

TRB Workshop on Recommendations for Bridge and Tunnel Security

January 11, 2004

Prioritization and Design Criteria

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Today's Presentation

- Port Authority's Participation and Dialogue with the Blue Ribbon Panel

In context of the Blue Ribbon Panel Report:

- Discuss Risk Assessment Method for Bridges and Tunnels
- Show a real-life example of Risk Equation
- How Can We Prioritize Security Improvements?
- Conclusions

Port Authority Facilities

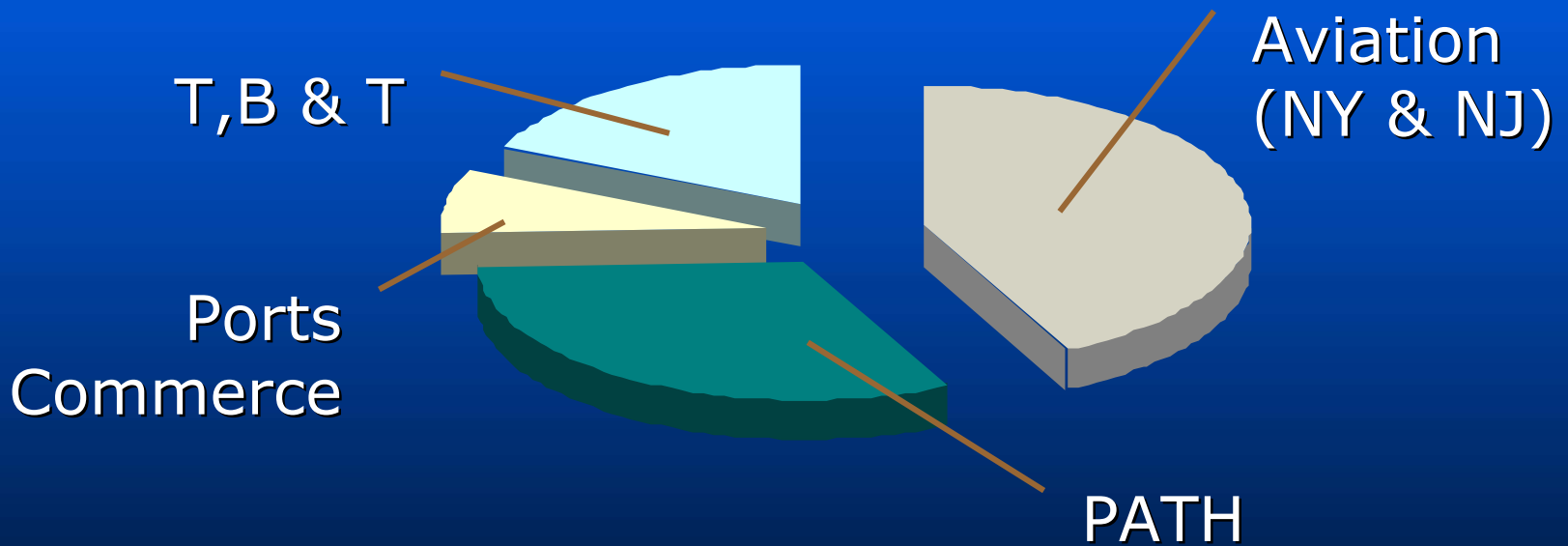


Sharing Port Authority's Experience

- 1993 Terrorist Bombing at the World Trade Center and Recovery Program
- September 11, 2001 Terrorist Destruction of World Trade Center and PATH commuter rail station
- 9/11 Recovery and Restoration of PATH Service at World Trade Center and Exchange Place Stations

Port Authority's Security Program

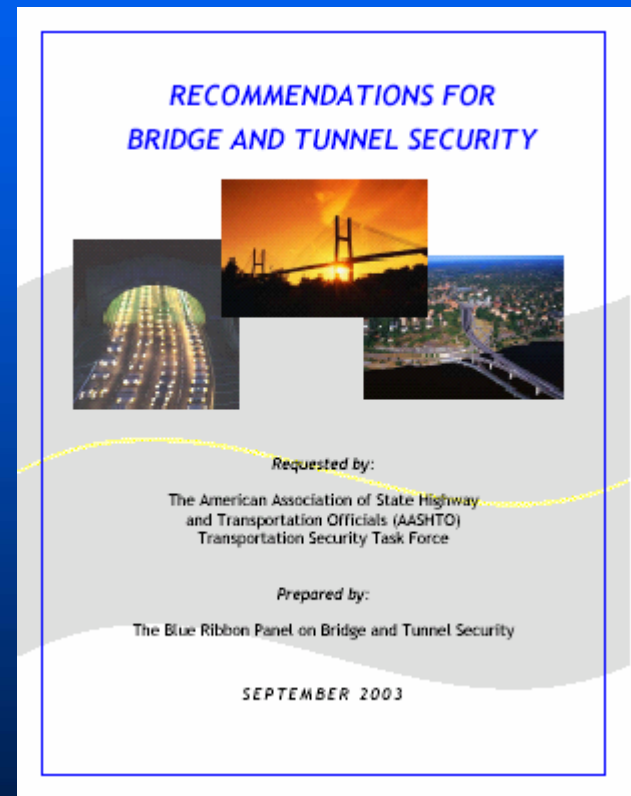
2003 – 2007 Five Year Security Capital Program



Program Total \$ 500,000,000

AASHTO/FHWA Blue Ribbon Panel Report

- Let's look at the Risk Assessment Method recommended by the BRP
- Let's look at step by step process to prioritize security improvements recommended by the BRP



Importance of Methodology

Method goes far to prevent trouble in business: for it makes the task easy, hinders confusion, saves abundance of time, and instructs those that have business depending, both what to do and what to hope.

—William Penn (1693)

Risk Assessment Method

$$R = O \times V \times I$$

- **R** is the **Risk** factor
- **O** is the **Occurrence** factor
- **V** is the **Vulnerability** factor
- **I** is the **Importance** factor

- The equation reflects an approach similar to that for assessing seismic and other natural hazards.

Risk Assessment Method

$$R = O \times V \times I$$

- **O** value reflects likelihood the bridge /tunnel (or component) will be attacked
- **Occurrence** attributes are: Attractiveness as a target, Security level against attack, Visibility as a target, Publicity if attacked, Prior threats/attacks
- Input to value comes from law enforcement and security experts

Risk Assessment Method

$$R = O \times V \times I$$

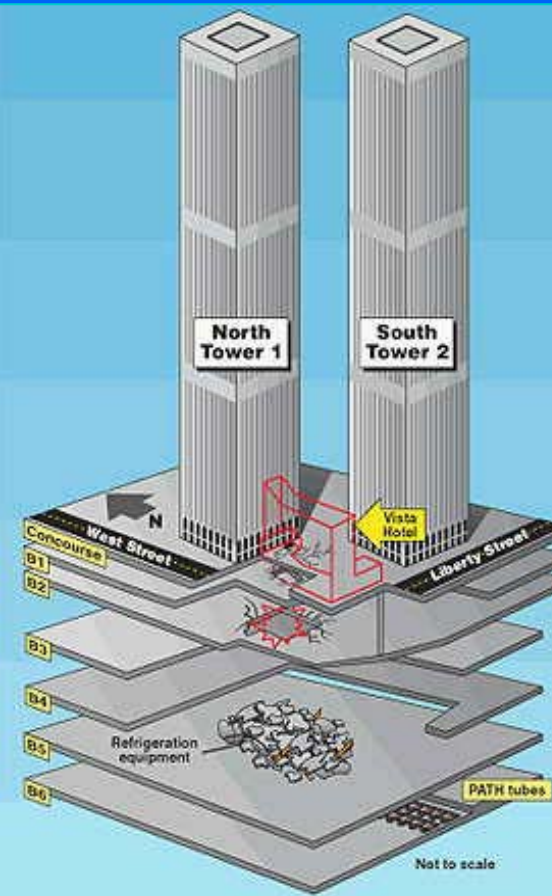
- **V** value reflects the likely degree of damage to the bridge/tunnel (or component) from an attack (threat)
- **Vulnerability** attributes are: expected damage, expected downtime, expected number of casualties
- Input to value comes from engineering analysis and expertise

Risk Assessment Method

$$R = O \times V \times I$$

- **I** value is a characteristic of the bridge /tunnel facility that reflects the consequence of its loss, independent of the type of hazard that might damage it
- **Importance** attributes: historical value, evacuation route, regional economy, cost/time to replace, revenue loss, critical utilities, exposed population, military value
- Input to value comes from owners, operators, users, regional government

Risk Assessment Example



Structure:

Component:

Threat:

World Trade Center Towers

Tower Column – Sub Grade Parking

Conventional explosive in vehicle

Risk Assessment Example

$$R = O \times V \times I$$

Structure: World Trade Center Towers

Component: Tower Column – Sub Grade Parking

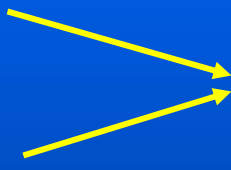
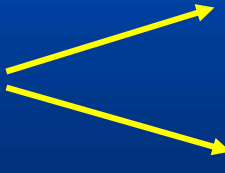
Threat: Conventional explosive in vehicle

- **O** is very large (high visibility, publicity, etc.)
- **V** is close to zero (for this threat)
- **I** is very large (occupancy, regional economy, etc.)

- **R** is relatively low (for this component & threat)

Steps to Prioritize Security Improvements

Six Steps From BRP Report "Design Process"

- 1) Threat Component  $R=OxVxI$ (consequence)
- 2) Accept or Mitigate? (owner decides)
- 3) Mitigate  Security control of access
or
Engineered solution – harden, etc.
- 4) Estimate cost of mitigation
- 5) Recalculate $R=OxVxI$ (with revised O or V)
- 6) Reduced R \longrightarrow Cost/benefit \longrightarrow Prioritize Mitigation

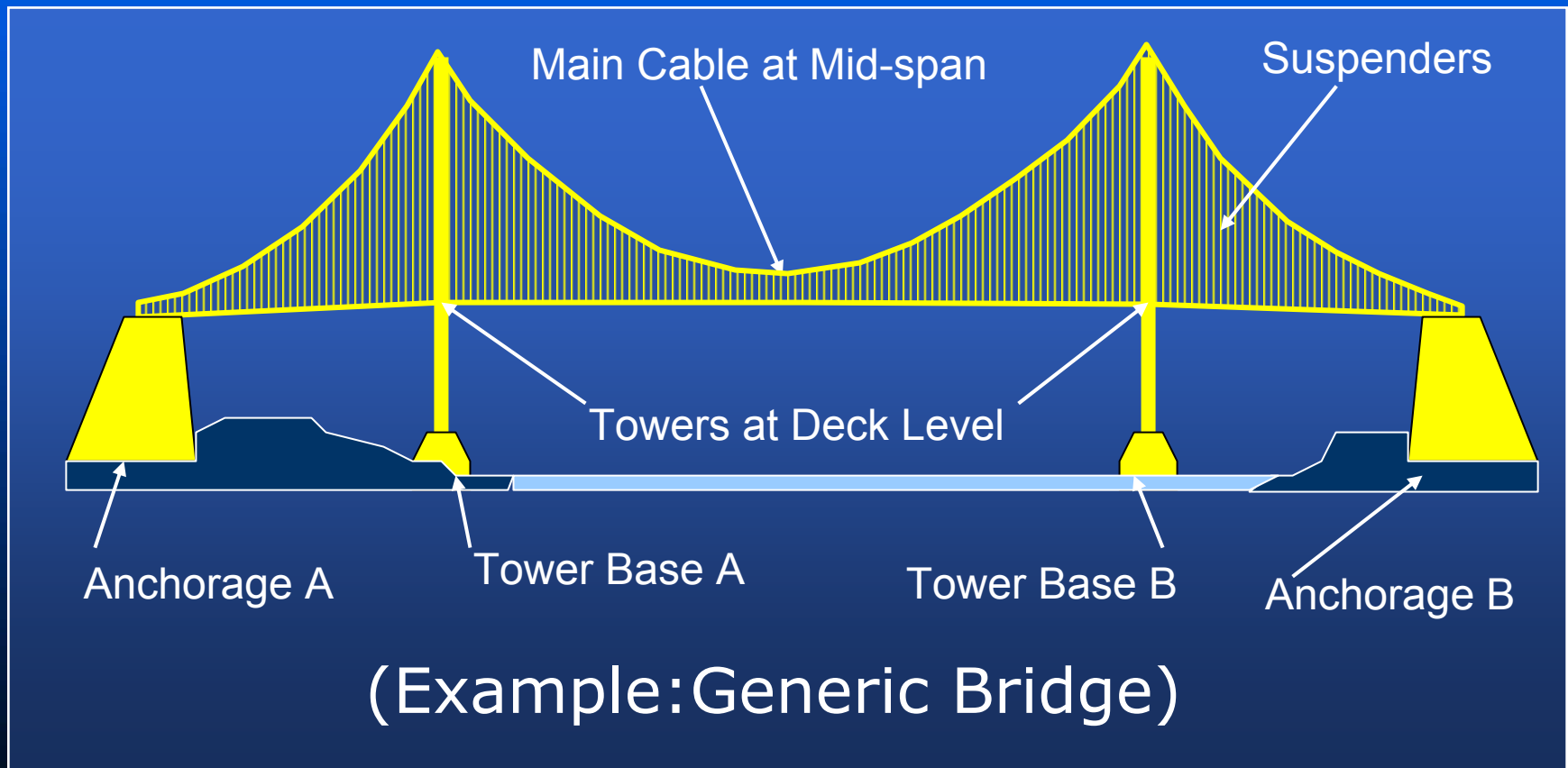
Steps to Prioritize Security Improvements

Threats to Bridges/Tunnels

- Precision demolition attack (strategically placed explosives, shape charges, cutting tools)
- Conventional Explosives (delivery by pedestrian, vehicle, water borne)
- Collision to structure (vehicle, water borne)
- Fire (fuel vehicle, fuel barge, incendiary device)

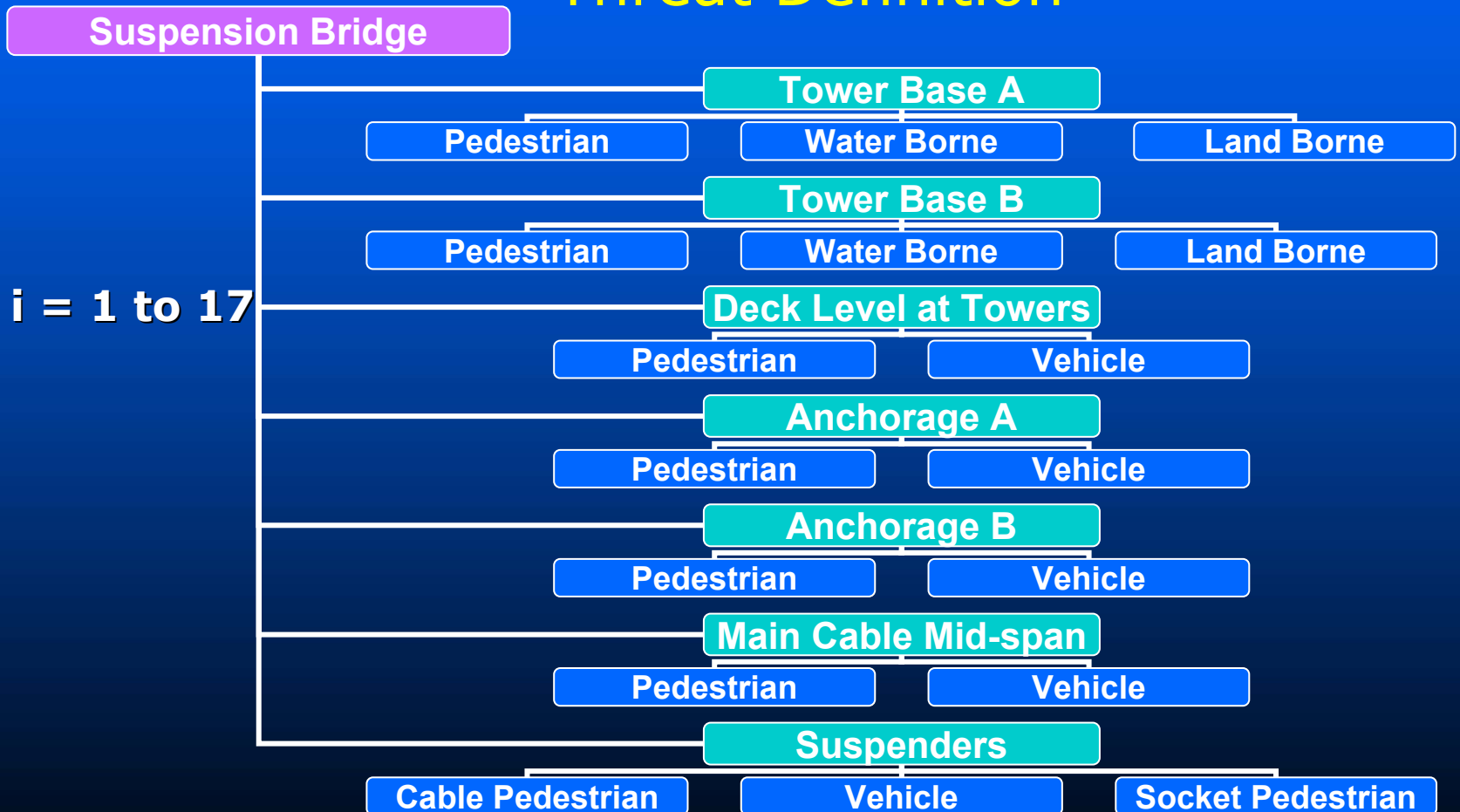
Steps to Prioritize Security Improvements

Critical/Vulnerable Components



Steps to Prioritize Security Improvements

Threat Definition



Steps to Prioritize Security Improvements

Occurrence Value (Vulnerability Value Similar)

- Computed for each threat:



- Weighted sum of utility values:

$$OF_i = \sum_{j=1}^5 x_j w_j$$

- Occurrence Attributes mapped to utility values
 - Access for attack
 - Security against attack
 - Visibility as a target
 - Publicity if attacked
 - Past threats/attacks

Steps to Prioritize Security Improvements

Importance Value

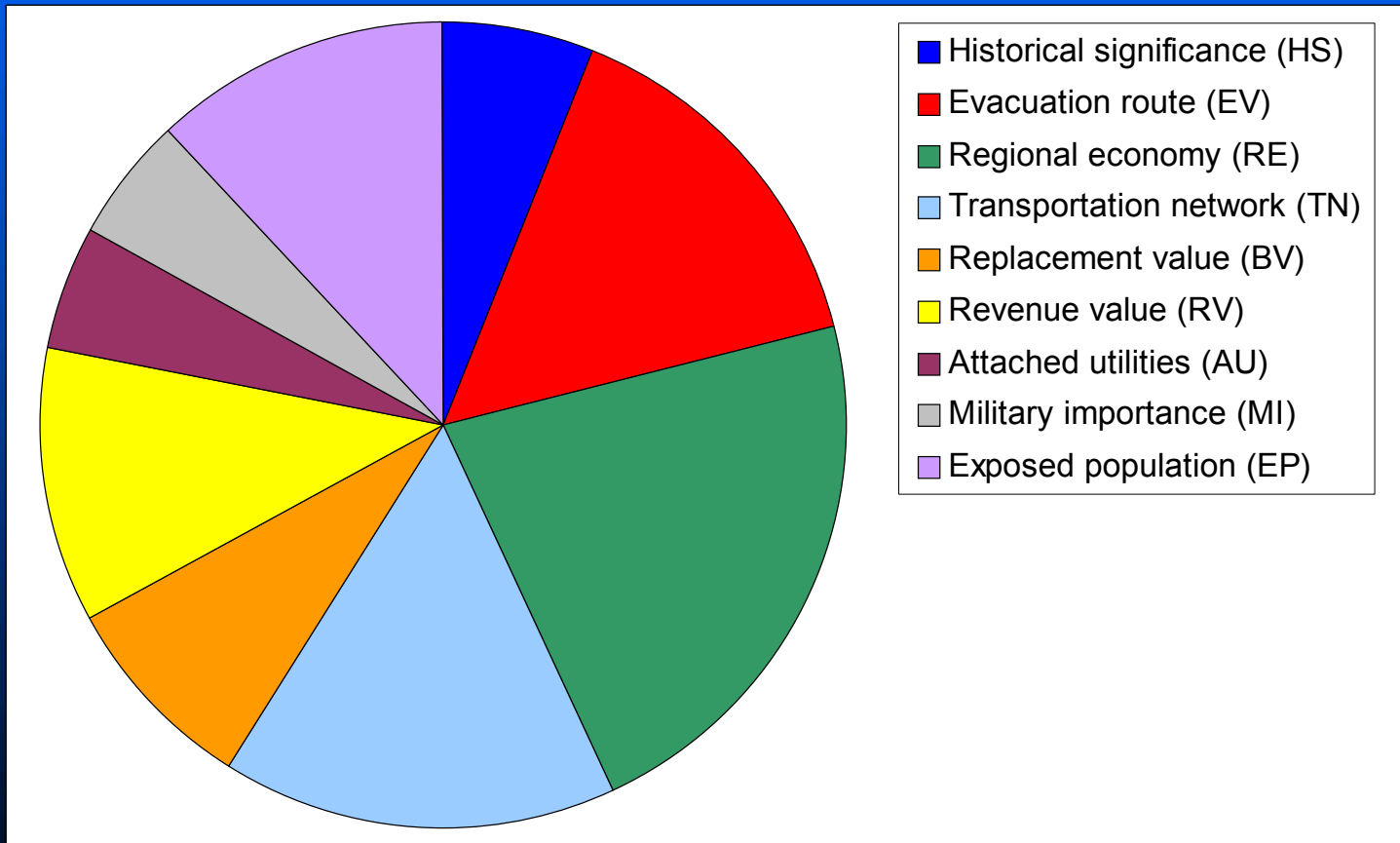
- Computed once for the facility
- Weighted sum of utility values:

$$IF = \sum_{j=1}^9 x_j w_j$$

- Attributes mapped to utility values
 - Historical/symbolic importance
 - Replacement value
 - Use as evacuation route
 - Importance to regional economy
 - Importance to transportation network
 - Annual revenue
 - Attached utilities
 - Use as military route
 - Exposed population

Steps to Prioritize Security Improvements

Weighting Factors on Importance



Steps to Prioritize Security Improvements

$$\mathbf{R} = \mathbf{O} \times \mathbf{V} \times \mathbf{I}$$

**Bridge
Facility
Risk
Score**

$$= \sum_i^n [\mathbf{O}F_i \times \mathbf{V}F_i] \times \mathbf{I}F$$

- $\mathbf{O}F_i$ or $\mathbf{V}F_i$ is a weighted factor summed over all the attributes of \mathbf{O} and \mathbf{V} for each critical component (i) in the bridge, or for \mathbf{I} , the bridge as a whole
- The bridge facility score is a sum over all (n) critical bridge components (i)

Steps to Prioritize Security Improvements

Examples Of Mitigating Threats

- Establish Secure Perimeter
- Surveillance, Intrusion Detection & Enforcement
- Visible Security Presence
- Minimize Time on Target

Steps to Prioritize Security Improvements

Examples Of Mitigating Consequences

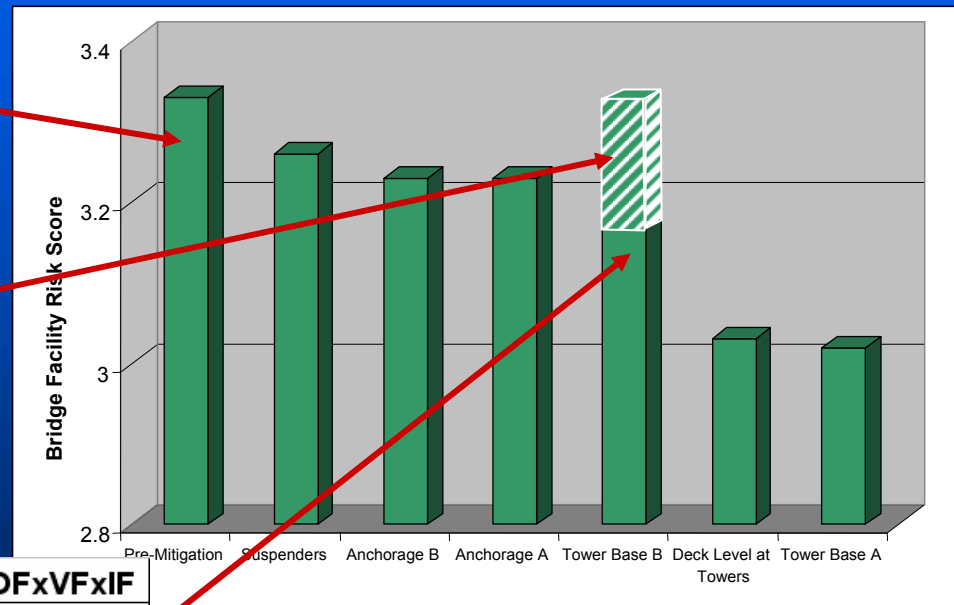
- Create Standoff Distance
- Add design Redundancy
- Harden/Strengthen Structural Elements
- Develop An Accelerated Response And Recovery Plan

Steps to Prioritize Security Improvements

Post-Mitigation Risk Scores

Bridge Facility Risk Score

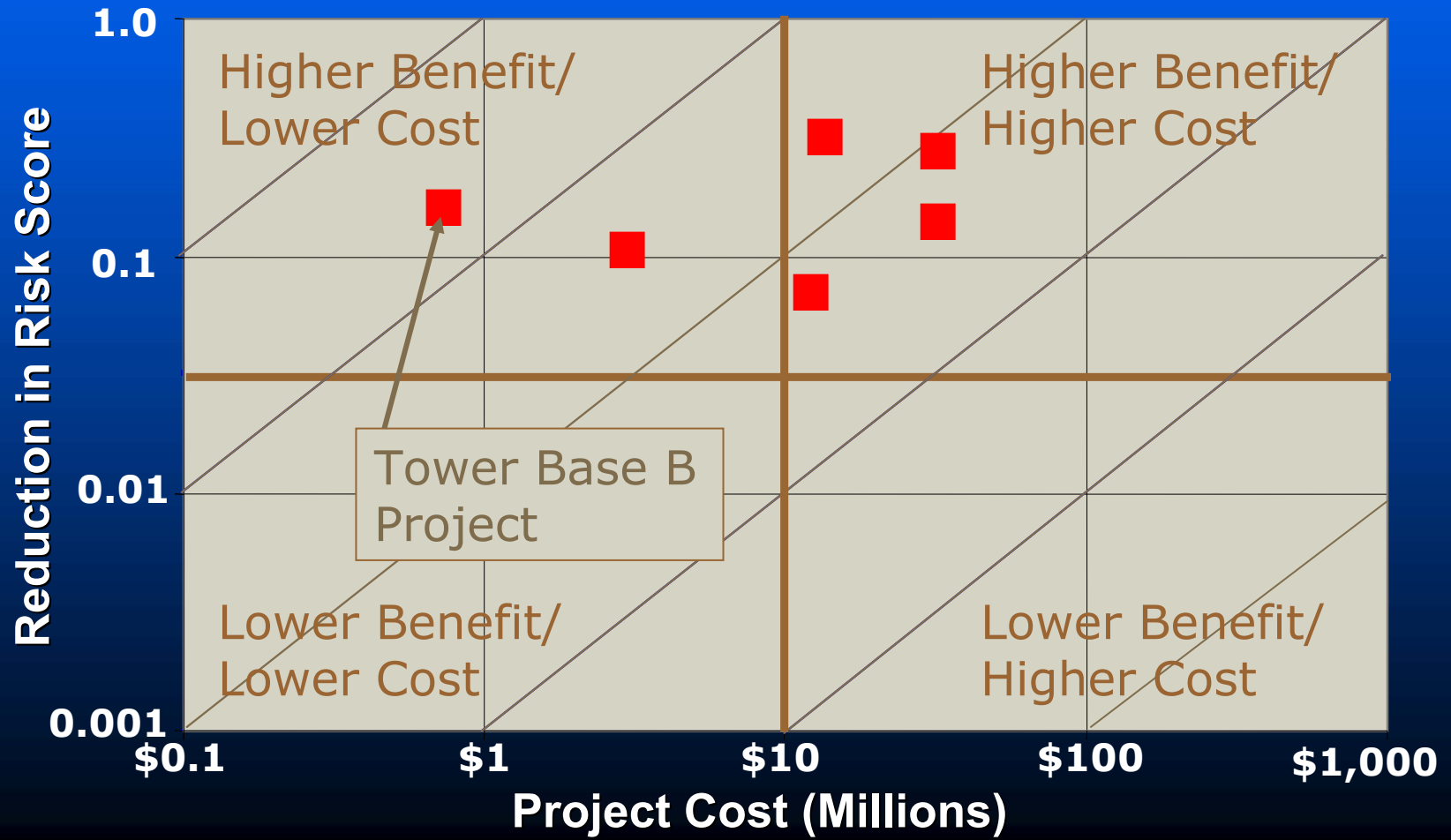
0.16 Reduction in Risk Score for Tower Base B Mitigation Project



Mitigation Project	Cost (\$1000)	Risk = OFxVFxIF
Tower Base B	750	3.17
Anchorage B	2,840	3.23
Anchorage A	2,840	3.23
Suspenders	12,360	3.26
Tower Base A	13,940	3.02
Deck Level at Towers	30,870	3.03

Steps to Prioritize Security Improvements

Benefit/Cost Comparison To Prioritize Projects



Conclusions

- A model for assessing risk from natural disasters can be applied to risk from terrorist attacks
- No matter what mitigation measures are taken, risk from attack can never be eliminated ($R=0$)
- The amount of risk reduction from a mitigation project is a good measurement of benefit
- Mitigation projects can be prioritized by comparing the cost and benefit (risk reduction) when available funds are limited

Conclusion

In safety, do not forget danger;
in peace, do not forget
disorder.

—Chinese proverb