Designation: B 745/B 745M – 97

Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains[1]

This standard is issued under the fixed designation B 745/B 745M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers corrugated aluminum pipe intended for use for storm water drainage, underdrains, the construction of culverts, and similar uses. Pipe covered by this specification is not normally used for the conveyance of sanitary or industrial wastes.

1.2 This specification does not include requirements for bedding, backfill, or the relationship between earth cover load and sheet thickness of the pipe. Experience has shown that the successful performance of this product depends upon the proper selection of sheet thickness, type of bedding and backfill, controlled manufacture in the plant, and care in the installation. The purchaser must correlate the above factors and also the corrosion and abrasion requirements of the field installation with the sheet thickness. The structural design of corrugated aluminum pipe and the proper installation procedures are given in Practices B 790/B 790M and B 788/B 788M, respectively. A procedure for using life-cycle cost analysis techniques to evaluate alternative drainage system designs using corrugated metal pipe is given in Practice A 930.

1.3 This specification is applicable to orders in either inch-pound units as B 745 or SI units as B 745M. Inch-pound units and SI units are not necessarily equivalent. SI units are shown in brackets in the text; they are the applicable values when the material is ordered to B 745M.

2. Referenced Documents

2.1 *ASTM Standards:*

A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[2]

A 307 Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength[3]

A 563 Specification for Carbon and Alloy Steel Nuts[3]

A 563M Specification for Carbon and Alloy Steel Nuts [Metric][3]

A 930 Practice for Life-Cycle Cost Analysis of Corrugated Metal Pipe Used for Culverts, Storm Sewers, and Other Buried Conduits[2]

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate[4]

B 209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric][4]

B 221 Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes[4]

B 221M Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes [Metric][4]

B 316/B 316M Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods[4]

B 633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel[5]

B 666/B 666M Practice for Identification Marking of Aluminum and Magnesium Products[4]

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel[5]

B 744/B 744M Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe[4]

B 788/B 788M Practice for Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe[4]

B 790/B 790M Practice for Structural Design of Corrugated Aluminum Pipe, Pipe Arches, and Arches for Culverts, Storm Sewers, and Other Buried Conduits[4]

C 443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets[6]

D 1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber[7]

F 467 Specification for Nonferrous Nuts for General Use[3]

F 467M Specification for Nonferrous Nuts for General Use [Metric][3]

F 468 Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use[3]

F 468M Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use [Metric][3]

F 568 Specification for Carbon and Alloy Steel Externally

[1] This specification is under the jurisdiction of ASTM Committee B-7 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.08 on Aluminum Culvert.

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[2] *Annual Book of ASTM Standards*, Vol 01.06.

[3] *Annual Book of ASTM Standards*, Vol 15.08.

[4] *Annual Book of ASTM Standards*, Vol 02.02.

[5] *Annual Book of ASTM Standards*, Vol 02.05.

[6] *Annual Book of ASTM Standards*, Vol 04.05.

[7] *Annual Book of ASTM Standards*, Vol 08.01.

***A Summary of Changes section appears at the end of this standard.**

Threaded Metric Fasteners[3]
F 593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs[3]
F 594 Specification for Stainless Steel Nuts[3]
F 738M Specification for Stainless Steel Metric Bolts, Screws, and Studs[3]
F 836M Specification for Stainless Steel Metric Nuts[3]
2.2 *AASHTO Standard:*[8]
T 249 Test for Helical Lock Seam Corrugated Pipe

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*
3.1.1 *fabricator*—the producer of the pipe.
3.1.2 *manufacturer*—the producer of the sheet.
3.1.3 *purchaser*—the purchaser of the finished product.

4. Classification

4.1 The corrugated aluminum pipe covered by this specification is classified as follows:
4.1.1 *Type I*—This pipe shall have a full circular cross-section, with a single thickness of corrugated sheet, fabricated with annular (circumferential) or helical corrugations.
4.1.2 *Type IA*—This pipe shall have a full circular cross-section, with an outer shell of corrugated sheet and an inner liner of smooth (uncorrugated) sheet, fabricated with helical corrugations and lock seams.
4.1.3 *Type IR*—This pipe shall have a full circular cross-section, with a single thickness of smooth sheet, fabricated with helical ribs projecting outwardly.
4.1.4 *Type II*—This pipe shall be a Type I pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
4.1.5 *Type IIA*—This pipe shall be a Type IA pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
4.1.6 *Type IIR*—This pipe shall be a Type IR pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
4.1.7 *Type III*—This pipe, intended for use as underdrains or for underground disposal of water, shall be a Type I pipe which has been perforated to permit the in-flow or out-flow of water.
4.1.8 *Type IIIR*—This pipe, intended for the underground disposal of water or for subsurface drainage, shall be a Type IR pipe which has been perforated to permit the outflow or inflow of water.
4.2 Perforations in Type III pipe are classified as Class 1 or Class 2 and perforations in Type IIIR pipe are classified as Class 4, as described in 8.3.2.

5. Ordering Information

5.1 Orders for material to this specification shall include the following information as necessary, to adequately describe the desired product:
5.1.1 Name of material (corrugated aluminum pipe),
5.1.2 ASTM designation and year of issue, as B 745-_ for inch-pound units or B 745M-_ for SI units,
5.1.3 Type of pipe (4.1),
5.1.4 Method of fabrication for Type I and Type II pipe (7.1),
5.1.5 Diameter of circular pipe (8.1.1), or span and rise of pipe-arch section (8.2.1),
5.1.6 Length, either total length or length of each piece and number of pieces,
5.1.7 Description of corrugations (7.2),
5.1.8 Sheet thickness (8.1.2),
5.1.9 Coupling bands, number, and type (9.1) if special type is required,
5.1.10 Gaskets for coupling bands, if required (9.3),
5.1.11 For perforated pipe, the class of perforations. If no class is specified for Type III pipe, Class 1 perforations will be furnished. Type IIIR pipe is furnished with Class 4 perforations only (8.3.2.1 and 8.3.2.3).
5.1.12 Certification, if required (13.1), and
5.1.13 Special requirements.

6. Materials

6.1 *Aluminum Sheet for Pipe*—All pipe fabricated under this specification shall be formed from aluminum-alloy sheet conforming to Specification B 744/B 744M.
6.2 *Aluminum Sheet for Coupling Bands*— The sheet used in fabricating coupling bands shall conform to Specification B 744/B 744M.
6.3 *Rivets*—The material used for rivets in riveted pipe shall conform to the requirements of Specification B 316/B 316M for alloy 6053-T4, with the following mechanical properties:

Tensile Strength, min, ksi [MPa]	25 [170]
Yield Strength, min, ksi [MPa]	14 [95]
Shear Strength, min, ksi [MPa]	15 [105]
Elongation in 2 in., 50 mm, or 4x dia., min, %	16

If bolts and nuts are substituted for rivets (see 7.3.1), they shall meet the following requirements for either steel bolts and nuts, stainless steel bolts and nuts, or aluminum alloy bolts and nuts:

	Bolts	Nuts
For B745 pipe		
(Steel)	A307	A563, Gr. A
(Stainless Steel)	F593, Alloy Grp 1, 2, or 3	F594, Alloy Grp 1, 2, or 3
(Aluminum Alloy)	F468, Alloy 6061-T6	F467, Alloy 6061-T6
For B745M pipe		
(Steel)	F568, Cl. 4.6	A563M, Cl. 5
(Stainless Steel)	F738M, Alloy Grp A1, A2, or A4	F836, Alloy Grp A1, A2, or A4
(Aluminum Alloy)	F468M, Alloy 6061-T6	F467M, Alloy 6061-T6

The steel bolts and nuts shall be hot-dip galvanized in conformance with Specification A 153, or be mechanically galvanized in conformance with Specification B 695 Class 40.
6.4 *Hardware for Coupling Bands*—Bolts and nuts for coupling bands shall conform to the requirements shown in 6.3 except for the coating on steel bolts and nuts. Steel bolts, nuts, and other threaded steel items used with coupling bands shall be zinc coated by one the following processes: hot-dip process as provided in Specification A 153, electroplating process as provided in Specification B 633 Class FE/ZN 8 or mechanical process as provided in Specification B 695 Class 8. Other steel

[8] Available from American Association of State Highway and Transportation Officials, 444 North Capitol Street NW, Suite 225, Washington, DC 20001.

hardware items used with coupling bands shall be zinc coated by one of the following processes: hot-dip process as provided in Specification A 153; electroplating process as provided in Specification B 633 Class FE/ZN 25; or mechanical process as provided in Specification B 695 Class 25. Aluminum angles and lugs shall conform to the requirements of Specification B 221 or B 221M for alloy 6063-T6.

6.5 *Gaskets*—If gaskets are used in couplings, they shall be a band of expanded rubber meeting the requirements of Specification D 1056 for the "RE" closed cell grades, or O-rings meeting the requirements of Specification C 443.

7. Fabrication

7.1 *General Requirements*—Pipe shall be fabricated in full circular cross-section.

7.1.1 Type I pipe shall have annular corrugations with lap joints fastened with rivets or shall have helical corrugations with a continuous lock seam extending from end to end of each length of pipe. As there are important differences in the structural characteristics of annular, riveted pipe versus helical pipe, it is important for the purchaser to stipulate, for Type I and Type II pipe, the method of fabrication desired. If the method of fabrication is not stated in the ordering information, the fabrication method shall be at the option of the fabricator.

7.1.2 Type IA pipe shall be fabricated with a smooth liner and helically corrugated shell integrally attached at helical lock seams extending from end to end of each length of pipe. The shell shall have corrugations of nominal 2⅔ (or 3 in. [68 or 75 mm] pitch.

7.1.3 Type IR pipe shall be fabricated with helical ribs projecting outward with a continuous lock seam extending from end to end of each length of pipe.

7.2 *Corrugations*—The corrugations shall be either annular or helical as provided in 7.1. The direction of the crests and valleys of helical corrugations shall not be less than 60° from the axis of the pipe for pipe diameters larger than 21 in. [525 mm], and not less than 45° from the axis for pipe diameters of 21 in. [525 mm] and smaller.

7.2.1 For Type I and IA pipe, corrugations shall form smooth continuous curves and tangents. The dimensions of the corrugations shall be in accordance with Table 1 for the size indicated in the order.

7.2.2 For Type IR pipe, the corrugations shall be essentially rectangular ribs projecting outward from the pipe wall. The dimensions and spacings of the ribs shall be in accordance with Table 2 for the size indicated in the order. See also Fig. 1. For the 11½ in. [292 mm] rib spacing, a stiffener shall be included midway between the ribs, if the sheet between the ribs does not include a lock seam. This stiffener shall have a nominal radius of 0.25 in. [6.4 mm] and a minimum height of 0.20 in. [5.1 mm] toward the outside of the pipe.

NOTE 1—The nominal dimensions and properties for smooth corrugations and for ribs are given in Practice B 790/B 790M.

7.3 *Riveted Seams*—The longitudinal seams shall be staggered to the extent that no more than three thicknesses of sheet are fastened by any rivet. Pipe to be reformed into pipe-arch shape shall also meet the longitudinal seam requirement of 8.2.2.

TABLE 1 Corrugation Requirements for Type I, IA, II, IIA, and III Pipe

Nominal Size	Maximum Pitch[A]	Minimum Depth[B]	Inside Radius[C]	
			Nominal	Minimum
		B 745 (in.)		
1½ by ¼ [D]	1⅞	0.24	9/32	0.25
2⅔ by½	2⅞	0.48[E]	11/16	0.5
3 by 1	3¼	0.95	9/16	0.5
6 by 1	6¼	0.95	2.2	2.0
		B 745M (mm)		
38 by 6.5[D]	48	6.0	7	6.5
68 by 13	73	12[E]	17	12
75 by 25	83	24	14	12
150 by 25	160	24	56	51

[A] Pitch is measured from crest to crest of corrugations, at 90° to the direction of the corrugations.

[B] Depth is measured as the vertical distance from a straightedge resting on the corrugation crests parallel to the axis of the pipe, to the bottom of the intervening valley.

[C] Minimum inside radius requirement does not apply to a corrugation containing a helical lock seam.

[D] The corrugation size of 1½ by ¼ in. [38 x 6.5 mm] is available only in helically corrugated pipe.

[E] For pipe 12 to 21 in. [300 to 525 mm] dia. inclusive, the minimum corrugation depth shall be 0.42 in. [11 mm].

NOTE 2—Fabrication of pipe without longitudinal seams in 120° of arc, so that the pipe may be installed without longitudinal seams in the invert, is subject to negotiation between the purchaser and fabricator.

7.3.1 The size of rivets, number per corrugation, and width of lap at the longitudinal seam shall be as stated in Table 3, depending on sheet thickness, corrugation size, and diameter of pipe. For pipe with 1 in. [25 mm] deep corrugations, ½-in. [Metric M12] diameter bolts and nuts may be used in lieu of rivets on a one-for-one replacement ratio. Circumferential seams shall be riveted using rivets of the same size as for longitudinal seams and shall have a maximum rivet spacing of 6 in. [150 mm], measured on centers, except that six rivets will be sufficient in 12-in. [300 mm] diameter pipe.

7.3.2 All rivets shall be driven cold in such a manner that the sheets shall be drawn tightly together throughout the entire lap. The center of a rivet shall be no closer than twice its diameter from the edge of the sheet. The distance between the centerlines of the two rows of rivets, where two rows are required, shall not be less than 1½ in. [38 mm]. All rivets shall have neat, workmanlike, and full hemispherical heads or heads of a form acceptable to the purchaser, shall be driven without bending, and shall completely fill the hole.

7.4 *Helical Lock Seams*—The lock seam for Type I pipe shall be formed in the tangent element of the corrugation profile with its center near the neutral axis of the corrugation profile. The lock seam for Type IA pipe shall be in the valley of the corrugation, shall be spaced not more than 30 in. [760 mm] apart, and shall be formed from both the liner and the shell in the same general manner as Type I helical lock seam pipe. The lock seam for Type IR shall be formed in the flat zone of the pipe wall, midway between two ribs.

7.4.1 The edges of the sheets within the cross-section of the lock seam shall lap at least 5/32 in. [4.0 mm] for pipe 10 in. [250 mm] or less in diameter and at least 5/16 in. [7.9 mm] for pipe greater than 10 in. [250 mm] in diameter, with an occasional

TABLE 2 Rib Requirements for Type IR Pipe

Nominal Size	Rib Width, Min[A]	Rib Depth, Min[B]	Rib Spacing, Max[C]	Bottom Outside Radius, Min	Bottom[D] Outside Radius, Max Avg.	Top Outside Radius, Min	Top[D] Outside Radius, Max Avg.
				in.			
¾ by ¾ by 7½	0.68	0.73	7¾	0.10	0.25	0.10+t	0.25+t
¾ by 1 by 11½	0.68	0.95	11¾	0.10	0.25	0.10+t	0.25+t
				mm			
19 by 19 by 190	17	19	197	2.5	6.0	2.5+t	6.0+t
19 by 25 by 292	17	24	298	2.5	6.0	2.5+t	6.0+t

[A] Width is a dimension of the inside of the rib but is measured on the outside of the pipe (outside of the rib). It shall meet or exceed the stated minimum width plus two wall thicknesses, that is, $2T + 0.68$ in. [$2t + 17$ mm].
[B] Depth is an average of the ribs within a sheet width measured from the inside by placing a straight edge across the open rib and measuring to the bottom of the rib.
[C] Spacing is an average of three adjacent rib spacings for ¾ by ¾ by 7½ in. [19 by 19 by 190 mm] pipe and two adjacent rib spacings for ¾ by 1 by 11½ in. [19 by 25 by 292 mm] pipe measured center-to-center of the ribs, at 90° to the direction of the ribs.
[D] The averages of the two top rib radii and of the two bottom radii shall be within the minimum and maximum tolerances. The term outside radius refers to the surface outside of the pipe. See Fig. 1.

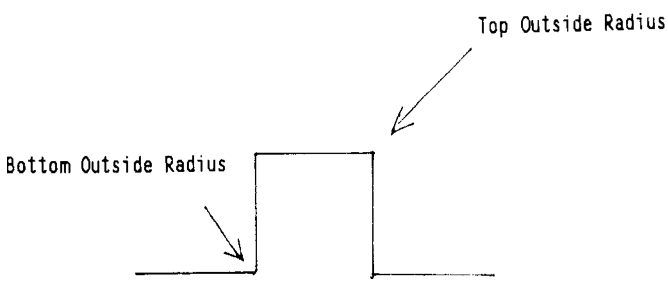

FIG. 1 Outside Radius of the Pipe (see Table 2)

TABLE 3 Riveted Longitudinal Seams

Specified Sheet Thickness, in.	Specified Sheet Thickness, mm	2⅔ × ½ in. / 68 × 13 mm[A,B] Rivet Diameters, min., in.	mm	3 × 1 in. / 75 × 25 mm[C,D] Rivet Diameters, min., in.	mm	6 × 1 in. / 150 × 25 mm[E,D] Rivet Diameters, min., in.	mm
0.060	1.52	5⁄16	8.0	⅜	9.5	½	12.7
0.075	1.91	5⁄16	8.0	⅜	9.5	½	12.7
0.105	2.67	⅜	9.5	½	12.7	½	12.7
0.135	3.43	⅜	9.5	½	12.7	½	12.7
0.164	4.17	⅜	9.5	½	12.7	½	12.7

Nominal Corrugation Size spans the 2⅔ × ½ in., 3 × 1 in. and 6 × 1 in. columns.

[A] One rivet each valley for pipe diameters 36 in. [900 mm] and smaller. Two rivets each valley for pipe diameters 42 in. [1050 mm] and larger.
[B] Minimum width of lap: 1½ in. [38 mm] for pipe diameters 36 in. [900 mm] and smaller, and 3 in. [75 mm] for pipe diameters 42 in. [1050 mm] and larger.
[C] Two rivets each valley for all pipe diameters.
[D] Minimum width of lap: 3 in. [75 mm] for pipe of all diameters.
[E] Two rivets each crest and valley for all pipe diameters.

tolerance of minus 10 % of lap width allowable. The lapped surfaces shall be in tight contact. The profile of the sheet shall include a retaining offset adjacent to the 180° fold (as described in AASHTO T249) of one sheet thickness on one side of the lock seam, or one-half sheet thickness on both sides of the lock seam, at the fabricator's option. There shall be no visual cracks in the metal, loss of metal-to-metal contact, or excessive angularity on the interior of the 180° fold of metal at the completion of forming the lock seam. The lock seam shall be mechanically staked (indented) at periodic intervals, or otherwise specially constructed to prevent slippage.

7.4.2 Specimens cut from production pipe normal to and across the lock seam shall develop the tensile strength as provided in Table 4, when tested according to AASHTO T249. For Type IA pipe, the lock seam strength shall be as tabulated based on the thickness of the corrugated shell.

TABLE 4 Specified Aluminum Alloy Sheet Thicknesses and Lock Seam Tensile Strength

Specified Sheet Thickness[A,B], in.	Specified Sheet Thickness[A,B], mm	Lock Seam Tensile Strength, min., lbf/in.	Lock Seam Tensile Strength, min., kN/m
0.036	0.91	100	17
0.048	1.22	145	25
0.060	1.52	170	30
0.075	1.91	245	43
0.105	2.67	425	74
0.135	3.43	550	96
0.164	4.17	700	122

[A] Thicknesses listed are those included in Specification B 744/B 744M.
[B] For Type IA pipe, the lock seam tensile strength requirement shall be based on the thickness of the corrugated shell.

7.4.3 When the ends of helically corrugated lock seam pipe have been rerolled to form annular corrugations, either with or without a flanged end finish, the lock seam in the rerolled end shall not contain any visible cracks in the base metal and the tensile strength of the lock seam shall be not less than 60 % of that required in 7.4.2.

7.5 *End Finish*:

7.5.1 To facilitate field jointing, the ends of individual pipe sections with helical corrugations or ribs may be rerolled to form annular corrugations extending at least two corrugations from the pipe end, or to form an upturned flange meeting the requirements in 7.5.3, or both. The diameter of ends shall not exceed that of the pipe barrel by more than the depth of the corrugation. All types of pipe ends, whether rerolled or not, shall be matched in a joint such that the maximum difference in the diameter of abutting pipe ends is ½ in. [13 mm].

7.5.2 When pipe with helical corrugations or ribs is rerolled to form annular corrugations in the ends, the usual size of annular corrugations is 2⅔ (by ½ in. [68 by 13 mm].

7.5.3 If a flanged finish is used on the ends of individual pipe sections to facilitate field jointing, the flange shall be uniform in width, be not less than ½ in. [13 mm] wide, and shall be square to the longitudinal axis of the pipe.

7.5.4 The ends of all pipe which will form the inlet and outlet of culverts, fabricated of sheets having normal thicknesses of 0.075 in. [1.91 mm] and less, shall be reinforced in a manner approved by the purchaser, when specified.

8. *Pipe Requirements* Pipe Requirements

8.1 *Type I, Type IA, and Type IR Pipe*: