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Standard Specification for Intrusion Resistant Generic Vault Structures¹

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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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

¹ This specification is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems Products and Services.

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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:²

A184/A184M Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A635/A635M Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for

F1090 Classification for Bank and Mercantile Vault Construction

2.2 Underwriters Laboratories Inc. Standards:³

ANSI/UL 608 Standard for Burglary Resistant Vault Doors and Modular Panels

ANSI/UL 680 Standard for Emergency Vault Ventilators and Vault Ventilating Ports

2.3 American Concrete Institute Standards:⁴

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 For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

⁴ Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

3.1.2 *classification*—a systematic rating of products, based on testing, in accordance with Classification **F1090**.

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, and so forth, 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 **F1090** 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 **A615/A615M**), 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 **A635/A635M**), 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 ½ 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 $\frac{3}{4}$ 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 D1557.

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 318.⁵

7.3 Reinforcing:

7.3.1 All reinforcing shall be in accordance with ACI 318.⁶

7.3.2 All reinforcing materials shall be in accordance with Specification A615/A615M and Specification A635/A635M.

7.3.3 If used, steel bar mats shall be installed in accordance with Specification A184/A184M.

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 318.⁷

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 318.⁸

7.4.1 The design mix shall contain a ratio of 40 % clean, fine sand to 60 % coarse aggregate, maximum size of $\frac{3}{4}$ 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 318.⁹

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 318.⁵

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, and so forth shall have surfaces roughed, cleaned, and filled with high-strength patching material.

7.7.3 Honeycombs in excess of $\frac{3}{4}$ 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 318.¹⁰

7.8.2 Curing during hot weather shall be in accordance with ACI 318.¹¹

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.

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

⁸ See Chapter 4, "Concrete Quality."

⁹ See Chapter 5, "Mixing and Placing Concrete."

¹⁰ See Chapter 5, Section 5.6, "Cold Weather Requirements."

¹¹ See Chapter 5, Section 5.6, "Hot Weather Requirements."

⁵ See Chapter 6, "Formwork, Embedded Pipes, and Construction Joints."

⁶ See Chapter 7, "Details of Reinforcement."