



Standard Specification for Intrusion Resistant Generic Vault Structures¹

This standard is issued under the fixed designation F 1247; 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.

^{ε1} NOTE—Section 12, Keywords, was added editorially in August 1996.

1. Scope

1.1 This specification is for the use and guidance of those who purchase, design, construct, install, approve, or modify generic vault structures intended for protection of valuables against loss due to forced entry.

1.2 This specification includes the descriptions of terms, classifications, materials, practices, and methods to be followed in constructing, fabricating, or modifying intrusion resistant generic vaults.

1.3 This specification does not address fire resistivity, nor does it address modular panels.

1.4 This specification is not intended to prevent the use of systems, methods, or devices that provide a level of intrusion resistance equivalent or better than that prescribed herein. Any system, method, or device different from that detailed herein may be examined, in accordance with the intent of this specification, and if found to be equivalent or better, may be included.

1.5 Nothing in this specification shall be construed to prohibit better or safer conditions than the requirements specified herein.

1.6 Materials and construction details outlined in this specification are intended to detail protective requirements necessary to achieve the required level of intrusion resistance, and are not intended to address structural soundness or operational fitness, areas for which the project engineer, architect, or equipment supplier are responsible.

1.7 Each referenced document cited in Section 2 shall be meant to be the edition in effect on the date this specification was published.

NOTE 1—A rationale is given in Appendix X1.

1.8 The values stated in inch-pound units are to be regarded as the standard. The SI values in parentheses are given for information purposes only.

¹ This specification is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.80 on Protective Containment Structures.

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1.9 The following precautionary statement pertains to the test method portion only, Section 9, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

A 184/A184M Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement²

A 615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement²

A 635 Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled³

F 1090 Classification for Bank and Mercantile Vault Construction⁴

2.2 Underwriters Laboratories Inc. Standards:⁵

ANSI/UL608 Standard for Burglary Resistant Vault Doors and Modular Panels

ANSI/UL680 Standard for Emergency Vault Ventilators and Vault Ventilating Ports

2.3 American Concrete Institute Standards:⁶

ACI 318 Building Code Requirements for Reinforced Concrete

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *bar support*—any factory fabricated product, such as chairs, ladders, bolsters, and spacers, that are designed to hold, a specific distance apart, deformed steel bars and expanded steel bank vault mesh in preparation for concrete pouring.

² Annual Book of ASTM Standards, Vol 01.04.

³ Annual Book of ASTM Standards, Vol 01.03.

⁴ Annual Book of ASTM Standards, Vol 15.07.

⁵ Available from Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

⁶ Available from American Concrete Institute, Box 19150, Redford Station, Detroit, MI 48219.

3.1.2 *classification*—a systematic rating of products, based on testing, in accordance with Classification F 1090.

3.1.3 *component*—a part of the enclosure.

3.1.4 *devices*—components of a vault, except the walls, floor, and ceiling, that are integral parts of the vault, such as doors, emergency ventilators, or transfer systems, or all of the above.

3.2 *door, vault*—a movable barrier assembly constructed of intrusion resistant materials by which a passageway is closed or opened.

3.3 *emergency ventilator*—an assembly constructed of intrusion-resistant materials for the introduction of fresh air.

3.4 *enclosure*—to include the walls, floor, ceiling, and devices of the vault.

3.5 *equivalent*—a term applied to two or more methods, procedures, materials, devices, etc., expected to give the same average results.

3.6 *fastening*—the connection or attachment, or both, of a device within its intended opening.

3.7 *forced entry*—an entry by destructive means.

3.8 *generic construction*—commonly available construction materials not protected by trademark registration.

3.9 *heating, ventilating, and air conditioning (HVAC) port*—an assembly constructed of intrusion-resistant materials providing an opening for the intake or exhaust of air.

3.10 *intrusion resistant*—constructed to prevent a successful penetration by means and techniques as described in ANSI/UL 608.

3.11 *manhole size opening*—a 96 in. ²(620 cm²) opening, the smallest dimension of which is not less than 6 in. (15 cm).

3.12 *modify*—any change in the design or construction of a vault.

3.13 *modular panel*—wall, floor, or ceiling components, manufactured of intrusion resistant material, that are intended for assembly at the place of use and that are capable of being disassembled and relocated.

3.14 *monolithic*—an enclosure formed or composed of materials without “true” joints or seams, excepting “cold” concrete seams necessitated by construction technique.

3.15 *prefabrication*—a generic vault constructed at a site other than the location of its intended use.

3.16 *snap (form) ties*—any factory-fabricated adjustable-length snap off or removable metal tie designed to prevent form deflection and spalling concrete surfaces on removal.

3.17 *vault*—an intrusion resistant enclosure, intended for the safekeeping of valuables, and sized to allow entry by at least one person.

3.18 *vault ventilator*—see **emergency ventilator**.

3.19 *walls*—see **enclosure**.

4. Classification

4.1 The vault shall be rated as a unit and that rating shall be determined by the component having the lowest classification. The walls, floor, and ceiling of a vault shall be formed or composed of materials without “true” joints or seams, with the exception of “cold” concrete seams necessitated by construction technique.

4.2 Components of a building shall not be used as part of the vault unless constructed to provide the equivalent intrusion resistance.

4.3 The vault enclosure shall be classified in accordance with Classification F 1090 as Type M, Type 1, Type 2, or Type 3.

4.3.1 *Type M Vault*—Construct Type M vault as follows:

4.3.1.1 Use 9 in. (23 cm) reinforced concrete, as specified in 6.3-6.3.2.2, and

4.3.1.2 Use vault door(s) bearing the label: “Underwriters Laboratories Inc. Burglary Resistant Vault Door, Class M,” (see ANSI/UL 608).

4.3.2 *Type 1 Vault*—Construct Type 1 vault as follows:

4.3.2.1 Use 12 in. (30 cm) reinforced concrete, as specified in 6.4-6.4.2.2, and

4.3.2.2 Use vault door(s) bearing the label: “Underwriters Laboratories Inc. Burglary Resistant Vault Door, Class 1,” (see ANSI/UL 608).

4.3.3 *Type 2 Vault*—Construct Type 2 vault as follows:

4.3.3.1 Use 18 in. (46 cm) reinforced concrete, as specified in 6.5-6.5.2.3, and

4.3.3.2 Use vault door(s) bearing the label: “Underwriters Laboratories Inc. Burglary Resistant Vault Door, Class 2,” (see ANSI/UL 608).

4.3.4 *Type 3 Vault*—Construct Type 3 vault as follows:

4.3.4.1 Use 27 in. (68 cm) reinforced concrete as specified in 6.6-6.6.2.4, and

4.3.4.2 Use vault door(s) bearing the label: “Underwriters Laboratories Inc. Burglary Resistant Vault Door, Class 3,” (see ANSI/UL 608).

5. Materials and Manufacture

5.1 The materials used in the construction of the vault shall meet the minimum requirements as specified in 5.2-5.8.

5.2 *Concrete*—Concrete shall develop an ultimate compression strength of at least 4000 lbs/in.² [4000 psi (281 kg/cm²)] at 28 days, in accordance with ACI 318.

5.3 *Concrete Reinforcement*—Concrete used for the vault shall be reinforced using the following materials:

5.3.1 Deformed steel bars, (see Specification A 615/A 615M), number five (#5) Imperial type or number fifteen (#15) metric type (⁵/₈ in. (16 mm) diameter, Grade 40), or

5.3.2 Expanded steel bank vault mesh, (see Specification A 635) weighing at least 6 lbs/ft² (30 kg/m²) and having a diamond pattern not more than 3 by 8 in. (8 by 20 cm).

5.4 Spacing between reinforcing grids within (horizontal) ceilings and floors shall be accomplished with the use of bar supports. The use of concrete bricks and blocks or other solid objects shall be prohibited.

5.5 Spacing between reinforcing grids in (vertical) walls shall be accomplished by wire tying-off to spacers or snap ties. The portion of the tie remaining within the concrete after removal shall be 1 to 1½ in. (25 to 38 mm) inside the concrete, and shall not leave holes larger than 1 in. (25 mm) diameter in the concrete surface.

5.6 *Conduit and Other Piping*—Conduit and other piping shall be rigid and uninterrupted, and shall not exceed 1½ in. (38 mm), outside diameter.

5.7 Devices shall have, as a minimum, the equivalent classification as the vault enclosure, in accordance with ANSI/UL 608 and ANSI/UL 680.

5.8 *Grout*—Grout shall be a high-strength, non-shrink, epoxy-based patching material, at least fifty percent (50 %) greater in strength (psi) to the concrete used in the vault enclosure.

6. Dimensions, Mass, and Permissible Variations

6.1 Use of the vault enclosure as a building component shall not diminish the intrusion resistance of the vault.

6.2 *Grids*—Place deformed steel bars as follows:

6.2.1 In vault walls, space 4 in. (10 cm) on center in horizontal and vertical rows, that are parallel to the faces of the wall, to form a grid. The horizontal rows in a wall shall be continuous with or spliced to those in adjacent walls.

6.2.2 In vault floors and ceilings, space 4 in. (10 cm) on center in horizontal rows, that are perpendicular to each other and parallel to the faces of the ceiling or floor, to form a grid. The grids in the ceiling and floor shall be continuous with, or spliced to, the vertical rows in the walls.

6.2.3 Expanded steel bank vault mesh shall be placed parallel to the face of the wall, floor, or ceiling. The grids of expanded steel mesh in the walls shall be continuous with or spliced to the grids of expanded steel mesh in the ceiling, floor, and adjacent walls.

6.3 *Type M*—Construct the vault of reinforced concrete at least 9 in. (23 cm) thick.

6.3.1 Provide two grids of reinforcing bars in a staggered manner with the second grid offset 2 in. (5 cm) on center in two directions from the first grid, as shown in Fig. X3.1.

6.3.1.1 The first grid shall be 2 in. (5 cm) from the outer face of the concrete as measured to the center line of the grid.

6.3.1.2 The second grid shall be spaced 5 in. (13 cm) on center from the first grid; or

6.3.2 Provide two grids of expanded steel mesh in a staggered manner with the second grid offset 1½ in. (38 mm) short way of diamond (swd) from the first grid, as shown in Fig. X3.2.

6.3.2.1 The first grid shall be 2 in. (5 cm) from the outer face of the concrete as measured to the center line of the grid.

6.3.2.2 The second grid shall be spaced 5 in. (13 cm) on center from the first grid.

6.4 *Type I*—Construct the vault of reinforced concrete at least 12 in. (30 cm) thick.

6.4.1 Provide three grids of reinforcing bars in a staggered manner with successive grids offset 1½ in. (33 mm) on center in the same two directions as the offset on the preceding grid, as shown in Fig. X3.3.

6.4.1.1 The first grid shall be 2 in. (5 cm) from the outer face of the concrete as measured to the center line of the grid.

6.4.1.2 The second grid shall be spaced 4 in. (10 cm) on center from the first grid.

6.4.1.3 The third grid shall be spaced 4 in. (10 cm) on center from the second grid; or

6.4.2 Provide two grids of expanded steel mesh in a staggered manner with the second grid offset 1½ in. (38 mm) short way of diamond (swd) from the first grid, as shown in Fig. X3.2.

6.4.2.1 The first grid shall be 2½ in. (6 cm) from the outer face of the concrete as measured to the center line of the grid.

6.4.2.2 The second grid shall be spaced 7 in. (18 cm) on center from the first grid.

6.5 *Type 2*—Construct the vault of reinforced concrete at least 18 in. (6 cm) thick.

6.5.1 Provide four grids of reinforcing bars in a staggered manner with successive grids offset 1 in. (25 mm) on center in the same two directions as the offset on the preceding grid, as shown in Fig. X3.4.

6.5.1.1 The first grid shall be 2 in. (5 cm) from the outer face of the concrete as measured to the center line of the grid.

6.5.1.2 The second grid shall be spaced 5 in. (13 cm) on center from the first grid.

6.5.1.3 The third grid shall be spaced 4 in. (10 cm) on center from the second grid.

6.5.1.4 The fourth grid shall be spaced 5 in. (13 cm) on center from the third grid; or

6.5.2 Provide three grids of expanded steel mesh in a staggered manner with successive grids offset 1 in. (25 mm) short way of diamond (swd) from the adjacent grid, as shown in Fig. X3.5.

6.5.2.1 The first grid shall be 2 in. (5 cm) from the outer face of the concrete as measured to the center line of the grid.

6.5.2.2 The second grid shall be spaced 7 in. (18 cm) on center from the first grid.

6.5.2.3 The third grid shall be spaced 7 in. (18 cm) on center from the second grid.

6.6 *Type 3*—Construct the vault of reinforced concrete at least 27 in. (69 cm) thick.

6.6.1 Provide five grids of reinforcing bars in a staggered manner with successive grids offset ¼ in. (2 cm) on center in the same two directions as the offset on the preceding grid, as shown in Fig. X3.6.

6.6.1.1 The first grid shall be 2 in. (5 cm) from the outer face of the wall as measured to the center line of the grid.

6.6.1.2 The second grid shall be spaced 5½ in. (14 cm) on center from the first grid.

6.6.1.3 The third grid shall be spaced 6 in. (15 cm) on center from the second grid.

6.6.1.4 The fourth grid shall be spaced 6 in. (15 cm) on center from the third grid.

6.6.1.5 The fifth grid shall be spaced 5½ in. (14 cm) on center from the fourth grid; or

6.6.2 Provide four grids of expanded steel mesh in a staggered manner with successive grids offset ¾ in. (2 cm) short way of diamond (swd) from the adjacent grid, as shown in Fig. X3.7.

6.6.2.1 The first grid shall be 3 in. (8 cm) from the outer face of the wall and measured to the center line of the grid.

6.6.2.2 The second grid shall be spaced 7 in. (18 cm) on center from the first grid.

6.6.2.3 The third grid shall be spaced 7 in. (18 cm) on center from the second grid.

6.6.2.4 The fourth grid shall be spaced 7 in. (18 cm) on center from the third grid.

6.7 Permissible openings in vaults shall be as follows:

6.7.1 Doors as specified in 4.3.

6.7.2 Underwriters Laboratories Inc. Listed Emergency Vault Ventilators or Vault Ventilating (HVAC) Ports, (see ANSI/UL 680).

6.7.3 Conduit entries and exits shall not be within 18 in. (46 cm) of each other. Conduit penetrating the vault walls shall have at least two bends within the wall and entry in the outer face shall be at least equal radial inches apart from exit in the inner face, as the thickness of the wall it penetrates. Arrange bends so that their slope is to the exterior of the vault.

6.8 The installation and fastening of a door, ventilator, or port shall be in accordance with the manufacturer's written, or illustrated, installation instructions. The fastening of a door, ventilator, or port shall be designed to maintain the integrity of the vault.

6.9 Recesses into either the interior or exterior faces of the enclosure shall be permitted, provided that they do not decrease the specified thickness of the vault enclosure.

6.10 Design keys so as not to reduce the integrity of the vault.

7. Workmanship, Finish, and Appearance

7.1 Site preparation for the vault shall be in accordance with Test Method D 1557.

NOTE 2—See Appendix X2 for additional recommendations.

7.2 Penetrations:

7.2.1 All openings shall be in accordance with the requirements given in Section 6.

7.2.2 Install conduit and pipe in accordance with ACI 318.⁷

7.3 Reinforcing:

7.3.1 All reinforcing shall be in accordance with ACI 318.⁸

7.3.2 All reinforcing materials shall be in accordance with Specification A 615/A 615M and Specification A 635.

7.3.3 If used, steel bar mats shall be installed in accordance with Specification A 184/A 184M.

7.3.4 Chairs used to maintain each horizontal reinforcing grid the specified distance from either the form work or each other, shall be continuous. Concrete blocks or other solid objects shall be prohibited.

7.3.5 Standard hooks shall have 90° bends, 4 in. (10 cm) on center from grid to grid. Install the hooks in accordance with ACI 318.⁹

7.3.6 The installed reinforcement system shall be inspected by the owner's representative prior to concrete placement.

7.4 Concrete quality shall be in accordance with ACI 318.¹⁰

7.4.1 The design mix shall contain a ratio of 40 % clean, fine sand to 60 % coarse aggregate, maximum size of ¾ in. (2 cm) diameter.

NOTE 3—See Appendix X2.2 for additional recommendations for the design mix.

7.5 Mixing and Placing Concrete:

7.5.1 Concrete shall be mixed and placed in accordance with ACI 318.¹¹

7.5.2 There shall be minimal vibration activity to prevent concrete segregation.

7.5.3 The walls, floor, and ceiling of the vault shall be formed or composed of materials without "true" joints or seams, with the exception of "cold" concrete seams necessitated by construction technique.

7.5.4 Interruptions in the pour that cause cold joints shall be interlocked or overlapped to prevent a straight-through seam.

7.6 Formwork:

7.6.1 All formwork shall be in accordance with ACI 318.⁷

7.6.2 After removal of forms, the enclosure shall be inspected by the owner's representative before any finishing procedures.

7.7 Finishing:

7.7.1 The finishing procedure shall not reduce the integrity of the vault structure.

7.7.2 Honeycombs, voids, form tie holes, etc. shall have surfaces roughed, cleaned, and filled with high-strength patching material.

7.7.3 Honeycombs in excess of ¾ in. (2 cm) depth over a 96 in.² (619 cm²) area shall be tested by an independent concrete testing laboratory acceptable to the owner's representative.

7.8 Curing:

7.8.1 Curing during cold weather shall be in accordance with ACI 318.¹²

7.8.2 Curing during hot weather shall be in accordance with ACI 318.¹³

7.9 Grouting—Place the grouting material to continuously fill all voids.

8. Significance and Use

8.1 This specification provides guidelines for the selection of a generic vault, in accordance with its intended use.

8.2 This specification is intended to assist users in availing themselves of various generically constructed products, while maintaining consistency with their selected intrusion-resistance level.

8.3 This specification is not meant to recommend or prefer the use of any single product, any type level, or its application.

9. Test Methods

9.1 Test the materials and concrete used to construct the vault for specified quality in order to meet the specifications.

9.1.1 Conduct the tests in accordance with ACI 318.¹⁴

9.1.2 Transmit records of all tests to the owner for permanent keeping.

10. Rejection and Rehearing

10.1 Vaults that fail to conform with the requirements of this specification may be rejected by the owner. Rejection should be reported to the producer or supplier promptly and in writing.

⁷ See Chapter 6, "Formwork, Embedded Pipes, and Construction Joints."

⁸ See Chapter 7, "Details of Reinforcement."

⁹ See Chapter 7, Section 6.1, "Standard Hooks."

¹⁰ See Chapter 4, "Concrete Quality."

¹¹ See Chapter 5, "Mixing and Placing Concrete."

¹² See Chapter 5, Section 5.6, "Cold Weather Requirements."

¹³ See Chapter 5, Section 5.6, "Hot Weather Requirements."

¹⁴ See Chapter 3, Section 3.1, "Tests of Materials."

10.2 In case of dissatisfaction with the result of the test, the producer or supplier may request a rehearing.

11. Certification

11.1 When specified in the purchase order or contract, a producer or supplier certification shall be furnished to the purchaser stating that the vault was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test result shall be furnished.

11.2 When specified in the purchase order or contract, certification by an independent third party indicating conformance to the requirements of this specification shall be furnished.

12. Keywords

12.1 intrusion deterrence; intrusion resistance; vault; vault construction; vault structure

APPENDIXES

(Nonmandatory Information)

X1. RATIONALE

X1.1 Determination as to intrusion resistance is based upon the criteria for testing as detailed in UL Standards 608 (third edition) and 680.

X1.2 Testing was performed on a representative sample using two basic techniques. First, a portable coring machine equipped with a diamond embedded matrix bit core was used to drill a manhole size opening through the sample. Second, electric hammers, acetylene cutting torch, and various hand

tools were used, in combination, to create a manhole size opening through an untouched portion of the sample.

X1.3 Actual testing was restricted to one test team, consisting of two skilled operators and one non-participating assistant.

X1.4 Testing procedures recorded net working time, that is, the only the time during which the attack is actively in progress.

X2. SUPPLEMENTARY RECOMMENDATIONS FOR CONSTRUCTION METHODS

X2.1 Site and structural engineers should be consulted to ensure the integrity of the site on which the vault will be built, (see 7.1).

X2.2 The other variables (cement, water, plasticizer, and slump) in the design mix for the concrete should be determined

by the concrete supplier based upon local conditions, recognizing that there will be no criticism should the concrete have a compressive strength greater than 4000 psi (281 kg/cm²), (see 7.4.1).

X3. TYPES OF GRID REINFORCEMENT

X3.1 Types of grid reinforcement to be used in this specification are given in Figs. X3.1-X3.7.

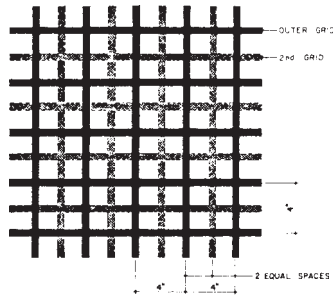


FIG. X3.1 Two Grid Reinforcing

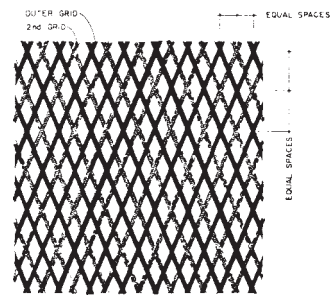


FIG. X3.2 Two Grid Reinforcing

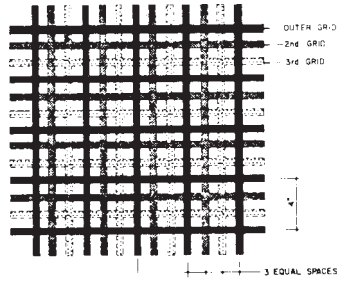


FIG. X3.3 Three Grid Reinforcing

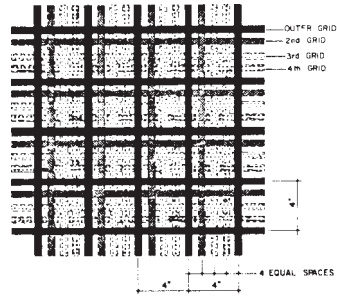


FIG. X3.4 Four Grid Reinforcing

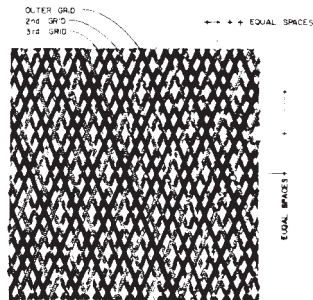


FIG. X3.5 Three Grid Reinforcing

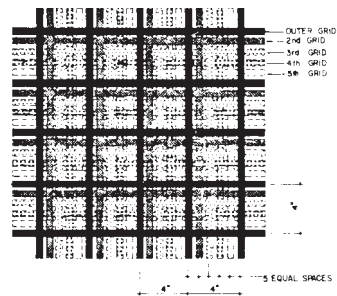


FIG. X3.6 Five Grid Reinforcing

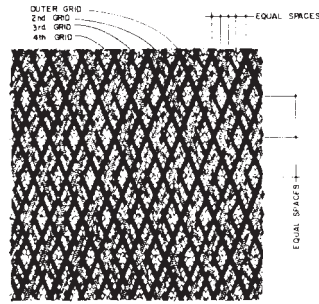


FIG. X3.7 Four Grid Reinforcing

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