IDD HP Resilience Program

Cutting-Edge Risk and Resiliency Tools

NAS – Oct 5, 2011

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HP Resilience Workshops (2009-2011)

- Designing for a Resilient America: A Stakeholder Summit on High Performance Resilient Buildings and Related Infrastructure
- The Ultra High Performance Concrete (UHPC) Workshop
- Aging Infrastructures Workshop
- Stabilization of Building Workshop
- Security, Energy, and Environmental Summit
- Monitoring and Sensing of Near Collapse Building Workshop
- Near Collapse Buildings Workshop for Emergency Management Personnel
- Advanced Materials and the Infrastructure of the Future Workshop

NIAC AND DHS/S&T/IDD

NIAC Definition:
Infrastructure resilience is the ability to **reduce** the magnitude and/or **duration** of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to **anticipate, absorb, adapt** to, and/or **rapidly recover** from a potentially disruptive event.

HP Resilience Model

- Promotes the adoption of high performance and resilience concepts in a comprehensive and cost effective manner
- Promotes an integrated approach that addresses the capacity of the physical environment to anticipate, absorb, adapt to, and rapidly recover from disruptive events
- Promotes an integrated approach that includes design and construction issues related to:
  - Blast, earthquake, high wind, and flood resistance and cyber security
  - Energy efficiency, environmental sustainability
  - Durability/extension of life and continuity of operations

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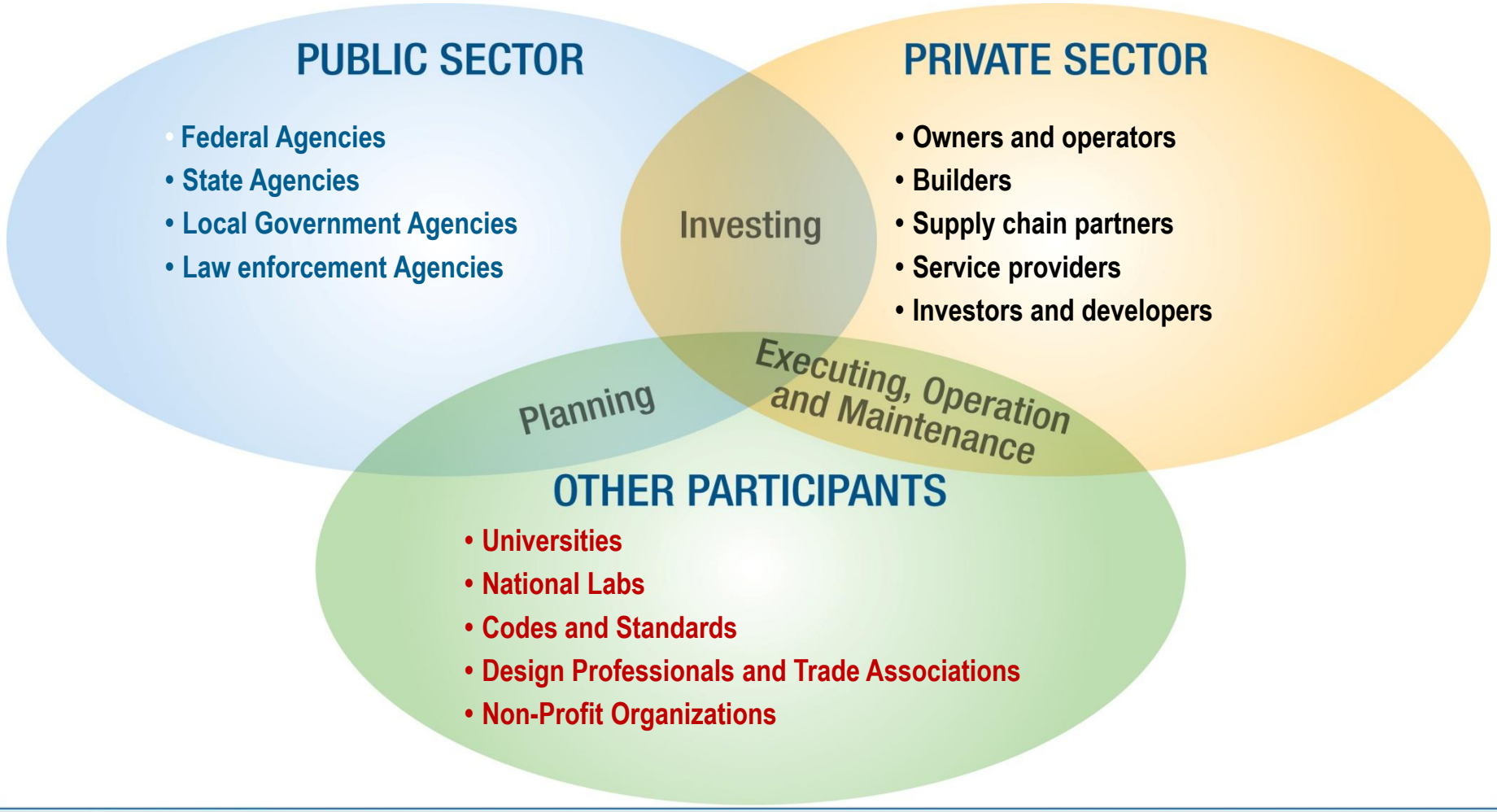
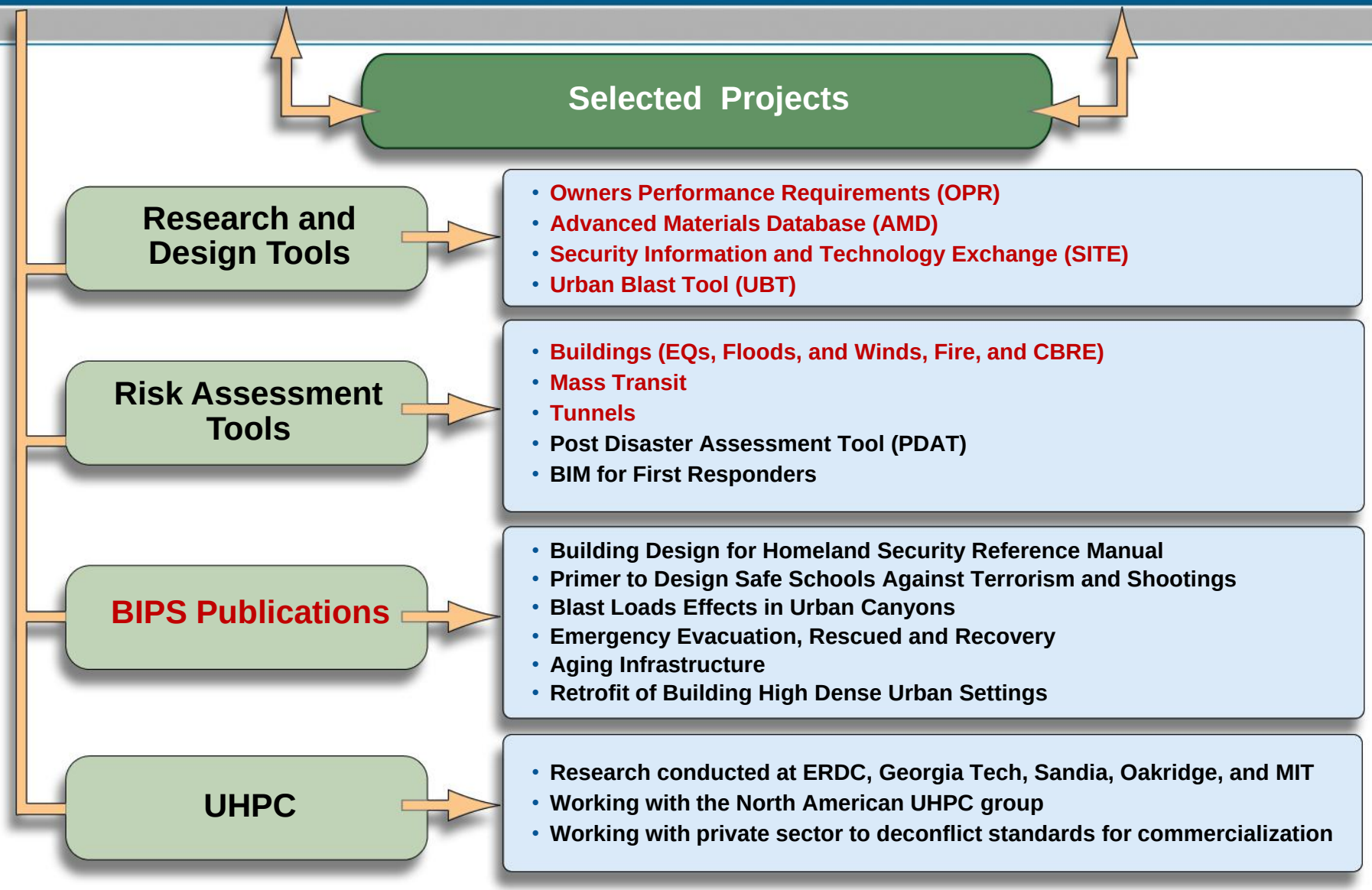
HP Resilience Stakeholders



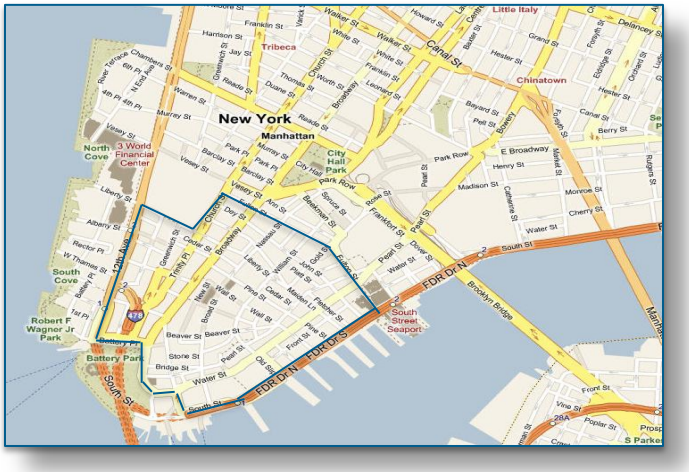
HP Resilience Program Taxonomy



Urban Blast Tool (UBT)

NYC Financial District (completed) and Mid Manhattan

- Geared toward the design community and first responders
- Very fast running providing guidance on Airblast loads based on CFD analysis
- Addresses column damage and potential for progressive collapse
- Displays glass debris hazards
- Use for evaluating emergency evacuation rescue and recovery (EERR) systems after an event



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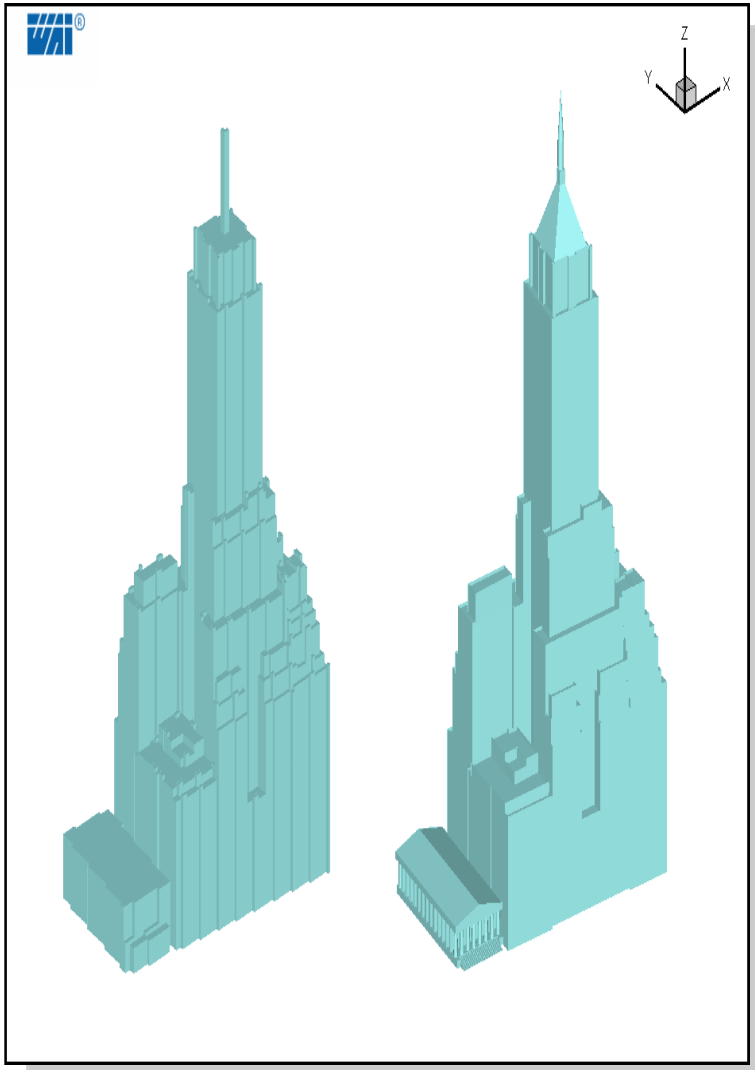
UBT Codes

- Airblast Codes for data base computations
- DTRA MAZ code for analyzing 3D propagation
- Navy's Gemini code for simulation of underwater explosion and shock propagation in air to model failure of curtain walls or façade
- Gemini code coupled with DYNA or FLEX structural code to predict damage to nearby targets



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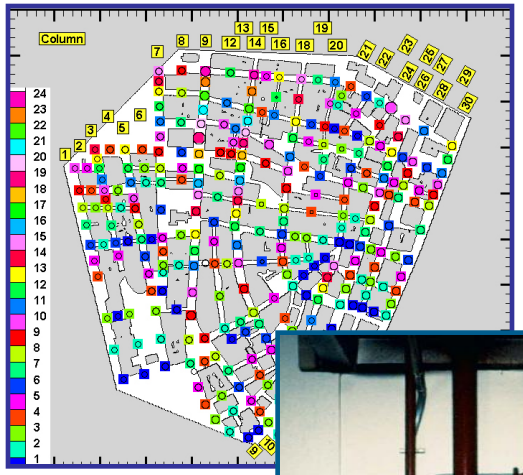
UBT – Future Development

- Develop an interactive version to allow owners to input critical data
- Add ProCAT Model to increase column accuracy in terms of progressive collapse
- Develop UBTs tailored for other major cities in the US
- Create a generic version applicable to most cities in the US
- Analyze and add more structural detailed studies to the UBT models
- Improve accuracy and generate additional EERR equipment fragility models



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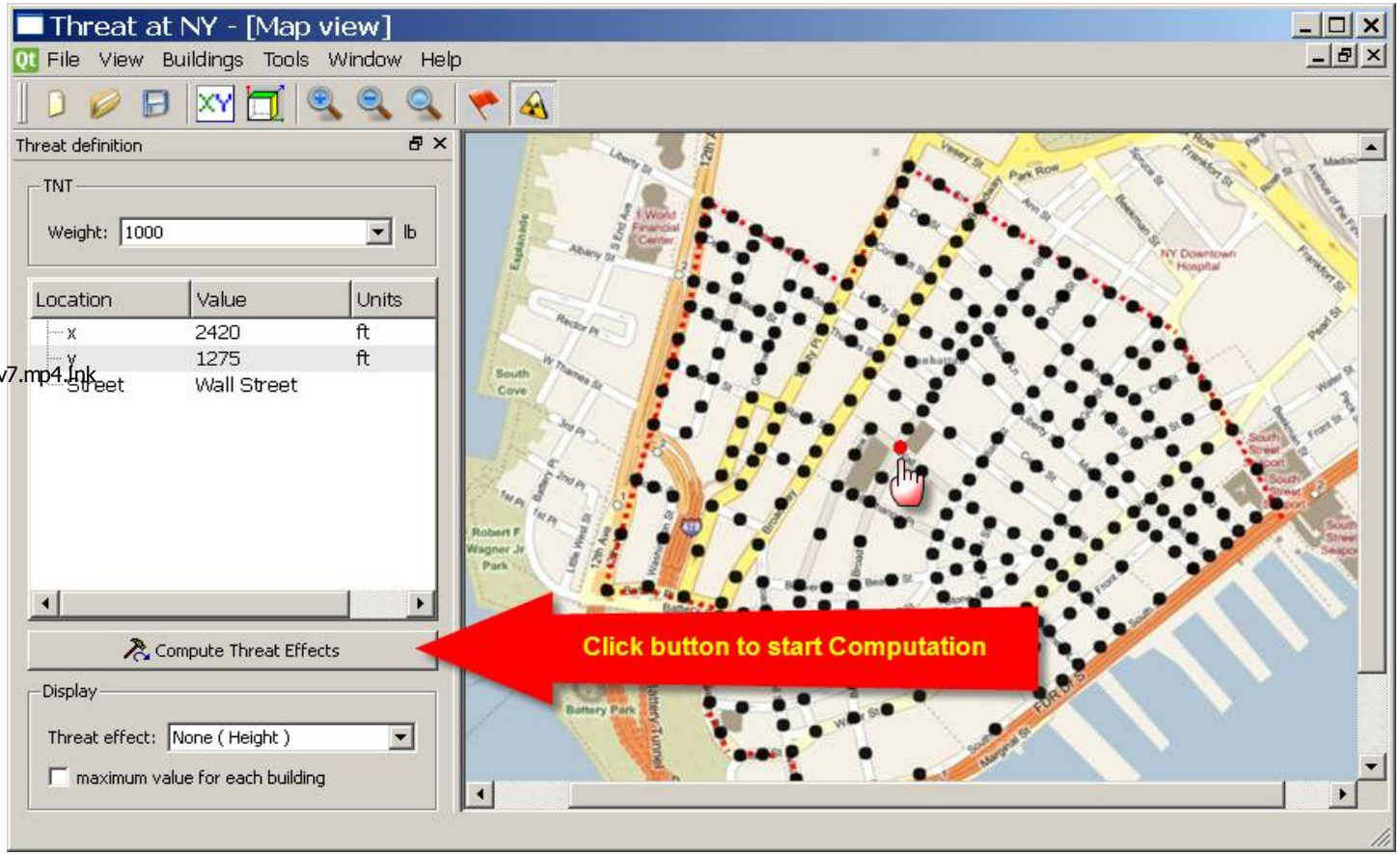
UBT - Demo

Shortcut to ubDowntownUSAv7.mp4.lnk



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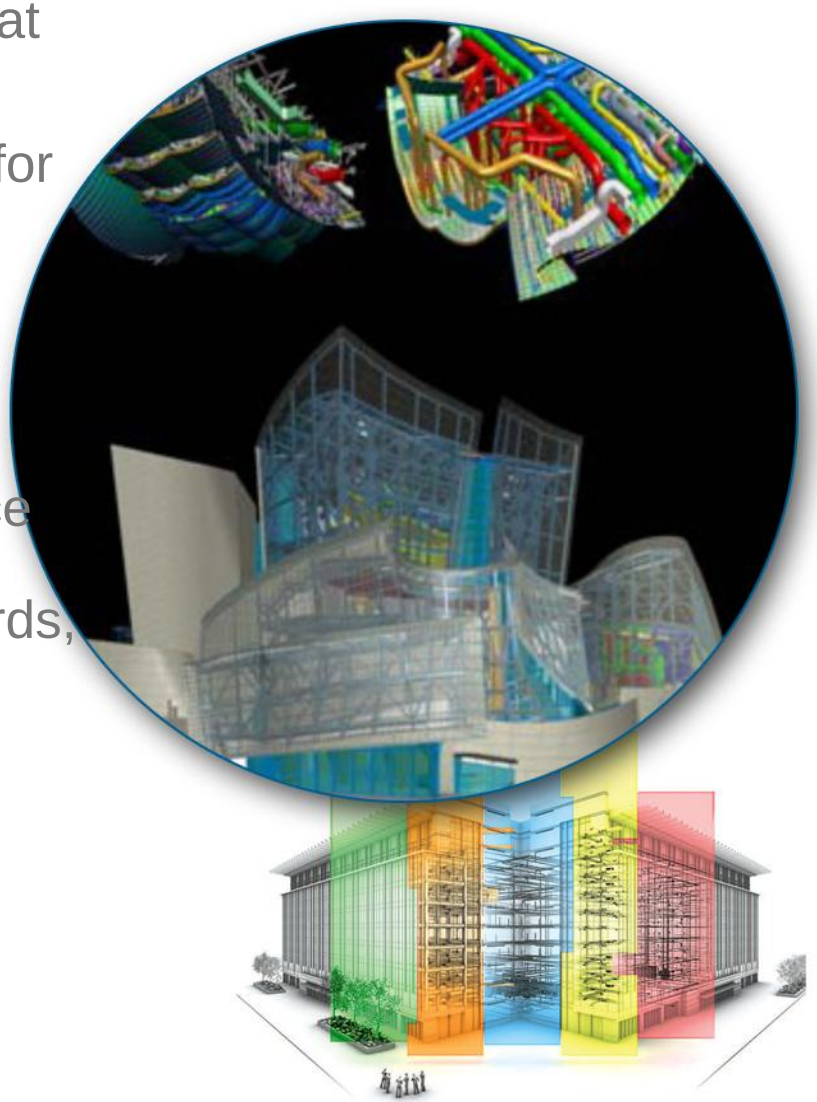
Owners Performance Requirements Tool (OPR)

The OPR Tool is a web-based system that allows building owners to:

- Determine specific performance goals for new and existing buildings
- Analyze a range of high-performance requirements based on EISA 2007
- Evaluate tradeoffs between high performance attributes and performance goals required by energy and environmental demands, threats, hazards, and building functions
- Performance goals may range from minimum standards (baseline) to high performance solutions (benchmarks)



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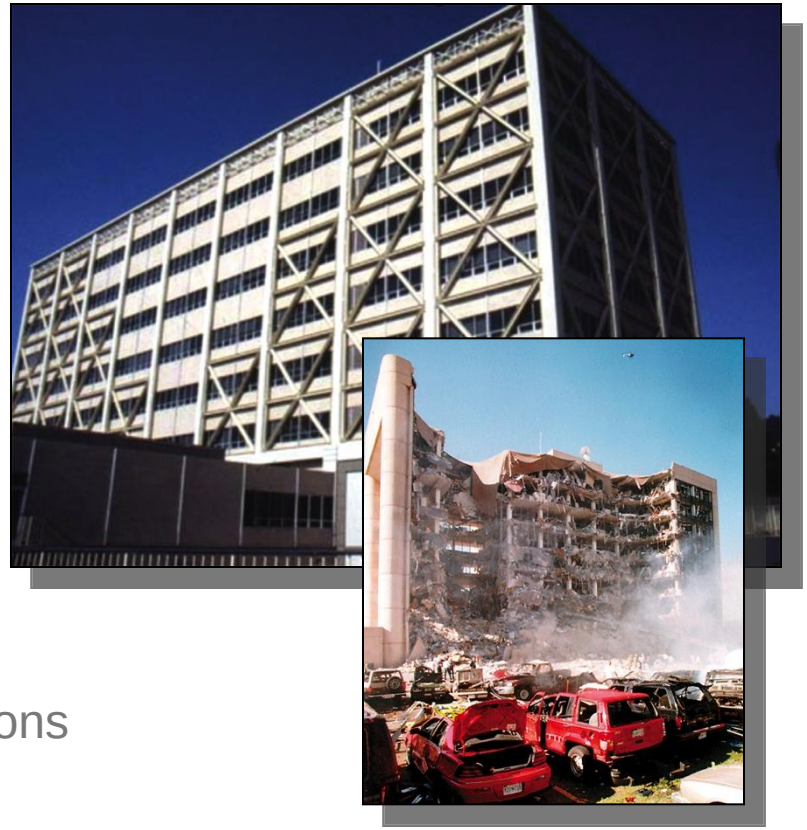
OPR Tool

The model employs **multi-attribute analysis and performance modeling** that allows the owner to identify performance goals, by evaluating different scenarios based on the following attributes:

- **Energy Conservation**
  - Thermal Transfer
  - Air Leakage
- **Environment**
  - Environmental Footprint
  - Moisture Migration
  - Water Penetration
  - Acoustic Transmission
- **Safety**
  - Seismic
  - Wind
  - Flood
  - Fire
- **Security**
  - Blast
  - CBR
  - Ballistics
  - Continuity of Operations



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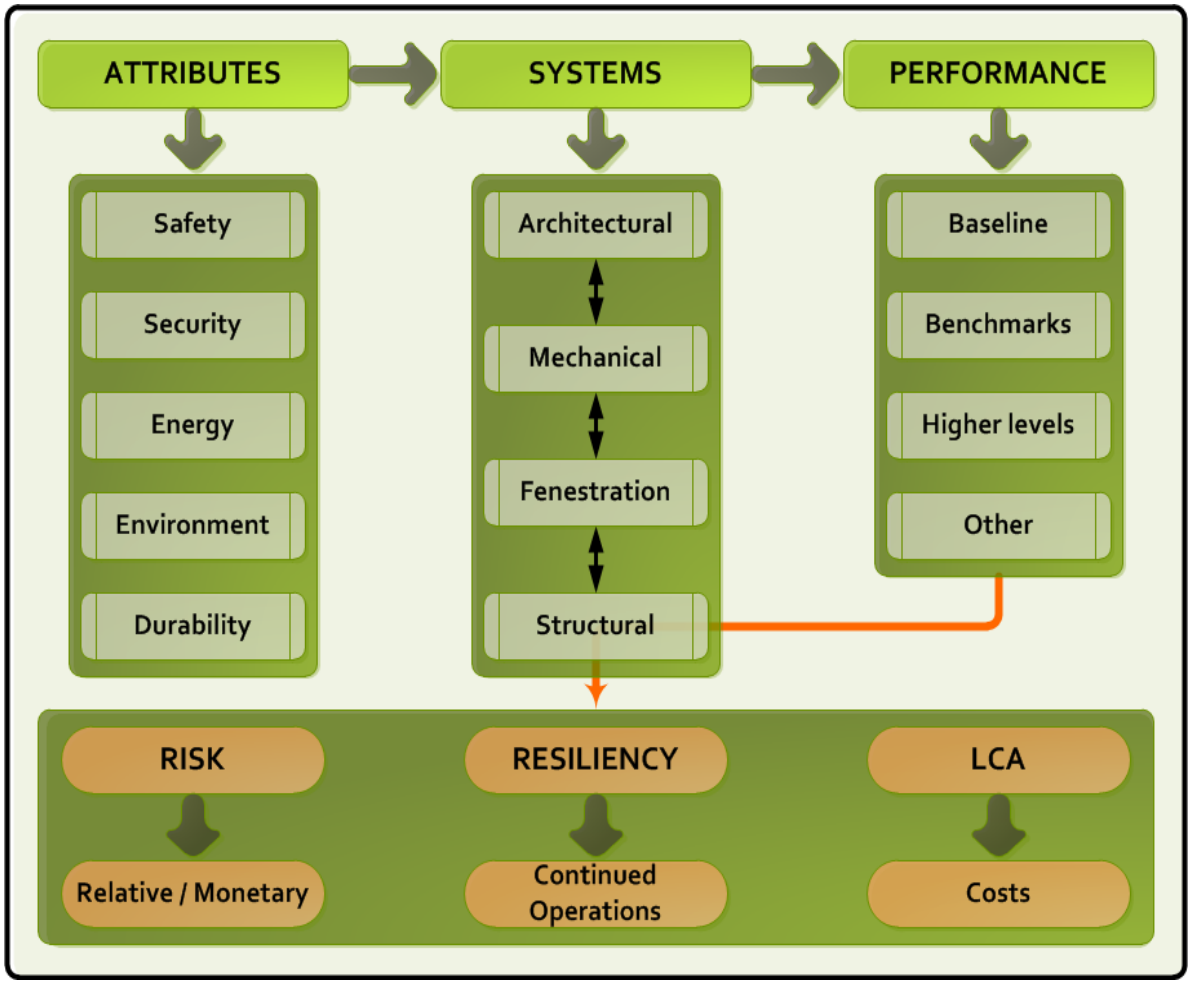
OPR Tool

- Five expert committees were formed to provide the performance and cost data.
- The OPR Tool is expected to be a part of the ASTM E06.55.09 Standard.
- The OPR is being released for external review at: www.oprtool.org/demo



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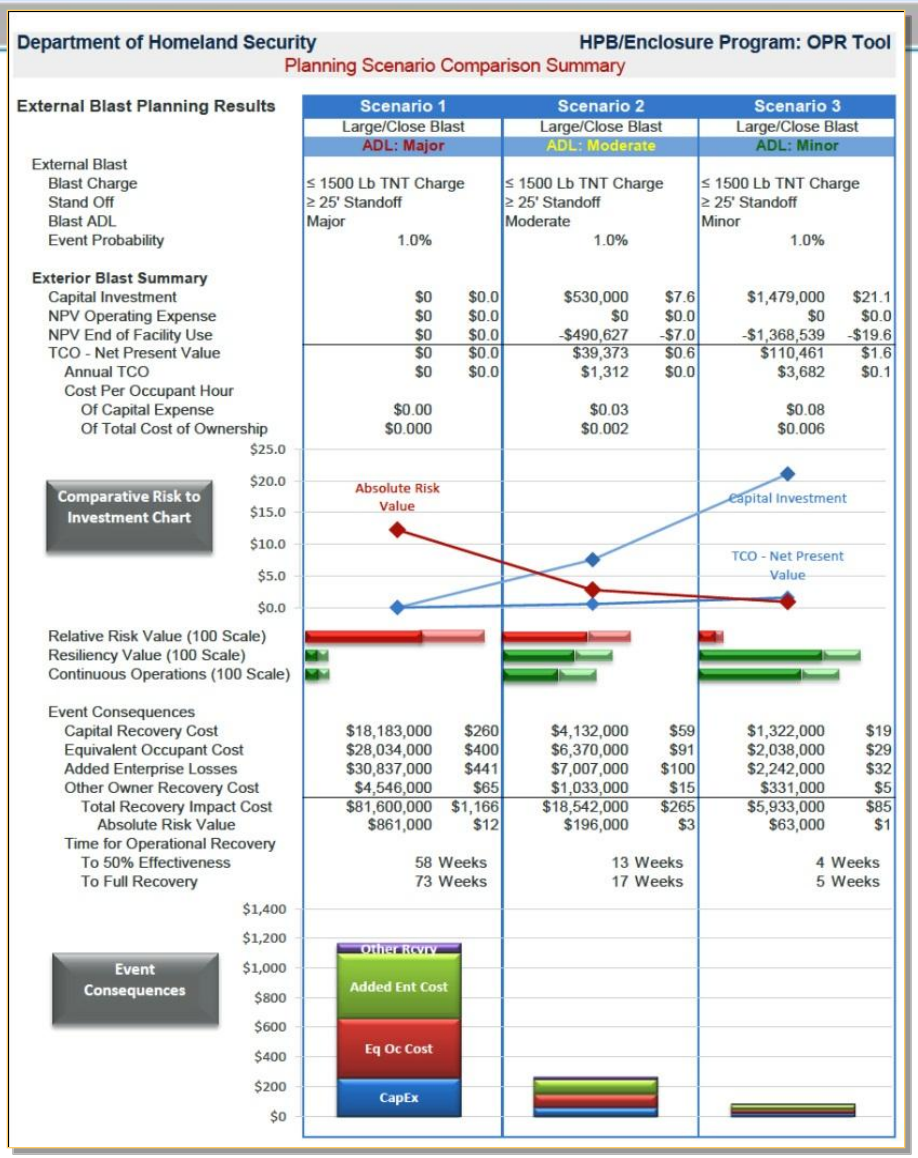
OPR Tool

- **OPR outputs** are based on analyzing multiple attributes simultaneously
- **OPR predictions** relies on the consensus and knowledge of the technical committees
- The model is strictly **performance based** and does not identify prescriptive solutions



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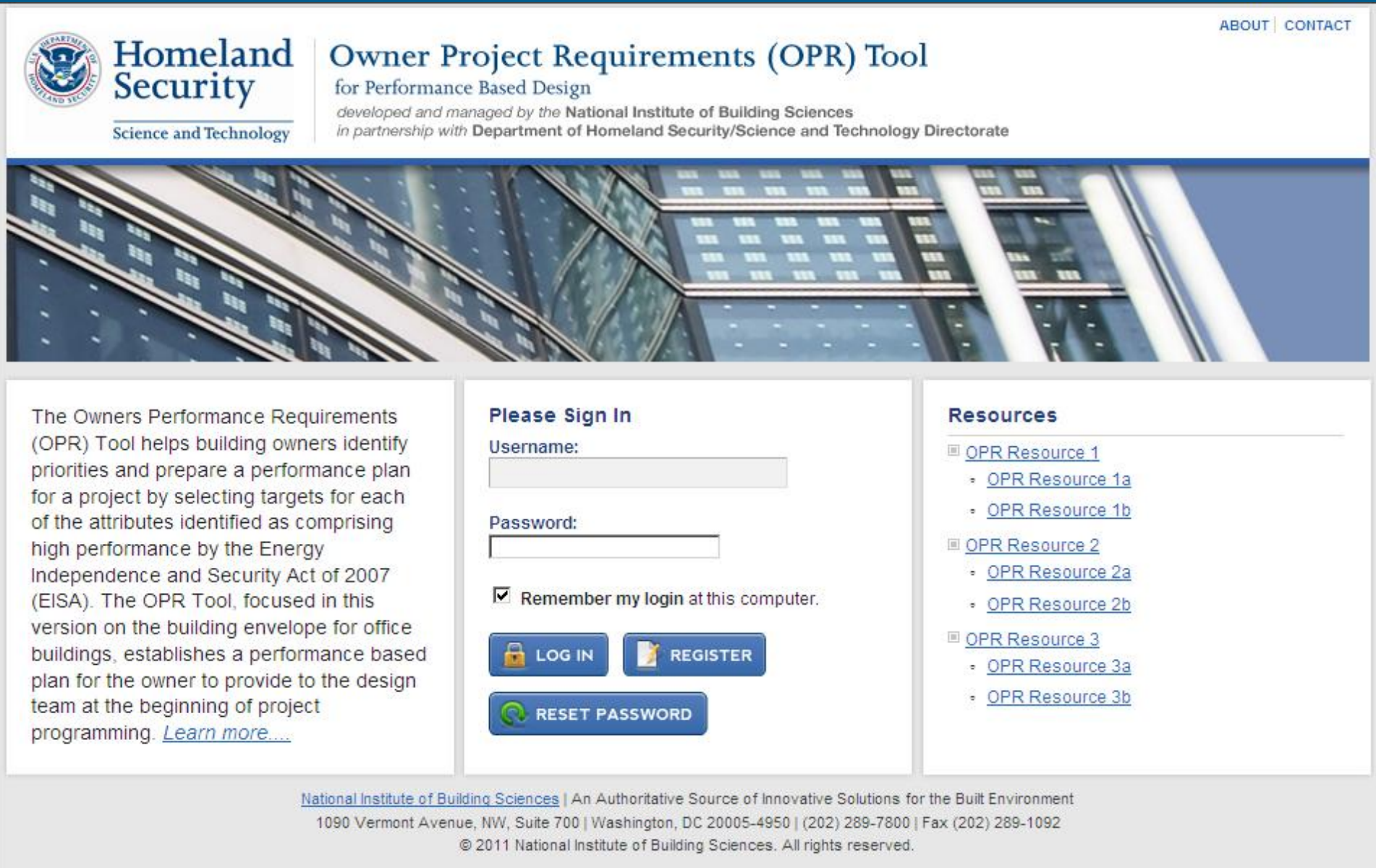
OPR Tool Website



PROJECT REQUIREMENTS REPORT

Project Information

Scenario Name: Trial 1 | Project Type: Existing Building Retrofit | Location: Pittsburgh, PA
Gross Building Area: 100000 SF | Number of Floors: 3 (Including 1 below grade) | Quality: Class B
Performance Targets: P++ Enhanced Performance | Re++ Enhanced Resilience | Ri-- Moderate Risk

Life Cycle Baseline Information

Use Period (TCO)	25 Years	Unit Cost		Occupancy Information	
		Energy Cost ($/KBtu)	$0.05	Census (GSF/Occupant)	150
Service Life (Years)		Service & Maintain Cost ($/GSF)	$0.25	Operation (Hours/Week)	40
Whole-building	50 Years	Annual Escalation Trend		Operation (Weeks/Year)	51
Exterior Wall	30 Years	Energy	5.0%	Indirect Project Cost	
Exterior Glazing	20 Years	Service & Maintain	5.0%	Construct	10%
Roof System	15 Years	Present Value Discount Rate	5.0%	Design, Test, Commission	12%

Facility Resilience

Safety

Seismic

Seismic Design Category SDC C

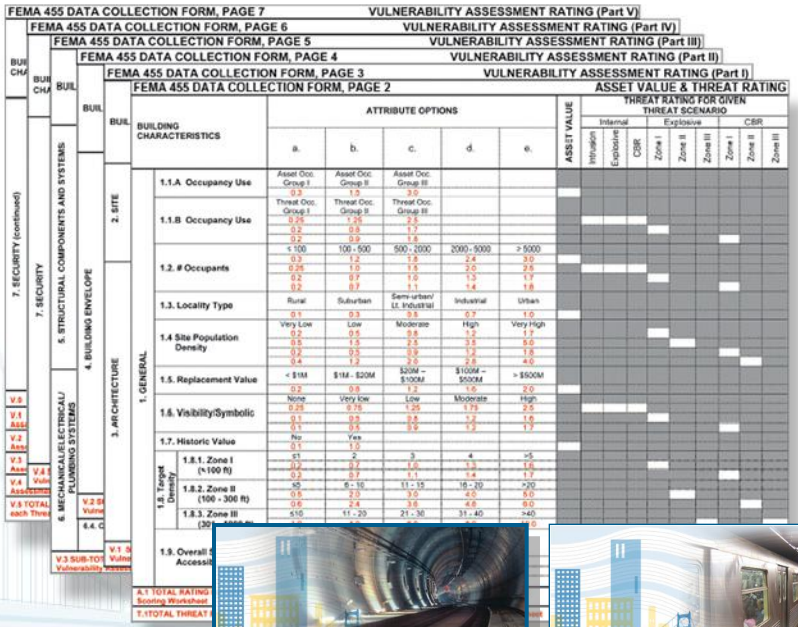
Performance Benchmark: Reduced Damage

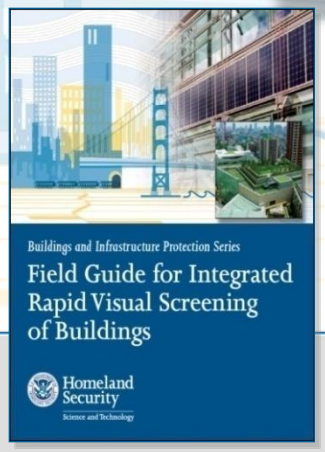
Extent of Damage and Continuity of Operations: Moderate damage to cladding may occur but cladding remains anchored to building structure. Seals and gaskets may tear and ability to provide weather protection is locally compromised. Glass edge damage may occur and glass may fall off setting blocks, but glass breakage is mitigated. The building remains safe to occupy; structural and nonstructural repairs are minor. There shall be no failure or gross permanent distortion of the building envelope system anchorage and framing. Minor cracking and deformation of cladding may occur, but is not expected. Interstory drift limits all structures: 0.0075h to 0.01h; h = story height

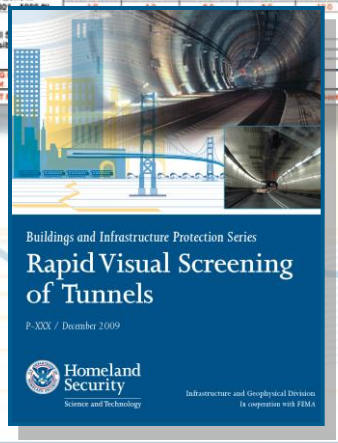
Performance Standard(s)

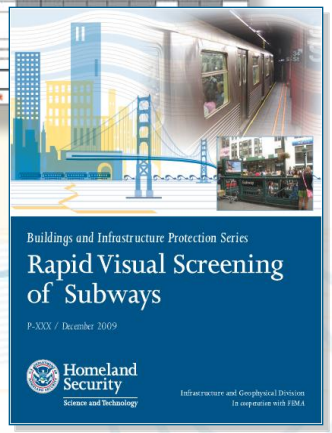
IBC-2009
ASCE 7-05
ASCE 41-06
NEHRP Recommended Provisions for Seismic Regulations
FEMA E-74
ASTM E 2026

IRVS Buildings, Subways, and Tunnels









IRVS Family

- Designed to prepare rapid but comprehensive assessments
- A simple, quick, and reliable tool for obtaining a preliminary risk assessment rating.
- Reliability depends on time devoted to collection of information and field inspections
- Can support other more thorough assessments
- Expected to save millions of dollars to federal, state, local government, and private sector
- An all hazard approach
- Computes risk and resilience providing scores and ratings
- Flexible methodology based on dictionaries and scores which are easy to adapt to institutional needs

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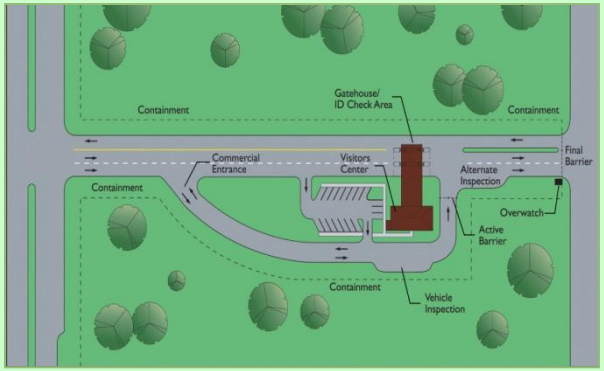
IRVS: Buildings

Consequences	Threat Rating	Vulnerability
• Locality Type • Number of Occupants • Replacement Value • On Historic Registry • Business Continuity • Physical Loss Impact	• Occupancy Use • Number of Occupants • Site Population Density • Visibility/Symbolic Value • Target Density • Overall Site Accessibility • Target Potential	• Site • Architecture • Building Envelope • Structural Components and Systems • Mechanical/Electrical/ Plumbing (MEP) Systems • Security



IRVS: Mass Transit Stations

Consequences	Threat Rating	Vulnerability
▪ Number of Tracks ▪ Number of Station Levels ▪ Impact of Physical Loss ▪ Number of Riders per day ▪ Commercial, and Industrial Facilities ▪ Adjacent Stations ▪ Adjacent Critical Infrastructure ▪ Social Effect of Loss ▪ Replacement Value ▪ Operational Redundancy ▪ Function Criticality	▪ Visibility ▪ Historic Nature/Landmark Status ▪ Number of Riders per day ▪ Previous Threats ▪ Accessibility ▪ Elevation ▪ Site Locality ▪ Adjacent Critical Infrastructure ▪ Function Criticality ▪ Storage Use	▪ Site ▪ Architectural ▪ Structural ▪ Ventilation (including HVAC) ▪ Fire Systems ▪ Operations (including power supply, lighting, etc.) ▪ Non-Structural ▪ Physical Security 

IRVS: Tunnels

Consequences	Threat Rating	Vulnerability
▪ Impact of Physical Loss ▪ Number of Vehicles/Trains per Day ▪ Nearby Commercial Facilities ▪ Adjacent Critical Infrastructure ▪ Social Effect of Loss ▪ Replacement Value ▪ Operational Redundancy ▪ Function Criticality	▪ Visibility ▪ Historic Nature ▪ Number of Vehicles/Trains per day ▪ Previous Threats ▪ Accessibility ▪ Elevation ▪ Site Locality ▪ Adjacent Critical Infrastructure ▪ Function Criticality	▪ Site ▪ Architectural ▪ Structural ▪ Ventilation (including HVAC) ▪ Fire Systems ▪ Operations (including power supply, lighting, etc.) ▪ Non-Structural ▪ Physical Security 

IRVS Analytical Background

- **Methodology:** knowledge is embedded in the tool. Major tool interactions are automatically calculated. Pre assigned weights, interaction logic, and context-based algorithms based on knowledge and tool validations
- **Risk:** For man made hazards, deals with target attractiveness . For natural hazards, it uses probability of occurrence. Risk is calculated as follows: **R = C x T x V**
- **Resilience:** computes robustness (R1), resourcefulness (R2), and recovery(R3) using information, such as hardening, training, and redundancies. Resilience is calculated as follows: **Resilience = R1 x R2 x R3**

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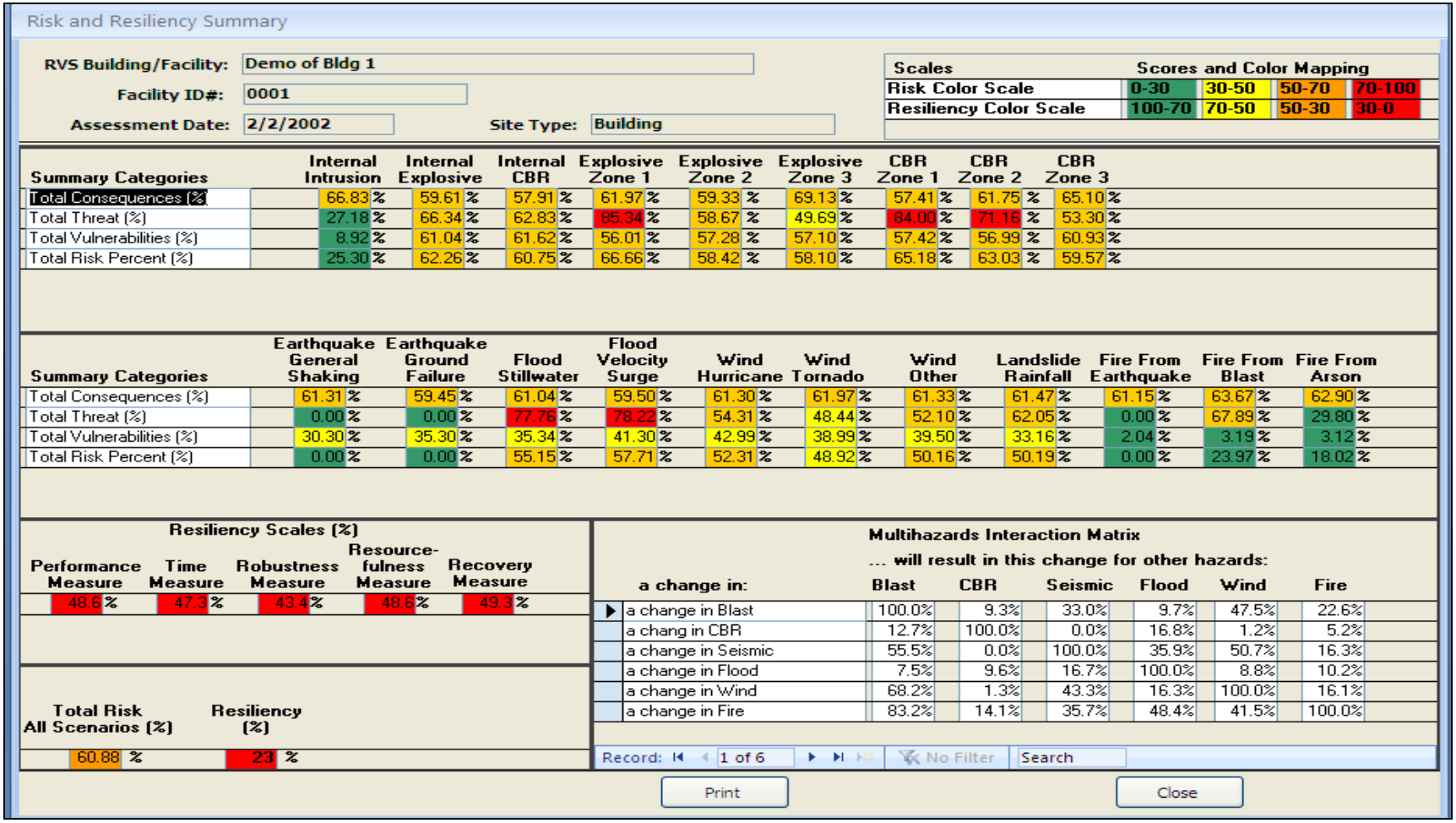
IRVS Scores



Risk and Resiliency Summary

RVS Building/Facility: Demo of Bldg 1

Facility ID#: 0001

Assessment Date: 2/2/2002 Site Type: Building

Scales	Scores and Color Mapping			
Risk Color Scale	0-30	30-50	50-70	70-100
Resiliency Color Scale	100-70	70-50	50-30	30-0

Summary Categories	Internal Intrusion	Internal Explosive	Internal CBR	Explosive Zone 1	Explosive Zone 2	Explosive Zone 3	CBR Zone 1	CBR Zone 2	CBR Zone 3
Total Consequences (%)	66.83 %	59.61 %	57.91 %	61.97 %	59.33 %	69.13 %	57.41 %	61.75 %	65.10 %
Total Threat (%)	27.18 %	66.34 %	62.83 %	85.34 %	58.67 %	49.69 %	84.00 %	71.16 %	53.30 %
Total Vulnerabilities (%)	8.92 %	61.04 %	61.62 %	56.01 %	57.28 %	57.10 %	57.42 %	56.99 %	60.93 %
Total Risk Percent (%)	25.30 %	62.26 %	60.75 %	66.66 %	58.42 %	58.10 %	65.18 %	63.03 %	59.57 %

Summary Categories	Earthquake General Shaking	Earthquake Ground Failure	Flood Stillwater	Flood Velocity Surge	Wind Hurricane	Wind Tornado	Wind Other	Landslide Rainfall	Fire From Earthquake	Fire From Blast	Fire From Arson
Total Consequences (%)	61.31 %	59.45 %	61.04 %	59.50 %	61.30 %	61.97 %	61.33 %	61.47 %	61.15 %	63.67 %	62.90 %
Total Threat (%)	0.00 %	0.00 %	77.76 %	78.22 %	54.31 %	48.44 %	52.10 %	62.05 %	0.00 %	67.89 %	29.80 %
Total Vulnerabilities (%)	30.30 %	35.30 %	35.34 %	41.30 %	42.99 %	38.99 %	39.50 %	33.16 %	2.04 %	3.19 %	3.12 %
Total Risk Percent (%)	0.00 %	0.00 %	55.15 %	57.71 %	52.31 %	48.92 %	50.16 %	50.19 %	0.00 %	23.97 %	18.02 %

Resiliency Scales (%)

Performance Measure	Time Measure	Robustness Measure	Resource-fulness Measure	Recovery Measure
48.6 %	47.3 %	43.4 %	48.6 %	49.3 %

Total Risk All Scenarios (%)	Resiliency (%)
60.88 %	23 %

Multihazards Interaction Matrix

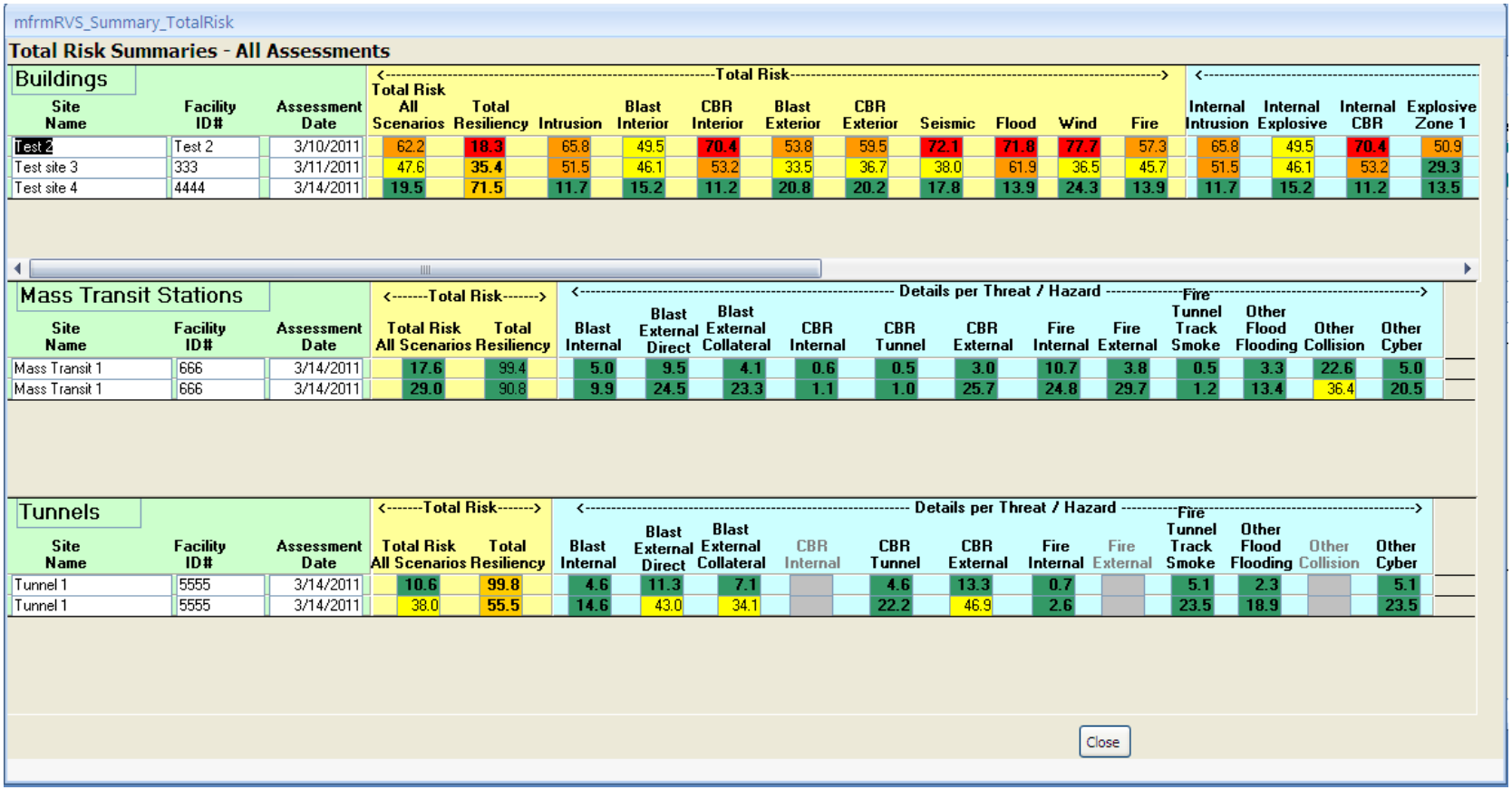
... will result in this change for other hazards:

a change in:	Blast	CBR	Seismic	Flood	Wind	Fire
a change in Blast	100.0%	9.3%	33.0%	9.7%	47.5%	22.6%
a chang in CBR	12.7%	100.0%	0.0%	16.8%	1.2%	5.2%
a change in Seismic	55.5%	0.0%	100.0%	35.9%	50.7%	16.3%
a change in Flood	7.5%	9.6%	16.7%	100.0%	8.8%	10.2%
a change in Wind	68.2%	1.3%	43.3%	16.3%	100.0%	16.1%
a change in Fire	83.2%	14.1%	35.7%	48.4%	41.5%	100.0%

Record: 1 of 6 No Filter Search

Print Close

IRVS Scores



mfrmRVS_Summary_TotalRisk

Total Risk Summaries - All Assessments

Buildings

Site Name	Facility ID#	Assessment Date	Total Risk All Scenarios	Total Resiliency	Intrusion	Blast Interior	CBR Interior	Blast Exterior	CBR Exterior	Seismic	Flood	Wind	Fire	Internal Intrusion	Internal Explosive	Internal CBR	Explosive Zone 1
Test 2	Test 2	3/10/2011	62.2	18.3	65.8	49.5	70.4	53.8	59.5	72.1	71.8	77.7	57.3	65.8	49.5	70.4	50.9
Test site 3	333	3/11/2011	47.6	35.4	51.5	46.1	53.2	33.5	36.7	38.0	61.9	36.5	45.7	51.5	46.1	53.2	29.3
Test site 4	4444	3/14/2011	19.5	71.5	11.7	15.2	11.2	20.8	20.2	17.8	13.9	24.3	13.9	11.7	15.2	11.2	13.5

Mass Transit Stations

Site Name	Facility ID#	Assessment Date	Total Risk All Scenarios	Total Resiliency	Blast Internal	Blast External Direct	Blast External Collateral	CBR Internal	CBR Tunnel	CBR External	Fire Internal	Fire External	Fire Tunnel Track Smoke	Other Flood Flooding	Other Collision	Other Cyber
Mass Transit 1	666	3/14/2011	17.6	99.4	5.0	9.5	4.1	0.6	0.5	3.0	10.7	3.8	0.5	3.3	22.6	5.0
Mass Transit 1	666	3/14/2011	29.0	90.8	9.9	24.5	23.3	1.1	1.0	25.7	24.8	29.7	1.2	13.4	36.4	20.5

Tunnels

Site Name	Facility ID#	Assessment Date	Total Risk All Scenarios	Total Resiliency	Blast Internal	Blast External Direct	Blast External Collateral	CBR Internal	CBR Tunnel	CBR External	Fire Internal	Fire External	Fire Tunnel Track Smoke	Other Flood Flooding	Other Collision	Other Cyber
Tunnel 1	5555	3/14/2011	10.6	99.8	4.6	11.3	7.1		4.6	13.3	0.7		5.1	2.3		5.1
Tunnel 1	5555	3/14/2011	38.0	55.5	14.6	43.0	34.1		22.2	46.9	2.6		23.5	18.9		23.5

Close

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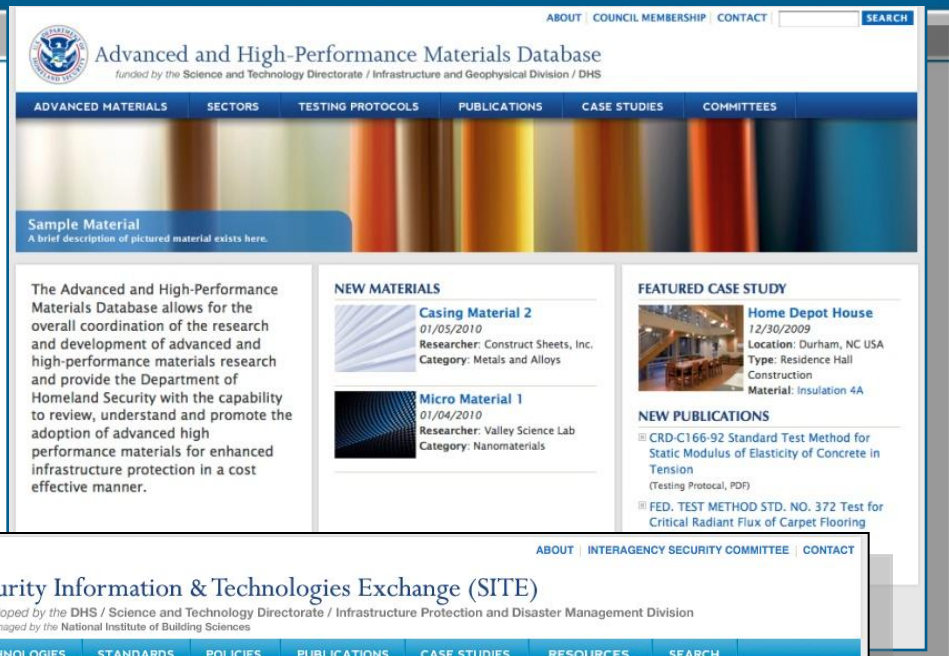
HP Materials Databases

- **AMD** provides a platform for the systematic organization of advanced materials through the documentation and search ability of their high-performance properties

- **SITE**, an online database for security products meeting ISC, VA, and DOD requirements



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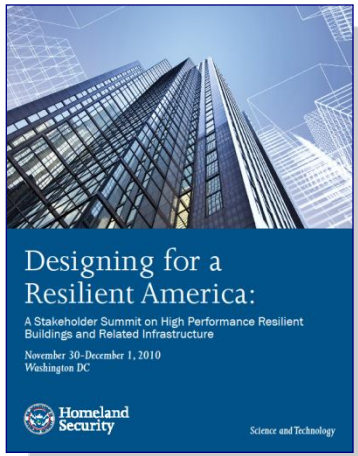
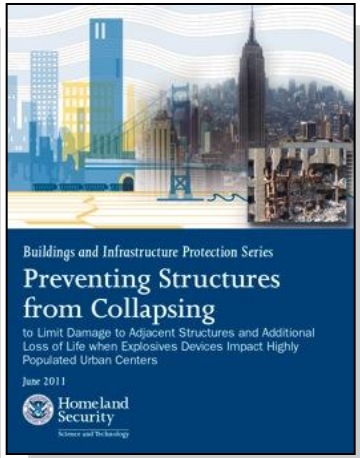
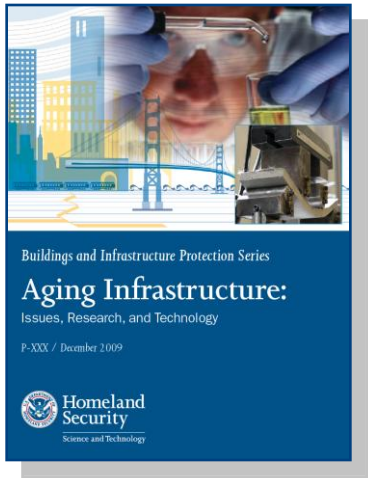
BIPS Publications

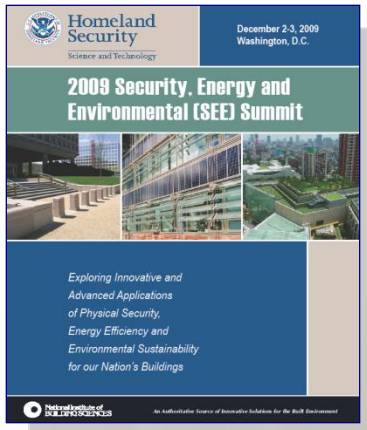
Publications

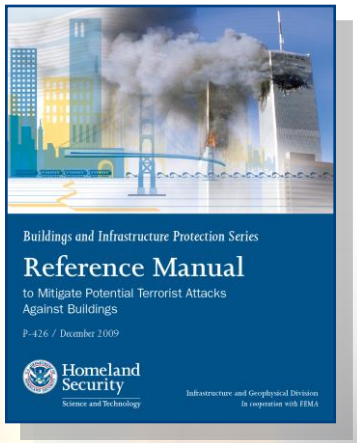
- Aging Infrastructure
- RVS Manuals
- Update of FEMA 426
- Update of FEMA 428
- Preventing Structures from Collapsing
- Designing for a Resilient America
- Security, Energy, and the Environment

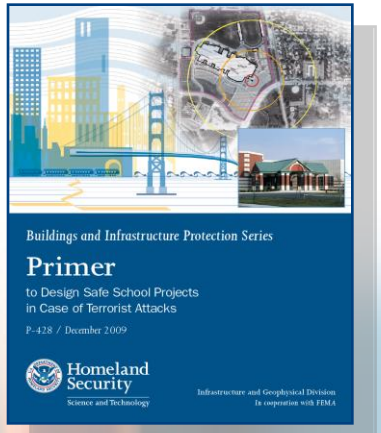












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IDD High Performance Resilience Program

The High Performance – Integrated Design Resilience Program

The High Performance – Integrated Design Resilience program's overall goal is to provide the built environment with enhanced blast and CBR resistance that meets all performance requirements needed by our nation's buildings and infrastructure at the highest possible level. The program promotes an integrated approach that combines all hazards (natural and man-made), aging/extension of life, and continuity of operations to anticipate, absorb, adapt to, and rapidly recover from a disruptive event. The achieved resilience reduces the impact of the event and the duration of its effect through resourcefulness, robustness, and rapid recovery. The program is supported by three primary paradigms: 1) that it is possible to provide a built environment that has the highest level of performance and resiliency in a comprehensive and cost effective manner; 2) that to achieve this, all facets of the process from design to operation must be integrated and 3) that through high performance and integrated design infrastructure can achieve resilience from a disruptive event.

High Performance – Integrated Design Resilience Program

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http://www.dhs.gov/files/programs/high-performance-integrated-design-program.shtm