Paper #294 - Integrating GIS and Facilities Management Software with DOD Anti-Terrorism Standards

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1.0 Abstract

Government and private facilities need to take precautions to protect their infrastructure, personnel, and physical assets. Tools and methodology have been developed for conducting vulnerability and survivability assessments to identify facility security vulnerabilities and provide recommendations and mitigations. Geographic Information Systems (GIS) are being used as a tool for assessments and as a front end into facility management software. The DoD Anti-Terrorism Standards have been incorporated into the GIS/Facilities Management package as another assessment tool and to provide best practices to identify and prioritize facility security projects. Analysis, such as blast and Chemical-Biological-Radiological, are viewed using simple tools.

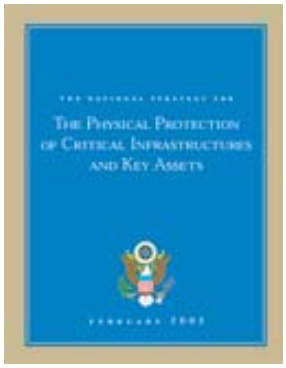
2.0 National, Federal, and DoD Guidance Documents and Publications

This paper will provide a brief history of the evolution of the national strategy and policy to protect critical infrastructure and key assets, tools and methodologies available to support threat, vulnerability and risk assessment analysis to mitigate terrorist attack, recent advances in integrating the tools into state-of-the-art Commercial-Off-The-Shelf (COTS) software applications, and describe future efforts being considered to support real time response.

2.1 Department of Homeland Security

The Department of Homeland Security has developed several key publications that provide the roadmap for the coordinated efforts of the federal government, state and local government, private business, and other organizations.

The National Security Strategy provides the top level framework. The strategy states, “It provides direction to the federal government departments and agencies that have a role in homeland security. It suggests steps that state and local governments, private companies and organizations, and individual Americans can take to improve our security and offers incentives for them to do so. It recommends certain actions to the Congress. In this way, the *Strategy* provides a framework for the contributions that we all can make to secure our homeland.”



There are two documents that expand on the National Strategy: The National Security Strategy For The Protection of Critical Infrastructure And Key Assets, and the National Strategy to Secure Cyberspace. The documents define the critical infrastructures and systems to be protected. The strategies recognize the need for a systems engineering approach to the analysis and description of infrastructure and cyber systems.

Critical Infrastructure Sectors

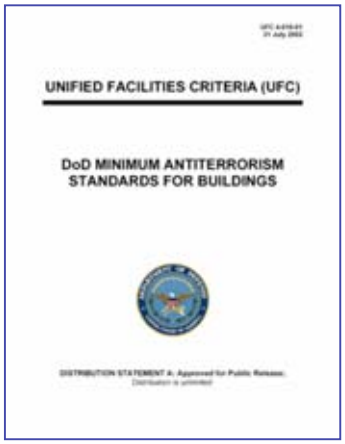
Agriculture
Food
Water
Public Health
Emergency Services
Government
Defense Industrial Base
Information and Telecommunications
Energy
Transportation
Banking and Finance
Chemical Industry and Hazardous Materials
Postal and Shipping

The National Security Strategy For The Protection of Critical Infrastructure And Key Assets states, "The facilities, systems, and functions that comprise our critical infrastructures are highly sophisticated and complex. They consist of human capital and physical and cyber systems that work together in processes that are highly interdependent. They each encompass a series of key nodes that are, in turn, essential to the operation of the critical infrastructures in which they function. To complicate matters further, our most critical infrastructures typically interconnect and, therefore, depend on the continued availability and operation of other dynamic systems and functions. For example, e-commerce depends on electricity as well as information and communications. Assuring electric service requires operational transportation and distribution systems to guarantee the delivery of fuel necessary to generate power. Such interdependencies have developed over time and are the product of innovative operational processes that have fueled unprecedented efficiency and productivity. Given the dynamic nature of these interdependent infrastructures and the extent to which our daily lives rely on them, a successful terrorist attack to disrupt or destroy them could have tremendous impact beyond the immediate target and continue to reverberate long after the immediate damage is done."

The national strategy is coordinated at the state and local level using the Statewide Template Initiative. This document states, "The primary objective of the Statewide Template Initiative (STI) is to assist state and local and tribal authorities in their

development of coordinated and comprehensive Homeland Security plans. The *Template's* questions, which were developed by leaders of state and local governments and emergency response community, provide a foundation for the preparation of comprehensive and compatible state, local and tribal Homeland Security plans that maximize state and local terrorism prevention and response."

2.2 DoD Unified Facility Criteria (UFC) Minimum Antiterrorism Standards



In early 2003 the Department of Defense (DoD) issued the Unified Facility Criteria (UFC) Minimum Antiterrorism Standards. The UFC is also intimately coupled with the Department of Homeland Security objectives and national security strategy. The UFC provides the philosophy, design strategies and assumptions that DoD has adopted in response to the lessons learned designing facilities to survive terrorist attacks. The UFC states "the overarching philosophy upon which this document is based is that comprehensive protection against the range of possible threats may be cost prohibitive, but that an appropriate level of protection can be provided for all DoD personnel at a reasonable cost. That level of protection is intended to lessen the risk of mass casualties resulting from terrorist attacks." Table 1 is a summary of the standards and recommendations.

UFC 4-010-01 APPENDIX B **DoD MINIMUM ANTITERRORISM STANDARDS FOR NEW AND EXISTING BUILDINGS**	
Standard 1	Minimum Standoff Distances.
Standard 2	Building Separation.
Standard 3	Unobstructed Space.
Standard 4	Drive-Up/Drop-Off Areas.
Standard 5	Access Roads.
Standard 6	Parking Beneath Buildings or on Rooftops.
Standard 7	Progressive Collapse Avoidance.
Standard 8	Structural Isolation.
Standard 9	Building Overhangs.

Standard 10	Exterior Masonry Walls.
Standard 11	Windows and Glazed Doors.
Standard 12	Building Entrance Layout.
Standard 13	Exterior Doors.
Standard 14	Mailrooms.
Standard 15	Roof Access.
Standard 16	Overhead Mounted Architectural Features.
Standard 17	Air Intakes.
Standard 18	Mailroom Ventilation.
Standard 19	Emergency Air Distribution Shutoff.
Standard 20	Utility Distribution and Installation.
Standard 21	Equipment Bracing.
Standard 22	Under Building Access.
Standard 23	Mass Notification.
Recommendation 1	Vehicle Access Points.
Recommendation 2	High-Speed Vehicle Approaches.
Recommendation 3	Vantage Points.
Recommendation 4	Drive-Up/Drop Off.
Recommendation 5	Building Location.
Recommendation 6	Railroad Location.
Recommendation 7	Access Control for Family Housing.
Recommendation 8	Standoff for Family Housing.
Recommendation 9	Minimize Secondary Debris.
Recommendation 10	Structural Redundancy.

Recommendation 11	Internal Circulation.
Recommendation 12	Visitor Control.
Recommendation 13	Asset Location.
Recommendation 14	Room Layout.
Recommendation 15	External Hallways.
Recommendation 16	Windows.

Table 1 - DoD Minimum Antiterrorism Standards for New and Existing Buildings

Each standard provides a text description and/or tables, charts or graphics to illustrate the standard. Standard 1 Stand-off distance is illustrated in Figure 1.

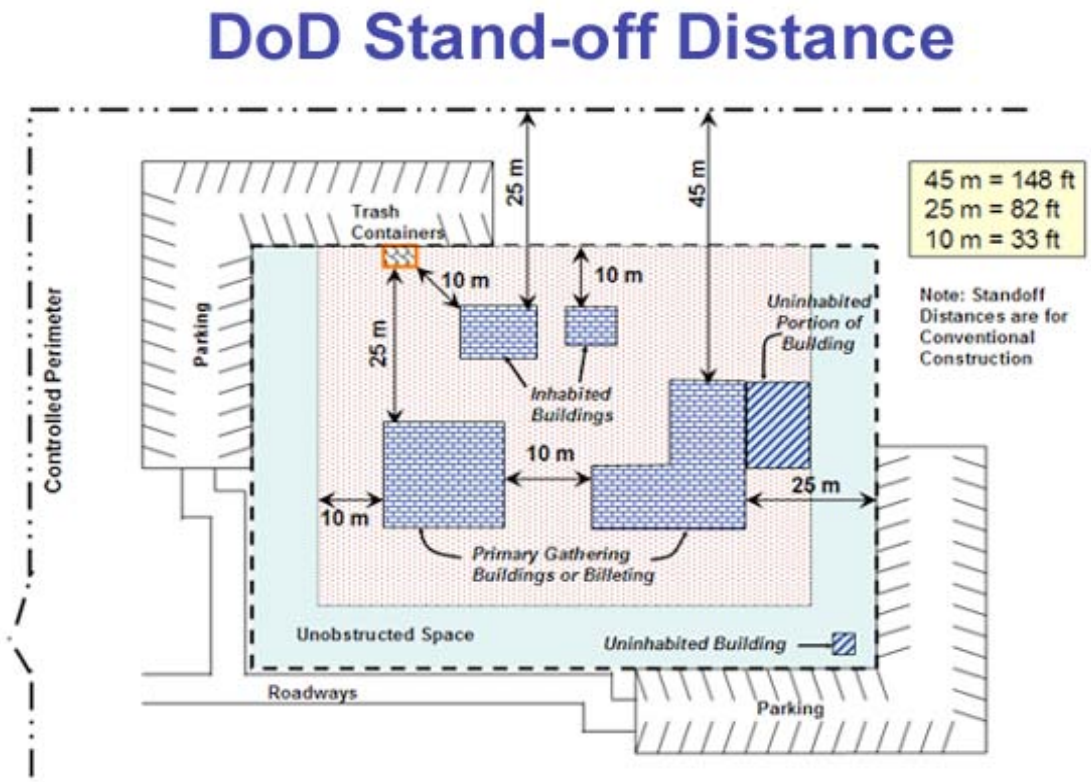
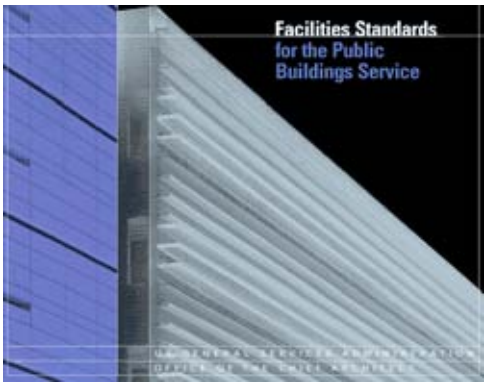


Figure 1 – DoD Stand-off Distance

The DoD works closely with other agencies to provide shared resources and design guidance including the General Services Administration (GSA), Federal Emergency Management Agency (FEMA), Environmental Protection Agency (EPA), and the Department of State (DOS).

2.3 GSA Public Building Standards



The GSA Public Building Standards (PBS) incorporate many of the DoD processes and are further developed with additional guidance and resources for commercial properties. Many of the modeling tools for blast, windows, and Chemical-Biological-Radiological (CBR) analysis were developed by DoD, Federal Emergency Management Agency (FEMA), and the Environmental Protection Agency (EPA) and are now being made available to the design community.

Several government agencies, organizations and commercial companies began developing basic guidelines and criteria to provide basic information on initiatives that could be taken to reduce the risk of a terrorist attack.

2.4 Centers For Disease Control - National Institute of Occupational Safety and Health

The Centers for Disease Control (CDC)-National Institute of Occupational Safety and Health (NIOSH) published "Protecting Building Environments from Airborne Chemical, Biological and Radiological Attacks" and "Filtration and Air-Cleaning System to Protect Building Environments".

2.5 Partnership For Critical Infrastructure

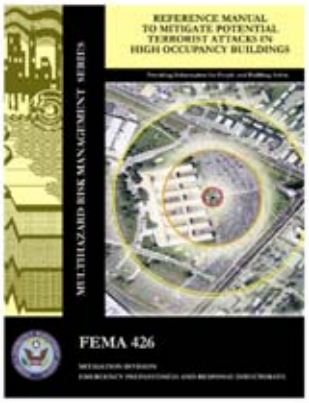
The Department of Commerce and private business created the Partnership For Critical Infrastructure. The partnership has a focus on IT infrastructure security.

2.6 The Infrastructure Security Partnership

Several associations and the government formed The Infrastructure Security Partnership. The partnership has a focus on civil infrastructure.

THE INFRASTRUCTURE
SECURITY PARTNERSHIP

2.7 Federal Emergency Management Agency



FEMA has two publications to provide guidance on terrorist attack mitigation, FEMA 386-7 Integrating Human-Caused Hazards Into Mitigation Planning and FEMA 426 "Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings". FEMA 386-7 is written for planners, responders, and building officials. FEMA 426 is a compilation of many government assessment, blast and CBR design publications material that has historically been restricted or applied to military facilities but has been revised to address the traditional facilities such as commercial office buildings, schools, retail and public facilities. The audience is meant to be the architects, engineers, building owners and contractors responsible for new construction, renovation and retrofit. FEMA 426 is a master publication with primers for commercial buildings, insurance, and architects due to be released.

2.8 RS Means "Building Security: Strategies and Costs

RS Means published the "Building Security: Strategies and Costs" which provides physical security cost elements broken into the traditional Construction Specifications Institute format. The book provides the assemblies and costs for physical security systems, vehicle barriers, fencing and security lighting systems. The book was coordinated with FEMA Publication 426 to provide consistent definition of terminology and analysis methodology.

3.0 Integrating Geographic Information Systems, Commercial Off The Shelf Facility Applications and Government Developed Blast and CBR Applications Into Threat Assessment and Methodology and Mitigation

GIS provides the robust database storage, analytical tools, and visualization capability to support the national strategies and have the flexibility to incorporate different approaches in methodology and information gathering techniques. There are a number of mature Commercial Off The Shelf (COTS) assessment, management, work order, and space planning applications on the market. The government has created the majority of traditional blast and CBR models and most are restricted to Official Use Only or higher use. HAZMAT models developed by the EPA are available and can be integrated into GIS applications. FEMA has begun to integrate the EPA ALOHA/CAMEO model into HAZUS Multihazard.

GIS, Facility Condition Assessment, Facility and Space Planning software, blast and CBR modeling applications can be integrated to provide the engineers, architect, planner, owner and other stakeholders a comprehensive analysis of a site, building and community infrastructure and support systems. The analysis supports the decision process for protecting the people and building during or after an attack, capital improvements planning, operations and maintenance, and the evaluation of risk for insurance or financial planning.

3.1 Threat, Vulnerability and Risk Assessment to Mitigate Terrorist Attack

Buildings are historically a primary target as illustrated in Figure 2. Explosives remain the terrorist weapon of choice.

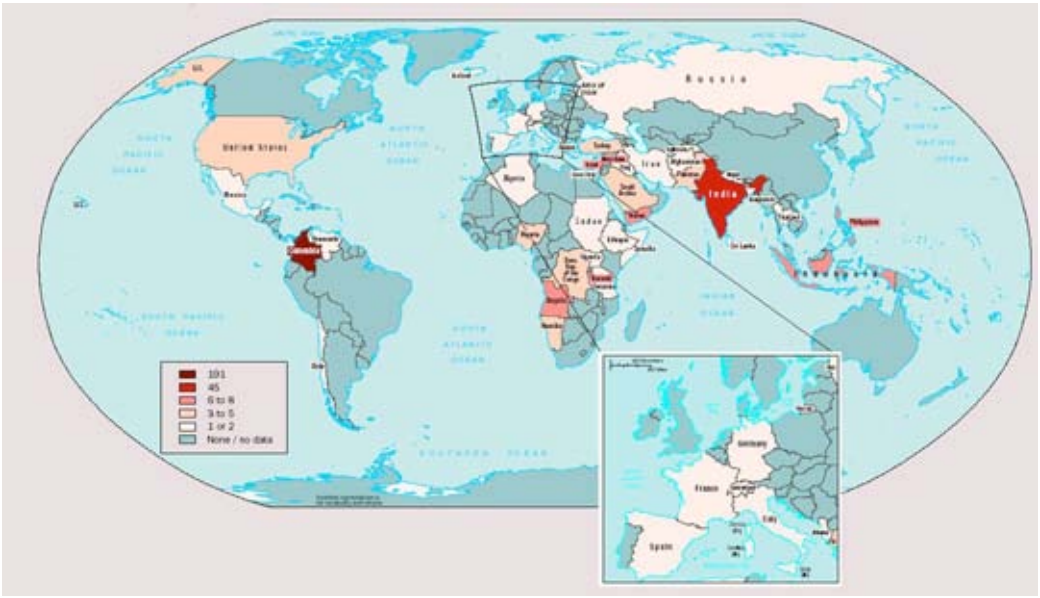


Figure 2 – Department of State Report on Global Terrorism

The DoD Minimum Antiterrorism Standards were developed to provide a level of protection for DoD facilities and personnel consistent with operating or living in a known threat environment, that is, military installations and people are high value targets that are actively watched and attacked. Within the US, the vast majority of businesses, organizations, and people are not primary targets, however, the effects of collateral damage caused by an attack on nearby critical infrastructure, federal or iconic commercial properties can have a significant impact on any facility.

Conducting a Threat, Vulnerability and Risk Assessment to mitigate potential terrorist attacks is different than the traditional risk assessment for natural hazards. The DoD UFC provides a starting point to integrate threat, vulnerability and risk assessment processes for man-made technological and terrorist attacks into traditional Facility Condition Assessment (FCA) software applications. The DoD standards provide a criteria

by which a building can be assessed and evaluated, similar to evaluating a building for compliance with the building codes or ADA requirements.

Terrorists targeting a building conduct an analysis of the target, looking for the tactics that can be used, the vulnerabilities that can be exploited, and the type of weapon to be employed. For the building owner, security and engineering staff the level of protection and ability of the building to survive, recover and operate in a post attack environment depend upon the mitigation measures selected.

The assessment process described in FEMA 426 and illustrated below uses a systematic and objective approach to evaluate the threat, vulnerability, risk and mitigation measures that can be employed to detect, deter, deflect or minimize impacts of an attack.

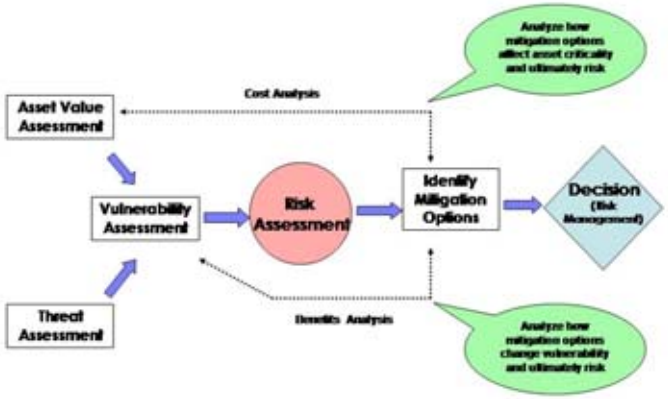


Figure 3 – FEMA 426 Assessment Methodology

The initial assessment begins with the collection of GIS data about the site, community, and related systems. A GIS system interface can be used to integrate assessment data, building data, CAD drawings, and display the analytical information and traditional standalone blast, CBR model results. The GIS interface drills down through successive imagery and map information as shown in Figures 4 and 5.

Figure 4 – GIS Interface and Site Imagery

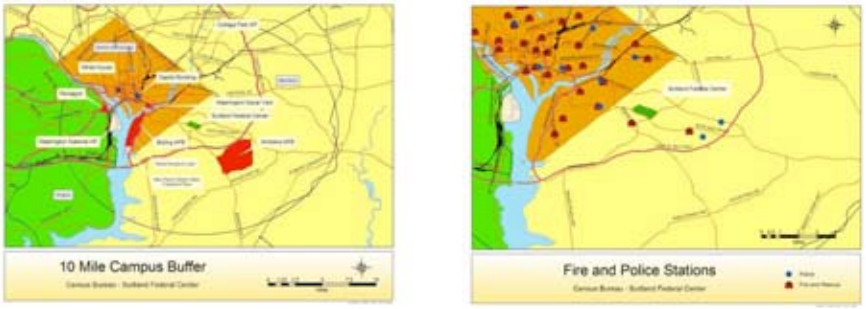


Figure 5 – Regional Map Layers

The GIS data is used in conjunction with the on-site assessment to evaluate the building. The assessment should result in a functional analysis of the building, and an infrastructure analysis of the building. The analysis should identify Single Point Vulnerabilities (SPV) where an organization could be disabled, disrupted, or destroyed with a well placed weapon. Using GIS and CAD, the building can be color coded by function and jpeg photos of each vulnerability tied to specific room as shown in Figure 6.

Figure 6 – Building Functional Analysis

An example of a Functional Analysis is illustrated below. The facility has several functional SPVs:

Standard 4	The loading dock and warehouse provide single point of entry to the interior
Standard 14 and Standard 18	The mailroom is located within the interior and not on exterior wall or separate HVAC system
Standard 1	The telecom switch and computer data center are adjacent to the warehouse
Standard 1	The trash dumpster and emergency generator are located adjacent to the loading dock

Table 2 – Functional Analysis by DoD Minimum Antiterrorism Standard

This building can be functionally disabled by an explosive device in the warehouse or a CBR device opened in the mailroom.

The Infrastructure Analysis should identify the building system, utility and architectural SPVS as shown in Figure 7.

Figure 7 – Infrastructure Analysis

The facility has several infrastructure SPVs:

Standard 17	Ground level air intakes
Standard 20	Single electrical main service point of entry
Standard 4 and Standard 9	Drive through atrium passenger drop off

Table 3 – Infrastructure Analysis by DoD Minimum Antiterrorism Standard

There are a number of COTS Facility Condition Assessment (FCA) and object oriented CAD Facility Management (FM) applications that can be easily modified to incorporate threat, vulnerability and risk assessment data that use the basic facility information inherent in most FCA, Work Order management and CAD facility management applications. Figures 8 and 9 are several data input screens from CAFM2000 and VFA *facility* illustrating the incorporation of the threat and vulnerability data and the DoD Minimum Antiterrorism Standards.

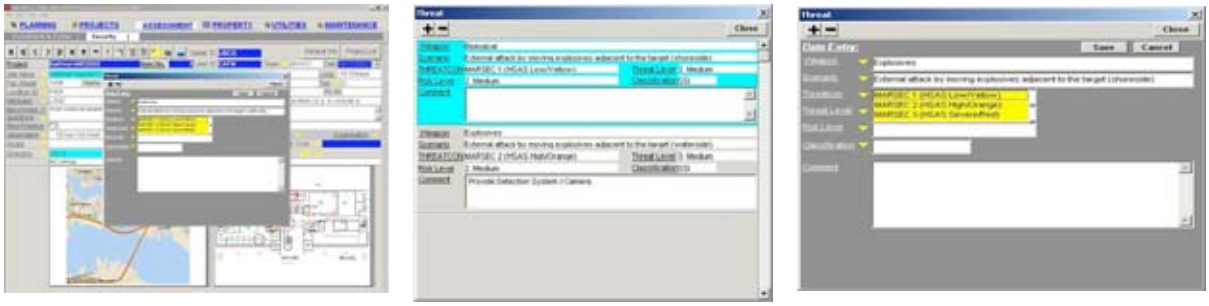


Figure 8 – Threat, Vulnerability and Risk Data Input Screens (CAFM2000)

Similar to entering an observation of a deficiency for a code compliance or standards finding (i.e., building does not meet ADA entry requirement: replace door, add ramp and rail), a vulnerability observation can be entered (i.e., building does not meet DoD Standard 14 – Mailroom: move interior mailroom to exterior wall and install separate HVAC zone)

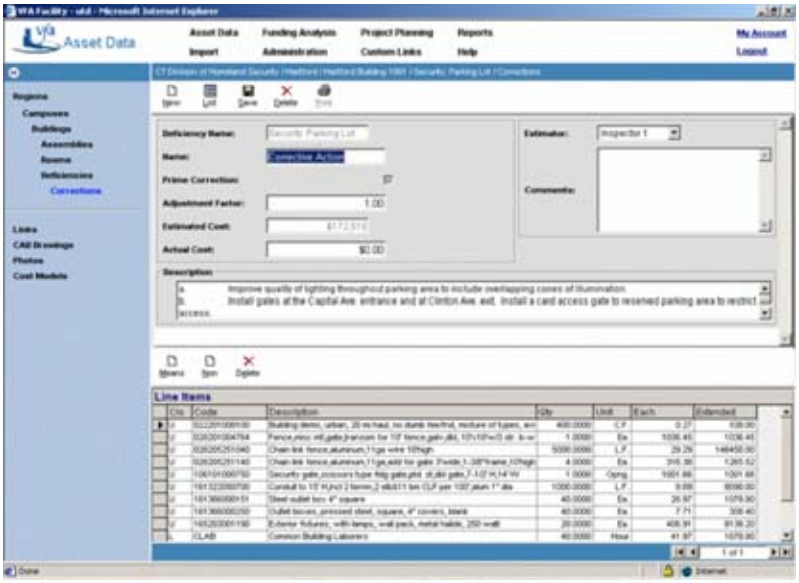


Figure 9 – Vulnerability Observation and Mitigation Recommendation (VFA)

Beginning in September 2003, DoD has instructed GSA that all properties used by DoD must meet the minimum standards. Other federal agencies, state and local governments are evaluating the standards and the impact on the local building inventory. The Department of Veterans Affairs has elected to use the DoD standards and have pioneered the methodology development and implementation of the standards for their healthcare facilities. They elected to use the DoD Standards since many of their facilities are commercial properties and leased or maintained by the GSA. As part of the methodology development, a checklist was developed that followed the Construction Specifications Institutes format and was cross referenced to the standards and other guidance.

6	Mechanical Systems (HVAC and CBR)	Guidance
6.1	Where are the air intakes and exhaust louvers for the building? (low, high, or midpoint of the building structure) Are the intakes and exhausts accessible to the public?	*Air intakes should be located on the roof or as high as possible. Otherwise secure with fencing or enclosure. The fencing or enclosure should have a sloped roof to prevent throwing anything into the enclosure near the intakes*
6.2	Is roof access limited to authorized personnel by means of locking mechanisms? Is access to mechanical areas similarly controlled?	*Roofs are like entrances to the building and are like mechanical rooms when HVAC is installed. Adjacent structures or landscaping should not allow access to the roof.*
6.3	Are there multiple air intake locations?	*Single air intakes may feed several air handling units. Indicate if the air intakes are localized or separated. Installing low-leakage dampers is one way to provide the system separation when necessary.*

Table 4 – Building Security Checklist (Department of Veterans Affairs)

The checklist was further developed and expanded in FEMA Publication 426 and can be used to quickly evaluate a building for the initial vulnerability analysis.

The checklist can be easily integrated into COTS applications. The use of object oriented COTS FM applications such as ArchiFM integrated with GIS enables the CAD drawings to become the basis for identifying and monitoring space, tenants, assets, people, and infrastructure systems.

Figure 10 – Integrated CAD, Space and Asset Management (ArchiFM)

Each room in traditional 2D CAD drawings become objects with parameters and class features as shown in Figure 11.

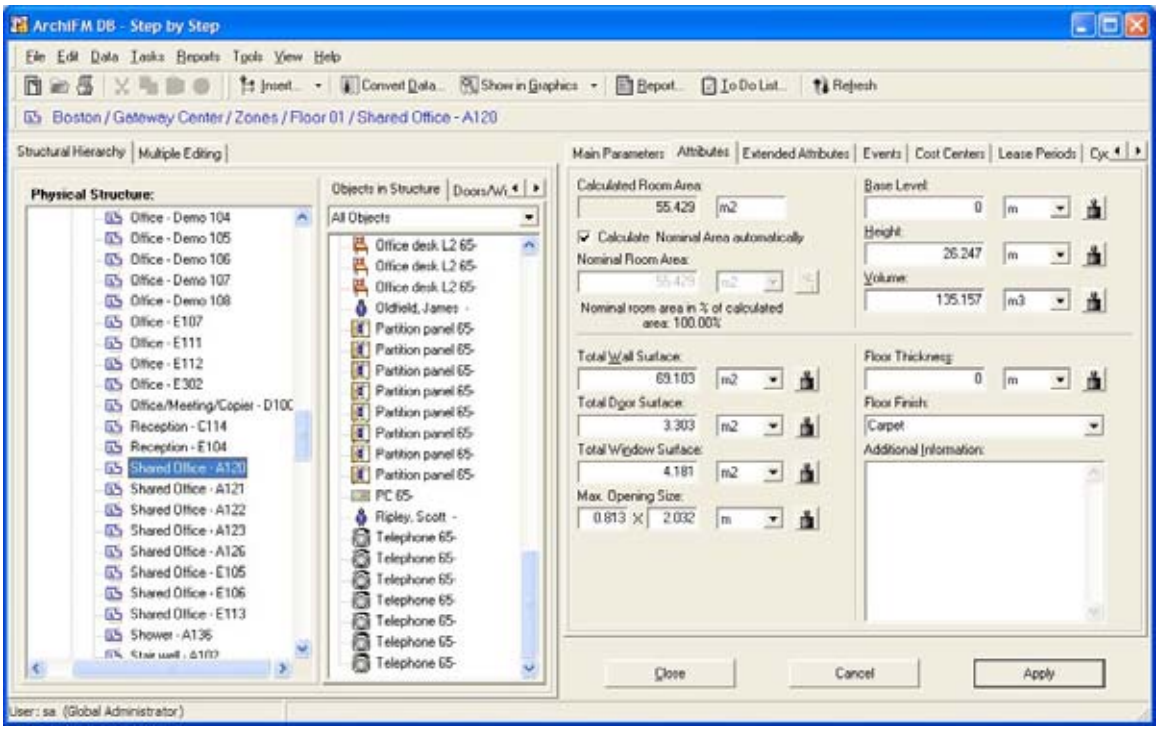


Figure 11 – Object and Room Definition (ArchiFM)

Any layer (site, architectural, mechanical, electrical, etc.) can be displayed in 3D and rotated to view from any perspective. Security systems and cameras can be located to provide line of sight analysis, identify camera blind spots, and determine light levels. The HVAC system is shown in Figure 12 and the Security System is shown in Figure 13.

Figure 12 – 3D View of HVAC Ductwork (ArchiFM)

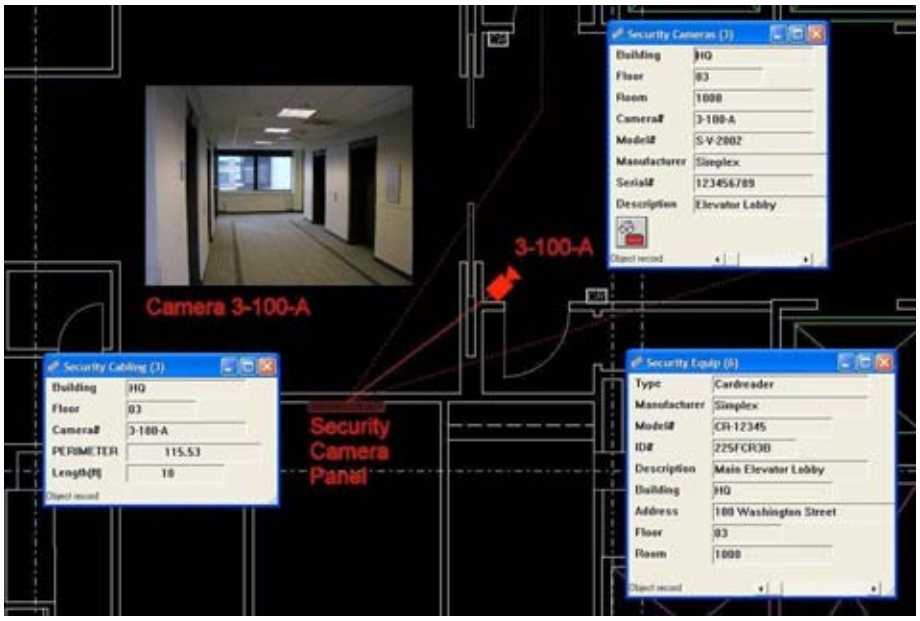


Figure 13 – Security Camera System (ArchiFM)

The GIS, FCA and FM applications can share the facility data, jpegs, CAD files, and other data elements using simple scripts. Costing the vulnerability mitigations while conducting a traditional FCA allows the owner to easily see what the incremental costs are required to mitigate vulnerabilities concurrent with work required to meet regulatory requirements. A typical report is illustrated in Figure 14.

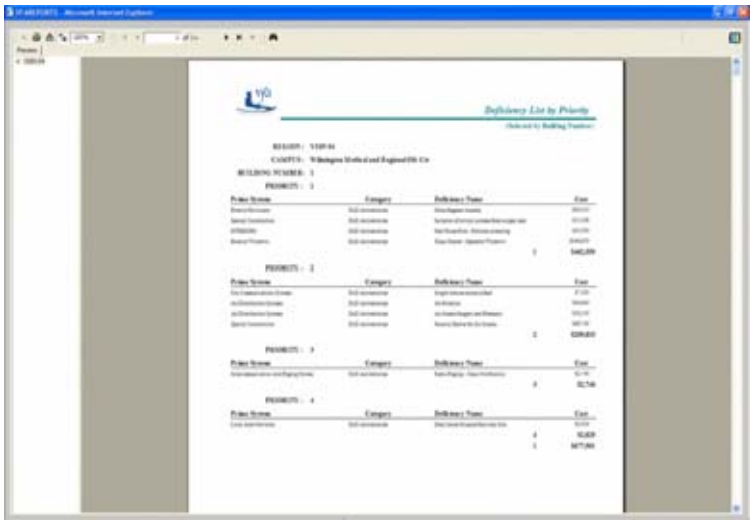


Figure 14 – Vulnerability Mitigation Report by Priority and DoD Antiterrorism Standard (VFA)

3.2 Integrating GIS with DoD Antiterrorism Standards, Traditional Blast and CBR Models, and New Applications

The GIS data and DoD Antiterrorism Standards can be integrated to provide a visual representation of blast and plume effects using relatively simple rules. The site perimeter, roads, rail, entry control points are identified. The blast stand-off distance required or the area affected by a plume can be overlain on the site to see what the potential effects to the building and surrounding community as shown in Figures 15 and 16.

Figure 15 – Blast Stand-off Distance (UTD)

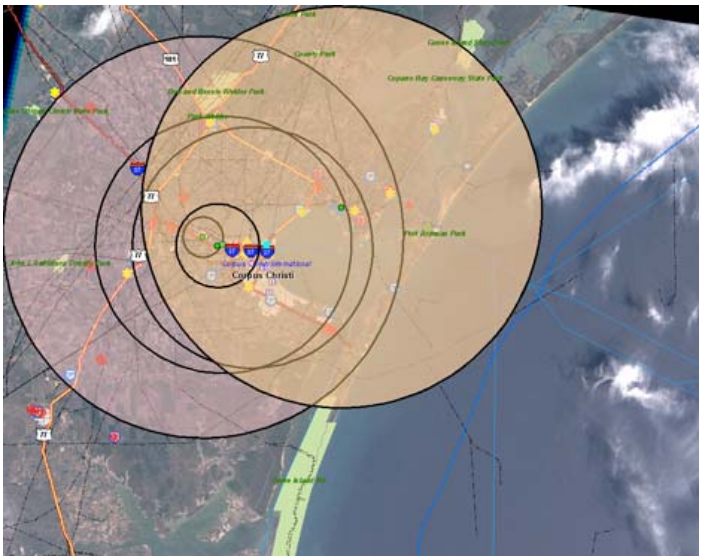


Figure 16 – HAZMAT Spill and Plume Boundary (UTD)

Most current generation advanced blast and CBR models are run as standalone applications. The models typically require the building to be input into each program with simple geometries and do not use CAD files for input. The buildings may be generic structures with only number of floors and type of construction, such as WinDAS or SmokeView shown in Figures 17 and 18, or require each beam and column to be created as in Blast FX shown in Figure 19.

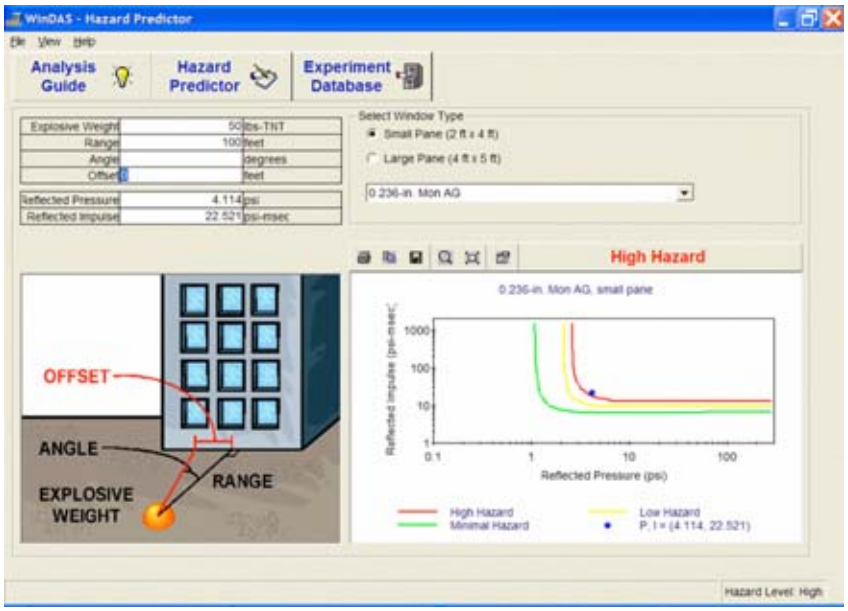


Figure 17 – WinDAS Blast Modeling (GSA)

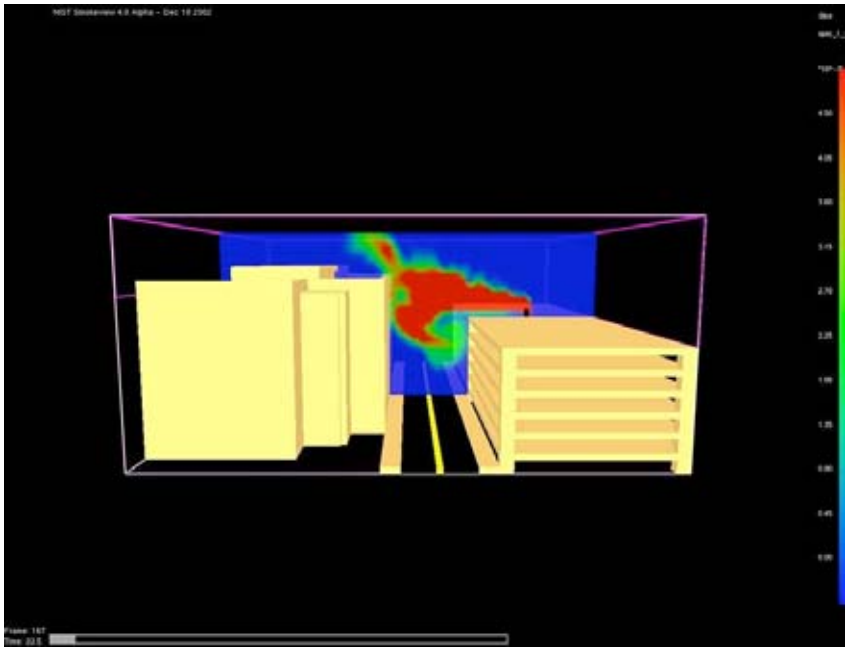


Figure 18 – SmokeView Modeling (NIST)

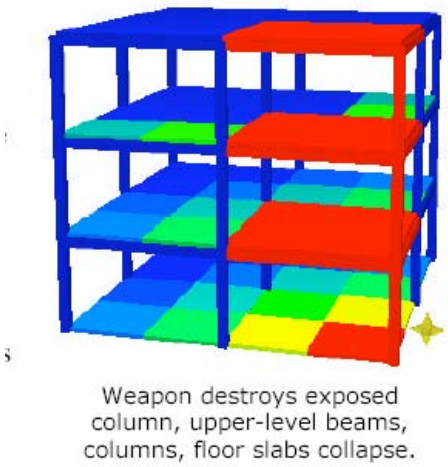


Figure 19 – BlastFX Modeling (NorthrupGrumman)

The GIS imagery can be used in more advanced tools to provide enhanced modeling and simulation capability. Digital Sandbox uses advanced blast tables of several classes of buildings with known material properties to provide a very rapid 3D modeling and visualization capability. The GIS map is imported as shown in Figure 20, corners of the building are mapped, number of floors and type of construction are entered, and the location and type of weapon selected.

Figure 20 – GIS Image Imported into Site Profiler (Digital Sandbox)

The algorithm creates the 3D blast analysis which can now be evaluated for different mitigation solution such as increasing stand-off distance, berms, blast hardening the structure and windows, or placing vehicle barriers. The bomb detonation point and building response is shown in Figure 21.

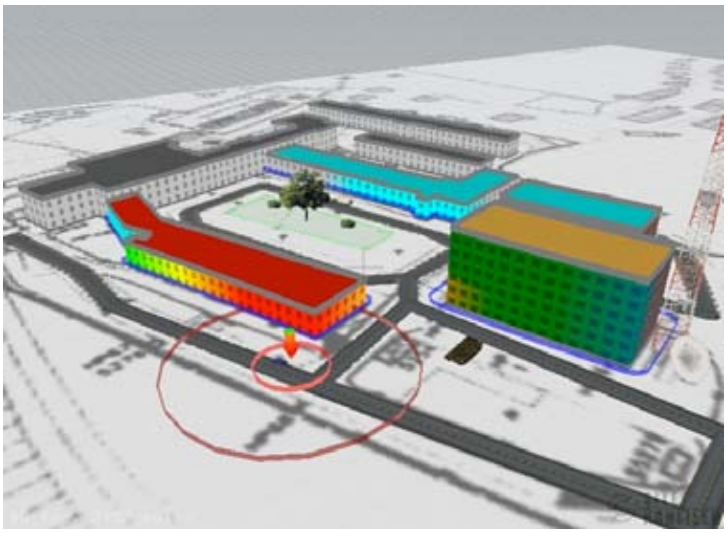


Figure 21 – Blast Analysis Using BEEM2 Modeling (Digital Sandbox)

The Hazards Prediction Assessment Capability (HPAC) application is the primary tool used by the government to model CBR events. The application is an ArcView 3.2 generation model which is able to model military grade weapons such as Sarin, Anthrax, and other CBR agents as illustrated below. The model is restricted to government users and is technically challenging to use. The output is dependent upon the winds, humidity, aerosolization of the agent, and is viewed as a dispersion plume with the probability of infection or casualties. An HPAC analysis is shown in Figure 22.

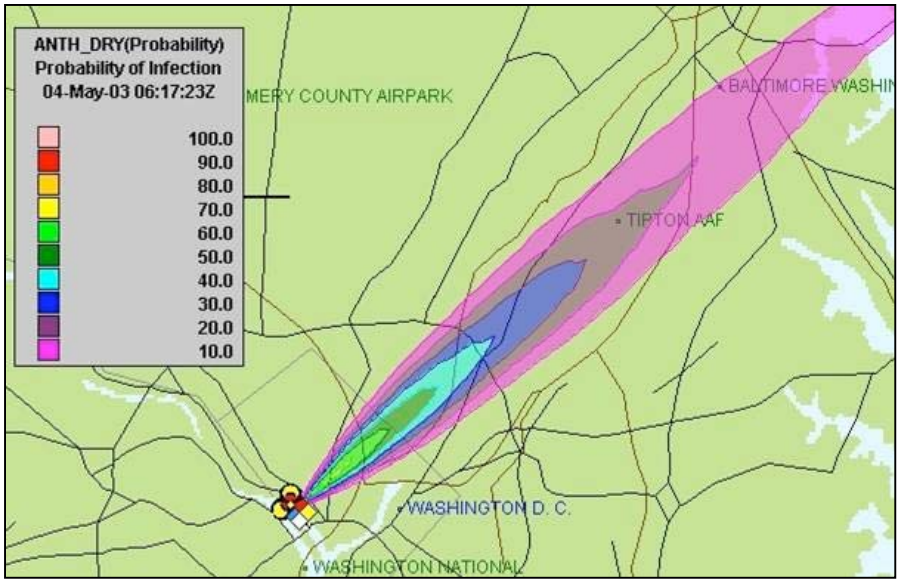


Figure 22 - Hazards Prediction and Assessment Capability Modeling (UTD)

There are several efforts underway to couple or integrate the blast and CBR models with 3D object oriented applications and GIS. The FEMA HAZUS-MH program due to be

released in summer 2003 has been developed to allow third party modules to interface and use the underlying infrastructure and census data sets. HAZUS-MH application will have a limited capability to display combined blast and CBR information as shown in Figures 23 and 24. The analysis will still require extensive technical skill and manipulation, but a basic capability for the general public user familiar with a HAZMAT program such as CAMEO should provide a preliminary CBR capability.

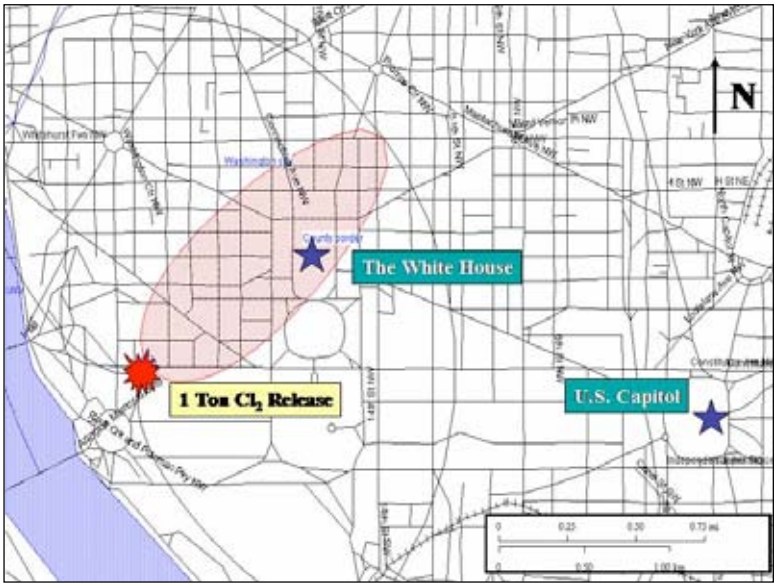


Figure 23 –HAZUS CAMEO HAZMAT Modeling (FEMA)

Figure 24 –HAZUS Dirty Bomb Modeling Analysis (FEMA)

Future generations should enable the user to drill down through the GIS, into the building, and run the various models (blast, CBR, cost, mitigation, emergency response, etc.) from a single interface and provide very accurate facility response, life cycle costs, and enhanced protection to the building occupants.

4.0 Conclusion

GIS, Facility Condition Assessment, Facility and Space Management COTS products are being modified to incorporate threat, vulnerability and risk assessment capability to respond to the requirement to mitigate terrorist threats. The advances in object oriented and 3D rendering and visualization techniques provide extremely accurate and fast running tools to evaluate the extremely complex system interactions of the infrastructure, equipment, and assets of a building that is exposed to a blast or CBR event.

Future generation tools will integrate CAD drawings into the blast and CBR modeling and simulation applications and provide very detailed analysis of complex shapes (beams, columns, slabs, roofs, curtain walls, polygons, etc.) and systems (HVAC duct work, piping, IT and electrical nodes, building automation systems, etc.). GIS is the enabling integration and visualization tool that can tie the applications into a seamless operating environment.

5.0 References

Department of Homeland Security

The National Strategy For Homeland Security
http://www.dhs.gov/dhspublic/display?theme=85

National Strategy for Physical Protection of Critical Infrastructure and Key Assets
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National Strategy to Secure Cyberspace
http://www.dhs.gov/dhspublic/display?theme=85

Statewide Template Initiative - Homeland Security Advisory Council
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Department of Defense

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