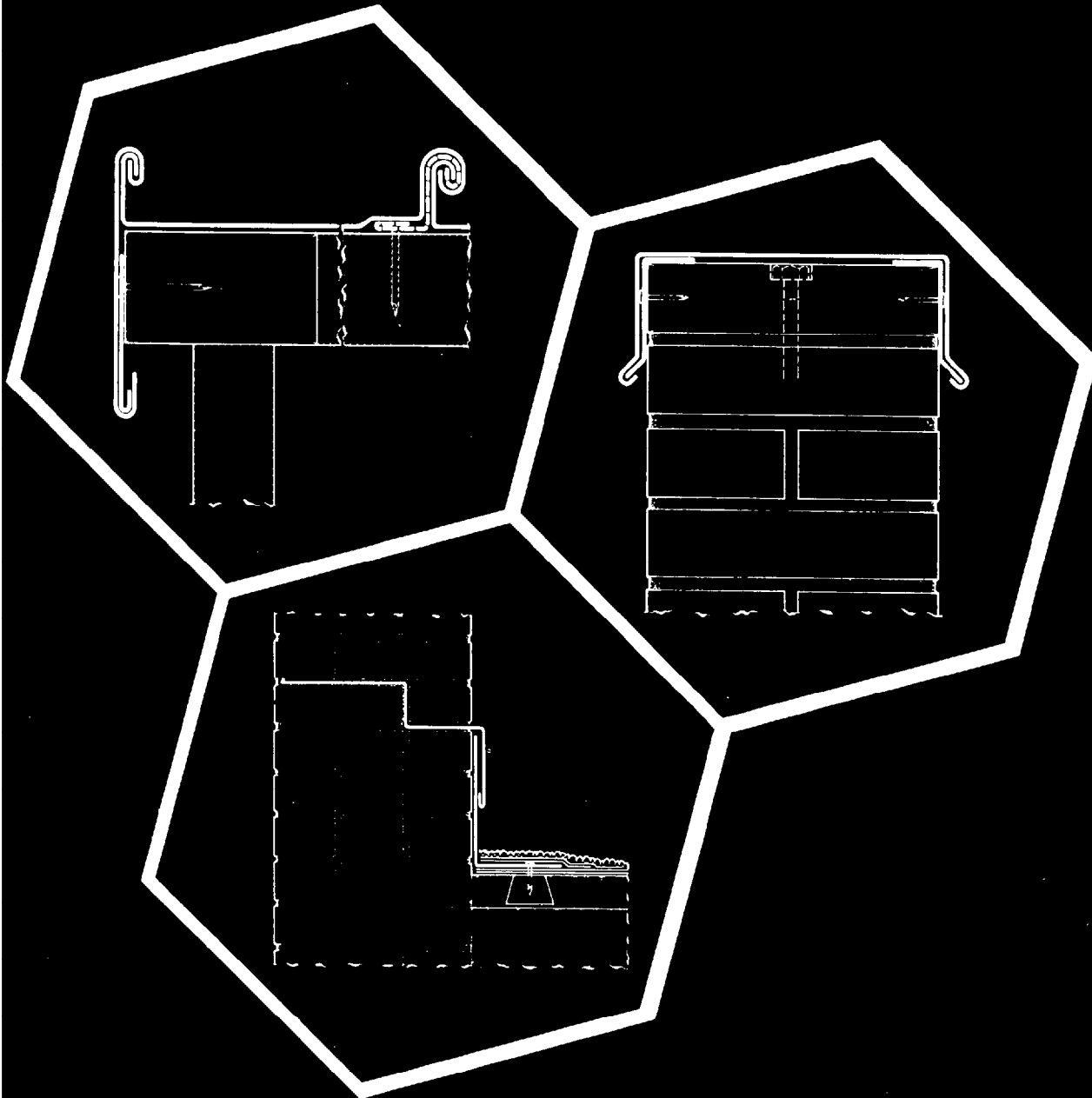


Specifications for aluminum sheet metal work in building construction

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Specifications for aluminum sheet metal
work in building construction
Construction manual series Section 5



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Aluminum Construction Manual

Section 5

ALUMINUM SHEET METAL WORK IN BUILDING CONSTRUCTION

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Incorporated
900 19th Street, N.W., Washington, D.C. 20006

Properties and Characteristics of Aluminum Sheet



WHY USE ALUMINUM?

Why use aluminum for roofing and flashing applications? Because it is economical, readily available, easy to fabricate, highly resistant to corrosion, can be left to weather in its natural state or may be painted or anodized for decorative purposes. As a painted material, it has the advantage that it will not rust if the protective paint coating is broken; thus, it requires little maintenance. As an anodized material, it is available in an attractive range of grey, black, bronze, gold and amber colors. Left in its natural state it will weather to a uniform grey.

This manual has been prepared to familiarize architects, contractors, building officials and students with what constitutes good practice in material selection, design and installation of aluminum sheet metal work for roofing and flashing that is custom fabricated for a specific job. It does not deal with products or proprietary systems such as siding and roofing and roof-deck systems.

Corrosion resistance

One of aluminum's most useful characteristics is its tendency to develop an extremely thin, tough, invisible oxide coating on its surface immediately on exposure to air. This oxide film, although only 2 to 4 ten-millionths of an inch thick on first forming, is almost completely impermeable and highly resistant to attack by corroding atmospheres. The thickness of this film increases with exposure time, but the rate of oxide formation gradually decreases as the increasing thickness of the film adds further

protection against corrosion. Where corrosion may be caused by contact with dissimilar metals, measures such as specified in section 3.2 of the specifications included in this book may be taken. In urban and most industrial environments, aluminum does not need painting or anodizing, except for decorative purposes. In coastal areas, aluminum will long outlast most other metals and coated metals.

Workability

Aluminum is ductile and malleable and may be bent, formed, seamed or hammered into almost any desired shape. The ease with which aluminum may be handled, transported, bent, formed or otherwise worked may result in tangible savings. This is particularly so on large buildings and/or where handling and transportation are problems. Such savings may be effected not only on the job but in the shops as well. Here, the light weight and good formability of aluminum permit more work to be turned out per day with less fatigue on the part of the workers.

Joining and sealing

Mechanical seams and joints for aluminum are the same as for other sheet metals. Aluminum sheet is usually attached to the substrate with aluminum nails or cleats. Rigid joints are achieved through the use of double lock seams or riveting or, in some cases, welding. Soldering aluminum is not recommended, but since the tendency today is to avoid soldering sheet metal work because of the many difficulties involved with soldered joints, this limitation is of little relevance. Synthetic or rubber based sealants are used where watertightness cannot be achieved with standard seams, such as in the S-lock on top of an aluminum coping cover (see page 27) or in a reglet (see pages 25 and 27).

Finishes for aluminum sheet

Mill finish aluminum sheet is generally used for roofing and flashing applications and can be obtained plain or in a variety of embossed patterns. Embossed sheet has been found to be useful in minimizing oil canning and handling marks. Decorative and protective finishes can also be applied to aluminum sheet.

Painted aluminum sheet, plain or embossed, is available in a wide range of colors and is finding increased use in residential, commercial and monumental construction for valleys, fascias, gravel stops and other flashings. This baked enameled sheet can be cut, pierced, drilled and formed without the finish separating from the base metal. Even if the enamel film should be broken or the metal exposed at a cut edge or drilled hole, there is no danger of the film flaking or staining, since there is no rust-like corrosion. Where painted aluminum is marred by metalworking tools in the field, the scratches can be touched up with matching enamel. Maintenance of a painted aluminum roof is less critical than maintenance of other painted metal roofs. The paint serves mainly a decorative function, since aluminum is itself corrosion-resistant.

Anodizing is one of the most important protective finishes for all types of aluminum. However, since the surface film may be crazed by forming and cannot be touched up, as a painted surface can, its use is normally limited to preformed shapes that may be anodized subsequent to forming. Anodizing is basically the artificial thickening, by an electrolytic process, of the natural oxide coating that forms on aluminum. The thickened coating is much more resistant to corrosion and all kinds of abrasion than

the thinner natural film. Ordinarily, anodized aluminum sheet is used with a clear finish. However, it can also be obtained in a range of colors suitable for exterior use in various shades of gold, amber, bronze, grey and black. The colors are achieved by integral color anodizing of certain aluminum alloys or by electrolytic deposition of inorganic colorants. Anodic colors achieved with organic dyes are not suitable for exterior use.

ALUMINUM SHEET ALLOYS AND TEMPERS

Definition of aluminum sheet

Aluminum sheet is defined as a rolled product, rectangular in cross section, having a thickness range of 0.006-through 0.249-inch, with the edges sheared, slit or sawed within close limits. It is available as flat sheet or in coiled form. If aluminum is thinner than 0.006 inches, it is known as foil, while if it is thicker than 0.249 inches, it is called plate.

Using The Aluminum Association Alloy Designation System

The alloy and temper generally used for sheet metal work is 3003-H-14. Acceptable alternate alloys are 1100, Alclad 3003, 3004, Alclad 3004, 3105, 5005 and 5052, usually in the H14, H24 and H34 tempers. Where sheet is to be anodized, specific alloys must be employed to produce the desired effects. The composition and tempers of wrought aluminum and wrought aluminum alloys are designated by a standard system devised by The Aluminum Association and adopted by the American National Standards Institute as ANSI H35.1.

The Aluminum Association system divides aluminum and its alloys into eight groups, according to chemical composition:

Designations for Alloy Groups		Alloy No.
Aluminum—99.00% minimum and greater		1xxx
Aluminum Alloys grouped by Major Alloying Elements	Major Alloying Element	
	Copper	2xxx
	Manganese	3xxx
	Silicon	4xxx
	Magnesium	5xxx
	Magnesium and Silicon	6xxx
	Zinc	7xxx
	Other Element	8xxx
Unused Series		9xxx

Mechanical properties of aluminum and its alloys, such as tensile strength, ductility and hardness, vary widely not only from one alloy group to another but among different metallurgical states, or tempers, of a single alloy. A designation for temper is part of The Aluminum Association system and when used, follows the alloy designation, the two designations being separated by a dash.

The temper designation consists of a letter—O, H or T. O stands for "annealed," and indicates the lowest strength and softest state of any particular alloy. H is applied to alloys whose strength can be increased by work-hardening, while T is applied to the alloys that become stronger when heat-treated.

A two- or three-digit number is always part of an H designation. The first digit indicates the type of treatment and the second, the degree of work-hardening attained. H1 identifies alloys that have been work-hardened only; H2 means the metal has been partially annealed after work-hardening, to reduce somewhat the degree of hardness. H3 is similar to H2, but applies to magnesium-containing alloys. The heat-treatment indicated by H3 is called stabilization, as without this treatment, these alloys tend to soften over a period of time at room temperatures. The second digit goes from 1 to 9, with 2, 4, 6 and 8 indicating $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and fully hard (0 by itself denotes the fully soft state); 9 is used for extra-hard tempers, and the odd numbers show intermediate values of tensile strength. The third digit, when added, indicates a slight variation in temper or mechanical properties from the two-digit H temper designation to which it is added.

More information on aluminum alloys and tempers may be obtained from The Aluminum Association publication "Aluminum Standards & Data."

TYPICAL MECHANICAL PROPERTIES OF ALUMINUM ALLOYS AND TEMPERS MOST COMMONLY USED IN SHEET METAL WORK (FOR COMPARISON OF ALLOYS, NOT FOR DESIGN)

Alloy and Temper	Tensile Strength—ksi		Elongation—percent in 2 in.
	Ultimate	Yield	
1100-H14	18	17	9
3003-H14			
Alclad 3003-H14	22	21	8
3004-H34			
Alclad 3004-H34	35	29	9
3105-H14	25	22	5
5005-H34	23	20	8
5050-H34	28	24	8
5052-H34	38	31	10

1. SCOPE

These specifications shall apply to the proper use of aluminum in roofing, flashing and other sheet metal work in building construction. They are not intended to cover the details or specifications of proprietary or pre-formed sheet metal systems or products, such as horizontal siding, fascia and soffit systems, curtain wall systems, corrugated or ribbed roofing and siding, etc.

2. MATERIALS

2.1 Aluminum Sheet

2.1.1 ALLOY AND TEMPER of sheet shall be 3003-H14 unless otherwise specified. Acceptable alternate alloys are 1100, alclad 3003, 3004, alclad 3004, 3105, 5005, 5050 and 5052, usually in the H14, H24 and H34 temper.

Notes:

1. Alloy composition and mechanical properties shall conform to Aluminum Standards and Data published by The Aluminum Association.
2. Where severe forming is involved a softer temper may be employed and where little forming is required a harder temper may be used.
3. Alclad sheet products provide extra protection against pitting corrosion in severe industrial or in industrial-marine environments.
4. Other and/or new aluminum sheet alloys and tempers may be submitted to The Aluminum Association for approval.

2.1.2 THICKNESS of sheet shall be sufficient for the intended specification, but in no case shall be less than the minimum nominal thickness listed in Table 1.

2.1.3 DIMENSIONAL TOLERANCES of sheet shall conform to Aluminum Standards and Data published by The Aluminum Association.

2.1.4 FINISH of sheet shall be "Mill Finish" unless otherwise specified. Sheet finishes shall conform to standards of The Aluminum Association.

Note:

Embossed, anodized or painted sheet shall be acceptable under this specification provided they have the necessary strength and formability for the intended purposes.

2.2 Building Paper or Roofing Felt used over non-vented or poorly vented spaces, where condensation may occur, shall be vapor barriers conforming to Federal Specifications UU-B-790A, Type I, Grade A; HH-R-590A, Type II, Class C or, alternately, polyethylene sheet not less than 4 mils thick conforming to Federal Specifications L-P-378B or L-P-512A.

Over well vented spaces, the building paper or roofing felt shall be vapor repellent, but not necessarily vapor proof, and shall conform to Federal Specifications UU-B-790A, Type I, Grade C or D; HH-R-590A, Type II or HH-R-595B, Type I or II.

Note:

Some building papers and roofing felts conforming to the above Federal Specifications may contain additives of heavy metals or chemicals corrosive to aluminum and should be avoided.

For building papers or roofing felts, the minimum weight shall be 15 lb. type. The underlayment shall be overlapped at least 2 inches so as to shed water and shall be secured along the laps with large flat headed aluminum nails at 6 inch centers.

2.3 Sealants.

2.3.1 ONE PART SYNTHETIC OR RUBBER-BASE SEALANTS shall be those conforming to Federal Specification TT-S-230A(1). Use shall be in conformance with manufacturer's recommendations.

2.3.2 TWO PART SYNTHETIC OR RUBBER-BASE SEALANTS shall be those conforming to Federal Specifications TT-S-00227E (1) or ANSI A116.1. Use shall be in conformance with manufacturer's recommendations.

2.4 Elastic Cement shall meet requirements of Federal Specification SS-C-153.

2.5 Fasteners.

2.5.1 CLEATS shall be aluminum of the same alloy, temper and thickness as the sheet being applied unless otherwise specified. Cleats shall not be less than 2 inches wide and long enough to

Table 1 Minimum Nominal Sheet Thickness, Inches
(This is not intended to limit thickness of proprietary products)

	Residential	Non-Residential
Roofing		
Standing Seam	0.024	0.032
Batten Seam	0.024	0.032
Shingles	0.019**	0.019**
Proprietary Systems	0.019**	0.024**
Flashings		
Base	0.019*	0.032
Cap	0.019*	0.032
Ridge, Hip	0.024	0.032
Coping Covers	0.024	0.032
Scuppers	0.024	0.032
Splash Pans	0.032	0.040
Chimney	0.019*	0.032
Apron	0.024	0.032
Head	0.019*	0.032
Sill	0.019*	0.032
Curbs	0.024	0.032
Thru-wall		
Lintel	0.024	0.032
Spandrel	0.024	0.032
Sill	0.024	0.032
Parapets	0.024	0.032
Gravel Stops & Fascia	0.024	0.032
Edge Strips	0.024	0.032
Gutters		
Gutters	0.027	0.032
Cleats, Continuous	0.024	0.032
Hangers	0.064	0.080
Rainwater Goods		
Downspouts and Headers	0.019	0.032
Leader Heads	0.024	0.032
Clips	0.040	0.064
Straps	0.040	0.064
Valley	0.019*	0.032
Snow, Eave	0.024	0.032
Expansion joint, building		0.032

*Preferred thickness is 0.024".

**The thickness of shingles and proprietary roofing systems should be determined for specific application on the basis of negative and positive load test data for the products and their performance when tested to meet applicable building code requirements.

be fully incorporated into the seam with the other end folded back over the nail heads. They shall be fastened securely with two aluminum nails placed parallel to the seam.

2.5.2 NAILS for fastening aluminum sheet metal work shall be made of aluminum alloys 6061 or 5056 conforming to Federal Specification FF-N-105B, Type II, Style 20.

2.5.3 SCREWS, BOLTS AND NUTS. Screws and bolts shall be made of aluminum alloys 6061-T6 or 2024-T4 except that 2024-T4 alloy fasteners shall not be used in corrosive industrial and marine environments. Nuts shall be made of aluminum alloys 6061-T6 or 6262-T9. Stainless steel (300 series) screws, bolts and nuts shall be acceptable alternates. Washers shall be used beneath the heads to prevent tearing of the sheet or the sheet tearing off over the screw or bolt heads.

2.5.4 WASHERS shall be made from 1100-H18 alloy or from the same aluminum alloys as the sheet or fasteners being used. The minimum thickness of the washers shall be 0.040 inches. Where weathertightness is required a rubbertype washer shall be used beneath the aluminum washer or fastener head.

2.5.5 EXPANSION INSERTS, plugs, anchors and shields shall be of wood, fibre, plastic, lead or aluminum and shall be chosen to suit the environments of each particular application.

2.5.6 RIVETS shall be aluminum alloy 1100-H14 unless otherwise specified. The rivets shall have a minimum shank diameter of 0.187 inches and shall be sufficiently long to form a proper head. Blind rivets may be used where maximum watertightness, strength or corrosion resistance are not required. Acceptable blind rivets shall be 1100 sleeve, 5056 mandrel; 5050 sleeve, 5056 mandrel; 5052 sleeve, 5056 mandrel; 5052 sleeve, 7178 mandrel and 5056 sleeve, 1020 steel mandrel. Stainless steel or Monel blind rivets are acceptable alternates.

2.6 Paint for backpainting shall be bituminous paint of the cut-back type conforming to specification MIL-C-450 B (1) or TT-C-494. Where appearance is a factor methacrylate type lacquers conforming to MIL-L-19537C (2) may be used.

3. PREPARATION OF SURFACES

3.1 General. All surfaces upon which aluminum sheet is to be placed shall be smooth, even and free of small projections and hollows. The surface shall be dry before and during the placing of the aluminum. For wood surfaces the lumber shall be of good quality, well seasoned, straight and free of knotholes and splits. It shall be laid with all joints true and even and firmly attached with all fastener heads flush with the top surface. On masonry surfaces adequate provision shall be made for receiving fasteners in accordance with the plans for sheet metal work.

3.2 Dissimilar Metals. Corrosion of aluminum caused by contact with dissimilar metals (galvanic corrosion) shall be prevented by proper design considerations and installation procedures.

Notes:

1. Indoors under dry conditions — galvanic corrosion will not occur and, therefore, aluminum may be used in contact with any metal commonly used in buildings.

2. Outdoors and indoors where moisture is present or condensation may occur — galvanic corrosion between aluminum and:

(a) **Iron and steel** is very slow and can be prevented readily by painting the iron or steel with a good quality exterior grade primer and top coat or bituminous paint (Section 2.6).

(b) **Zinc** is insignificant. Zinc even tends to protect the aluminum.

(c) **Galvanized steel** is insignificant. However, when the zinc is consumed, the steel will rust which may cause staining. In severe industrial environments this can happen in a relatively short time and the precautions in (a) should be followed.

(d) **Cadmium** plated steel is insignificant. However, when the cadmium is consumed, the steel will rust which may cause staining. As the cadmium coating usually applied is very thin, this may happen in a relatively short time in industrial environments and the precautions in (a) should be followed.

(e) **Stainless steel** is insignificant.

(f) **Monel** is insignificant.

(g) **Copper, brass and bronze** will occur and, therefore, direct contact of aluminum and these metals should be avoided. Drainage of water off these metals onto aluminum should not be permitted.

(h) **Lead** is insignificant.

3. Highly corrosive environments — such as those on the sea-coast and around chemical plants, mine and mill complexes, refineries, etc., may promote galvanic corrosion even though aluminum by itself has good corrosion resistance. In these environments, advice should be sought from specialists who will be able to recommend appropriate precautionary measures.

3.3 Wood Sheathing or wood surfaces to be covered with aluminum shall be covered with building paper or roofing felt (Section 2.2). Alternately, the wood shall be thoroughly painted with two coats of any good quality exterior type paint or the aluminum shall be back painted (Section 2.6).

Notes:

1. Kiln dried lumber, impregnated against decay is recommended for sheathing, cant strips, coping blocks and fascia boards. Satisfactory preservatives are coal tar creosote, coal tar oil, chlorinated naphthalenes, zinc naphthenate, pentachlorophenol (with or without addition of zinc derivatives), tributyl tin oxide, orthophenylphenol. Other preservatives may be used but assurance should be obtained from the manufacturer that they are not harmful to aluminum.

2. Aluminum paint, consisting of 2 lbs. of aluminum paste pigment (ASTM Specification D962-66, Type 2, Class B) per gallon of varnish meeting Federal Specification TT-V-81F, Type II or equivalent, is an excellent primer and paint for wood. However, any good quality exterior type paint may be used.

3.4 Concrete and Masonry surfaces to be covered with aluminum shall be covered with building paper or roofing felt (Section 2.2) or alternately the aluminum shall be back painted thoroughly (Section 2.6). Where aluminum is to be caulked into slots or reglets in masonry, brickwork, or concrete, the slot or reglet shall be filled with sealant (Section 2.3) so that the sealant covers both surfaces of that part of the flashing in the slot or reglet.

4. JOINING

4.1 Mechanical Seams and Joints for aluminum shall be the same as those used for other sheet metals. Lap and lock seams shall not be riveted or otherwise fastened together to restrict relative movement unless it is desired to transfer such movement to a different location.

End joints of formed sheet members such as ridge, hip, valley, gable or rake strips, battens, aprons, gravel stops, coping and cap flashing shall not be riveted or fastened together to restrict thermal movement. Where slope is sufficient to provide drainage and flat widths are less than 8 inches, simple laps may be employed. For flashing with flat widths over 8 inches or surfaces with slopes less than 3 in 12, sealant filled controlled slip joints shall be employed. Joints must be installed to allow for the maximum thermal movement of 1/8 inch or as determined for the project allowing for the temperature of the metal at the time of installation.

Solar radiation can develop material temperatures of 140°F on bare aluminum and up to 180°F on dark painted metal. Radiation to the night sky can produce surface temperatures 10° to 15°F below ambient air (more in arid regions and at higher altitudes), so joints should be designed for temperature variations of 100°F minimum (equivalent to 1/8 inch) and higher depending on local conditions and surface variation.

The installer must keep the metal temperature at time of installation in mind and larger clearances need to be left for expansion of sections installed earlier in the morning or during cool weather.

4.2 Soldering of aluminum shall not be permitted.

4.3 Brazing can be used to join aluminum, but inorganic fluxes are employed which can be corrosive to aluminum if not completely removed after brazing. Thus, brazing should be done under shop conditions and with joint designs where complete removal of flux residue is possible. Filler alloy 4047 is most commonly used.

4.4 Welding aluminum sheet metal in the field shall be done with the gas tungsten-arc (TIG) and gas metal-arc (MIG) welding processes only. If the sheet is anodically treated, the anodic coating must be removed in the weld area to permit proper weld fusion. Oxyfuel-gas welding can also be used with aluminum and, as in brazing, requires complete removal of the flux residue, so should be used under shop conditions. Filler alloy 4043 can be used for oxyfuel-gas welding all the sheet alloys; however, 1100 alloy filler can be used for welding 1100 and 3003 base alloys for improved weld ductility and color match with parts which are anodized after welding. Filler alloy 5356 is not suitable for oxyfuel-gas welding. Common filler alloys for arc welding the sheet alloys are listed in Table 2:

Table 2 Filler Alloys for Welding Aluminum Sheet Metal

Base Metal	5052	5005, 5050	3004, Alclad 3004, 3005	1100, 3003, Alclad 3003, 3105
1100, 3003, Alclad 3003, 3105	4043a	4043a	4043a	4043b
3004, Alclad 3004, 3005	4043a	4043a	4043a	
5005, 5050	4043a	4043a		
5052	4043a			

- a. 5356 may be used for improved strength, ductility and color match. 5356 is the most readily available filler which is compatible with the sheet alloys in this table.
- b. 1100 may be used for improved ductility and color match.



LAP SEAM



LAP SEAM RIVETED



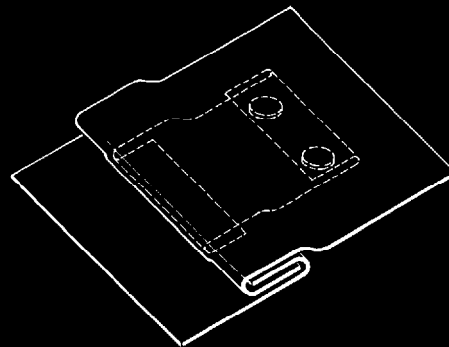
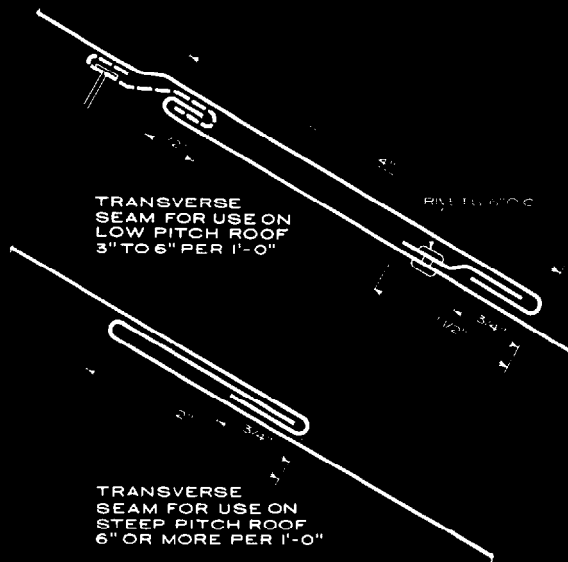
"S" LOCK SEAM



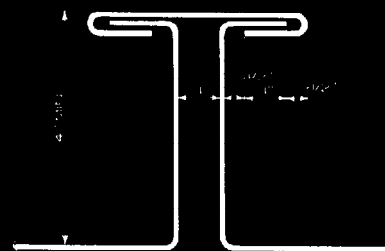
SINGLE OR LOOSE-LOCK SEAM



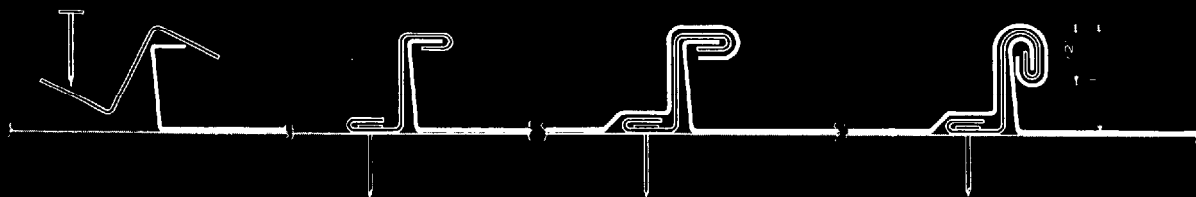
DOUBLE LOCK SEAM



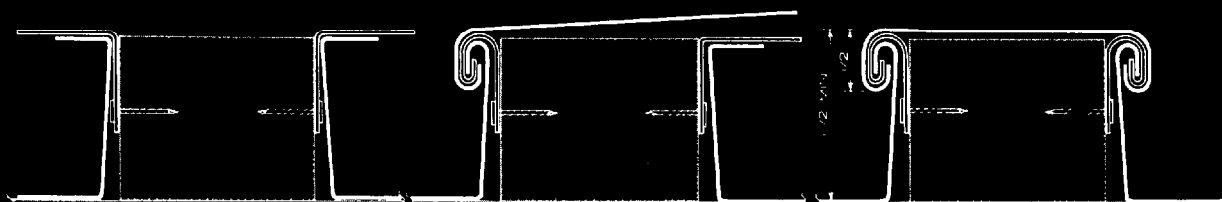
FLAT-LOCK SEAM CLEATED



TYPICAL EXPANSION JOINT



DEVELOPMENT OF TYPICAL STANDING SEAM



DEVELOPMENT OF TYPICAL BATTEN SEAM

5. STANDING SEAM ROOFING

5.1 Roof Slopes to which these specifications apply shall be not less than 3 inches per foot.

Note:

Roof slopes less than 3 inches per foot require special precautions in design and installation.

5.2 Building Paper or Roofing Felt. Roof surfaces shall be covered with building paper or roofing felt (Section 2.2).

5.3 Roof Pans shall be formed of sheets not longer than 10 feet and no straight run of roofing shall exceed 30 feet. Sheet thickness shall be 0.024 inch where width of pan between standing seams does not exceed 20 inches or 0.032 inch where width of pan between standing seams is from 20 to 27 inches. To allow for expansion, pan width should be $\frac{1}{8}$ inch less than the center to center spacing of standing seams.

Notes:

1. *Standing seam roofing is best installed over wood decks since the cleats used to secure the aluminum roofing are nailed directly to the deck. If decks other than wood are used, properly located nailers should be incorporated in the deck construction.*

2. *When standing seams are formed or finished in the field the cleats become rigidly locked into the multiple folds of the seam; slippage does not occur between standing seam roof pans and the cleats that are secured to the deck. With long runs of roofing (over 30 feet) expansion movement may eventually loosen the nails in the deck, placing the roof installation in an unsafe condition.*

3. *Where long runs of standing seam roofing are unavoidable, expansion or sliding cleats should be used where the length on either side of the center of the run exceeds 15 feet.*

5.4 Transverse Seams

5.4.1 FOR ROOF SLOPES 6 INCHES OR MORE PER FOOT the lower end of each pan shall be folded under $\frac{3}{4}$ inch. The fold shall be slit 1 inch away from the corner to form a tab where the pan turns up to make a standing seam. The upper end of each pan shall be folded over 2 inches. The $\frac{3}{4}$ inch fold on the lower end of the upper pan is hooked into the 2 inch fold on the upper end of the underlying pan. Alternate pans shall begin at the eaves with half length sheets, staggering transverse seams.

5.4.2 FOR ROOF SLOPES 3 TO 6 INCHES PER FOOT the lower end of each pan shall be folded under $\frac{3}{4}$ inch. The fold shall be slit 1 inch away from the corner to form a tab where the pan turns up to make the standing seam. The upper end of each pan shall be folded over $\frac{1}{2}$ inch. A $1\frac{1}{2}$ inch wide locking strip the full width of the pan shall be secured not less than 4 inches below the top folded edge by rivets spaced not more than 6 inches apart. The $\frac{3}{4}$ inch fold on the lower end of the pan shall hook into the locking strip of the underlying pan. Alternately, transverse seams may be made as specified in Section 5.4.1 and filling the seams with sealant (Section 2.3). Alternate pans shall begin at the eaves with half length sheets, staggering transverse seams.

5.5 Standing Seams shall finish 1 inch high except on curved surfaces where they may finish $\frac{3}{4}$ inch. One side edge shall be

bent up $1\frac{1}{2}$ inches and the other $1\frac{3}{4}$ inches. The first fold shall be a single fold $\frac{1}{4}$ inch wide and the second fold shall be $\frac{1}{2}$ inch wide. The lock portion of the standing seam shall be five (5) plies in thickness. A space of not less than $\frac{1}{8}$ inch shall be provided between adjacent pans at the bottom of each standing seam. At eaves, ends of standing seams shall be closed by folding over a tab provided at one side of each roof pan.

5.6 Cleats (Section 2.5.1) shall be not less than 2 inches wide and shall be spaced 12 inches apart in each standing seam. If the roof deck is a material other than wood, nailers shall be provided for the securement of cleats (Section 2.5.1).

5.7 Ridges and Hips shall be provided with standing seams constructed as for the main roof. Where standing seams of the main roof terminate at ridges or hips they shall be laid flat and folded into ridge or hip standing seams. Standing seams on opposite side of ridges or hips should be staggered to avoid excessive thicknesses of metal in the ridge or hip standing seam.

Alternate methods of finishing hips and ridges shall be as shown in the detail drawings.

5.8 Valleys shall be formed from aluminum sheets not exceeding 10 feet in length of the same gauge and alloy as used for the roof pans. Each sheet shall lap the lower one not less than 6 inches in the direction of flow. The valley sheet shall extend under the roof pans on both sides not less than 6 inches. At the valley line adjacent to the lower edge of the roof pans, a $\frac{3}{4}$ inch double fold shall be made to engage a $\frac{3}{4}$ inch single fold at the lower ends of the roof pans. The outer edge of the valley sheets shall be folded $\frac{1}{2}$ inch for cleating and in these folds cleats shall be installed on 24 inch centers. Valley sheets shall be nailed along top edge only.

5.9 Eaves. At eaves, where no gutters occur, each pan shall be hooked $\frac{3}{4}$ inch over a previously placed aluminum edge strip. Edge strips shall be continuous and shall be formed from sheets not longer than 10 feet; ends of adjacent lengths shall lap at least 1 inch. The edge strip shall extend up on the roof deck at least 4 inches and be secured with nails spaced not more than 4 inches apart along the upper edge. The lower edge shall be turned out $\frac{3}{4}$ inch to form a drip. Face nailing of the edge strip shall not be permitted.

Where seams finish back from eave edge the lower edge of the roofing shall engage a previously placed apron strip. The connection between the roof pans and upper edge of the apron strip shall be as described in Section 5.4. The lower edge of the apron strip shall be hooked over a previously placed edge strip as previously described.

5.10 Gable Rakes. Side edges of pans at gable rakes shall finish over an edge strip as described in Section 5.9 or, alternately, shall turn up $1\frac{1}{2}$ inches and be locked into an aluminum fascia strip forming a standing seam 1 inch high. Where the standing seam finishes at the roof edge, the lower edge of the fascia strip shall be hooked $\frac{3}{4}$ inch over a previously placed continuous edge strip that is secured to the decking with aluminum nails spaced 4 inches apart.