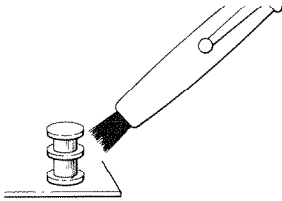


1. Remove tarnish or oxidation with lead cleaner.

NOTE: Do not twist or bend component lead where it meets body.

2. Clean with solvent.

TERMINALS

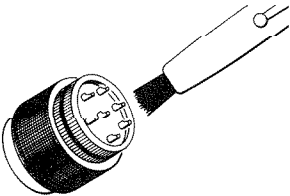


1. Clean with fiberglass brush to remove oxidation. Heavy oxidation may require careful use of stainless steel brush.

2. Rag with non-chlorinated scouring powder may be used with twisting action.

3. Clean with solvent.

CONNECTORS



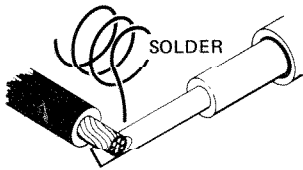
1. Clean solder cups with fiberglass brush.

2. Rows of channel pins may be cleaned with brass bristle brush.

3. Clean with solvent.

FIGURE 3-6. STRIPPING/CLEANING FOR SOLDERING

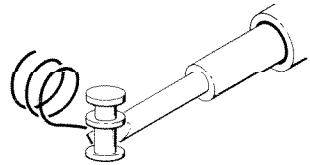
.....WITH AN IRON



## WIRE

1. Twist conductor strands tightly in direction of strand lay.
2. Heat conductor with tinned soldering iron.
3. Apply rosin core solder to wire, not soldering iron tip.

NOTE: Do not overheat. Insulation may melt or char.

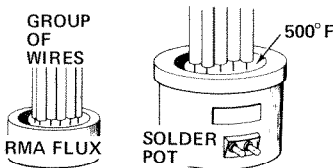


## COMPONENTS

1. Heat terminal or lead with tinned soldering iron.
2. Apply solder to component, not tip.

NOTE: Use heat sink for heat sensitive components (diodes, transistors, etc).

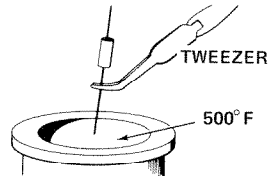
.....WITH A SOLDER POT (PREFERRED METHOD)



## WIRE

1. Group wires and tap gently on bench top to even ends.
2. Dip exposed strands 1/8 in. deep in RMA rosin flux.
3. Immerse in solder pot halfway.

NOTE: Silver plated wire "wicks" quickly. Do not leave conductors in solder too long.



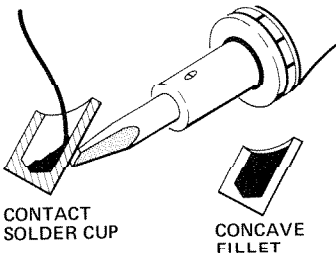
## COMPONENTS

1. Grasp component with off set tweezers or heat sink.
2. Dip leads in RMA rosin flux.
3. Dip tin leads in solder pot.

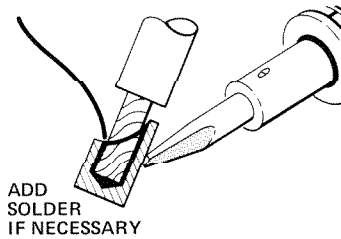
NOTE: Do not exceed six seconds in solder pot. Use a heat sink on diodes, etc.

FIGURE 3-7. COMPONENT TINNING

..... INTO PREFILLED CUP

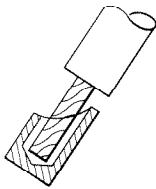


1. Heat contact cup with tinned soldering iron.
2. Apply rosin core solder to inside of cup until a concave fillet is achieved.

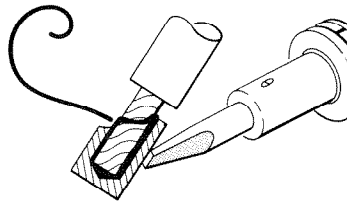


3. While solder is still molten, insert tinned wire into cup.
4. Heat until solder flows evenly into strands.
5. Allow to cool without moving wires.
6. Solvent clean flux residue with brush. Air dry.

..... INTO UNFILLED CUP

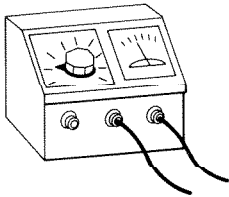


1. Insert tinned wire into empty (but tin coated) solder cup.



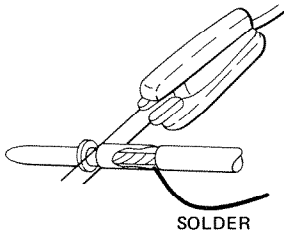
2. Heat outside of contact cup.
3. Apply solder to wire and inside of cup until fillet is achieved.
4. Allow to cool without moving wire.
5. Solvent clean flux residue with brush. Air dry.

FIGURE 3-8. CONTACT SOLDERING WITH SOLDERING IRON

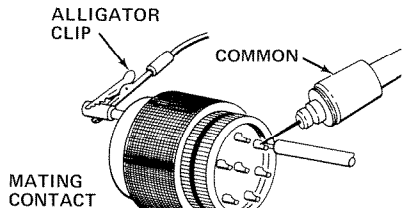
**CONTROL UNIT SETTINGS**

Set current on resistance control unit to lowest range adequate to do job. Should heat component to melt solder within 5 seconds.

NOTE: Trial and error on scrap excess parts may be required to get right setting.

**APPLICATION OF ELECTRODES****TWIN ELECTRODE  
HANDPIECE**

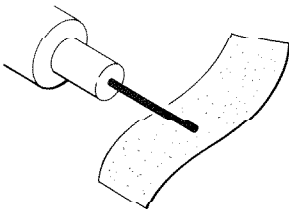
OR

**SINGLE ELECTRODE  
HANDPIECE**

1. Apply electrode(s) to contact.

NOTE: If unit is equipped with footswitch, do not activate current until electrodes are attached to prevent arcing.

2. Heat component without moving electrodes.
3. Apply solder to joint. Let flow thoroughly.
4. Allow to cool, then solvent wash.

**CLEANING ELECTRODES**

1. Keep electrode clean to ensure good contact. Clean with wire brush or emery cloth.
2. If necessary, shape electrode tip to suit component being worked.

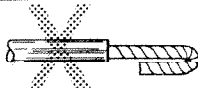
**FIGURE 3-9. CONNECTOR SOLDERING WITH RESISTANCE UNIT**

WIRE & LEAD BENDING

Soldering  
SECTION 3-11



BEND MUST BE SMOOTH



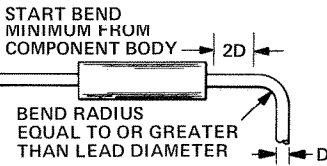
NOT SHARP



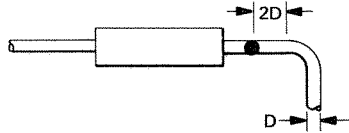
NO BIRDCAGING

- Tin all wires before forming leads.
- Always bend within tinned area of exposed conductor.
- Do not permit "bird caging".

FIGURE 3-10. WIRE LEAD BENDING

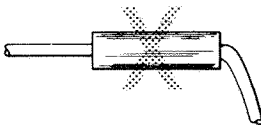


STANDARD LEAD

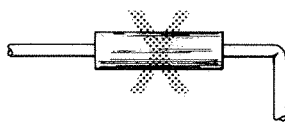


WELDED LEAD

- Bend must start at least twice the lead diameter ( $D$ ) from component body or weld.
- Bend radius must at least equal diameter of lead.
- Avoid sharp bends that deform shape of conductor.

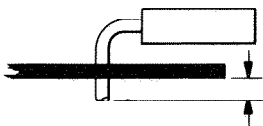


CLOSE BEND MAY CRACK COMPONENT



NO SHARP BENDS

FIGURE 3-11. COMPONENT LEAD BENDING



Leads extending through PC board eyelets must extend below board from 1/32 in. to 1/16 in. (0.030 ± 0.060)

FIGURE 3-12. COMPONENT LEADS ON P.C. BOARD

GENERAL REQUIREMENTS

- In all cases, maintain strip gap shown in Component Preparation (Section 3-7).
- In NO case, shall wires or component leads be wrapped on each other. See Figure 3-14.
- A maximum of (3) wires/leads per termination is allowed except for turrent terminals where (3) wires/leads per section is permissible.

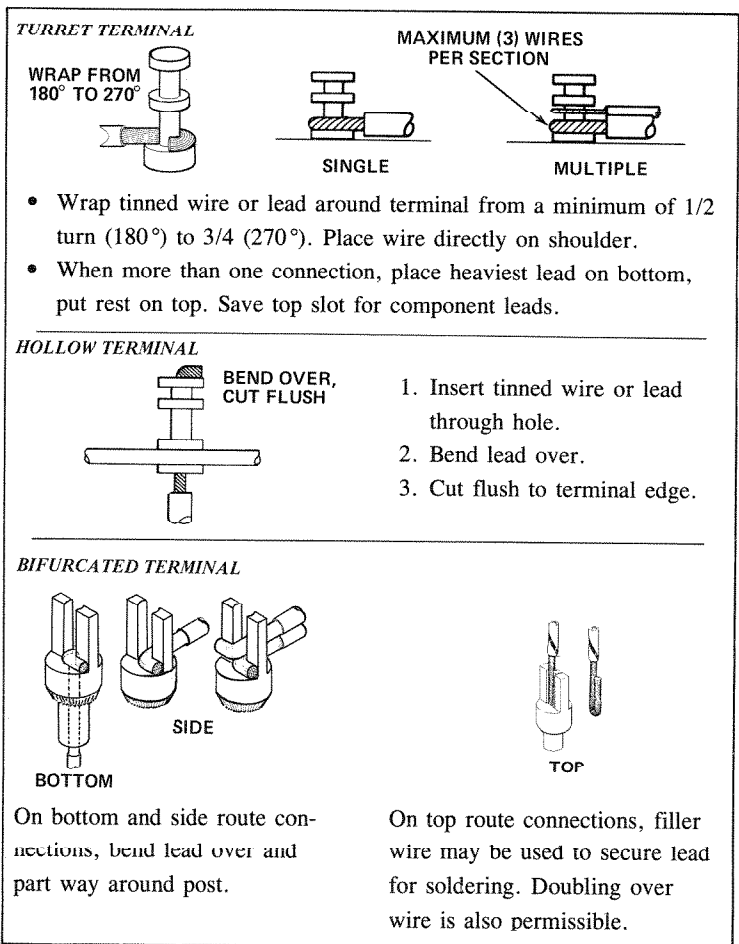


FIGURE 3-13 WRAPPING WIRE LEADS (SHT 1 OF 2)



**COMPONENT CONNECTIONS  
BEFORE SOLDERING**

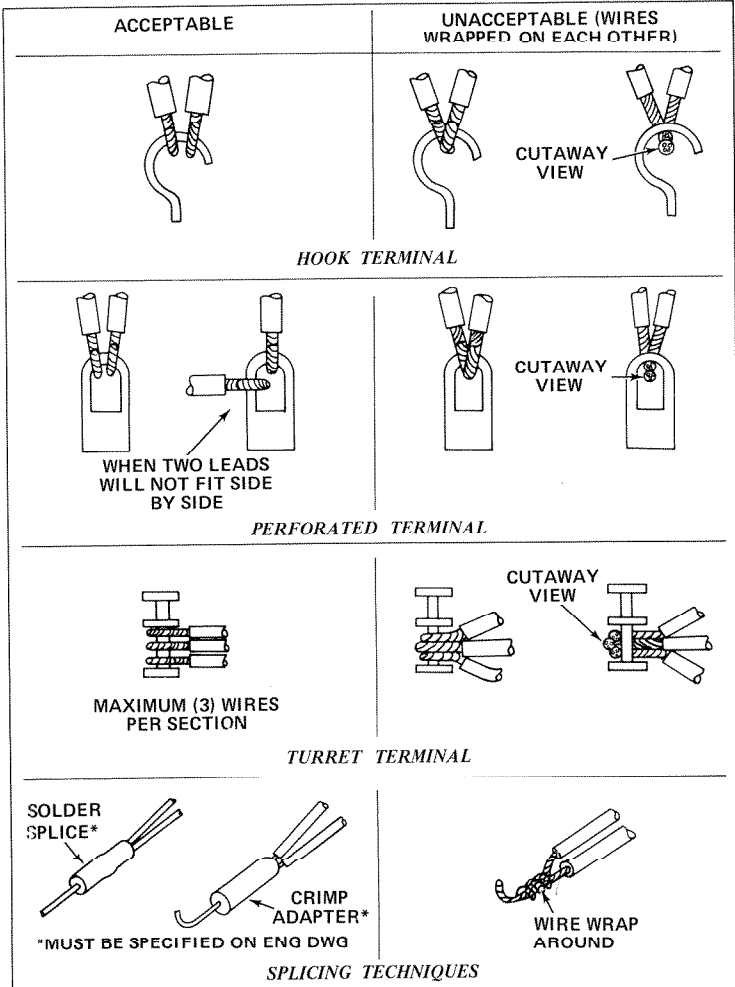
**Soldering  
SECTION 3-12**

**HOOK OR PERFORATED TERMINAL**

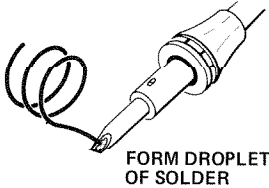


- Wrap tinned lead half way around and make firm connection without deforming lead surfaces.

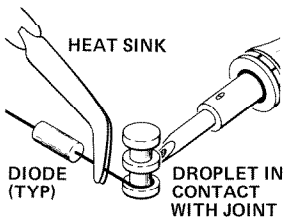
**FIGURE 3-13 WRAPPING WIRE LEADS (SHT 2 OF 2)**



**FIGURE 3-14 ACCEPTABLE & UNACCEPTABLE WIRE LEAD WRAPPING**

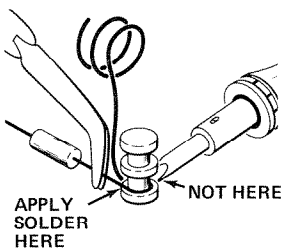


1. Form droplet on tinned soldering iron tip by adding small amount of solder.

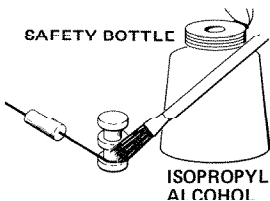


2. Place tip on joint with solder droplet against parts being heated.

NOTE: Where heat sensitive components are being soldered, use heat sinks.



3. Apply rosin core solder to joint, not tip. Observe a good flow but do not overheat.
4. Allow to cool without moving leads.
5. Joint should be produced within 5 seconds; otherwise check for too small an iron, dirt etc.



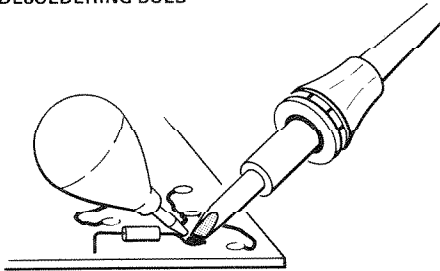
6. Clean finished joints with natural bristle brush and solvent. Remove all flux residue and air dry.

NOTE: Force air drying is permissible. Use oil free filtered air at 20 PSI.

FIGURE 3-15. COMPONENT SOLDERING

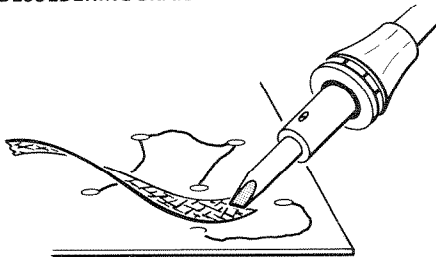
When it is required to remove a soldered component to effect a rework/repair, or to remove excess solder, the following techniques are used.

... USING A DESOLDERING BULB



1. Apply heat sinks where necessary.
2. Tin soldering iron tip.
3. Apply tip to joint until solder flows.
4. Squeeze desoldering bulb and release slowly, drawing liquid solder up into bulb.

.... USING DESOLDERING BRAID



1. Apply heat sinks where necessary.
2. Apply liquid flux to joint and desoldering braid.
3. Place surface of braid on joint.
4. Apply soldering iron to braid until joint is heated and solder wicks up into braid.
5. Remove braid before joint cools.

**NOTE:** MEPS-33000-823 (PACE REWORK CENTER) DESCRIBES ADDITIONAL PROCEDURES AND EQUIPMENT FOR DESOLDERING CONNECTIONS

FIGURE 3-16. DESOLDERING CONNECTIONS

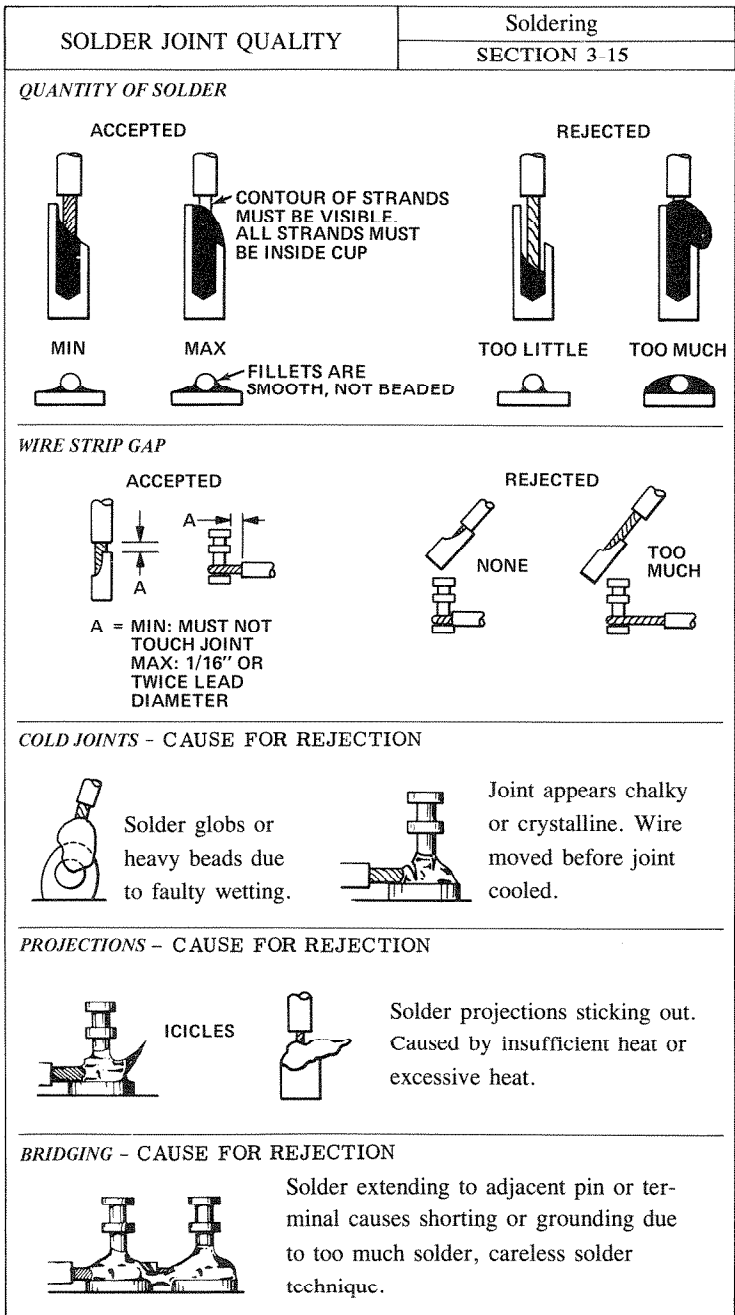


FIGURE 3-17. SOLDER JOINT CRITERIA

## DO

- Keep work area clean and free of dust, dirt, oil.
- Always wear safety glasses when soldering.
- Keep iron tip clean and well tinned.
- Clean components thoroughly before soldering.
- Make a firm mechanical connection to prevent leads from moving when soldering.
- Apply solder to component, not soldering iron tip.
- Clean all completed joints with solvent and natural bristle brush.

## DON'T

- Never use acid, chloride or organic flux; only RMA rosin flux is permitted.
- Don't attempt to solder components with obvious oxidation, dirt or grease on iron tip or components.
- Don't over tin stranded wire as it may wick up under insulation and cause breakage later.
- Don't move wire while hot solder is cooling; causes "cold" joint.
- Never flick or shake hot solder joint; spattering solder may injure personnel or damage components.
- Don't form wire to wire solder splices unless supported by a terminal or other approved component.