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Standard for Safety for Enclosures for Electrical Equipment, Non-Environmental Considerations

Third Edition, Dated February 29, 2024

Summary of Topics

This new Fourteenth Edition of ANSI/UL 50 dated February 29, 2024 includes (a) Optional Performance Tests for Certain Construction Requirements; (b) Revisions to [Table 6.6](#); (c) Corrections to Annex [B](#) and Annex [E](#); (d) Revision of Sketch F of [Figure 6.10](#); (e) Addition of Annex [G](#)

Commitment for Amendments

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This ANSI/UL Standard for Safety consists of the Fourteenth Edition. The most recent designation of ANSI/UL 50 as an American National Standard (ANSI) occurred on February 29, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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Preface

This is the harmonized ANCE, CSA Group, and ULSE standard for Enclosures for Electrical Equipment, Non-Environmental Considerations. It is the fourth edition of NMX-J-235/1-ANCE, the third edition of CSA C22.2 No. 94.1, and the fourteenth edition of UL 50. This edition of NMX-J-235/1-ANCE supersedes the previous edition published on October 16, 2015. This edition of CSA C22.2 No. 94.1 supersedes the previous edition published in 2015. This edition of UL 50 supersedes the previous edition published on October 16, 2015.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and ULSE. The efforts and support of the CANENA Technical Harmonization Committee 70/31 Enclosures Working Group are gratefully acknowledged.

This Standard is considered suitable for use for conformity assessment within the stated scope of the standard.

The present Mexican standard was developed by the CT CDI Control y Distribución Industrial from the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE, with the collaboration of the enclosures manufacturers and users.

This Standard was reviewed by the CSA Integrated Committee on Enclosures, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This standard uses the IEC format but is not based on, nor is it considered equivalent to, an IEC standard.

This standard is published as an equivalent standard for ANCE, CSA Group, and ULSE.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Reasons for differences from IEC

The THSC investigated and found no existing IEC standards or work programs covering the scope of the products in this Standard.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

ENCLOSURES FOR ELECTRICAL EQUIPMENT, NON-ENVIRONMENTAL CONSIDERATIONS

1 Scope

1.1 This standard applies to enclosures for electrical equipment intended to be installed and used in non-hazardous locations in accordance with the Canadian Electrical Code, Part I, CSA C22.1, the provisions of the National Electrical Code, NFPA 70, and the provisions of Mexico's Electrical Installations, NOM-001-SEDE, as follows:

- a) Enclosures for indoor locations, Types 1, 2, 5, 12, 12K, and 13; and
- b) Enclosures for indoor or outdoor locations, Types 3, 3X, 3R, 3RX, 3S, 3SX, 4, 4X, 6, and 6P.

1.2 This standard covers the non-environmental construction and performance requirements for enclosures to provide a degree of protection to personnel against incidental contact with the enclosed equipment. The additional environmental construction and performance requirements for enclosures are located in CSA C22.2 No. 94.2, UL 50E, and NMX-J-235/2-ANCE (See Annex B, Ref. No. 15), which are intended to be used in conjunction with this standard.

1.3 Where an individual product standard contains requirements that are at variance with those of this standard, the requirements of the individual product standard take precedence.

1.4 In the United States and Mexico, cabinets and cutout boxes and junction and pull boxes are covered by Clauses 9 and 10 of this Standard. In Canada, junction boxes, cutout boxes, and pull boxes are covered by CSA C22.2 No. 40 and are not covered by this standard. See Annex B, Ref. No. 12.

1.5 Outlet boxes having a volume of not more than 1640 cm³ (100 in³) are covered by CSA C22.2 No. 18.1, NMX-J-023/1-ANCE, and the UL 514 series (see Annex B, Ref. No. 6 and 13) and are not covered by this standard.

1.6 In Canada and the United States, swimming pool type junction boxes are covered by CSA C22.2 No. 89 and UL 1241 (see Annex B, Ref. No. 11) and are not covered by this standard.

2 Units of Measurement

2.1 The values given in SI (metric) units shall be normative. Any other values given shall be for informational purposes only.

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA Group, or UL standards as appropriate for the country where the product is to be used.

3.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

3.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

4 References

4.1 For undated references to standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this standard was approved. For dated references to standards, such reference shall be considered to refer to the dated edition and all revisions published up to the time the standard was approved.

4.2 In Canada, general requirements are as indicated in Annex B, Ref. No. 10.

5 Definitions

5.1 The following definitions apply in this standard:

5.2 ACCESSIBLE EDGES – Edges that are subject to contact by persons installing, using, or maintaining the product.

5.3 BOX – That portion of an enclosure not including the cover or door.

5.4 BREAKOUT – A portion of a wall of a cast or molded enclosure so fashioned, usually by the use of one or more rings of reduced thickness of the wall material, that the material within the outer perimeter of the ring to be removed may be readily broken away at the time of installation in order to provide an opening similar to that provided by a knockout.

5.5 CABINET – See Annex B, Ref. No. 17.

5.6 COVER – An unhinged portion of an enclosure that covers an opening.

5.7 CUTOUT BOX – See Annex B, Ref. No. 17.

5.8 DEGREE OF PROTECTION – The extent of protection provided by an enclosure against access to parts which result in a risk of injury, ingress of foreign solid objects, and/or ingress of water as verified by standardized test methods.

5.9 DESIGN TESTS – Tests to demonstrate performance of a product designed to applicable standards; they are not intended to be production tests.

5.10 DOOR – A hinged portion of an enclosure that covers an opening.

5.11 ENCLOSURE – A surrounding case constructed to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection to the enclosed equipment against specified environmental conditions. The specific enclosure types, their applications, and the environmental conditions for which they are designed to protect against are as follows:

TYPE 1 – Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection against ingress of solid foreign objects (falling dirt).

TYPE 2 – Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

TYPE 3 – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); and that will be undamaged by the external formation of ice on the enclosure.

TYPE 3R – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); and that will be undamaged by the external formation of ice on the enclosure.

TYPE 3S – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); and for which the external mechanism(s) remain operable when ice laden.

TYPE 3X – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); that provide an increased level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

TYPE 3RX – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); that provide an increased level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

TYPE 3SX – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); that provide an increased level of protection against corrosion; and for which the external mechanism(s) remain operable when ice laden.

TYPE 4 – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose-directed water) and that will be undamaged by the external formation of ice on the enclosure.

TYPE 4X – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts ; to provide a degree of protection against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose-directed water); that provides an increased level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

TYPE 5 – Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and settling airborne dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

TYPE 6 – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, hose-directed water and the entry of water during occasional temporary submersion at a limited depth); and that will be undamaged by the external formation of ice on the enclosure.

TYPE 6P – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, hose-directed water, and the entry of water during prolonged submersion at a limited depth); and that will be undamaged by the external formation of ice on the enclosure.

TYPE 12 – Enclosures constructed (without knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against light splashing and consequent seepage of oil and non-corrosive coolants.

TYPE 12K – Enclosures constructed (with knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against light splashing and consequent seepage of oil and non-corrosive coolants.

TYPE 13 – Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts ; to provide a degree of protection against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against the spraying, splashing, and seepage of oil and non-corrosive coolants.

5.12 INDOOR LOCATIONS – Areas that are protected from exposure to the weather.

5.13 JUNCTION OR PULL BOX – An enclosure which is provided with a cover secured by fasteners other than hinges.

5.14 KNOCKOUT – A portion of a wall of a sheet metal enclosure so fashioned that it may be removed readily by a hammer, screwdriver, and pliers at the time of installation in order to provide a hole for the attachment of an auxiliary device or raceway, cable, or fitting.

5.15 NONVENTILATED– Constructed so as to provide no intentional circulation of external air through the enclosure.

5.16 OIL-RESISTANT GASKETS – Gaskets made of material that is resistant to oil and oil fumes.

5.17 OUTDOOR LOCATIONS – Areas that are exposed to the weather.

5.18 **THREADED CONDUIT ENTRY** – A conduit entry that is threaded so as to secure a rigid conduit without the use of a bushing or locknut.

5.19 **VENTILATED** – Constructed so as to provide for the circulation of external air through the enclosure to remove excess heat, fumes, or vapors.

6 Construction

6.1 General

6.1.1 An enclosure shall completely enclose all live parts that may be housed in it.

6.1.2 All enclosures, other than those designed to be free standing or those designed for a specific installation, such as a cast-metal box intended to be installed in poured concrete, shall be provided with means for mounting.

6.1.3 Any part that is not required in order to comply with the requirements in this standard and does not serve to maintain the mechanical, electrical, or environmental integrity of the enclosure need not comply with the requirements of this standard.

6.1.4 An enclosure, frame, or similar device shall not have accessible edges that are sharp or pointed such that they constitute a risk of injury to persons during normal installation, maintenance, and use, unless:

- a) Accessible edges are protected by guards or the use of handles to minimize access to sharp edges or points, or
- b) An accessible edge or portion of an accessible edge is required to be sharp in order to perform a working function, or
- c) If it is possible to avoid the hazard through proper procedures, then signs, labels or the manufacturer's instructions shall describe the procedure to avoid the hazard during installation, maintenance, and use.

When considering sharp edges and points, all stages of the installation process shall be considered.

6.1.5 Whenever reference measurements are necessary to determine that a part as mentioned in [6.1.4](#) is not sufficiently sharp to constitute a risk of injury to persons, the method described in Annex B, Ref. No. 9, shall apply. In Canada, [6.1.5](#) shall not apply.

6.1.6 An enclosure shall have the necessary strength and rigidity to maintain its shape so that doors will close tightly.

6.1.7 Metal into which screws are threaded shall provide for the engagement of at least two full threads, other than as permitted by [6.1.8](#). Sheet metal shall be permitted to be extruded at a tapped hole to give the thickness necessary for two full threads if the original thickness is not less than the pitch of the thread. Rivets, screws, bolts, and similar fastenings in a sheet-metal enclosure shall have a diameter at least 50 percent greater than the thickness of the finished sheet metal with which they are used.

6.1.8 The following combinations of minimum number of threads and minimum thickness steel shall be considered acceptable:

- a) 32 threads per 25.4 mm (32 threads per inch) installed in 1.35 mm (0.053 in);
- b) 28 threads per 25.4 mm (28 threads per inch) installed in 1.70 mm (0.067 in);

- c) 24 threads per 25.4 mm (24 threads per inch) installed in 2.03 mm (0.080 in);
- d) 20 threads per 25.4 mm (20 threads per inch) installed in 2.36 mm (0.093 in);
- e) 18 threads per 25.4 mm (18 threads per inch) installed in 2.74 mm (0.108 in); and
- f) 16 threads per 25.4 mm (16 threads per inch) installed in 3.12 mm (0.123 in).

6.1.9 A fastener for use with a conventional screw, other than a tapped hole or nut, shall be acceptable if it has the necessary mechanical strength and is otherwise acceptable for the application.

6.1.10 Other than the following items, both the inside and outside surfaces of an enclosure made of ferrous material shall be protected against corrosion as specified in 7.2 of Annex [B](#), Ref. No. 15:

- a) Bearings, sliding surfaces of a hinge or shaft, and the like, located on the exterior of enclosures;
- b) Sheared or cut edges and punched holes of galvanized sheet steel; and
- c) Parts such as a decorative grille, and the like, that are not required to form part of the enclosure.

6.2 Observation windows

6.2.1 A material used for an observation window and forming a part of the enclosure shall be reliably secured in such a manner that it cannot be readily displaced in service in accordance with [6.2.5](#) or [6.2.6](#) and shall provide mechanical protection of the enclosed parts, in accordance with [6.2.2](#) or [6.2.4](#).

6.2.2 Except as permitted by [6.2.3](#), glass used for an observation window not more than 102 mm (4 inches) in any dimension and not less than 1.40 mm (0.055 inch) thick or glass used for an observation window having no dimension greater than 305 mm (12 inches) and not less than 2.92 mm (0.115 inch) thick need not be subject to additional evaluation. Glass used to cover a larger opening shall comply with the Crushing resistance test (see [8.10](#)) and Resistance to impact (normal only) test specified in Annex [B](#), Ref. No. 1.

6.2.3 For glass made of clear safety type or wire-reinforced type designated AS2 to ANSI Z26.1, [6.2.2](#) does not apply.

6.2.4 A polymeric material used as an observation window shall comply with the requirements of [6.6](#).

6.2.5 In the United States, a material used for an observation window shall be mechanically secured or shall be secured using an adhesive complying with the adhesive requirements specified in Annex [B](#), Ref. No. 16, or Annex [E](#).

6.2.6 In Canada, a material used for an observation window shall be mechanically secured or shall be secured using an adhesive complying with Annex [E](#).

6.3 Openings

6.3.1 General

6.3.1.1 Other than as covered in [6.3.1.2](#), openings provided in any enclosure type shall comply with the applicable tests in Annex [B](#), Ref. No. 15, with these openings unfilled.

6.3.1.2 Openings in accordance with [6.3.2](#), [6.3.4](#), and [6.3.5](#) shall be appropriately filled to maintain the environmental integrity of the enclosure.

6.3.2 Equipment openings

6.3.2.1 Enclosures may be provided with openings that are intended to be closed by field installed equipment (such as pushbutton switches, door latches, etc.) if these enclosures are marked in accordance with [7.7](#).

6.3.2.2 Openings that comply with [Table 6.1](#) do not require the enclosures to be marked in accordance with [7.7](#).

Table 6.1
Equipment-Mounting Holes

Maximum linear dimension of enclosure mm (inch)	Area of largest surface of enclosure mm ² (square inch)	Maximum total area of holes mm ² (square inch)	Maximum area of any one hole mm ² (square inch)
457 (18)	87 000 (135)	193 (0.30)	45.2 (0.07)
Over 457 (18)	Over 87 000 (135)	335 (0.52)	83.9 (0.13)

6.3.3 Ventilation

6.3.3.1 Ventilated enclosures shall comply with NMX-J-235/2-ANCE/CSA C22.2 No. 94.2/UL 50E, 7.3.5.1.

6.3.4 Mounting openings

6.3.4.1 For Type 1, 2, 3R, 3RX, or 5 enclosures, mounting means may be provided internal to the equipment cavity if the mounting openings comply with [Table 6.2](#).

6.3.4.2 If mounting openings other than as noted in [Table 6.2](#) are provided in Type 1, 2, 3R, 3RX, or 5 enclosures, instructions shall be included with the enclosure that indicate how to maintain the environmental integrity of the enclosure when mounted.

Table 6.2
Enclosure-Mounting Holes

Maximum linear dimension of enclosure mm (inches)	Area of largest surface of enclosure mm ² (square inch)	Maximum number of holes	Maximum total area of holes mm ² (square inches)
178 (7)	20 600 (32)	4	774 (1.2)
457 (18)	87 000 (135)	6	774 (1.2)
1020 (40)	254 000 (1 000)	6	970 (1.5)
Over 1020 (40)	Over 254 000 (1 000)	8	1 290 (2.0)

6.3.4.3 Mounting openings for enclosures constructed from a polymeric material shall additionally comply with [6.6.5](#). Mounting openings requirements for enclosure Types 3, 3X, 3S, 3SX, 4, 4X, 6, 6P, 12, 12K, and 13 are in 7.3.4 of Annex [B](#), Ref. No. 15.

6.3.5 Breakouts, knockouts and conduit openings

6.3.5.1 All breakouts, knockouts, and conduit openings shall comply with [6.10](#).



6.3.5.2 A Type 12 enclosure shall not contain breakouts or knockouts but may have conduit openings if these openings comply with [6.10](#).

6.3.6 Additional openings

6.3.6.1 A Type 1 enclosure may be provided with no more than four additional openings for the escape of air or for the drainage of paint during the painting process and the like. The size of these openings shall be no larger than two 3.2 by 3.2 mm (1/8 by 1/8 inch) openings and two 6.4 by 6.4 mm (1/4 by 1/4 inch) openings for enclosures not more than 457 mm (18 inches) long or wide in which the largest surface does not exceed 87,100 mm² (135 in²). In a larger enclosure, an opening shall not be larger than 6.4 by 6.4 mm (1/4 by 1/4 inch).

6.4 Sheet metal enclosures

6.4.1 Thickness

6.4.1.1 Other than as permitted by [6.4.1.2](#), a box shall not be thinner than specified in [Table 6.3](#) or [Table 6.4](#).

Table 6.3
Thickness of Sheet Metal for Boxes, Steel

Without supporting frame		With supporting frame or equivalent reinforcing		Minimum thickness ^c
Maximum width ^a	Maximum length ^b	Maximum width ^a	Maximum length ^b	
mm (inches)	mm (inches)	mm (inches)	mm (inches)	mm (inch)
457 (18.0)	Not limited	686 (27.0)	Not limited	1.35 (0.053)
508 (20.0)	635 (25.0)	737 (29.0)	914 (36.0)	
559 (22.0)	Not limited	838 (33.0)	Not limited	1.52 (0.060)
635 (25.0)	787 (31.0)	889 (35.0)	1092 (43.0)	
635 (25.0)	Not limited	991 (39.0)	Not limited	1.70 (0.067)
737 (29.0)	914 (36.0)	1041 (41.0)	1295 (51.0)	
838 (33.0)	Not limited	1295 (51.0)	Not limited	2.03 (0.080)
965 (38.0)	1194 (47.0)	1372 (54.0)	1676 (66.0)	
1067 (42.0)	Not limited	1626 (64.0)	Not limited	2.36 (0.093)
1194 (47.0)	1499 (59.0)	1727 (68.0)	2134 (84.0)	
1321 (52.0)	Not limited	2032 (80.0)	Not limited	2.74 (0.108)
1524 (60.0)	1880 (74.0)	2134 (84.0)	2616 (103.0)	
1600 (63.0)	Not limited	2464 (97.0)	Not limited	3.12 (0.123)
1844 (73.0)	2286 (90.0)	2616 (103.0)	3226 (127.0)	

^a The smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^b "Not limited" applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

^c The minimum thickness refers to the base material and does not include a coating thickness.

Table 6.4
Minimum Thickness of Sheet Metal for Boxes – Aluminum, Copper, or Brass

Without supporting frame		With supporting frame or equivalent		Minimum thickness
Maximum width ^a	Maximum length ^b	Maximum width ^a	Maximum length ^b	
mm (inches)	mm (inches)	mm (inches)	mm (inches)	mm (inch)
457 (18.0)	Not limited	1067 (42.0)	Not limited	1.91 (0.075)
508 (20.0)	635 (25.0)	1143 (45.0)	1397 (55.0)	
635 (25.0)	Not limited	1524 (60.0)	Not limited	2.41 (0.095)
737 (29.0)	914 (36.0)	1626 (64.0)	1981 (78.0)	
940 (37.0)	Not limited	2210 (87.0)	Not limited	3.10 (0.122)
1067 (42.0)	1346 (53.0)	2362 (93.0)	2896 (114.0)	
1321 (52.0)	Not limited	3124 (123.0)	Not limited	3.89 (0.153)
1524 (60.0)	1880 (74.0)	3302 (130.0)	4064 (160.0)	

^a The smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^b "Not limited" applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

6.4.1.2 A box without a supporting frame may be thinner than required by [6.4.1.1](#) if it complies with the Deflection test described in [8.1](#), but it shall not be less than 1.35 mm (0.053 inch) excluding any coating.

6.4.1.3 A supporting frame shall be formed of angles, channels, folded rigid sections of sheet metal, or the equivalent, rigidly fastened together and having essentially the same outside dimensions as the surfaces of the enclosure. A construction shall not be considered to have a supporting frame if it is:

- a) A single sheet with single formed flanges (formed edges);
- b) A single sheet that is corrugated or ribbed; or
- c) An enclosure formed or fabricated from sheet metal.

6.4.2 Joints and fastenings

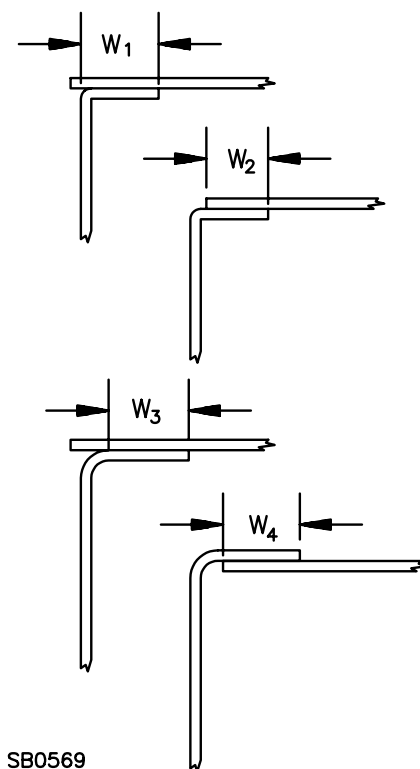
6.4.2.1 All seams, joints, or splices at corners or back edges of an enclosure shall be closed by:

- a) Overlapping flanges formed of sheet metal from which the enclosure is made;
- b) Metal surfaces overlapping adjacent surfaces or supporting frame;
- c) Separate overlapping flanges; or
- d) Continuous welding that provides a construction equivalent to an integral-flanged construction.

6.4.2.2 The overlap required by [6.4.2.1](#) shall be at least 11.1 mm (7/16 inch) and shall extend approximately the full length of the seam. See [Figure 6.1](#).

Figure 6.1

Overlap Between Flat Cover and Enclosure Flange and at Corner or Enclosure Seam



SB0569

The figure illustrates the method of determining the amount of contact between a flat cover and a flanged enclosure wall and the amount of overlap at a corner or enclosure seam. If the radius of the flange bend is small, the flange width and overlap is considered to be W_1 , or W_2 , depending upon the actual construction, and shall not be less than 11.1 mm (7/16 inch). If the radius of the flange bend is excessive or if the flat sheet is on the inside of the flange, the overlap, W_3 , or W_4 , shall be measured over only that portion where the two pieces of metal are actually in contact with each other, and shall not be less than 11.1 mm (7/16 inch).

NOTE: To determine whether a telescoping cover complies with the requirement in [6.7.6.3](#), the cover shall be in its normally closed position, and a mark shall be scribed on all walls of the enclosure along the edge of the flange. The overlap is the measured distance, W , between the scribed marks and the edges of the enclosure walls, as illustrated. In scribing the marks, the cover shall be held in a fixed position so as to prevent displacement of the cover by the scribing tool, but without bending or distorting any portion of the enclosure, the cover, or other part of the enclosure.

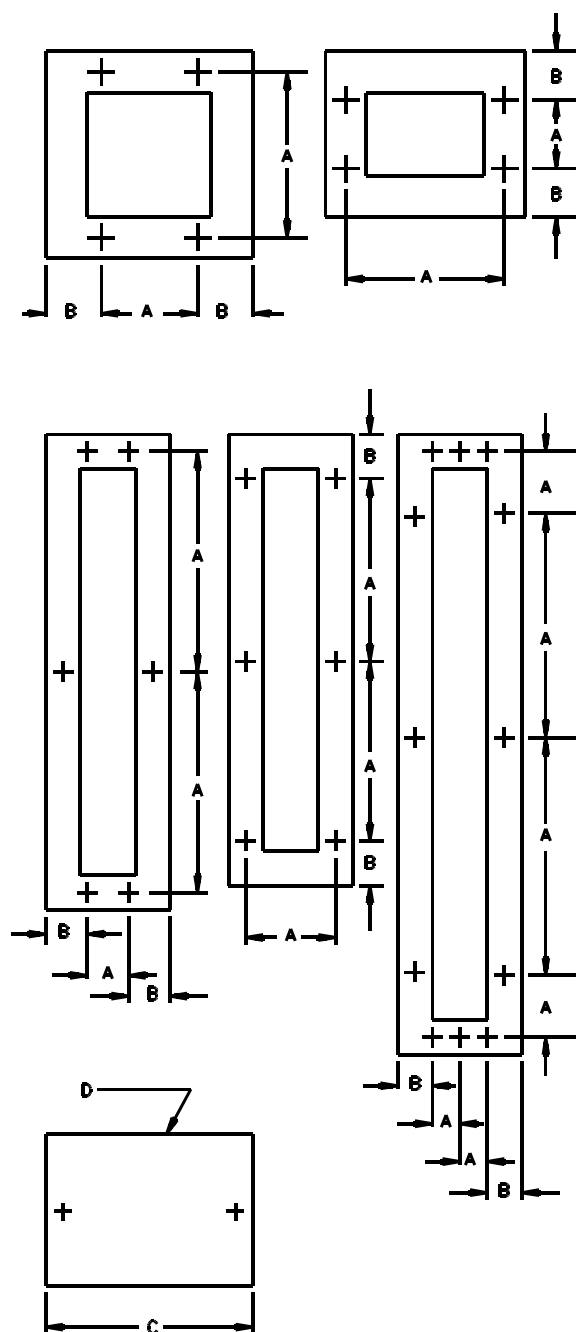
6.4.2.3 A flange joining adjacent sides, including top and bottom, of an enclosure shall have at least one fastening for each 76.2 mm (3 inches), or fraction thereof, of enclosure depth. One such fastening shall be located not more than 38.1 mm (1-1/2 inches) from the front edge of the enclosure.

6.4.2.4 An enclosure having integral flanges and not over 102 mm (4 inches) deep shall be permitted to employ a single fastening at each front corner of the enclosure to secure adjacent sides, including top and bottom.

6.4.2.5 A flange at the back edge of an enclosure shall have fastenings located not more than 38.1 mm (1-1/2 inches) from each end and not more than 152 mm (6 inches) apart.

6.4.2.6 For an enclosure employing a metal supporting frame, the fastenings securing a metal surface to the frame shall comply with [6.7.3](#) and [Figure 6.2](#) and [Figure 6.3](#).

Figure 6.2
Permissible Locations of Fastenings



SC0690

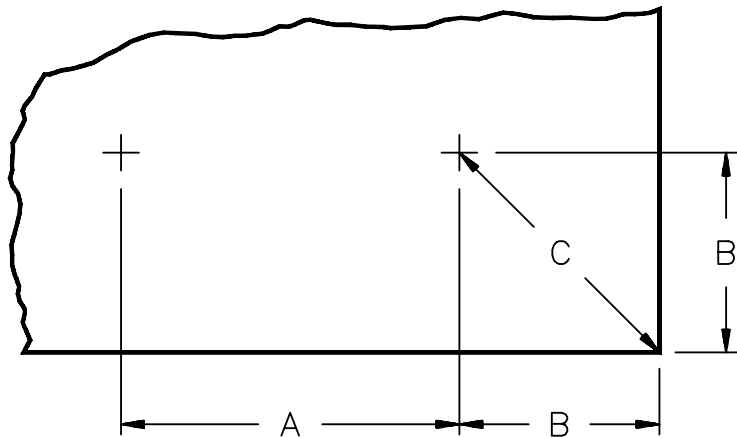
A – 610 mm (24 inches)

B – 152 mm (6 inches) maximum (from corner of box)

C – 216 mm (8-1/2 inches) maximum

D – 32 900 mm² (51 square inches) maximum area (cover)

Figure 6.3
Permissible Locations of Fastenings



SA0686A

A – 610 mm (24 inches) maximum

B – 152 mm (6 inches) maximum (from edge of enclosure)

C – 216 mm (8-1/2 inches) maximum

Note: 32 900 mm² (51 square inches) maximum area (cover)

6.4.2.7 A separate flange shall not have less than two fastenings on each side of a seam.

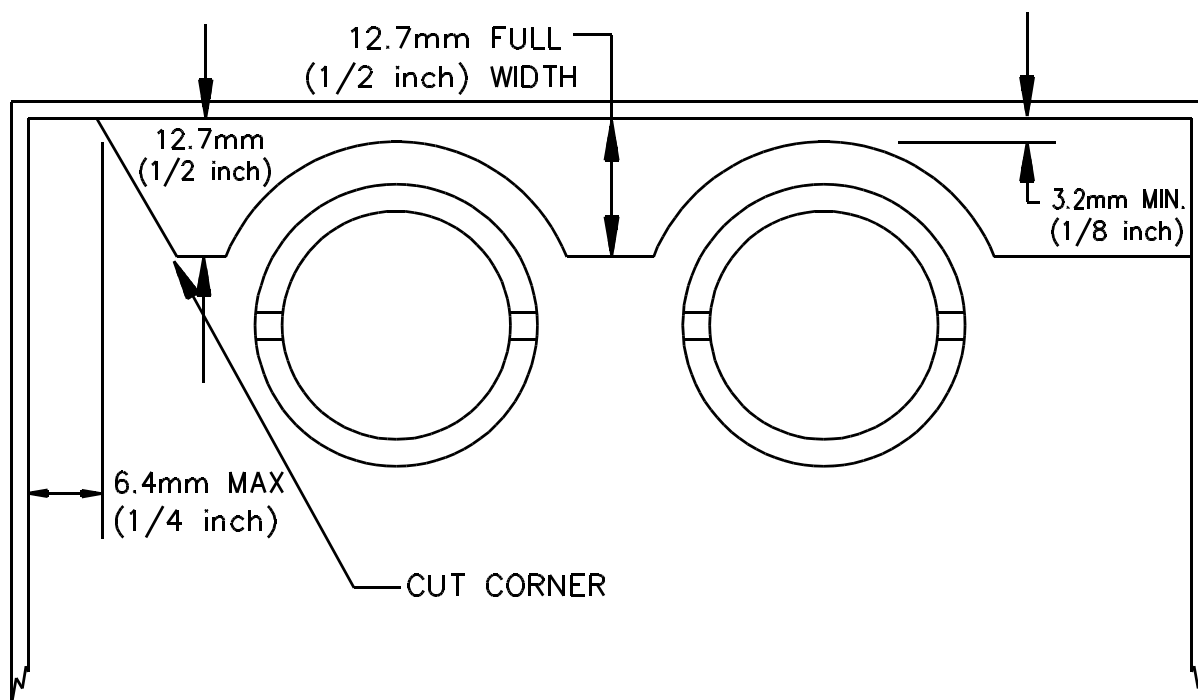
6.4.2.8 With reference to the requirements in [6.4.2.3](#) to [6.4.2.6](#), rivets, welds, bolts and screws having machine-screw threads shall be acceptable forms of fastenings.

6.4.3 Notches

6.4.3.1 A flange shall be permitted to be notched to accommodate knockouts and breakouts, as illustrated in [Figure 6.4](#) under the following conditions:

- No individual notch shall be larger than is necessary to accommodate a conduit bushing corresponding in size to the adjacent knockout and breakout;
- Each notch shall be circular and approximately concentric with the center of the knockout or breakout;
- Notches shall be permitted to overlap each other only if the width of the flange between them is not reduced to less than 12.7 mm (1/2 inch); and
- The flange width between any notch and the inside wall of the enclosure shall not be less than 3.2 mm (1/8 inch).

Figure 6.4
Notched Flange Construction



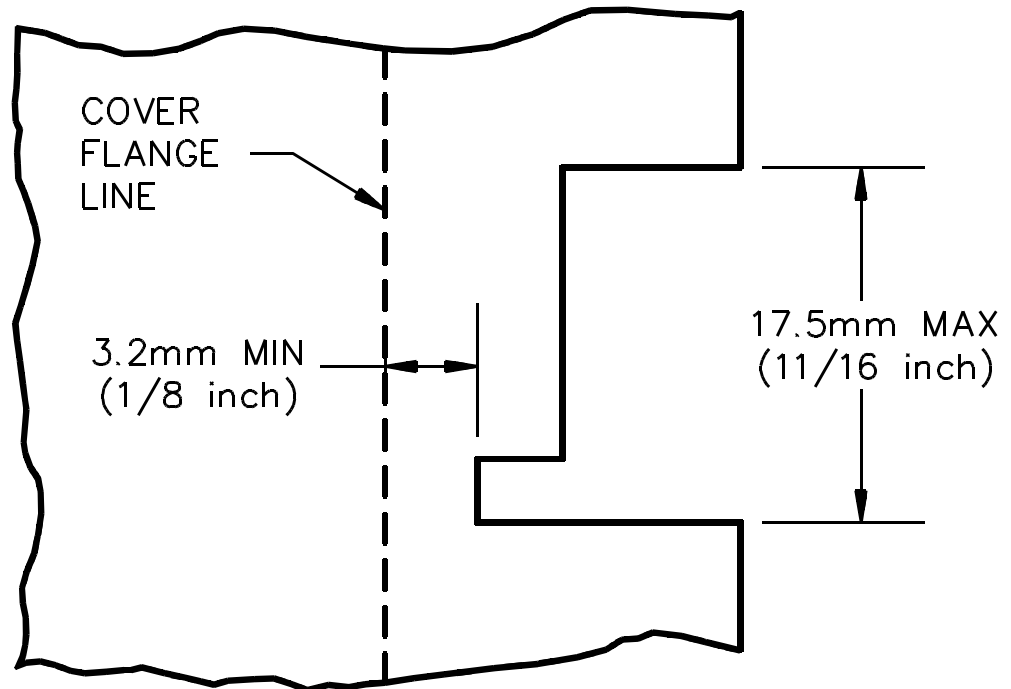
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6.4.3.2 The bottom end of a corner flange shall be permitted to be cut away at an angle to facilitate forming.

6.4.3.3 The front edge of each of the two side walls of an enclosure may have one notch for each enclosure door, for the purpose of holding the door in the open position, when the construction complies with [6.4.3.4](#) or [6.4.3.5](#).

6.4.3.4 The notch shall not be more than 17.5 mm (11/16 inch) wide, and the flange of the closed door shall overlap the deepest edge of the notch by at least 3.2 mm (1/8 inch). See [Figure 6.5](#).

Figure 6.5
Notch for Holding Cover Open



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6.4.3.5 The notch size limitation, the minimum cover flange overlap, or both do not apply to a notch located behind a fixed side flange, such as a hood, that overlaps the notch by at least 3.2 mm (1/8 inch), and if the space between adjacent surfaces of the fixed side flange and the side of the enclosure is not more than 3.2 mm (1/8 inch) plus the thickness of the cover flange metal. See [Figure 6.6](#).