SOLDERED CONNECTIONS
BASIC SOLDERING REQUIREMENTS AND METHODS

CONTENTS

1. GENERAL

1.1 Scope of Section

1.11 This section covers the basic requirements and methods for soldering.

1.2 Precautions Against Personal Injury, Equipment Damage and Service Interruptions

1.21 General precautions to be taken against personal injury, equipment damage and service interruptions are covered in Handbook 0 and are to be observed at all times as they apply to the operations being performed. Specific precautions, when applicable, are included in this section with the associated method.

1.3 Verification

1.31 Items for the verification of the equipment installed by the operations covered in this section are listed in Paragraph 4.

1.311 The items in Paragraph 4 may also be used as a self-check guide when performing operations covered by this section.

2. FUNDAMENTALS OF SOLDERING

2.1 Fusing of Wire and Terminal

2.11 Soldered connections shall be soldered so as to provide a secure metallic connection between the parts soldered. The cross section of a typical properly soldered connection is shown in Figure 1.

2.111 Soldering is the process of fusing three metals (wire, terminal and solder) and is brought about by the application of solder in a molten state (at an established minimum temperature 100°F higher than the melting point of the solder) in the presence of a flux.

2.112 Most of the terminals and wires to be soldered are purposely tinned for soldering. The tinning permits the fusing action to take place between the tin-copper alloy surfaces at temperatures permissible for soldering coppers used on telephone apparatus. The melting point of an alloy of copper and tin is lower than that of either one of the two metals.

2.12 The metals to be soldered must be thoroughly cleaned of all enamel, grease, dirt and oxides to permit the proper fusing action to take place.

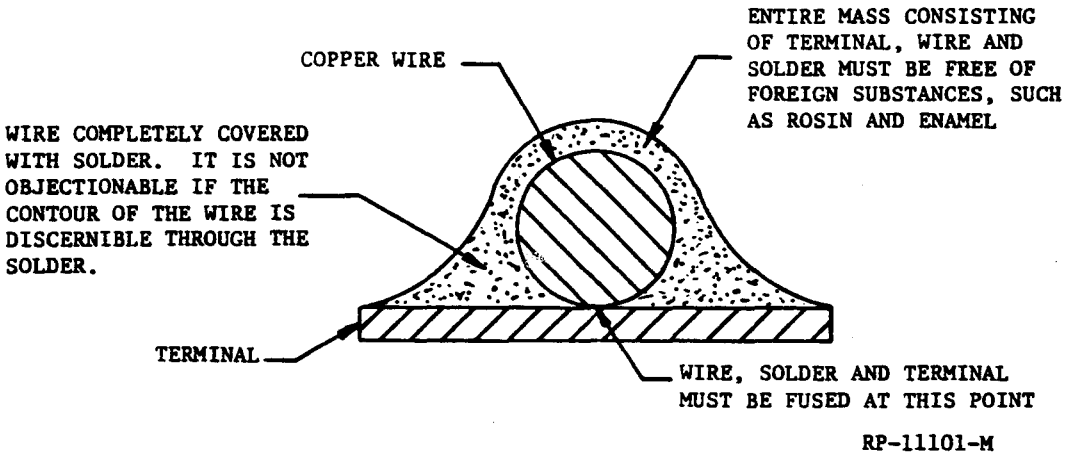


FIG. 1 CROSS SECTION OF A TYPICAL PROPERLY SOLDERED CONNECTION (PAR. 2.11)

2.121 In some of the older central offices a layer of grime and oxidation has been built up on terminals, banjo wires, etc., resulting in the deterioration of the tinning. Some of the installation force has attempted to break down this deposit by using non-standard cleaners, non-standard fluxes, the R-3669 Solder Stick, etc., which has led to disastrous results.

→2.122 The only approved method of removing grime and oxidation from terminals, banjo wires, etc., is described in Section 320, Paragraphs 6.61 through 6.613 of this handbook.

2.2 Purpose of Flux

2.21 All metals when heated in air, more or less rapidly acquire a film of oxide. The primary function of the rosin flux in solder is to remove the oxide from the surface thus insuring perfect fusion of the metals.

2.211 Rosin is a noncorrosive flux and vaporizes quickly when heated. The oxide present on the surfaces is carried off in the vaporization. Rosin is the only flux approved for use insoldering switchboard wiring.

2.3 Prerequisites and Technique of Soldering

2.31 The prerequisites of good soldering are as follows:

2.311 Wire properly connected. Refer to Section 320 and 323.

2.312 A properly shaped and smooth soldering copper tip. Refer to Handbook 28, Section 501.

→2.313 A properly tinned soldering copper or iron clad tip. Refer to Handbook 28, Section 501.

2.314 A hot soldering copper. Refer to Handbook 28, Section 501.

2.315 Clean surfaces where the solder is to be applied.

2.32 The technique of heating the wire and terminal, applying solder, withdrawing the copper from the completed connection and preventing the wire from moving during these operations while the solder is cooling from a liquid to a solid state is the same regardless of the percent of tin in the solder, the type of terminal, the gauge of the wire whether the wire is tinned or untinned. The only variable which must be given consideration is the time element.

3.321 The factors causing a variation in the time element are as follows:

2.3211 Heavier terminals and the larger size wires require a longer heating period than the lighter terminals and smaller size wires.

2.2 Change Paragraph 2.322 to read as follows:

2.322 A higher tin content rosin core solder of .070" dia. (RM-728225) and .040" dia. (R-5091), both of which are 60% tin and 40% lead, have been standardized for use in the field. There is also a mildly activated rosin core solder (900320631) which has been standardized for specific use. All three of these solders have a melting range of 360° - 370°F which will substantially reduce the melting and cooling off periods.

NOTE: Laboratory tests disclose that a mass of solder will remain molten for a much longer time than is commonly thought. During most of the cooling period the simimolten solder will close in back of any movement of the wire and will freeze solidly to make a secure connection. Just at the instant of solidification, however, the solder is so friable (easily pulverized) that if it is disturbed at that instant it will break up just as if it were a globule of wet sand.

3. COMMON REQUIREMENTS AND METHODS

3.1 Solder

3.11 Use only the approved rosin core soldered as listed in HB 250, Catalog of Supplies except as specified in Paragraph 3.34.

3.2 Heating Wire and Terminal

3.21 Judge the temperature of soldering coppers by applying a piece of solder on the tinned surface of the tip, held in a vertical plane away from the face, to prevent injury from sputtering solder. Serious burns may be caused by holding the heated copper near the face or hands to test the temperature.

3.22 Look at the soldering copper before picking it up. Otherwise the copper may be grasped at the stem which would cause a serious burn.

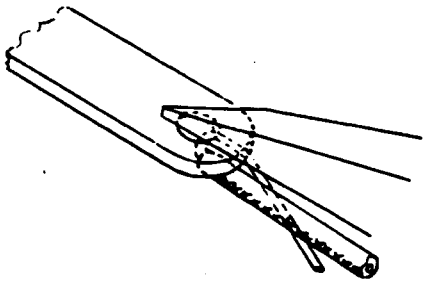
3.23 Keep the tips of soldering coppers clean and free from accumulations of rosin and burned insulation. Fires may be caused by incandescent particles of carbon from this source falling on the frayed insulation of old wiring.

3.24 Heat wire and terminal completely as shown in Figure 2 before applying solder. For repetitive soldering operations the tinned tip carries a small globule of molten solder to the successive connections which is the medium through which the heat is transmitted to all parts of the uneven surface presented by the wire on the terminal.

3.241 Where difficulties are encountered, due to connections having been made at untinned or incompletely tinned terminals or with untinned or incompletely tinned wire, the connection should frist be heated and the tip withdrawn briefly to permit the surfaces of the connection to be retinned by rubbing them with solder. The connection should then be reheated and the soldering operation continued as described herein.

NOTE: The above method is based on the same principle applied to the tinning of soldering copper tips. Refer to Handbook 28, Section 501.

3.242 When soldering neoprene or plastic insulated wire, extra care shall be taken that the soldering cooper is not applied to the connection any longer than necessary to make a good connection, since these materials have a tendency to recede with excessive heating.



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1. Hold tinned side of tip against wire and terminal until they become completely heated.

2. Use care not to heat terminal excessively beyond the immediate soldering location, so that other wires, such as straps, which are already soldered will not become loosened. At terminals imbedded in a compound use care to avoid melting the compound.

FIG. 2 HEATING WIRE AND TERMINAL (PAR. 3.24)

3.243 Neoprene and plastic insulated wire without textile covering shall not be allowed to come in direct contact with another terminal which is being soldered. Special care shall be exercised to avoid even momentary contact between the soldering copper or other heat source and the insulation of wires of these types. This also applies to connections made on solderless wrapped terminals that must be soldered.

3.3 Application of Solder

3.31 R-3234 Plano Safety Eyeglasses or R-3235 Prescription Safety Eyeglasses are considered adequate eye protection for soldering terminals. When unsoldering or cleaning terminals R-3055, all Plastic Safety Goggles should be worn.

3.32 Apply solder to wire and terminal as shown in Figure 3, making sure that the wire remains flat on the terminal so that it will be fused directly to the terminal. A wire surrounded by solder (wire not in contact with the terminal) results in a mechanically weak connection. The solder should be applied slowly at the first and second connections to avoid "spits" in case a "pocket" was formed at the end of the solder at the completion of a previous soldering operation.

3.33 The points of application of solder to terminals in various positions are shown in Figure 4.

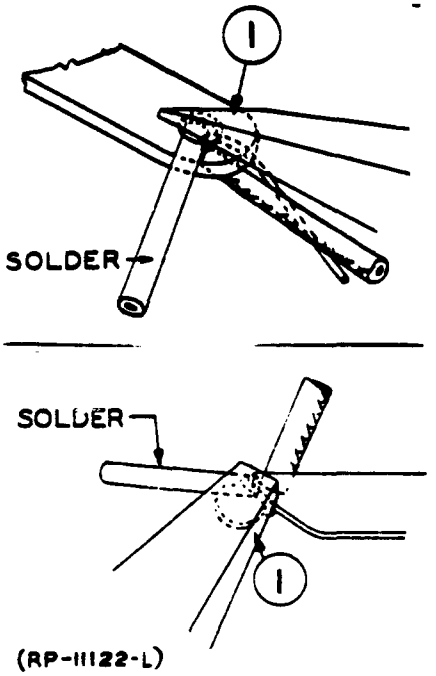
3.34 At times it is necessary to make connections on terminals, banjo wire, etc., that has collected dirt, grime and has become oxidized over a period of years. When these situations are encountered, refer to Section 320, Paragraphs 6.61 through 6.613 of this handbook to complete the soldered connection.

3.4 Completing Connection

3.41 Withdraw the soldering copper from the terminal as shown in Figure 5. Wipe the accumulated solder off the tip on the wiping pad on the holder.

3.411 Flipping the copper to remove accumulations of solder may cause serious eye injuries or body burns or the solder may fall into the equipment and become a service hazard. Tapping the tip against ironwork or other surfaces may cause opens in the heating unit or loose parts in the assembly.

3.42 When soldering operations are discontinued, even for a brief interval, the soldering copper should be placed in the holder so that the flare of the handle is between the guard and cage to prevent the copper from sliding or being accidentally pulled out of the holder.



1. Tilt the copper and apply solder to the junction of the heated wire and terminal.

2. Apply sufficient solder to completely cover the wire.

3. Rub the copper tip on the wire and terminal while exerting a slight pressure in order to spread the solder evenly over all portions of the connection, using care not to distrub the position of the wire on the terminal.

FIG. 3 APPLYING SOLDER TO HEATED WIRE AND TERMINAL (PAR. 3.32)

3.5 Appearance of Soldered Connections

3.51 All unsightly flux shall be removed with the fibre spudger so that the soldered connection is neat and clean. Consistent presence of unsightly flux is indicative of poor workmanship.

3.52 Excessive globules of solder projecting from the terminal and pile-ups of solder on the terminal shall be removed. Consistent presence of these items is indicative of poor workmanship.

3.6 Clearance Between Soldered Connections

3.61 After the terminals have been spread for connecting purposes, the clearance between the solder of the completed connection and adjacent metal framework, should not be less than 1/32".

3.62 The clearance between the solder and adjacent bare wire, terminal or solder of an adjacent connection shall not be less than 1/64" except on K carrier cable balancing panels where a clearance of not less than 1/32" is required.

3.63 Terminals of apparatus whose design permits movement, such as the floating contact terminals in sockets for electron tubes, crystals, or multiple contact receptacles and plugs, shall have a clearance of not less than 1/32 inch measured with the terminals in their most adverse positions. It is intended that this requirement be met when the apparatus in question is checked with its mating apparatus or equivalent in place and without applying other pressures on the terminal. The terminals shall have free movement after the soldering operation.

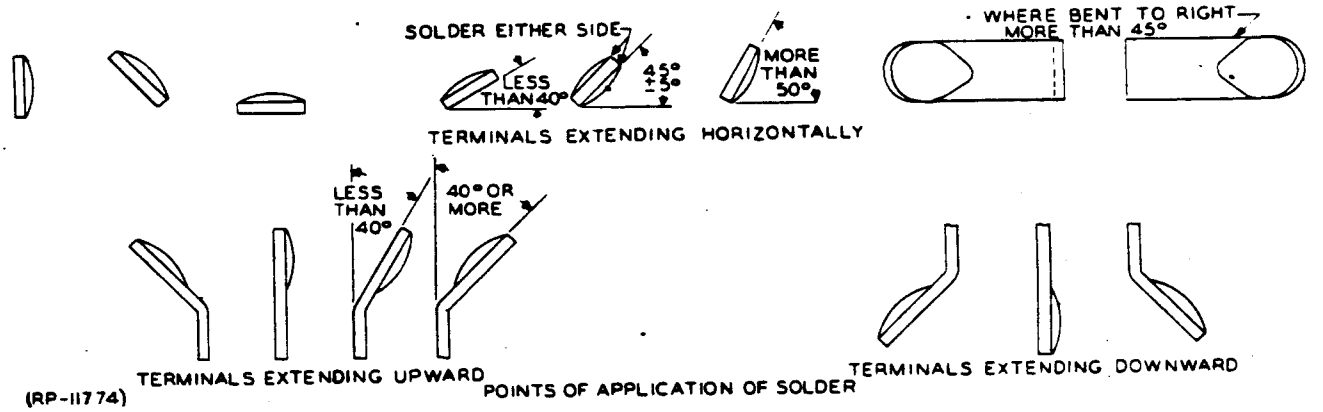
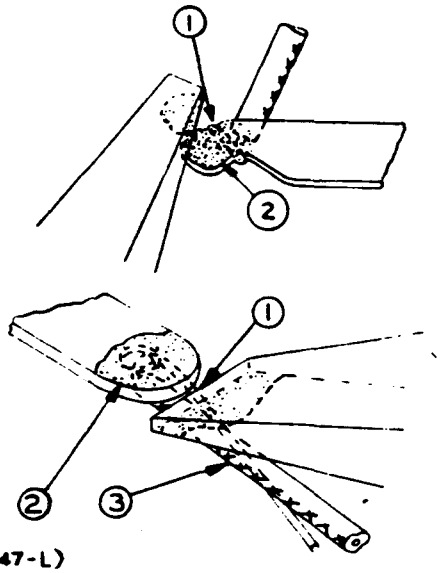


FIG. 4 POINTS OF APPLICATION OF SOLDER (PAR. 3.33)



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1. Withdraw tip along wire to remove excess solder. Use care to see that the wire and terminal are not under tension as the tip is withdrawn to prevent wire from being moved until solder solidifies.

2. The soldered connection should have a smooth bright appearance, wire fused to terminal and completely covered.

3. Use care not to burn insulation.

FIG. 5 COMPLETING THE SOLDERED CONNECTION (PARS. 3.4 and 3.243)

3.7 Checking Quality

3.71 Examine each soldered connection in completed rows as the work proceeds and make sure that the proper wire has been connected to the terminals and that each connections meets the conditions covered in Paragraphs 2.11 and 3.51 to 3.63.

3.711 Before proceeding to the next row resolder all connections not meeting the conditions covered in Paragraph 2.11 or where wires are not connected to the proper terminal.

4. VERIFICATION

	VERIFICATION ITEMS AND BRIEF STATEMENT OF REQUIREMENTS	REFERENCE Par. No.	REFERENCE Fig. No.
4.1	Security and Appearance of Soldered Connections		
4.11	All soldering done with standard rosin-core solder, except as specified in Par. 3.34.	3.11	
4.12	Connection secure and free of foreign substance such as rosin and enamel.	2.11	Fig. 1
4.13	All unsightly flux and excessive globule of solder removed from terminals.	3.51 3.52	
4.14	Insulation on skinners not burned or otherwise damaged. (For connections on solder and solderless wrap type terminals).	3.242 3.243	
4.2	Clearance Between Connections		
4.21	1/32" clearance maintained between soldered connections and adjacent metal framework.	3.61	
4.22	1/64" clearance maintained between adjacent soldered connections except on K carrier cable balancing panels or apparatus with free floating terminals where a 1/32" clearance shall be maintained.	3.62 3.63	

→ Indicates new or changed information

[Vertical line at side of paragraphs indicates requirements

Engineering Planning Manager
(Installation)

Reason for Reissue:
To include UIS Section 322 dated 11-25-76 and add new solder numbers R-5091 and 900320631 and Handbook 28, Section 501 reference.