Specialty Steel Doors

A Primer on Acoustic, Blast Resistant, Tornado Resistant, and More

Steel Door Institute
steeldoor.org

What Will You Learn About?

This presentation covers the following specialty door and frame assemblies:

- **Acoustic**
- **Blast Resistant**
- **Bullet Resistant**
- **Tornado**
- **Hurricane**
- **Stainless Steel**
- **Lead-Lined**
- **Custom**

Acoustical Door Assemblies

Acoustically door assemblies (ie. frame, hardware, and seals) are engineered to prevent a specific amount of airborne sound from passing through the door opening.

These assemblies are commonly used in schools, offices, hotels, and concert halls and more.

Acoustically rated door systems are growing increasingly popular in office buildings too. A few benefits of a quieter workplace include higher productivity, less sick time, and higher employee retention.

Acoustical Door Assemblies

- Assemblies are assigned **Sound Transmission Class** (STC) values
- The STC scale is a logarithmic progression: an increase of 3 points doubles the sound transmission reduction
- Steel is the optimum acoustic door material

STC 50 – 54	Very loud sounds are faintly heard
STC 40 – 49	Loud speech is barely audible
STC 35 – 39	Loud speech is audible but words hard to distinguish
STC 30 – 34	Loud speech can be distinguished but normal speech is barely heard or inaudible

Acoustical Door Assemblies

- Single door openings are readily available in a range of STC 32 – 54
- Pairs of doors are generally available up to STC 40 – 48
- Vision lights and embossments available

Acoustical Door Assemblies

- For doors with glass kits, the STC rating decreases as the glass kit size increases
  - Use of laminated glass with an air pocket is recommended to help reduce the transmission of sound waves

- Door openings rated up to STC 54 generally can be a standard 1¾" thick.

- Door openings rated STC 55+ can only be achieved with doors that are 2 ¼" or thicker. This increases the cost of the doors.

Acoustical Door Assemblies

Outdoor-Indoor Transmission Class (OITC)

- The measurement of sound transmission from the external environment into the building envelope
- Testing uses ASTM E1332 Standard Classification for the Determination of Outdoor-Indoor Transmission Class
- OITC includes a range of frequencies lower than the STC testing to more closely replicate the sounds of rail and vehicular traffic

Acoustical Door Assemblies

Test Methods

Door assemblies are tested in accordance with ASTM E90 acoustical ratings.

- A door is installed into a test wall with a high STC rating (greater than 60) between two rooms. One room is the source of the sound, while the other is the receiving room where measurement will take place.

- Different sound frequencies are generated and a sound attenuation value is determined at each frequency.

Acoustical Door Assemblies

Inoperable Test vs. Operable Test

- Perimeter of the door opening is sealed with putty and tape for the **inoperable test**

- The resulting acoustical value is solely for the door and frame assembly

- While this is a valid test condition, it is not indicative of the STC performance of an operable door

Acoustic Doors

Inoperable Test vs. Operable Test (con't)

- In the **operable test**, the door is in working condition and must open and close

- The resulting acoustic rating also highlights the loss of STC between the two tests. This is typically 1 to 5 STC points depending on the quality of the seal and threshold assembly.

- The STC rating from the **operable test** is what manufacturers publish

What STC Rating Do You Need?

- The STC rating of commercial steel doors are often in the 25-35 range.
- For situations where sound control is critical, such as in an office where confidential meetings are held, doors above STC 40, 45 or even higher may be needed.
- For these, some design professionals may choose to work with an acoustic consultant.

Specifying Acoustic Assemblies

- There's no need to overspecify acoustic doors. Often the intent is simply to suppress the sounds of people or equipment from room to room.

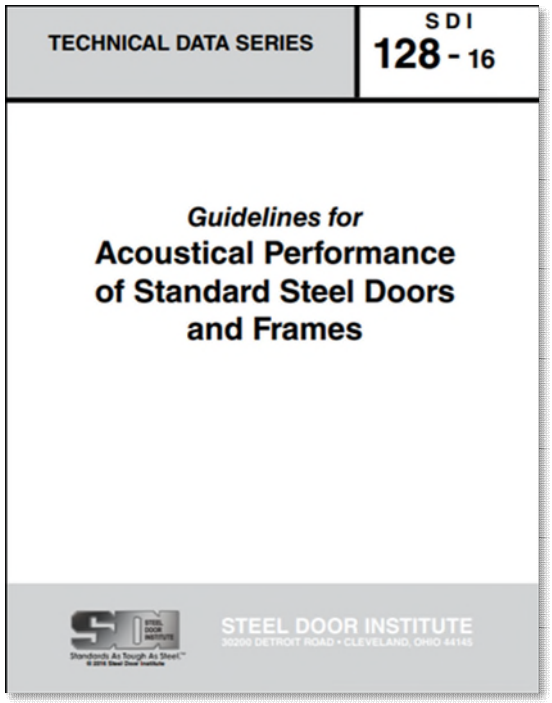
- Specifying a door with an STC rating in the 40s is adequate in most situations.

Specifying Acoustic Assemblies

- SDI does not recommend a specific core be specified for STC doors. The selection should be on the basis of the desired STC value rather than the core material.

- Make sure the required STC and OITC values are included in specifications.

Specifying Acoustic Assemblies



- Doors with STC above 35 **should not** be included in Spec Sections for standard or custom doors and frames.
- They should be specified as special assemblies warranting closer attention to details such as hardware, seals and installation.
- More information is available in **SDI 128** or by consulting a manufacturer.

Blast Resistant Door & Frame Assemblies

Blast resistant door assemblies protect people and property from detonations resulting from high explosives, vapor clouds, fine dust clouds, chemical reactions, and more.

They are specified for buildings where security is a concern or an explosive event would be possible, such as military bases, government offices, and industrial facilities.

Blast Resistant Assemblies

Blast resistant door manufacturers offer assemblies that can withstand peak blast pressures ranging from very low levels of less than 1 lb. per square inch (psi) to more than 50 psi, as well as long blast durations which increase the impulse loading.

Explosion risk

Blast Resistant Definitions

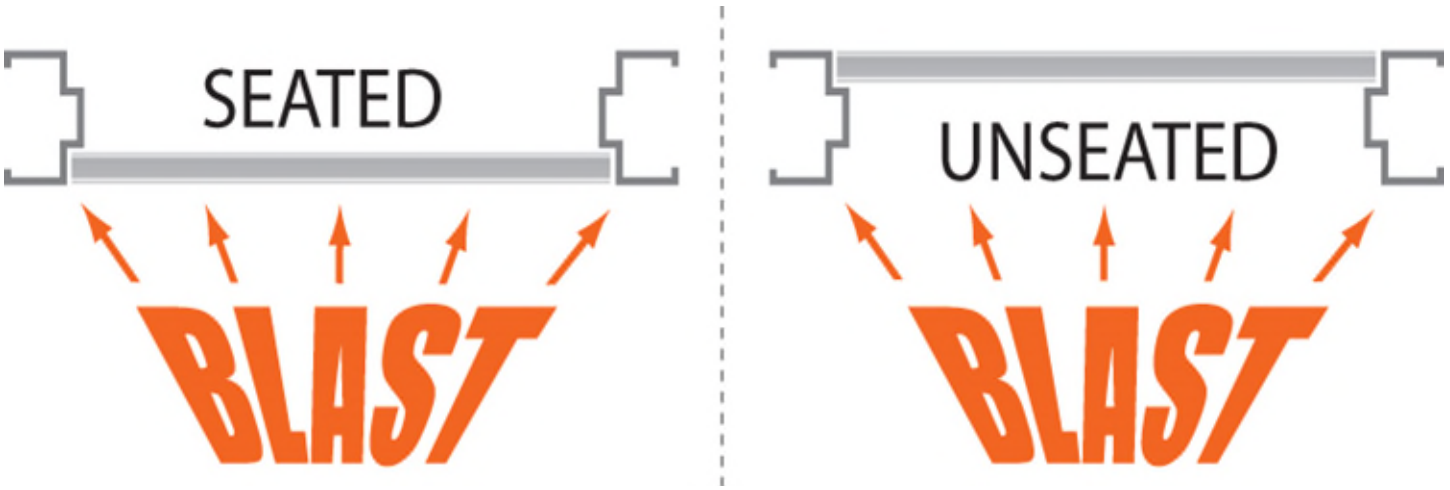
Blast pressure: The maximum pressure expected to be exerted on the assembly by the projected blast event (measured in psi).

Blast duration: Measured in milliseconds, the length of time required for the blast pressure to decay to zero.

Blast impulse: The blast energy as described by the area under the pressure vs. time curve (measured in pressure-time units such as psi-msec).

Blast Resistant Definitions

Blast direction: The direction of the blast load relative to the door assembly.



Blast Resistant Definitions

Rebound: The percentage of the initial peak blast pressure that is reflected back on to the blast resistant unit.

Required response: The acceptable level of damage that would result from the projected blast event on a door assembly. The responses range from Category I (no damage) to Category V (catastrophic failure). There are several different definitions of response provided in the documents listed on the next slide.

Blast Door Standards

ASTM F2247, ASTM F2927 and ASTM F1642 are commonly specified test methods for blast doors.

UFC 4-010-01 is one of the primary specifications required for all Department of Defense related construction.

ASCE (Design of Blast Resistant Buildings in Petrochemical Facilities) and **PIP STC01018** are primarily used for petrochemical and offshore facilities.

Blast Resistant Specs

- When requesting a quote, design professionals should provide:
  - ✓ Door size
  - ✓ Either flush or with vision panel
  - ✓ Peak pressure, impulse and standoff distance
  - ✓ Seated or unseated
  - ✓ Rebound requirements, if applicable
  - ✓ Damage Category or Hazard Level (including the governing authority or specification such as **ASTM F2247**)

- Specifiers should work with a blast consultant to determine the projected blast conditions and desired response category.

Blast Resistant Specs

Sample Blast Requirement

- ✓ Size: 3’0” x 7’0”
- ✓ Vision: Yes, 12” x 12” Visible
- ✓ Pressure: 4 psi
- ✓ Impulse: 28 psi-msec
- ✓ Blast Direction: Seated
- ✓ Rebound: 50%
- ✓ Damage Level Category: II per **ASTM F2247**

Blast Resistant Assemblies

- Vision lights require a check of the blast resistance of the entire assembly, including the vision kit and glazing.
  - The mounting kit must be able to withstand the projected blast loading imparted by the glazing
  - The glazing must provide the specified level of performance.
  - The most common specification for glazing performance is GSA Test Protocol: **GSA-TS01-2003**.

- In general, blast resistant glazing requires a laminated component comprising either the single glazing pane or the inside pane of an insulated glass unit.

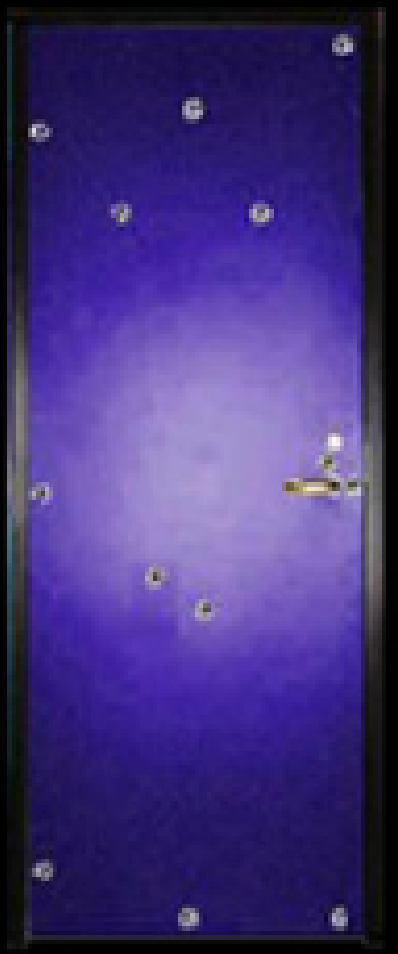
Blast Categories

Response categories following the blast event for doors can generally be defined as:

- **Category I**: undamaged
- **Category II**: permanent plastic damage but operable
- **Category III**: non-catastrophic failure (inoperable but remains a barrier to blast)
- **Category IV**: limited hazard failure (may rebound open)
- **Category V**: high hazard failure (door may be a flying debris hazard)

Bullet Resistant Assemblies

Benefits: Often tested in accordance with **UL 752** and assigned a level from 1-10 that lets you know how resistant the door is to gun fire.



Applications: Used in government buildings, cashier stands, high crime rate areas and any structure where increased safety is desired.

Bullet Resistant Assemblies

- Steel doors are generally available up to level 8.
- Architects should consider working with a security consultant to analyze the building conditions and determine the appropriate bullet resistance level.

LEVEL	BULLET	CALIBER	SHOTS
1		9mm (124g) FMJ	3
2		.357 Magnum (158g) SP	3
3		.44 Magnum (244g) SP	3
4		.30 Caliber Rifle (180g) SP	1
5		7.62mm Rifle (150g) FMJ	1
6		9mm Multi (124g) FMJ	5
7		5.56mm Rifle (55g)	5
8		7.62 Multi Rifle (150g) FMJ	5
8 (AP)		30-06 Rifle (166g) AP	5

Bullet Resistant Door Options

- The doors may be flush or have full glass vision lights. They are also available in pairs.

- The doors may be fire rated up to three hours and combined with STC and blast resistant capabilities.

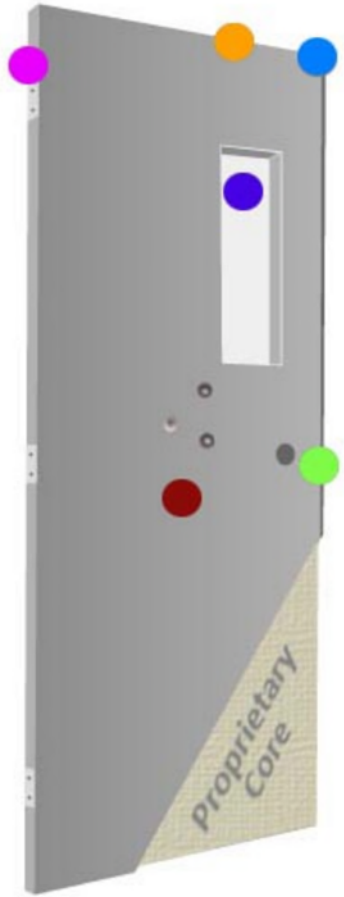
Bullet Resistant Standards

- The standard that should be specified is often spelled out by whomever is commissioning the project.
- **UL 752** is the most common test method, which assigns a level from 1 – 10.
- **NIJ 0108.01** is one of the primary specifications used by the government.
- **NCEL-MIL-SAMIT** is generally used for military projects.

Bullet Resistant Doors Specs

- A variety of cores can be bullet resistant, such as steel stiffened, honeycomb, and polystyrene.

- It is only necessary to specify a **UL 752** level and not a specific core material because many of the cores are proprietary once you get into higher bullet resistance levels.



Tornado Door & Frame Assemblies

About 1,000 tornadoes occur in the United States every year with the power to destroy or remove standard doors. Tornado-tested assemblies are proven to stand up to storm pressures and debris.

Most tornadoes wreak havoc in “Tornado Alley”, which runs from Texas up through Oklahoma, Kansas, Nebraska and into Iowa. However, tornados have occurred in every state

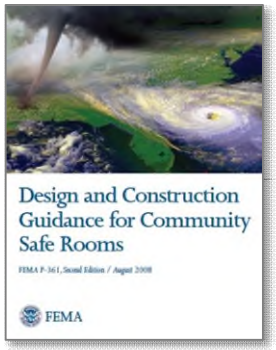
Tornado door & frame assemblies can save lives.

Tornado Shelter Building Codes

It is important that distributors in areas susceptible to tornadoes understand the pertinent building codes, the applicable requirements for tornado shelters, and common solutions.

Tornado Standards

FEMA P-361 offers *best practices* on the design and construction of safe rooms but ***does not*** regulate construction.



ICC 500 is the Standard for the Design and Construction of Storm Shelters.

- Referenced within the International Building Code since 2009
- Basis for mandatory shelter construction requirements found in 2015 edition of the IBC

Steel Tornado Doors

- Steel is the most prevalent door material to pass **FEMA P-361** and **ICC 500**.
- No wood door, with or without metal sheathing, has successfully passed **FEMA P-361**.
- Aluminum and fiberglass doors are not currently listed for tornado resistance without internal steel plating.

Test footage of steel door withstanding three projectiles at 100mph

Tornado Door Assemblies

- Tornado products are tested and installed as an assembly including:
  - Hinges
  - Door
  - Frame
  - Anchors
  - Latching hardware

- Do not mix and match tornado door components. The ***assembly*** must be approved and certified.

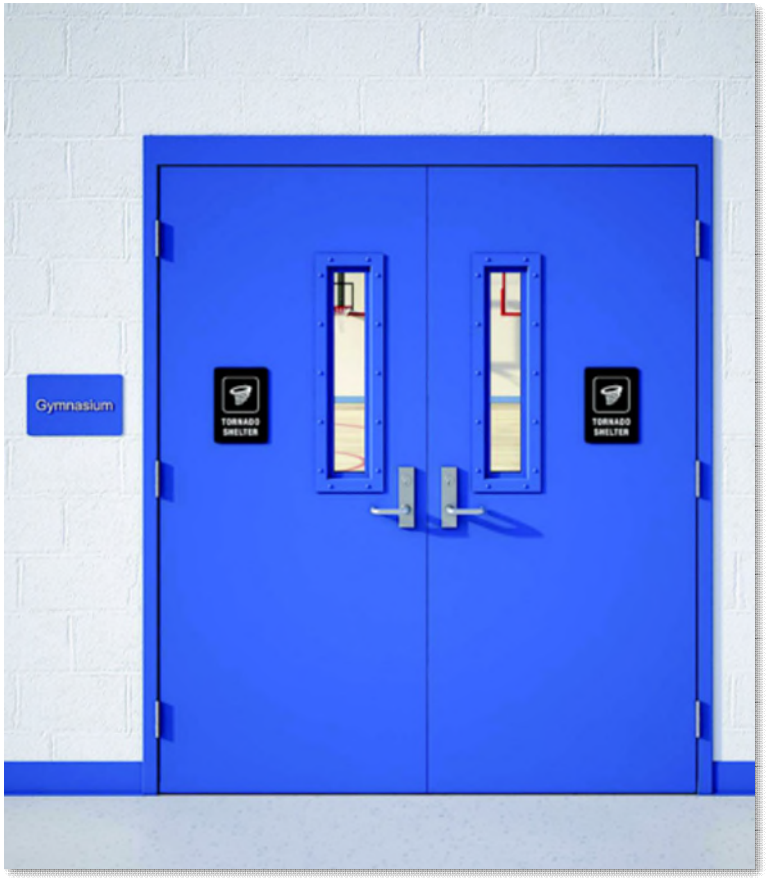
Tornado Door & Frame Installation

- Proper installation of tornado doors is critical. An improper installation may result in the door sagging or not withstanding the labeled windload.

- Door suppliers should consider having a pre-installation meeting with the contractor, specifier, and installer to discuss the installation. This is especially important with tornado doors due to the potentially catastrophic repercussion of a faulty installation.

Tornado Door Specs

- ✓ The assembly, including hardware, should be specified
- ✓ Ensure the products selected are permitted on the shelter being designed
- ✓ Verify specific listings with third-party certification agencies such as Intertek and UL. You can generally just perform a search on their website.



Hurricane Door & Frame Assemblies

Hurricane rated assemblies are subjected to several different tests to ensure they can withstand the wind and flying debris caused by hurricanes.

Hurricane-rated assemblies are most often used in North American buildings located near the Atlantic Ocean and the Gulf of Mexico.

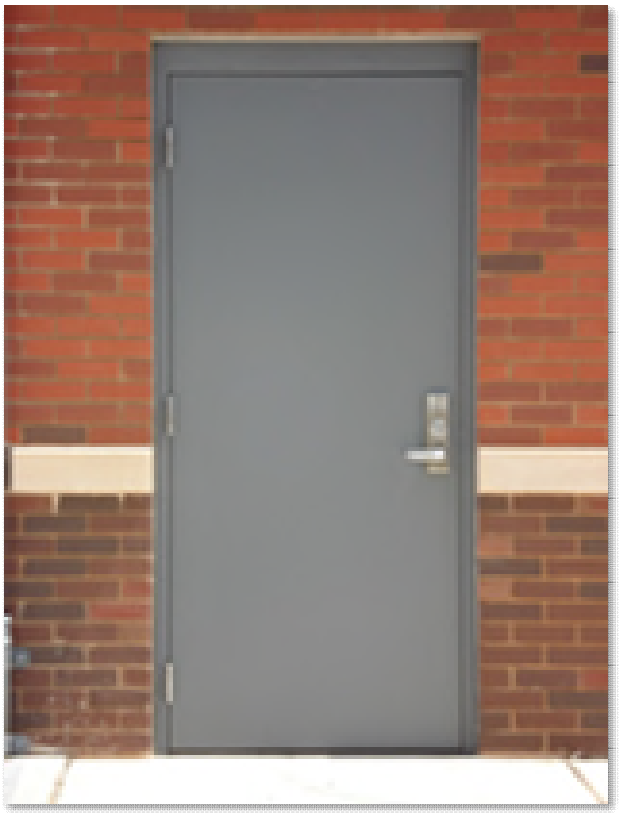
Hurricane Door & Frame Assemblies

- Dramatically reduce the chances of personal injury or death in the event of a hurricane
- Minimize property damage and create protected shelter spaces for evacuees
- Allow for conformance to local or state code requirements

History of Hurricane Doors

- Hurricane Andrew in 1992 killed **65 people** and caused **$26 billion** in damage

- Impetus for city, county and state authorities to develop new, hurricane resistant building codes.



History of Hurricane Doors

- Miami-Dade County was the first to develop a windstorm product certification for building materials referred to as the Notice of Acceptance (NOA).

- The structure of the NOA system was used by manufacturers to demonstrate their product's compliance with the provisions of the Florida Building Code.

- The state of Florida then developed Florida Building Code (FBC) product approval listings, similar to the NOA structure, but applicable throughout the state.

History of Hurricane Doors

- More recently, the state of Texas has developed their own product approval system under the Texas Department of Insurance (TDI) for requirements for building products, like Division 8 materials.

- These requirements are reviewed and modified every few years and will continue to evolve with the industry.

Hurricane Doors

Design Pressures and Testing

- Door assemblies are tested with the positive and negative pressures that occur in hurricanes. They are then rated with a “design pressure.”

- Pressures are different than wind speeds.
  - A wind speed of 170 mph produces a design pressure of +49/-53 psf. This value will vary depending on height above ground, location on building, and other factors.

Hurricane Doors

Design Pressures and Testing

There are three standard hurricane tests and associated test standards:

- **Large Missile Impacts** (TAS 201, ASTM E1886/E1996, ANSI A250.13, and ICC 500
- **Uniform Static Air Pressure** (TAS 202, ASTM E330, and ANSI A250.13)
- **Cyclic Wind Pressure Loading Test** (TAS 203, ASTM E1886/E1996, and ANSI A250.13)

Specifying Hurricane Assemblies

When specifying hurricane doors, it's important to:

- Ensure that the structural engineer has provided a design pressure for each opening
- Select listed opening assemblies with equal or greater design pressure values
- Meet the functional needs of the opening, i.e., rated with panic exit hardware, glazing, etc.

Stainless Steel Doors

- Provide a modern, sleek appearance
- Are rust and corrosion resistant
- Require little maintenance
- Are hygienic
- Are available three-hour fire rated, STC rated up to 51, and can be designed for bullet, blast and windstorm resistant

Stainless Steel Doors

- Stainless steel doors are found in a variety of buildings such as offices, hospitals, food processing plants and buildings in corrosive environments
- Usually offered with a composite core (e.g. polystyrene or honeycomb) but may be available with steel stiffeners

Stainless Steel Finishes

- Stainless steel is usually specified for its aesthetics
- Numerous finishing options enable architects to add a distinct design element to their doors

Stainless Steel Finishes

Stainless steel finishes are “rolled” (unpolished) and are referenced by #1-8. Lower number finishes are more **matte**, while higher numbers are more **reflective**.

Stainless Steel Finishes

The most common stainless steel finishes include:

- **#2B Unpolished** — suitable for painting, such as in concealed areas where stainless steel performance is required but aesthetics are not important
- **#4 Brushed Satin** — low reflectivity
- **#6 Long Grain Satin** — more reflective than a #4 finish
- **#8 Mirror** — highly reflective; fine polishing lines are barely visible. Fingerprints show on mirror-like finishes, so they are best-suited for low traffic openings.
- There are many more such as **Angel Hair**, **Swirl**, and **Distressed**.

Tips on Stainless Steel Finishes

- The appearance of finishes are not defined by standards so you should always view a sample.
- Finishes do not affect the performance of the door or frame.
- Finishes are a design element and must be specified. Specifications should be precise (“Finish #8”) and not descriptive (“brushed finish”).
- Finishes with horizontal lines are more likely to collect dirt than vertical patterns.

Stainless Steel Doors

Corrosion Resistance

- Due to alloy's high oxidation resistance, stainless steel doors are common where rust or corrosion are a concern. These can be marine environments, areas with heavy rainfall or other locations with consistent moisture.

- Smoother finishes are better suited for corrosive environments.

Stainless Steel Doors

Corrosion Resistance

- Stainless steel doors are available in two types of alloy:
  - **Type 304 alloy** - standard corrosion resistance
  - **Type 316 alloy** - heavy duty corrosion resistance

- Stainless steel internal reinforcements should be specified to optimize the corrosion resistance

Stainless Steel Doors

Hygienic Properties

- Stainless steel doors with a custom seamless edge wash easily and can be sanitized thoroughly, making them a popular choice for sanitary environments such as food handling facilities and medical buildings.

Lead-Lined Doors and Frames

Lead-lined doors prevent the transmission of radiation. They are commonly specified for x-ray protection in clinics, hospitals, imaging centers, veterinary offices and other healthcare environments.

They are also used for radiation shielding in buildings where security is a concern, such as aerospace, airports and defense environments.

Lead-Lined Doors and Frames

- Lead lined doors are generally manufactured with a steel stiffened core, but other cores are sometimes used.

- Lead-lined doors and frames are also available:
  - with vision lights (if lead glass is used)
  - with borrowed lights or sidelight frames
  - fire rated up to 90 minutes
  - STC-rated
  - bullet resistant levels 1-4
  - with stainless steel skins

Specifying Lead-Lined Doors

- The most common lead thicknesses in doors and frames are **1/16”**, **3/32”**, **1/8”** and **1/4"**. Although lead as thick as **1”** is available for unique applications.

- Consult with a qualified health radiation physicist familiar with local standards and regulations to determine appropriate lead thickness.

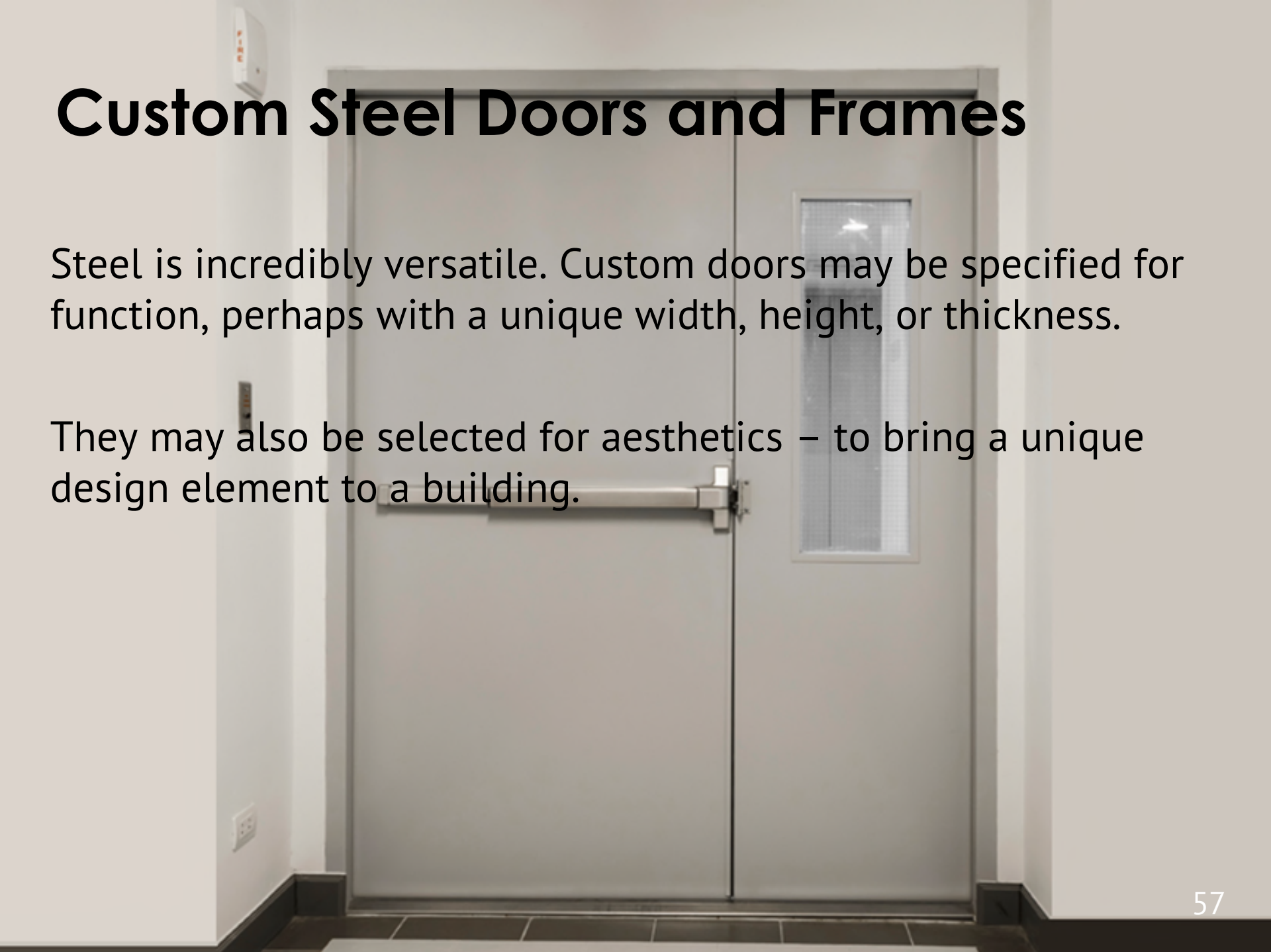
- The lead thickness value of the door and frame shall have the same or greater radiation attenuation value as the surrounding wall.

- The position of the radiation source, hand of the opening and position of lead in the wall should be specified as it will affect the location of the lead in the door and frame.

Custom Steel Doors and Frames

Steel is incredibly versatile. Custom doors may be specified for function, perhaps with a unique width, height, or thickness.

They may also be selected for aesthetics – to bring a unique design element to a building.



Custom Steel Doors and Frames

- Hollow metal door manufacturers have lasers and shears that allow them to trim and size the sheet metal to your specs very efficiently.

- Fiberglass door manufacturers use molds and presses, making custom jobs more time-consuming.

Custom Steel Doors and Frames

Semi-Custom Products

- Architects often request “semi-custom” products, which are standard products ordered with unique attributes such as width, height, window location, jamb profile

Full Custom Products

- “Full custom” products may have a special core or be extremely oversized

- Other custom requests are for special door thicknesses or when standard cores are incompatible, so a custom core is required

Frames with Unique Designs

- Arch top and circular window frames are eye-catching
- Non-right angle or polygon sidelights add a modern appearance
- Locations for unique designs
  - ✓ Museums
  - ✓ Churches
  - ✓ Temples
  - ✓ Public architecture
  - ✓ and more

Custom Finishes and Embossments

Steel doors can have:

- Swirls or patterns etched in the steel
- Logos etched into steel doors (great for corporate offices)
- Embossments, such as the door in the image to the left, bring elegance to a room along with the longevity of a steel door

In Conclusion

Steel's natural strength makes it the optimum material for specialty doors. Steel outperforms wood, aluminum, and fiberglass in demanding environments where sound reduction, security, windstorm resistance and three-hour fire ratings are important.

Even when those other materials use special cores or other techniques, they are still unable to match the performance and longevity of steel.

Visit steeldoor.org for more information.