

# Guideline for Specifying Steel Doors and Frames for Blast Resistance



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30200 DETROIT ROAD • CLEVELAND, OHIO 44145



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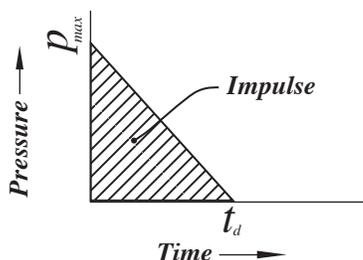
## 1 Introduction

Blast-resistant hardening, or the structural strengthening of buildings, is one measure an owner may employ to minimize the risk to people and equipment from the hazards of accidental or intentional explosions. Many architects are finding it necessary to include blast-resistant products in new and existing construction. These products do not fall under any building code, but are required by a number of government agencies such as the Department of Defense (DoD), Veterans Affairs (VA), Department of State (DOS), and the General Services Administration (GSA). They are backed by analysis or 3<sup>rd</sup> party test data (from an accredited lab) to show their performance level under blast load conditions. This document will serve as a guide to identify the proper criteria, and to give brief explanations of each criterion. Additional requirements, fire rating, swing, etc. are not covered.

## 2 Definitions

**2.1 Blast Resistant Product:** Assembly comprised of a door (or pair of doors) and a frame with hardware, or a glazing system that is rated to resist a specified blast peak pressure and impulse to a required performance level. Higher level doors and frames are typically sold and shipped as one unit in order to be certified by the manufacturer that it will meet the projected blast and performance requirements.

**2.2 Blast Pressure:** The maximum pressure to be exerted on the assembly by the blast event, typically specified as peak-reflected pressure.



**Blast Wave (Idealized)**

**2.3 Positive Phase Impulse:** The area under the curve formed by the integral of blast pressure ( $P_{max}$ ) vs. time ( $T_d$ ).

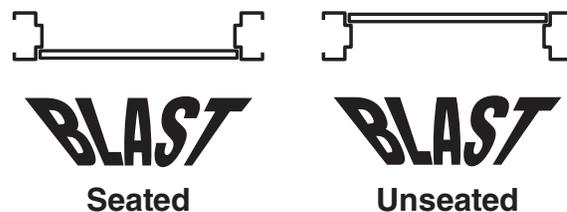
**2.4 Charge Weight:** The equivalent explosive weight (lbs or kg) of TNT in the blast event. Different agencies have specific requirements for charge weight to be used. See agency specific criteria for DoD, VA, GSA, and DOS to determine required charge weight and in some cases, the required standoff distance.

**2.5 Duration:** The amount of time it takes the peak pressure to decay to ambient conditions (or zero), typically specified in milliseconds (ms).

**2.6 Rebound:** Load acting in the opposite direction of the initial blast load that may be a result of negative phase pressure loading and system response, and is typically expressed as a percentage of the initial peak blast pressure.

**2.7 Stand-off Distance:** The distance from the centroid of the explosive device to the specified opening or structure.

**2.8 Seated/Unseated:** The orientation of the door in the frame, in relation to the blast origin.



**2.9 Blast Product Response & Damage Category** (Also referred to as **Level of Protection** in the Unified Facilities Criteria (UFC)): The amount of structural damage (permanent deformation) present after the blast event. With respect to a door and frame unit, the operability of the door, and whether or not the door and/or frame become detached and present a debris hazard. With respect to a glazing system, whether or not the glazing fractures, and if it presents a flying debris hazard. There are multiple standard test methods written that outline test procedures to follow to show how a blast-resistant unit will react in a blast event.

### Blast Product Response & Damage Categories

<b>UFC 4-010-01 2018 – Levels of Protection</b>	
<b>Below AT Standards</b>	Severe damage and/or collapse of structure
<b>Very Low</b>	Heavy structural damage
<b>Low</b>	Moderate damage, unable to be repaired economically
<b>Medium</b>	Minor damage, able to be repaired economically
<b>High</b>	Minimal damage, no permanent deformation

<b>ASTM F2247-18 – Response Categories</b>	
<b>Category I</b>	No permanent deformation to the specimen is present, and the door is fully operable.
<b>Category II</b>	Measurable permanent deformation is present, but the door is operable.
<b>Category III</b>	Non-catastrophic failure, however the unit is inoperable. For unseated loads, the latching mechanism is permitted to fail, allowing the door to swing open, but the door remains supported by the hinges.
<b>Category IV</b>	The unit is severely deformed and may become detached from the hinges; however the door will not become a flying debris hazard.

<b>ASTM F2912-17 – Hazard Ratings</b>	
<b>No Break (H1)</b>	No fractures are present in the glazing, and no damage is visible to the unit.
<b>No Hazard (H1)</b>	The glazing has fractured, but no breakage has occurred (no debris).
<b>Minimal Hazard (H2)</b>	The glazing has fractured, and minimal fragments are present on the floor near the interior face of the glazing system (between 0 and 40 inches).
<b>Very Low Hazard (H3)</b>	The glazing has fractured and noticeable fragments are present on the floor near the interior face of the glazing system (between 40 and 120 inches). The total fragment weight cannot exceed 15 grams.
<b>Low Hazard (H4)</b>	The glazing has fractured, and fragments have fallen between 40 and 120 inches from the specimen. The witness panel, which is 120 inches away, has 25 or less perforations below 20 inches above the floor, and 10 or less perforations above 20 inches above the floor. 5 or less perforations may fully penetrate the full layered witness panel.
<b>Moderate Hazard (H5)</b>	The glazing has fractured, and fragments have fallen between 40 and 120 inches from the specimen. The witness panel has numerous perforations below the 20 inch mark above the floor, and 25 or less perforations above the 20 inch mark. 5 or less perforations may fully penetrate the full layered witness panel.
<b>High Hazard</b>	The glazing has fractured and the witness panel, which is 120 inches away, has more than 25 perforations higher than the 20 inch mark above the floor. There are more than 5 perforations that fully penetrate the full layered witness panel.

<b>ASTM F2927-21 – Door Response Damage Categories</b>	
<b>Category I</b>	The door specimen is unchanged and fully operable.
<b>Category II</b>	The unit has acceptable permanent deformation but is still operable.
<b>Category III / S</b>	The door remains secure during and after the loading event. The door may get lodged in the frame, and cannot be opened or passed through by a person without the use of tools, from the threat side.
<b>Category III / U</b>	The door does not remain secure after the loading event. The door can be opened or passed through without the use of the supplied hardware, and without the use of tools. The door can swing open during rebound, but remains attached to the frame at the hinges.
<b>Category IV</b>	The door can become separated from the frame and cause a flying debris hazard, or the door and frame unit may separate from the wall and cause a debris hazard. The flying debris will not go further than 3 meters.
<b>Category V</b>	The door or the door and frame unit together become dislodged and cause a flying debris hazard that will go further than 3 meters.

**2.9.1** Paraphrased response and damage categories are given on page 2 to highlight the differences in test methods and design criteria. For the full verbiage, please reference the specified test methods and standards organization.

### 3 Blast Standard Test Methods and Design Criteria

**3.1 ASTM F2247-18** – *Standard Test Method for Metal Doors Used in Blast Resistant Applications (Equivalent Static Load Method)* – Determines ultimate static capacity. Requires further evaluation to relate to explosive charges or other dynamic loads

**3.2 ASTM F2927-21** – *Standard Test Method for Door Systems Subject to Airblast Loadings* – Used to determine blast capacity for a shock wave created by live explosives or a shock tube.

**3.3 ASTM F2912-17** – *Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings* – Used to determine blast capacity from a shock wave or explosion

**3.4 ASTM F1642-17** – *Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings* – The data obtained from this test method is used in ASTM F2912 to determine a hazard rating.

**3.5 GSA-TS01-2003** – *Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings* – The sole test protocol by which blast resistant windows and related hazard mitigation technology and products shall be evaluated for facilities under the control and responsibility of the US General Services Administration.

**3.6 ASCE 2010, 2<sup>nd</sup> edition** – *Design of Blast Resistant Buildings in Petrochemical Facilities*

**3.7 PIP STC01018-2014** – *Blast Resistant Building Design Criteria*

**3.8 UFC 4-010-01 2018** – *Department of Defense Minimum Antiterrorism Standards for Buildings* – The intent is to minimize mass casualties in buildings or portions of buildings owned, leased, privatized, or otherwise occupied, managed, or controlled by or for DoD in the event of a terrorist attack.

Blast Requirements to be provided (Except DoD Projects)	Sample Criteria (Door)	Sample Criteria (Window)
Product Size (Scheduled Opening)	3'-0" x 7'-0" Door & Frame Assembly	4'-0" x 4'-0" Window
Peak Reflected Pressure, Duration, & Rebound	4psi, 100ms, 50% Rebound	2psi, 200ms
Door Configuration (Seated/Unseated)	Seated in Frame	—
Wall Conditions	Welded to Steel Subframe	Anchored to Wall
Category Response	II	Very Low Hazard (H3) per ASTM F2912-17
Applicable Blast Test Standard	ASTM F2927-21	ASTM F1642-17
Glazing Requirements/Thickness	No Vision Light Required	TBD by Manufacturer

Blast Requirements to be provided (DoD Projects)	Sample Criteria (Door)
Product Size	3'-0" x 7'-0"
Charge Weight	II
Stand-off Distance	250 ft
Level of Protection	Medium
UFC Revision, Revision Date, and Change Date (If Applicable)	UFC 4-010-01, 12 December 2018

Sample Blast Quote Request Form

Blast Resistant Door – Request for Quote																
Door				Blast Requirements												
Opening ①		Door Type ②	UL 10c Fire Rating ③	Seated or Unseated	Peak Load (psi)	Reflected, Side-on or Free-Field	Impulse (psi-ms)	Duration (ms)	% Rebound Response	Response Category	Jamb Width	Wall Type (C, M, or S)	Lock Type			
Qty	Swing	Width	Height	Material												
1																
2																
3																
4																
5																
①										<p><b>Material:</b> The doors material type (CR-Cold Rolled, GV-Galvanized, or SS-Stainless Steel) (Note: Stainless Steel doors may have mild steel internal reinforcements. Glavanneated doors may have cold-rolled or mild steel internal reinforcements)  <b>Hinges:</b> Heavy Duty S.S. Hinges 32D</p>						
②										<p>Glazing will be specified as necessary to meet the blast requirements. Please specify if the glazing is to be supplied by the Manufacturer or if you, the customer, will provide the glazing  <input type="checkbox"/> Glass by Manufacturer <input type="checkbox"/> Glass provided by customer</p>						
③	<p><b>Fire Rating</b> – Opening is required to withstand a fire for 1/3, 3/4, 1-1/2 or 3-hour rating.</p>															
④				<p><b>Peak Load</b> – Peak blast pressure expressed in psi.                  Peak Load stated above is Peak Reflected Pressure unless noted otherwise  <b>Duration</b> – Blast duration in milliseconds.  <b>Impulse</b> – Impulse is a function of Peak Load and Duration. It is only necessary to provide either impulse or duration</p>			<p><b>Rebound Response</b> – Represents the expected psi capacity the door will be required to withstand in the opposite direction of the blast in percent form.  <b>0%</b> No rebound response required.  <b>50%</b> Rebound response is capable of 50% of the specified blast load (psi)  <b>100%</b> Rebound response capacity is equal to blast load.                  Note: Rebound is not applicable for an unseated blast load or static loading.</p>						<p><b>Category:</b>                  I No permanent damage                  II Permanent damage to the panel, but the door remains operable                  III The door panel is damaged &amp; inoperable, and the latch may fail, allowing the door to swing open in rebound                  IV Door panel is severely deformed with openings between the door and frame. Under dynamic load, the door may separate from the frame, and/or the frame anchorage may fail.</p>			
⑤	<p>Jamb width – Overall width of the frame section profile (depth)</p>															
⑥	<p>Wall type – Wall condition the frame will be anchored to (Concrete, Masonry or Structural Steel [Tube steel])</p>															
<p>Lock Type – Mortise Panic Device (MP) or Mortise Lock (ML) – Stainless Steel Finish</p>				<p>Contact Person:</p>				<p>Title:</p>								
<p>Test Method:</p>				<p>Company:</p>				<p>Phone:</p>								
<p>Revision:</p>				<p>E-mail:</p>				<p>Fax:</p>								
<p></p>				<p>Contact Phone:</p>				<p>Date:</p>								



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## AVAILABLE PUBLICATIONS

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### Specifications

- ANSI/SDI A250.6** Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
- ANSI/SDI A250.8** Specifications for Standard Steel Doors and Frames (SDI-100)
- SDI-108** Recommended Selection & Usage Guide for Standard Steel Doors
- SDI-118** Basic Fire Door, Fire Door Frame, Transom/Sidelight Frame, and Window Frame Requirements
- SDI-128** Guidelines for Acoustical Performance of Standard Steel Doors and Frames
- SDI-129** Hinge and Strike Spacing
- SDI-133** Guideline for Specifying Steel Doors & Frames for Blast Resistance
- SDI-136** Guideline for Specifying Windstorm Products

### Test Procedures

- ANSI/SDI A250.3** Test Procedure & Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames
- ANSI/SDI A250.4** Test Procedure & Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
- ANSI/SDI A250.10** Test Procedure & Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
- ANSI/SDI A250.13** Testing and Rating of Severe Windstorm Resistant Components for Swinging Door Assemblies for Protection of Building Envelopes (Not applicable for FEMA 320/361 or ICC-500 Shelters)
- SDI-113** Standard Practice for Determining the Steady-State Thermal Transmittance of Steel Door and Frame Assemblies
- SDI-131** Accelerated Physical Endurance Test Procedure for Steel Doors

### Construction Details

- ANSI/SDI A250.11** Recommended Erection Instructions for Steel Frames
- SDI-110** Standard Steel Doors & Frames for Modular Masonry Construction
- SDI-111** Recommended Details for Standard Steel Doors, Frames, Accessories and Related Components
- SDI-122** Installation Troubleshooting Guide for Standard Steel Doors & Frames

### Miscellaneous Documents

- SDI-112** Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames
- SDI-117** Manufacturing Tolerances for Standard Steel Doors and Frames
- SDI-124** Maintenance of Standard Steel Doors & Frames
- SDI-127** Industry Alert Series (A-L)
- SDI-130** Electronic Hinge Preparations
- SDI-134** Glossary of Terms for Hollow Metal Doors and Frames
- SDI-135** Guidelines to Measure for Replacement Doors in Existing Frame Openings

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30200 DETROIT ROAD • CLEVELAND, OHIO 44145  
440.899.0010 • [www.steeldoor.org](http://www.steeldoor.org)