Relativistic Heavy Ion Collider
Magnet Division Procedure

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REVISION RECORD

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A	3/7/95		Initial Release.	
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1 Scope:

This procedure outlines generic soldering details and definitions to be used as guidance in soldering the cold mass tin/silver alloy solder joints. Tin/silver alloy is a higher temperature solder, 221^0C vs. lead/tin 183^0C. The flux system used, an "R" type for low halide content, was designed to be optimal for the lead/tin system. As a result, the higher temperatures needed for the tin/silver alloy forces a change in the basic soldering techniques needed to produce good solder joints. The equipment and materials to be used will be called out in the applicable MAP. Under no circumstances will RA, RMA, or water based acid flux be used in any RHIC cold mass assembly. Only approved R type fluxes can be used.

2 Applicable Documents

None

3 Requirements

3.1 Material/Equipment

None

3.2 Safety Precautions

3.2.1 Operators shall be instructed by their cognizant technical supervisor in the proper methods of soldering.

3.2.2 Forced or exhausted ventilation should be used in locations where buildup of fumes is possible.

NOTE

When hoods are used, ensure proper logbook entries are made.

3.2.3 Specific steps of this procedure contain Electrical and Mechanical Assembly operations that impact the environment. Prior to performing these steps, personnel shall complete the applicable facility specific environmental training.

3.2.4 Ensure unused solder is recycled or disposed of properly.

3.2.5 Proper Personal Protective Equipment (PPE) shall be worn when handling chemicals or mechanically cleaning equipment. This includes, but not limited to safety glasses and disposable latex gloves. Contact your ES&H Coordinator or Facility Representative.

NOTE

Latex gloves only give marginal protection to most solvents used and should only be considered as protection from incidental contact /exposure. If the glove is contaminated, it should be removed and a new glove put on.

3.2.6 Sharps (i.e. razor blades or hypodermic syringes even without needles) shall be disposed of per the Regulated Medical Waste Management SBMS Subject Area

4 Procedure

4.1 Cleaning

NOTE

Cleaning is used prior to soldering to remove foreign materials from the surfaces to be joined. This is not performed by the flux. It may be physical or chemical. Any cleaning technique must be evaluated for the possibility of residues. Cleaning is used after the soldering operation to remove flux residues. With the paste flux, it will also be used to remove petrolatum residues.

4.1.1 Mechanical: Wire brush, brass brush, steel wool, sandpaper, filing. All mechanical cleaning procedures will produce additional particles, for example, sandpaper will leave alumina or carbide particles on the surface or surroundings, and steel wool, which leaves steel wool fibers. Any procedure for cleaning which produces particles must be evaluated for impact of the particles within the assembly.

4.1.2 Solvent: Alcohol, Freon, acetone, water. Contamination can be either soluble or non soluble in water. The type of contamination to be removed must be evaluated for cleaning effectiveness. The specific procedure will specify the type of cleaning required for the parts and application.

4.1.3 Tarnished Silver: Use a scotchbrite pad to remove the tarnished surface. Do not remove the silver plating exposing the underlying base metal. Remove all particles generated, and either wipe the final surface with a dry cloth, or spray the surfaces clean with alcohol and let dry. Odd shaped parts may require the use of a wirebrush, in which case a brass bristle brush is best.

4.1.4 Oxidized Nickel Surfaces: Clean the surface with a scotchbrite pad to a uniform color surface. Remove particles with a dry cloth or alcohol wash.

4.1.5 Bare Heavily Oxidized Copper: These may be worked by tinning, either with an iron, or by dipping. Flux the surface repeatedly, and slowly work the solder along the surface.

4.1.6 Oxidized Solder Or Tin Coat: These can be recovered by fluxing generously, and re-tinning. Clean the residue after tinning, prior to fluxing for the next operation. Do not use a poor solder surface as is, since a typical solder joint will not allow inspection of the final integrity of the solder to base metal wetting.

4.2 Fluxing

NOTE

Fluxing is the placing of flux onto the surfaces to be soldered. Any process which puts the flux on is acceptable, although it is desirable to not use too much because of the cleanup mess. Too little will result in poor solder joints. Fluxing will be dependent on the type of flux, liquid or paste. The type of flux used will be called out in the procedure.

4.2.1 Liquid: Used for small joints, the liquid will wick into all available spaces by surface tension. It is easily introduced by the use of a hypodermic needle or a small paint brush. For parts which are to be tinned as a separate operation, the flux can be in a container, and the part dipped into the liquid. For larger joints, the wicking capability of the flux is limited by the clearances of the parts. Too large a clearance, and the flux will not wick adequately.

4.2.2 Paste: The paste is put onto the surfaces to be soldered prior to assembly. Do not rely on the wicking action of the hot paste to coat surfaces which are not initially pasted. This is typically applied by use of a flux brush, although any method may be used. Large geometry connections, such as copper braid to copper bus, can be dip soldered using the wicking of the paste flux. The reason is the high mass of the parts with respect to the input of heat. Since the parts take a long time to heat, the braid will be effective in pulling the flux into the joint.

4.3 Tinning

NOTE

Tinning is used to pre-coat a conductor prior to assembly into the final joint configuration. This provides an excellent passivation of the conductor surface, and makes the final soldering operation easier. It may also be used to hold wire

strands together, however it will also stiffen stranded wire. Care should be exercised with stranded wire, as bending a tinned wire may cause some of the strands to break. Tinning is to be performed on clean parts.

4.3.1 Solder Pot Tinning:

4.3.1.1 Small parts will typically perform better using the liquid flux, while larger parts may require the use of the flux paste.

4.3.1.2 Dip the part into liquid flux, or apply paste to the part with a brush.

4.3.1.3 Lower the part into the solder pot slowly, with no surfaces parallel to the surface of the solder. Once contact has been made, keep the part immersed a maximum of 1/4 inch. Do not submerge the piece until the solder begins to show a positive meniscus with the part. When the solder has begun to wet the piece, slowly immerse into the pot. This allows the flux to attack the oxides. Immersion of the part too quickly can wipe the flux from the surface prior to activation of the flux, resulting in lack of adhesion of the solder.

4.3.1.4 Once the full part has wetted, remove it from the pot. It is not necessary to "bake" the part in the pot. Once the solder has wicked into all available spaces, the flux performs no additional work.

4.3.1.5 Copper piece parts which have been rolled using a lubricant may de-wet at the first dipping. This is because the rolling process traps lubricant in the pores of the metal, and subsequent rolling tends to close some pores. This results in a part which will resist all cleaning attempts, and will still outgass at the first dip. To effectively wet these parts, a multiple dip is required. The best fluxing action will be obtained by dipping the still hot part into the tub of flux paste. This will provide the best flux activation, and the fastest recovery of the surface.

4.3.1.6 Do not wipe the molten solder from the surface you are trying to coat. Doing so will remove the solder alloy, leaving behind a copper/tin intermetallic. This intermetallic will passivate in room air, and the R flux in use is not optimized to reduce this passivation. If a surface is to be flat for physical reasons such as fixturing at a later date, the part will have to be oriented during cool down to allow the liquid solder to settle flat.

4.3.2 Soldering iron tinning

4.3.2.1 Flux the piece using either liquid or paste flux.

4.3.2.2 Place the iron tip against the work. It may help to pre-tin the tip of the iron immediately prior to touching the work, as this will aid in heat transfer.

4.3.2.3 Immediately place the solder in the joint between the tip and the work. Feed solder slowly into the space until the work has come up to temperature and wicked the solder.

4.3.2.4 If necessary, use the iron tip to remove excess solder.

4.4 Soldering

4.4.1 Applying The Solder: The typical procedure for soldering requires that the work to be soldered is to be heated, and the solder is applied to the work. This is commonly used to prevent the generation of cold solder joints. With tin/silver solder, this procedure is capable of burning all the flux before the parts are hot enough to melt the solder. To expedite the transfer of heat, a combination of contact between the parts and the iron and applying the solder between the iron and the parts is best. Once the solder started wetting the parts, the heat transfer to the parts is by metal conduction, not by flux conduction.

4.5 Post cleaning

4.5.1 Both the paste and liquid flux are easier to clean while the part is still hot. If possible, clean and wipe the parts during the cool down from soldering. At present, several solvents are in use:

- Citric Acid Based Cleaner.
- Alcohol And Acetone
- Trichlor or Freon Degreaser (Vapor Phase Method): These solvents, while effective, are environmentally hazardous, and are limited in use to specific cleaning machines, not for portable use in a production line.

5 Definitions:

5.1 Flux

5.1.1 Flux performs two main functions.

NOTE

Fluxes are only to be used for oxide removal, not gross cleaning of contamination.

- Oxide removal: When the surface which is flux coated is heated during the process of soldering, the flux will activate. This will occur at a temperature which is dependent on the flux type. This activation is necessary for the removal of the oxides. Activation must occur prior to the melting of the solder in order to be effective. When soldering to silver surfaces, fluxes can strip silver oxide, but are not effective in removing silver sulfides. Silver sulfide, commonly referred to as tarnish, must be physically removed from the surface. Do not use chemical means, such as Tarn-X, as this may introduce unknown, uncontrolled chemicals into the cryogenic environment.

- Protective coating during wetting: Once the oxide has been stripped from the surface, the surface must be protected from exposure to free oxygen during the heating of the materials. The flux, prior to burn-off, will coat and protect the surface. This protection is limited in time, and tin/silver soldering temperatures reduce this time even further. The petrolatum in the paste flux is used to extend the working time.

5.1.2 Rosin fluxes come in three generic types; R, RMA, and RA.

- R: Non activated rosin flux. This is typically used where oxide removal is not difficult, and where after the fact corrosion is of concern. This is the flux of choice for all soldering of components which will be within the cryogenic environment.

- RMA: Mildly activated rosin flux. This is used when the surface to be soldered presents a more difficult surface oxide. Much easier to use than R, it may contain chemicals from the halide group, and is not allowed within the cryogenic environment.

- RA: Activated rosin flux. Used when the surface oxide is very difficult to remove. This will contain high concentrations of halides, and is not acceptable for use within the cryogenic environment.

5.1.3 Rosin fluxes are available in paste and liquid forms.

- Paste: The paste used presently contains a carrier of petrolatum (Vaseline). The advantages include a consistent viscosity and additional coverage during reflow. Disadvantages include cleanup of the petrolatum residue, and the need to physically place the paste on all surfaces to be soldered. This is because the wicking of the flux will occur only after introduction of heat, and the limited time for soldering may not guarantee adequate coverage.

- Liquid: The liquid flux in use has a carrier of alcohol. It's purpose is to keep the flux in a liquid form for ease of application. Advantages include easy wicking of the flux into all interstitial spaces of a solder joint, and lack of petrolatum residue after completion of the soldering operation. Disadvantages include maintaining viscosity during storage, and introducing an adequate supply of flux into large, open joints such as dipole superconductor lap joints.

5.2 Solder

5.2.1 Solders are primarily used for electrical continuity between two conductors. The present solders in use are of two types:

- 63/37 (Eutectic tin/lead): This is not used within the cryogenic environment, but is allowed for external connections. The melting temperature is 183^0C, or 361^0F. The standard form is a wire of various gauges, and including a core of flux, either R or RMA type.

- 96/4 (Eutectic tin/silver): This is the only approved solder for use within the cryogenic environment. The melting temperature is 221^0C, or 430^0F.

5.3 Plating

5.3.1 Plating allows a component to be manufactured from one material, and the surface to be of another. This is commonly used for surface corrosion protection, and can be used to provide a solderable surface on an otherwise unsolderable material.

5.4 Wicking

5.4.1 Wicking is when liquid is pulled into the small spaces between two materials by surface tension. The paste flux will wick once heat has been applied. Factors to be controlled for consistent wicking are room temperature, surface cleanliness, and viscosity of the flux.

5.5 Reflow

5.5.1 Reflow is the act of melting the solder. It can be either to produce a joint, disassemble a joint, or touch up an existing joint. Any reflow operation to produce or touch up a solder joint must have a flux coating on the surfaces of the joint prior to heating. If this is not followed, the bare surfaces of the conductors will oxidize heavily, and the flux will have difficulty in breaking up the oxide. This will result in non-wetted surfaces. It is possible to have a non-wet condition between two liquid solder surfaces. Simply melting two pre-tinned surfaces in contact with each other does not guarantee a proper joint.

5.6 Strain Relief

5.6.1 Strain relief is the use of a loop of wire to prevent the direct pulling of a soldered joint as a result of physical movement, either through mechanical means, or because of differing expansion rates during cool down, or warm-up. It is used to prevent wire breakage, and to prevent tensile failure of a soft solder joint.

5.7 Halides

5.7.1 A class of chemicals containing fluorine, bromine, chlorine, or iodine. Activated and mildly activated fluxes will typically use one or more of these compounds. The actual process during activation is the breakdown of these compounds into acids. Types of acids are hydrofluoric, hydrochloric, etc. These acids are responsible for the quick oxide removal. It is also these acids which would be likely candidates for corrosion of cryogenic components, and use of these should be avoided.

5.8 Heating

5.8.1 Soldering Iron: If required, the procedure will call out the specific iron type, tip type, and temperature setting if applicable. Any specific instructions for heating, solder application, etc., will be detailed in the specific procedure.

5.8.2 Torch: Generally will tend to burn the flux during flame contact. Torches are best when large masses are involved requiring large amounts of heat, and are best used by heating the part away from the joint.

5.8.3 Fixturing: Specific fixturing for large joints will be called out for use in the applicable procedure, and details for use will also be within the procedure.

6 Quality Assurance Provisions:

6.1 The Quality Assurance provisions of this procedure require that all assembly and test operations be performed in accordance with the procedural instructions contained herein.

6.2 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

6.3 All Discrepancies shall be identified and reported in accordance with RHIC-MAG-Q-1004.