SECTION 076110

copper roofing

THIS SECTION USES THE TERM "ARCHITECT." CHANGE THIS TERM AS NECESSARY TO MATCH THE ACTUAL TERM USED TO IDENTIFY DESIGN PROFESSIONAL AS DEFINED IN THE GENERAL AND SUPPLEMENTARY CONDITIONS.

roofing is part of a system. coordinate roof covering with roof deck and insulation systems.

flat seam roofing recommendations:

* Slopes greater than 6:12 – dry seams without sealant or solder.
* slopes greater than 3:12 up to 6:12 – sealant or butyl tapes concealed in seams.
* flat and slopes up to 3:12 – Fully solder seams.

1. - GENERAL
   1. SUMMARY
      1. Section Includes:

EDIT LIST BELOW TO SUIT PROJECT.

* + - 1. Flat-seam copper roofing.
      2. Flat locked and soldered (flat seam soldered) roofing.
      3. Standing-seam copper roofing.
      4. Batten-seam copper roofing.
      5. Horizontal-seam (Bermuda type) copper roofing.
      6. Custom-designed copper roofing.

RETAIN BELOW FOR FIELD PAINTING (ALSO FOR OTHER FINISHING).

* + 1. Related Requirements:
       1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
       2. Copper Roofing Finishes: Refer to the Division 09 "Painting" Sections for requirements for priming and finishing installed copper roofing; not work of this Section.
       3. Division 05 Sections for structural and light-gauge framing.
       4. Division 07 Section "Thermal Insulation" for roof insulation.
       5. Section 074210 – Copper Wall Cladding.
       6. Section 076210 - Copper Roofing Specialties: Accessories on roof other than mechanical and structural items.
       7. Section 076215 - Copper Flashing and Trim: Flashing and other trim not part of roofing.
       8. Section 076220 - Copper Gutters and Downspouts: Gutters and downspouts associated with roofing.
       9. Section 079514 – Copper Expansion Joint Cover Assemblies.

ABOVE MAY BE EDITED TO IDENTIFY SPECIFIC ITEMS SUCH AS REGLETS, RELIEF VENTS, ROOF EXPANSION ASSEMBLIES, ORNAMENTAL ITEMS, ETC.

* + - 1. Division 07 Section "Joint Sealants" for field-applied panel sealants.
      2. Wood framing and decking is specified in a Division 06 Section.

DELETE ANY OF THE FOLLOWING PROVISIONS WHICH ARE NOT APPLICABLE TO THE TYPE OF ROOFING REQUIRED.

* 1. COORDINATION
     1. Coordinate copper roofing with rain drainage work, flashing, gutters, downspouts, trim and construction of decks, parapets, walls, and other adjoining work to provide permanently watertight, secure, and noncorrosive installation.
  2. PERFORMANCE REQUIREMENTS

design professional is responsible for designING system, including anchorage, fastener size, and spacing.

* + 1. Installation Requirements: Fabricator is responsible for installing system, including anchorage to substrate and necessary modifications to meet specified and drawn requirements and maintain visual design concepts in accordance with Contract Documents and following installation methods as stipulated in the "Copper in Architecture” handbook published by the Copper Development Association Inc. (CDA)
       1. Drawings are diagrammatic and are intended to establish basic dimension of units, sight lines, and profiles of units.
       2. Make modifications only to meet field conditions and to ensure fitting of system components.
       3. Obtain Architect’s approval of modifications.
       4. Provide concealed fastening wherever possible.
       5. Attachment considerations: Account for site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening and fracturing connection between units and building structure or between components themselves.
       6. Obtain Architect’s approval for connections to building elements at locations other than indicated in Drawings.
       7. Accommodate building structure deflections in system connections to structure.
    2. Performance Requirements:
       1. System shall accommodate movement of components without buckling, failure of joint seals, undue stress on fasteners, or other detrimental effects when subjected to seasonal temperature changes and live loads.
       2. Design system capable of withstanding building code requirements for negative wind pressure.
    3. Interface With Adjacent Systems:
       1. Integrate design and connections with adjacent construction.
       2. Accommodate allowable tolerances and deflections for structural members in installation.
  1. SUBMITTALS
     1. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
     2. Product data including metal manufacturer's specifications, installation instructions, and general recommendations for roofing applications. Include certification or other data substantiating that materials comply with requirements.

DELETE BELOW IF DETAILS OF NO IMPORTANCE OR COVERED ADEQUATELY BY WORKING DRAWINGS.

* + 1. Shop drawings showing manner of forming, joining, and securing copper roofing, and pattern of seams. Show expansion joint details and waterproof connections to adjoining work and at obstructions and penetrations.

DELETE BELOW IF WORK FULLY CONCEALED, TO BE UNFINISHED, OR FIELD PAINTED, OR IF EXPOSURE OF NO VISUAL IMPORTANCE OR IS WELL KNOWN.

* + 1. Samples consisting of 6-inch (150 mm) or 12-inch (300 mm) square specimens of specified copper roofing material.
    2. Certificates: Fabricator's certification that products furnished for Project meets or exceeds specified requirements.
  1. CLOSEOUT SUBMITTALS
     1. Provide maintenance data in Operations and Maintenance manual for maintaining applied coatings on copper panels.
  2. QUALITY ASSURANCE
     1. Fabricator’s Qualifications: Company specializing in copper sheet metal roofing work with three years experience in similar size and type of installations.
     2. Installer: A firm with 3 years of successful experience with installation of copper roofing of type and scope equivalent to Work of this Section.
     3. Industry Standard: Except as otherwise shown or specified, comply with applicable recommendations and details of the "Copper in Architecture” handbook published by the Copper Development Association (CDA). Conform to dimensions and profiles shown.
     4. Wind Uplift: Provide roof assemblies meeting wind uplift ratings as required by code.

DELETE ENTIRE MOCK-UP PROVISION BELOW UNLESS THE EXPENDITURE IS JUSTIFIED BY AN EXTENSIVE, UNUSUAL, OR CRUCIAL APPLICATION OF METAL ROOFING.

* + 1. Mock-Up: Before proceeding with final purchase of materials and fabrication of copper roofing components, prepare a mock-up of work. Incorporate materials and methods of fabrication and installation identical with project requirements. Install mock-up at roof area location directed by Architect. Retain accepted mock-up as quality standard for acceptance of completed copper roofing. If accepted, mock-up may be incorporated as part of copper roofing work.
       1. Mock-up area is indicated on Drawings.

DELETE EITHER ABOVE OR BELOW.

* + - 1. Provide mock-up of sufficient size and scope to show typical pattern of seams, fastening details, edge construction, and finish texture and color.
  1. DELIVERY, STORAGE, AND HANDLING
     1. Packing, Shipping, Handling, and Unloading: Protect finish panel faces.
     2. Acceptance at Site: Examine each panel and accessory as delivered and confirm that finish is undamaged. Do not accept or install damaged panels.
     3. Storage and Protection:
        1. Stack pre-formed material to prevent twisting, bending, and abrasions.
        2. Provide ventilation.
        3. Prevent contact with materials which may cause discoloration or staining.
  2. WARRANTY
     1. Warrant installed system and components to be free from defects in material and workmanship for period of 2 years.
     2. Include coverage against leakage and damages to finishes.

1. - PRODUCTS
   1. MANUFACTURERS

DELETE THIS ARTICLE IF OWNER-IMPOSED OR OTHER PROJECT REQUIREMENTS PROHIBIT MENTION OF MANUFACTURERS' NAMES.

* + 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering materials that may be incorporated in the Work include, but are not limited to, the following:

RETAIN ABOVE FOR NONPROPRIETARY OR BELOW FOR SEMIPROPRIETARY SPECIFICATION. REFER TO DIVISION-1 SECTION "MATERIALS AND EQUIPMENT."

* + 1. Manufacturers: Subject to compliance with requirements, provide materials by one of the following:

BELOW ARE EXAMPLES ONLY. RETAIN OR INSERT ONLY THOSE MANUFACTURERS BELOW WHOSE MATERIALS CORRESPOND WITH OTHER REQUIREMENTS AND WHOSE AVAILABILITY AND SUITABILITY FOR APPLICATION INDICATED HAVE BEEN VERIFIED.

* + - 1. Hussey Copper, Ltd.
      2. KME America
      3. Aurubis Buffalo, Inc.
      4. PMX Industries Inc.
      5. Revere Copper Products, Inc.
  1. MATERIALS
     1. Copper Roofing Sheets: Cold-rolled copper sheet complying with ASTM B370 temper H00, unless otherwise indicated, and as follows:
        1. Weight: 16 oz. per sq. ft. (0.0216-inch thick) (0.55 mm) unless otherwise indicated.

DELETE ABOVE OR BELOW OR EDIT AS APPROPRIATE. REFER TO MANUFACTURERS' LITERATURE FOR SELECTION OF THICKNESS APPROPRIATE TO APPLICATION INDICATED.

* + - 1. Weight: 20 oz. per sq. ft. (0.0270-inch thick) (0.69 mm) unless otherwise indicated.

RETAIN BELOW FOR BATTEN ROOFING.

* + - 1. Batten Caps: 16 [20] oz. per sq. ft.
    1. Miscellaneous Materials: Provide materials and types of fasteners, solder, protective coatings, separators, sealants and accessory items as recommended by copper sheet manufacturer for copper roofing work, except as otherwise indicated.

REVISE BELOW WITH SPECIFIC REQUIREMENTS WHERE DESIRED FOR PROJECT.

* + 1. Accessories: Except as indicated as work of another specification Section, provide components required for a complete roof system, including trim, copings, fascias, ridge closures, cleats, seam covers, battens, flashings, gutters, louvers, sealants, gaskets, and closure strips. Match materials and finishes of roof.
       1. Sealing Tape: Pressure-sensitive 100 percent solids polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
       2. Joint Sealant: One-part, copper compatible elastomeric polyurethane, polysulfide, butyl or silicone rubber sealant as tested by sealant manufacturer for copper substrates. Refer to Division 07.

select roofing type below.

* + - 1. Cleats
         1. Concealed type as indicated in the "Copper in Architecture” handbook published by the Copper Development Association (CDA) for flat-seam [flat lock seam] [standing seam], [and batten seam] spaced on 12 inch (300 mm) centers.
         2. Fabricate cleats to allow thermal movement of copper roof panels while preventing copper panel distortion due to wind uplift forces.
      2. Trim, Closure Pieces, and Accessories:

determine iF same weight as roof panel or heavier weight is desired for trim.

* + - * 1. Same material, thickness [heavier weight], and finish as adjacent copper roof panels, brake formed to required profiles.
        2. Comply with standards conforming to recognized industry standard sheet metal practice.
    1. Bituminous Coating: SSPC - Paint 12, Cold-Applied Asphalt Mastic (Extra Thick Film), nominally free of sulfur, compounded for 15-mil dry film thickness per coat.

based on actual roof design, do not use “peel and stick” self-adhering type membranes if a double vapor barrier will be created in the roof/insulation assembly.

* + 1. High Temperature Grade Water Barrier Underlayment: Cold applied, self-adhering membrane composed of a high density, cross laminated polyethylene film coated on one side with a layer of butyl rubber or high temperature asphalt adhesive. Provide primer when recommended by water barrier manufacturer.
       1. Minimum Thickness: 30 mil.
       2. Tensile Strength: ASTM D412 (Die C Modified); 250 psi.
       3. Membrane Elongation: ASTM D412 (Die C Modified); 250%
       4. Permeance (Max): ASTM E96; 0.05 Perms.
       5. Acceptable Products:
          1. Blueskin PE 200 HT, Henry.
          2. Ultra, W.R. Grace Company.
          3. CCW MiraDRI WIP 300 High Temperature, Carlisle Coatings and Waterproofing.

DELETE ABOVE and retain below IF ALTERNATIVE UNDERLAYMENT IS USED.

* + 1. Roofing Felt Underlayment: Asphalt saturated felt weighing not less than 30 lbs per 100 square feet.

USE BELOW UNDER COPPER INSTALLED ON roofing felt underlayment.

* + 1. Paper Slip Sheet: Minimum 4-lb. red rosin-sized building paper.

RETAIN BELOW IF BATTENS ARE INTENDED AS PART OF ROOFING WORK.

* + 1. Batten Bars and Strips: If size is not indicated, provide battens of nominal 2-inch (50 mm) by 2 inch (50 mm) size [1-1/2-inch (38 mm) by 1-1/2-inch (38 mm) minimum].
       1. Copper Batten Caps: 20-ounce cold-rolled copper.

DELETE IF NO BATTEN-TYPE ROOFING REQUIRING WOOD STRIPS OR IF BATTENS TO BE PART OF DIVISION-6 "CARPENTRY" WORK.

* + - 1. Wood Batten Strips: Fabricated to size indicated from lumber complying with requirements of Division 06 Section "Rough Carpentry" and preservative treated by pressure process using a chemical solution that is nonhygroscopic and noncorrosive to type of copper roofing.

INSERT OTHER MATERIALS AS NEEDED FOR ROOFING WORK (ELASTOMERIC SEALANTS, INSULATION, SOLDER, REGLETS, GASKETS, ETC.)

* + 1. Nails for Wood Substrates: Copper or hardware bronze, 0.109 inch minimum not less than 7/8‑inch (22 mm) long barbed with large head.
    2. Screws & Bolts: Copper, bronze, brass, or passivated stainless steel (300 Series) of sufficient size and length to sustain imposed stresses.
    3. Cleats: 16 or 20 oz ounce cold rolled copper, as required to sustain loads 2-inch (50 mm) wide x 3-inch (75 mm) long.
    4. Solder: ASTM B32; Provide 50-50 tin/lead or lead free alternative of similar or greater strength solder.
    5. Flux: Muriatic acid neutralized with zinc or approved brand of soldering flux.
    6. Rivets:
       1. Pop Rivets: 1/8-inch (3 mm) to 3/16-inch (4.5 mm) diameter, with solid brass mandrels.
       2. Provide solid copper rivet (tinner’s rivets) where structural integrity of seam is required.
  1. FABRICATION
     1. General Metal Fabrication: Shop-fabricate work to greatest extent possible. Comply with details shown and with applicable requirements of the "Copper in Architecture” handbook published by the Copper Development Association (CDA) and other recognized industry practices. Fabricate for waterproof and weather-resistant performance with expansion provisions for running work, sufficient to permanently prevent leakage, damage, or deterioration of the work. Form work to fit substrate. Comply with material manufacturer's instructions and recommendations for forming material. Form exposed copper work without excessive oil-canning, buckling, and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.
        1. Fabricate to allow for adjustments in field for proper anchoring and joining.
        2. Form sections true to shape, accurate in size, square, free from distortion and defects.
        3. Cleats: Fabricate cleats and starter strips of same material as sheet, interlockable with sheet in accordance with CDA recommendations.
        4. Tin edges of copper sheets and cleats at soldered joints for flat lock and soldered system.
        5. Flat Seam Panel Seams (unsoldered, high slope):

select appropriate flat seam joint type. refer to note at beginning of section for use of solder and sealant in seams.

* + - * 1. Fabricate flat seams for loose lock [sealant in] [dry] joints.
        2. Fabricate seams for panels to be installed in overlapped, interlocking shingle manner.
        3. Fold two adjacent edges over 180 degrees for width of 3/4 inch and other two adjacent edges under 3/4 inch (19 mm). Refer to CDA "Copper in Architecture” handbook.
        4. Fabricate flat seam roofing from pans 18 inches (450 mm) by 24 inches (600 mm) in size.
      1. Flat Locked and Soldered (Flat Seam Soldered) Panel Seams:

select appropriate flat seam joint type. refer to note at beginning of section for use of solder and sealant in seams.

flat locked panels are locked to cleats by use of MALLET TO ENGAGE SEAMS.MALLET TO ENGAGE SEAMS.Mallet to engage seams.

* + - * 1. Fabricate flat seams for solid soldered joints.
        2. Fabricate flat seam roofing from pans 18 inches (450 mm) by 24 inches (600 mm) in size.
        3. Fold two adjacent edges over 180 degrees for width of 3/4 inch and other two adjacent edges under 3/4 inch (19 mm). Refer to CDA "Copper in Architecture Handbook".
        4. Tin edges of panels at least 1 ½ inch prior to forming seams, and as soon as possible prior to installation.
        5. Fabricate seams for panels to be installed in overlapped, interlocking shingle manner for locked down engaged seams.
      1. Standing Seam Panels:
         1. Fabricate pans to interlock standing seam with center to center seam spacing as indicated on Drawings.
         2. Fabricate interlocking seams to heights and patterns indicated.
         3. Form overlapping and interlocking transverse joints.
      2. Batten Seam Panels:
         1. Fabricate pans to create center to center standing and batten seam spacing as indicated on Drawings.
         2. Fabricate battens to sizes indicated.
         3. Form overlapping and interlocking transverse joints.
         4. Provide 1/2 inch (13 mm) single lock seam at batten caps.
      3. Horizontal Seam (Bermuda) Panels:
         1. Fabricate pans with long runs and pan size as indicated on Drawings.
         2. Form interlocking seams with cleats folded into seam.
         3. Seam height of 3/4 inch (19 mm) [\_\_\_\_\_\_\_\_\_\_] offset from adjacent panel.
         4. Form overlapping transverse joints.
    1. Seams: Fabricate nonmoving seams in copper sheet with flat-lock seams. Tin edges and cleats to be soldered, form seams, and solder.
    2. Expansion Provisions: Where lapped or bayonet-type expansion provisions in work cannot be used, or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1-inch (25 mm) deep, filled with mastic sealant (concealed within joints).
    3. Sealant Joints: Where movable, non-expansion-type joints are indicated or required for proper performance of work, form copper to provide for proper installation of elastomeric sealant, in compliance with the "Copper in Architecture” handbook published by the Copper Development Association (CDA).
    4. Separations: Provide for separation of copper from noncompatible metal or corrosive substrate by coating concealed surfaces at locations of contact, with bituminous coating or other permanent separation as recommended by manufacturer/fabricator.
    5. Solder:
       1. Solder and seal non-moving copper joints on slopes up to 3:12, except those indicated or required to be expansive type joints.
       2. After soldering, remove flux. Wipe and wash solder joints clean. Refer to CLEANING Article in PART 3.
  1. FINISHES
     1. Natural weathering mill finished copper. No applied finish.

\*\*\*\*\* OR \*\*\*\*\*

REVIEW PAINT SELECTION WITH COATINGS MANUFACTURER, REFER TO DIVISION 09.

* + 1. To retard natural weathering, apply a uniform coating of high grade paraffin oil, or a clear lacquer coat.

clear coatings to retard weathering not recommended due to maintenance requirements.

* + 1. Clear Lacquer Coating:
       1. Clear, Organic Coating: Clear, air‑drying, acrylic lacquer specially developed for coating copper alloy products, equivalent to Incralac by StanChem applied by air spray in 2 coats per manufacturer's directions, with interim drying, to total thickness of 1.0 mil.

1. - EXECUTION
   1. EXAMINATION
      1. General: Examine conditions and proceed with work when substrates are ready.
      2. Confirm that substrate system is even, smooth, sound, clean, dry, and free from defects.
      3. Verify roof openings, pipes, sleeves, ducts, and vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
   2. PREPARATION
      1. Clean surfaces to receive copper roofing. Substrate to be smooth and free of defects. Drive all projecting nails or other fasteners flush with substrate.

MOST SUBSTRATE CONDITIONS REQUIRE UNDERLAYMENT AND SLIP SHEETS. DELETE BELOW ONLY UPON RECOMMENDATION OF METAL MANUFACTURER FOR SPECIFIC PROJECT CONDITION.

* + 1. Water Barrier Underlayment:
       1. Install high temperature grade water barrier on clean, dry roof substrate.
       2. Remove dust, dirt, and loose fasteners.
       3. Remove protrusions from the deck area.
       4. Verify substrate has no voids, damaged, or unsupported areas.
       5. Repair voids or unacceptable areas before installing membrane.
       6. Prime substrates with manufacturer’s approved primer if required for proper installation of membrane over substrate.
       7. Install membrane in strict accordance with manufacturer’s printed application procedures, precautions, and limitations.
       8. Start application at low points and lap membrane shingle fashion to prevent water penetration.
       9. Membrane Underlayment: Apply horizontally, lapping preceding layer not less than 4 inches (100 mm). End lap membrane not less than 6 inches (150 mm).
          1. Maximize adhesion to substrate by brooming or rolling membrane in place after placement.
          2. Center membrane at valleys, hips, and ridges.

DELETE ABOVE and retain below to agree with underlayment selection in part 2 above.

* + 1. Roofing Felt Underlayment:
       1. Install underlayment over solid substrates with horizontal overlaps and endlaps staggered.
       2. Lay parallel to ridge line with 2-1/2 inch (63 mm) sidelaps and 6 inch (150 mm) endlaps.
       3. Start application at low point, working up deck laying plies in shingle fashion.
       4. Fasten underlayment with copper roofing nails spaced on 12 inch (300 mm) centers maximum.
    2. Install underlayment and paper slip sheet on substrate under copper roofing to greatest extent possible unless otherwise recommended by manufacturer of sheet metal. Paper slip sheets must be installed over the underlayment. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under copper roofing. Lap joints 2 inch (50 mm) minimum.
  1. INSTALLATION
     1. Manufacturer's Recommendations: Except as otherwise shown or specified, comply with recommendations and instructions of manufacturer of copper being fabricated and installed.
     2. General:
        1. Separate dissimilar metals by painting each metal surface in area of contact with a bituminous coating, by applying rubberized asphalt or butyl underlayment to each metal surface, or by other permanent separation as recommended by manufacturers of dissimilar metals.
        2. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of copper roofing to profiles, patterns, and drainage arrangements shown and as required for permanently leakproof construction. Provide for thermal expansion and contraction of the work, as indicated. Seal joints as shown and as required for leakproof construction. Shop-fabricate materials to greatest extent possible.
        3. Sealant-Type Joints: Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1-inch (25 mm) into sealant. Form joints to conceal sealant completely. When ambient temperature is moderate at time of installation, 40 degrees to 70 degrees F (4 degrees to 21 degrees C), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher or lower ambient temperatures. Do not install sealant-type joints at temperatures below 40 degrees F (4 degrees C). Comply with requirements of Division 07 "Joint Sealant" Sections for handling and installing sealants.
        4. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks considering temper and reflectivity of metal. Provide uniform, neat seams with minimum exposure of solder, and sealant. Except as otherwise shown, fold back sheet metal to form a hem on concealed side of exposed edges.
        5. Conceal fasteners and expansion provisions where possible in exposed work, and locate so as to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
        6. Tin uncoated copper surfaces and cleats at edges of flat seam panel sheets to be soldered, for a width of 1-1/2 inch (38 mm), using solder recommended for copper work.

select roofing type below.

* + 1. Flat Seam Roofing:
       1. Install copper work in accordance with the "Copper in Architecture” handbook published by the Copper Development Association (CDA).
       2. Flat Seam Metal Roof Panels: Fasten system to substrate with concealed metal cleats and screws/nails at spacings required to resist code required wind uplift.
       3. Align, level, and plumb system with structure.
       4. Fasten cleats using cleats mated to folded flat seams and fastener pattern to resist design loads with screws or barbed nails of sufficient length to penetrate substrate.
       5. Fully seat adjacent panel to on two sides to achieve continuous engagement of seam joint.

See Item D (below) if seams are to be soldered (low slope).

* + 1. Flat Lock Soldered (“Flat Seam Soldered”) Seam Roofing:
       1. Install copper work in accordance with CDA "Copper in Architecture Handbook".
       2. Flat Seam Metal Roof Panels: Fasten system to substrate with concealed metal cleats and screws at spacings required by fabricator to resist code required wind uplift.
       3. Align, level, and plumb system with structure.
       4. Fasten cleats or nails using cleats mated to folded flat seams and fastener pattern to resist design loads with screws or barbed nails of sufficient length to penetrate substrate.
       5. Tin and prepare panels as described in specification Section 2.3 “Fabrication”.
       6. Only install the number of panels in a day that can be field soldered before the end of the day’s work. Install overnight protection on the unsoldered tinned edges of panel seams to prevent contamination before the start of the next work day.
       7. Fully seat adjacent panel to on two sides to achieve continuous engagement of seam joint.
       8. Mallet or dress down engaged seams.
       9. Apply flux and fully sweat seams with solder to achieve watertight installation.
       10. Install expansion battens at 25 to 30 feet (7500 mm to 9000 mm) in both directions.
    2. Standing Seam Roofing:
       1. Fold lower end of each pan under 3/4 inch (19 mm). Slit fold one inch (25 mm) away from corner to form tab where pan turns up to make standing seam. Fold upper end of each pan over 2 inches (50 mm). Hook fold on lower end of upper pan into fold on upper end of underlying pan.
       2. Apply pans beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.
       3. Finish standing seams one inch (25 mm) [one and a half inch (38mm)] high. Bend up one side edge 1-1/2 inch (38 mm) [2 inch (50mm)] and other 1-3/4 inch (44 mm) [2-1/4 (66mm)]. Make first fold 1/4 inch (6 mm) wide single fold and second fold 1/2 inch (13 mm) wide, providing locked portion of standing seam with 5 plies in thickness. Fold lower ends of seams at eaves over at 45 degree angle. Terminate standing seams at ridge and hips by turning down in tapered fold.
       4. Form valleys of sheets not exceeding 10’-0" (3000 mm) in length. Lap joints 8 inches (200 mm) in direction of drainage. Extend valley sheet minimum 6 inches (150 mm) under roofing sheets. At valley, double fold valley and roofing sheets and secure with cleats spaced 12 inch (300 mm) centers.
    3. Batten Seam Roofing:
       1. Turn up sides of sheets to extend above top of battens 1/2 inch (13 mm). Turn this 1/2 inch (13 mm) at right angles to battens.
       2. Form cross seams with 3/4 inch (19 mm) fold under on lower end and 2 inch (50 mm) fold over on upper end. Slit folds in cross seams at each corner one inch (25 mm) in from batten to form tab. Hook fold on lower end of pan into fold on upper end of underlaying pan.
       3. Apply pans beginning at eaves.
       4. Place cover strips over battens, locking edges with flanges of pan malletted down against sides of battens. Cover batten ends with cap folded and locked into extensions of batten covers and vertical legs of pans.
       5. At intersections of roof slope with ridge and hip battens, turn up edges of roof pans against sides of battens and terminate in 1/2 inch (13 mm) flange at top of battens. Install cover strips over top of hip and ridge battens.
       6. Form valleys of sheets not exceeding 10’-0" (3000 mm) in length. Lap joints 8 inches (200 mm) in direction of drainage. Extend valley sheet minimum 6 inches (150 mm) under roofing sheets. At valley, double fold valley and roofing sheets and secure with cleats spaced 12 inch (300 mm) centers.
       7. At eaves without gutters, hook pan over edge strip. Extend edge strip up under metal roofing 4 inches (100 mm) and secure with nails at 3 inch (75 mm) centers, at one inch (25 mm) from upper end.
       8. Install batten flush with gable. Extend batten cover down exterior face and lock into edge strip.
    4. Horizontal Seam (Bermuda) Panels:
       1. Install wood nailers parallel to long seam.
       2. Infill between nailers with tapered insulation or fiberboard.
       3. Start panel installation at eave.
       4. Interlock cleat into joints of adjacent panel.
       5. Fasten cleats to wood nailers on 12 inch (300 mm) centers.
       6. Install overlapping transverse joints in accordance with the "Copper in Architecture” handbook published by the Copper Development Association (CDA). Install accessories, flashings, closures, and related trim to provide complete watertight system.
    5. Coordinate installation of panels with adjacent construction to ensure watertight enclosure.
  1. CLEANING
     1. Remove protective film (if any) from exposed surfaces of copper roofing promptly upon installation. Strip with care to avoid damage to finishes.
     2. Upon completion of each area of soldering, carefully remove flux and other residue from surfaces. Neutralize acid flux by washing with baking soda solution, and then flushing clear water rinse. Use special care to neutralize and clean crevices.
     3. Clean exposed metal surfaces of substances that would interfere with uniform oxidation and weathering.
  2. PROTECTION
     1. Provide final protection in a manner acceptable to installer that ensures that copper roofing is without damage or deterioration at time of Substantial Completion.

END OF SECTION