GSX
GLOBAL SECURITY EXCHANGE

27-29 SEPTEMBER 2021
ORLANDO, FL, USA | ONLINE

INNOVATIVE ENGINEERING INCORPORATED

Bomb Blast Facility Protection for Security, Risk, and Property Managers

GSX 2021
Orlando, Florida
Wednesday September 29, 2021

Today’s Presenters

- **Stephen L Morgan PSP**
  - Project Director, Innovative Engineering Inc.
  - Education
    - BSCET, **Southern Polytechnic State University**
    - **Security Engineering**: USACE Protective Design Center
    - **Interagency Security Committee (ISC)** Risk management Process: Applied Research Associates (ARA)
    - **“Design of Blast Resistant Structures”** presented by Baker Risk, Houston Texas, Virginia
    - “**Blast Resistance by Design**” Stone Security Engineering
  - Experience: 16 Years Security Engineering
  - Expertise
    - Risk Assessments
    - Site Layout
    - Physical Security Peer Reviews
    - Blast Design
    - Progressive Collapse

Today’s Presenters

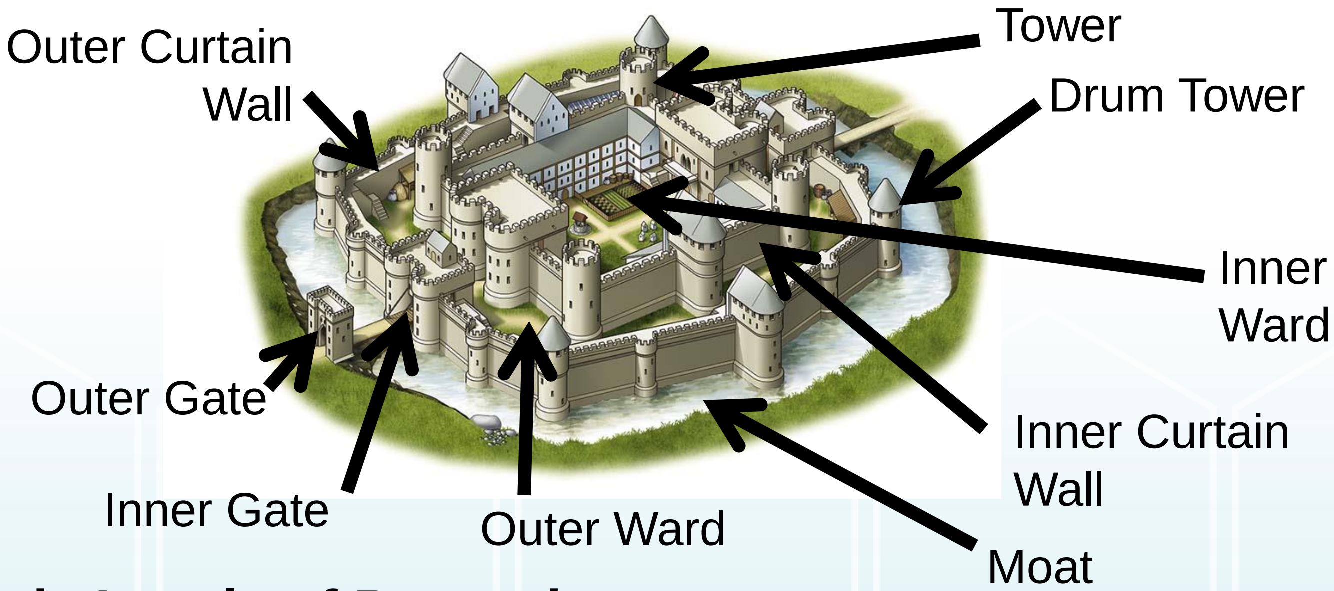
- **Scott L Weiland PE SE**
  - Principal, Innovative Engineering Inc.
  - Education
    - BSCE **University of Michigan**
    - Graduate Studies in **Structural Dynamics:**
      - San Jose State University
      - Georgia Institute of Technology
    - **Security Engineering:** USACE Protective Design Center
    - **Interagency Security Committee (ISC)** Risk Management Process: ARA
    - Counter Terrorism Workshop for Improvised Explosive Devices (IED) and Vehicle-Borne Improvised Explosive Devices (VBIED) - **Department of Homeland Security (DHS)**
  - Registration: PE in 38 States + PR & GU
  - Experience
    - 41 Years Design and Construction
    - **26 Years Physical Security Engineering**

Learning Objectives

- Basis for security criteria
- Risk assessment process and how to develop design criteria
- Blast Design fundamentals
- Progressive Collapse prevention
- How to minimize the impact on the cost of new and renovated construction

Physical Security Basics

Physical Security Basics



- **Concentric Levels of Protection**
  - Progressively reduces the threat as the distance to the asset decreases
  - All of the individual protections form a Protective System

Protective System

Protective System Functions

Detect

- Electronic Security System
  - -Intrusion detection
  - -Alarm communication
  - -Alarm assessment
  - -Access control
- Security Forces
- Security Lighting
- Facility Personnel
- Responsible Citizens

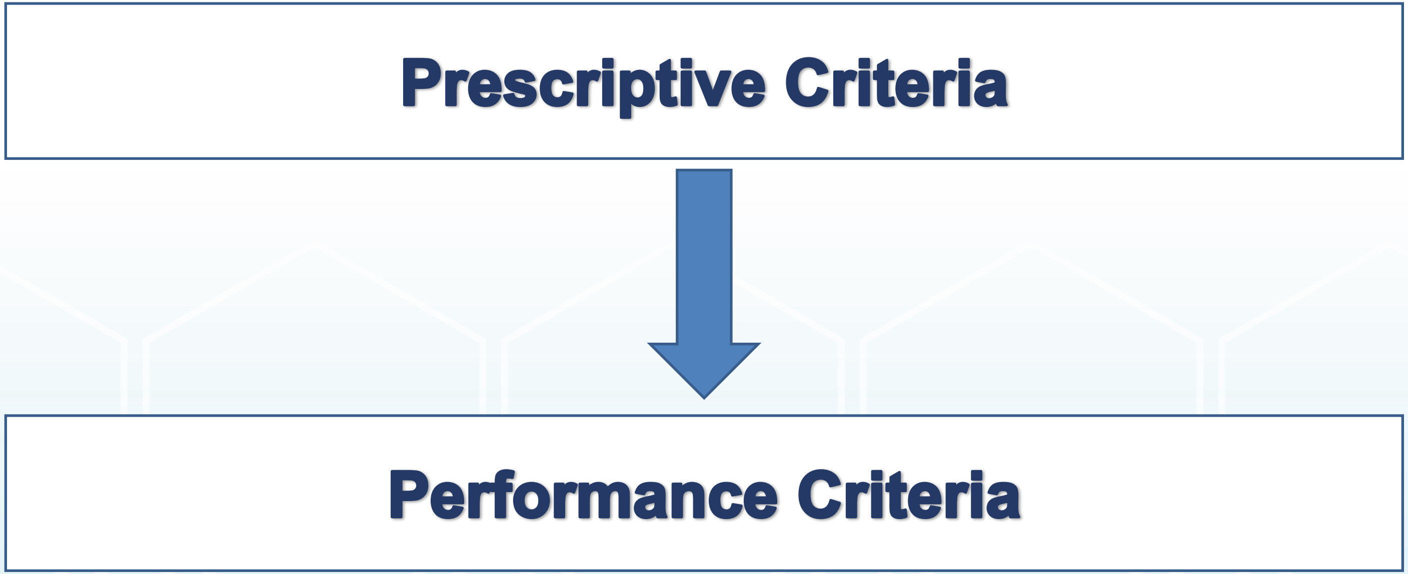
Delay or Defeat

- Barriers
  - - Fences
  - - Facility roof, walls, and floors
  - - Doors
  - - Windows
  - - Locks
- Distance
- Vegetation
- Procedures

Respond

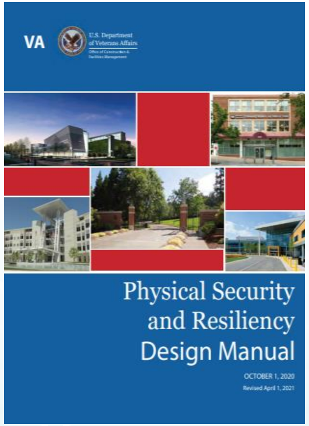
- Interruption
  - -Communication to response force
  - -Deployment of response force
  - -Neutralization

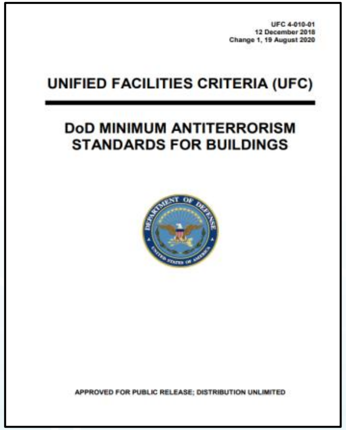
Development of the Protective System



Prescriptive Physical Security Criteria

- Prominent Prescriptive Design Criteria
  - DoD Minimum Antiterrorism Standards for Buildings, UFC 4-010-01
  - VA Physical Security and Resiliency Design Manual (PSRDM)
- UFC 4-010-01 and VA PSRDM are both minimum standards deemed acceptable by Risk Assessments previously conducted. There are instances particularly within DoD where risk assessments determined threats beyond the scope of UFC 4-010-01





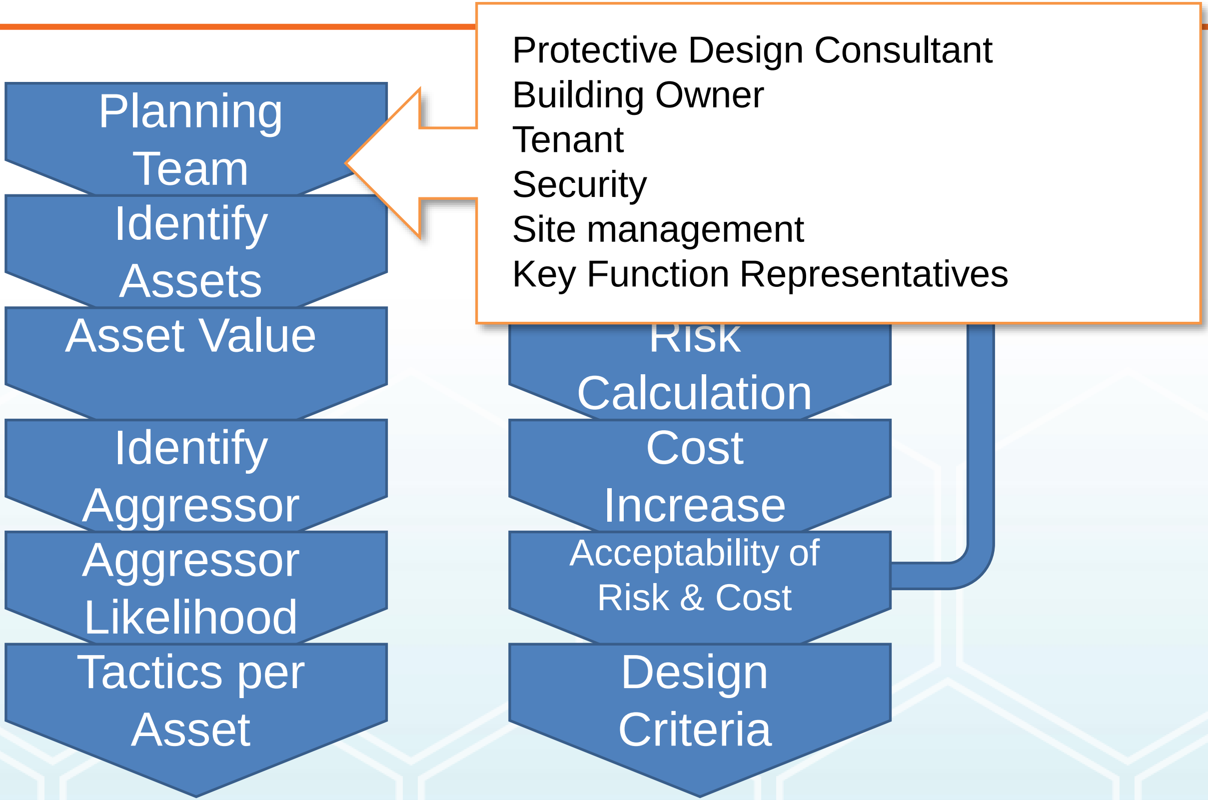
Risk Assessment Process

Risk Assessment Basics

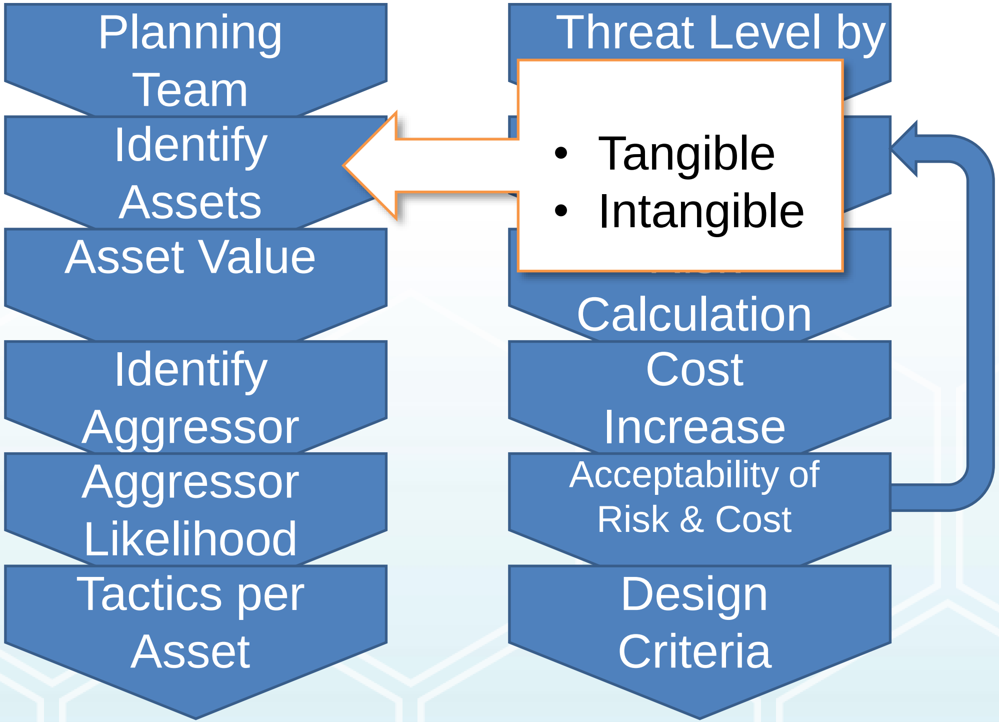
- Asset
  - Tangible and Intangible
  - Supports building function
  - Degree of debilitating impact if damaged or destroyed.
- Threat
  - Aggressor
    - Existence
    - Capability
    - History
    - Intentions
    - Targeting
  - Weapons, tools and tactics
- Vulnerability
  - Weaknesses that can be exploited

Risk Assessment Basics

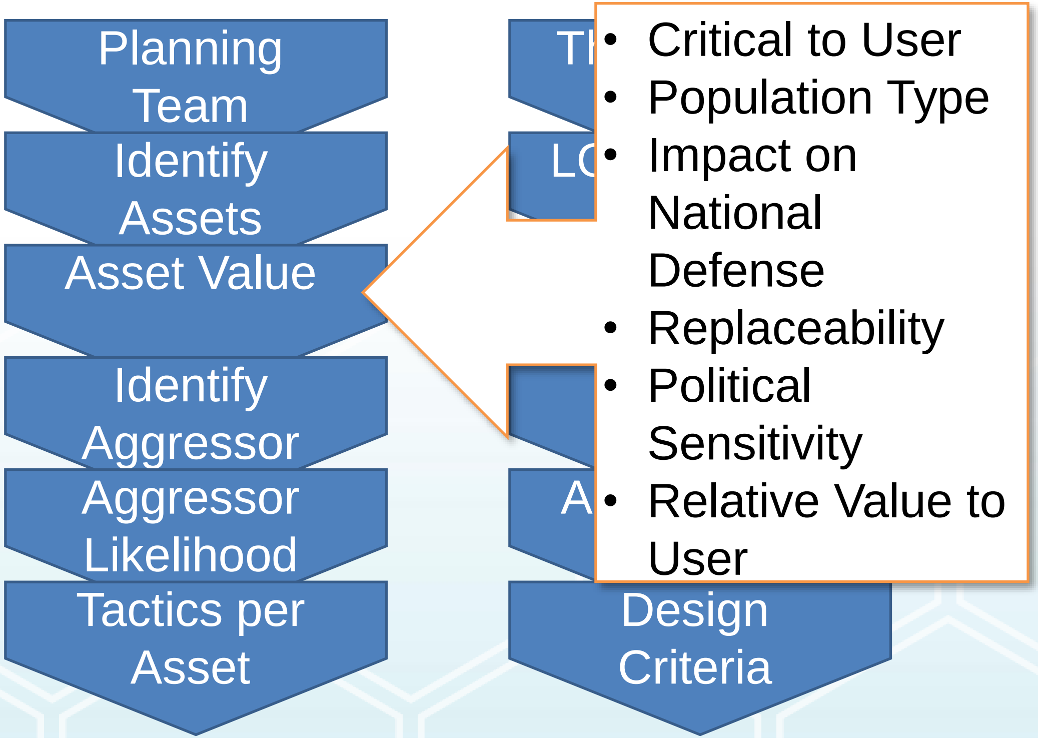
Risk Assessment Basics



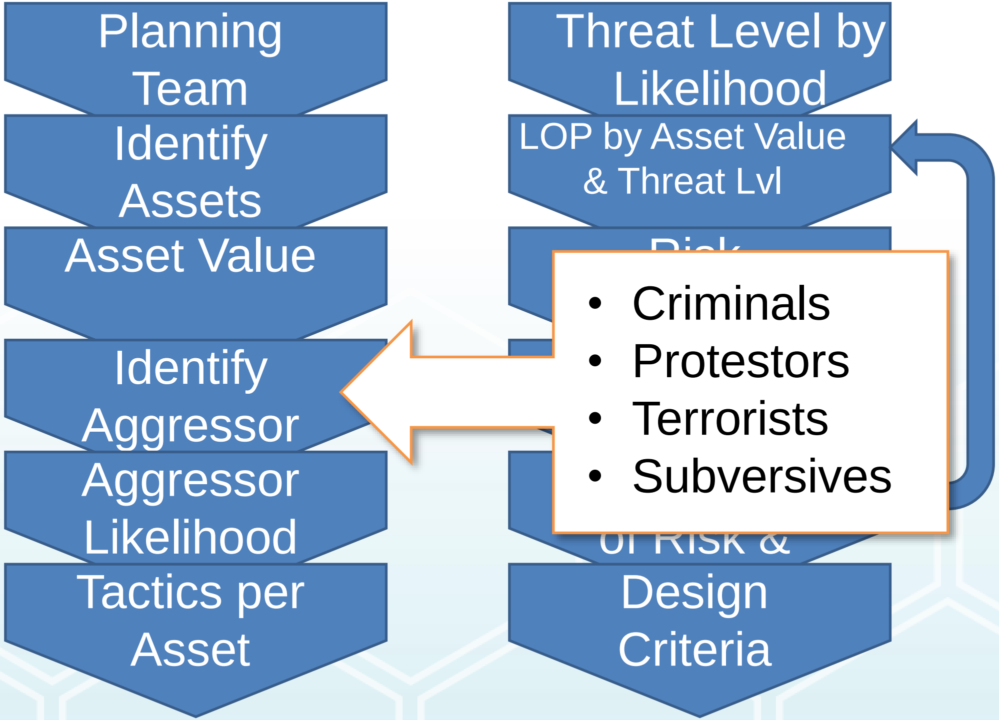
Risk Assessment Basics



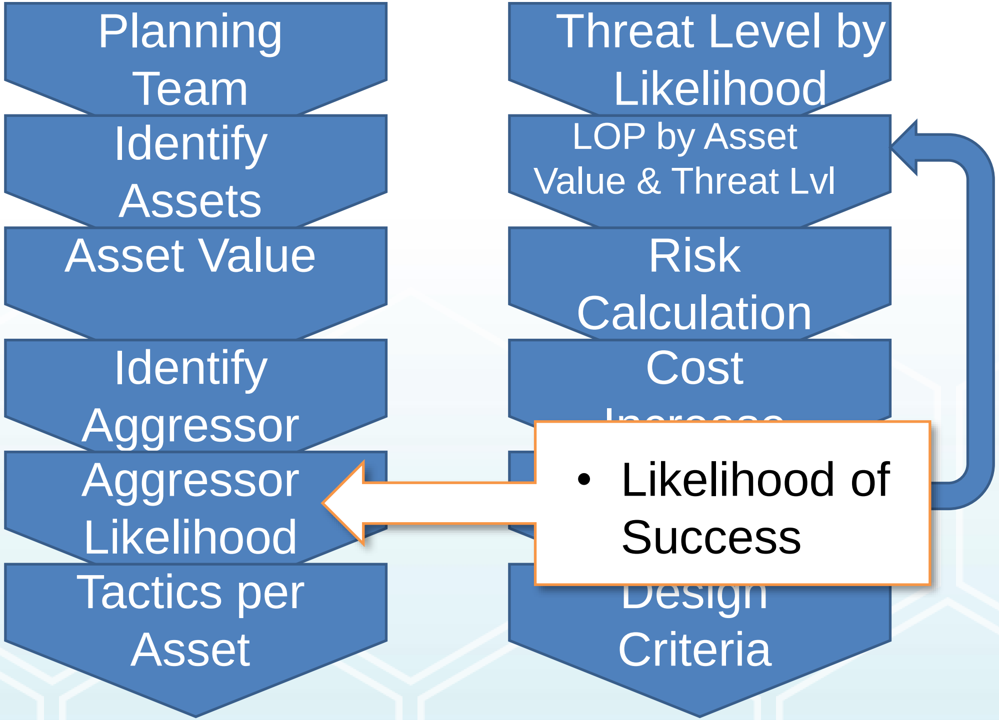
Risk Assessment Basics



Risk Assessment Basics



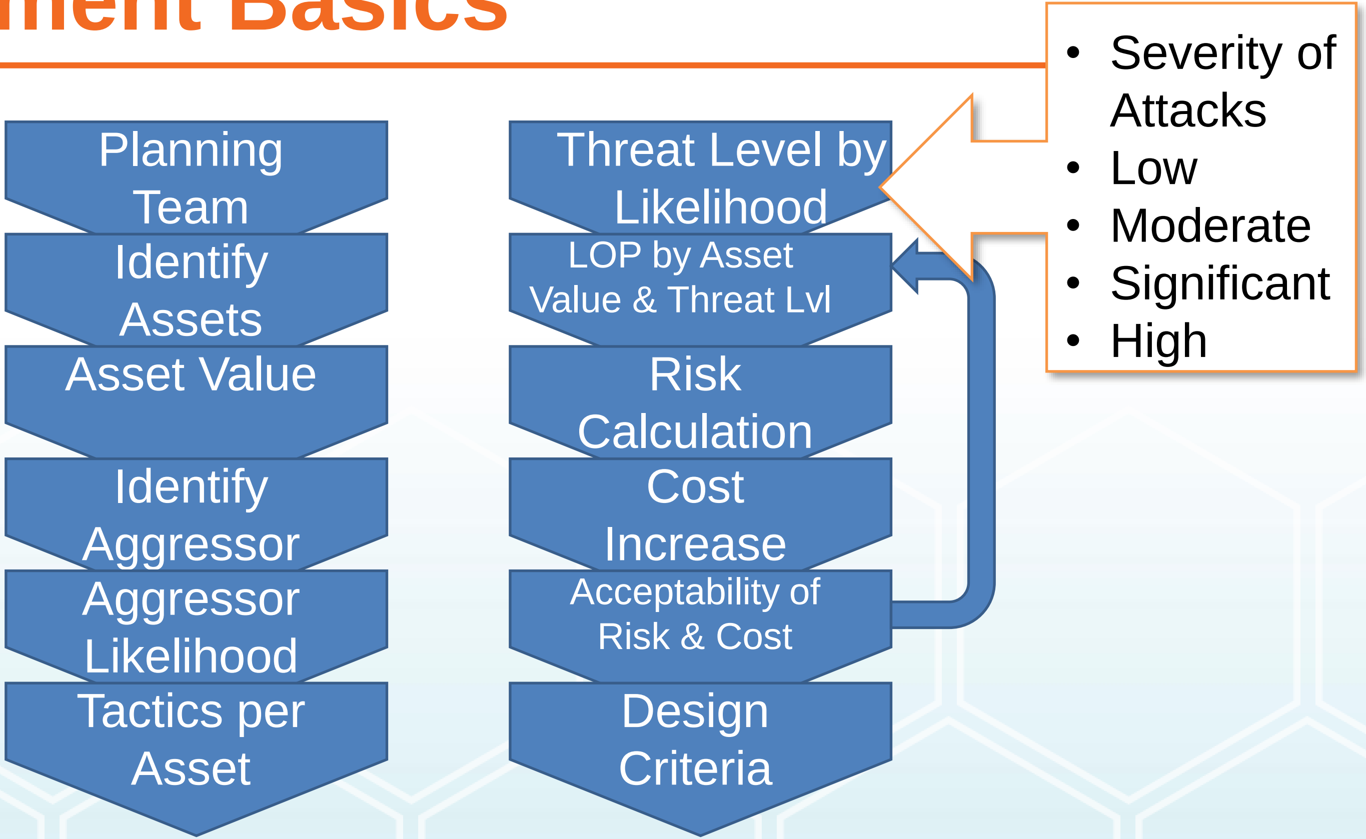
Risk Assessment Basics



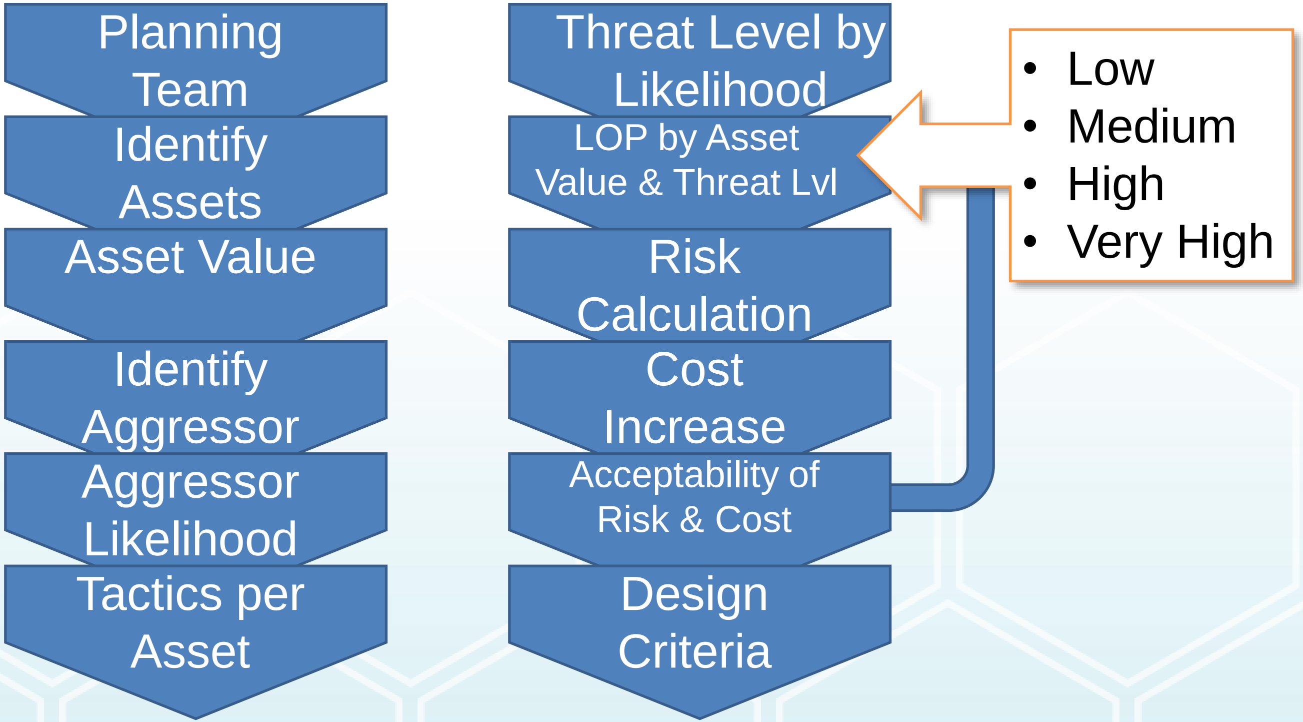
Risk Assessment Basics

- Explosives & Incendiary Devices
- Standoff Weapons
- Entry
- Surveillance & Eavesdropping
- Contamination

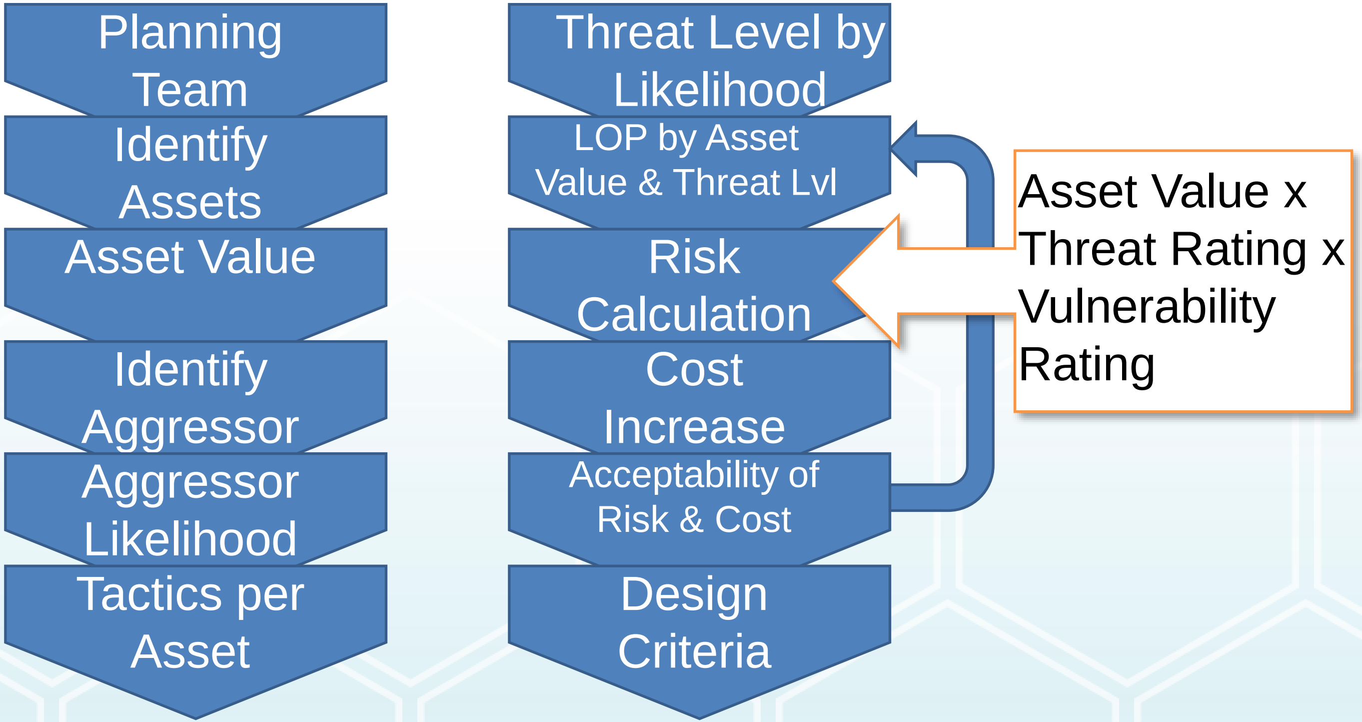
Risk Assessment Basics



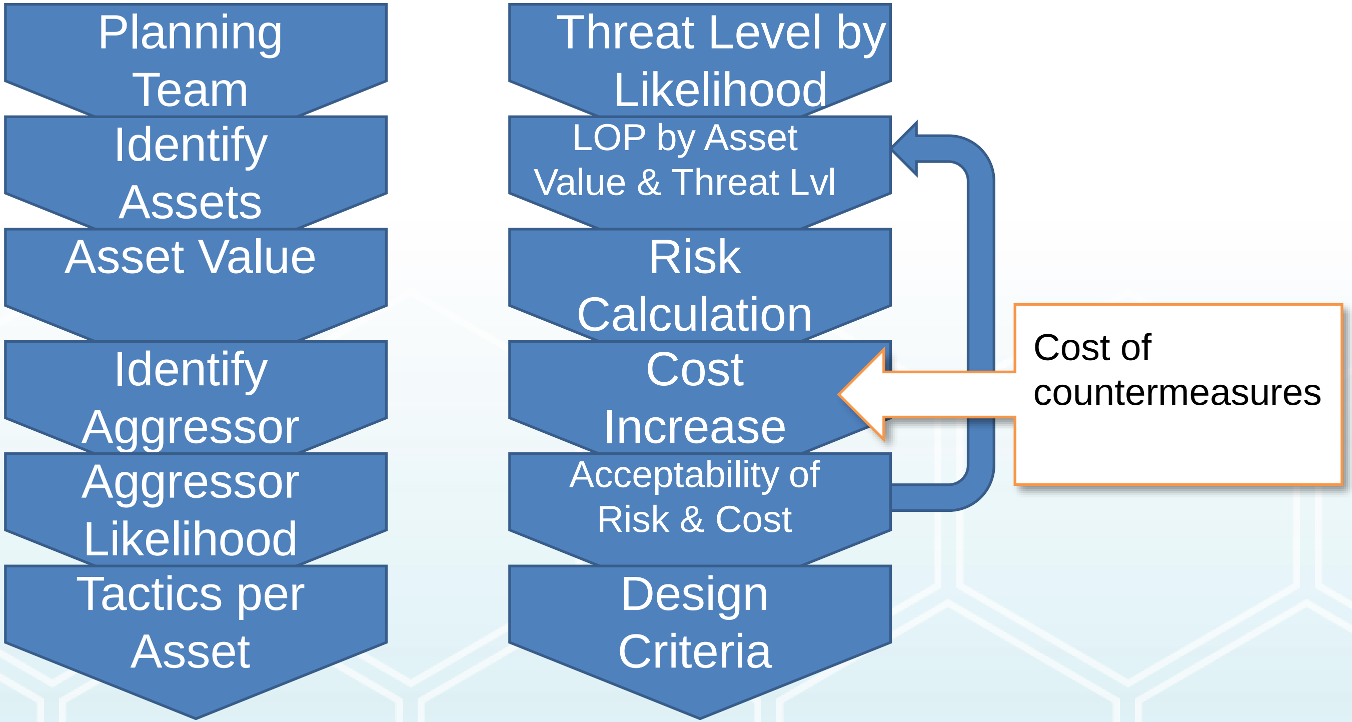
Risk Assessment Basics



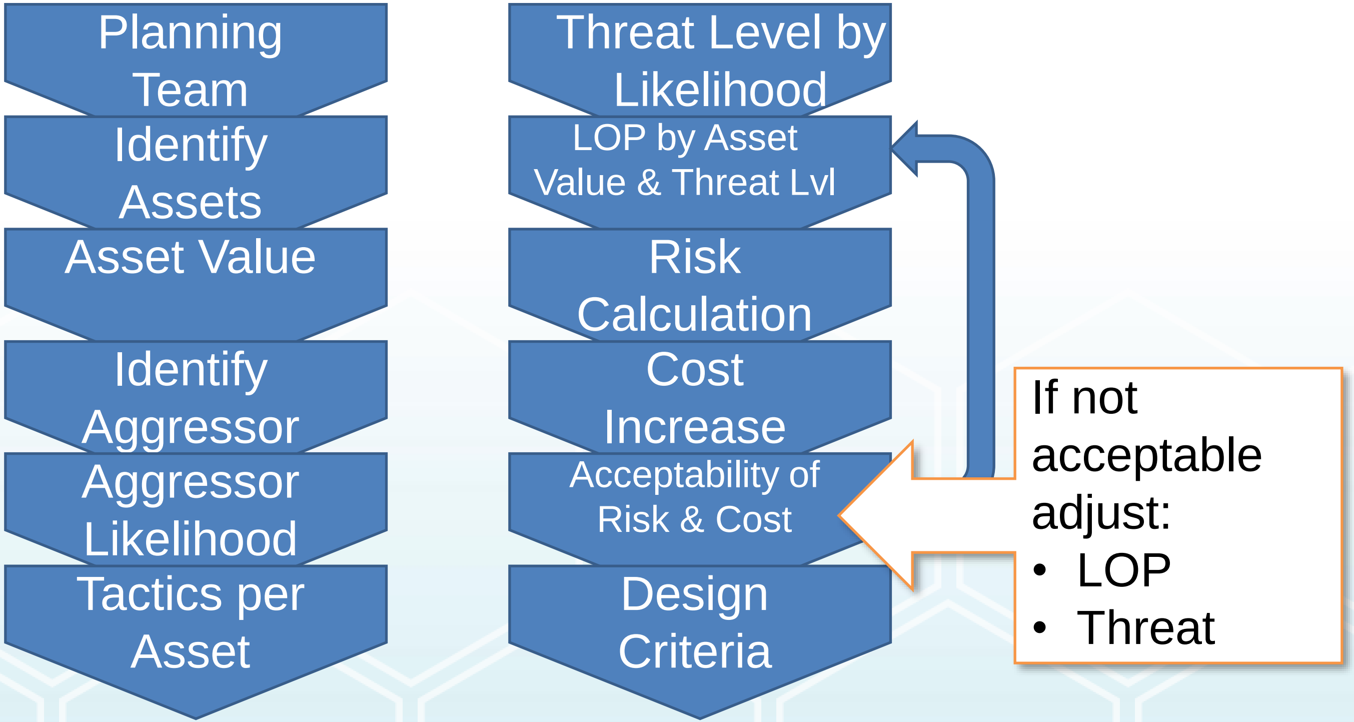
Risk Assessment Basics



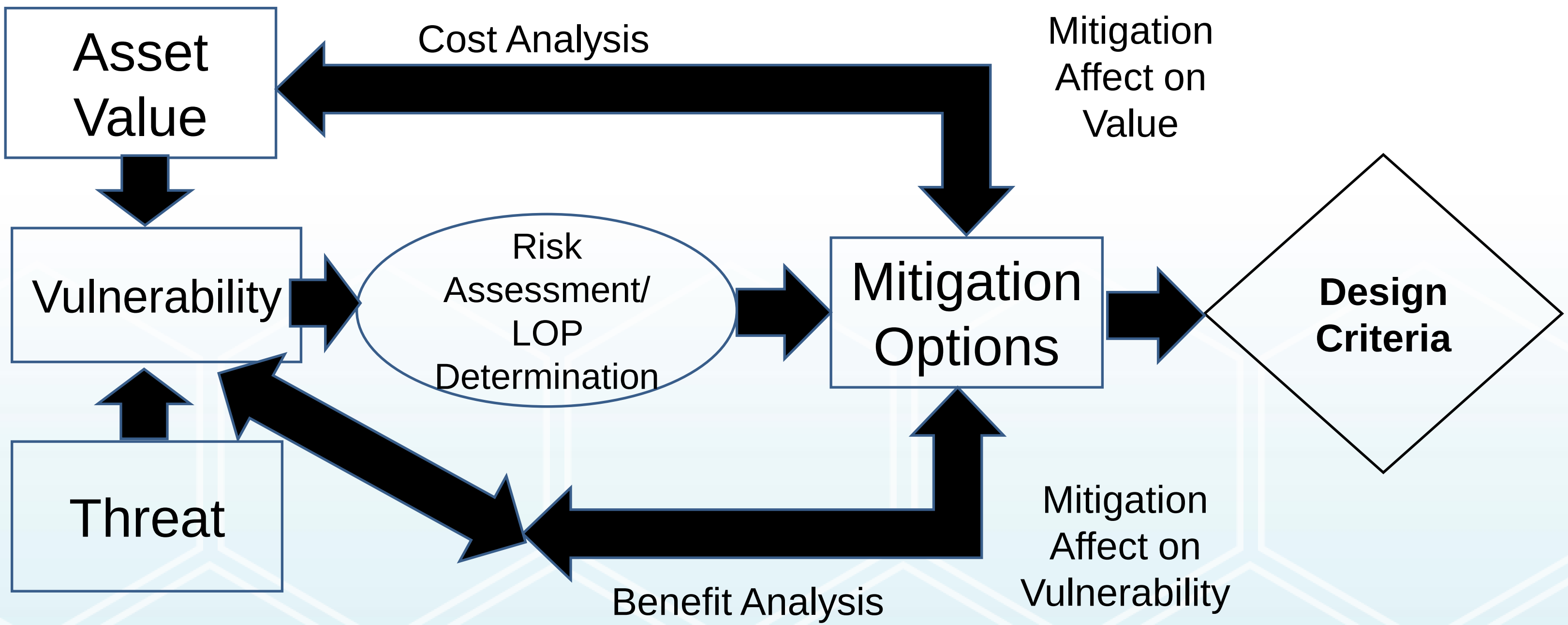
Risk Assessment Basics



Risk Assessment Basics



Risk Assessment Process

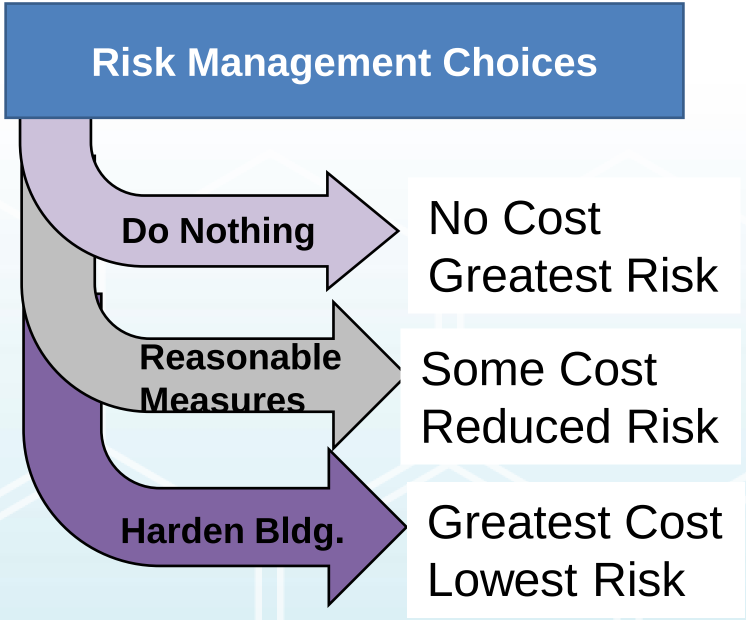


Risk = Asset Value x Threat Rating x Vulnerability Rating

Source: FEMA 426

Risk Assessment Process

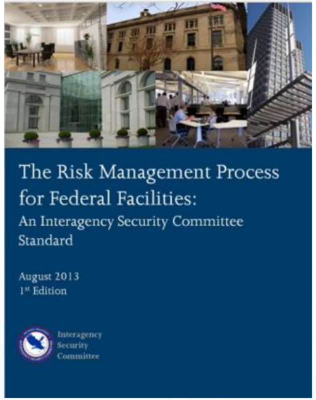
- Prioritize Risk = Asset Value x Threat x Vulnerability
- Identify Mitigation Options
  - Reduce value, threat, vulnerability
- Estimate Cost
- Cost-Benefit Analysis
  - By committee
    - Protective Design Consultant
    - Building Owner
    - Tenant
    - Security
    - Site management
    - Key Function Representatives
    - Others
- Codify Design Criteria

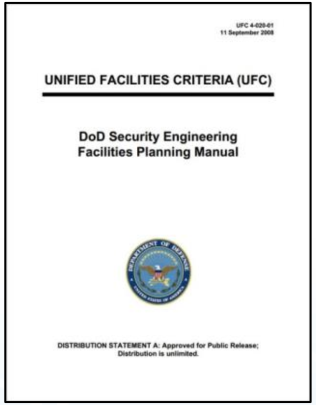


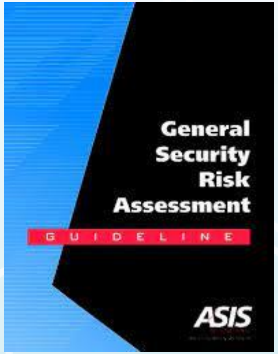
Source: FEMA 426

Risk Assessment Standards

- Prominent Standards
  - ISC, The Risk Management Process for Federal Facilities
  - DoD Security Engineering Facilities Planning Manual, UFC-4-020-01
- Other Standards
  - ASIS General Security Risk Assessment Guideline
  - TSA, Recommended Security Guidelines for Airport Planning, Design and Construction
- Results in Physical Security Design Criteria for a given project







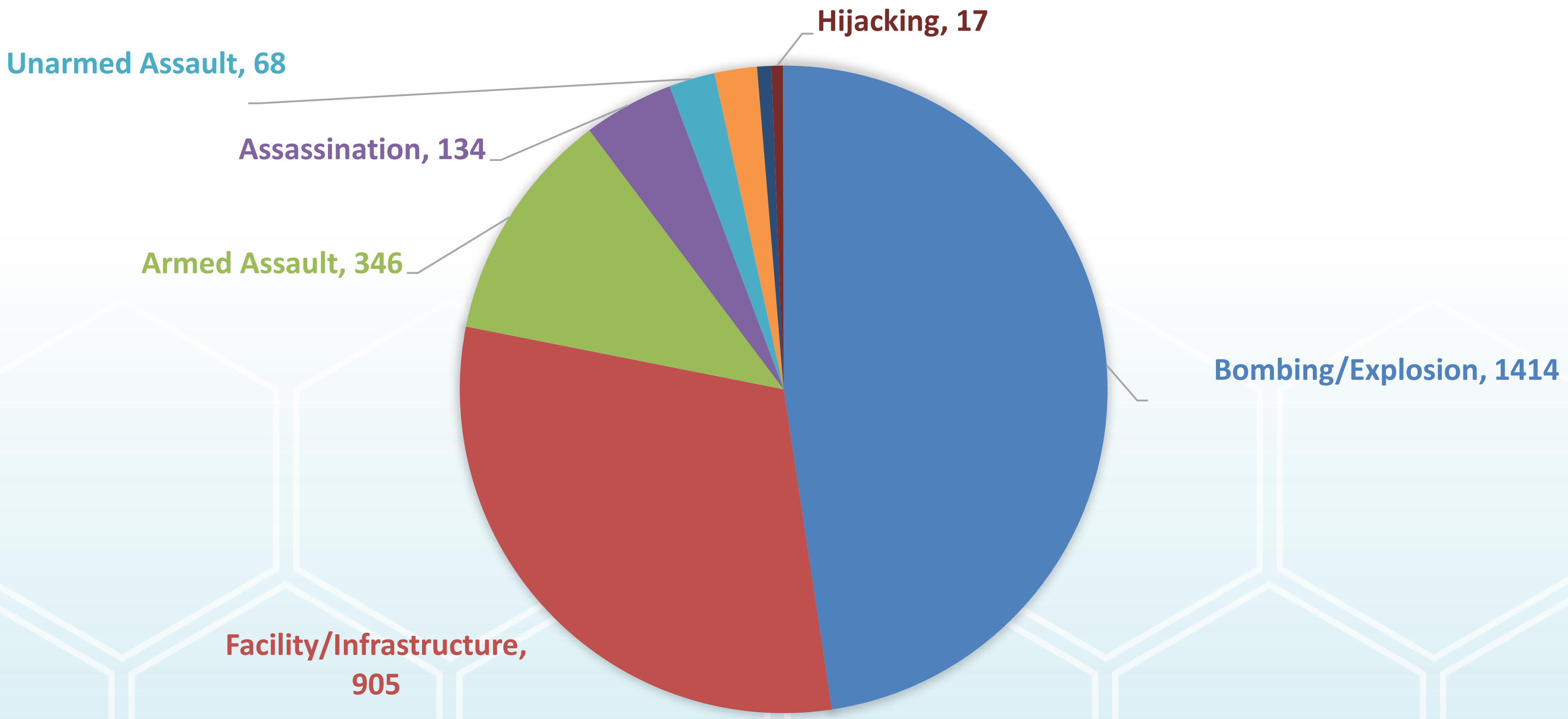
GSX GLOBAL SECURITY EXCHANGE

Blast Design

Blast Design Primer

By Scott L Weiland PE SE

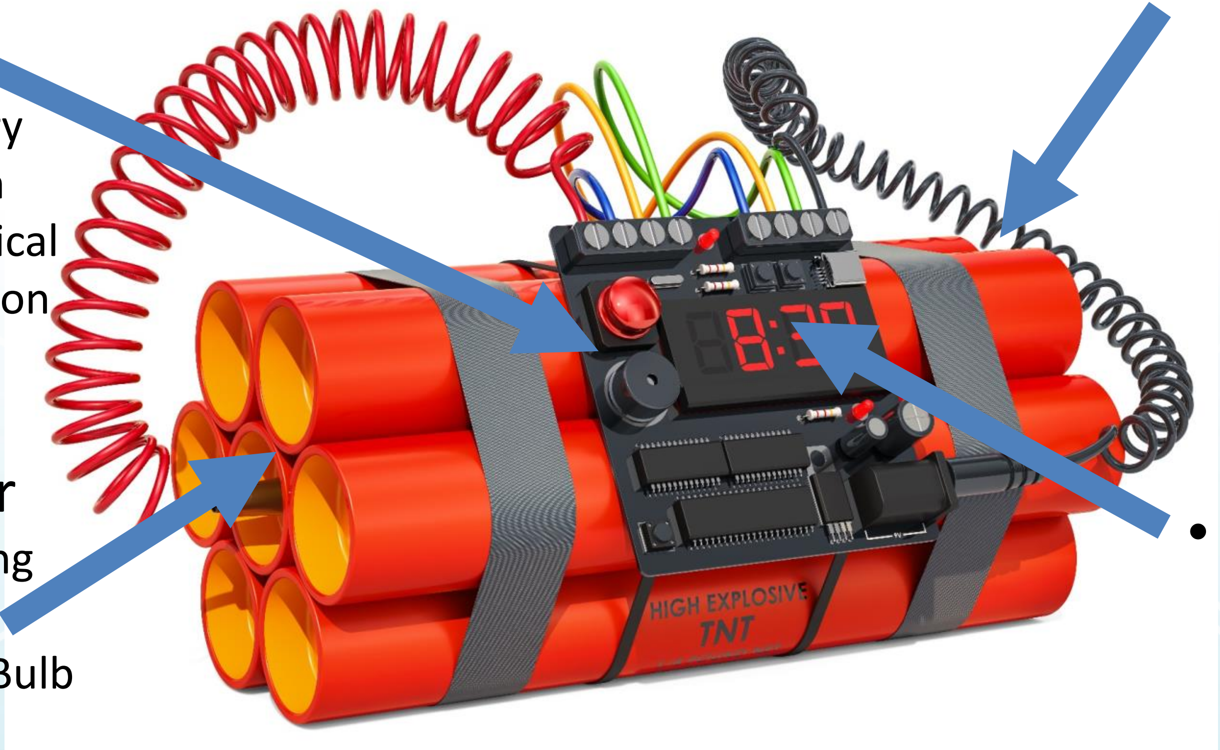
Tactics Used in Terrorist Attacks 1970 - 2018



Source: statista

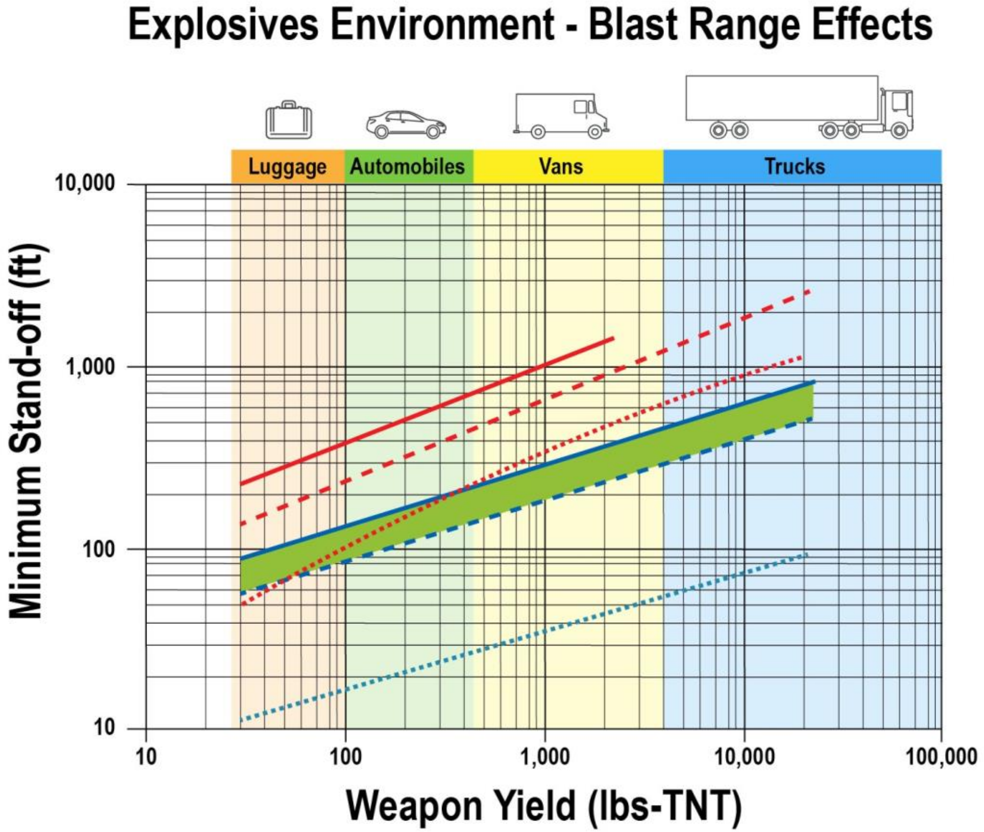
High Energy Explosives - PIES

- Power
  - Battery
  - Match
  - Chemical Reaction
- Initiator
  - Blasting Cap
  - Light Bulb



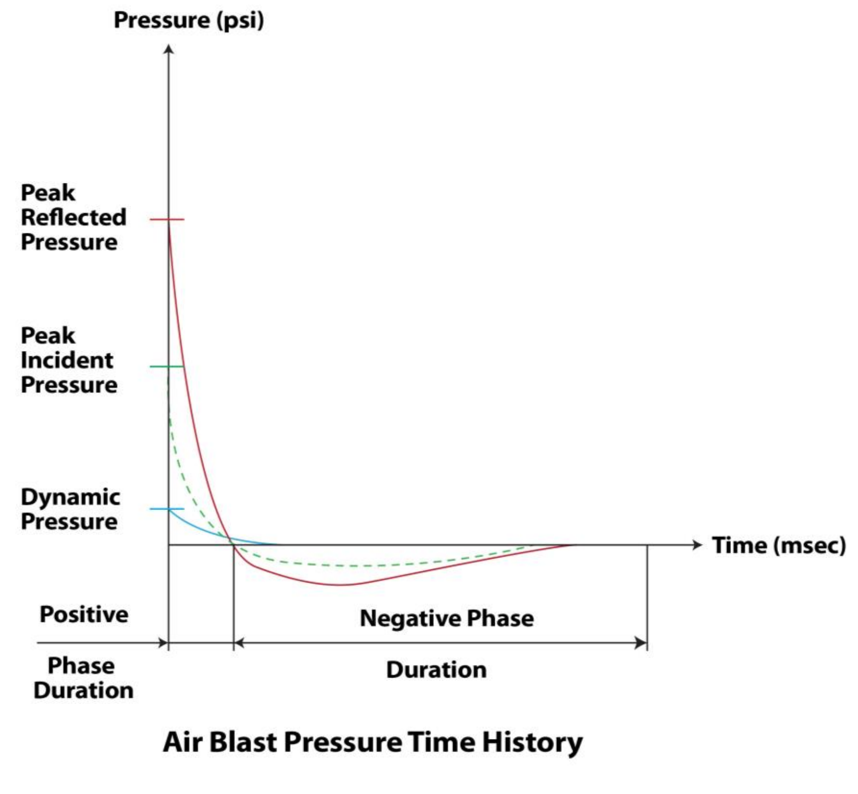
- **Explosive**
  - Low Explosive
  - **High Explosive**
  - Homemade Explosive (HME)
- **Switch**
  - Cell Phone
  - Timer

Minimize Bomb Threat



Pressure Shock Wave

Blast Theory – Time History



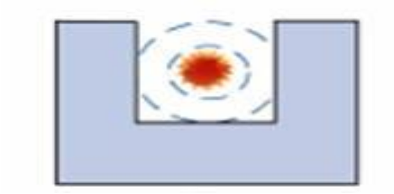
- Pressures decay exponentially with time.
- Dynamic, non-linear, time history analysis.
- Dynamic Pressure (Wind)

Source: FEMA 427

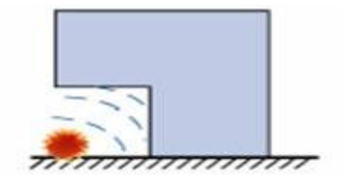
Blast Theory – Vehicle Bomb

- Surface Burst (VBIED)
- Pressure Radiates
- Reflected Pressure
- Refracted Pressure
- Side-On Pressure

Blast Theory - Shapes That Affect Blast

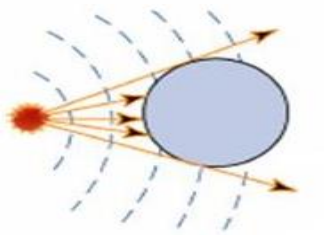


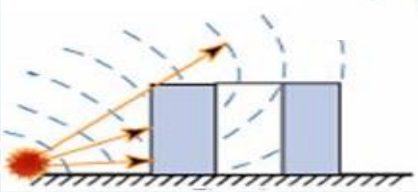
Re-entrant corners



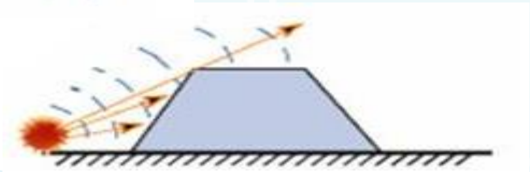
Overhang

Round Shape

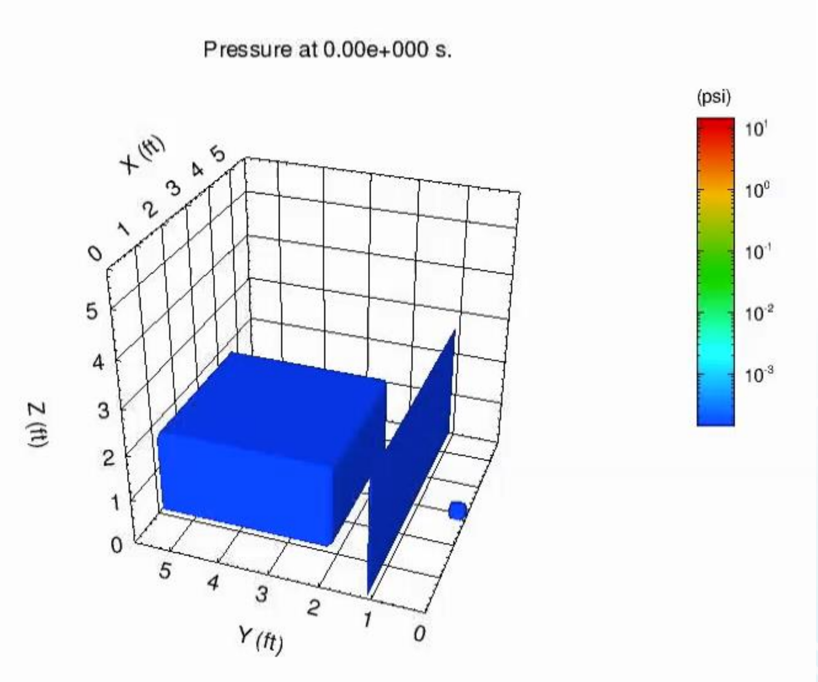




Blast Wall



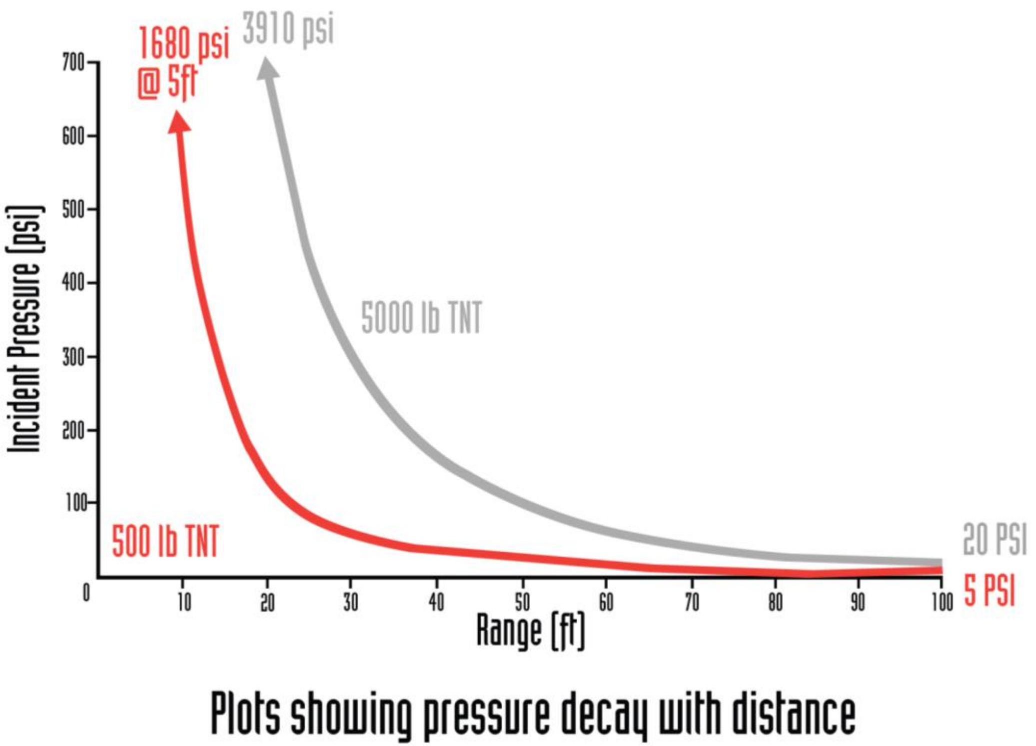
Berm



Blast Wall - CFD

Blast Theory - Distance

- Blast Pressure Decays with Distance



Source: FEMA 427

Blast Theory - Distance

Murrah Building

- 4,000 lbs. TNT*
- 15 ft Stand-Off

Khobar Towers

- 20,000 lbs. TNT*
- 80 ft. Stand-Off

Blast Theory - Explosion

- Shock Wave
- Reflected Pressure
- Rebound
- Side-On Pressure

Blast Theory - Explosion

- Shock Wave
- Reflected Pressure Wave
- Rebound

Blast Design – Conservation of Energy

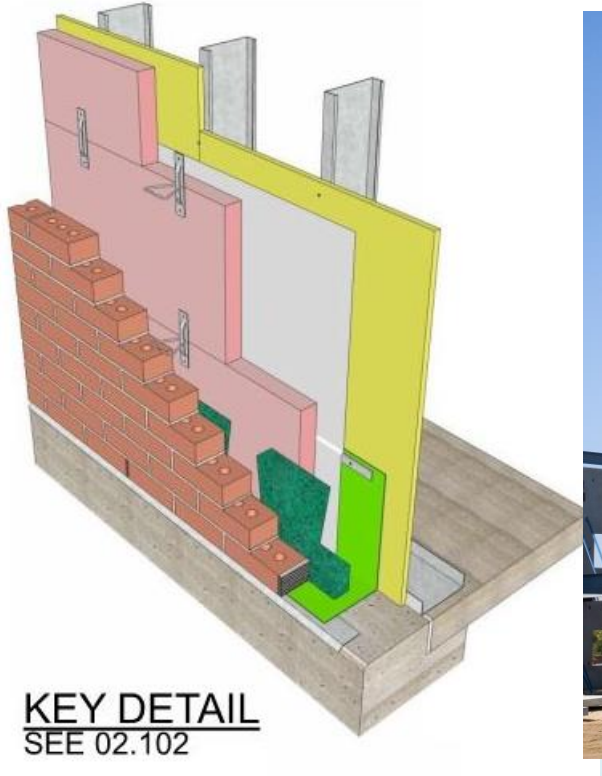
Energy Equation

- $W_P = W_K + W_S$
  - W_P = Blast Energy
  - W_K = Kinetic Energy
  - W_S = Strain Energy

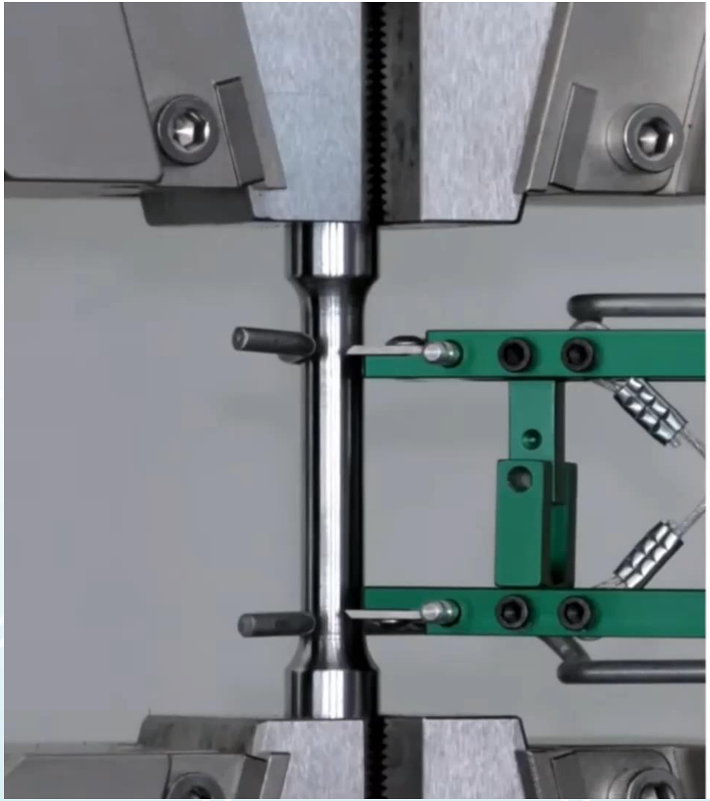
Blast Design – Kinetic Energy

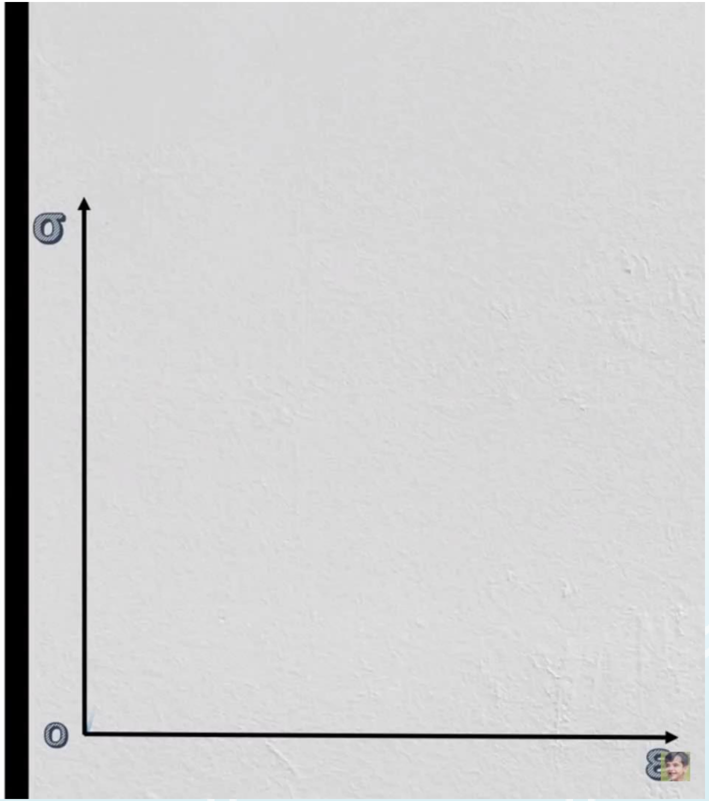
$$W_K = \frac{m_e * V^2}{2}$$

Masonry Wall Institute



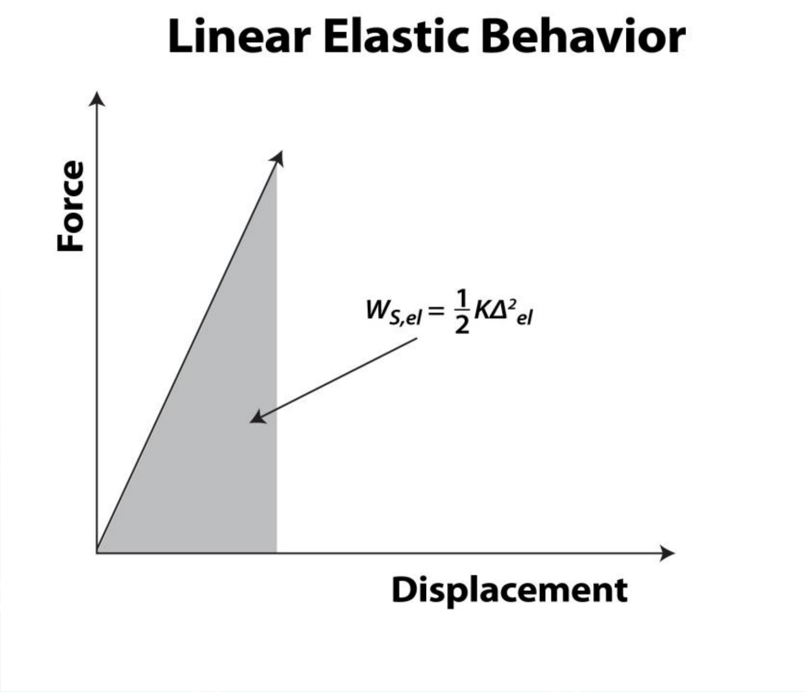
Blast Design – Strain Energy – Ductility



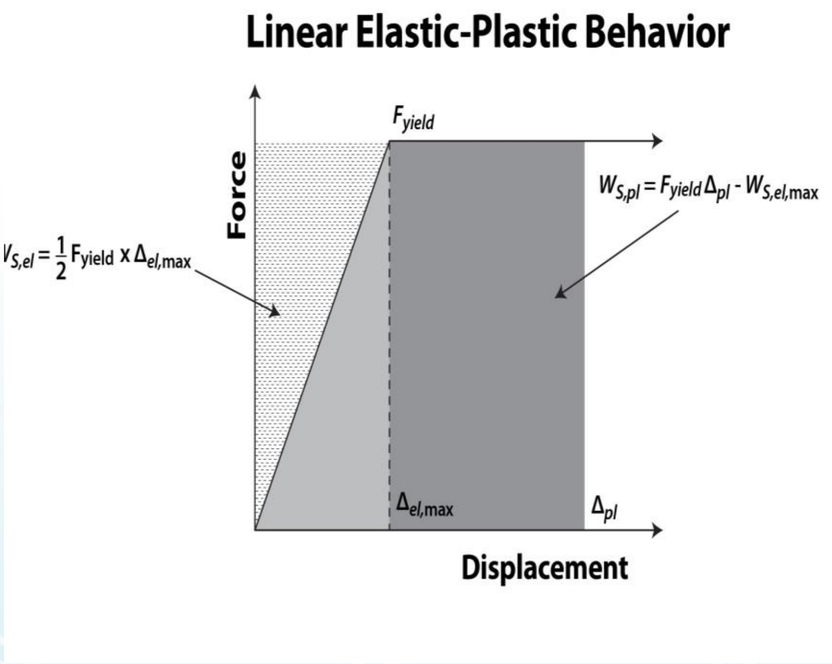


- Regions
  - Elastic
  - Plastic
- Area = Strain Energy

Blast Design – Strain Energy



μ = 1.0



μ > 2.0

Blast Theory – Energy Absorption

- Laminated Glass
  - 1st Level
    - 2 ½”
    - Forced Entry Resistant
    - Ballistic Resistant
    - Blast Resistant
  - 2nd & 3rd Level
    - 2”
    - Blast Resistant

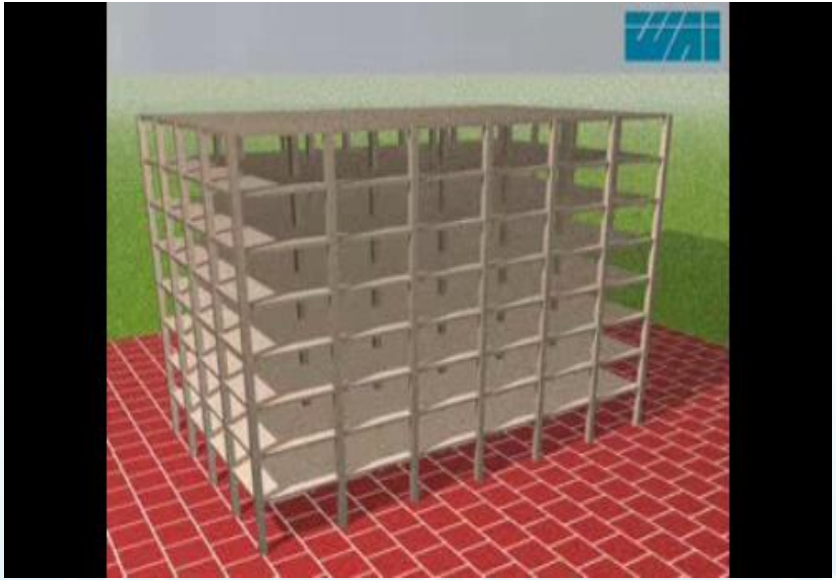
Progressive Collapse Prevention

Blast Design Primer

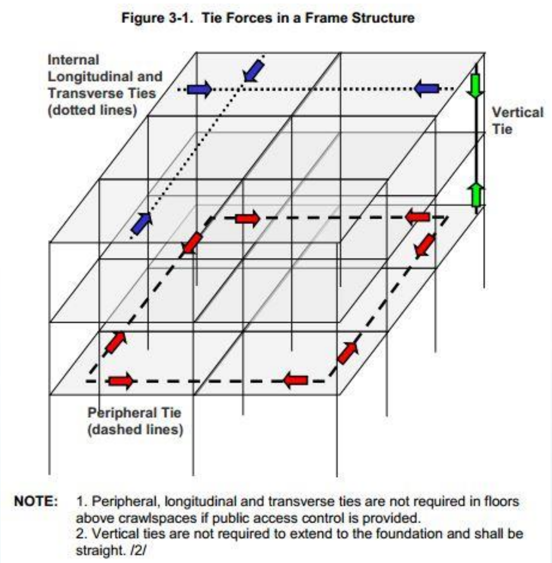
Progressive Collapse

"The spread of an initial local failure from building element to building element, eventually resulting in the collapse of an entire structure or a disproportionately large part of it."

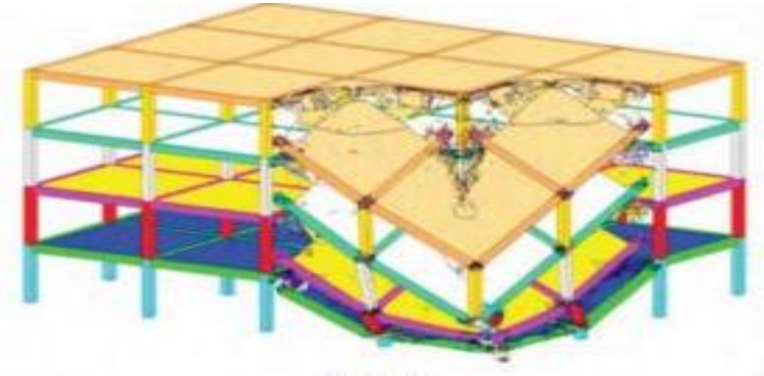
- Threat Independent
- Not generally required for structures less than 3 stories
- Mitigation provided by:
    - Redundancy
    - Local Hardening



Design and Analysis Techniques



Source: UFC 4-023-03



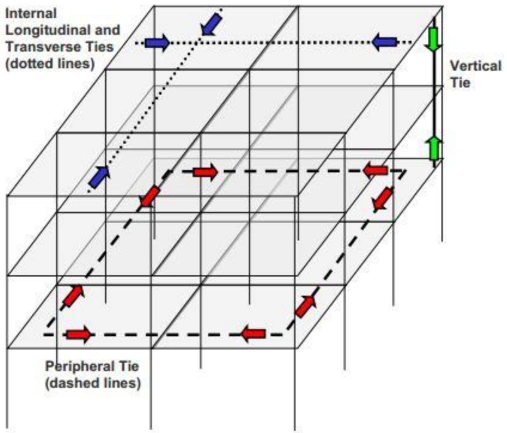
Source: BIPS 05

- Progressive Collapse
  - Tie Force Method (Indirect Design Procedure)
  - Alternate Path Method (Direct Design Procedure)

Design and Analysis Techniques

- Tie Force Method is based primary on bay span and the load carried by the floor/roof level under analysis. Horizontal and vertical ties develop tension capacity to tie the building together to enhance continuity and ductility and provide alternate load paths in the event the primary load path is lost.
- Ties members are limited by the amount of end rotation that can be achieved while still being able to resist the tensile tie force. Generally beams and girders are not used as ties as the amount of end rotation is too great for the member to still resist the given loading
- The tie system consists of internal, peripheral and vertical ties. The internal ties run continuous in each orthogonal direction and are tied to continuous peripheral ties. Vertical ties consist of the building columns or load bearing walls
- Location, continuity, splicing and anchorage of ties are vital in the design of the tie force resisting system.
- Enhanced local resistance design is required for the columns/load bearing walls to resist required shear and flexural design forces

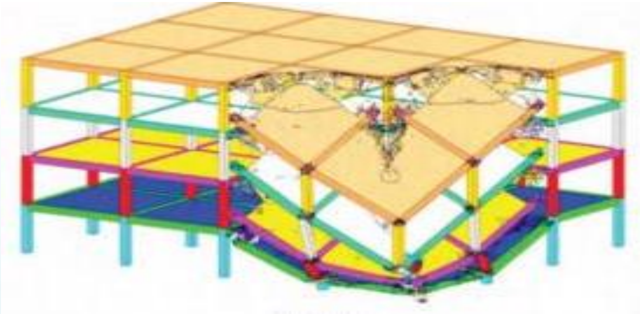
Figure 3-1. Tie Forces in a Frame Structure



NOTE: 1. Peripheral, longitudinal and transverse ties are not required in floors above crawlspaces if public access control is provided.
2. Vertical ties are not required to extend to the foundation and shall be straight. /2/

Design and Analysis Techniques

- Alternate Path method is a higher fidelity design procedure which follows the same LRFD design concepts used in seismic design. The analysis is typically conducted with 3 dimensional structural design software
- The alternate path method analysis can be conducted via three approaches. Linear Static Procedure (LSP), Non-Linear Static Procedure (NSP) and Non-Lineal Dynamic Procedure (NDP). Each procedure increases with modeling fidelity and accuracy of predictive results but also increases with complexity of analysis and time associated with the analysis.
- The general procedure is to remove perimeter corner, re-entrant corner, and interior columns/load bearing walls both on the building perimeter and high risk interior area of the building on various levels of the structure and design the primary and secondary members for the resulting force and deformation controlled forces so that progressive collapse will not occur.
- Enhanced local resistance design is required for the columns/load bearing walls to resist required shear and flexural design forces.
- Acceptance, modeling and detailing criteria is highly material dependent.



GLOBAL SECURITY EXCHANGE

Implementation of Physical Security Design

Blast Design Primer

Physical Security Involvement

- Some aspect of physical security is required on every project.
- Involvement of a physical security professional should begin at the planning phase of a project with a risk assessment. This ensures that the requirements are clearly in the scope of work and the construction estimate is defined and includes cost for the protective system. Poorly written project scopes that only reference criterion are a major source of change orders and or increased design fees
- During the initiation of the design phase, the design team should have the physical security professional involved to ensure the scope is clearly defined and understood by all parties involved in the design.
- Early involvement both on the planning and design phases of project ensures that both phases are clear on the requirements and do not require future re-work to incorporate the physical security design.

Project Scope Understanding and Clarity

- Clearly understanding the project scope and requirements is the most critical step in ensuring the delivery of the project on budget. Not fully understanding and clarifying the project scope generally leads to either over or under designed protective systems.
- Key questions regarding physical security that must be answered at the beginning of the project
- Is a risk assessment required? If not is there any outcomes of the risk assessment that would fall outside the scope of the governing criteria? If so, what is the governing risk assessment methodology?
- What is the governing physical security criterion for the project?
- Are there any criteria that are local to the installation/facility or to the government agency that are required for use on the project?

Project Scope Understanding and Clarity

- Is the project new construction or modification/renovation/addition to existing construction?
- What is the mission criticality of the facility?
- Will there be intent on future vertical or horizontal expansion. If so, what impact will that have on the facilities mission criticality Ensure all interpretations of the scope of work and criteria related to the scope have been confirmed by the agency prior to commencing the design phase.
- There are grey areas within any criteria that can be open to interpretation. However, the agency having jurisdiction is the final say on the criteria.

Scope Understanding Example

- USACE Facility
- Primary body of the scope referenced the minimum standards UFC for the AT/FP requirements.
- Small excerpt referenced a Security Risk Analysis which identified a Medium Level of protection
- Medium level of protection is beyond the minimum standards and beyond what was designed for the project.
- Interpretation was not fully confirmed

5.4.3 Loads: See paragraph *6* for site and project specific structural loading criteria. Unless otherwise specified in paragraph *6*, use Exposure Category C for wind. If not specified, use Category C unless the Designer of Record can satisfactorily justify another Exposure Category in its design analysis based on the facility Master Plan. Submit such exceptions for approval as early as possible and prior to the Interim Design Submittal in Section "Design After Award". Design the ancillary building items, e.g. doors, window jambs and connections, overhead architectural features, systems and equipment bracing, ducting, piping, etc. for gravity, seismic, lateral loads and for the requirements of UFC 4-010-01, DOD Minimum Antiterrorism Standards for Buildings. Ensure and document that the design of glazed items includes, but is not limited to, the following items under the design loads prescribed in UFC 4-010-01 :

(a) Supporting members of glazed elements, e.g. window jamb, sill, header

(b) Connections of glazed element to supporting members, e.g. window to header

(c) Connections of supporting members to each other, e.g, header to jamb

(d) Connections of supporting members to structural system, e.g. jamb to foundation.

6.6.8.4 Antiterrorism Force Protection (ATFP)

Design exterior building elements to meet the requirements of UFC 4-010-01. Refer to the Physical Security Risk Analysis in Appendix EE.

Poorly Defined Scope Example

- VA facility
- What is Future Growth?
- Mission criticality went from Life Safety as required by the current project to Mission Critical for the future growth.
- Leads to increased construction and design cost or reduction in programmed space to meet the budget

A/E SCOPE OF WORK

1. This project (minor) will engage an architectural/engineering (A/E) firm to provide a complete design for new construction that creates a new building or addition at the VA [redacted] Campus. The new site selection and/or addition would need to be designed to provide accommodations for future growth. It also must have the capability to utilize existing floor space into the design, as well as, combine existing common areas. The need for vertical transportation will be dependent on the proposed design. The project will also require extensive phasing with all disciplines, staff and patient needs. The site around the [redacted] campus slopes steeply and will require extensive site work, in addition the utility services in the area and physical security issues will need to be developed and will be extensive.

Clarity in Construction Documents

- Confusion in the construction documents are generally the biggest attributor to physical security costs and changes during the construction phase of a project.
- The most common issue involves specification of delegated design of vendor products for the protective system. These products are typically windows, doors, glazed curtainwall and non-load bearing light gauge stud wall systems
- The most prevalent problem is specifying the incorrect blast loading criteria, blast loading response and acceptable testing method
- Most A/E firms and delegated designers of vendor products are familiar blast requirements of the UFC (DoD) and ISC (GSA). However, with that familiarity comes misuse on another agency's project such as with the VA. There are instances where these more available designed and tested system will not work for the VA blast requirements.

Specifications Examples

- VA Facility
- Performance Specifications for blast resistant windows

1.7 PERFORMANCE REQUIREMENTS:

A. Shapes and thickness of framing members shall be sufficient to withstand a design wind load of not less than 30 pounds per square foot of supported area with a deflection of not more than 1/175 times the length of the member and a safety factor of not less than 1.65 (applied to overall load failure of the unit). Provide glazing beads, moldings, and trim of not less than 0.050 inch nominal thickness.

B. Air Infiltration: When tested in accordance with ASTM E 283, air infiltration shall not exceed 0.06 cubic feet per minute per square foot of fixed area at a test pressure of 6.24 pounds per square foot 50 mile per hour wind.

C. Water Penetration: When tested in accordance with ASTM E 331, there shall be no water penetration at a pressure of 8 pounds per square foot of fixed area.

D. Glazing, doors, and frames shall comply with UFC 4-010-01, Oct 8, 2003, including change of Jan 22, 2007, Standard 10 Windows and Skylights, and Standard 12 Exterior Doors.

1. Table B-1: Standoff Distances for New and Existing Buildings
   a. Location: Controlled Perimeter
   b. Building Category: Primary Gathering Building
   c. Applicable Level of Protection: Low
   d. Applicable Expolosive weight: 1
2. Table B-3: Laminated Glass thickness Selection for Insulating Glass Unit Windows.
   a. Applicable Level of Protection: low
   b. Applicable Explosive Weight: 1
   c. Glass Thickness at Conventional Construction Standoff Distance: 0.250"
   d. Minimal Interlayer Thickness: 0.030"
3. Aluminum Frames:
   a. B-3.1.1.2 In accordance with ASTM F2248, ensure that the framing members restrict deflections at edges of the blast resistant glazing they support to 1/160 of the length of the supported edge at allowable stress levels under the equivalent 3-second design loading. The equivalent 3-secong duration design loading determined usinf ASTM F2248 will be based on the applicable explosive weight at the actual standoff distance at which the window is sited, but not greater than the conventional construction standoff distance.

      In the case of a punched window, the supported edge length will be taken as equal to the span of the glass, regardless of any intermediate support connections. In the case of multi-panel glazing systems, the supported edge length to be considered will be taken as equal to the span of a single glass panel and the deflection will be calculated based on simple support conditions for that length.

Specifications Examples

- VA Facility
- Performance Specifications based on UFC criteria
- 100% incorrect

D. Glazing, doors, and frames shall comply with UFC 4-010-01, Oct 8, 2003, including change of Jan 22, 2007, Standard 10 Windows and Skylights, and Standard 12 Exterior Doors.

1. Table B-1: Standoff Distances for New and Existing Buildings
    a. Location: Controlled Perimeter
    b. Building Category: Primary Gathering Building
    c. Applicable Level of Protection: Low
    d. Applicable Expolosive weight: 1
2. Table B-3: Laminated Glass thickness Selection for Insulating Glass Unit Windows.
    a. Applicable Level of Protection: low
    b. Applicable Explosive Weight: 1
    c. Glass Thickness at Conventional Construction Standoff Distance: 0.250"
    d. Minimal Interlayer Thickness: 0.030"

Specifications Examples

- VA Project
- Performance Specifications based on the correct VA criteria

the PSDM. Unless noted otherwise, all exterior glazing are to be blast resistant and laminated.

1.4 DESIGN REQUIREMENTS

A. All façade fenestration shall be designed to crack but fragments shall enter the occupied space and land on the floor no further than 10 feet (3 m) from the façade in response to the calculated peak pressures and impulses resulting from the design level threat (W1) located at the stand-off distance, but no greater than GP1."

B. This building should be designed to meet the 2007 VA Physical Security Design Manual for Life Safety Protected Facilities.

C. Minimum Blast Requirements: Minimum blast resistant performance requirements for the exterior walls are specified.

1. All systems requiring blast resistance shall be designed using established methods and approaches for determining dynamic loads, structural detailing and dynamic response.

   Design and analysis approaches should be consistent with those in the references listed in these specifications.

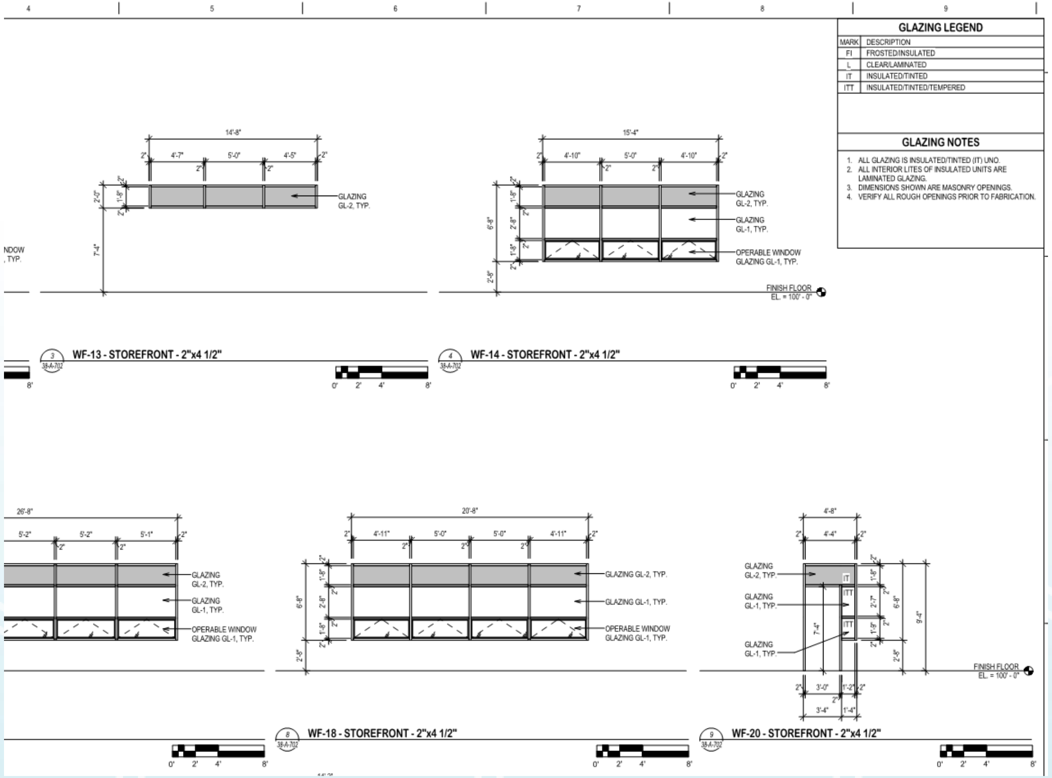
D. The glass shall be restrained within the mullions with a sufficient bite or structural silicone adhesive to allow it to develop its post-damage capacity.

Clarity in Construction Documents

- Another prevalent issue in the construction documents is unclear designation of the protective system on the contract drawings.
- Generally, we see issues where window, door and curtain wall is not designated as blast resistant, and the contractor is left to “interpret” which of these systems are required to be blast resistant. If the contractor interprets wrong their pricing will be incorrect, and the pricing is rarely on the high end of the incorrect spectrum
- Other items that commonly do not get designated on the contract drawings are location of rated vehicle barriers, areas on the site that require no parking designations, incorrect use of straight-line vehicle approaches to the building, incorrect location of drive up drop off canopy structures and correct location of mechanical system intakes to name a few.

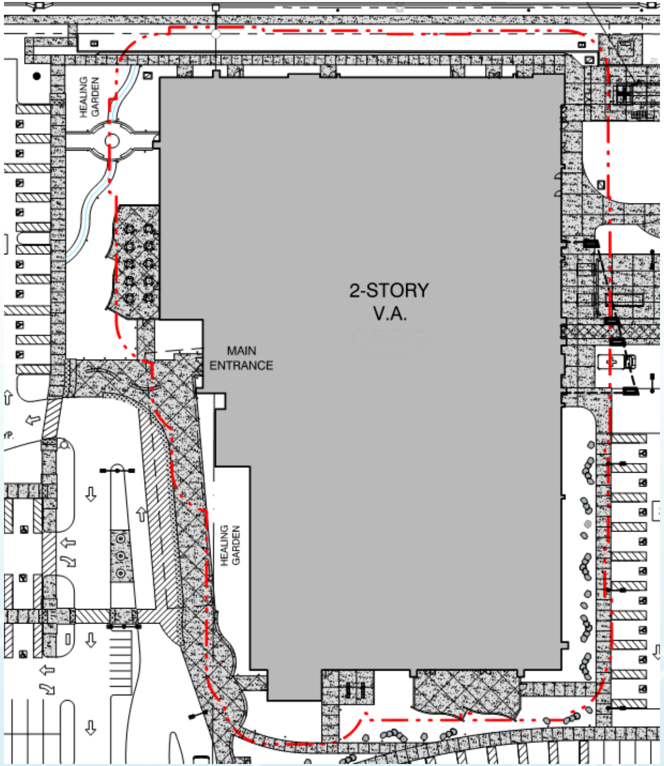
Drawing Examples

- Exterior Glazed openings
- No indication of blast resistance requirements
- Specifications did not indicate blast performance requirements
- All of which lead to changes and cost



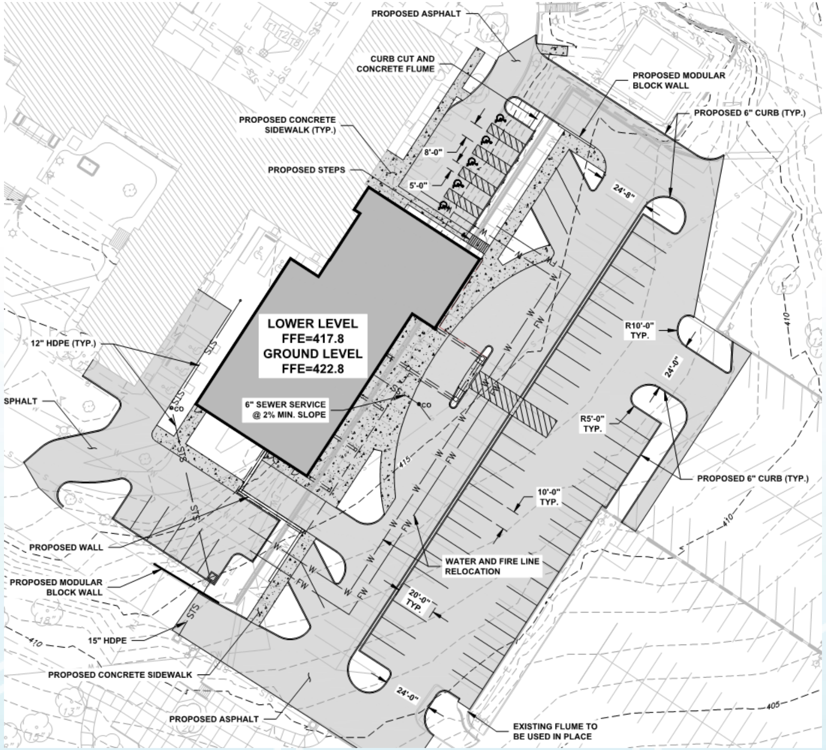
Drawing Examples

- Drawing dedicated to showing the required standoff and that all parking and roadways are beyond the minimum standoff required by the VA criteria
- As a reviewer if this is not shown on a drawing it is the first clue that physical security is not a forefront part of the design



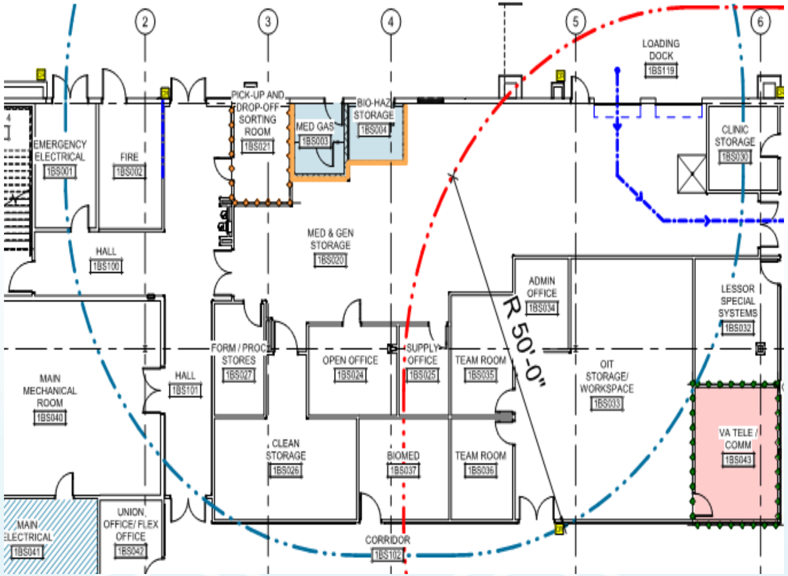
Drawing Examples

- Note no standoff distance is shown.
- If shown it would be obvious parking is within the minimum VA standoff.
- Straight line approaches are provided with no means to stop a vehicle.
- Involvement by the PSP didn't happen until well after 65% design phase.



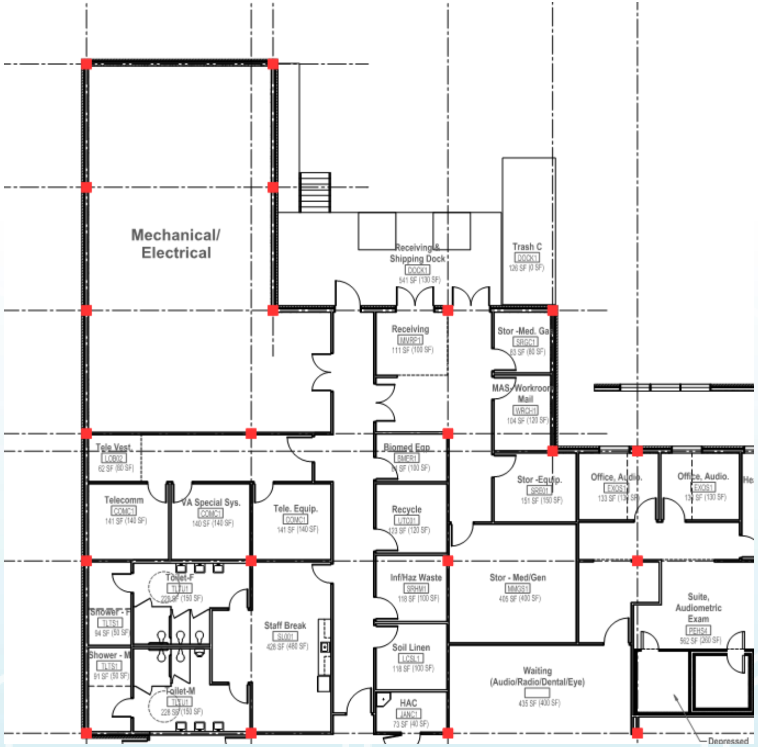
Drawing Examples

- Drawing dedicated to showing adjacencies required by the VA criteria.
- Great not only for the current project but future renovations that likely will occur



Drawing Examples

- Note no adjacencies shown.
- Violates the VA criteria.
- Critical issue as it affects every discipline on the project and could cause changes to the look of the facility and increase cost



Physical Security Do's and Dont's

- Do's
- Involve Physical Security Design from the beginning.
- Provide a clear and coordinated project scope
- Fully understand the project scope requirements
- Provide clear and coordinated construction documents.

- Dont's
- Use boiler plate scopes of work unless deemed appropriate by a risk assessment
- Wait until halfway through a project to involve physical security design.
- Leave questions or assumptions regarding the physical security design unanswered or unverified
- Provide ambiguous and uncoordinated construction document requirements.

Other Cost Saving Tips

- Standoff distance is your friend! Maximize it! Maximize standoff distance through means of more land or use of access-controlled parking. The cost of access-controlled parking generally is less than the building hardening if not used
- Provide building mass to the building envelope. The mass dampens blast effects and is relatively inexpensive compared to additional hardening.
- Physical security design does not equal BUNKER type construction. The building envelope only needs to be hardened to respond to the required level of protection and no more. Overdesign for blast loading is not only more expensive it can be counterproductive
- Physical security design does not equal Prison/High Security type construction. Use of Crime Prevention Through Environmental Design (CPTED) concepts can provide a more welcome less intrusive facility physical security design. CPTED options are generally less expensive and requires less maintenance and manpower

Questions/Contact Information

Stephen L Morgan PSP

Innovative Engineering Inc.
3380 Trickum Road
Bldg. 500, Ste 100
Woodstock, Georgia 30188
smorgan@ieiusa.com
(678)883-5863

Scott L Weiland PE SE

Innovative Engineering Inc.
11335 NE 122nd Way
Suite 105
Kirkland, Washington 98034
sweiland@ieiusa.com
(206)279-4360, ext. 202