



Products tested in USA for blast test – Shock Tube Testing of Window Systems

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Shock Tube Testing for Window Film Systems



February 2016
San Antonio, Texas

ABS Consulting Project Number 3615475

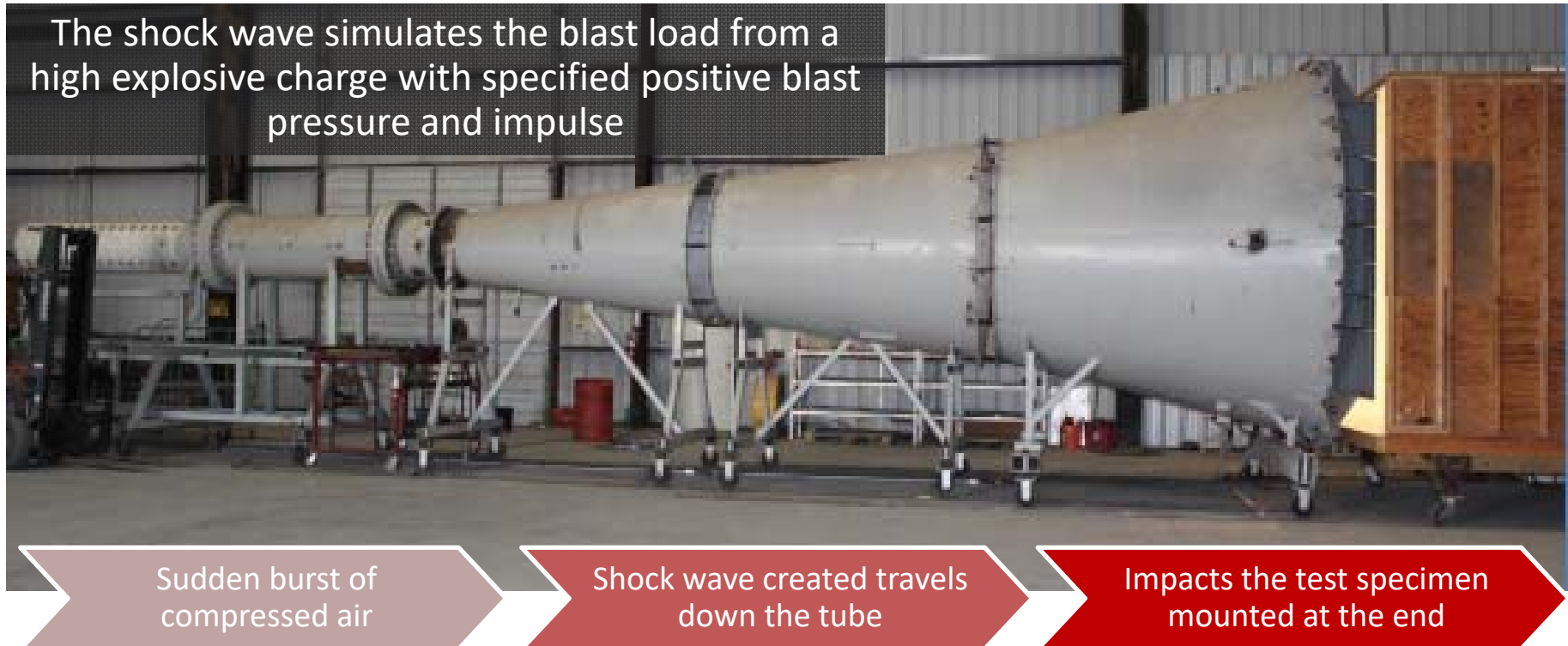


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Full scale blast testing of windows



The shock wave simulates the blast load from a high explosive charge with specified positive blast pressure and impulse





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Objective – determine the performance of the windows when subjected to various blast loads.

Test #	Blast Load*	Glazing Width (in)	Glazing Height (in)	Glazing Description
1	A	48	66	1/4" Annealed Glass Fixed Window with 8 mil Film, Four Side Wet Glaze Attachment
2	A	48	66	
3	A	48	66	
4	A	48	66	1/4" Annealed Glass Fixed Window with 8 mil Film, Daylight (Unanchored) Attachment
5	A	48	66	1/4" Annealed Glass Fixed Window without Film, Unprotected
6	B	48	62	1/4" Annealed Glass Fixed Window with 15 mil Film, Attached Two Sides Vertical with No-Bar Mechanical System, Attached Two Sides Horizontal with Wet Glaze
7	B	48	62	
8	B	48	62	
9	B	48	62	
10	C	40	40	1/4" Annealed Glass Fixed Window with 12 mil Film, Four Side Wet Glaze Attachment

Average Blast Load Applied to Test Specimens

Blast Load	Pressure (psi)	Impulse (psi-ms)
A	4.8	29.2
B	5.7	41.6
C	7.0	55.1

Window performance conditions were assigned in accordance with the performance criteria in **ASTM 1642**, **GSA** and **ISO 16934** test protocol.



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**Test 05
January 18, 2016**

No Film

**Applied Load:
Pressure: 4.9 psi
Impulse: 31.7 psi-ms**



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10+: -12.000 ms

Camera 1

10+: -12.000 ms

Camera 2



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Shock Tube Test**

**Test 01
January 18, 2016**

**Film System:
8 mil Film Anchored
4 Sides Wet Glaze**

**Applied Load:
Pressure: 4.5 psi
Impulse: 26.0 psi-ms**



10+: -12.000 ms Camera 1



10+: -12.000 ms Camera 2

safety zone | Hanita Coatings
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Classification according performance criteria per test protocol

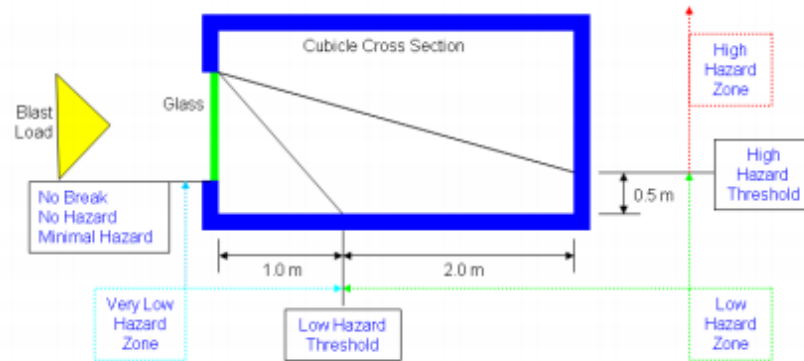


Figure 5. ASTM F1642-12 Performance Criteria Representation

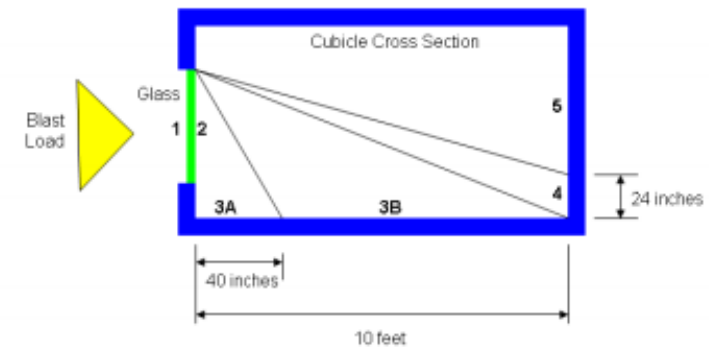


Figure 6. GSA Performance Criteria Representation

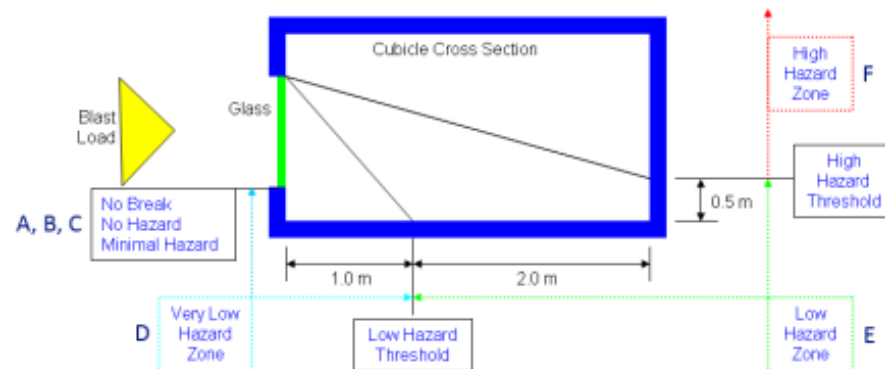
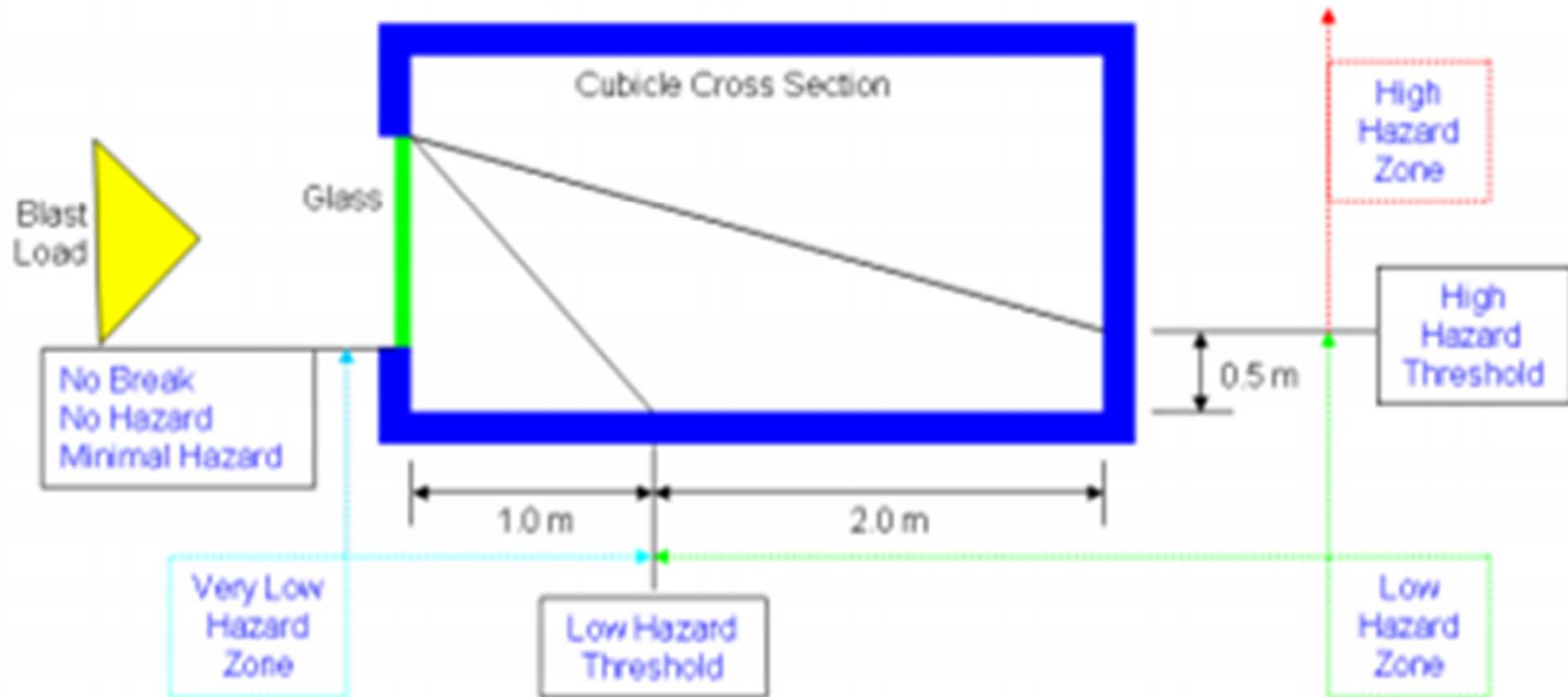


Figure 7. ISO 16934 Performance Criteria Representation

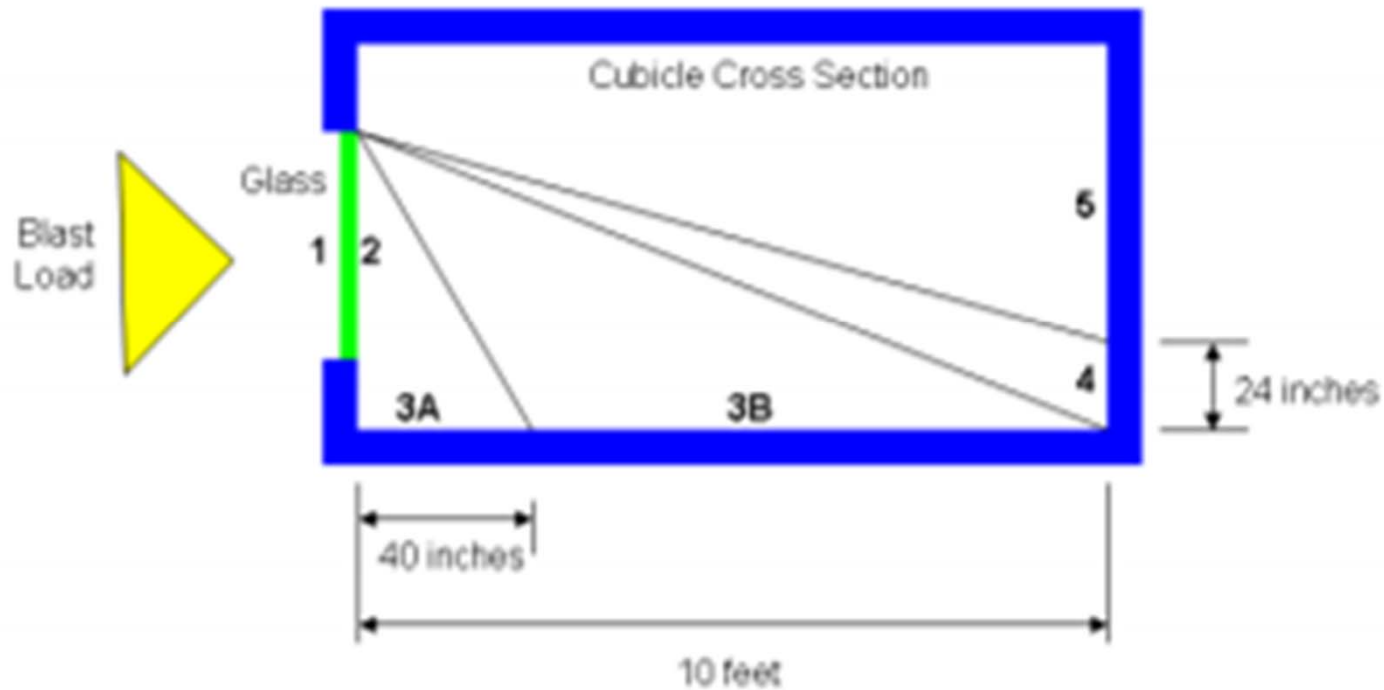


ASTM F1642-12 Performance Criteria Representation



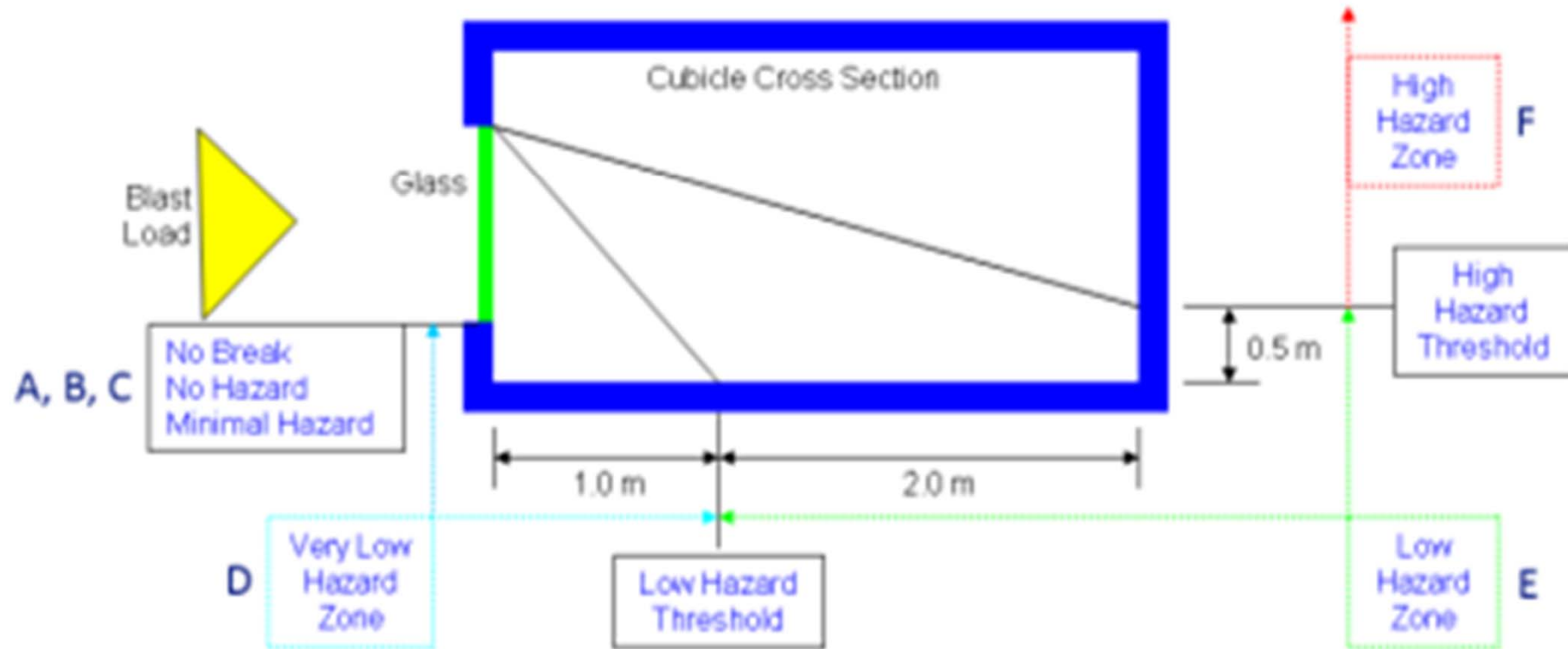


GSA Performance Criteria Representation





ISO 16934 Performance Criteria Representation





Summary of main results 1

	Window 1	Window 2	Window 3	Window 4	Window 5
Window Description	Fixed 1/4" Annealed	Fixed 1/4" Annealed	Fixed 1/4" Annealed	Fixed 1/4" Annealed	Fixed 1/4" Annealed
Film Thickness	8 mil Safety Zone	8 mil Safety Zone	8 mil Safety Zone	8 mil Safety Zone	None
Retrofit Description	4 Sides Wet Glaze, 3/4" Bead	4 Sides Wet Glaze, 3/4" Bead	4 Sides Wet Glaze, 3/4" Bead	Daylight / Unanchored	Unprotected
Damage Description	Glazing fractured, but fully retained in frame. Film had a 1" tear in the upper left corner.	Glazing fractured and released some fragments released. Film had multiple tears at the corners.	Glazing fractured and one fragment was released from a 3 inch tear in the upper right corner.	Glazing fractured and was fully released from frame. No measurable indents or perforations were noted in the witness panels.	Glazing fractured. Large fragments impacted and penetrated witness panel.
Average Pressure (psi)	4.49	4.78	4.59	5.11	4.89
Average Impulse (psi-ms)	9.86	11.04	10.49	11.49	11.64
GSA Performance Condition	2	2	2	3B	5
ASTM Performance Condition	No Hazard	No Hazard	Minimal Hazard	Low Hazard	High Hazard
ISO Performance Condition	B	B	C	E	F



Summary of main results 2

	Window 6	Window 7	Window 8	Window 9	Window 10
Window Description	Fixed 1/4" Annealed	Fixed 1/4" Annealed	Fixed 1/4" Annealed	Fixed 1/4" Annealed	Fixed 1/4" Annealed
Film Thickness	15 mil Safety Zone	15 mil Safety Zone	15 mil Safety Zone	15 mil Safety Zone	12 mil Safety Zone
Retrofit Description	Attached 2 Sides Vertical with No-Bar Mechanical System (6" Screw Spacing); Attached 2 Sides Horizontal with Wet Glaze, 3/4" Bead	Attached 2 Sides Vertical with No-Bar Mechanical System (6" Screw Spacing); Attached 2 Sides Horizontal with Wet Glaze, 3/4" Bead	Attached 2 Sides Vertical with No-Bar Mechanical System (6" Screw Spacing); Attached 2 Sides Horizontal with Wet Glaze, 3/4" Bead	Attached 2 Sides Vertical with No-Bar Mechanical System (6" Screw Spacing); Attached 2 Sides Horizontal with Wet Glaze, 3/4" Bead	4 Sides Wet Glaze
Damage Description	Glazing fractured and released one fragment. Film pulled out or silicone tearing was observed at all corners. A 3/8- inch film tear was observed in the upper right corner.	Glazing fractured but was fully retained in frame. Film pullout or silicone tearing was observed at three of the corners.	Glazing fractured and released some fragments. Film pullout or silicone tearing was observed at three corners. Bottom of frame bent.	Glazing fractured and released some fragments. Significant film pullout and silicon tearing was observed at all four corners.	Glazing fractured but was fully retained in frame. Film had a 1.3-inch tear in the lower left corner. There was no film pullout nor silicon tearing.
Average Pressure (psi)	5.69	5.48	5.71	5.77	6.97
Average Impulse (psi-ms)	13.89	13.94	15.77	15.52	19.16
GSA Performance Condition	2	2	3A	3A	2
ASTM Performance Condition	Minimal Hazard	No Hazard	Very Low Hazard	Very Low Hazard	No Hazard
ISO Performance Condition	C	B	C	B	B