BEEM Quick Reference

2007 Training

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1. Introduction:

This reference is to provide the user a quick reference for selection BEEM Typical Building types and Windows. Also included are the legend keys for UFC Levels of Protection, Window Hazard, and Human Injury as they relate to the 3 damage levels used by BEEM.

2. Portions of the BEEM Program to Avoid:

a. Standoff Contours: There are two standoff types that I have found to provide little value. There is no size of the member specified.

1. Steel Column
2. Concrete Column

b. Building Contours: There are several categories that I have found to provide little value. There is no size of the members specified.

1. Frame Material
2. Roof Material
3. Wall Material

c. SI Units: There is a bug in the SI units, do not use

d. BEEM Reports: The BEEM reports do not contain very useful information

e. BEEM FPCON Checklist: This check list is out of date. The file is located in the BEEM root directory and could be easily modified. (FPCONChecklist.html)

f. Custom Roof PI: There is a serious bug in the custom roof PI, please do not use till the next version of BEEM.

Appendix A
Typical Building Types

BEEM NAME	Description	Frame/Column	Roof	Wall
Steel	Butler Building	Steel	Corrugated Steel Decking	Steel
1-story concrete	Generic reinforced concrete building	reinforced concrete	reinforced concrete	reinforced concrete
2 story concrete	2-Story small concrete office building.	reinforced concrete	reinforced concrete	reinforced concrete
Brick house	1-Story Brick House.	wood	wood	brick
1-story lrg concrete	Large concrete building (>6,000 ft^2)	reinforced concrete	Corrugated Steel Decking	reinforced concrete
1-story sm. CMU wall	1 story small (<6,000 ft^2) building	reinforced concrete	reinforced concrete	reinforced masonry
1-story CMU wall	Small building (<6,000 ft ^2)	reinforced concrete	Corrugated Steel Decking	Unreinforced Masonry 12 in
FPT Type 1	Wall-Bearing Masonry, JMEM Type 1c, 1-6 stories Attached Commercial Offices/Retail (Brick) Multistory with Masonry, Load-Bearing Walls	Steel	Wood	Brick
FPT Type 2	Frame with Heavy Cladding, High-Rise, Commercial, JMEM Type 1a and 1b Attached Commercial High-Rise -- multistory steel framed, multistory reinforced concrete, framed, ER -- earthquake resistant	Steel Steel Steel Steel	reinforced concrete reinforced concrete reinforced concrete reinforced concrete	brick brick brick brick
FPT Type 3	Frame with Light Cladding, High Rise, Commercial, JMEM Type 1b Detached Close Set Commercial Offices Multistory Reinforced Concrete Framed	Steel	reinforced concrete	Metal stud (6in @ 16in spacing)
FPT Type 4	Box Wall Masonry, Up to 15 Stories, Commercial/Residential, JMEM Type 1c Detached Close Set Residential Houses/Apartments Multistory with Masonry Load-Bearing Walls	reinforced concrete	reinforced concrete	Metal stud (6in @ 16in spacing) /Reforced Concrete
FPT Type 5	Wall-Bearing Masonry, 1-3 Stories, Residential, JMEM Type 4b, Detached Close Set Houses Single Story Light Composite, Framed	reinforced concrete reinforced concrete reinforced concrete	wood wood wood	reinforced concrete reinforced concrete reinforced concrete
FPT Type 6	Wall-Bearing Massonry, JMEM Type 1c or 4b, 1-3 Stories, Detached Close Set Industrial Storage Multistory with Masonry, Load-Bearing Walls Single Story Light Composite Frame	Steel Steel Steel Steel	Wood Wood Wood Wood	reinforced concrete reinforced concrete reinforced concrete reinforced concrete

FPT Type 9	Wooden Wall Bearing, 1-3 Stories, Residential, JMEM 4a or 4b Closest Equivalent,	wood	wood	wood
	(Single Story Very Light Wood Frame	wood	wood	wood
	Single Story Wood Frame	wood	wood	wood
Temper Tent	'Temper Tent - 6061-T6 aluminum frame, covered with a 13oz canvas duck material, integral window and door sections. Typical dimensions 24 x 20 composed of 3 eight foot sections	Temper Tent Bass, Bait Rod Test data	Temper Tent Bass, Bait Rod Test data	Temper Tent Bass, Bait Rod Test data
Small Shelter Syste	Small Shelter System - 6061-T6 aluminum frame, covered with a 13oz canvas duck material, integral window and door sections. Typical dimensions 32.5 x 20 foot. and may be connected to create larger structures	'Small Shelter System Bait Rod Test data	'Small Shelter System Bait Rod Test data	'Small Shelter System Bait Rod Test data
Retrofit SEAHUT	Retrofit SEAHUT PI data is based on testing, Construction is entirely wood, 4 x 8 plywood attached to 2 x 4 studs. Typical Dimensions are 16 feet by 32 feet but could be larger Retrofit is one of several, extra nails, polymer coated. It is important to note that the structure response faired better when the building structure was left with some flexibility to it	Retrofit SEAHUT Bass, Bait Rod Test data	Retrofit SEAHUT Bass, Bait Rod Test data	Retrofit SEAHUT Bass, Bait Rod Test data
Standard SEAHUT	Standard SEAHUT PI data is based on testing, Construction is entirely wood, 4 x 8 plywood attached to 2 x 4 studs. Typical Dimensions are 16 feet by 32 feet but could be larger	Standard SEAHUT Bass, Bait Rod Test data	Standard SEAHUT Bass, Bait Rod Test data	Standard SEAHUT Bass, Bait Rod Test data
Low profile hotel lobby	Main entry of the Rasheed Hotel. Lower structure to either side of entrance doors. Reinforced concrete frame. Iraqi construction	reinforced concrete	Reinforced concrete	8 inch reinforce masonry
Highrise Hotel 4-18 stori	Reinforced concrete framed structure with large lobby for the first two floors, 14 floors for guest rooms, and a two story mechanical room. Iraqi construction	reinforced concrete	Reinforced concrete	8 inch reinforce masonry
Highrise Hotel Generic	4-18 Story highrise structure with concrete moment resisting frame, concrete walls and concrete roof. Iraqi construction	reinforced concrete	Reinforced concrete	6 inch reinforced concrete
Trailer	Standard trailer - aluminum sided with steel frame.	Steel	Aluminum	Metal Stud

Appendix B
Window Types

Window Pane Composition

There are two window sizes		
	US Units	**SI Units**
Large	49.2" x 61"	1.25m x 1.55m
Small	21.65" x 49.2"	0.55m x 1.25m

All window hazard P-I charts were obtained from the *Glazing Hazard Guide* , June 1997 edition, published by the Security

Glossary of Window Type Abbreviations and Symbols

AG	**Annealed Glass** is by far the most common material used for window glass. Also called “plate glass” or “plain glass.”
TTG	**Thermally Tempered Glass** is a high-strength glass that is produced by heating and then rapidly cooling annealed glass.
ASF	**Anti-Shatter Film** is a special film applied to window glass designed to hold fragments together after the glass cracks. All hazard level predictions made by AT Planner and WinDAS for filmed windows are based on a “daylight” application of anti-shatter film on the inside surface of the windowpane. “Daylight” film is attached only to exposed glass, and it is in no way held in the frame bite or otherwise attached to the window frame.
BBNC	**Bomb Blast Net Curtain** is a special type of curtain designed to catch filmed glass as it projects into a room.
Mon	**Monolithic** glass is uniform in its material composition, as compared to laminated glass, which is composed of alternating layers of glass and plastic.
Lam	**Laminated** glass consists of two or more individual sheets of glass bonded together by a polyvinyl butyral (PVB) plastic interlayer.
&	The “**&**” symbol denotes an air gap in an insulated window. For example, “Mon AG & Mon AG” represents two panes of monolithic annealed glass separated by an air gap.
+	The “**+**” symbol indicates the window was retrofitted with either anti-shatter film or a combination of anti-shatter film and a bomb blast net curtain. For example, "Mon AG + ASF + BBNC" represents a single pane of monolithic annealed glass retrofitted with both anti-shatter film and a bomb blast net curtain.

Window Type Pick List Entries for Small Pane Windows

WinHaz ID #	*GHG* Chart #	Window Type (SI Units)	Window Type (English Units)
	Small	21.65" x 49.2"	0.55m x 1.25m
1.	1a	4. mm Mon AG	0.157-in. Mon AG
2.	1b	4. mm Mon AG + 0.05-mm ASF	0.157-in. Mon AG + 2-mil ASF
3.	1c	4. mm Mon AG + 0.05-mm ASF + BBNC	0.157-in. Mon AG + 2-mil ASF + BBNC
4.	1d	4. mm Mon AG + 0.1-mm ASF	0.157-in. Mon AG + 4-mil ASF
5.	1e	4. mm Mon AG + 0.1-mm ASF + BBNC	0.157-in. Mon AG + 4-mil ASF + BBNC
6.	1f	4. mm Mon AG + 0.2-mm ASF	0.157-in. Mon AG + 8-mil ASF
7.	17a	6. mm Mon AG	0.236-in. Mon AG
8.	17b	6. mm Mon AG + 0.3-mm ASF	0.236-in. Mon AG + 12-mil ASF
9.	17c	6. mm Mon AG + 0.1-mm ASF	0.236-in. Mon AG + 4-mil ASF
10.	17d	6. mm Mon AG + 0.1-mm ASF + BBNC	0.236-in. Mon AG + 4-mil ASF + BBNC
11.	16	8. mm Mon AG	0.315-in. Mon AG
12.	19	10. mm Mon AG	0.394-in. Mon AG
13.	18	4. mm Mon TTG	0.157-in. Mon TTG
14.	3	6. mm Mon TTG	0.236-in. Mon TTG
15.	4	8. mm Mon TTG	0.315-in. Mon TTG
16.	5	10. mm Mon TTG	0.394-in. Mon TTG
Laminated glass (LAM) See Layer Specifications for Laminated Glass			
17.	14	6. 4-mm Lam AG	0.252-in. Lam AG
18.	15	6. 8-mm Lam AG	0.268-in. Lam AG
19.	8	7. 5-mm Lam AG	0.295-in. Lam AG
20.	48	11. 3-mm Lam AG	0.445-in. Lam AG
21.	11	11. 5-mm Lam AG	0.453-in. Lam AG
22.	41	15. 4-mm Lam AG	0.606-in. Lam AG
23.	42	19. 4-mm Lam AG	0.764-in. Lam AG
Insulated window types that consist of panes of glass separated by an air gap. Laminated panes contain jumps to the laminated window specifications.			
24.	2	4. mm Mon AG & 4-mm Mon AG	0.157-in. Mon AG & 0.157-in. Mon AG
25.	2a	4. mm Mon AG & 4-mm Mon AG + 0.1-mm ASF	0.157-in. Mon AG & 0.157-in. Mon AG + 4-mil ASF

26.	2b	4. mm Mon AG & 4-mm Mon AG + 0.1-mm ASF + BBNC	0.157-in. Mon AG & 0.157-in. Mon AG + 4-mil ASF + BBNC
27.	66a	6. mm Mon AG & 6-mm Mon AG	0.236-in. Mon AG & 0.236-in. Mon AG
Insulated window types that consist of panes of glass separated by an air gap. Laminated panes contain jumps to the laminated window specifications.			
28.	66b	6. mm Mon AG & 6-mm Mon AG + 0.1-mm ASF	0.236-in. Mon AG & 0.236-in. Mon AG + 4-mil ASF
29.	66c	6. mm Mon AG & 6-mm Mon AG + 0.1-mm ASF + BBNC	0.236-in. Mon AG & 0.236-in. Mon AG + 4-mil ASF + BBNC
30.	20	4. mm Mon AG & 6.4-mm Lam AG	0.157-in. Mon AG & 0.252-in. Lam AG
31.	9	6. mm Mon AG & 7.5-mm Lam AG	0.236-in. Mon AG & 0.295-in. Lam AG
32.	10	6. mm Mon TTG & 7.5-mm Lam AG	0.236-in. Mon TTG & 0.295-in. Lam AG
33.	50	6. mm Mon TTG & 11.5-mm Lam AG	0.236-in. Mon TTG & 0.453-in. Lam AG
34.	49	8. mm Mon TTG & 11.5-mm Lam AG	0.315-in. Mon TTG & 0.453-in. Lam AG
35.	12	6. mm Mon TTG & 6-mm Mon TTG	0.236-in. Mon TTG & 0.236-in. Mon TTG
36.	13	6. 4-mm Lam AG & 6.4-mm Lam AG	0.252-in. Lam AG & 0.252-in. Lam AG

WinHaz ID #	*GHG* Chart #	Window Type (SI Units)	Window Type (English Units)
	Large	49.2" x 61"	1.25m x 1.55m
Monolithic glass (**Mon**)			
37.	21a	4. mm Mon AG	0.157-in. Mon AG
38.	21b	4. mm Mon AG + 0.1-mm ASF	0.157-in. Mon AG + 4 mil ASF
39.	21c	4. mm Mon AG + 0.1-mm ASF + BBNC	0.157-in. Mon AG + 4 mil ASF + BBNC
40.	21d	4. mm Mon AG + 0.2-mm ASF	0.157-in. Mon AG + 8 mil ASF
41.	34a	6. mm Mon AG	0.236-in. Mon AG
42.	34b	6. mm Mon AG + 0.1-mm ASF + BBNC	0.236-in. Mon AG + 4 mil ASF + BBNC
43.	33	8. mm Mon AG	0.315-in. Mon AG
44.	32	10. mm Mon AG	0.394-in. Mon AG
45.	35	4. mm Mon TTG	0.157-in. Mon TTG
46.	28	6. mm Mon TTG	0.236-in. Mon TTG
47.	29	8. mm Mon TTG	0.315-in. Mon TTG
48.	30	10. mm Mon TTG	0.394-in. Mon TTG
Laminated glass (LAM) See Layer Specifications for Laminated Glass			
49.	38	6.4-mm Lam AG	0.252-in. Lam AG
50.	37	6.8-mm Lam AG	0.268-in. Lam AG
51.	22	7.5-mm Lam AG	0.295-in. Lam AG
52.	47	11.3-mm Lam AG	0.445-in. Lam AG
53.	23	11.5-mm Lam AG	0.453-in. Lam AG
54.	24	15.4-mm Lam AG	0.606-in. Lam AG
55.	25	19.4-mm Lam AG	0.764-in. Lam AG
Insulated window types that consist of panes of glass separated by an air gap. See Layer Specifications for Laminated Glass for information on the composition of the laminated panes.			
56.	43	4. mm Mon AG & 7.5-mm Lam AG	0.157-in. Mon AG & 0.295-in. Lam AG

57.	26	6. mm Mon AG & 7.5-mm Lam AG	0.236-in. Mon AG & 0.295-in. Lam AG
58.	27	6. mm Mon TTG & 7.5-mm Lam AG	0.236-in. Mon TTG & 0.295-in. Lam AG
59.	52	6. mm Mon TTG & 11.5-mm Lam AG	0.236-in. Mon TTG & 0.453-in. Lam AG
60.	51	8. mm Mon TTG & 11.5-mm Lam AG	0.315-in. Mon TTG & 0.453-in. Lam AG
61.	39a	4. mm Mon AG & 4-mm Mon AG	0.157-in. Mon AG & 0.157-in. Mon AG
62.	39b	4. mm Mon AG & 4-mm Mon AG + 0.1-mm ASF	0.157-in. Mon AG & 0.157-in. Mon AG + 4 mil ASF
63.	65a	6. mm Mon AG & 6-mm Mon AG	0.236-in. Mon AG & 0.236-in. Mon AG
64.	65b	6. mm Mon AG & 6-mm Mon AG + 0.1-mm ASF	0.236-in. Mon AG & 0.236-in. Mon AG + 4 mil ASF
65.	36	6. mm Mon TTG & 6-mm Mon TTG	0.236-in. Mon TTG & 0.236-in. Mon TTG
66.	40	8. mm Mon TTG & 8-mm Mon TTG	0.315-in. Mon TTG & 0.315-in. Mon TTG
67.	44	6.4-mm Lam AG & 6.4-mm Lam AG	0.252-in. Lam AG & 0.252-in. Lam AG
Laminated (LAM) Thermally Tempered Glass (TTG) See Layer Specifications for Laminated Glass			
68.	31	9.5-mm Lam TTG	0.374-in. Lam TTG

Appendix C
UFC Level of Protection /BEEM Damage Levels

Levels of Protection
New and Existing Buildings

Table C2.1 Levels of Protection – New Buildings

Level of Protection	Potential Structural Damage	Potential Door and Glazing Hazards	Potential Injury
Below AT standards	Severely damaged. Frame collapse/massive destruction. Little left standing.	Doors and windows fail and result in lethal hazards	Majority of personnel suffer fatalities.
Very Low	Heavily damaged - onset of structural collapse: Major deformation of primary and secondary structural members, but progressive collapse is unlikely. Collapse of non-structural elements.	Glazing will break and is likely to be propelled into the building, resulting in serious glazing fragment injuries, but fragments will be reduced. Doors may be propelled into rooms, presenting serious hazards.	Majority of personnel suffer serious injuries. There are likely to be a limited number (10% to 25%) of fatalities.
Low	Damaged – unrepairable. Major deformation of non-structural elements and secondary structural members and minor deformation of primary structural members, but progressive collapse is unlikely.	Glazing will break, but fall within 1 meter of the wall or otherwise not present a significant fragment hazard. Doors may fail, but they will rebound out of their frames, presenting minimal hazards.	Majority of personnel suffer significant injuries. There may be a few (<10%) fatalities.
Medium	Damaged – repairable. Minor deformations of non-structural elements and secondary structural members and no permanent deformation in primary structural members.	Glazing will break, but will remain in the window frame. Doors will stay in frames, but will not be reusable.	Some minor injuries, but fatalities are unlikely.
High	Superficially damaged. No permanent deformation of primary and secondary structural members or non-structural elements.	Glazing will not break. Doors will be reusable.	Only superficial injuries are likely.

Below Antiterrorism Standards

Severely Damaged

Potential Structural Damage	**Frame collapse/massive destruction. Little left standing.**
Potential door and glazing hazards	**Doors and windows fail and result in lethal hazards.**
Potential Injury	**Majority of personnel suffer fatalities.**

Very Low Level of Protection

Heavily Damaged – Onset of Structural Collapse

	New Buildings	Existing Buildings	Expeditionary
Potential Structural Damage	**Major deformation of primary and secondary structural members. Collapse of non-structural elements. *Progressive collapse unlikely.***	**Major deformation of primary structural members. Collapse of secondary & non-structural elements. *Progressive collapse unlikely.***	**Major portions of structure (over 50%) will collapse. Over 50% of secondary structural members will collapse**
Potential door and glazing hazards	**Glazing breaks and is propelled into building. Serious fragment injuries, but fragments reduced.** **Doors may be propelled into room resulting in serious hazards.**		
Potential Injury	**Majority of personnel suffer serious injuries.** **Limited number (10% -20%) of fatalities**		

Baseline Standard for inhabited buildings.

Low Level of Protection

Damaged – Unrepairable

	New Buildings	Existing Buildings	Expeditionary
Potential Structural Damage	**Major deformation of non-structural and secondary structural elements. Minor deformation of primary structural elements**	**Collapse of non-structural elements. Major deformation of secondary structural elements. Minor deformation of primary structural members.**	**Some sections of the structure may collapse or lose structural capacity (10% - 20% of structure.)**
Potential door and glazing hazards	**Glazing will break, but fall within 1 meter of wall or otherwise not present serious hazard.** **Doors may fail, but rebound out of frames.**	**Glazing will break and be propelled into building, but should result in survivable fragment injuries.** **Doors may fail, but rebound out of frames.**	**Not applicable.**
Potential Injury	**Majority of personnel suffer significant injuries. There may be a few (<10%) fatalities.**		

Baseline Standard for Billeting and Primary Gathering Buildings.

Medium Level of Protection

Damaged – Repairable

	New Buildings	Existing Buildings	Expeditionary
Potential Structural Damage	**Minor deformations of non-structural elements and secondary structural elements. No permanent deformation of primary structural members.**	**Major deformation of non-structural elements. Minor deformations of secondary structural elements. No permanent deformation of primary structural members.**	**Minor to major deformations of both structural and non-structural elements. Some secondary debris likely. Structure remains intact with collapse unlikely.**
Potential door and glazing hazards	**Glazing will break, but will remain in frame.** **Doors stay in frames, but will not be reusable.**		**Not applicable.**
Potential Injury	**Some minor injuries, but fatalities are unlikely.**		

High Level of Protection

Superficial Damage

	New Buildings	Existing Buildings	Expeditionary
Potential Structural Damage	**No permanent deformation of non-structural elements or primary or secondary structural members.**		
Potential door and glazing hazards	**Glazing will not break.** **Doors will be reusable.**		**Not applicable.**
Potential Injury	**Only superficial injuries likely.**		

Appendix D
Window Hazard Levels

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Window Hazard Levels

U.K. Glazing Hazard Standard	BEEM Damage Level	Description
No break	No Damage	No visible damage to the glazing or frame.
Break Safe	Low Damage	Glazing fragments inside the room are within a maximum distance of 1 meter from the window line.
Low Hazard	Medium Damage	Glazing fragments are thrown into the room for a distance of approximately 1 to 3 meters, but do not exceed a height of 0.5 meter above the floor at the 3-meter distance. Injuries would be limited to lower body cuts, and fatalities would not be expected although there would be some risk to persons within 1 to 2 meters of windows.
High Hazard	High Damage	Glazing fragments are thrown much further into the room and at high velocity above the 0.5-meter height at the 3-meter range. Serious injuries, including cuts to the upper body and face, from the flying fragments would be expected. Fatalities could occur.
See Figure 4		

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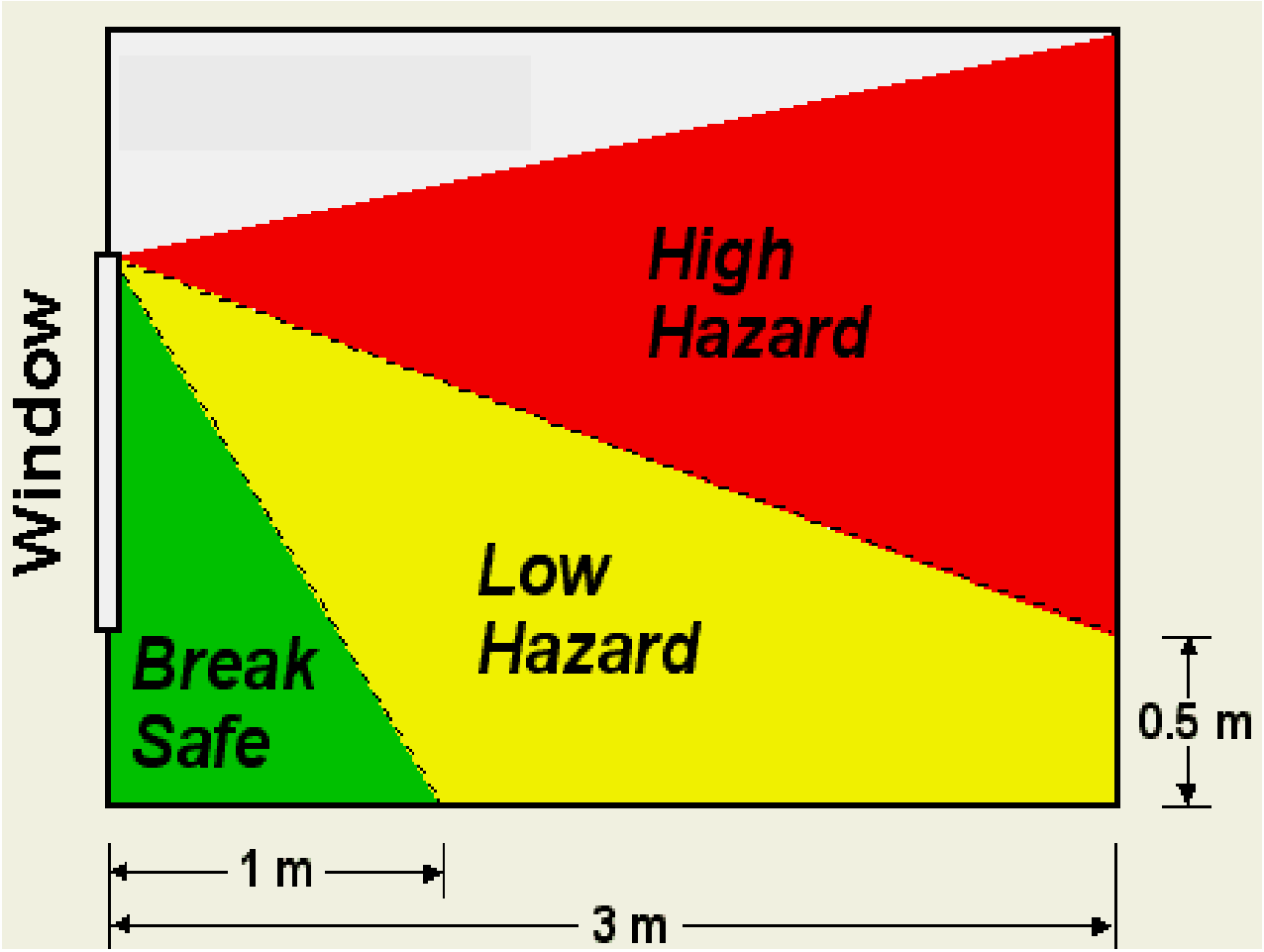
Window Hazard Levels



Appendix E
Human Injury in the Free Field

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Human Injury

Quantifying Human Injury						
	Low Damage		Medium Damage		High Damage	
	Description	Criteria	Description	Criteria	Description	Criteria
Lethality due to Human Lung Damage	**Threshold of lethality**	P-i curves **Figure 5**	**50% lethality**	P-i curves **Figure 5**	**99% Lethality**	P-i curves **Figure 5**
Human Lethality Based on Tertiary Damage to Skull	"Mostly Safe" = **Threshold of lethality**	V = 10 ft/sec, **Figure 6**	**50% fracture**	v = 18 ft/sec **Figure 6**	**Near 100% fracture**	v = 23 ft/sec **Figure 6**
Human Eardrum Rupture	**Temporary Hearing Loss**	P-i curves **Figure 7**	**Threshold eardrum rupture**	P-i curves **Figure 7**	**50% eardrum rupture**	P-i curves **Figure7**

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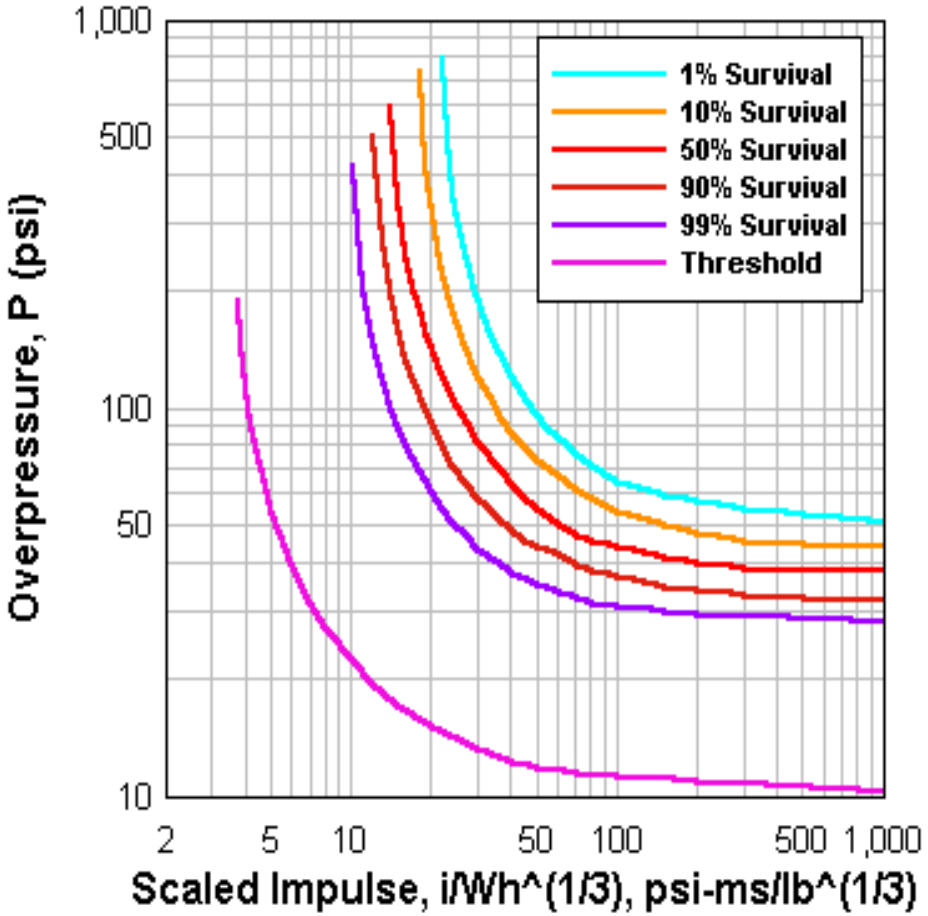
Lung Damage



- **X axis**
  - **Scaled impulse**
  - **Mass of subject**
- **Y axis**
  - **Scaled incident peak overpressure (incident/ambient atmospheric**

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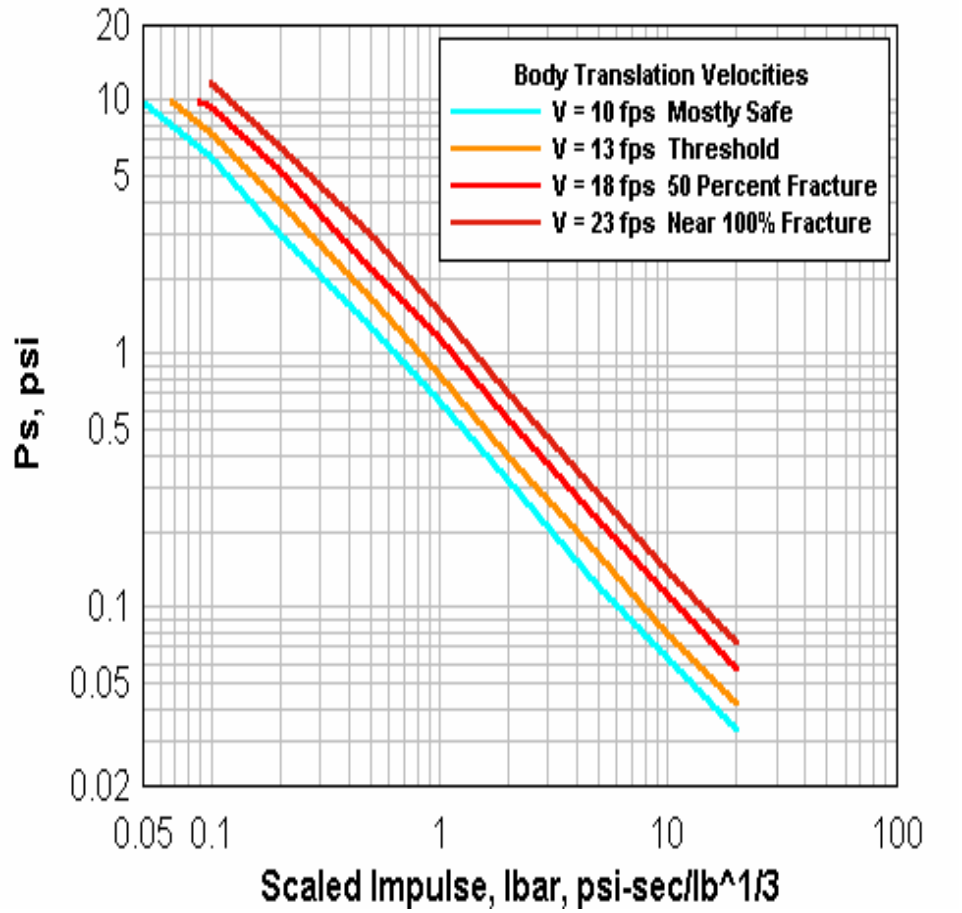
Skull Fracture



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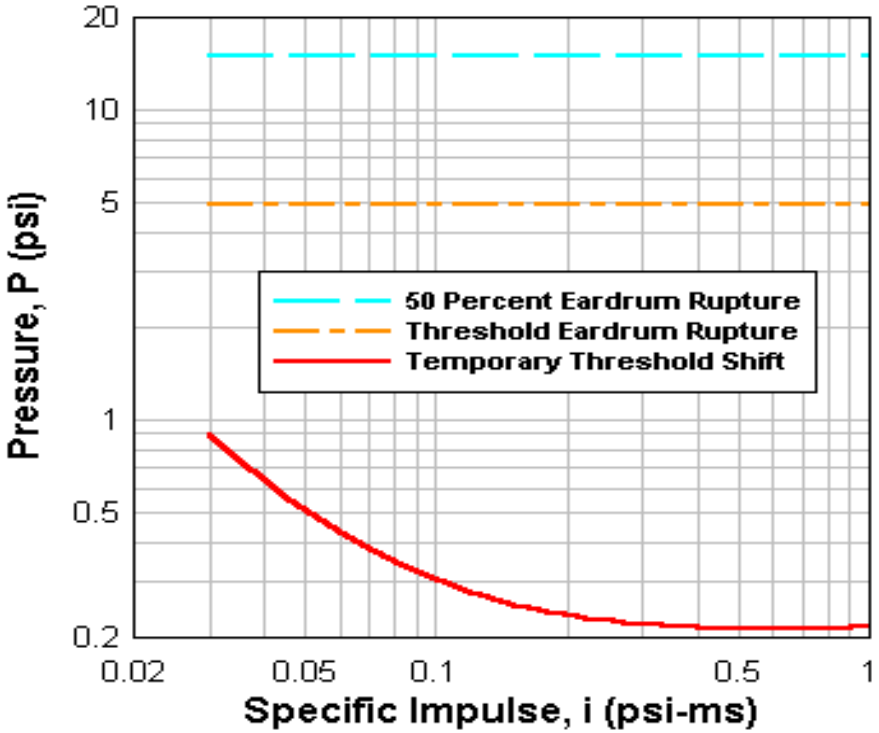
Ear Drum Rupture



- **Human Ear Damage for Blast Waves Arriving at Normal Angle of Incidence.**
- **Temporary Threshold shift: the case where 90% of those exposed are not likely to suffer a excessive earring loss.**