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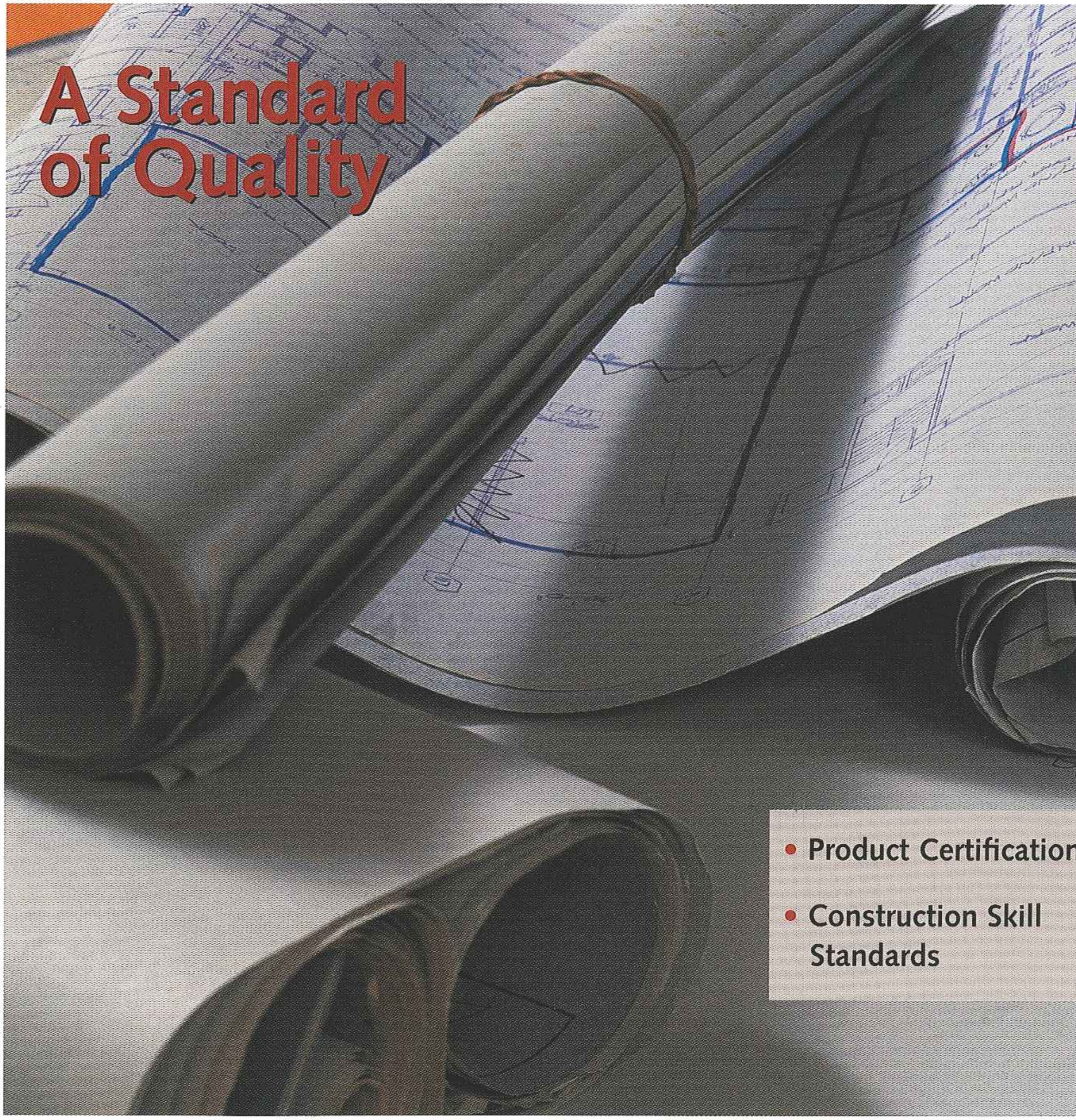

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The Magazine of the Construction Specifications Institute

A Primer on COPPER ROOFING

by Daniel Sternthal

Copper is an excellent, long-lasting flashing material. It reacts with the atmosphere as it weathers and changes from a brown oxide surface to a gray-green copper patina. The weathering reaction proceeds most rapidly when copper is exposed to diluted atmospheric moisture containing sulfur-bearing rain or "acid rain."

The patina acts as a protective film and inhibits further weathering of the copper. On copper roofs, the total corrosive effect is slight because the reaction is spread over a large area, and the moisture loses its acidity upon reacting with the copper.

Valley Flashing and Line Corrosion

Acid moisture normally does not neutralize when it falls on roofing such as tile, slate, asphalt, or wood shingles. However, when acid moisture concentrates in small areas in contact with copper, such as at valley flashing, damage to the copper can result. The risk of corrosion is most pronounced at the leading edge of shingles, where the edges rest directly on the copper flashing. Capillary action will retain highly acidic moisture in contact between the copper and the shingle's edge. This can result in a linear pattern of pitting corrosion of the flashing, sometimes referred to as "line corrosion." Incorrectly installed flashing will promote line corrosion and substantially shorten the life of valley flashing.

To mitigate line corrosion conditions, raise the leading edge of the shingles using a cant strip (see *Figure A*, page 60). This effectively breaks the acid rain capillary action and promotes unhindered water drainage. The cant can be fabricated from wood blocking using copper straps soldered to the flashing as hold-downs or from an inverted V-shaped, 20 oz copper strip soldered to the flashing.

ADDITIONAL INFORMATION

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Abstract

Copper roof systems have been used successfully for over 300 years. The author discusses common questions that arise when designing and installing copper roofing.

Raising the leading shingle edge approximately ⅝ in. is sufficient to break capillary action and prevent the acidic water from remaining at this interface. When installed correctly, copper valley flashing has far outlasted the underlying roofs without showing any signs of perforations or premature deterioration.

Long-Pan Panels Design

Two of the most complicated issues related to copper roofing are correct design and installation techniques for long-pan roof systems. The issues encompass roof pan length versus seam length, cleat design and spacing, as well as the physical expansion characteristics of copper sheets.

Historically, details and installation procedures have recommended installing continuous roof seam lengths up to 30 ft using fixed cleats. For seam lengths exceeding 30 ft, the recommendation has been to use expansion cleats. See *Figure B* for cleat types.

Although such techniques have proven effective, contemporary building design and construction practices require a more careful approach. Insulated roof systems (which can lead to higher roof temperatures) and lightweight roof decks (which lead to higher differential movement of building components) require careful analysis and design.

The Copper Development Association (CDA) has adopted an updated approach and is referencing all pans and seam lengths greater than 10 ft as long-pan construction. This definition requires specific installation techniques as related to transverse seam and cleat location and design (see *Figure C*, page 62).

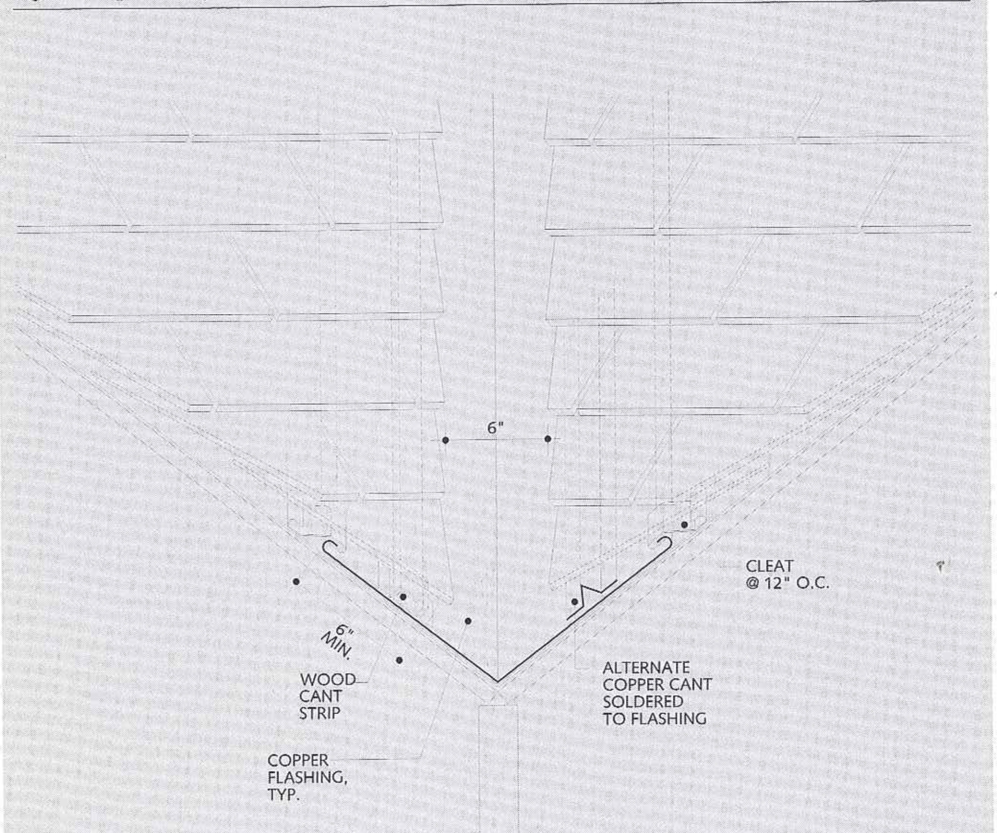
Copper expands approximately ⅛ in. per 10 ft of pan length per 100 °F temperature rise. A 30 ft pan will therefore expand approximately ½ in. for a 150 °F rise. This expansion must be accommodated either by fixing the pan at one end (accumulating the total expansion at the loose end) or by fixing the center of the pan (accumulating half of the total expansion at both free ends). In *Figure C*, a center location for cleats is assumed.

For a 30 ft pan run, transverse seams should be staggered 12 in. from adjacent pans, which gives rise to 30 ft and 28 ft alternating pans. A common centerline for both pan lengths can now be determined. Fixed cleats are installed at the centerline and at 6 in. o.c. on either side of the centerline. Expansion cleats are installed at 12 in. o.c. for the remaining pan run.

Fixing the center of the pans has reduced the effective expansion length attributed to the pans to 15 ft and 14 ft for the two pan sizes, resulting in a maximum expansion of approximately ¼ in. at the free ends (see *Figure C*).

Most commercially available expansion cleats allow a maximum of ¾ in. movement.

Figure A Open valley flashing



Therefore, when set at midpoint, a total expansion of ⅜ in. can be accommodated in either direction.

Designing for Severe Wind Conditions

Copper roof systems have been used successfully for over 300 years. However, modern construction methods require credible testing procedures to verify system integrity and ability to withstand naturally and artificially imposed loads and forces.

Because of many requests to provide data on the structural performance of copper roof systems, CDA contracted with Underwriters Laboratories, Inc. (UL) to conduct a series of tests on various copper systems. The first of the tests subjected a copper standing-seam roof to UL 580, Uplift Resistance Test Protocol.

The test panel consisted of UL's standard 10 x 10 ft chamber with an insulated copper roof system on a metal deck and structural system. The system cross section is shown in *Figure D*, page 64.

Of special interest are the stainless steel screws used to fasten the cleats to the deck and the polyethylene air barrier installed between the insulation and the structural steel deck.

At no time during the test did the copper system exhibit any unusual deformation, nor did any of the cleats work themselves loose from the structural deck. This system easily passed the UL 580 requirements and received the UL-90 designation.

Other standing-seam copper roof details can be designed to incorporate some of the details and techniques used for this test procedure. Upon request and submittal, UL staff will review the proposed system and offer an opinion as to whether it can meet the underlying designation.

Q&A

CDA's Copper in Architecture Seminar program has allowed the association to maintain contact with many architects, engineers, specifiers, and contractors. As a result of thousands of such presentations, CDA staff has responded to many design and construction questions. The following are some of the most common questions raised regarding copper in architecture.

Can artificial chemicals accelerate the naturally occurring green patina of copper? Due to precise temperature, humidity, and chemical requirements, it is not recommended that copper be artificially patinated in the field. There are U.S. copper sheet fabricators who provide factory prepatinated copper sheets. The patina is produced under controlled environments using patented chemical processes resulting in a true patina chemical conversion coating that carries an extensive warranty.[1]

How can the original copper color be protected from weathering after installation? There is no permanent protection system that will protect copper from weathering. There are clear coatings that will provide short-term protection for exterior applications and longer-term protection for interior applications.[2]

How can copper staining of materials be prevented? The natural weathering of copper results in the formation of copper salts at the surface of a copper sheet. These salts mix with rainwater and, if allowed to run onto other materials, will cause characteristic green stains. To prevent such stains, use overhangs, gutters, and drip edges, and slope copper surfaces away from other materials. Clear silicon-based

Table 1 Standard copper sizes

Strip copper	
Weight in oz/ft²:	16, 20, 24, 32
Width in inches:	10, 12, 14, 15, 16, 18, 20
Length in inches:	96, 120, coil
Sheet Copper:	
Weight in oz/ft²:	12, 16, 20, 24, 32
Width in inches:	24, 30, 36
Length in inches:	96, 120, coil
Coil Copper	
Weight:	16 oz soft temper
Width in inches:	6, 7, 8, 10, 12, 14, 16, 18, 20, 24
Length in ft:	50 to 100

Note: U.S. copper is available in maximum widths of 36 in.

Figure B Copper cleats

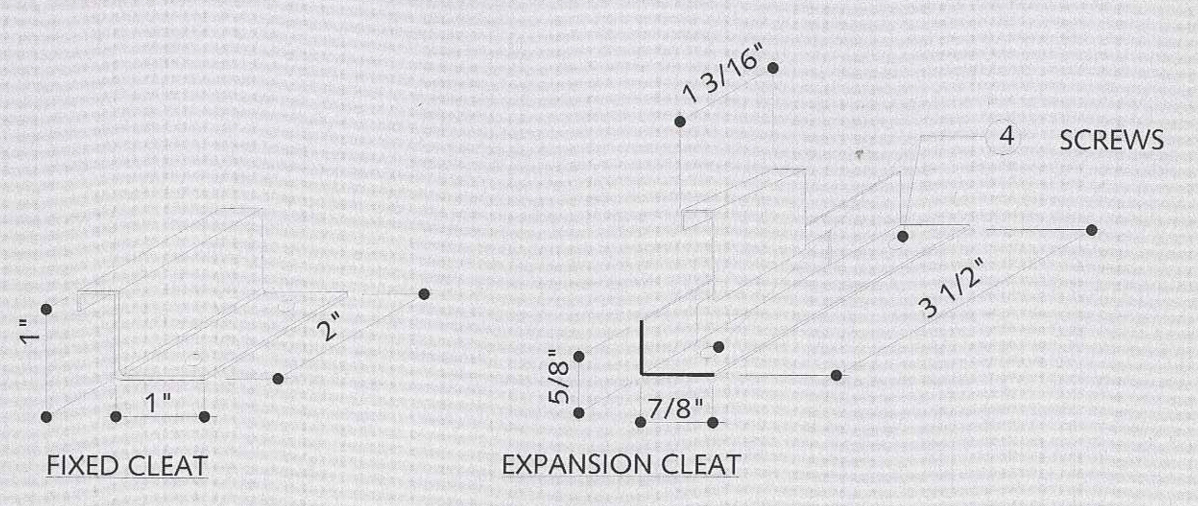
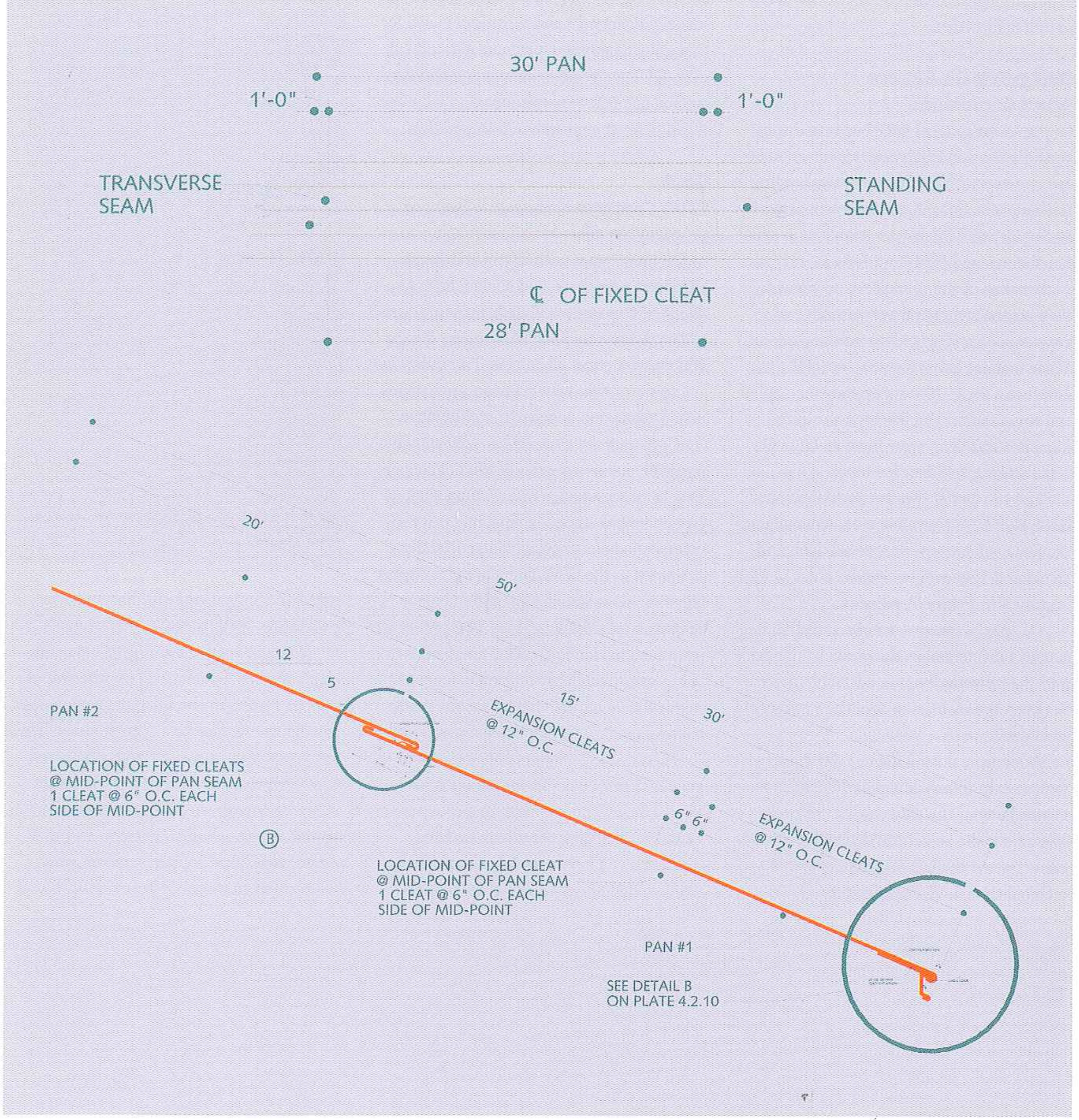


Figure C Long-pan construction

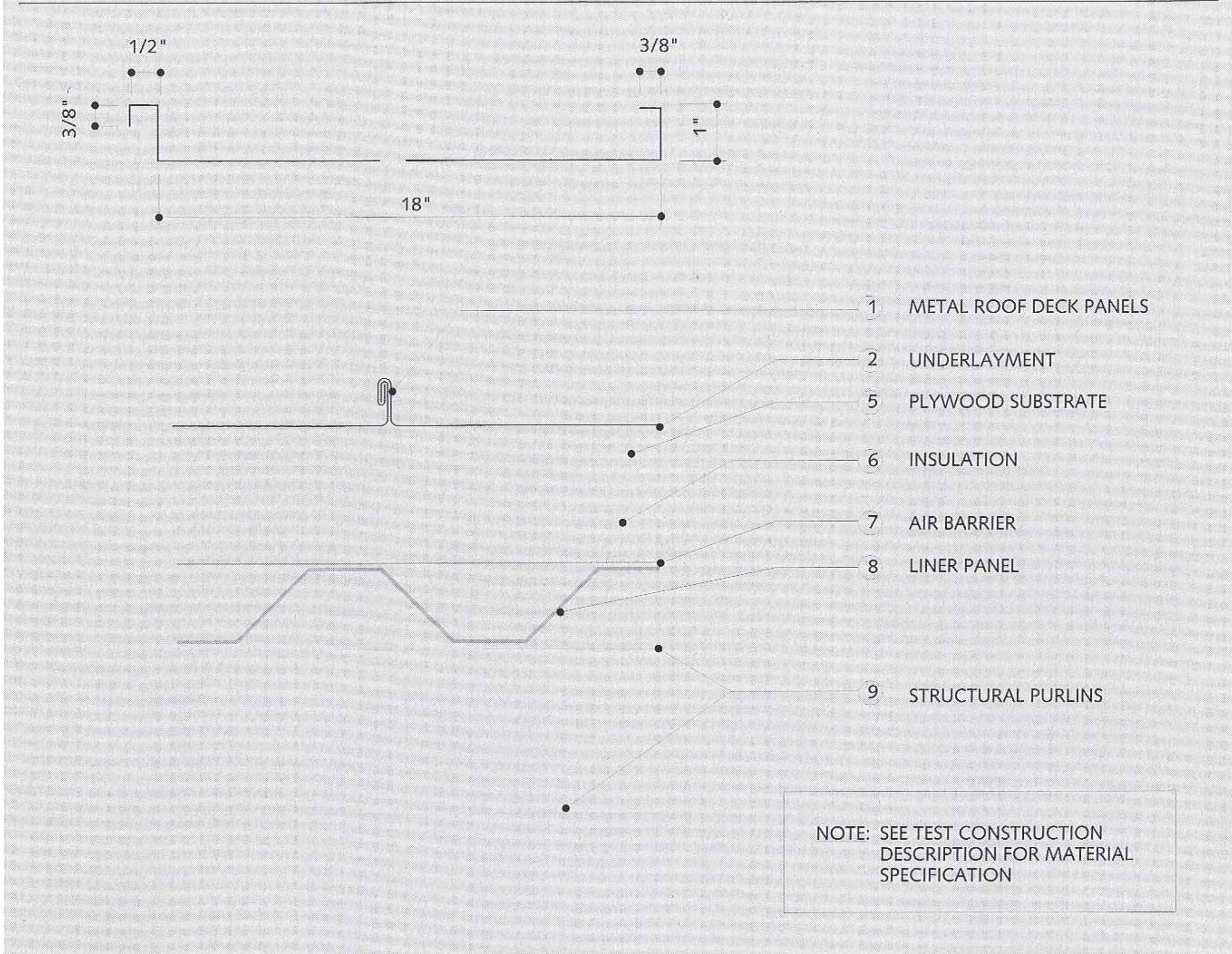


coatings on cementitious surfaces also can help protect the surface during the initial and most aggressive copper weathering.

What is galvanic corrosion and how can it be prevented? Metals are rated according to their nobility ratings. When dissimilar metals are in contact with each other in the presence of oxygen and moisture, the more noble metal will corrode the less noble. Copper is one of the most noble metals and must be separated from other less noble metals. Contact between dissimilar metals should always be avoided. If contact cannot be avoided, the contacted surfaces should be painted with bituminous or zinc chromate primers or paints. Taping or gasketing with nonabsorptive materials also is effective.

Are sealants required with copper systems? Most copper installations depend on self-flashed details requiring no sealants. Under some conditions, such as on low-slope roofs, sealants are recommended as a secondary waterproofing material. However, copper will outlast most sealants; where sealants are used they must be inspected and maintained regularly. In general, butyl, polysulfide, and polyurethane sealants are reasonably compatible with copper. Acrylic-, neoprene-, and nitrile-based sealants

Figure D UL-580 Wind Uplift Test Protocol



actively corrode copper. Silicone sealants had some successes with copper; however, their suitability should be verified with the manufacturer.

What is the role of solder in a copper system? Soldering is specified in roof and wall systems where watertight seams and joint strength are required. A soldered seam will join two pieces of copper in a cohesive unit that will expand and contract as one piece. Well-soldered seams are, in many cases, stronger than the original base material and will provide many years of satisfactory service.

What are the typical sizes for architectural copper products? Copper products are available in three distinct forms—strip, sheet, and coil. See *Table 1*, page 61, for sizes.

Are there any copper shingles manufacturers? Within the USA and Canada, there are at least 11 copper shingles manufacturers. Their systems are manufactured from solid copper products with specific installation instructions and warranties.[3]

Further Information

CDA's architectural regional managers can assist architects, specifiers, contractors, and owners in a variety of ways from in-house seminars to project design assistance to document and specifications review to recommending contractors. The regional managers are: western region, Martin Salmon, (213) 651-0626; midwestern region, Craig Thompson, (847) 842-9204; and eastern region, Wayne Seale, (610) 793-3868.

CDA has published five architectural copper specification sections in accordance with CSI guidelines and in the AIA MASTERSPEC® format. The specifications are available in hard copy or in electronic form on diskettes. They also can be downloaded from CDA's architectural Web site at www.architecture.copper.org. CDA has established an extensive Web site dealing with all aspects of the copper industry, including architectural, plumbing, electrical, and industrial applications. The general Web address is www.copper.org.

CDA offers two accredited programs: an in-office, box lunch Copper in Architecture seminar worth two Learning Units and an Architectural Copper Self Study Program worth 10 Learning Units. To schedule or order any of these programs, contact a CDA regional manager.

Notes

1. The companies providing these finishes are listed in CDA's *Copper in Architecture—Design Handbook*.
2. CDA has completed an extensive test program of various clear coatings meeting low VOC Federal requirements. To order the report, call CDA at (800) 232-3282 and request *Clear Coatings on Copper Alloys* #4145-1959.
3. Ask for the CDA's *Copper Roofing Shingles Manufacturers* list from one of the regional managers listed above or refer to CDA's Web page.

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