Patlamaya Dayanıklı Güvenli Tasarım – Kasıtlı Patlamalar İçin Tehdit Analizleri

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İMO MESLEKİÇİ SEMİNERLERİ

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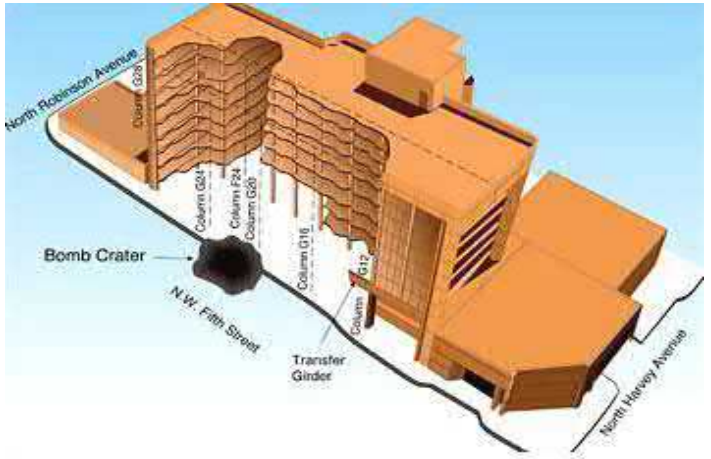
Sunumun İçeriği

- Patlamalar
- Patlama Yüklerinin Hesabı
- Patlama Etkileri
- Patlama Analizi Yöntemleri
- Kasıtlı Patlama Tehdit Analizleri
- Camlar ve Kapılar
- Parçacık Etkisi
- Güçlendirme Yöntemleri
- Progressive Collapse Analizi

Patlamalar

Oklahoma Patlaması



Failure boundaries of roof/floor slabs in the Murrah Building.

A powerful fertilizer bomb blew up the Alfred P. Murrah Federal Office Building on April 19, 1995, killing 168 people and injured 680+

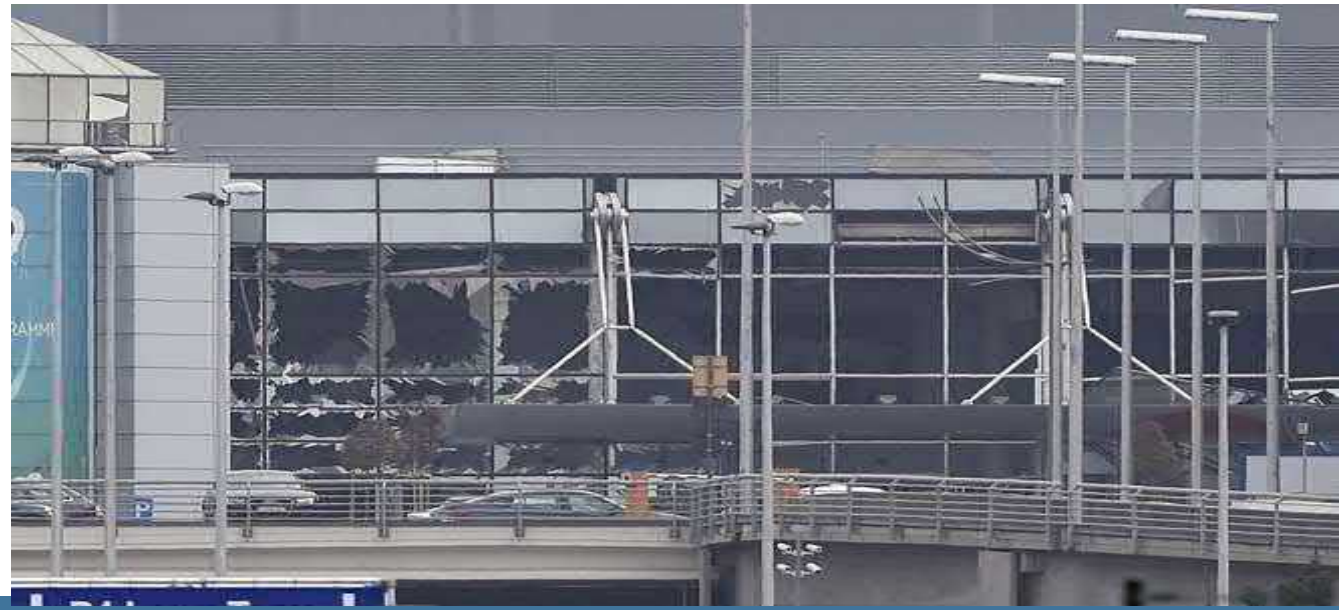
Blast from approximately over 5,000 pounds (2,300 kg) of equiv. TNT

Havaalanı Saldırıları

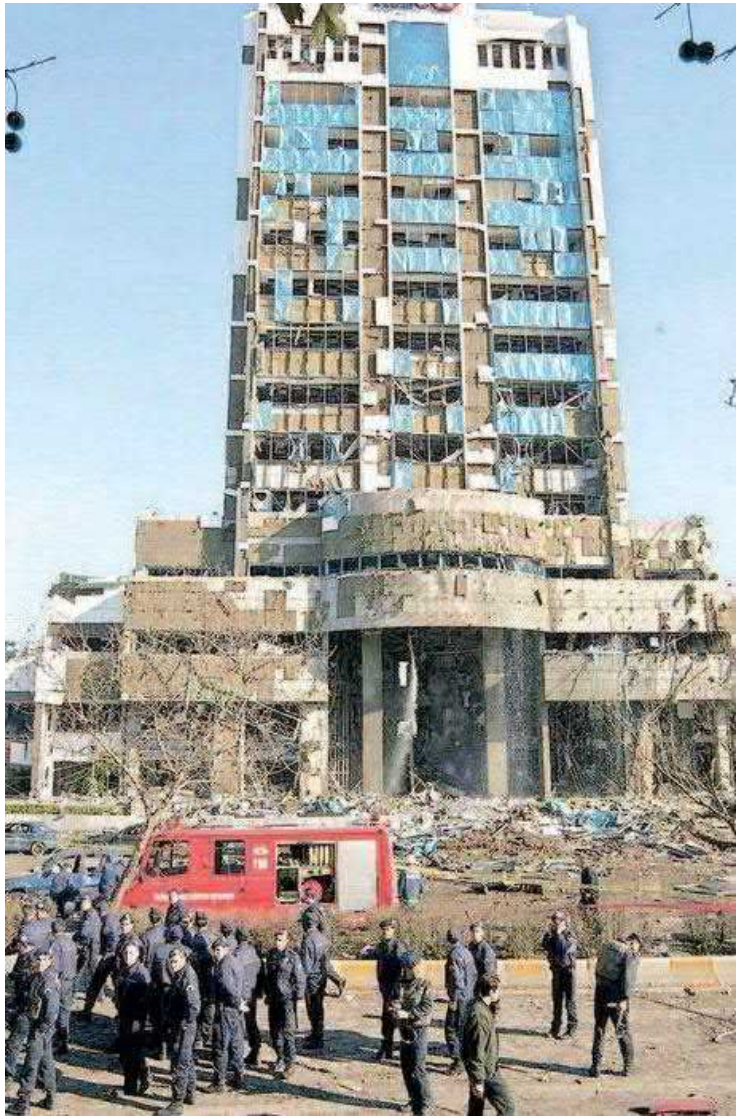
A small person-borne improvised explosive devices (PBIEDs):

- *The **2016, Ataturk airport** attack resulted in 43 fatalities and over 230 wounded. **Most injuries were due to glass fragments**.*
- unlikely to exceed 20 kilograms (kg) of weight. Such charges at close distance generate very high pressures with short durations.

- *The **2016, Brussel's airport** attack resulted in 35 fatality and 340 wounded. **Many injuries were due to glass fragments.***



Levent HSBC Saldırısı, Kasım 2003



November 20, 2003, two terrorist attacks in Istanbul

@ 10:55 Levent HSBC Turkey Headquarter

@ 11: 00 British Consulate

31 people killed, 400 were injured

detonation of a bomb, comprising 700 kilograms of ammonium sulfate, ammonium nitrate, and compressed fuel oil,[10] in a truck that had parked in front of the HSBC Bank AS building

Mardin Midyat Emniyet Binasi

08 Haziran 2016 – 3 killed, 52 injured

Mardin Midyat Emniyet Binasi

2020 Beyrut Patlaması

- On 4 August 2020, a large amount of ammonium nitrate stored at the port of the city of Beirut, the capital of Lebanon, exploded,
- causing at least 207 deaths, 7,500 injuries, and US$15 billion in property damage,
- and leaving an estimated 300,000 people homeless.
- A cargo of 2,750 tonnes of the substance (equivalent to around 1.1 kilotons of TNT) had been stored in a warehouse without proper safety measures
- Homes as far as 10 kilometers (6 miles) away were damaged by the blast

1ft = 0.30 mt, 2.1 mile = 3.38 km, 1 lbs = 0.45 kg

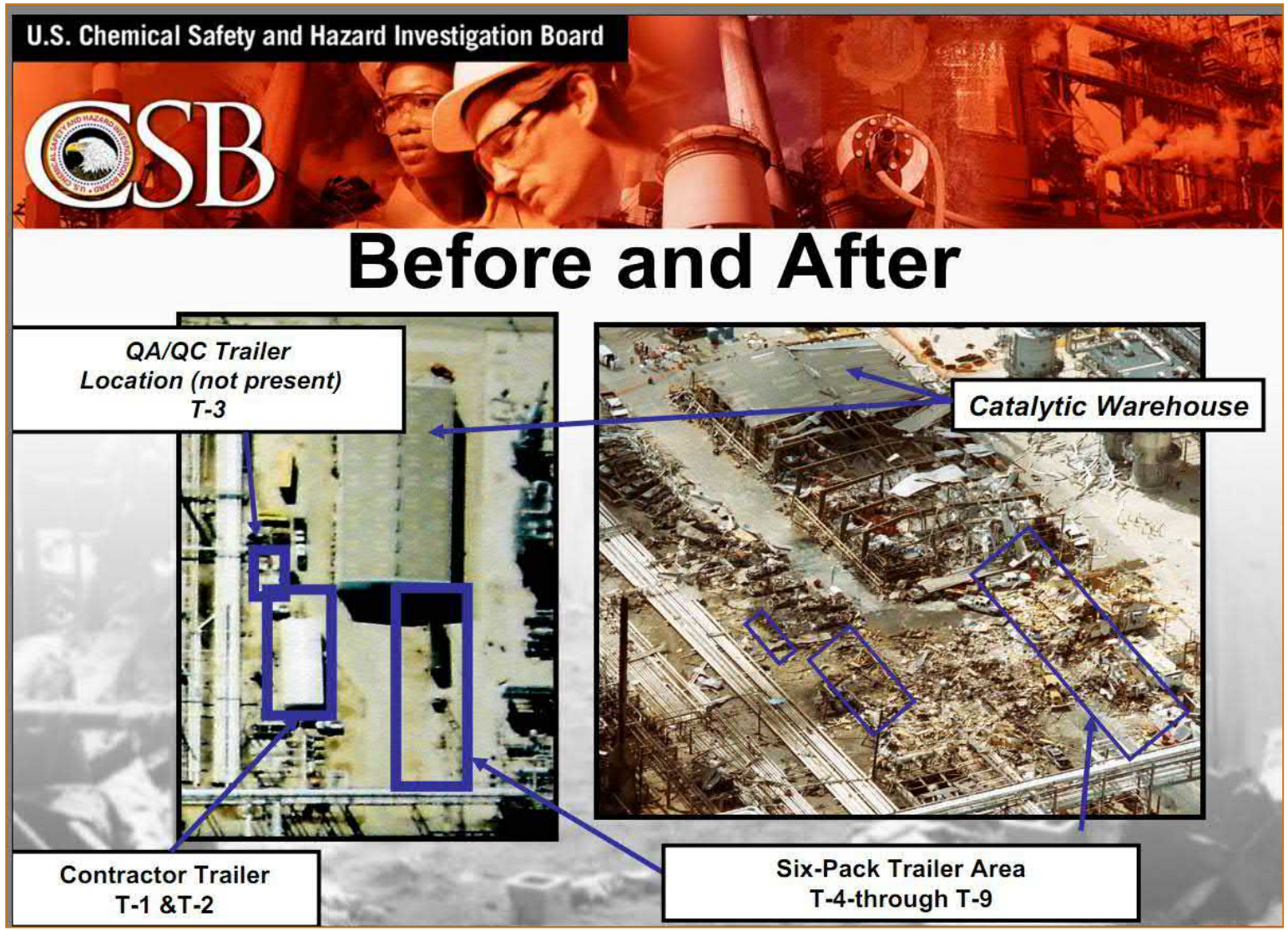
Terörist Saldırıları

A vehicle-borne improvised explosive device (VBIED):

- *The **1993, Bishopsgate, London** attack resulted in 1 fatality and 44 wounded and over **500 tons of glass fragments**.*

- ***Mosul Attack 2017,***

BP Texas City, Mart 2005



15 people killed, 170 of them injured

BP Texas City, Mart 2005

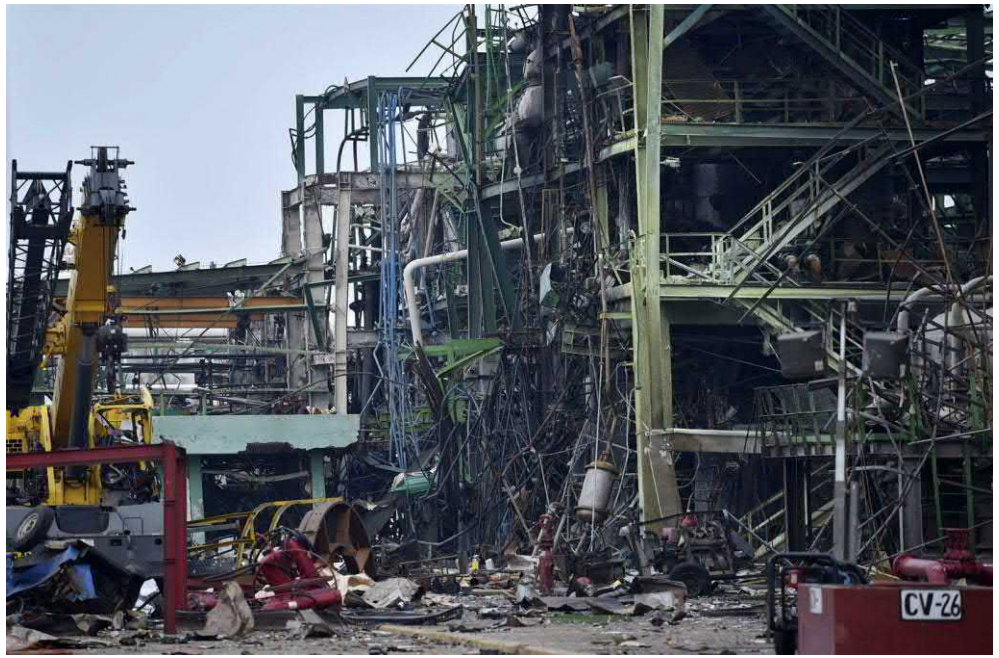
Ref: CSB

Kimyasal Patlamalar

- *The **2013 Texas** West Fertilizer Company explosion resulted in 15 fatalities and 200 injuries.*

Sanayi Yapılarında Patlamalar

Mart 2005



Nisan 2016

http://www.pophistorydig.com/topics/tag/oil-refinery-dangers/

Petrokimya Tesislerindeki Buhar Bulutu (VCE) Patlamaları

TÜPRAŞ

….

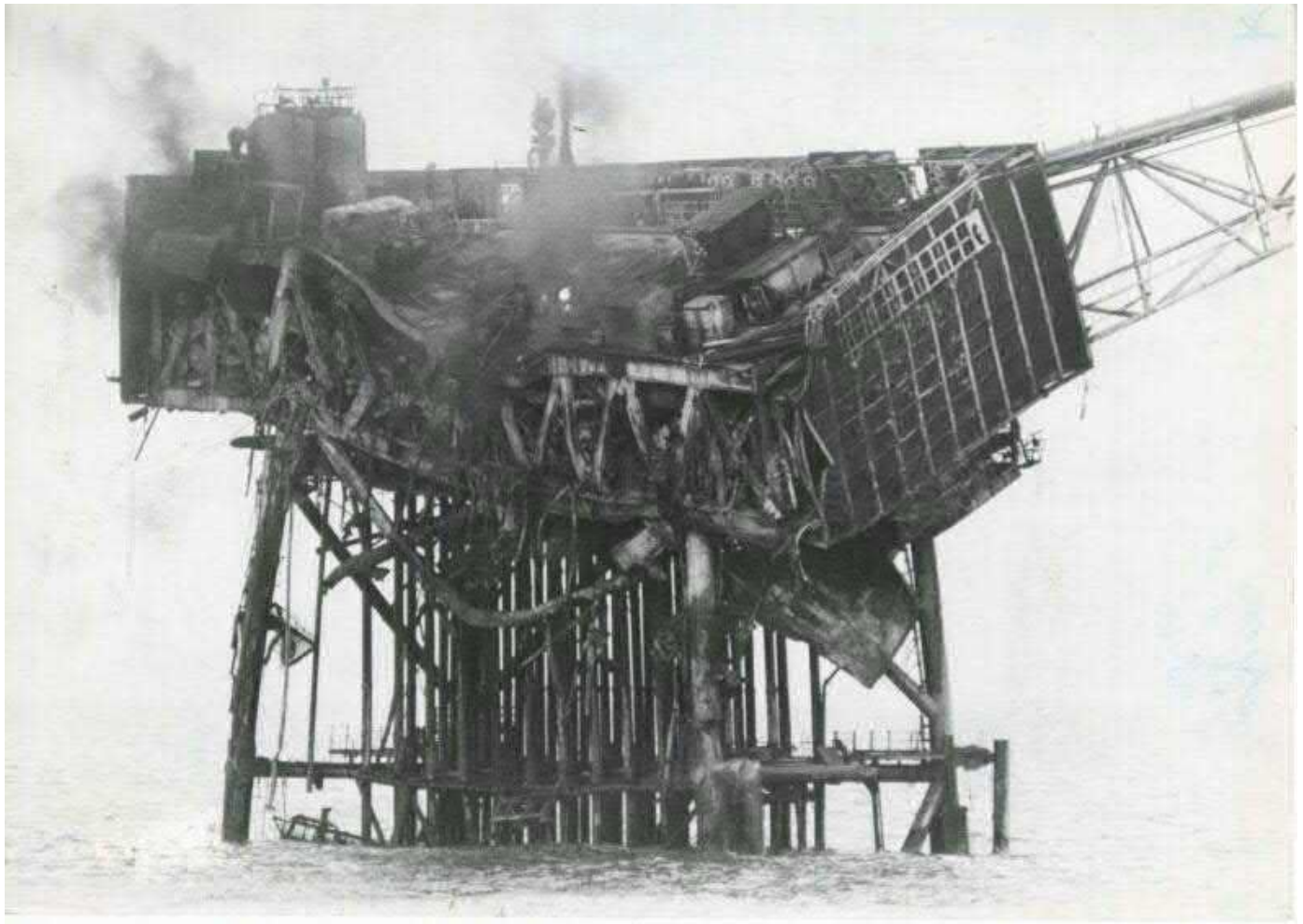
2017, 2 dead and 7 injuries

2016, 1 dead and 4 injuries

2014, 1 dead

…

Piper Alpha Offshore Platform Patlaması



167 people were killed when Occidental Petroleum's Piper Alpha oil rig in the North Sea exploded after a gas leak, July 1988

Deepwater Horizon Oil Rig Patlaması

April 2010 – 11 killed, 16 injured

Deepwater Horizon Oil Rig Patlaması

Sinking of the Deepwater Horizon Platform after a suspected methane burp and explosion, Extremely high pressures >>10 bars

Patlama Yükleri

Patlama Tipleri

İnfilak - Detonation (e.g. generated with TNT) occurs when the combustion is driven by *shock heating and pressurization of the unburned fuel to the point of auto-ignition*.

- The flame front and shock wave are coupled, resulting in sonic or supersonic velocities.
- The shock compresses the material, thus increasing the gas temperature to the point of auto ignition.
- Flammable gases, when mixed with an oxidizer, can detonate in certain environments.

Patlama Tipleri

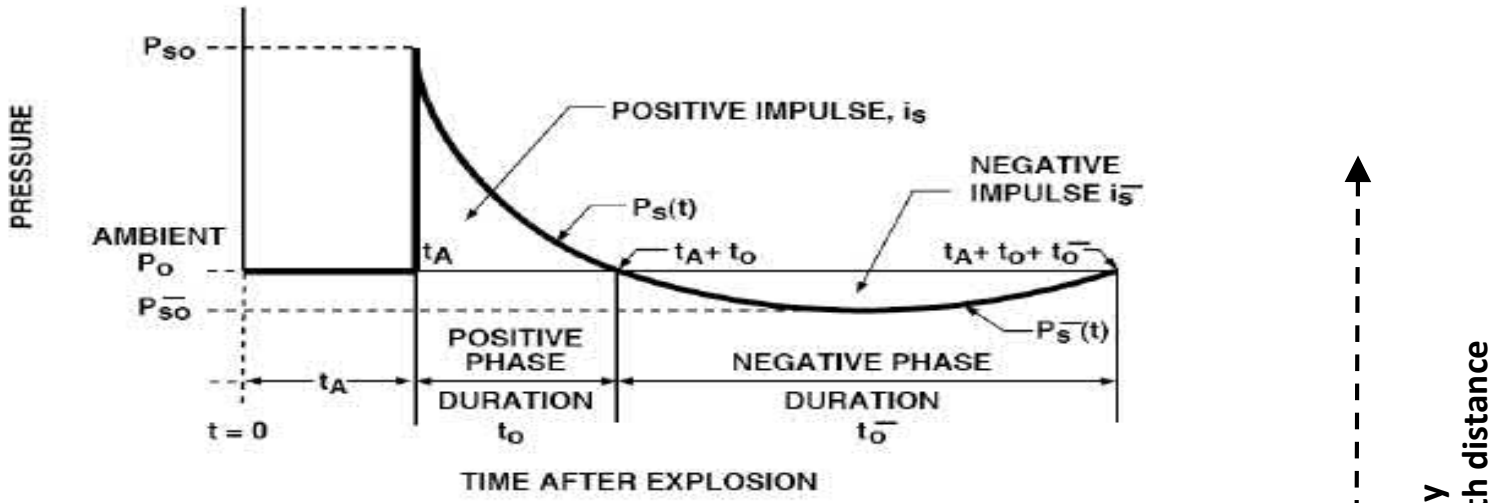
Yanarak Patlama - Deflagration (e.g. VCE) is a subsonic combustion event where the *hot burning material preheats the subsequent layer of cold unburned gas or dust and ignites it.*

- The ignition occurs through heat and mass transfer originating from the flame.
- Most Vapor Cloud Explosions (VCEs) are deflagration type explosions.

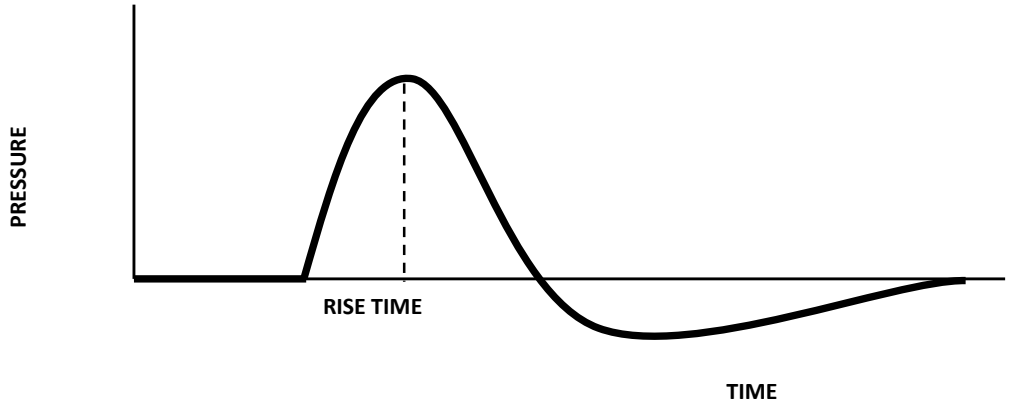
Patlama Tipleri

1 psi = 6.9 kPa

Shock Wave (Detonation)



Pressure Wave (Deflagration)



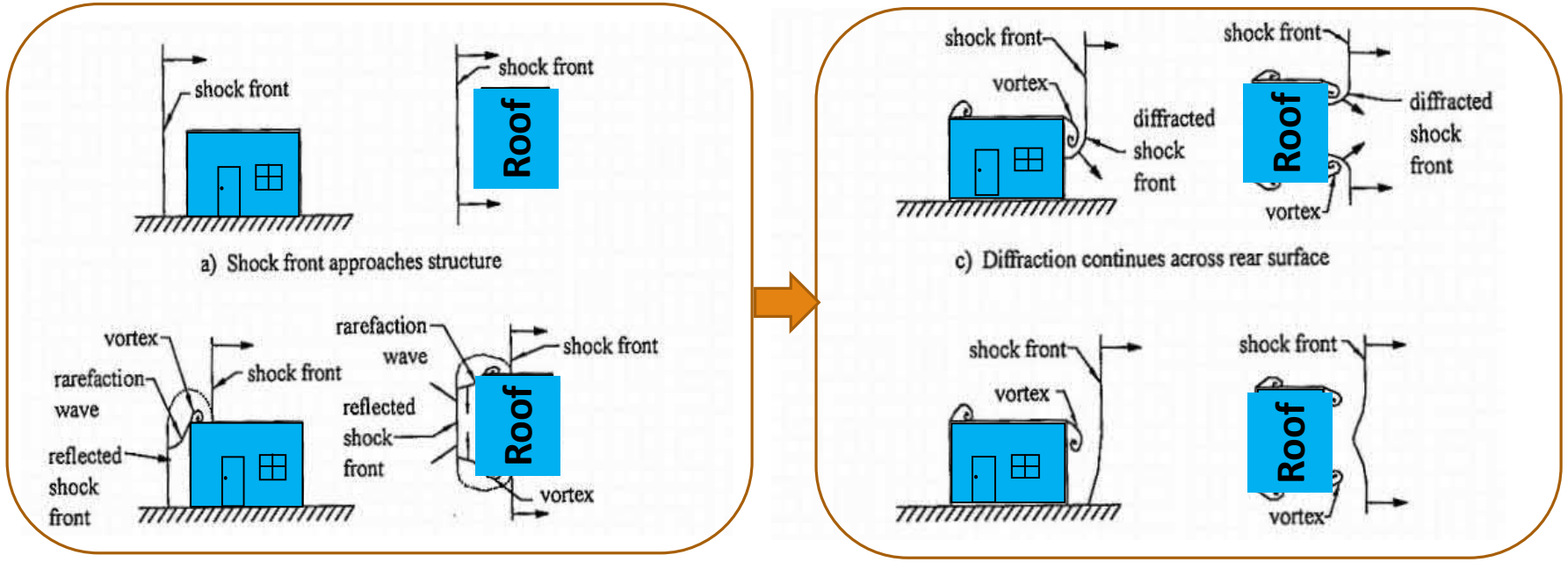
Increasing Severity Or "Shock up" with distance

Patlamaların Binalara Etkisi

Blast Load Measured by

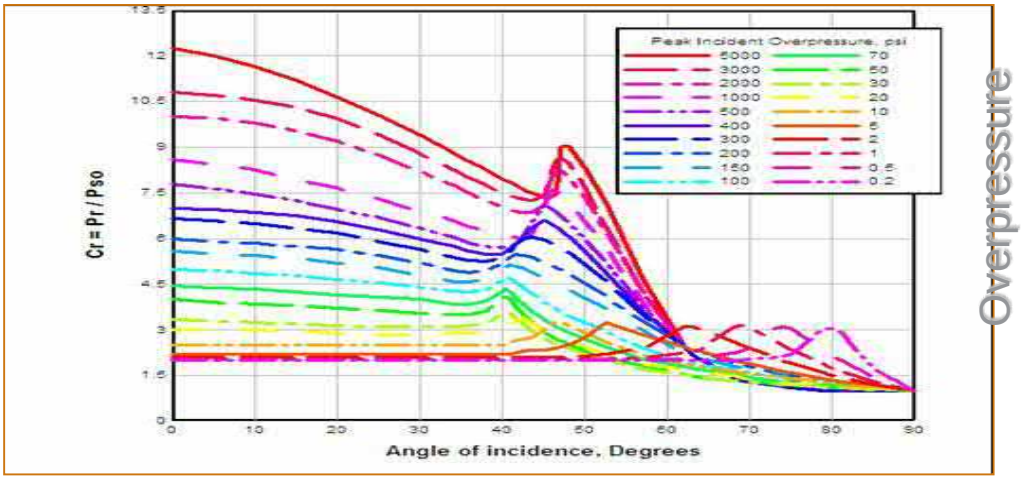
- **Pressure**
- **Impulse/ Duration (assumes a shape)**

- Reflected v Side-on
- Incident Angle
- Rise Time
- Negative Phase Pressure
- Clearing

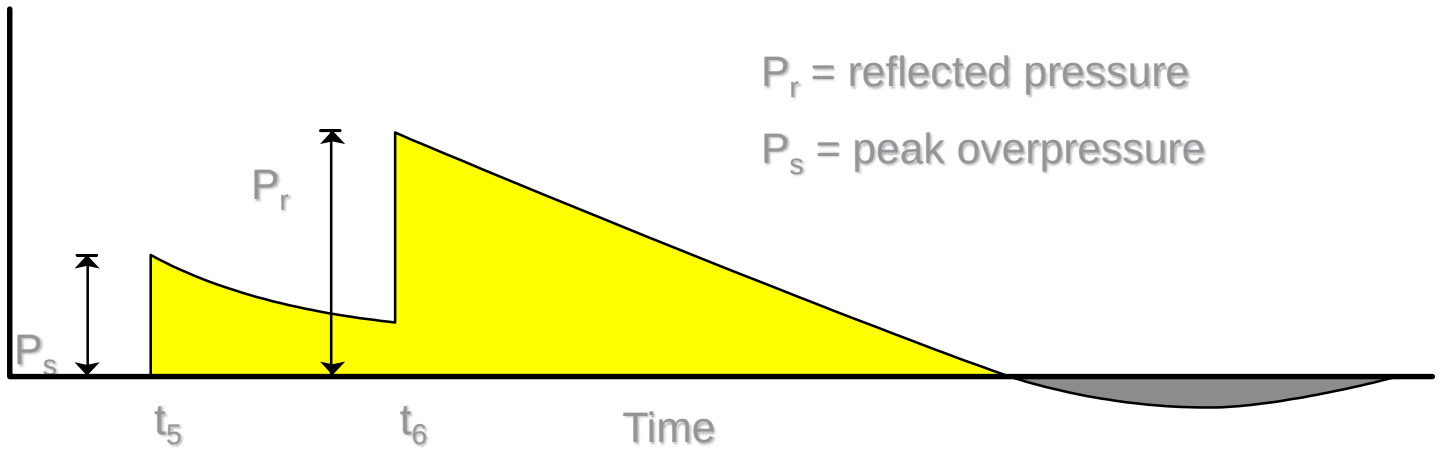


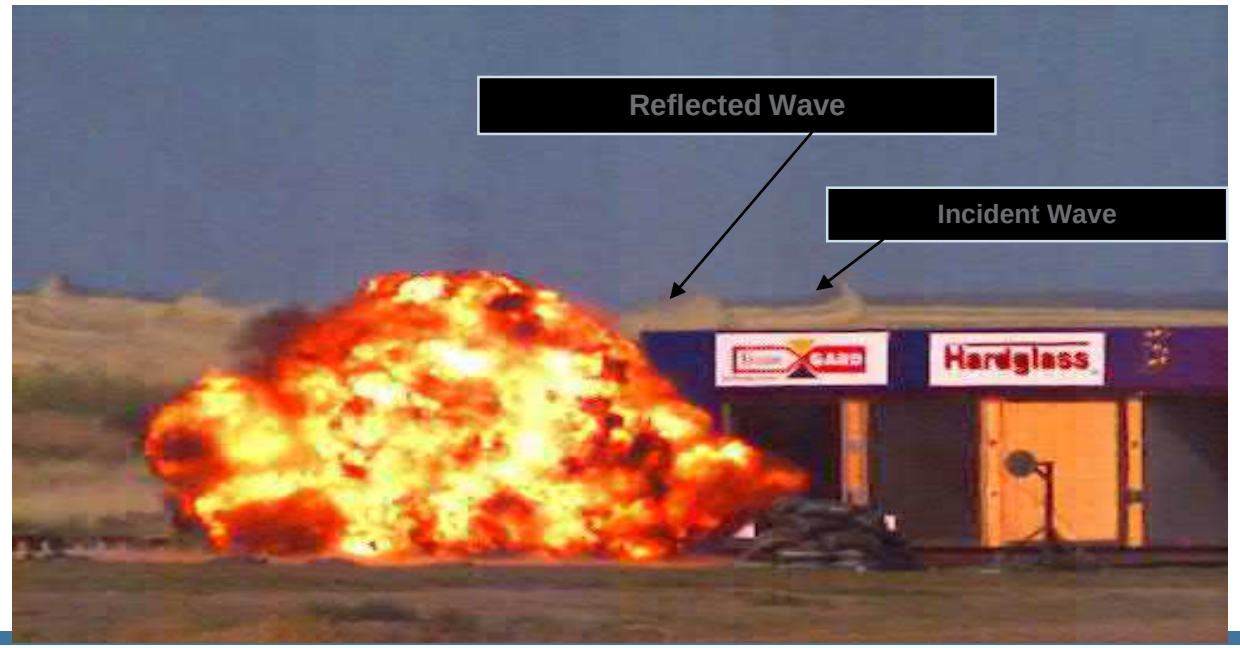
Ref: Design of Blast Resistant Buildings in Petrochemical Facilities, ASCE

Patlamaların Binalara Etkisi



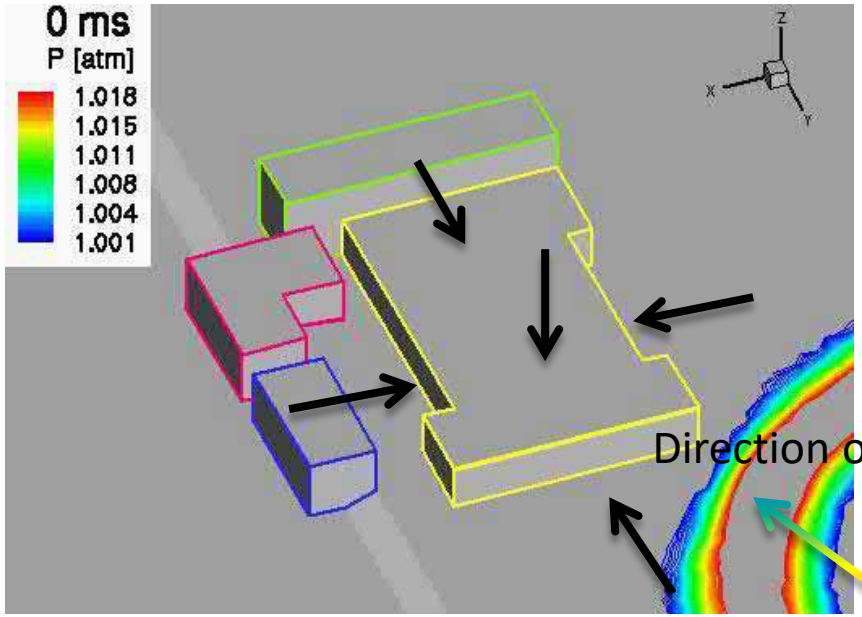
Overpressure





Geliş Açısı

Direction of blast



Direction of blast

Patlama Yükü Hesap Metodları

Near field is within the flame area.

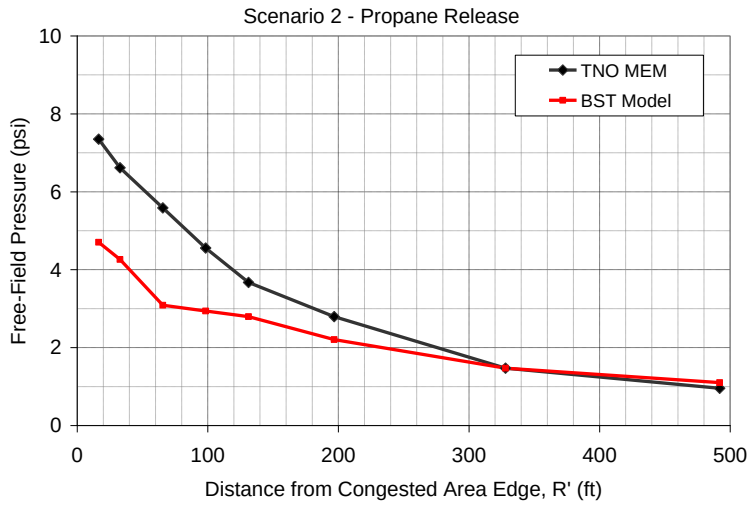
Computational Fluid Dynamics (CFD) is needed for modeling purposes to take into account directional effects, focusing effects, initial strength, shape and reflections.

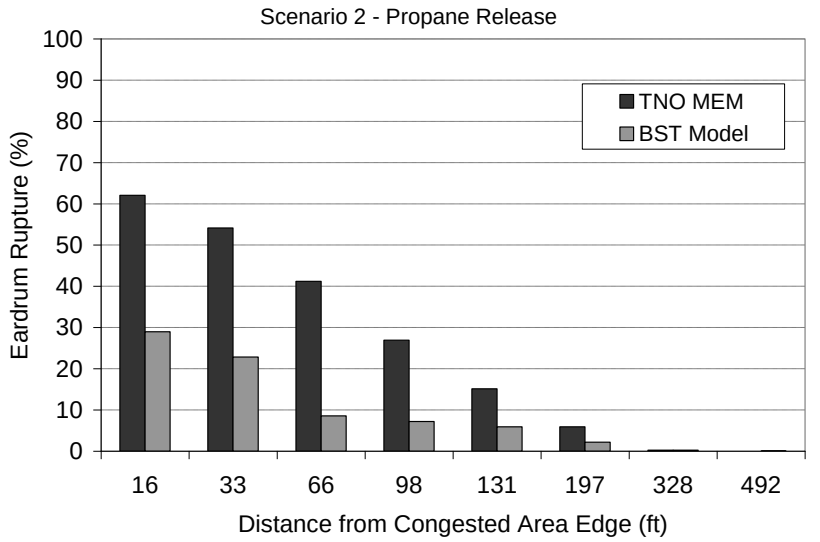
- CFD is utilized to simulate the propagation of blast waves in an environment of obstacles, to simulate pressures on unusually-shaped buildings, to simulate leakage through openings into buildings, to simulate interior explosions, and to simulate near-field explosion effects.

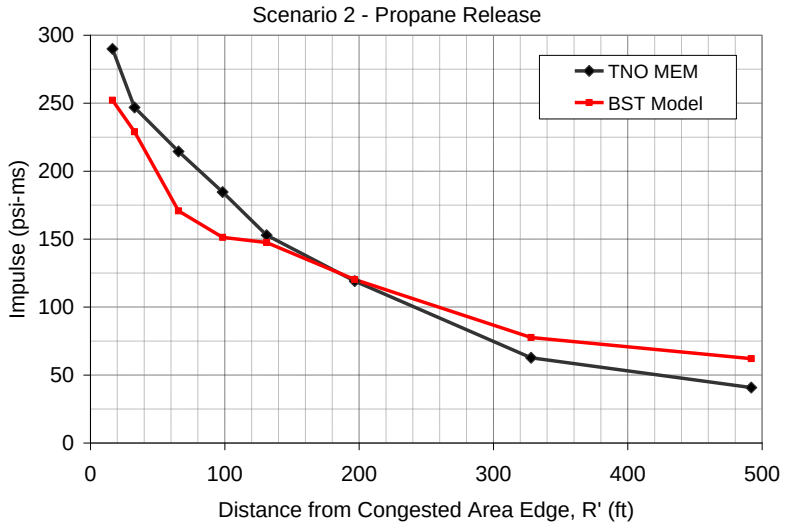
- **In far field there is no congestion to accelerate the flame.**
- **Pressure decays as you move away from the flame front.**
- **Can be modeled with conventional methods provided the source is relatively symmetric.**
  - **Multi-Energy Method**
  - **Baker-Strehlow-Tang (BST) Method**
  - **TNT Equivalency**

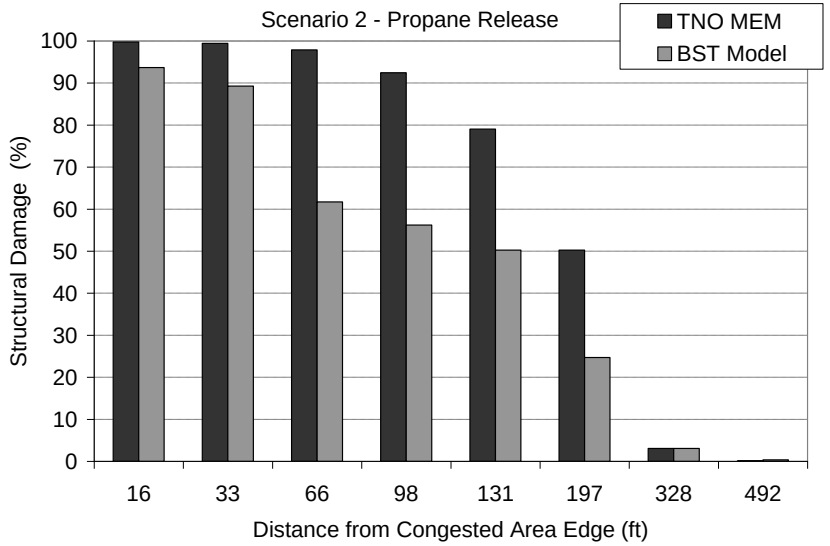
.

Patlama Yükü Hesap Metodları - BST vs TNO MEM





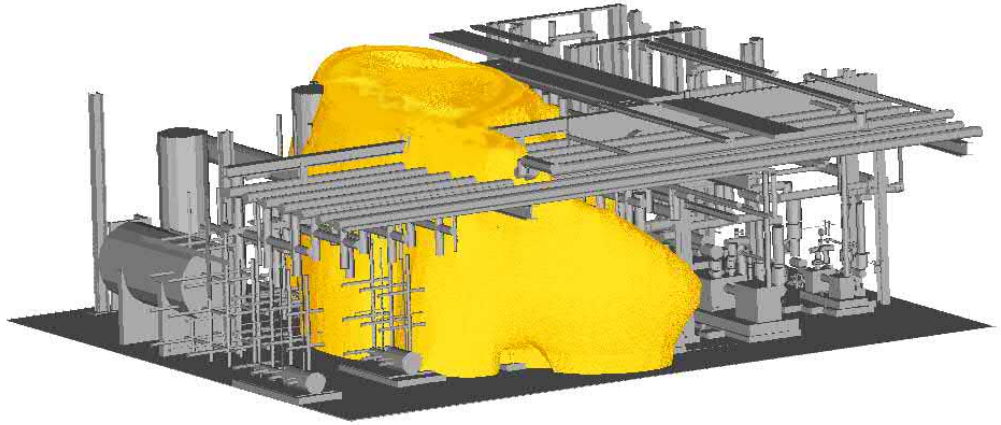


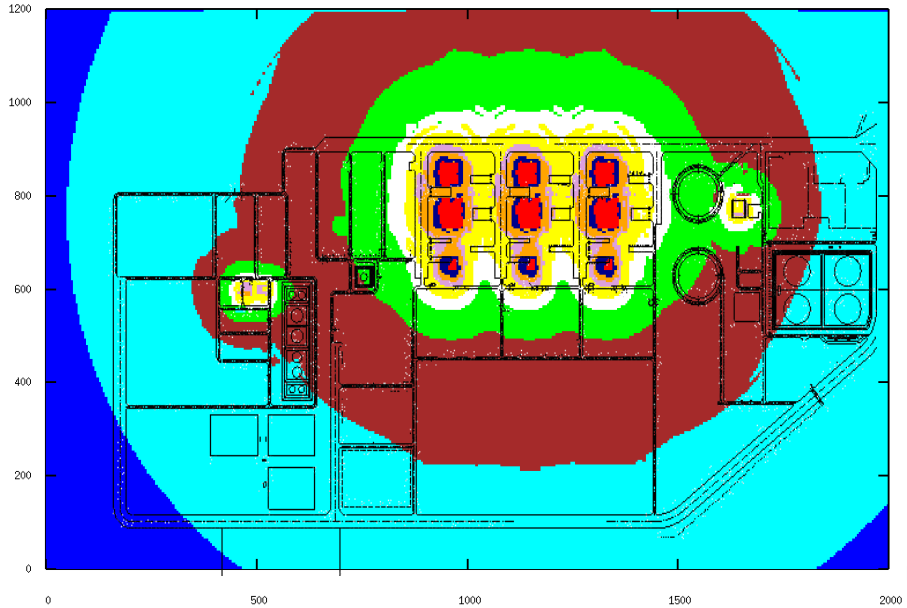


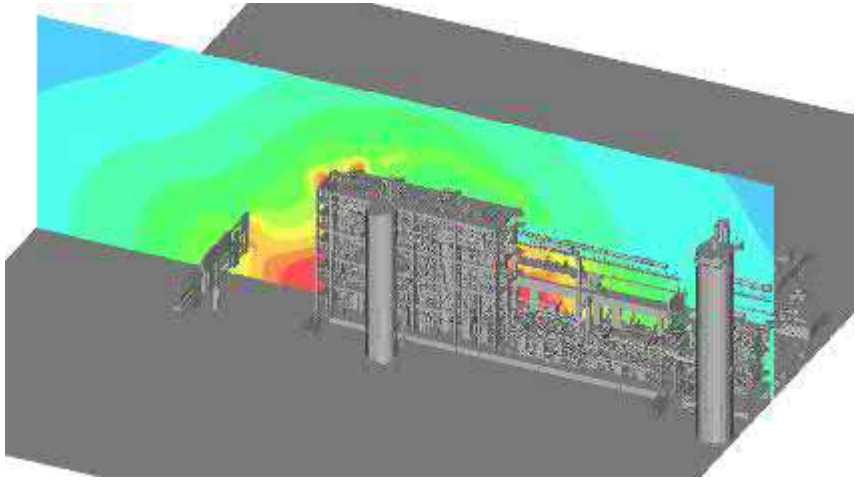
Hesaplamalı Akışkanlar Dinamiği Yöntemi (CFD)

Modelling and analysis data:

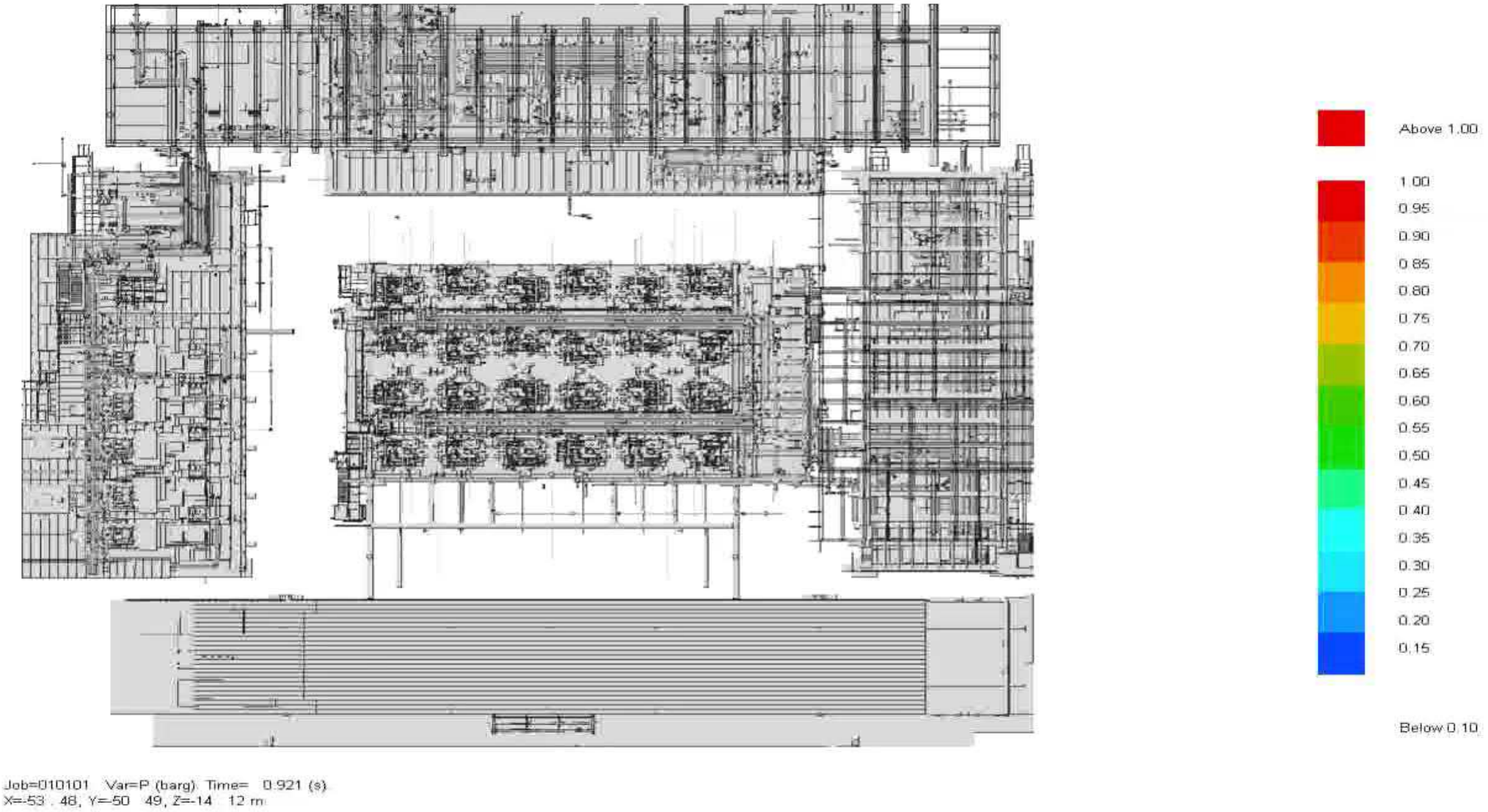
- Design load specification
- Analysis of individual risk
- Occupied building impairments



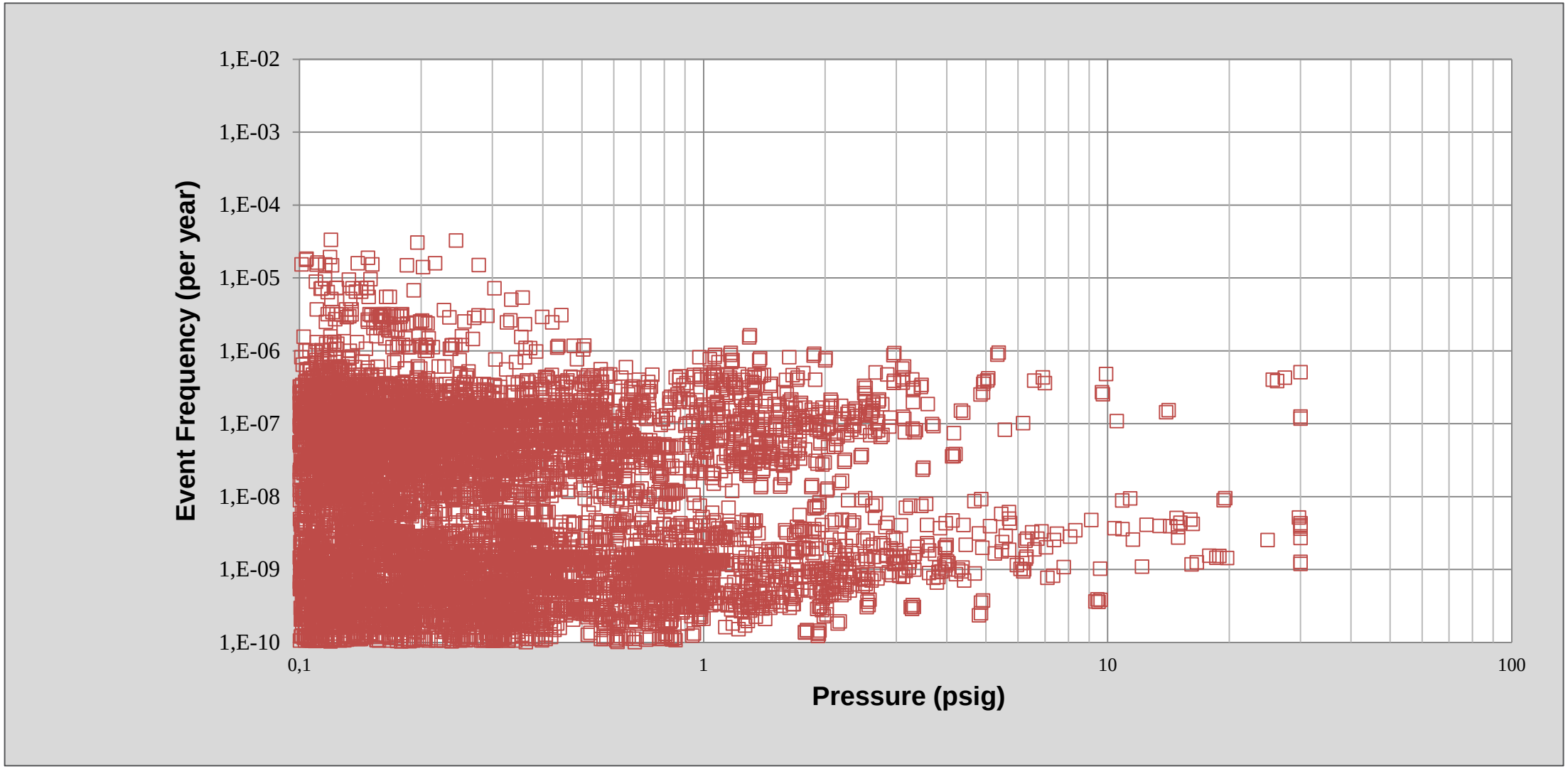




Patlama Yükü Hesabı Metodları

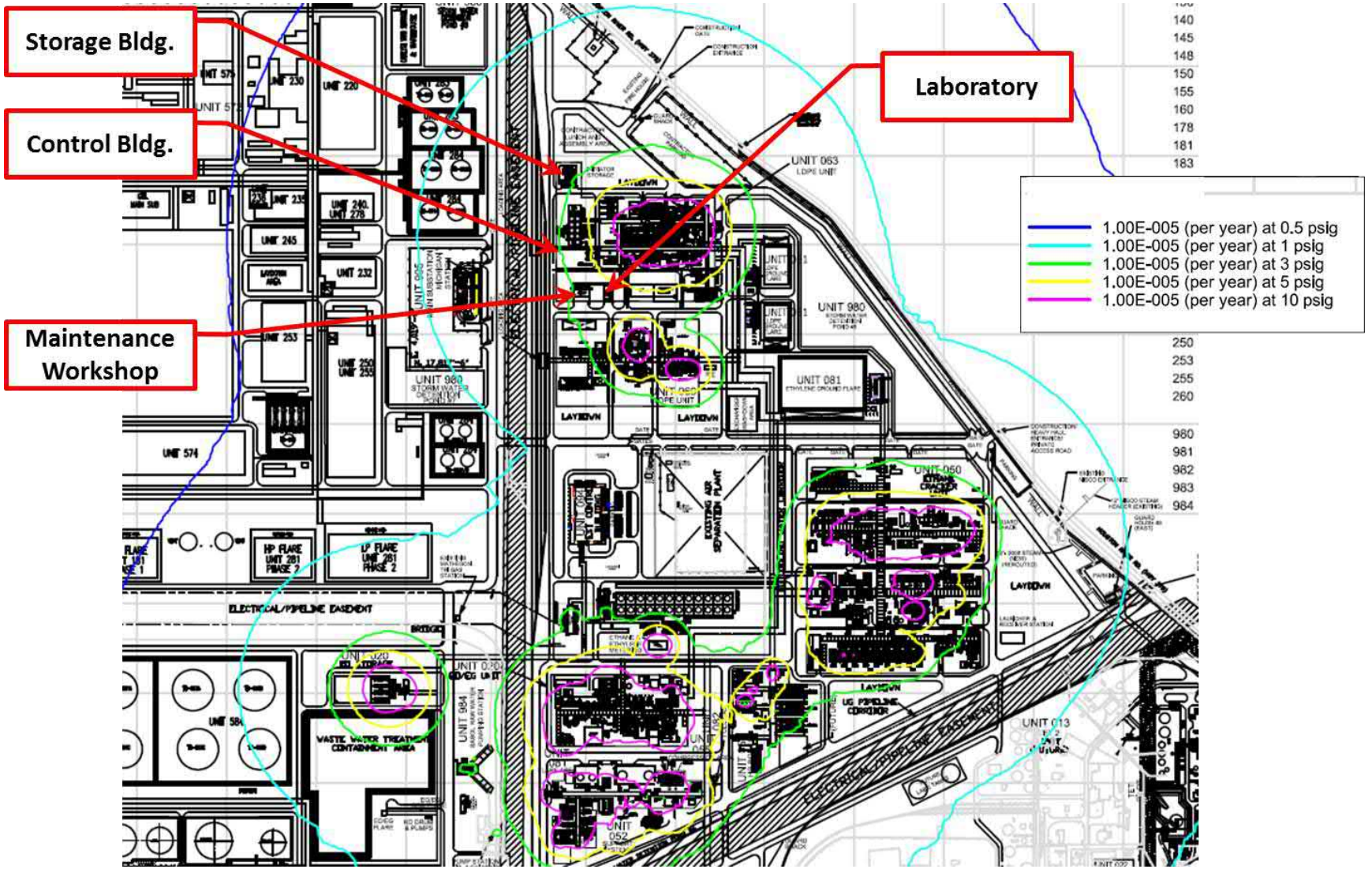


Patlama Yükü ve Patlama Senaryoları

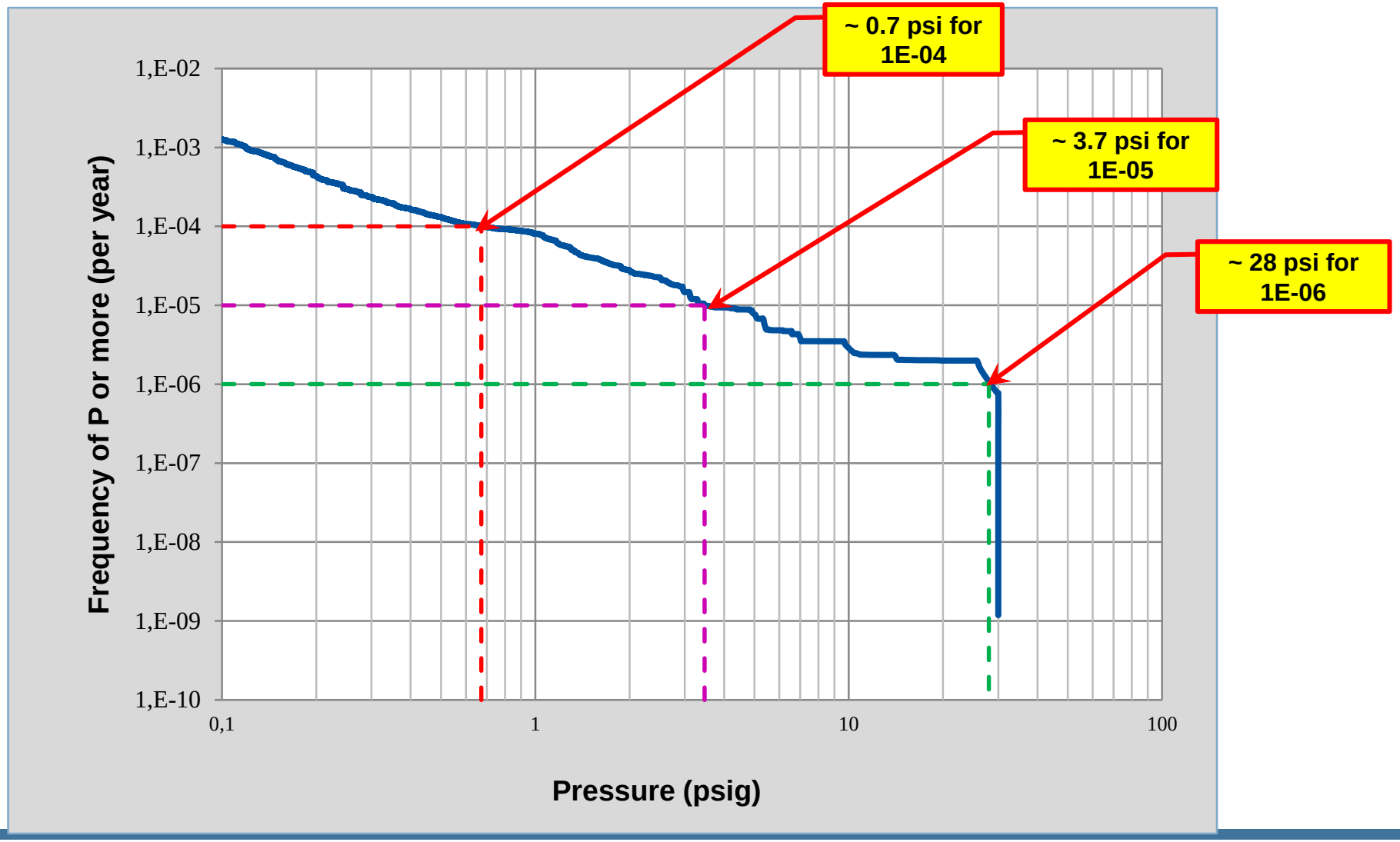


Many Scenarios! What is the design Load?

Örnek Patlama Basıncı Eğrileri

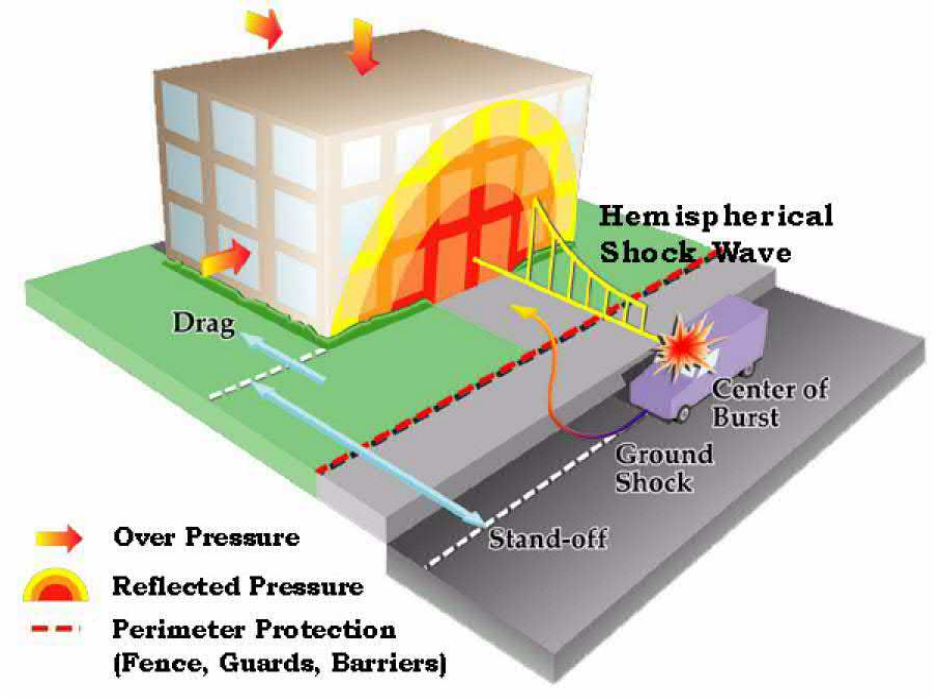


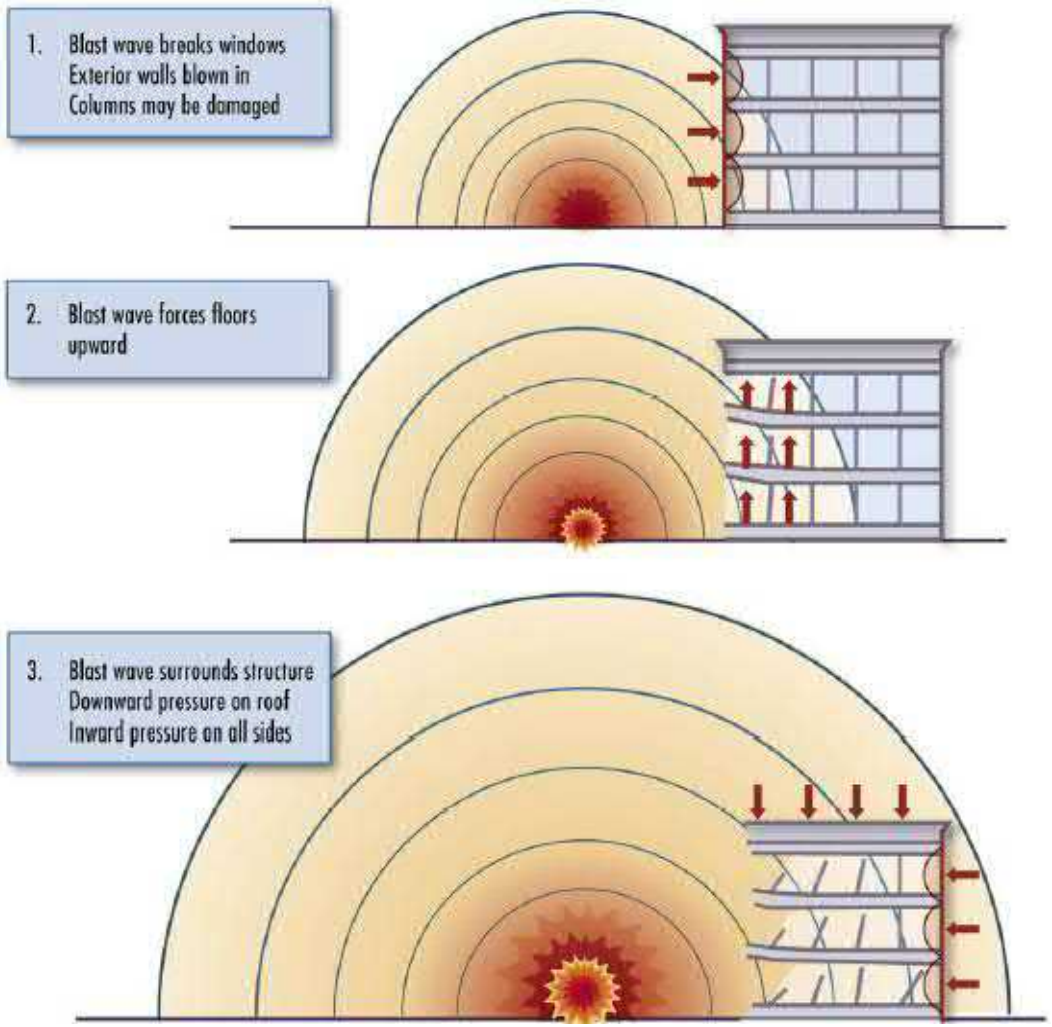
Patlama Basıncı Aşılma Eğrisi



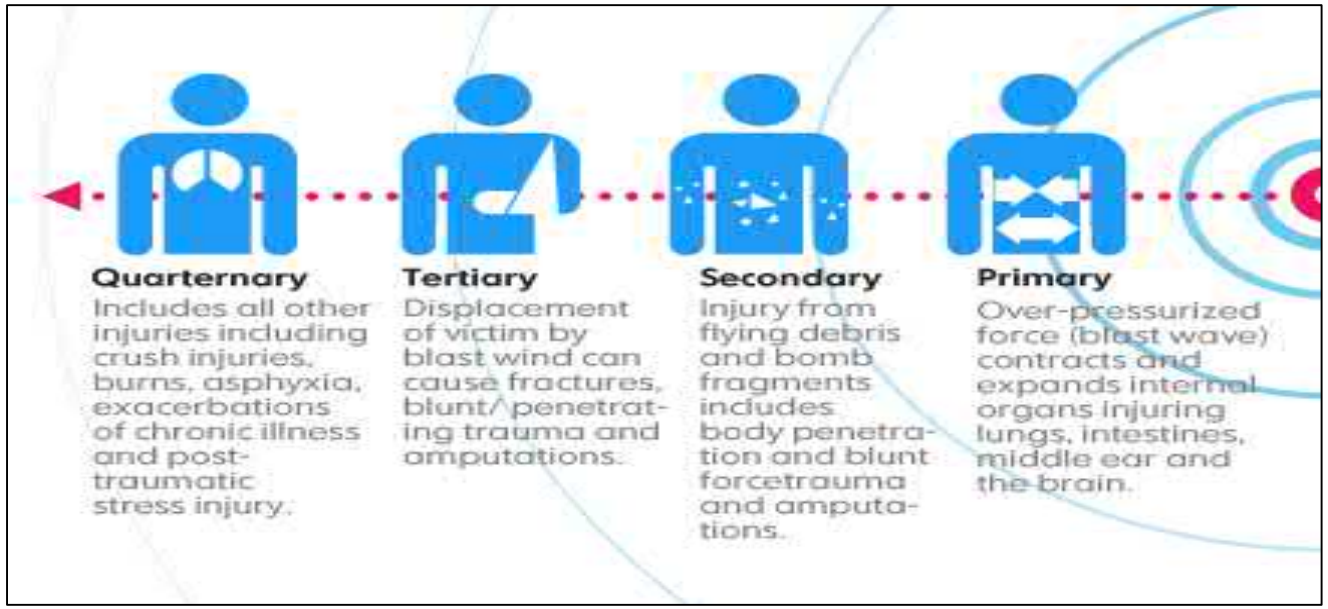
Patlama Etkileri

Yapılara Etkisi



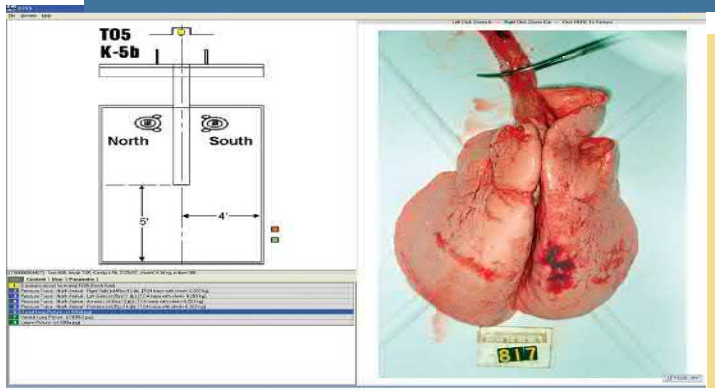


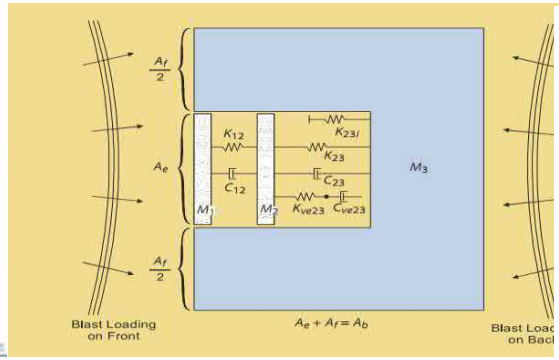
Patlamanın İnsan Vücuduna Etkisi

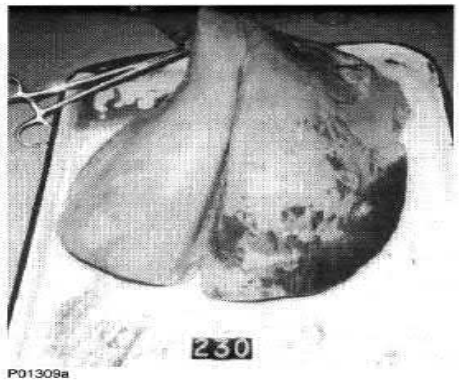


Critical Organ or Event	Maximum Effective Pressure (psi)/bar*
Eardrum Rupture	
Threshold	5 / 0.345
50 percent	15 / 1.03
Lung Damage	
Threshold 30-40	30-40 / 2.06-2.75
50 percent 80 and above	80 / 5.51 and Above
Lethality	
Threshold	100-120 / 6.89-8.27
50 percent	130-120 / 8.96-9.65
Near 100 percent	200-250 /13.79-17.23

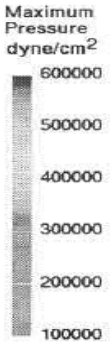
Patlamalardan Dolayı Yaralanmalar

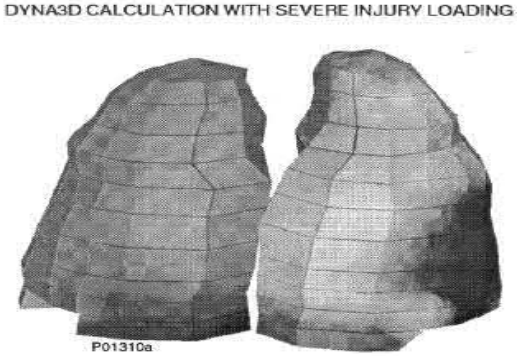




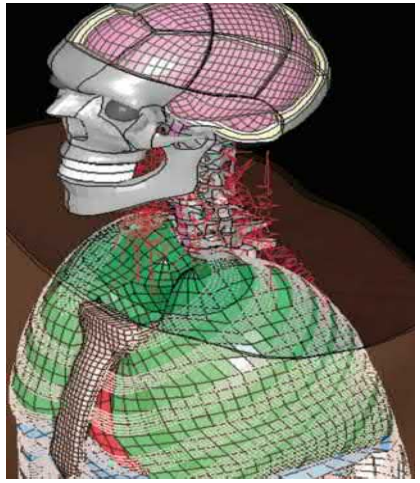


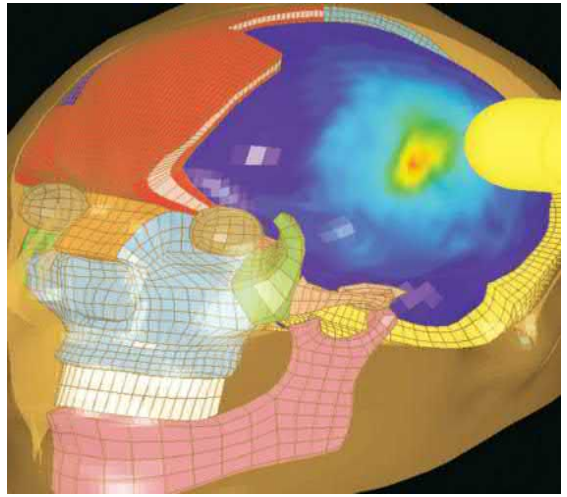
(a) Pathology photograph





(b) FEM simulation





BIOMECHANICAL MODELING OF INJURY FROM BLAST OVERPRESSURE

James H. Stuhmiller, Paul J. Masiello, Kevin H. Ho
Jaycor
9775 Towne Centre Drive, P. O. Box 85154
San Diego, California 92186-5154, USA

Maria A. Mayorga, Nancy Lawless, Greg Argyros
Walter Reed Army Institute of Research
Building 511, Trailers-Forest Glen Annex
Silver Spring, Maryland 20910, USA

Ref: Blast Injury Translating research into operational Medicine, by Stuhmiller, J.

•.An investigation of data concerning sudden stops in automobiles and passenger trains indicates that **personnel can sustain horizontal accelerations less than 0.44g without being thrown off balance.**

• the tolerable **horizontal acceleration of 0.50g** required to provide protection against ground-shock effects resulting from nuclear detonations should be safe for non-restrained personnel (standing, sitting, or reclining).

UNIFIED FACILITIES CRITERIA (UFC) 3-340-02

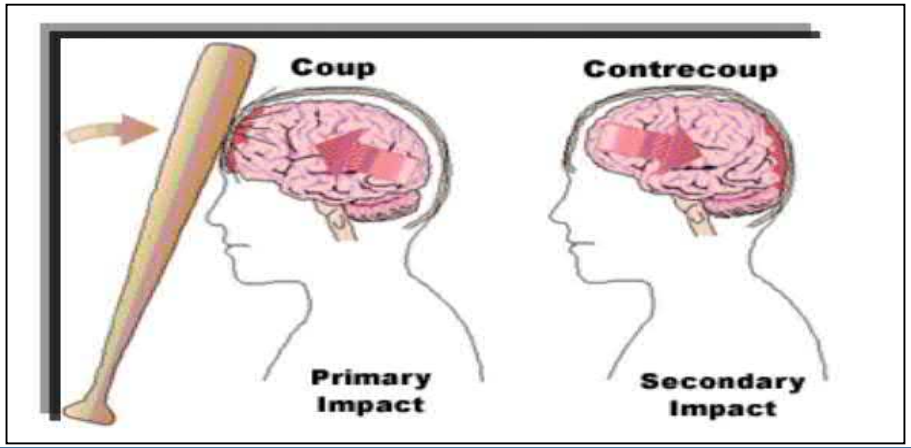
Patlamalardan Dolayı Yaralanmalar

$$HIC = MAX\left\{\left[\left(\frac{1}{t_2 - t_1}\right)\int_{t_1}^{t_2} a(t)dt\right]^{2.5}(t_2 - t_1)\right\}$$

Abbreviated Injury Scale (AIS)	Severity	Type of Injury	HIC Value
0	None	None	
1	Minor	Superficial injury	< 250
2	Moderate	Recoverable	< 750
3	Serious	Possibly recoverable	< 1,250
4	Severe	Not fully recoverable without care	< 1,750
5	Critical	Not fully recoverable with care	< 2,500
6	Maximum Injury	Fatal	> 2,500

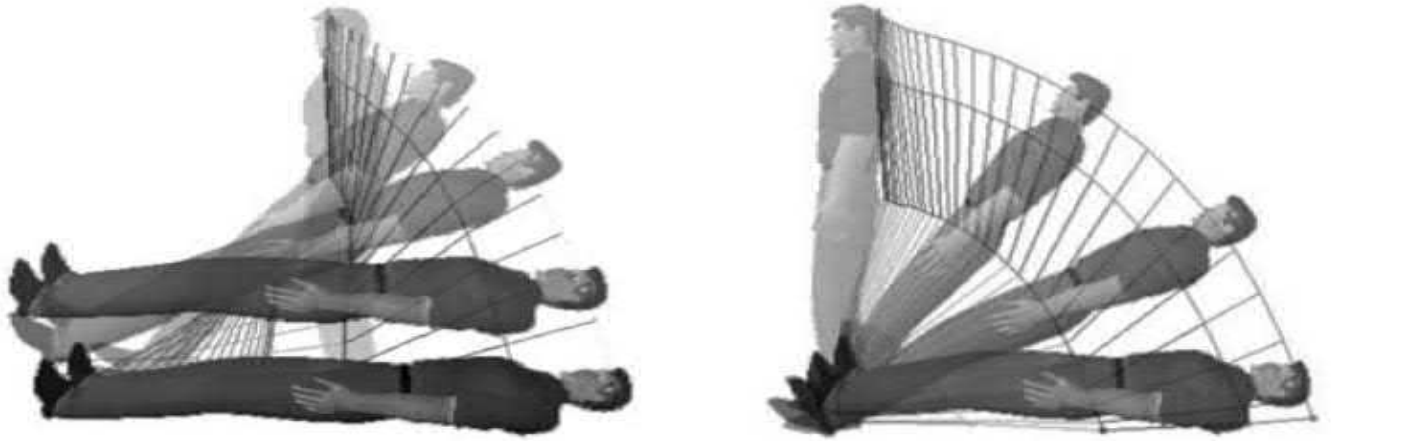
Impact Criterion	
Total Body Impact Tolerance	**Impact Velocity (in/sec)**
Safe	120.08
Lethality Threshold	2519.69
Lethality 50 Percent	6480.31
Lethality Near 100 Percent	16559.06
Skull Impact Tolerance	
Safe	120.08
Threshold	1559.06
50 Percent	2161.42
Near 100 Percent	2759.84

- It has been stated that only about 50 g's of force are needed to cause injury to the human brain, though this force does not necessarily cause damage.



Patlamalardan Dolayı Yaralanmalar

- When Blast pressure hits the building, due to floor movement, personnel inside is most likely to lose balance, fall, and to be injured by hitting their heads on the building floor or desks, walls, shelves



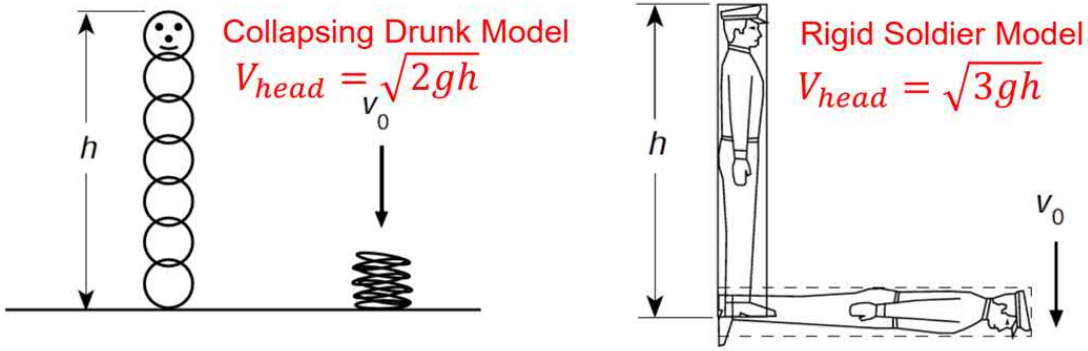
(a) Fall backwards on a slippery surface. (b) Fall backwards on a non-slippery surface.

Illustrations of Falling Patterns to the Ground

Ref.: Nagata and Ohno, Analysis of Backward Falls Caused by Accelerated Floor Movements Using a Dummy, Industrial Health, 2007, 45, 462-466

Patlamalardan Dolayı Yaralanmalar

- Professor Ralph L. Barnett at Illinois Institute of Technology, Chicago (1995) also proposed two falling models to estimate head impact velocity.



h = 1.67m: $\sqrt{2(9.81\frac{m}{s^2})(1.67m)} = 5.7\frac{m}{s}$ $\sqrt{3(9.81\frac{m}{s^2})(1.67m)} = 7.0\frac{m}{s}$

h = 1.83m: $\sqrt{2(9.81\frac{m}{s^2})(1.83m)} = 6.0\frac{m}{s}$ $\sqrt{3(9.81\frac{m}{s^2})(1.83m)} = 7.3\frac{m}{s}$

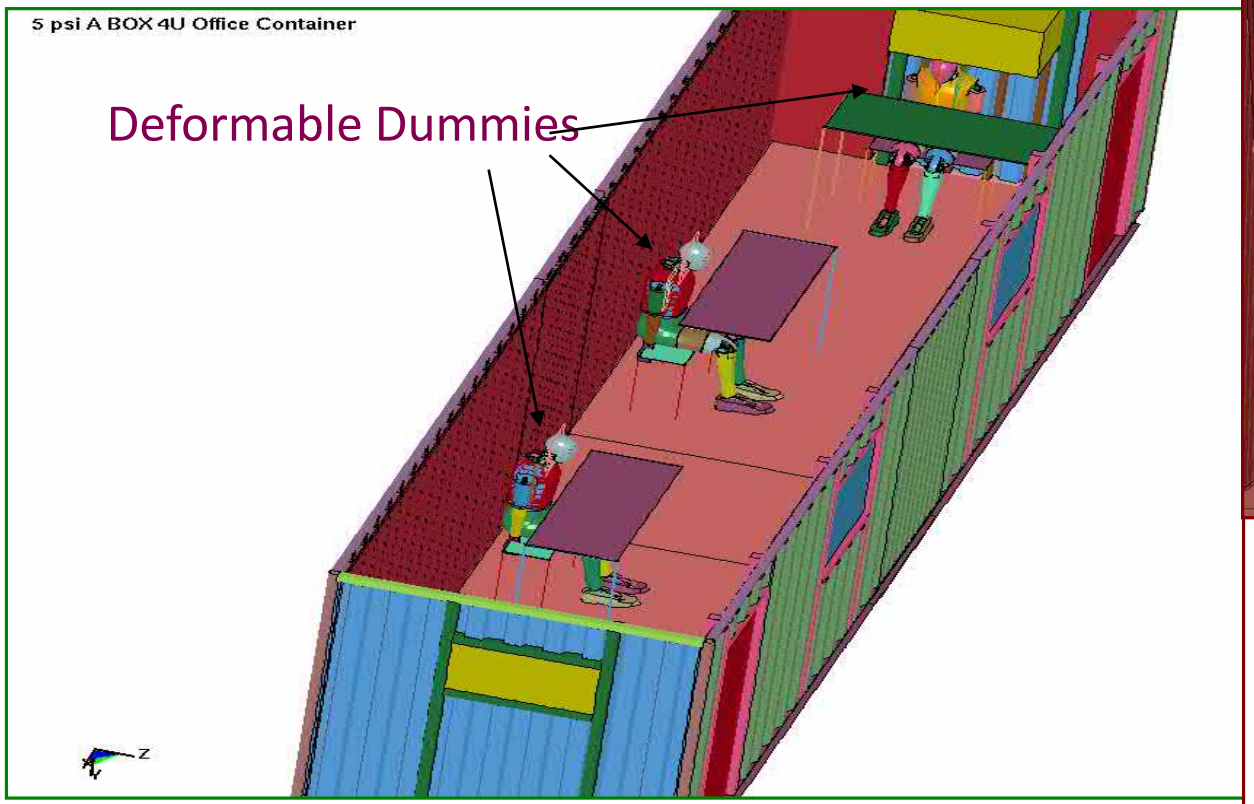
Nagata and Ohno (2007): V_{head} = 6.3 m/s for h = 1.67 m

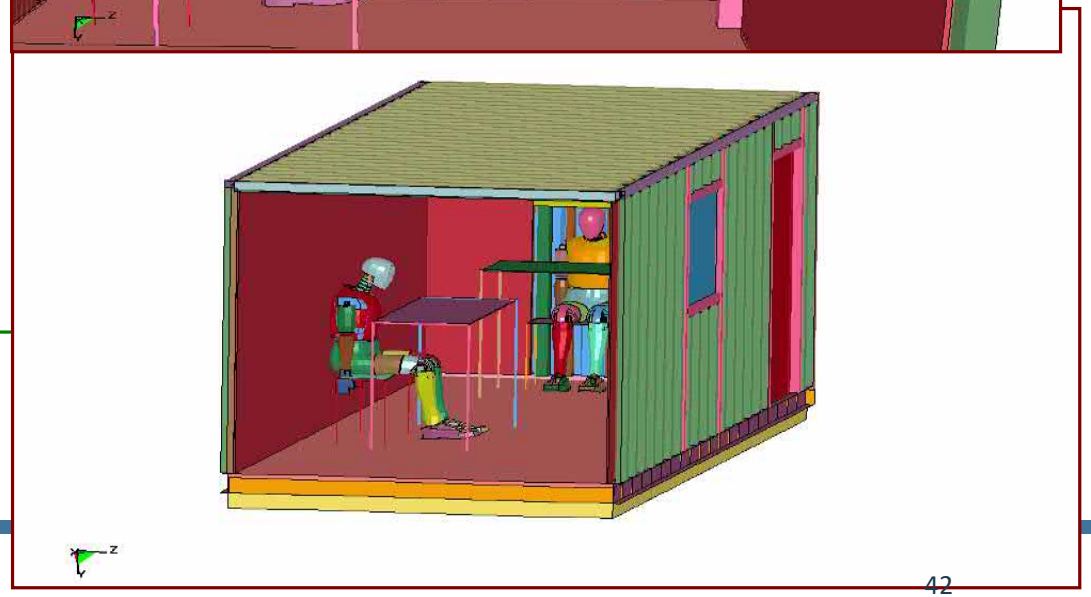
- According to the impact criterion (White, 1971), the injury level would be 50% to near 100% skull fracture and up to 50% lethality for body

Skull Fracture	**Impact Velocity (m/s)**
Mostly "safe"	3.0
Threshold	4.0
50 per cent	5.5
Near 100 percent	7.0
Total Body Impact	
Mostly "safe"	3.0
Lethality Threshold	6.5
Lethality 50 per cent	16.5
Lethality Near 100 percent	42.0

NagataOhno (2007) → 6.3 m/s 7.3 m/s ← Barnett (1995)

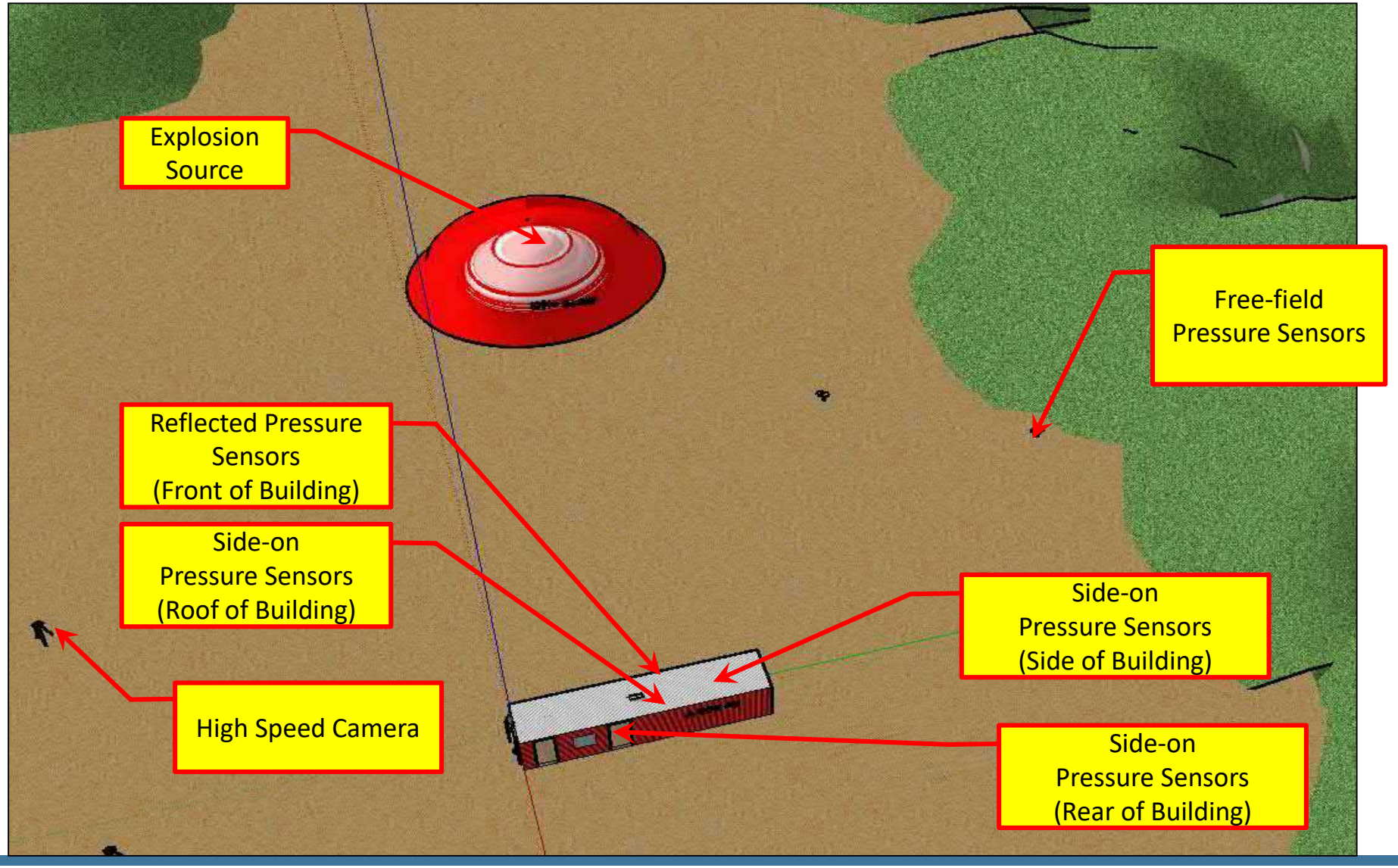
Patlamalardan Dolayı Yaralanmalar



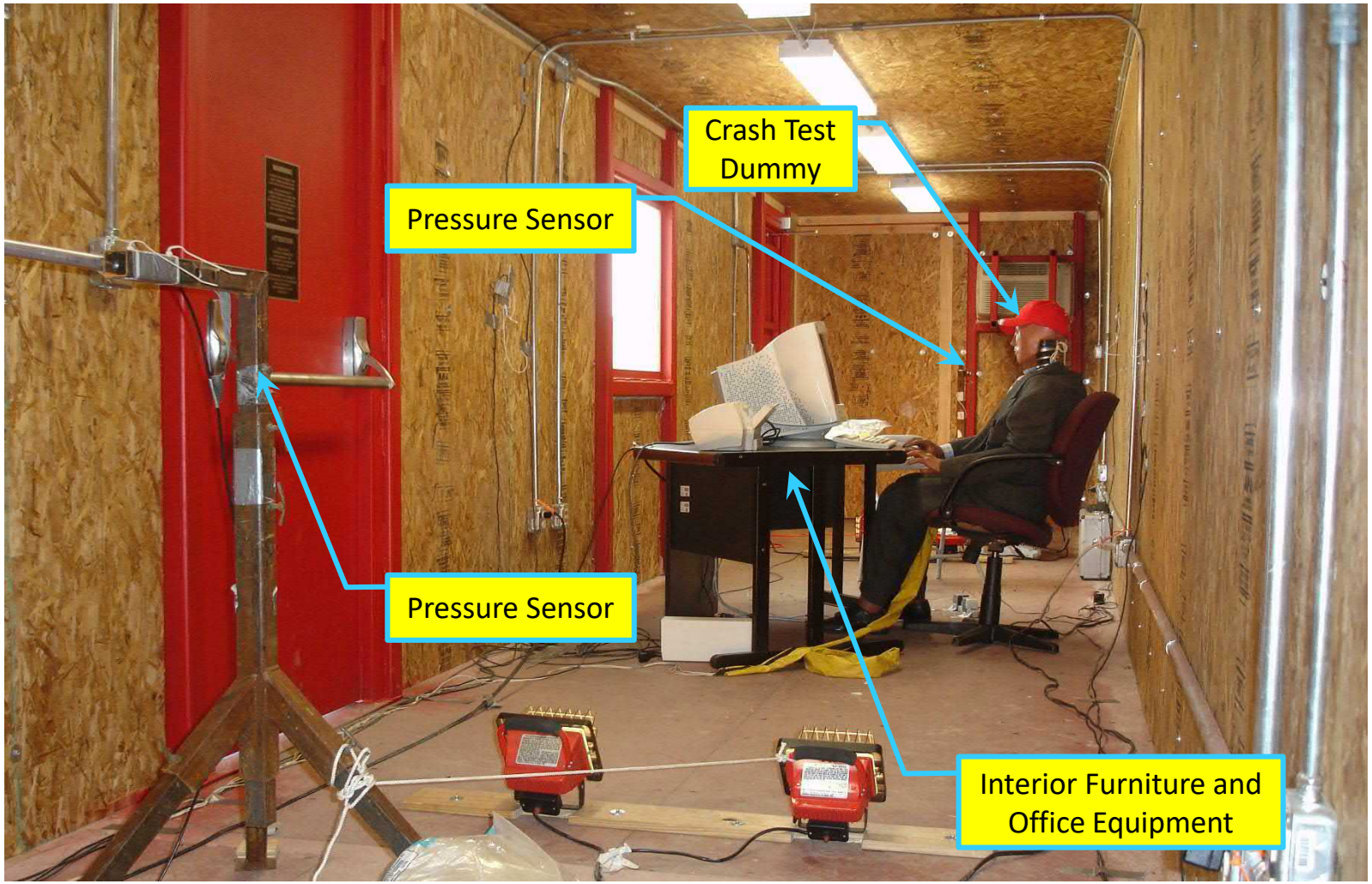


Patlama Etkileri – Patlama Test Programları

Patlama Testi – 2007



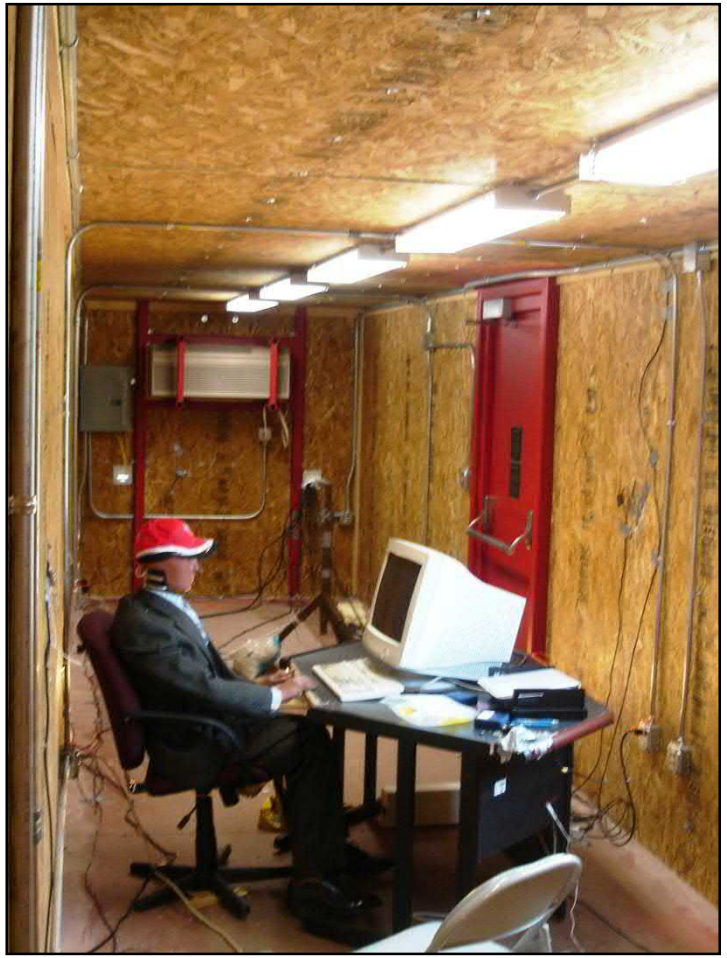
Patlama Testi - 2007



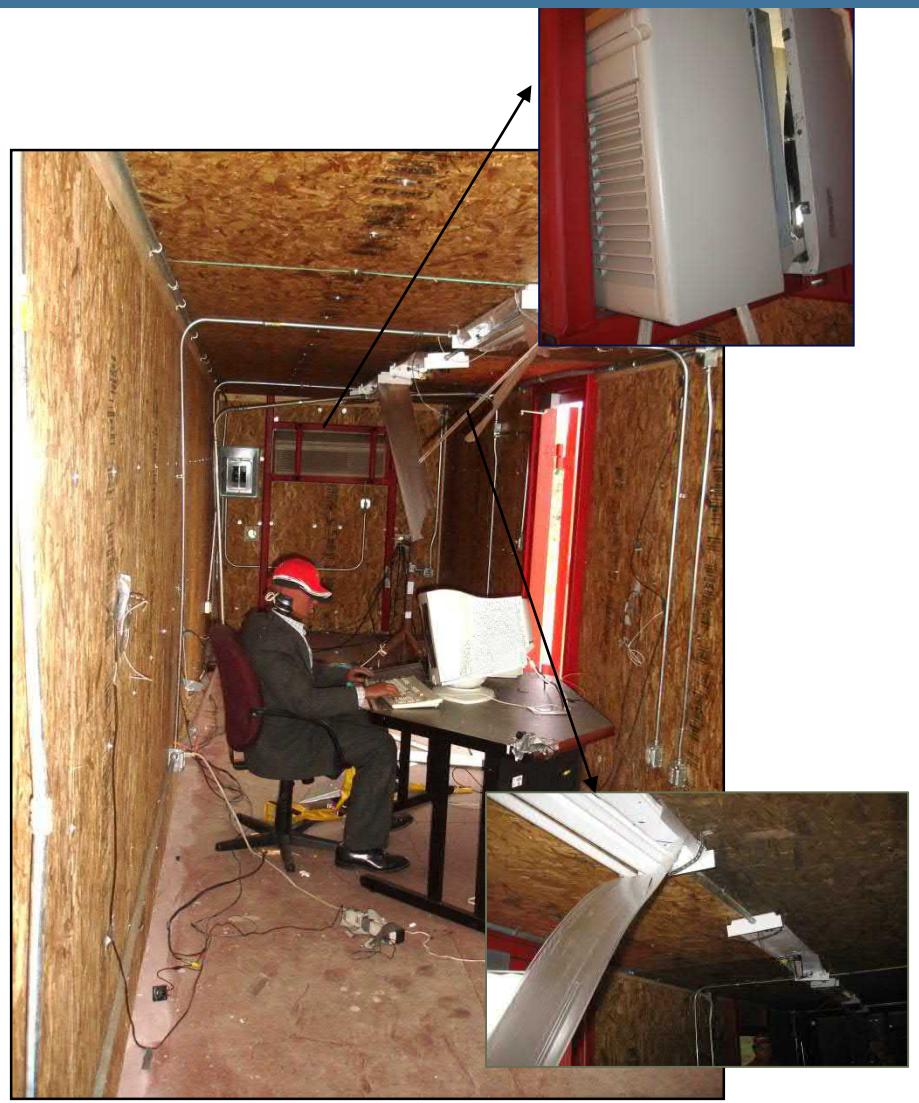
Patlama Testi (High Speed Camera, Movie 1) - 2007

Patlama Testi(High Speed Camera, Movie 2)

Yapısal Olmayan Elemanların Davranışı



Before the test



After the test

Yapısal Olmayan Elemanların Davranışı

After the test

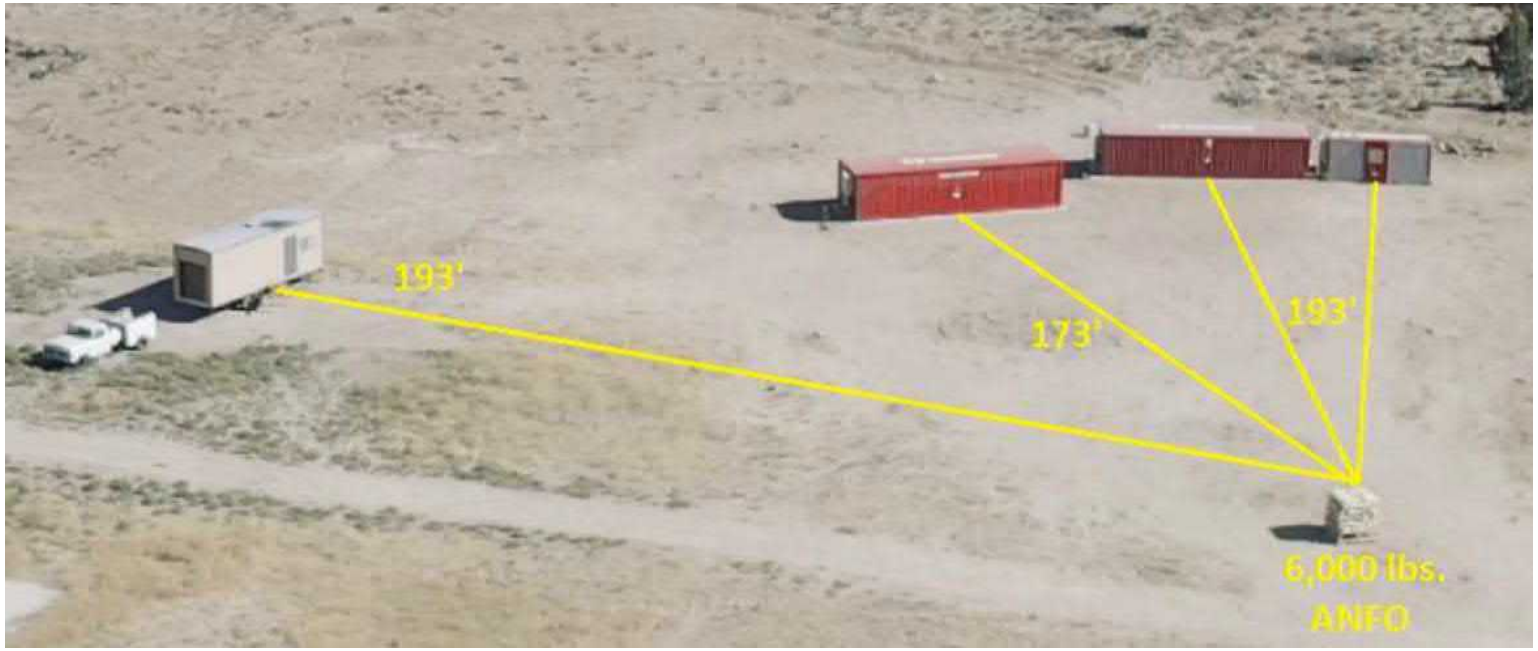
Yapısal Olmayan Elemanların Davranışı

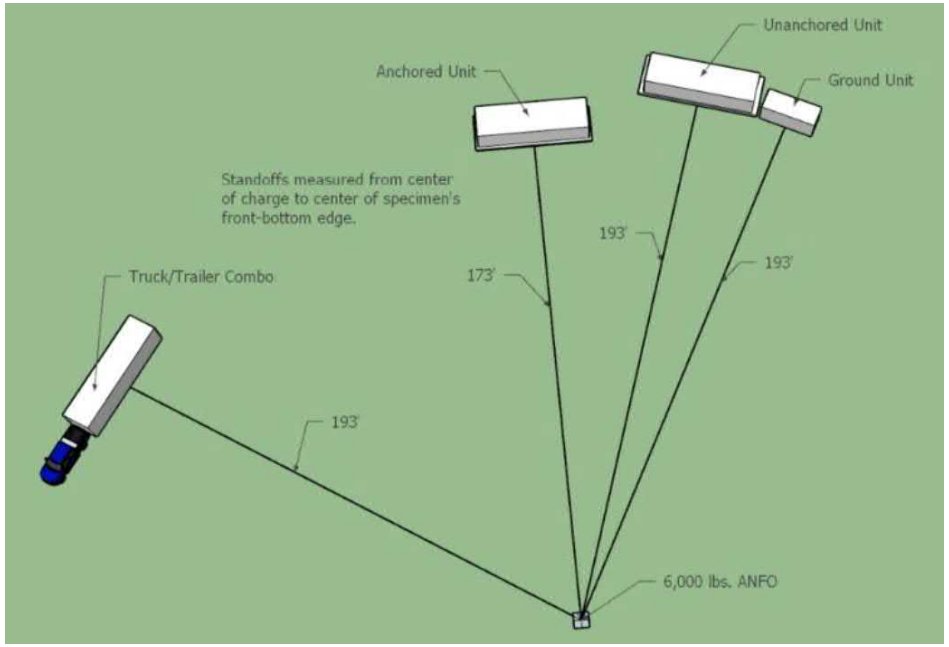
- Any design basis considers Non-Structural Members?

Yapısal Olmayan Elemanların Davranışı

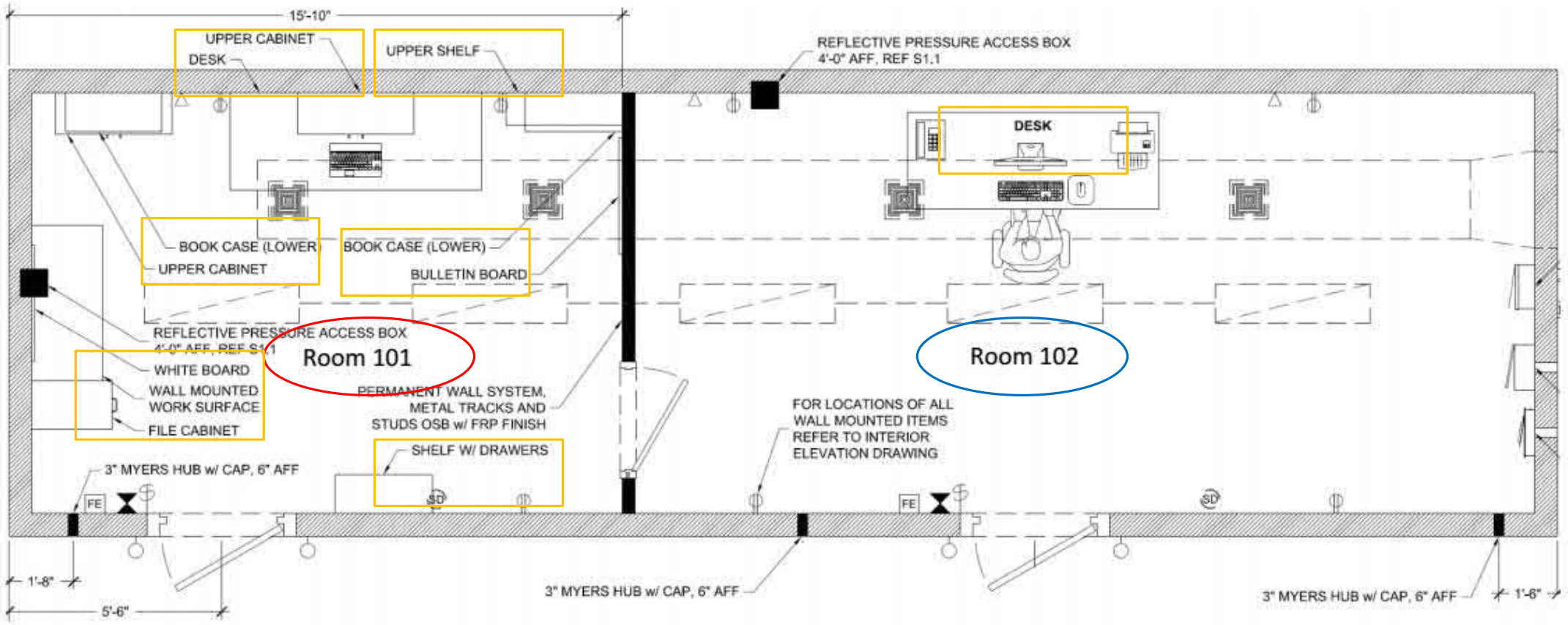
2. Patlama Test Programı – Ağustos 2020

Patlama Testi 1 – Ağustos 2020





12x40 BRM


15'-10"
UPPER CABINET
DESK
UPPER SHELF
REFLECTIVE PRESSURE ACCESS BOX
4'-0" AFF, REF S1.1
DESK
BOOK CASE (LOWER)
UPPER CABINET
BOOK CASE (LOWER)
BULLETIN BOARD
REFLECTIVE PRESSURE ACCESS BOX
4'-0" AFF, REF S1.1
WHITE BOARD
WALL MOUNTED
WORK SURFACE
FILE CABINET
Room 101
Room 102
PERMANENT WALL SYSTEM,
METAL TRACKS AND
STUDS OSB w/ FRP FINISH
FOR LOCATIONS OF ALL
WALL MOUNTED ITEMS
REFER TO INTERIOR
ELEVATION DRAWING
SHELF W/ DRAWERS
3" MYERS HUB w/ CAP, 6" AFF
FE
SD
FE
SD
1'-8"
5'-6"
3" MYERS HUB w/ CAP, 6" AFF
3" MYERS HUB w/ CAP, 6" AFF
1'-6"

12x40 BRM – ODA 101

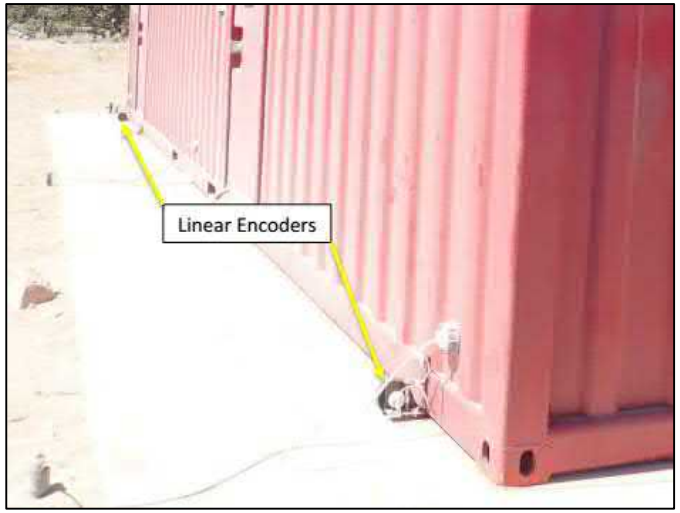
12x40 BRM


UF
Pressure Gauge


Free-Field Pressure Gauge
Pressure Gauge


ROOM 102 - instrumented ATD


Paint-line


Linear Encoders


Accelerometer
under wooden cover

Kamyon ve Ahşap Mobil Bina

Front

Rear

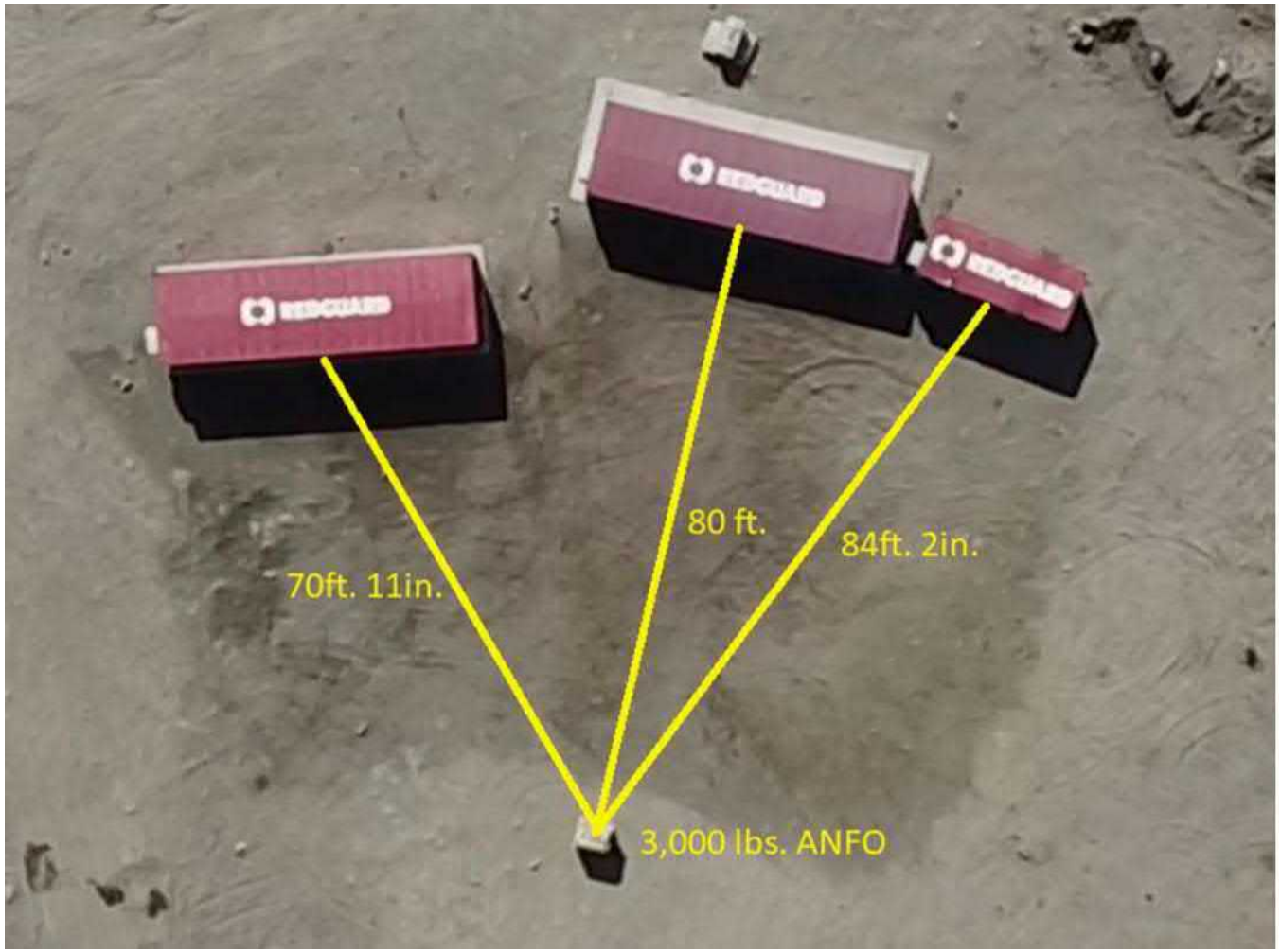
Patlama Testi 1 – Ağustos 2020

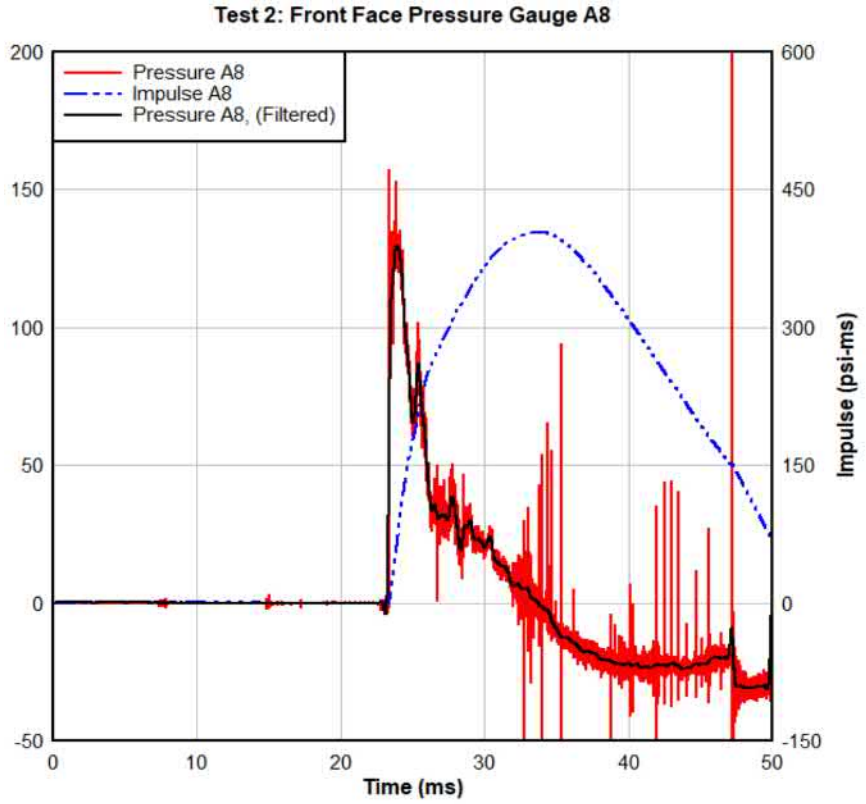
Patlama Test 1 – Ağustos 2020 Sonuçlar

Patlama Testi 1 – Ağustos 2020 Sonuçlar

Patlama Testi 1 – Ağustos 2020 Sonuçlar

Patlama Testi 2 – Ağustos 2020





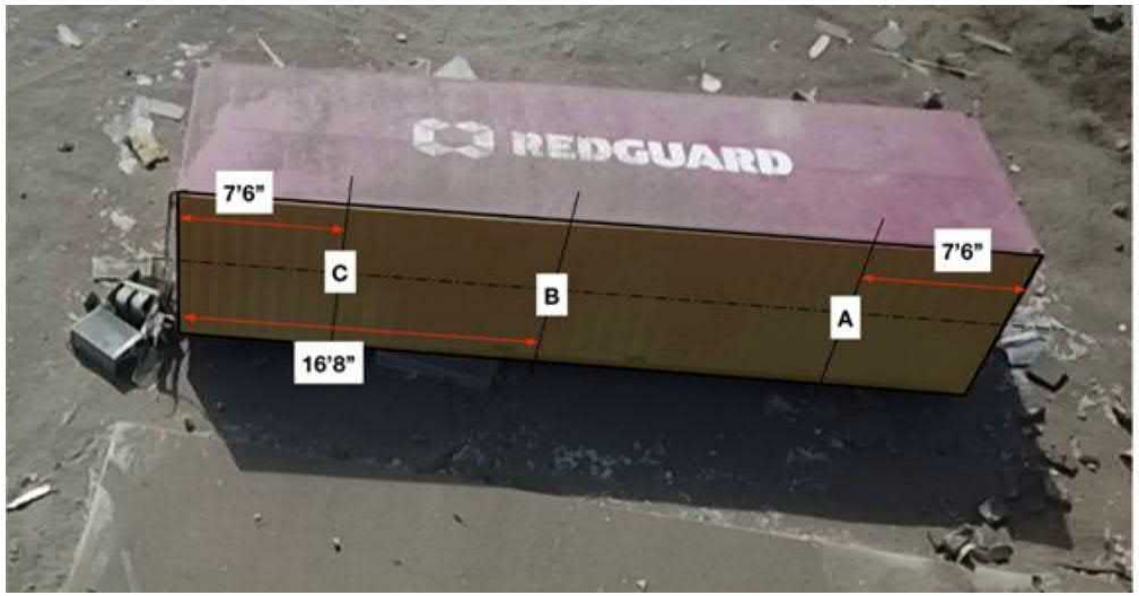
P = 157 psi , I = 404 psi-ms

Calculated: P = 83 psi, I = 428 psi-ms

Patlama Testi 2 – Ağustos 2020

Patlama Testi 2 – Ağustos 2020

Patlama Testi 2 – Ağustos 2020 Sonuçlar



Location of Deflection Control Points on Front Wall of Unanchored Unit

Permanent Deflection Measured at Control Points in Front Wall of Unanchored Unit

Location A	Location B	Location C
11.75 in	13.88 in	8.63 in

Location of Deflection Control Points on Front Wall of Ground Unit

Permanent Deflection Measured at Control Points on Front Wall of Ground Unit

Location A	Location B
8.75 in	2 in

Anchored Unit - Deformation Along Front Face (left, right) and Undeformed Side Face (right)

Patlama Testi 2 – Ağustos 2020 Sonuçlar

Ground Unit - Glazing Framing and Surrounding Damages

Failure of Interior Finishing Panels of Ground Unit

Patlama Testi 1 – Ağustos 2020 Sonuçlar – 12x40– ATD Yaralanma

Body Part	Measurement	Measured Values	Critical Values
Head	Resultant Acc.	70.5g	150g for 2ms duration
Head	Head Injury Criterion	28.5	500 (low); 1000 (moderate) 150 (no injury); 500 (major injury) 700
Neck	Neck Injury Criterion	0.04	1
Chest	Resultant Acc.	19.2g	60g for 3ms duration 40g for 7ms duration 60g (max.)
Lower Body	Pelvis, Femur and Tibia values are below critical values		

Patlamalardan Dolayı Yaralanmalar – Şarapnel Etkisi

Critical Organ	Weight (lbs)	Fragment Velocity (fps)	Energy (ft-lb)
Thorax	>2.5	10	4
	0.1	80	10
	0.001	400	2.5
Abdomen and limbs	>6.0	10	9
	0.1	75	9
	0.001	550	5
Head	>8.0	10	12
	0.1	100	16
	0.001	450	3

Table 3. Threshold of Serious Injury to Personnel Due To Fragment Impact UFC 3-340-02

İnsanları mı yoksa Yapıları mı korumamız gerekli?

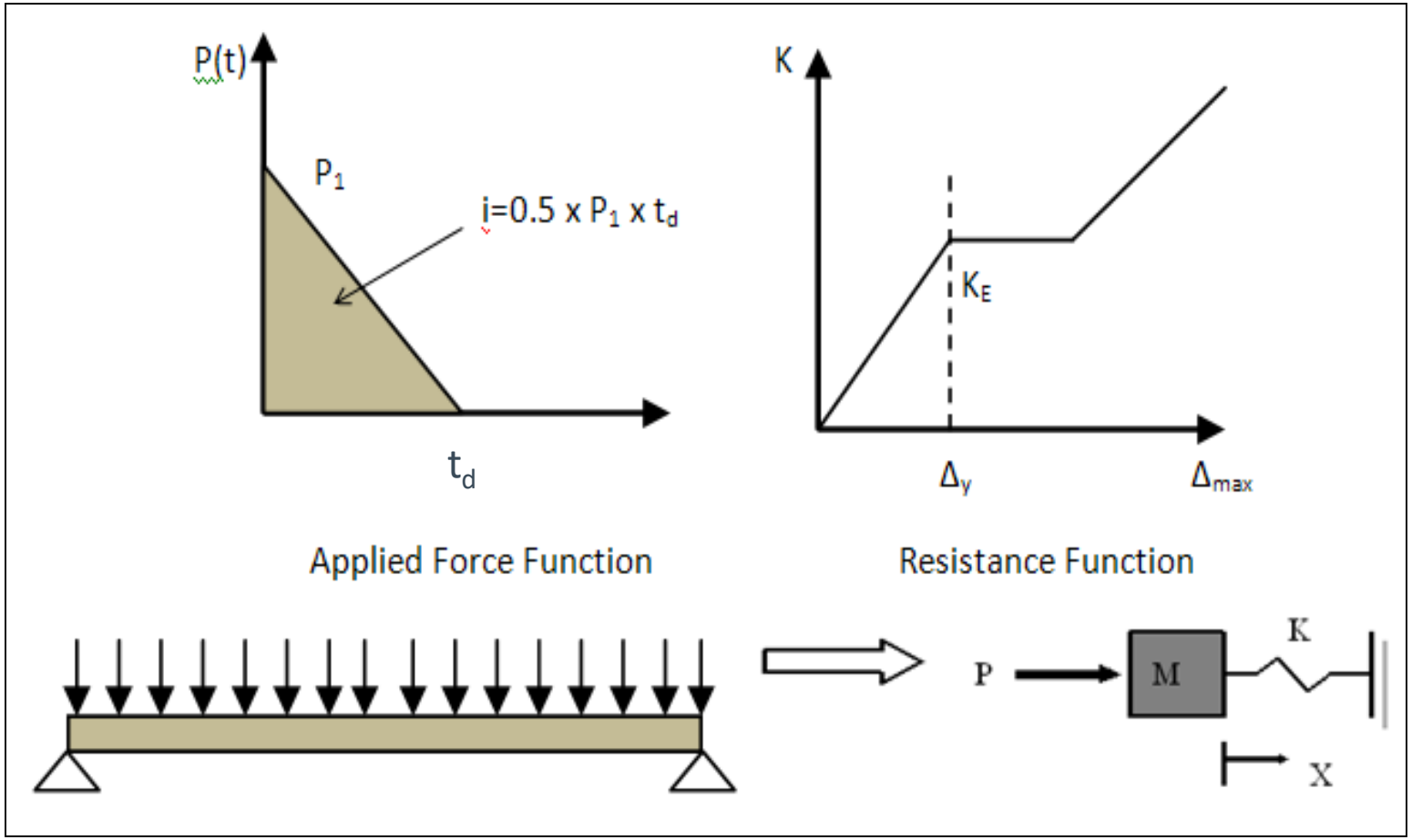
- By protecting the structure – You ARE protecting the people
- Primary causes of fatalities are building collapse or flying glass

Patlamalardan Dolayı Yaralanmalar

The majority of deaths were due to the collapsing structure

Patlama Analizi Yöntemleri ve Yaklaşımı

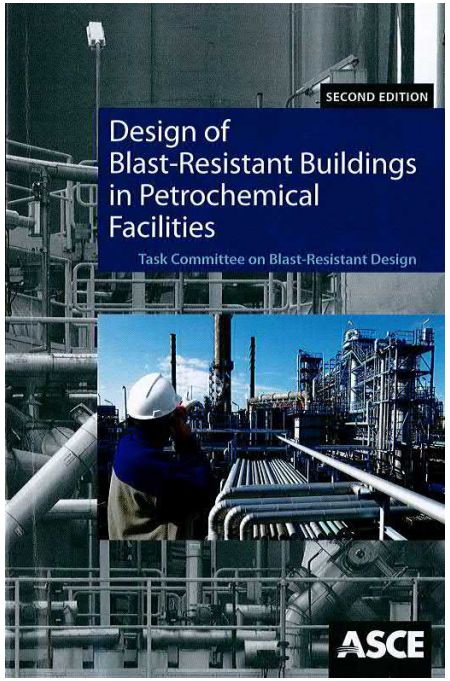
Tek Serbestlik Dereceli Modeller (SDOF)



Bina Hasar Seviyeleri – Kriterler

Component Damage Levels

Building Damage Level (BDL)	Damage Description
Low	Component has none to slight visible permanent damage.
Medium	Component has some permanent deflection. It is generally repairable, if necessary, although replacement may be more economical and aesthetic.
High	Component has not failed, but it has significant permanent deflections causing it to be unrepairable.



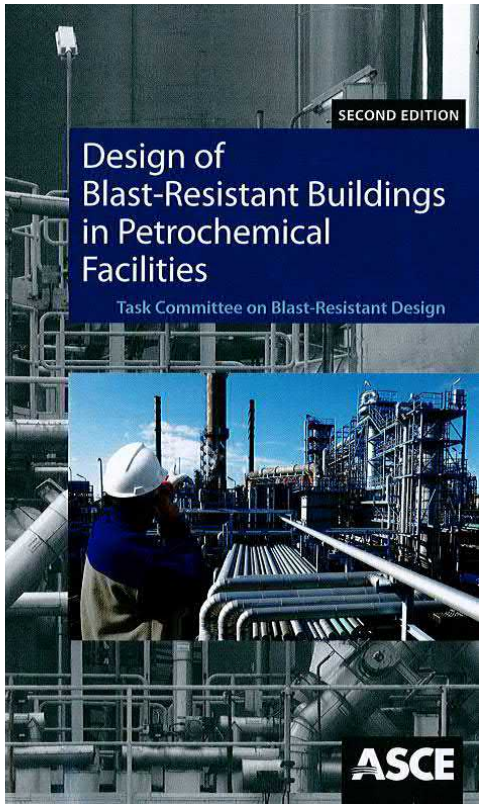
Building Damage Levels

Building Damage Level (BDL)	Damage Description
Low	Localized component damage. Building can be used; however repairs are required to restore integrity of structural envelope. Total cost of repairs is moderate.
Medium	Widespread component damage. Building should not be occupied until repaired. Total cost of repairs is significant.
High	Key components may have lost structural integrity and building collapse due to environmental conditions (i.e. wind, snow, rain) may occur. Building should not be occupied. Total cost of repairs approaches replacement cost of building.

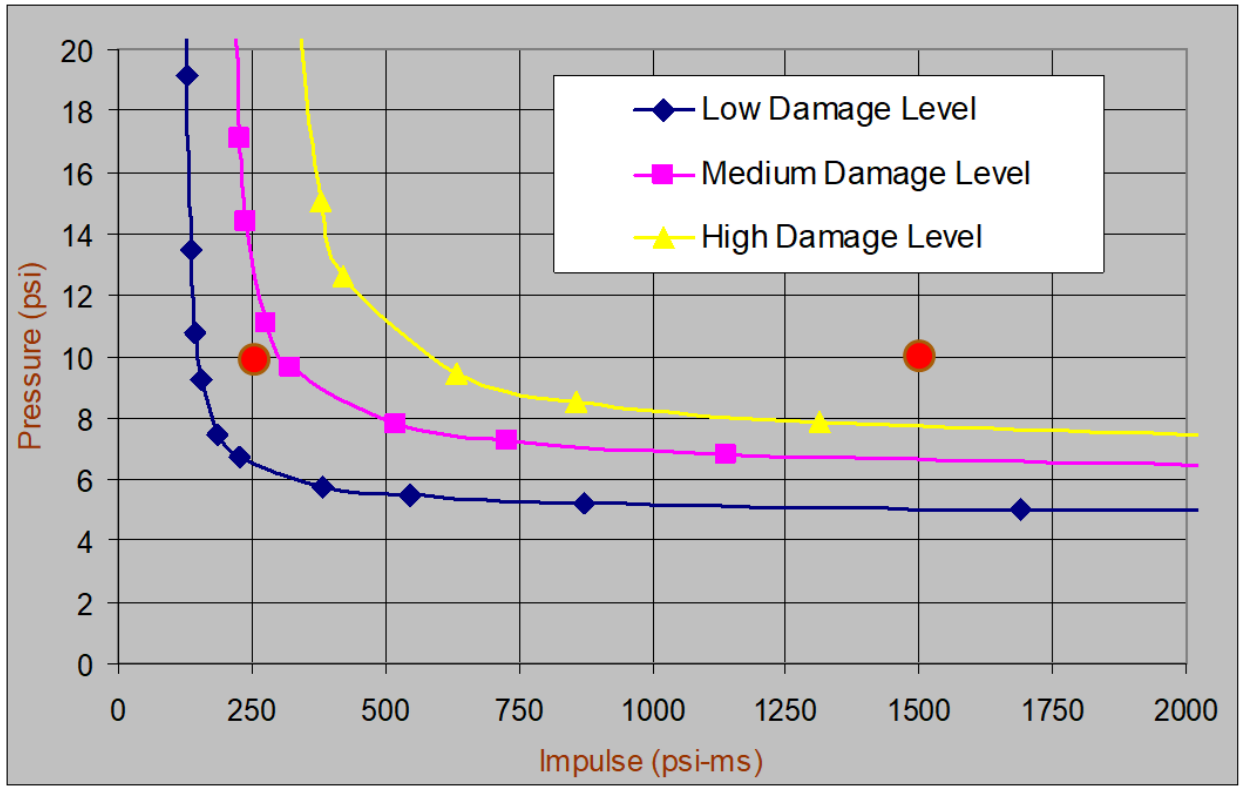
Yapı Elemanlarının Davranış Kriterleri

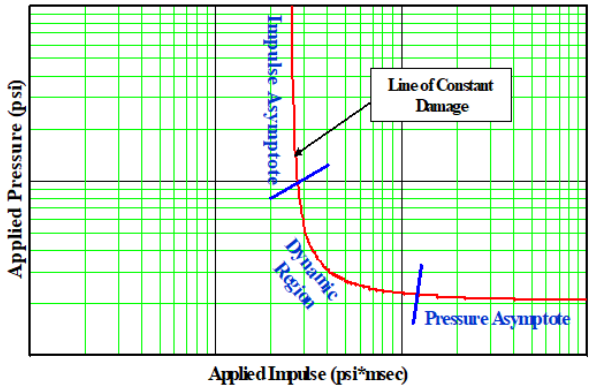
Response Limits For Steel Components

Structural Component	Low Response		Medium Response		High Response	
	μ	θ	μ	θ	μ	θ
Hot Rolled Steel Compact Secondary Members (Beams, Girts, Purlins)	3	2	10	6	20	12
Steel Primary Frame Members (with significant compression)	1.5	1	2	1.5	3	2
Steel Primary Frame Members (without significant compression)	1.5	1	3	2	6	4
Steel Plates	5	3	10	6	20	12
Open-Web Steel Joists	1	1	2	3	4	6
Cold-Formed Light Gage Steel Panels (with secured ends)	1.75	1.25	3	2	6	4
Cold-Formed Light Gage Steel Panels (with unsecured ends)	1.0	-	1.8	1.3	3	2
Cold-Formed Light Gage Steel Beams, Girts, Purlins and Non-Compact Secondary Hot Rolled Members	2	1.5	3	3	12	10



Basınç – Impuls (P-i) Eğrisi

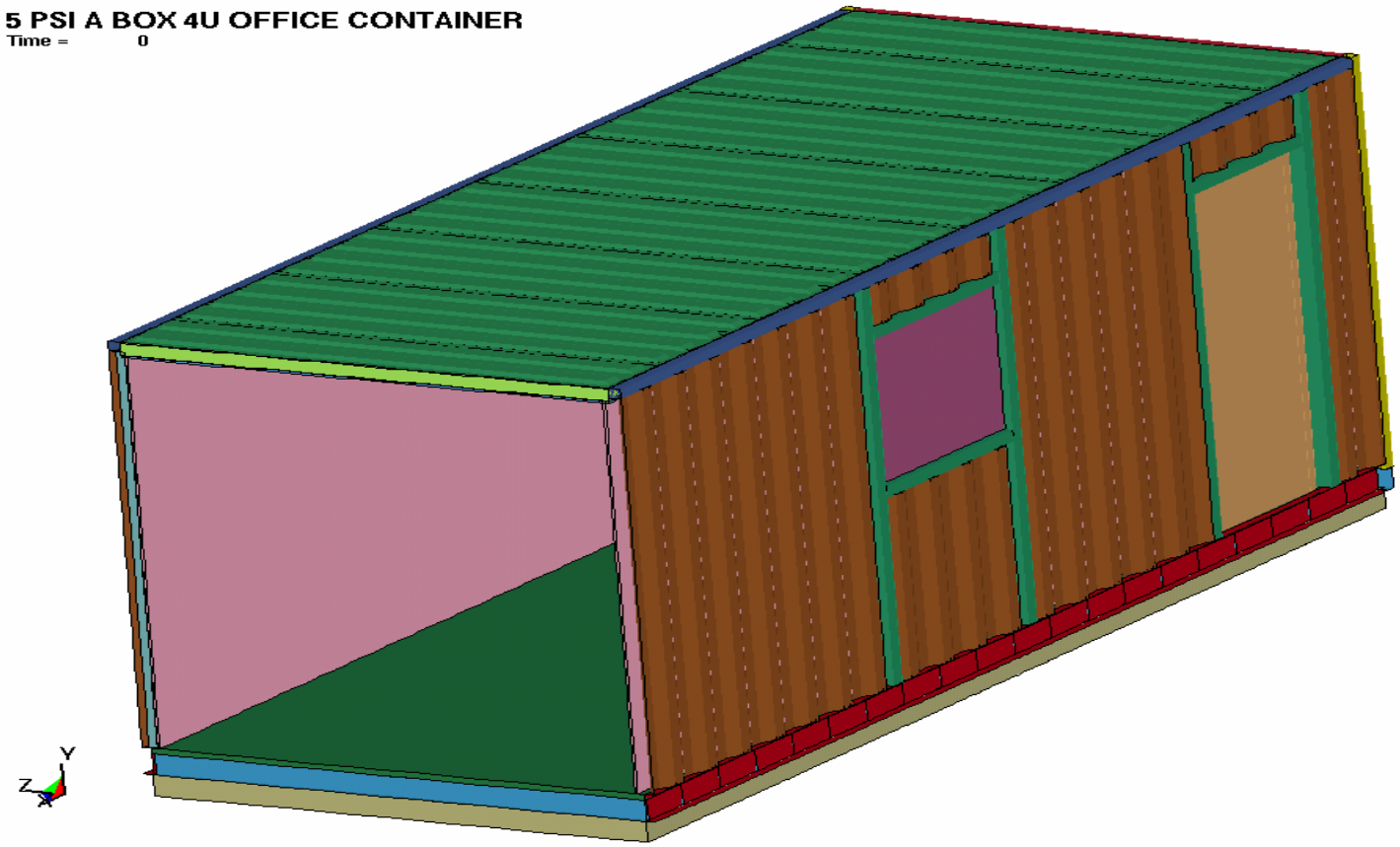




Overpressure vs Building Damage Tables

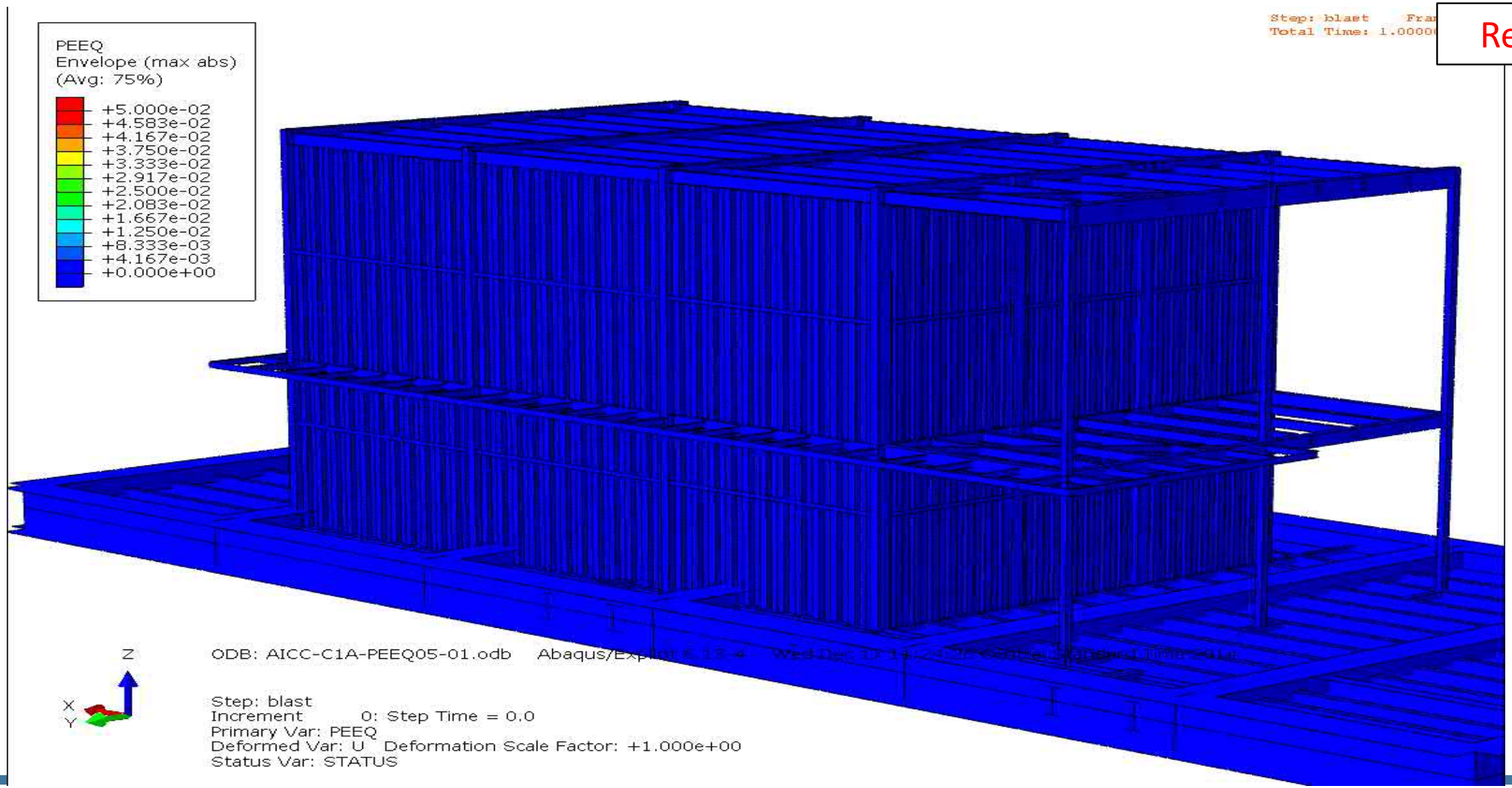
Peak Overpressure (psi)	Level of Damage Expected
0.02	Annoying noise (137 dB), if of low frequency (1 – 15 Hz)
0.03	Occasional breaking of large glass windows already under strain
0.04	Loud noise (143 dB); Sonic boom glass failure
0.10	Breaking of small windows under strain
0.15	Typical pressure for glass failure
0.30	'Safe distance' (probability 0.95 no serious damage beyond this value) Missile limit Some damage to house ceilings; 10% window glass broken
0.40	Limited minor structural damage
0.50 - 1.0	Large and small windows usually shattered; occasional damage to window frames
0.70	Minor damage to house structures
1.0	Partial demolition of houses, made uninhabitable
1.0 – 2.0	Corrugated asbestos shattered Corrugated steel or aluminum panels, fastenings fail, followed by buckling Wood panels (standard housing) fastenings fail, panels blown in
1.3	Steel frame of clad building slightly distorted
2.0	Partial collapse of walls and roofs of houses
2.0 – 3.0	Concrete or cinder block walls, not reinforced, shattered
2.3	Lower limit of serious structural damage
2.4 – 12.2	Range for 1 – 90% eardrum rupture among exposed populations
2.5	50% destruction of brickwork of houses
3.0	Steel frame building distorted and pulled away from foundation
3.0 – 4.0	Frameless, self-framing steel panel building demolished
4.0	Cladding of light industrial buildings ruptured
5.0	Wooden utility poles snapped
5.0 – 7.0	Nearly complete destruction of houses
7.0	Loaded train wagons overturned
7.0 – 8.0	Brick panels, 8-12 in. thick, non-reinforced, fail by shearing or flexure
9.0	Loaded train boxcars demolished
10.0	Probable total building destruction
14.5 – 29.0	Range for 1 – 99% fatalities among exposed populations due to direct blast effects

Sonlu Elemanlar Yöntemi ile Analiz



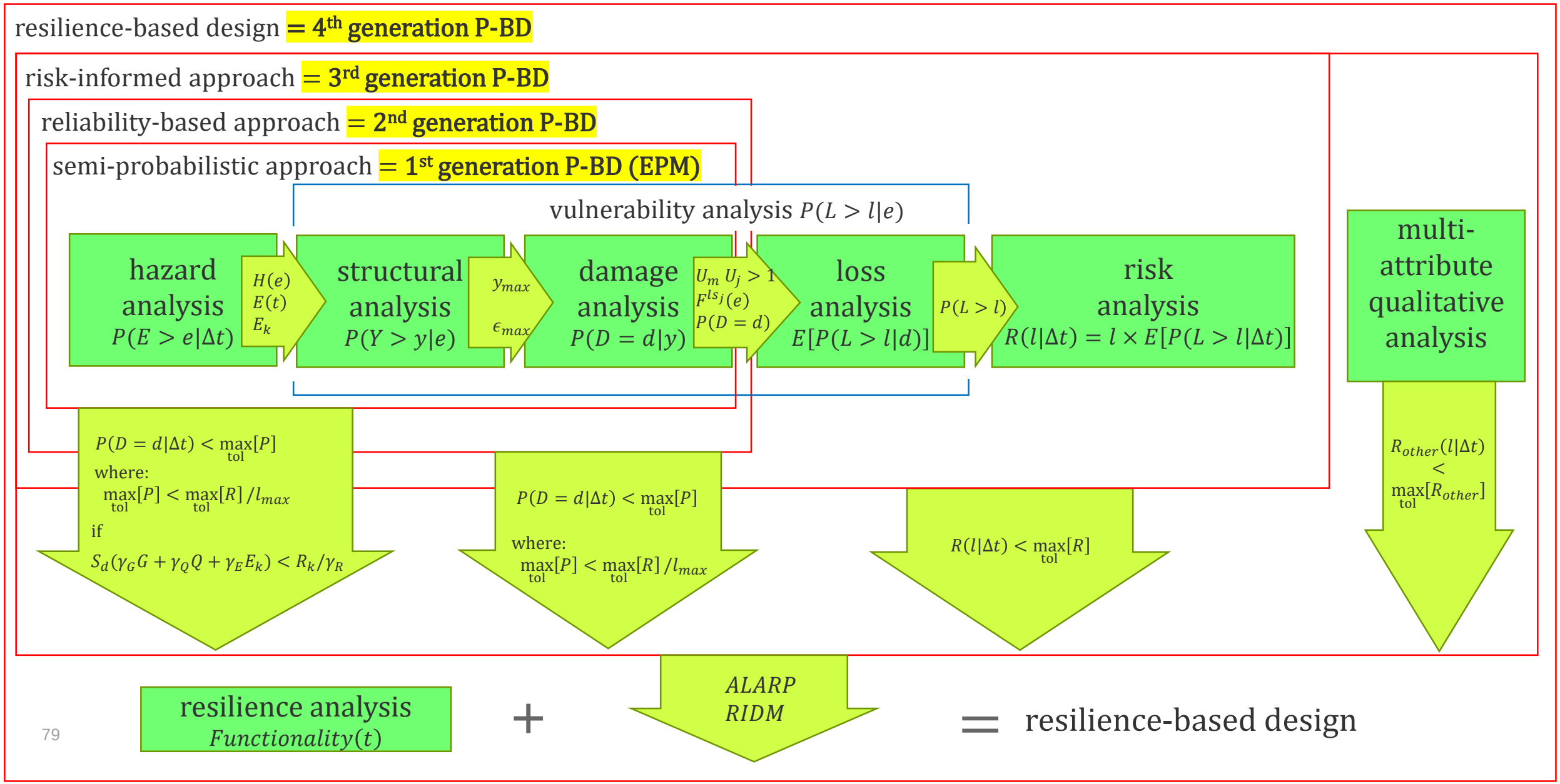
- Includes shell, thick shell, and solid elements
- proper material models for steel, wood, glass, and foam were used
- Filtered blast test loads were applied on the exterior and interior wall and roof components
- base displacement
- Strain rate effect was considered

Sonlu Elemanlar Yöntemi ile Analiz



Risk Tabanlı Patlama Analizi

analysis - hazard, response, damage, loss, risk & resilience



Risk Tabanlı Patlama Analizi

Likelihood of Harm:

- Determine frequencies associated with structural damage levels
- Calculate Building Individual Risk

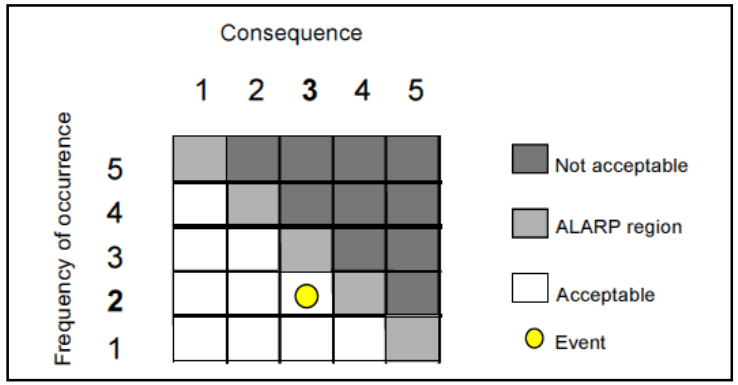
Hazard Curve:

- Pressure Exceedance Curve
- Generate Pressure vs Positive Phase Duration

Consequence:

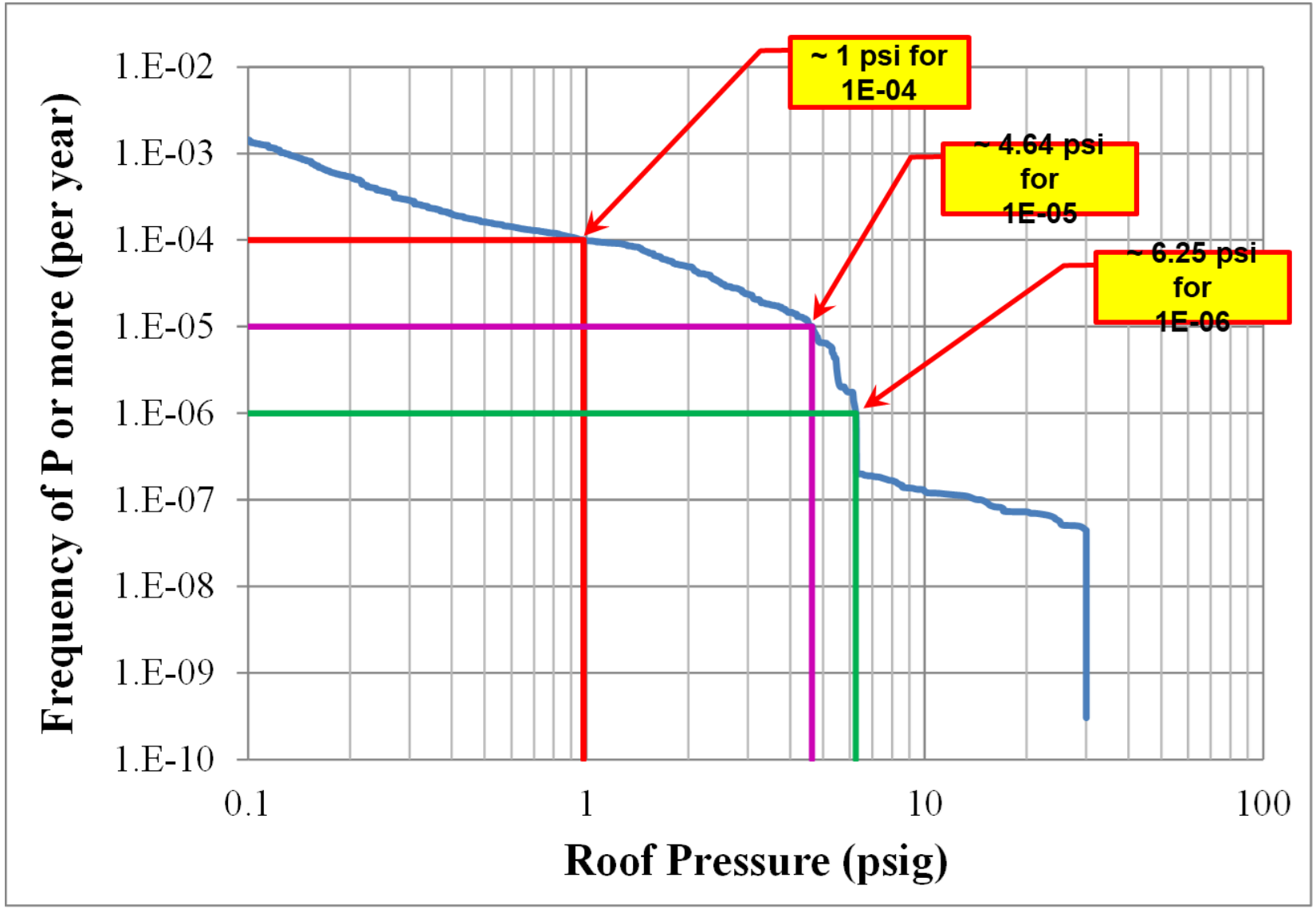
- Structural response analysis using SDOF or MDOF or Hybrid Approach
- Develop Pressure-Impulse Curve for Each Damage Sate
- Calculate OV for each damage level
- Calculate Expected fatalities for Each Damage State

Identify Risk using Risk Matrix



Develop Mitigation/Repair/Strengthening Options, **if Risk is not acceptable**

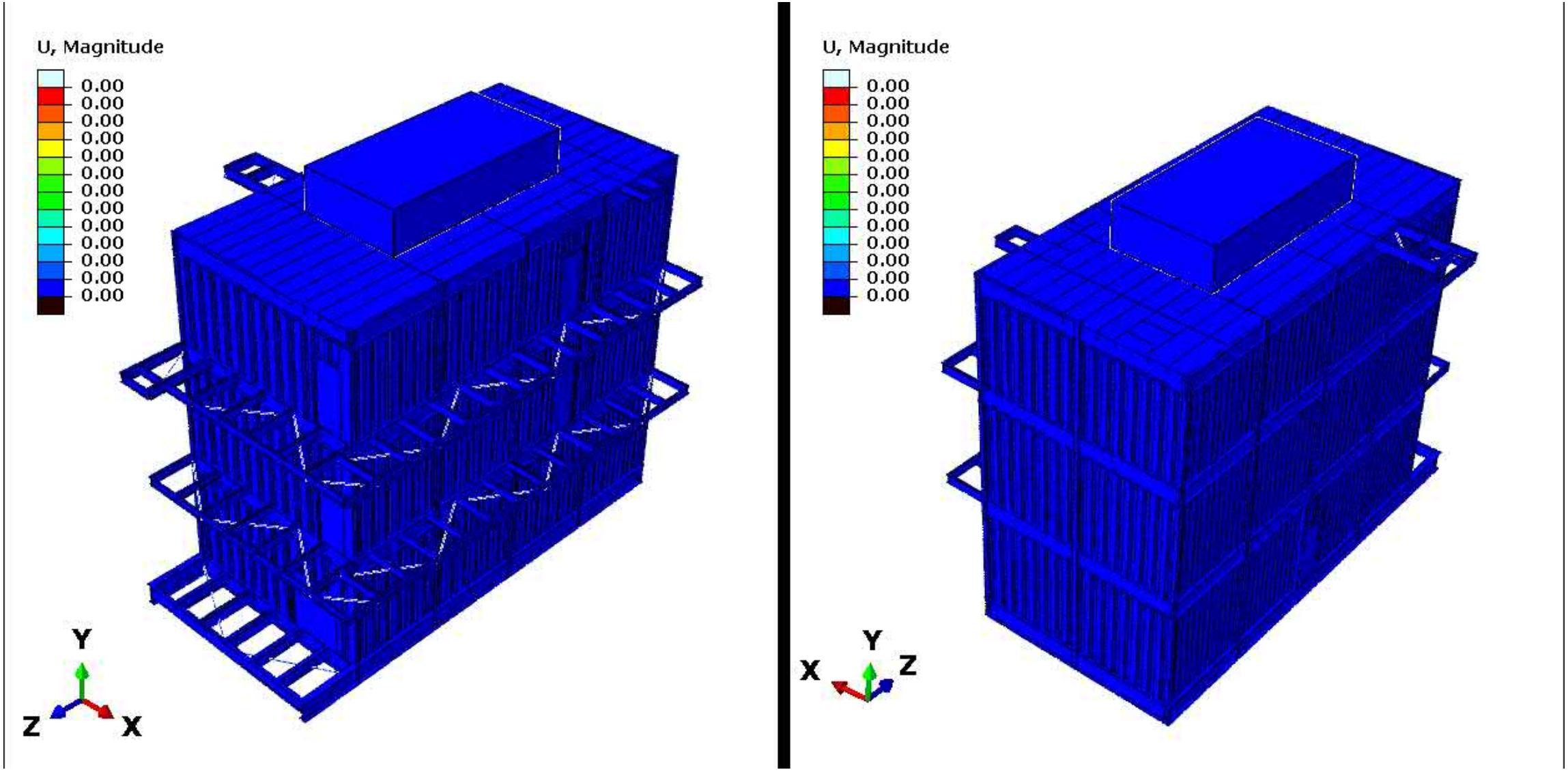
Overpressure Frequency of Exceedance Curves



Damage States for Blast Analysis

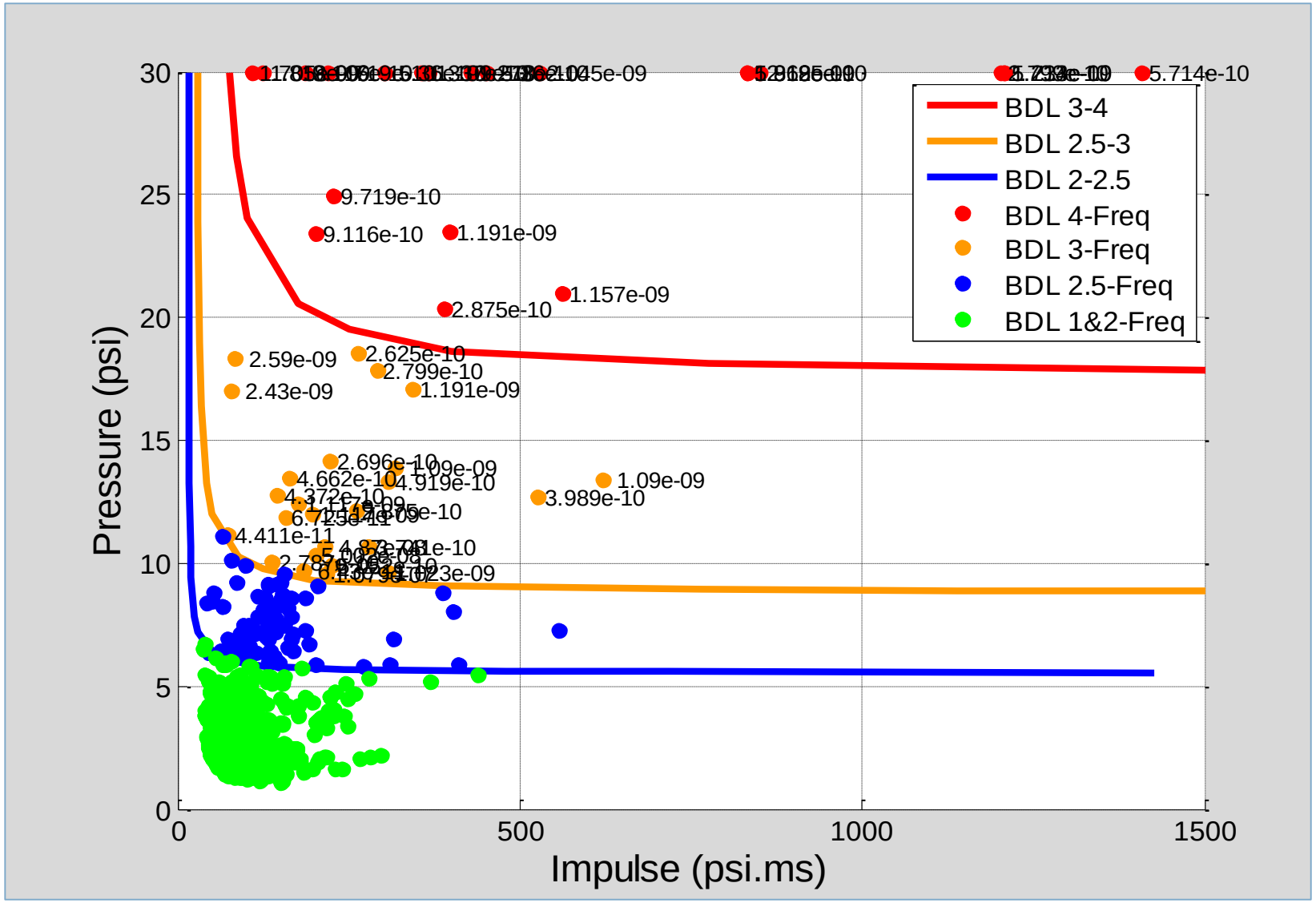
Damage States		Damage Description
Minor/Elastic	**1**	Onset of visible damage to reflected wall of building
Low	**2.0**	Reflected wall components sustain permanent damage requiring replacement, other walls and roof have visible damage that is generally repairable
Medium	**2.5**	Reflected wall components are collapsed or very severely damaged. Other walls and roof have permanent damage requiring replacement
High	**3**	Reflected wall has collapsed. Other walls and roof have substantial plastic deformation that may be approaching incipient collapse
Collapse	**4**	Complete failure of the building roof and a substantial area of walls

Blast Analysis



Deformation[in] Distribution

LQ Building P-I Curves



Occupant Vulnerability (OV)

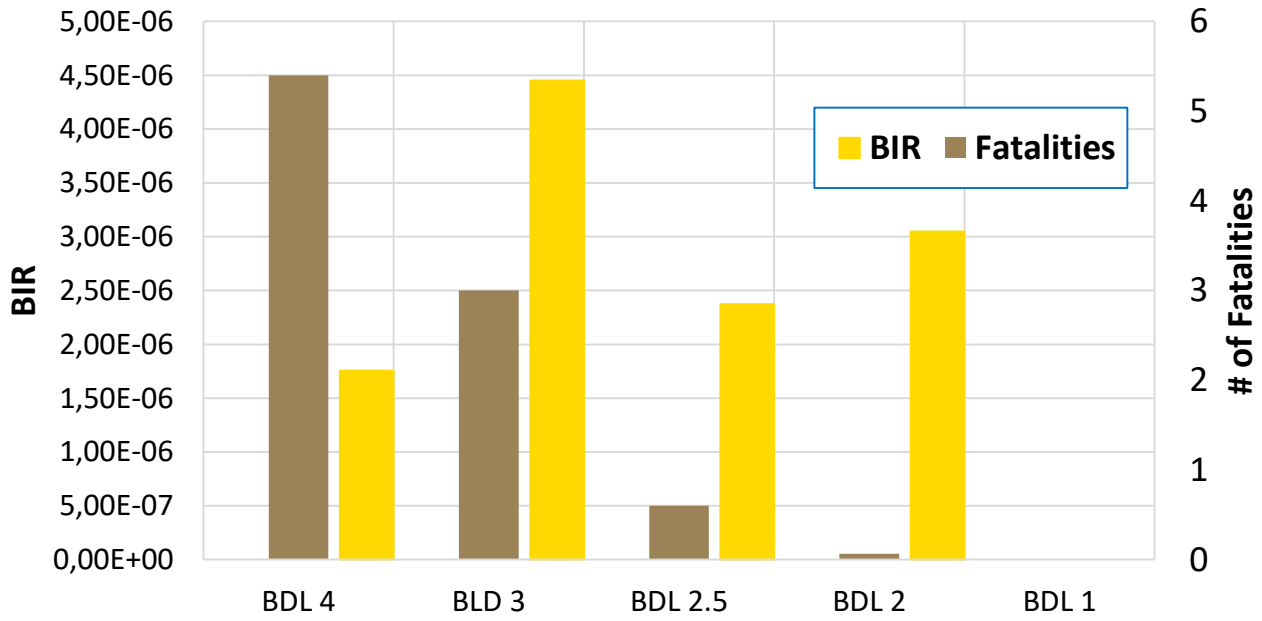
Building Damage States		Occupant Vulnerability OV (%)
Minor/Elastic	**1**	0.1
Low	**2.0**	1.0
Medium	**2.5**	10.0
High	**3**	50.0
Collapse	**4**	90.0

$$IR = \sum_{i=1,n} \boldsymbol{VN|DL_i} \times P(I|DL_i) \times P(DL_i)$$

$$\textbf{Building Individual Risk} = \boldsymbol{OV} \times OPP \times (Calc.Freqi - Calc.Freqi_{\_1})$$

Building with 6 occupants

Summary	Frequency	OV	BIR	# of fatalities
Sum of All Available Frequencies	3.12E-04			
BDL 4	1.95E-06	0.90	1.76E-06	5.4
BLD 3	8.90E-06	0.50	4.45E-06	3
BDL 2.5	2.37E-05	0.10	2.37E-06	0.6
BDL 2	2.77E-04	0.011	3.05E-06	0.066
BDL 1	0.00E+00		0.00E+00	0
		SUM =	**1.16E-05**	**9.07**



Kasıtlı Patlama Tehdit Analizleri

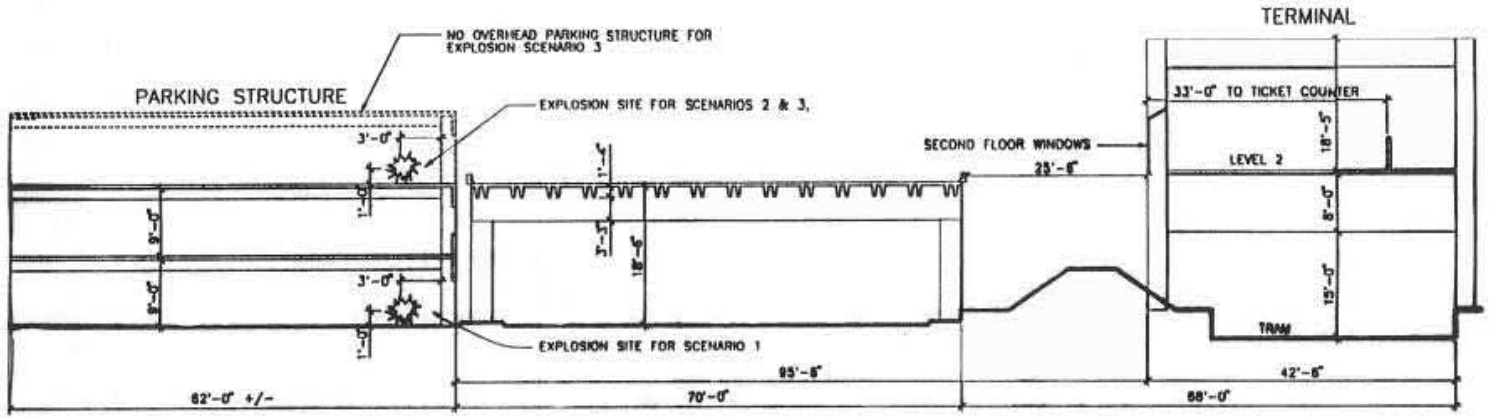
Havalanları Saldırıları

FAA Data from 1996-2001

48 Bombings identified worldwide

- 3 Large (100-220 lbs)
- 10 Medium (10-100 lbs)
- 35 Small (<10 lbs)

Havaalanlarının Güvenlik Analizi



"TYPICAL" CROSS SECTION THROUGH DFW PARKING GARAGE AND LANDSIDE TERMINAL BUILDING

Options	Comments	Protection Provided
Apply Film to Existing Panes and Wet Glaze Panes to Frame	Apply 0.012" Thick Film to One Surface, or 0.008" Thick Film to Both Surfaces of Pane, and Wet Glaze both Surfaces to Frame	Expected to Limit Threat to a Large "Floppy" Fragment at Low Velocity
Replace with Laminated Panes and Wet Glaze Panes to Frame	Wet Glaze both Surfaces of Pane to Frame	Expected to Limit Threat to a Large "Floppy" Fragment at Low Velocity
Place Full Height Lexan Panels in Back of Windows	0.25" Thick Lexan Panels Must be Well Anchored on One Edge	Stops Virtually All Window Fragments
Hang Lexan Panel Behind Annealed Glass Panes	0.25" Thick Panel Must Hang About 3' Below Bottom of Panes	Expected to Stop Most Glass Fragments
Replace with Tempered Glass Panes		Threat is Reduced to Mass Injury

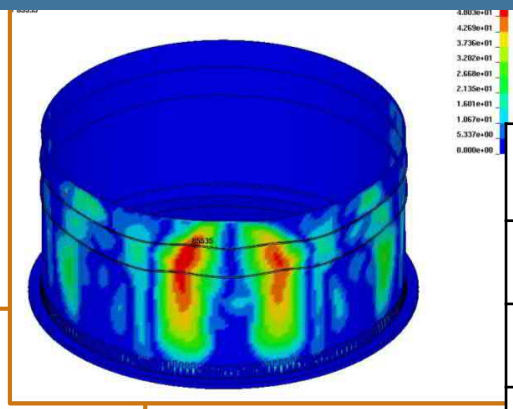
Depolama Tank Tesisleri

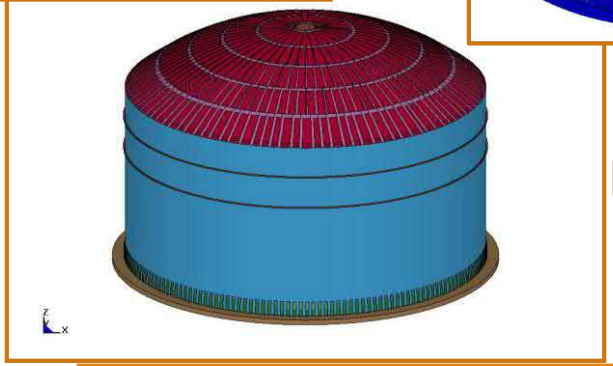
Endüstriyel Tesisler

- Tank Failure, Baghdad, Iraq in May 2016 that was caused by terrorist attack.

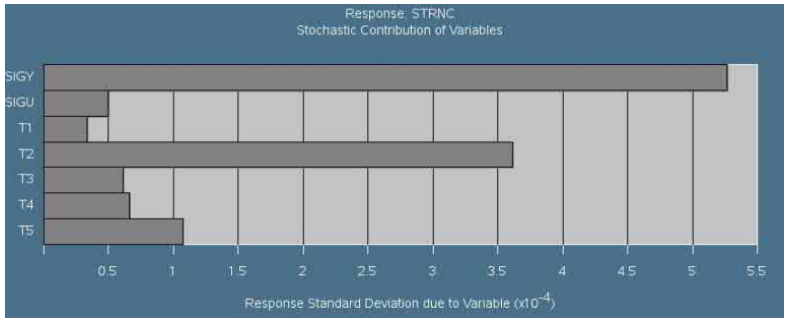
At least 14 people were killed on Sunday in an attack by a militant group at a gas plant near Baghdad,
http://www.newindianexpress.com/world/2016/may/16/14-killed-in-IS-suicide-bombing-at-gas-plant-in-Iraq-904247.html

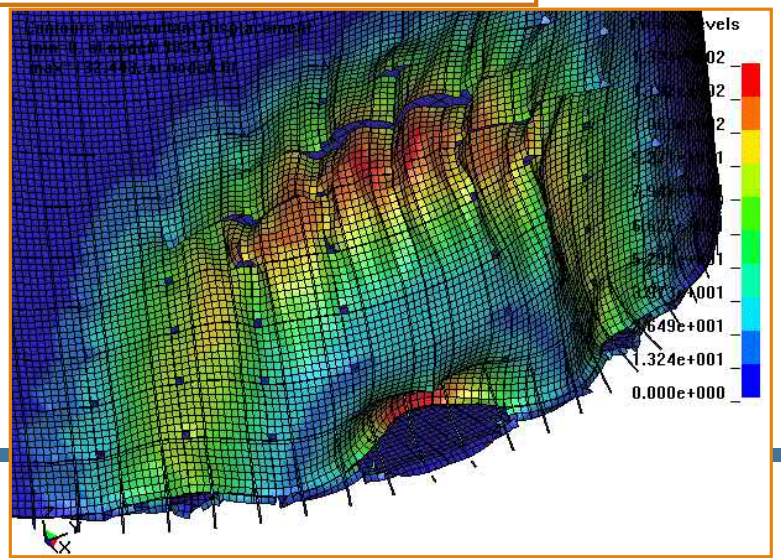
Depolama Tank Tesisleri Tehdit Analizleri

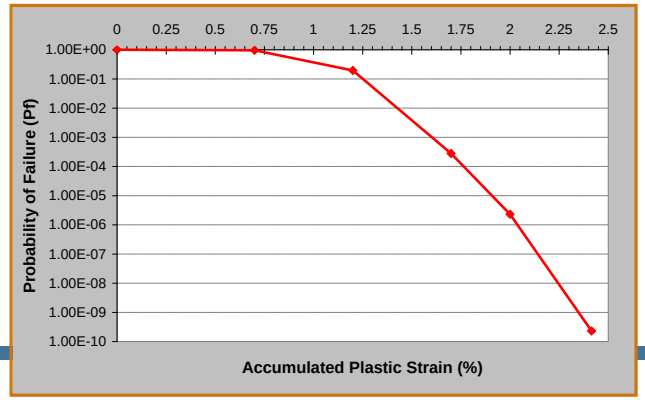




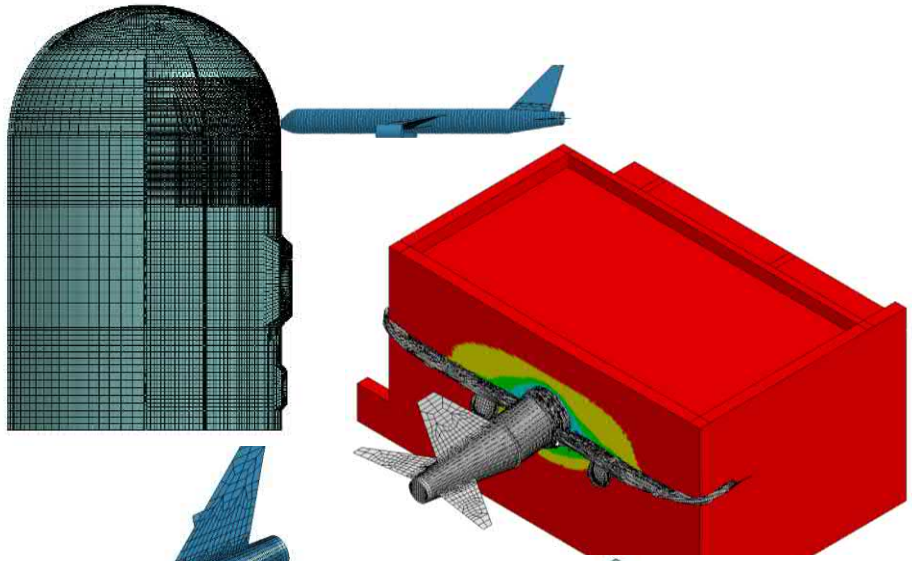
Variable	Distribution Type	Mean Value	COV
Thicknesses, t1,..,t5	Normal	0.25”-0.688”	4.6%
Yield Strength, fy	Normal	38.87 ksi	3.2%
Tensile Strength, fu	Normal	62.34 ksi	3.2%

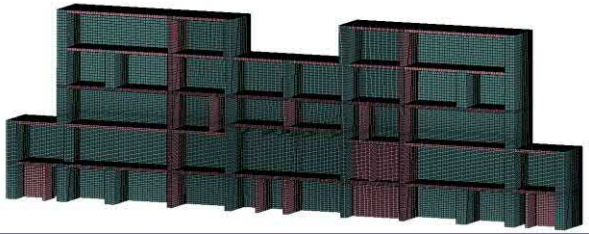


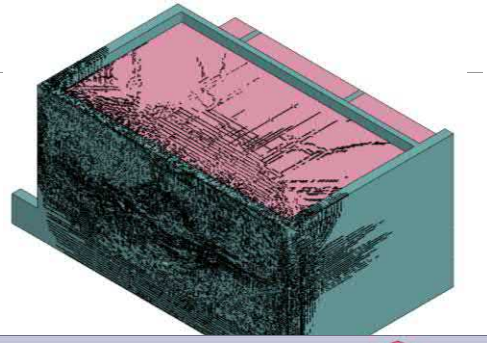


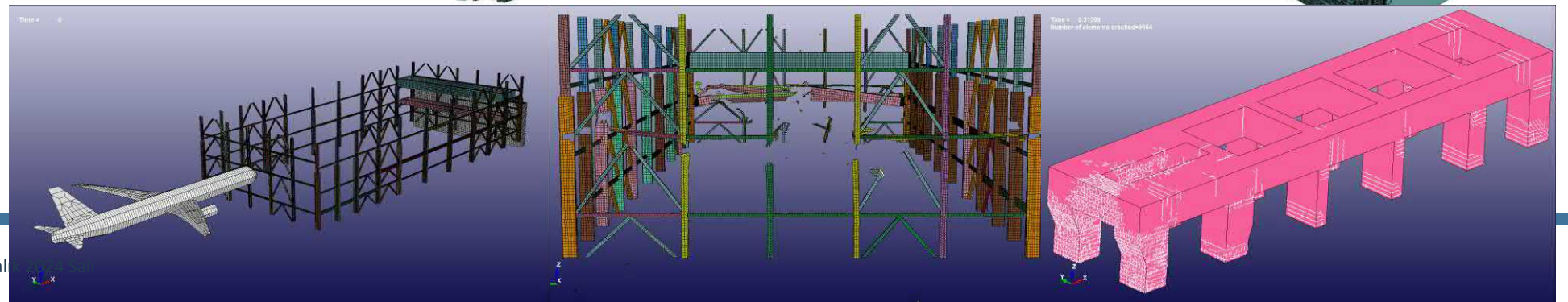


Tehdit Analizleri









Terörist Taktikleri Gelişiyor

Increased use of suicide bombers:

- Pedestrian bombers carry ~ 50# TNT
- LVIED – 100’s to 1000’s of pounds TNT
- use munitions rather than bulk explosives
  - Significant fragment threat

Increased use of teams:

- Draw people to the scene
  - African embassy bombings
  - Bali bombing
  - Abortion clinic bombing
- Overpower security
  - Recent attacks in Saudi Arabia

Tasarım Ölçütleri Süreci

Identify and categorize assets

Assess asset value

Determine Threat Level

- Identify likely aggressors and likelihood of attack
- Identify tactics and levels of severity
- Consolidate tactics into design basis threat

Determine appropriate level of protection

Identify design constraints – criteria

Tipik Tasarım Esaslı Tehdit (DBT) Parametreleri (1 of 2)

Aggressor Tactics	Design Basis Threat Severity	Weapons	Tools
Moving Vehicle Bomb	Very High	2000 lb TNT	12,000 lb truck
	High	500 lb TNT	5,000 lb truck
	Medium	100 lb TNT	4,000 lb car
	Low	50 lb TNT	4,000 lb car
Stationary Vehicle Bomb	Very High	2000 lb TNT	12,000 lb truck
	High	500 lb TNT	5,000 lb truck
	Medium	100 lb TNT	4,000 lb car
	Low	50 lb TNT	4,000 lb car
Exterior	High	IID, IED (100 lb TNT), and grenades	None
	Medium	IID, IED (2 lb TNT), and grenades	
	Low	IID, Rocks and clubs	
Standoff Weapons	High	Mortars (to 50 lb TNT)	None
	Low	Antitank Weapons	
Ballistics	Very High	30.06 AP	None
	High	7.62 mm M80 Ball	
	Medium	0.44 Magnum Handgun	
	Low	38 Super Handgun	

Tipik DBT Parametreleri (2 of 2)

Forced Entry	Very High	Handguns and submachine guns (up to UL-SPSA)	Unlimited hand, power, thermal tools, and explosives[1]
	High		Unlimited hand, powertools, and limited thermal tools/explosives[2]
	Medium		Unlimited hand tools, limited power/thermal tools, and hand-held hydraulic jacks
	Low	None	Unlimited hand tools
	Very Low		Limited Hand Tools
Visual Surveillance			Ocular devices
Acoustic Eavesdropping			Listening devices
Electronic Emanations Eavesdropping			Monitoring equipment
Mail Bomb Delivery		[3]IID, IED (2 lbm TNT)	None
Supplies Bomb Delivery		IED (100 lbm TNT)	
Airborne Contamination		Chemical and/or biological agents	Limited Hand Tools
Waterborne Contamination		Chemical, biological and/or radiological agents	

Varlık Tanımlama (Asset Identification)

What are you trying to protect?

- Your facility?
- Your customers?
- Your reputation?

What are they worth?

- Not just $, think operationally
- A small garage over/under building may be “worth” more than a large stand-alone facility

Koruma Seviyesi (Level of Protection)

Level of Protection may be defined for specific projects

Examples of acceptable response levels

- ISC and UFC Criteria
  - May allow some window breakage
  - Prohibit progressive collapse
- Airport terminal response
  - Keep the roof up

American Society of Civil Engineers – General guidance

Industry Guidance – Example – Explosion Research Cooperative

Tasarım Stratejileri

- Maximize standoff distance
- Prevent building collapse
- Minimize hazardous flying debris
- Provide effective building layout
- Limit airborne contamination
- Provide mass notification
- Facilitate future upgrades

Gözönüne Alınacak Unsurlar

Site Planning
- 1: Min. standoff distances
- 2: Building separation
- 3: Unobstructed space
- 4: Drive-up/drop-off areas
- 5: Access roads
- 6: Parking under or on

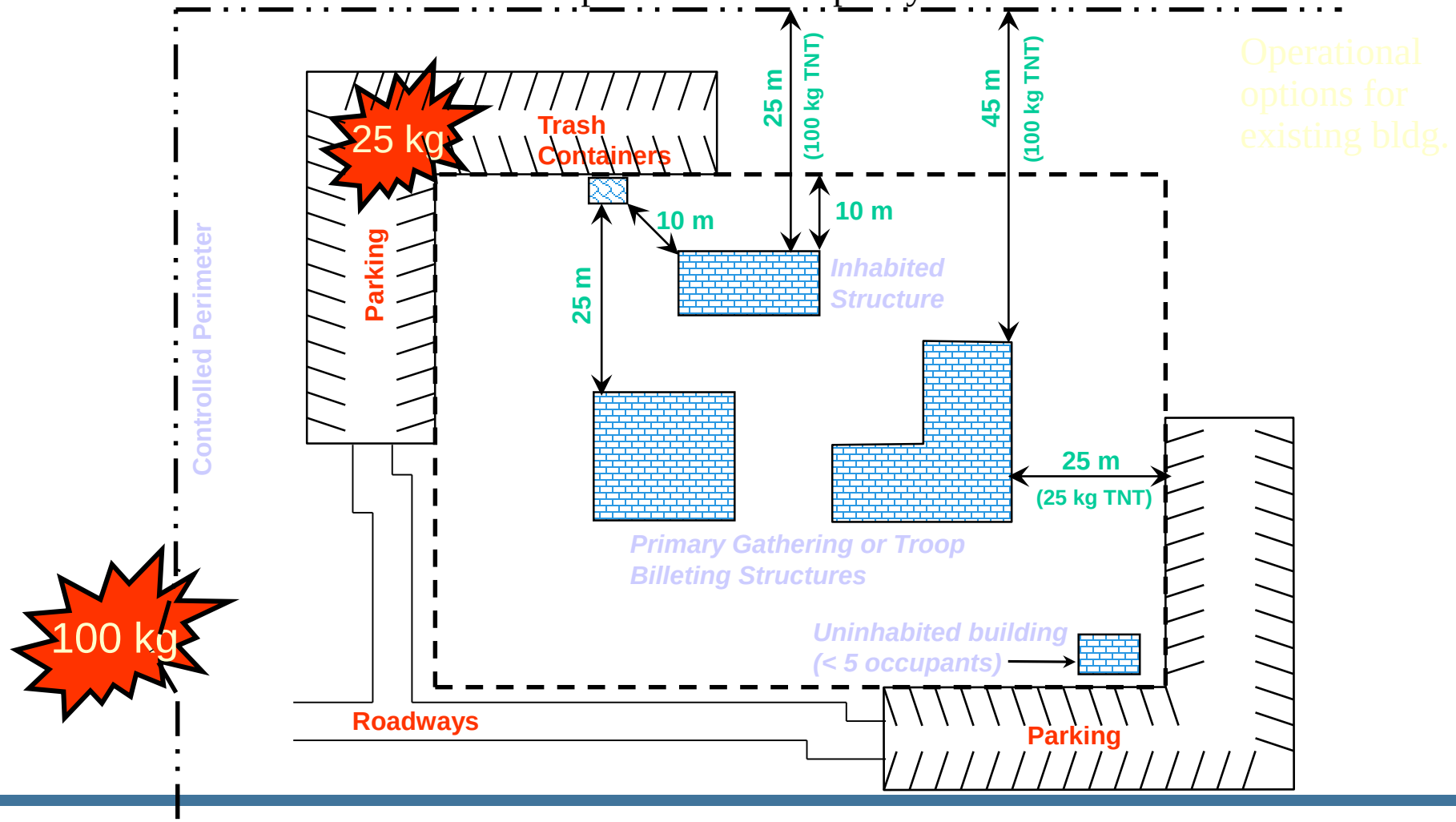
Structural Design
- 7: Progressive collapse
- 8: Structural isolation
- 9: Building overhangs
- 10: Exterior masonry walls

Architectural Design
- 11: Glazing
- 12: Main building entrances
- 13: Exterior doors
- 14: Mailrooms
- 15: Roof access
- 16: Overhead mounted architectural features

Electrical & Mech. Design
- 17: Air intakes
- 18: Air distribution emergency shutoff
- 19: Utility distribution & installation
- 20: Equipment bracing
- 21: Under building access
- 22: Mass notification

Standoff Mesafeleri

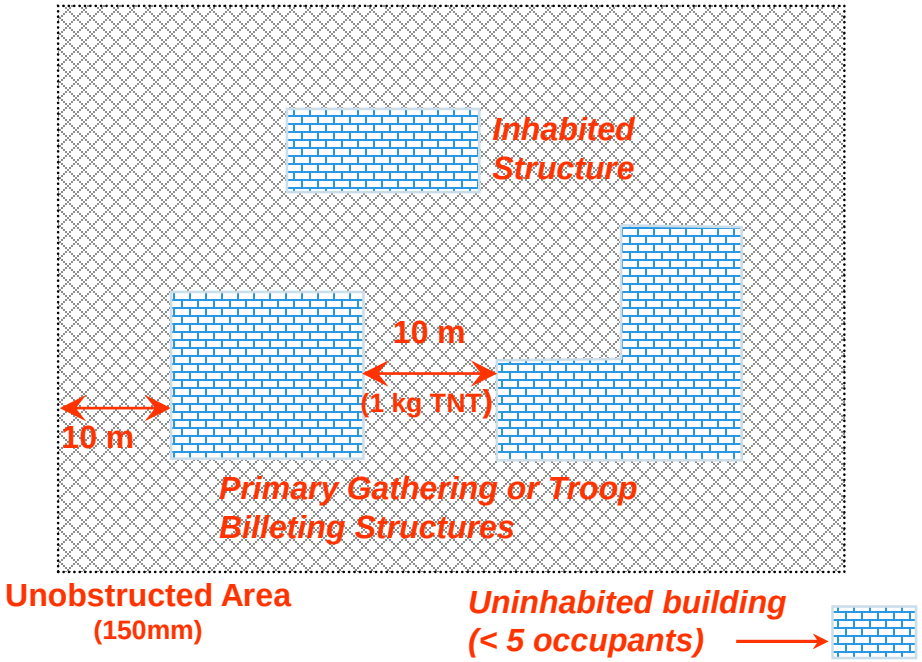
If no controlled perimeter exists, standoff from parking & roadways is increased to either 25m or 45m dependent on occupancy.



Ayrım Mesafeleri ve Açık, Engelsiz Alan

It is preferred that electrical & mechanical equipment not be located within the unobstructed area but it may be located in this area area as long as it does not provide a place of concealment

Equipment enclosures must not allow introduction of objects with a least dimension greater than of 150mm



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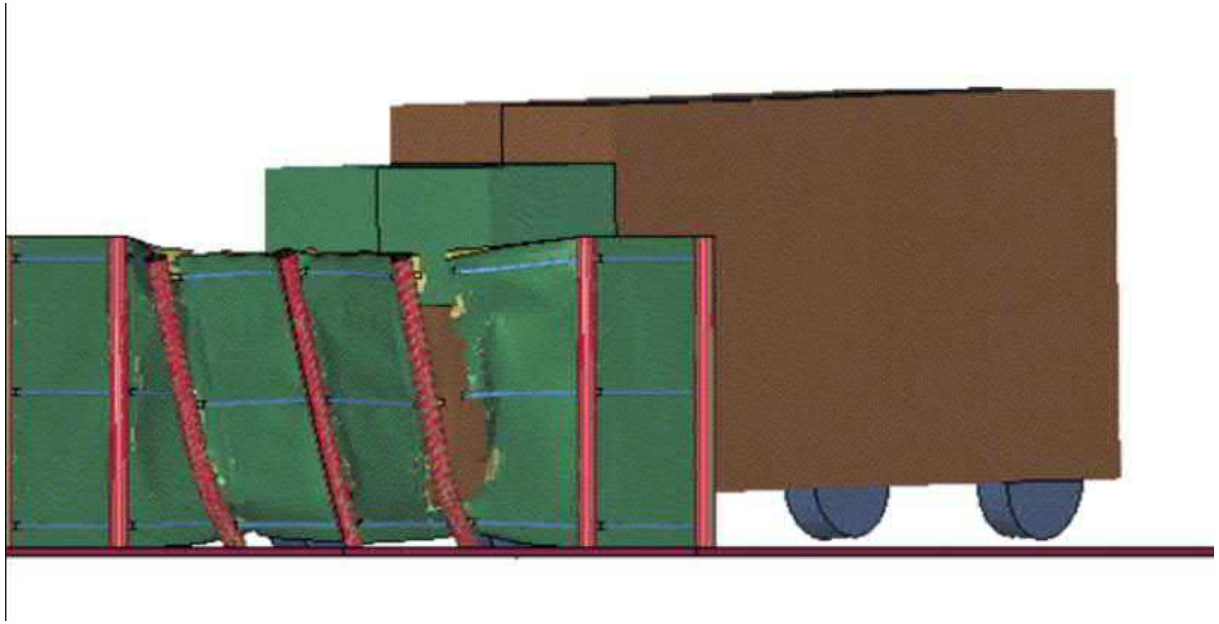

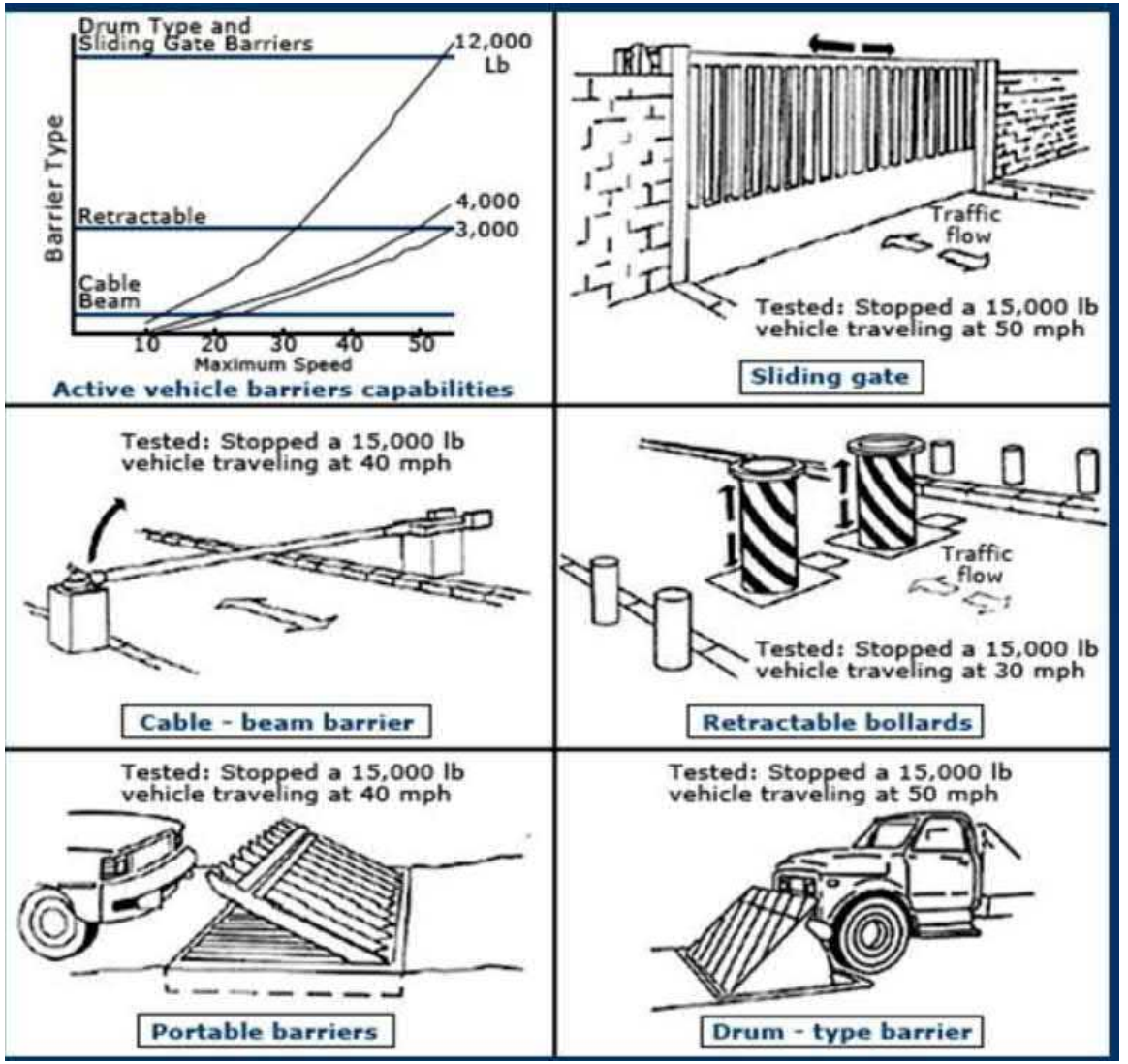

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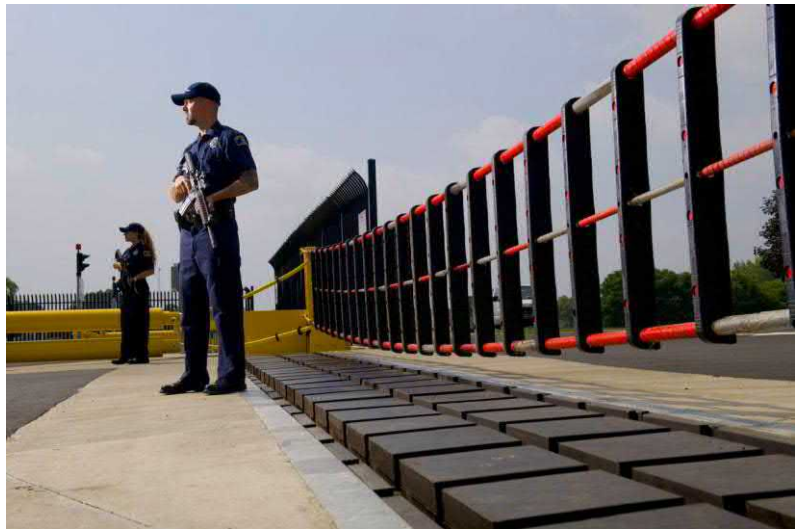

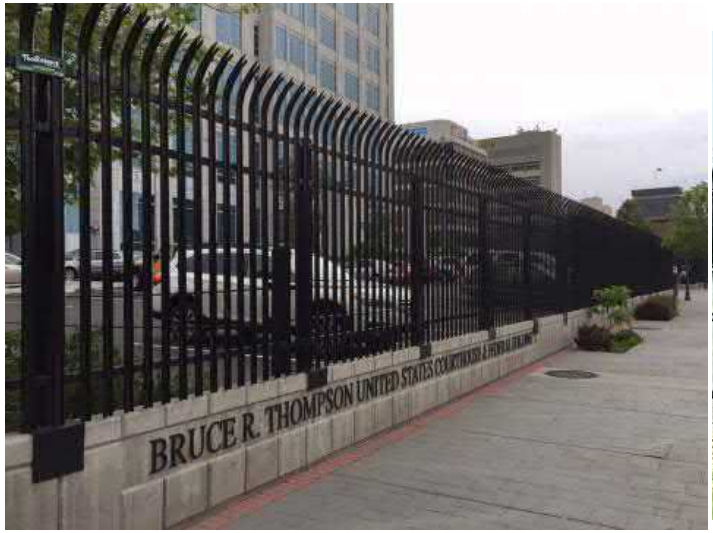

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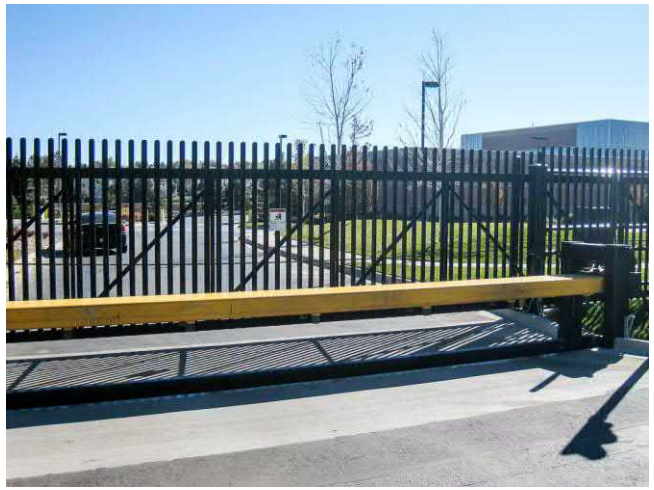
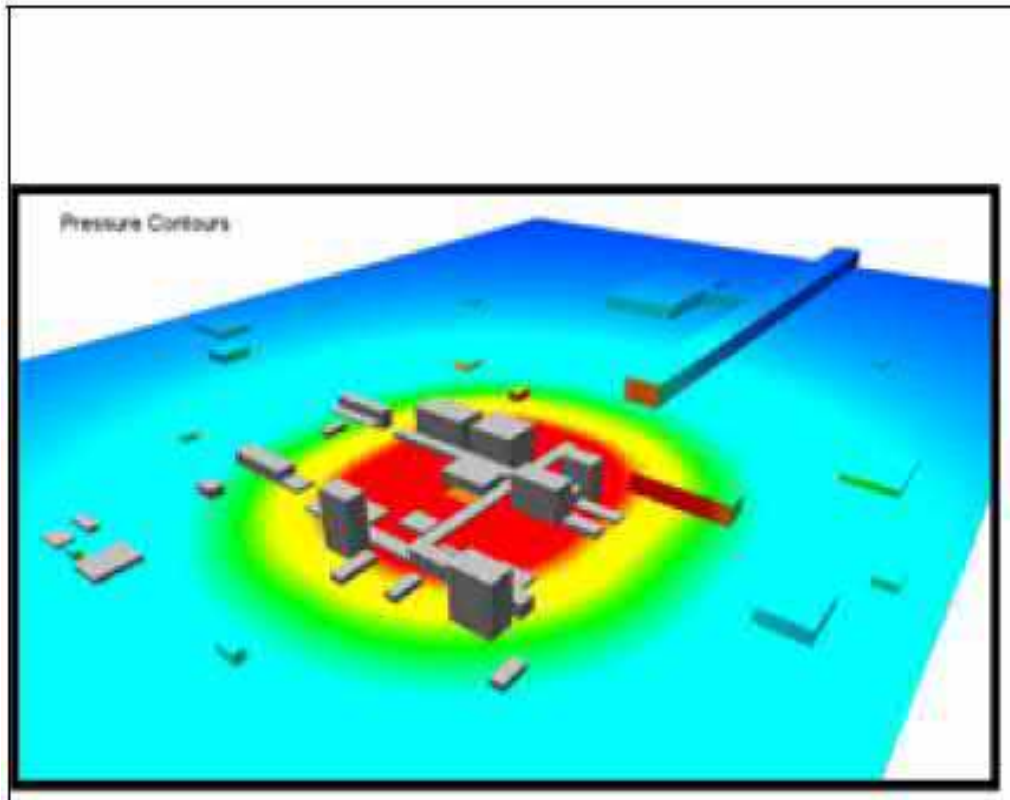
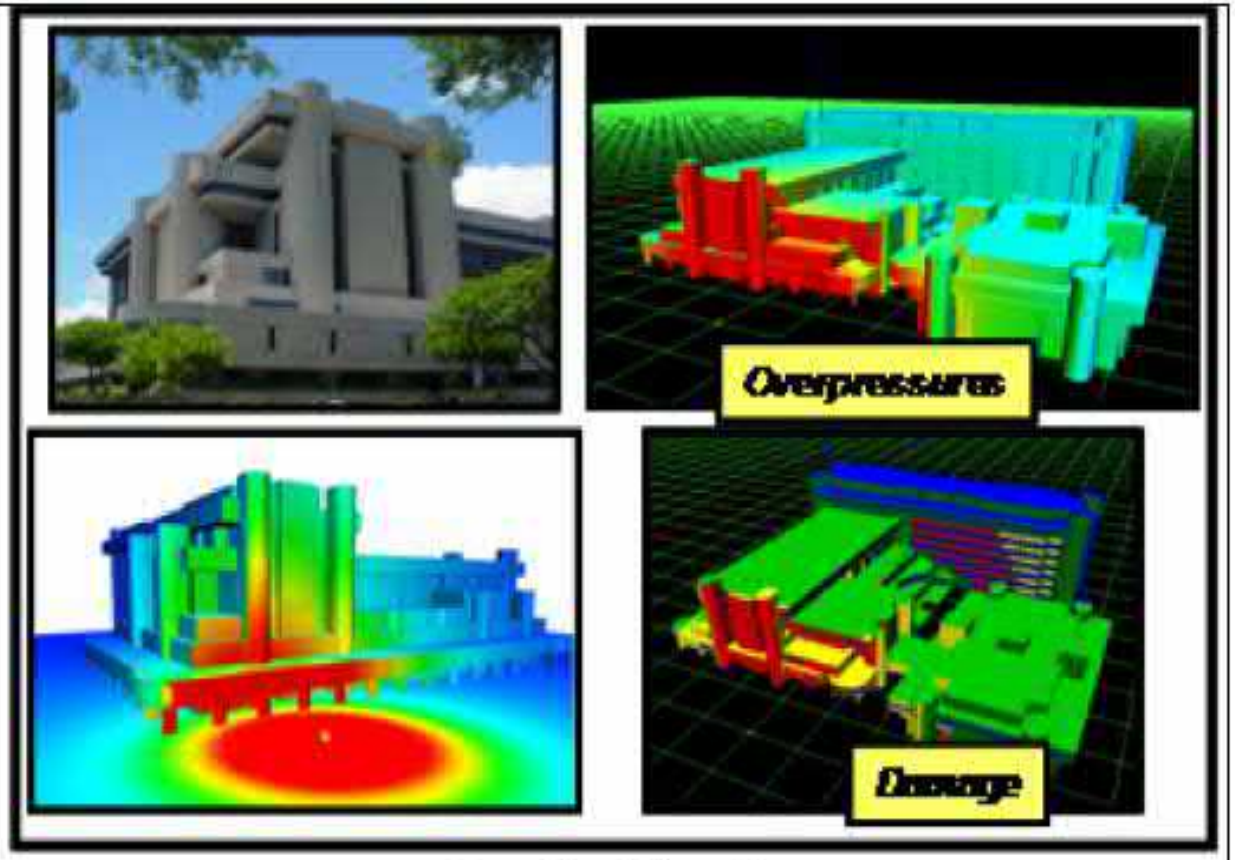


Terör Tehlikesi Değerlendirmesi

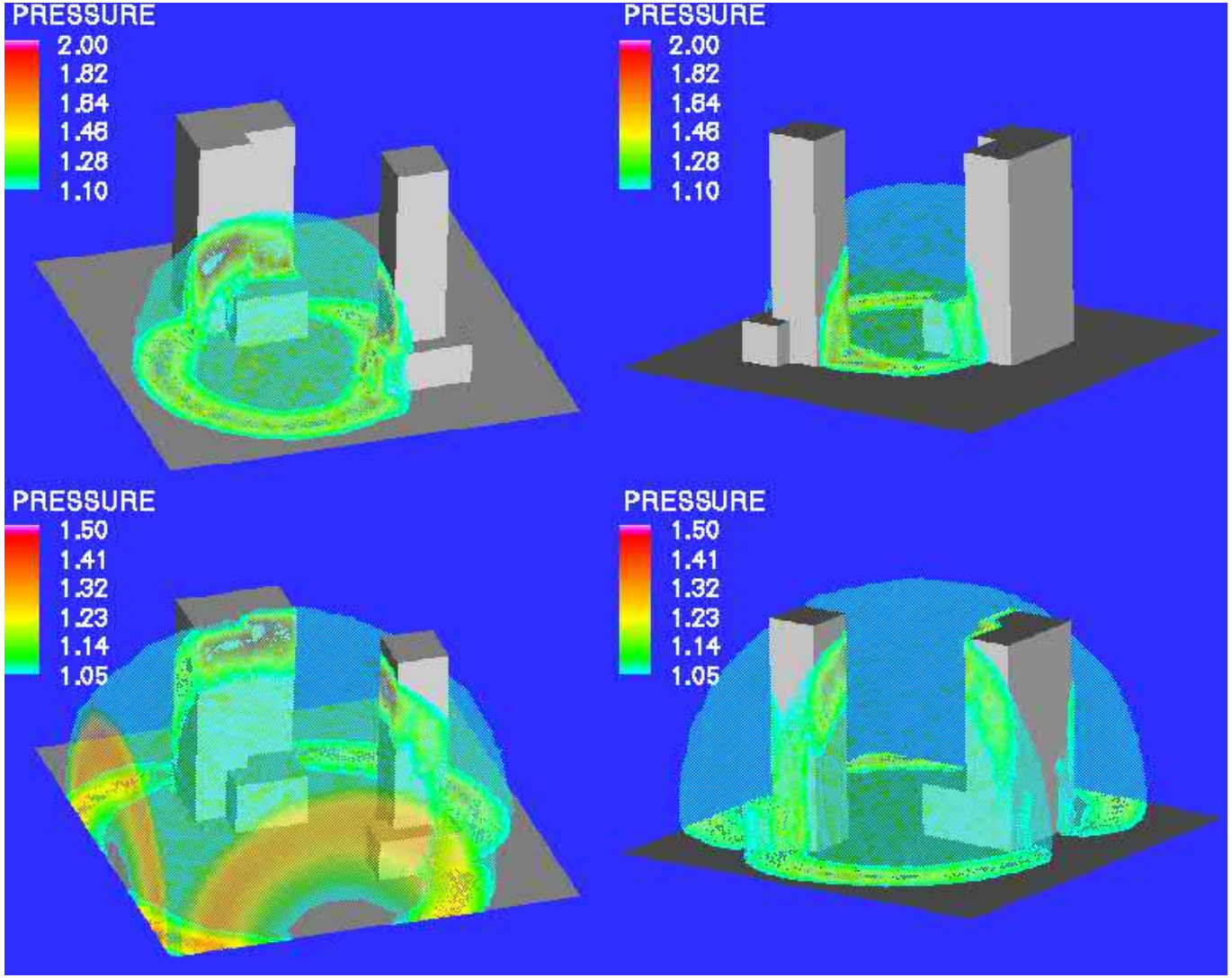


Facility

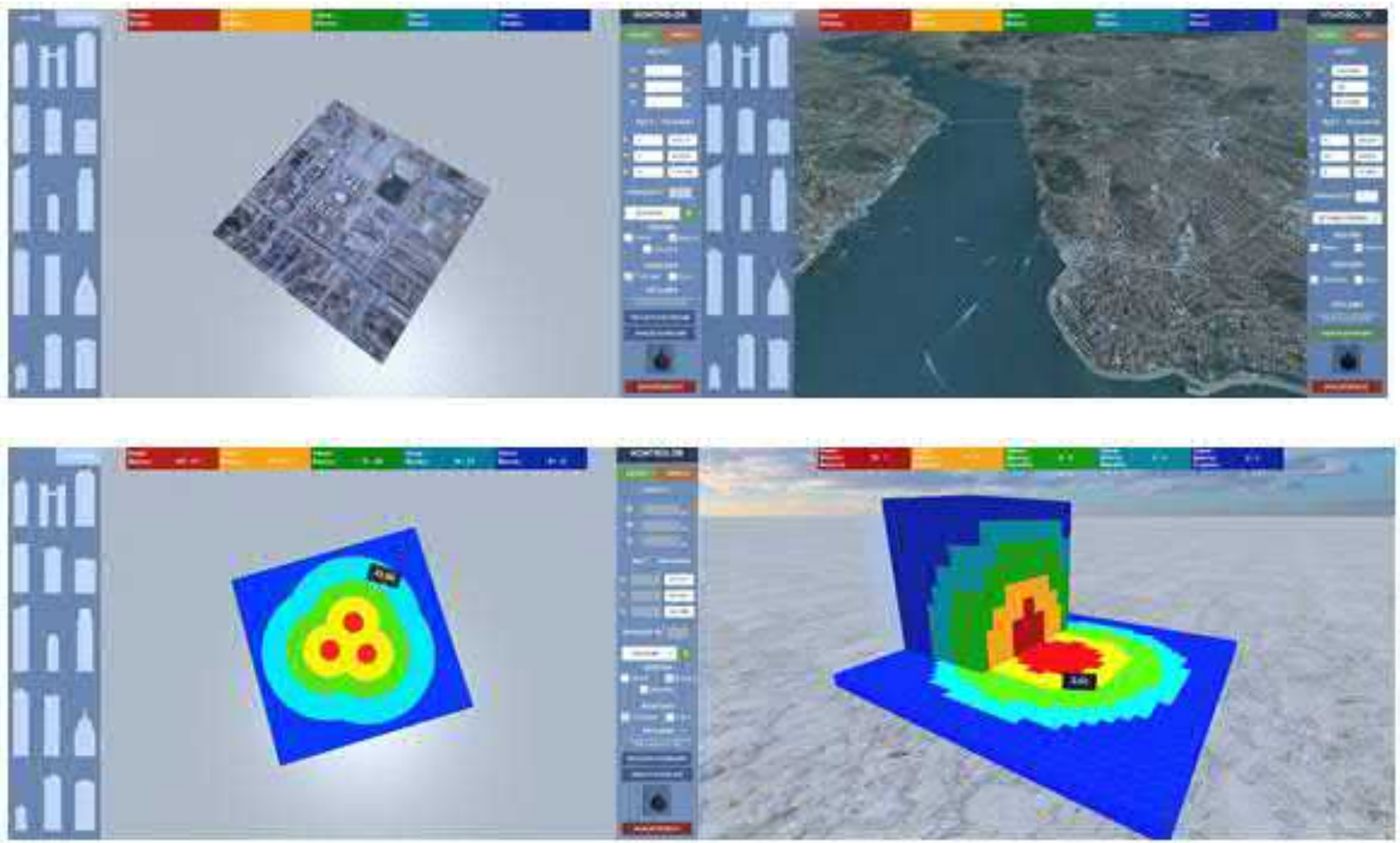


Individual Building

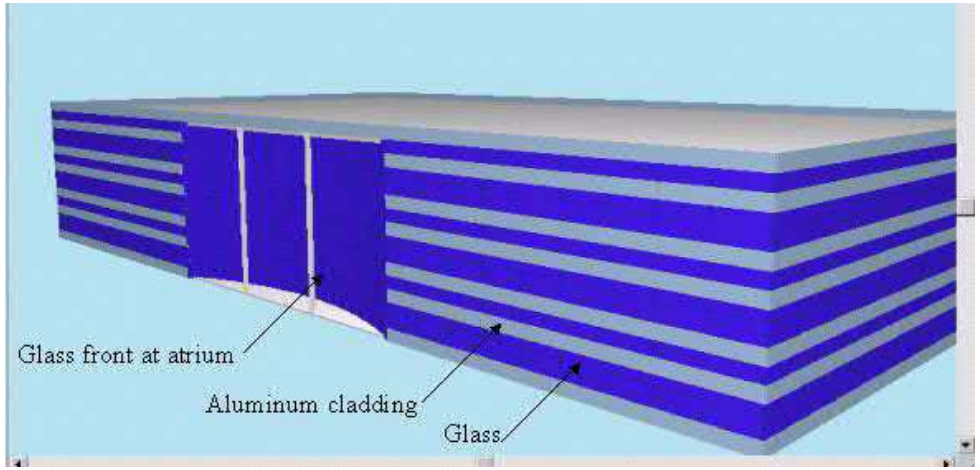
Alan Tehdit Analizi

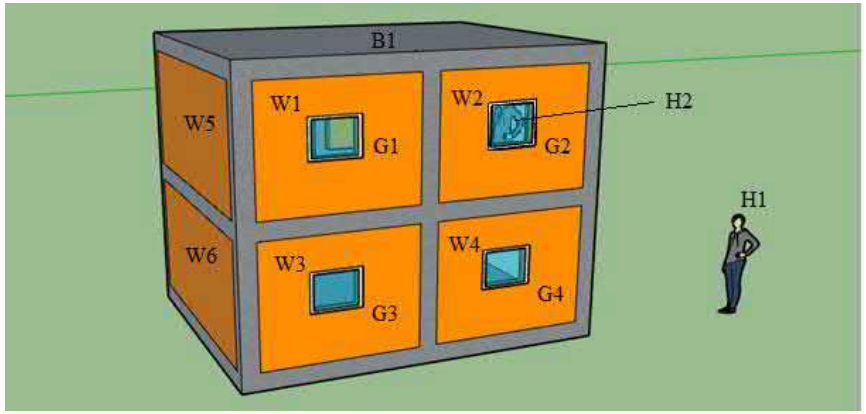


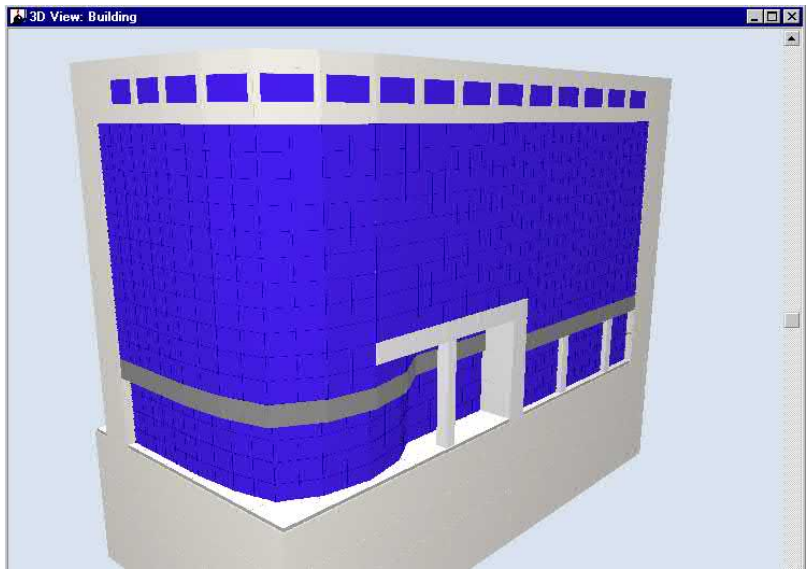
Terör Tehlikesi Değerlendirmesi (BeeBlast Yazılımı)

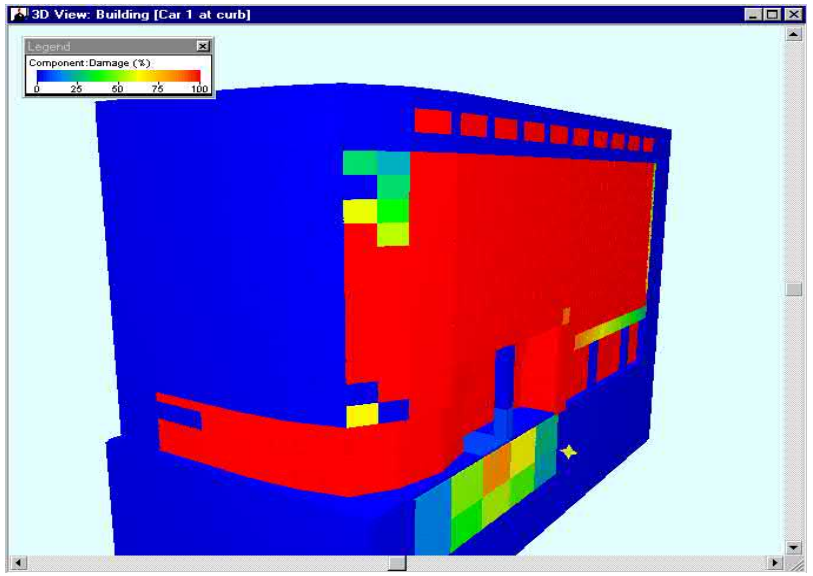


Terör Tehlikesi Değerlendirmesi and Yaralanma Modellemesi





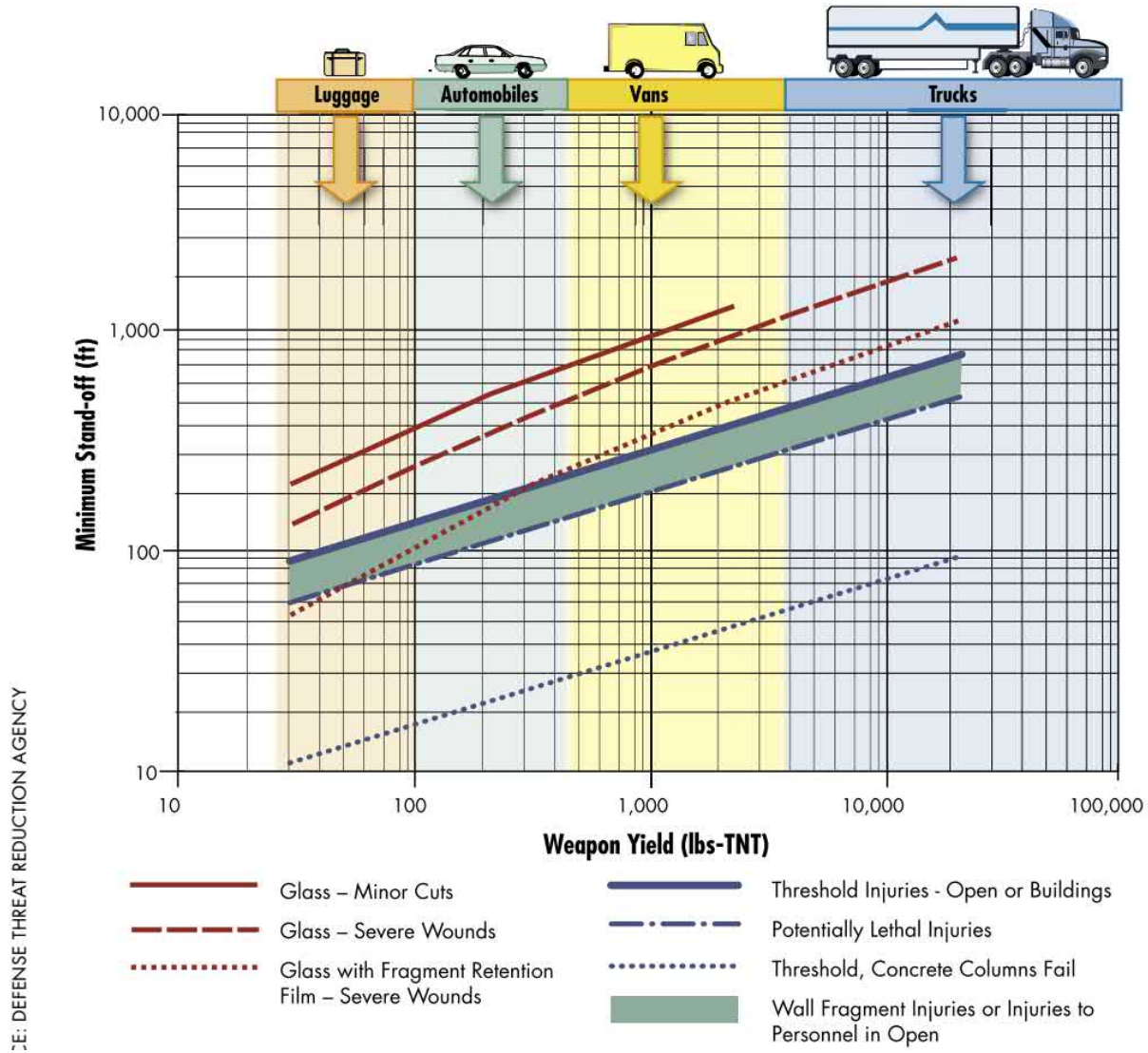




Patlayıcı Ağırlığı ve Tahliye Mesafesi

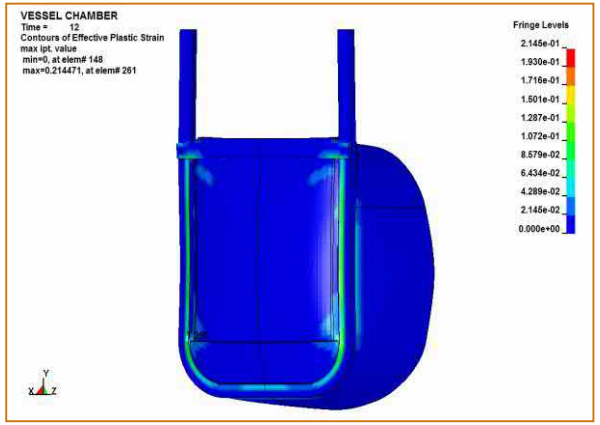
Threat Description		Explosives Capacity[1] (TNT Equivalent)	Mandatory Evacuation Distance[2]	Preferred Evacuation Distance[3]
	Pipe Bomb	5 lbs/2.3 kg	70 ft/21 m	1200 ft/366 m
	Suicide Vest	20 lbs/9.2 kg	110 ft/34 m	1,700 ft/518 m
	Briefcase/Suitcase Bomb	50 lbs/23 kg	150 ft/46 m	1,850 ft/564 m
	Sedan	500 lbs/227 kg	320 ft/98 m	1,900 ft/580 m
	SUV/Van	1,000 lbs/454 kg	400 ft/122 m	2,400 ft/732 m
	Small Delivery Truck	4,000 lbs/1,814 kg	640 ft/195 m	3,800 ft/1159 m
	Container/Water Truck	10,000 lbs/4,536 kg	860 ft/263 m	5,100 ft/1555 m
	Semi-Trailer	60,000 lbs/27,216 kg	1,570 ft/479 m	9,300 ft/2835 m

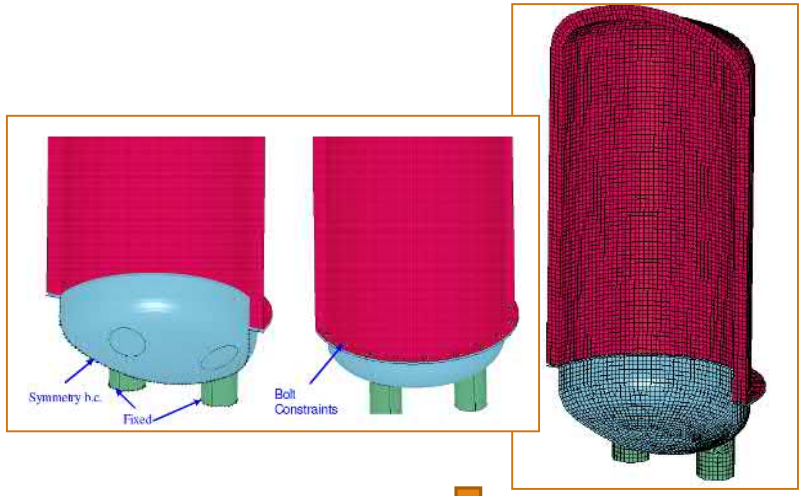
Patlayıcı Ağırlığı ve Minimum Mesafe

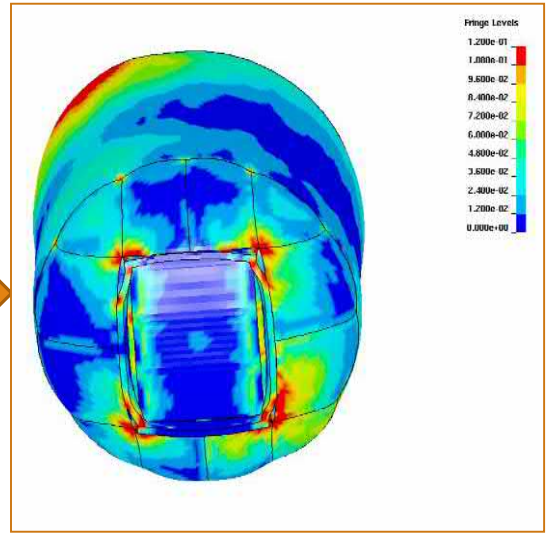


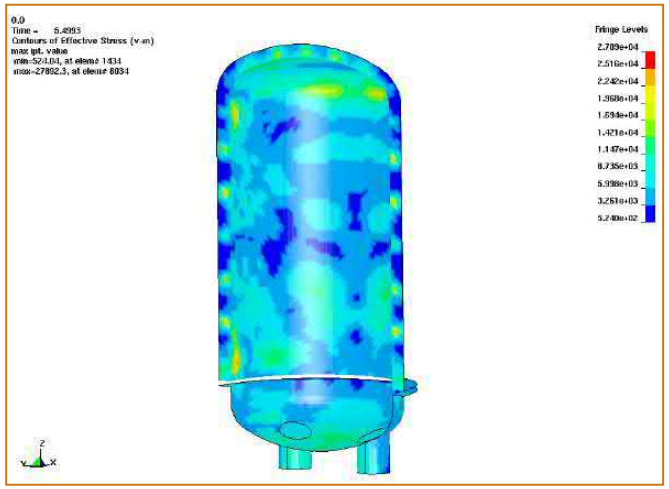
E: DEFENSE THREAT REDUCTION AGENCY

Patlama Odaları









Patlama Odaları