New York City Police Department

Engineering Security

Protective Design for High Risk Buildings

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EXECUTIVE SUMMARY

The New York City Police Department (NYPD) developed *Engineering Security: Protective Design for High Risk Buildings* to aid the New York City building community by providing information on how to prevent and mitigate the effects of a terrorist attack on a building. Since September 11, 2001, government agencies and the private sector have struggled to find an appropriate and sensible balance between security, on the one hand, and economic vitality, creativity, and openness, on the other. This struggle has played out in many different arenas, from domestic intelligence to airport security to cyber security. This document focuses on buildings: how to identify the very limited number of structures that present especially great terrorist risks and how to build or retrofit them in ways that mitigate those risks.

A number of executive branch agencies, including the Department of Homeland Security and the Department of Justice, have produced reports presenting risk-tiering systems or offering recommendations for improving building security. To date, no such report has been tailored to meet the specific needs presented by New York City's unique risk environment. The NYPD authored *Engineering Security* to fill that void.

Engineering Security contains two main parts: the NYPD's risk-tiering system, which organizes buildings into Low, Medium, and High Tiers based on assessed threat, vulnerability, and impact levels; and a set of recommendations tailored to buildings in the City that fall into the High Tier and, to a lesser extent, the Medium Tier.

In the NYPD's risk-tiering system, threat scores are determined by threat profile and target attractiveness; vulnerability scores are determined by adjacency, accessibility, and structural performance; and impact scores are determined by maximum occupancy or height, economic criticality, transportation criticality and proximity, and critical infrastructure proximity.

The vast majority of buildings in the City achieve overall risk scores that place them in the Low Tier. Only a relative few buildings fall into the Medium or High Tier. Generally, High Tier buildings present exceptional threat, vulnerability, and impact characteristics because they exhibit *many* of the following features: they are the targets of one or more credible specific threats; their architectural design is nationally recognizable; they are located adjacent to other High Tier buildings; the movement of people within them is not controlled nor are vehicles obstructed or screened before approaching or entering; their primary structural elements and individual columns do not satisfy load-bearing standards designed to enable buildings and structural elements to withstand specific blast pressures at certain distances; they have maximum occupancy levels of more than 10,000 people or they are taller than 800 feet; a successful attack on them would severely impact the local or regional economy, or affect the national economy for an appreciable period of time; they sit atop five or more sets of rail lines or a vehicular tunnel, or they are located adjacent to the footprint of a significant transportation hub servicing five or more sets of rail lines or the entrance to a bridge; and they are located so close to critical infrastructure that a successful attack would severely disrupt service.

The recommendations presented in *Engineering Security* are organized thematically. Most of the recommendations address traditional threats from explosive devices, including guidelines on enhancing perimeter security; achieving robust building design; designing effective access control, screening, and monitoring systems; and developing fire-resistance, emergency egress, and communication system solutions. The recommendations also address emerging threats from chemical, biological, and radiological weapons, including guidelines on deploying and using heating, ventilation, and air conditioning (HVAC) systems and associated detection devices.

As a first step toward enhancing perimeter security, the NYPD recommends that owners of High Tier buildings conduct vehicle threat vector analyses and incorporate hard perimeters into their design plans.

With respect to achieving robust building design, the NYPD recommends that owners of High Tier buildings incorporate designs in which crowd surges in excess of 500 people are directed away from potential projectile sources, particularly glass atriums, windows, and curtain walls; disperse critical facilities in order to reduce the potential for disruption of multiple critical systems during an attack; orient glass facades away from nearby High Tier buildings; take into account failure modes when selecting facade materials; ensure that walls surrounding critical and sensitive areas are made of strong material, such as concrete, as opposed to weaker material, such as sheetrock; develop robust primary structural elements capable of withstanding large blast pressures; and incorporate both threat-independent and threat-dependent design methods.

High Tier buildings also require systems to control, screen, and monitor people inside the building. The NYPD recommends that owners of High Tier buildings implement access control systems that incorporate identity authentication and turnstiles to enforce entry authorization; limit access to critical facilities, including building security, building engineering, and fire systems rooms; ensure that security personnel conduct background checks on all individuals with access to sensitive security information or critical facilities, both during and after construction, with recurring screenings of individuals involved with critical building functions; establish requirements for storage, disclosure, reproduction, transmission, shipment, disposition, and labeling of documents containing sensitive security information; set screening thresholds at levels no higher than the design basis threat level for a contact charge on a structural column; create protocols for screening of delivered packages with stationary x-ray equipment and explosives detection canines or equipment, and for screening of vehicles at direct entry points as well as at the entrances to underground parking areas and loading docks; provide for off-site screening of vehicles; install comprehensive closed-circuit television (CCTV) systems that incorporate comprehensive coverage of critical facilities and sensitive areas within and around buildings; and interface CCTV systems with current alarm points and access control systems to allow for remote assessment of alarm conditions.

Fire resistance, emergency egress, and communication systems are also important aspects of building security. The NYPD recommends that owners of High Tier buildings ensure that structures meet fire-resistance rating standards that provide for the time required either for burnout without partial collapse or for full evacuation of building occupants; provide for a stairwell width of at least 66 inches, or a stairwell width informed by a time motion egress study that provides an equivalent building exit time; incorporate two or more remotely located stairwells on each floor; and connect critical emergency responder radio system components in commercial buildings to emergency power systems.

There is increasing evidence of terrorist interest in using unconventional weapons, including chemical, biological, and radiological (CBR) agents. Building owners can use HVAC systems to mitigate the potential effects of unconventional attacks and detection technologies to provide early warning of such attacks. Accordingly, the NYPD recommends that owners of High Tier buildings locate HVAC system controls away from public areas, such as lobbies, loading docks, or mailrooms; invest in advanced filtration systems that can afford a measure of protection against CBR threats and consider equipping them with ultraviolet radiation technology; prepare operational response protocols to manage CBR release events through a process of detection, assessment, and fan and damper operations; monitor chemical, biological, and radiological detection technologies and carefully study the benefits of implementing such systems; and inform local law enforcement and first responders of the building's CBR countermeasures and associated emergency protocols.

Engineering Security's recommendations for High Tier and, to a lesser extent, Medium Tier buildings significantly exceed the requirements set out in municipal codes, including the New York City Building Code and Fire Code, and may conflict with prevailing zoning resolutions and guidelines. The long-standing governmental systems for regulating how buildings are built and renovated have not yet fully incorporated a method for differentiating the terrorist risks presented by specific structures or for mitigating the extreme risks at those structures. Additionally, the advent of computer-assisted design has allowed architects and engineers to develop highly optimized buildings that, while beautiful and efficient, are more vulnerable to catastrophic failure than older, less optimized structures. The NYPD offers these recommendations, which are not legally compulsory, as a step toward the more systematic inclusion of security considerations in the building design process.

The NYPD Counterterrorism Bureau's Threat Reduction Infrastructure Protection Section consults on many of the major development projects in the City. Although each building presents a unique set of security concerns, the NYPD has found many of its recommendations to be generally applicable to buildings that present elevated risk levels. *Engineering Security* represents the NYPD's attempt to organize and circulate these recommendations.

Engineering Security is a living document: as new threats and associated protective security design measures evolve, the NYPD will refine and supplement its recommendations.

PREFACE

Dear Friends:

New York's ever-evolving skyline speaks volumes about our City's economic vitality and growth – and our vision. With its soaring towers and expansive glass walls, it is a deep source of pride for our entire nation, while symbolizing perfectly how New Yorkers are constantly looking to the future.

In keeping with our City's tradition of forward-thinking change, our Administration has put long-term planning at the center of all our efforts for economic development, environmental protection, and – most importantly – safety and security. An important component of these efforts is *Engineering Security*, the New York City Police Department's program to help those in the business of building make their mark on our City's skyline in a way that is both creative and safe.

We understand that the threat of terrorism will remain a serious concern for the foreseeable future – and we continue to do everything possible to prevent another attack and mitigate the harmful effects one might cause. At the same time, we know that enhanced security does not need to come at the expense of aesthetic appeal, functionality, and environmental sustainability. While developers must incorporate design features that will protect the structures they create, *Engineering Security* provides sensible guidelines for balancing the important need for security and the realities of urban development.

Engineering Security is the result of a collaboration led by the NYPD that includes suggestions from the FDNY, the Department of Buildings, and the Department of City Planning, as well as insights from professional associations representing New York City's engineers, architects, and developers.

New Yorkers take great pride in having rebounded stronger than ever from the attacks of September 11, 2001. *Engineering Security* represents the next step forward, serving as a guide for our partners in the development community as they make the long-term investments that are so critical to our City's future.

Michael R. Bloomberg
Mayor

FOREWORD

In the post September 11th world, securing New York City from the global threat of terrorism has become an urgent priority. Accordingly, New Yorkers should think strategically and practically about the physical security of their buildings, and devise effective solutions that are attractive to security-conscious occupants.

To this end, the New York City Police Department has worked with real estate developers, architects, and engineers to better secure New York City's great buildings. This partnership complements the extensive work already undertaken by the NYPD to heighten counterterrorism patrol strength, enhance site-security evaluation, and expand worldwide intelligence collection and analysis.

Engineering Security is a product of these ongoing collaborative efforts. The recommendations presented in this document are informed by the broad experience of the NYPD's infrastructure protection team as well as the expertise of some of the leading minds in engineering and building design. The NYPD encourages anyone planning to build in New York City to carefully review and consider these recommendations and to direct questions concerning their integration with structural planning and design to the Police Department's Counterterrorism Bureau.

The constant pace of building in New York City is a testament to the public's great confidence in the City's future and its overall security. Still, we must remain vigilant and take precautions to protect that which we have worked hard to achieve. The same qualities that make the City's buildings recognized icons of design, culture, and commerce also make them continuous targets of terrorism. Although we cannot provide the same level of protection for every building in the City, working together we can implement effective, common sense security standards that will protect the lives and livelihoods of millions of New Yorkers and visitors. Thank you for your contributions to this crucial endeavor.

Raymond W. Kelly

Police Commissioner


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This document was prepared by the NYPD Counterterrorism Bureau. The document draws from the Counterterrorism Bureau's extensive experience conducting security reviews of high-profile buildings in and around New York City. The drafting of the document was a collaborative effort that required hundreds of hours of work by over a dozen members of the Bureau, with support from members of other NYPD units. These authors, editors, researchers, subject matter experts, and graphic designers included Assistant Chief John Colgan (ret.), Lt. Patrick Devlin (ret.), Sgt. Charles Famulari (ret.), Det. Robert Figgers, Susan Francisco, Anthony Fratta, Police Officer John Giretti, Vanessa Haas, Valerie Hodgson, Det. David Kao, Lt. David Kelly, Police Officer Ari Maas, Alexander Mahoney, Deputy Chief Joseph McKeever, Det. Arturo Mendez, Ryan Merola, Sgt. Arthur Mogil, Sgt. William Moore, Matthew Moran, Insp. Michael O'Neil (ret.), Sgt. Patrick O'Neill, Sgt. Mark Teitler, and Dr. Dani-Margot Zavasky. In addition, two members of the Bureau – Elana DeLozier and Jessica Tisch – made extraordinary contributions to this document; the completion of this work is due largely to their perseverance and dogged commitment to excellence. The project was directed by Dr. Richard A. Falkenrath, Deputy Commissioner of Counterterrorism.

A draft of this document was peer-reviewed by individuals chosen for their technical expertise in the fields of engineering and architecture and for their familiarity with the unique protective security design concerns of New York City. The NYPD Counterterrorism Bureau wants to thank the following individuals, as well as several others who wish to remain anonymous, for their candid expert comments during the peer review process:

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Many of the recommendations presented in *Engineering Security* draw on the recommendations and best practices presented in the National Institute of Standards and Technology's *Federal Building and Fire Safety Investigation of the World Trade Center Disaster*; the Federal Emergency Management Agency's *Risk Management Series*; and NOVA's *Building on Ground Zero: Lessons from the WTC Collapse*.

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About the Counterterrorism Bureau

Created in 2002 by Police Commissioner Raymond W. Kelly, the Counterterrorism Bureau has been at the forefront of local law enforcement efforts to detect and deter terrorism. The mission of the Counterterrorism Bureau, led by Deputy Commissioner Richard A. Falkenrath and Assistant Chief James R. Waters, is to develop innovative, forward-looking policies and procedures to guard against the threat of international and domestic terrorism in New York City. The Bureau accomplishes this through its Borough Counterterrorism Coordinators, who are responsible for conducting high visibility counterterrorism deployments to disrupt terrorist planning and surveillance based on real-time intelligence; the Joint Terrorism Task Force (JTTF), which partners NYPD detectives with FBI agents on terrorism investigations in the New York metro area and around the world; the Lower Manhattan Security Initiative (LMSI), which combines an increased police presence with technology to detect threats and deter pre-operational hostile surveillance; the Planning and Policy team, which is responsible for the review, analysis, and development of initiatives, policies, and legislative agendas related to counterterrorism; the Terrorism Threat Analysis Group (TTAG), which performs and disseminates strategic intelligence analysis, both open-source and classified, to the Bureau, the private sector, the U.S. intelligence community, and other law enforcement agencies; and the Counterterrorism Division (CTD), which includes six specialized units:

- the Project Management Office, which designs, implements, and ensures the evolution of large-scale counterterrorism projects from initial concept to deployable operations;

- the Threat Reduction Infrastructure Protection Section (TRIPS), which develops protective security strategies for high-risk buildings and critical infrastructure throughout the City;

- the Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) Section, which develops and implements plans, policies, and operations to detect and combat CBRNE threats;

- the Training Section, which develops and delivers counterterrorism training to the NYPD patrol force, other law enforcement agencies, and private sector entities;

- the SHIELD Unit, which manages the NYPD public-private security partnership; and

- the Emergency Preparedness and Exercise Section, which interfaces with the New York City Office of Emergency Management.


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LIST OF FIGURES AND BOXES

LIST OF ACRONYMS

CBR: Chemical, biological, and radiological

CBRNE: Chemical, biological, radiological, nuclear, and explosive

CCTV: Closed-circuit television

CIF: Common Intermediate Format

DCP: New York City Department of City Planning

DOT: New York City Department of Transportation

DBT: Design basis threat

FDNY: New York City Fire Department

FEMA: Federal Emergency Management Agency

GSA: General Services Administration

HEPA: High-efficiency particulate air

HVAC: Heating, ventilation, and air conditioning

IBC: International Building Code

IED: Improvised explosive device

IFC: International Fire Code

LIRR: Long Island Railroad

LMSI: Lower Manhattan Security Initiative

LPR: License plate reader

MERV: Minimum efficiency reporting value

MPIED: Man-portable improvised explosive device

MTA: Metropolitan Transportation Authority

NIST: National Institute of Standards and Technology

NYPD: New York City Police Department

PATH: Port Authority Trans-Hudson

UV: Ultraviolet

VBIED: Vehicle-borne improvised explosive device

WTC: World Trade Center

WTC1: World Trade Center Building One

WTC2: World Trade Center Building Two

WTC7: World Trade Center Building Seven

INTRODUCTION

Over the past century, New York City's skyline has become an enduring image of America's vitality and strength. Although each building faces a low probability of being attacked, in the post-September 11, 2001 era, building owners should consider security during their planning and design processes. Yet security must be balanced against aesthetic appeal, functionality, cost, and sustainability, among other concerns. Because each building is distinct, the New York City Police Department (NYPD) cannot offer a single blueprint for protective security design. Therefore, *Engineering Security* presents a general approach to assessing risk and designing security into new building construction and major renovations.

Buildings in dense urban environments are vulnerable to several different forms of terrorist attack. To date, threats from explosive devices have been most common; in the future, threats from chemical, biological, and radiological weapons may grow with the proliferation of those technologies. Given these threats, protective security design provides a comprehensive approach to improving security in buildings that present elevated risk levels. Protective security design aims to identify a series of key actions and design criteria to reduce physical damage to structural and non-structural components of buildings and related infrastructure.[1] Information about a building's protective security design features can, however, prove dangerous in the hands of potential terrorists, so safeguarding sensitive security documents is essential.

Every building faces a unique set of security concerns, based on variations in the threat, vulnerability, and potential impact associated with a terrorist attack. *Engineering Security* sets out a risk-tiering system designed to categorize buildings based on these variables. A set of protective security design recommendations correlates to each risk tier, providing guidance to building owners and design professionals; these recommendations include attack prevention and mitigation measures.

Because of the great uncertainties in any assessment of terrorism risk, *Engineering Security* applies a "minimax" strategy to protective security design. Developed to identify solutions in the face of uncertainty, the minimax theorem minimizes the maximum expected loss associated with a given risk.[2] Accordingly, the protective security design measures set out in this document seek to minimize the maximum potential casualties, damage, and economic loss caused by a terrorist attack.

The advent of computer modeling has made the need for protective security design more acute than ever before. In the pre-computer era, architects and engineers were forced to overbuild structures to ensure stability. New technologies have allowed the building community to optimize structures – to create soaring towers and expansive curtain walls just strong enough to support predictable loads. The advances of computing power have thus created an almost paradoxical tradeoff: the more efficiently built the structure, the more vulnerable it is to catastrophic failure when subjected to abnormal loading.

Evolution of Protective Security Guidelines

The recommendations presented in subsequent chapters can best be understood in light of an evolving series of federal and local government guidelines concerning protective security design. For nearly three decades, building security has been the subject of debate in various federal agencies, including the Department of State, the Department of Defense, the Department of Justice, and, most recently, the Department of Homeland Security.

Initially, federal guidelines focused on protecting U.S. interests abroad, primarily embassies and government buildings. The scope of these guidelines expanded to include the security of buildings on U.S. soil after the bombing of the Alfred P. Murrah Federal Building in Oklahoma City in 1995 and the attacks of September 11, 2001.

The first federal protective security guidelines were set out in the *Inman Report* of 1985, issued by the Secretary of State's Advisory Panel on Overseas Security.[3] Written in response to the 1983 vehicle-borne explosives attacks against a U.S. Marine Corps Barracks and the U.S. Embassy in Beirut, the report details the need for increased security at diplomatic facilities overseas, ultimately tying the level of security that buildings require to the level of threat that buildings and their occupants face. Although the *Inman Report* applies a risk-tiering method only to diplomatic facilities, the Department of State has since employed such a method in its *Security Guidelines for American Enterprises Abroad*, concerning the vulnerability of American private-sector interests overseas.[4]

Another risk-tiering method has been used in the context of protecting domestic buildings. Two months after the 1995 attack on the Alfred P. Murrah Federal Building in Oklahoma City, the Department of Justice issued *Vulnerability Assessment of Federal Facilities*, listing over 50 minimum protective security standards proposed for existing federal facilities and defining five risk tiers, each with corresponding security standards.[5] In 2001, the Interagency Security Council first published its own set of guidelines in *Security Design Criteria*, a periodically updated series.[6] While the starting point for *Security Design Criteria* was the Department of Justice's *Vulnerability Assessment of Federal Facilities* guidelines, the Interagency Security Council's guidelines ultimately employ different criteria for rating risk and assigning protection levels.[7]

Federal Emergency Management Agency Guidelines

Following the attacks of September 11, 2001, the Federal Emergency Management Agency (FEMA) published a series of documents addressing the various risks, including the terrorism risk, to buildings and related infrastructure nationwide. FEMA's *Risk Management Series* provides design guidance to enhance security and mitigate the potential impact of terrorist attacks. These best practices inform and complement the recommendations presented in subsequent chapters.

The core security documents in the *Risk Management Series* include: FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*; FEMA 430, *Site and Urban Design for Security: Guidance Against Potential*

Terrorist Attacks; and FEMA 452, *Risk Assessment: A How-To Guide to Mitigate Potential Terrorist Attacks Against Buildings*. FEMA 426 details security measures designed to reduce the physical damage caused by terrorist attacks.[8] FEMA 430 emphasizes architectural and engineering design considerations.[9] Finally, FEMA 452 sets out a process for determining threats to critical assets within buildings and assessing vulnerabilities to those threats.[10] The *Risk Management Series* includes specific case studies on integrating security with site design and should be referenced when selecting solutions to security needs at building sites. The recommendations set out in the FEMA studies are not legally compulsory.

National Institute of Standards and Technology Recommendations

In response to the destruction of the World Trade Center in 2001, the National Institute of Standards and Technology (NIST), a federal agency within the Department of Commerce, conducted a three-year building and fire safety investigation to study the factors contributing to the post-impact collapse of the World Trade Center Towers (WTC1 and WTC2) and Building 7 (WTC7). The final report on WTC1 and WTC2, published in September 2005, describes the aircraft impacts, subsequent fires, and eventual collapse of the towers, including an evaluation of the evacuation and emergency response procedures as well as the practices employed in the design, operation, and maintenance of the buildings.[11] The final report on WTC7, published in August 2008, finds that uncontrolled fires were the primary cause of the building's collapse: as heat from the fires caused steel floor beams and girders to expand, a catastrophic chain of events ensued, leading to the failure of a key structural column, which initiated the progressive collapse of the entire building.[12]

Both NIST reports conclude with a series of recommendations for improving building and fire safety. The report on WTC1 and WTC2 presents a total of 30 recommendations, ranging from enhancements to structural integrity and new methods for fire-resistant design, to improved evacuation and emergency response protocols.[13] The report on WTC7 offers an additional recommendation, suggesting that buildings be evaluated to ensure adequate fire performance of structural systems.[14] Additionally, both reports address existing codes, standards, and industry practices that warrant revision, while offering practical guidance to engage the building and fire-safety communities in implementing the proposed changes.[15] Like the FEMA recommendations, the NIST recommendations are not legally compulsory.

The NIST recommendations serve as the foundation for 23 new provisions that were adopted by the International Code Council for incorporation in the 2009 editions of the International Building Code (IBC) and International Fire Code (IFC), including: enhanced structural resistance to building collapse; an additional exit stairway in tall buildings; a 50 percent increase in stairway width for new high-rise buildings; strengthened bonding, installation, and inspection criteria for fireproofing; more reliable automatic sprinkler systems; new fire service access elevators for emergency responders; more visible and prevalent exit path markings; and more effective coverage for emergency responder radio communications.[16] While jurisdictions may modify these provisions prior to adoption, the standards advocated by the International Code Council are widely considered minimum safety standards that most jurisdictions strive to meet.[17]

Many of the recommendations presented in *Engineering Security* are predicated on the NIST recommendations: several have incorporated the NIST recommendations in whole or in part. Subsequent chapters expand on the integration of the NIST findings into *Engineering Security*.

Municipal Codes and Standards

While the federal government has promulgated comprehensive protective security design criteria to meet emerging terrorist threats to federal buildings, municipal governments have yet to codify these standards in the same way.[18]

Local building and fire codes are typically shaped by the demands of the marketplace, as real estate developers and design professionals seek to balance security concerns with economic considerations. Traditionally, such codes have required structural designs that can withstand normal loads as well as those associated with environmental conditions such as wind, snow, fire, and earthquakes.[19] Although few, if any, municipal codes fully account for the risks associated with terrorist bombings, in recent years, such codes have increasingly adapted to meet post-September 11, 2001, realities. New York City is pioneering this effort with its Building Code and Fire Code modeled on the IBC and IFC, respectively.[20]

Effective July 1, 2008, the New York City Building Code streamlines and modernizes the City's 1968 Code. The Building Code mandates certain protective security measures of universal applicability and suggests several design methods to improve structural performance and prevent progressive collapse.[21] The New York City Building Code goes further than most building codes to account for extreme loads associated with vehicular impact and accidental gas explosions.[22] Effective July 1, 2008, the New York City Fire Code also sets enhanced fire protection standards as well as operational and maintenance requirements for fire alarm systems, emergency communication systems, and means of egress.[23]

Unlike the recommendations developed by the federal government, the New York City Building Code and Fire Code – and municipal codes more generally – carry the force of law: failure to comply with them carries legal consequences.

Purpose and Process

Engineering Security presents a forward-looking approach to protective security design that will undoubtedly evolve as new countermeasures are developed to address emerging threats. Accordingly, the recommendations set forth in subsequent chapters are intended to be fluid and adaptable to a changing environment.

Recognizing that every building faces unique security concerns, *Engineering Security* presents not a one-size-fits-all prescriptive approach, but a method for tailoring protective security measures to meet particular needs. Buildings in New York City require varying levels of security: the vast majority warrant no special precautions, while a mere handful necessitate heightened security. The recommendations set forth in this document apply primarily to the latter group. While these recommendations provide specific direction, they should not be viewed as onerous requirements; these recommendations are instructive, not obligatory. *Engineering Security* sets out best practices for the building community, not legal requirements.

Box 1: Security Consultation with NYPD

Prior to initiating contact with the NYPD, building owners should conduct a risk assessment of their buildings to determine the appropriate risk tier (as outlined in Chapter Two). Owners of High Tier buildings and certain Medium Tier buildings are encouraged to contact the NYPD's Counterterrorism Bureau early in the design process. In appropriate circumstances, a member of the Counterterrorism Bureau will contact the owner to arrange a meeting. At the meeting, owners should be prepared to discuss their assessment of the building's risk, as well as protective security design features, including those that would require the consent of other City agencies.

Ultimately, achieving effective protective security design requires a public-private partnership between security experts and the building and design community. Box 1 outlines the NYPD's consultative process for facilitating such a partnership: a collaborative effort that should be thought of as a negotiation resulting in a series of action-oriented protective security design recommendations.

While the process described in Box 1 is particular to New York City, many of the recommendations outlined in subsequent chapters are widely applicable and may be applied to densely populated urban environments more generally.

Limitations

The NYPD authored *Engineering Security* with new building construction projects in mind. Nevertheless, many of the document's protective security design recommendations may be suitable for retrofitting existing structures. Certain existing buildings will require critical upgrades based on unique structural vulnerabilities; for example, exposed columns on some buildings may require retrofit upgrades such as localized hardening. Other existing buildings should incorporate sensible security upgrades, as appropriate, during the course of general renovations.[24]

Additionally, to the extent that zoning resolutions, as applied to specific buildings, may conflict with certain recommendations presented in *Engineering*

Security, building owners must work within the confines of local regulations. Building owners should consult with relevant professionals about the possibility of applying for waivers, variances, or exemptions to permit appropriate protective security design measures.

Organization and Content

Engineering Security was written for the use of building owners and design professionals as they select and implement appropriate protective security design measures. With this audience in mind, the document's recommendations – presented as suggestions rather than mandates – are organized thematically by chapter.

Chapter One provides background on the threat to buildings from explosive devices, including a discussion of different types of explosive devices and an overview of blast effects. Chapter Two presents a risk-tiering system that categorizes buildings into three risk tiers: Low, Medium, and High, based on assessed threat, vulnerability, and impact levels. The recommendations presented in subsequent chapters address the specific security challenges facing Medium and High Tier buildings.

Chapters Three through Seven present the NYPD's protective security design recommendations. Chapter Three focuses on perimeter security, emphasizing the importance of performing a vehicle threat vector analysis and evaluating the benefits of installing hard and soft perimeters. Chapter Four addresses building design features, including site layout and orientation choices that may affect the impact of an explosives attack as well as measures designed to mitigate the hazards associated with debris in large explosions and prevent collapse. Chapter Five discusses access control, screening, and monitoring techniques that may prove useful in preventing and deterring potential terrorist attacks. Chapter Six surveys emergency preparedness solutions, including fire-resistance, emergency egress, and communication system standards. While the recommendations presented in Chapters Two through Six focus mainly on threats from explosive devices, the recommendations presented in Chapter Seven pertain to unconventional terrorist threats involving chemical, biological, and radiological weapons; the recommendations focus on heating, ventilation, and air conditioning (HVAC) systems and detection technology.

Taken together, these chapters describe the NYPD's approach to protective security design, beginning with a risk assessment and determination of a risk tier, and leading to risk-appropriate protective security design recommendations.

CHAPTER ONE

THE THREAT TO BUILDINGS FROM EXPLOSIVE DEVICES

Although terrorists employ a wide variety of tactics and strategies, their attacks have often targeted buildings in urban environments. Buildings in densely populated areas are attractive targets for several reasons: they tend to be tall structures with high concentrations of occupants, allowing for mass casualties and injuries from a single targeted strike; and they tend to be valuable assets, allowing for extensive property losses in the event of an attack.

Explosive devices can cause casualties and property damage in a variety of ways. Beyond a building's collapse, an explosion can initiate uncontrollable fires that spread rapidly throughout the building; produce structural damage that traps people within the building; and cause debris, broken glass, and fragmented furniture to become harmful projectiles. This chapter provides an overview of the threat to buildings from explosive devices.

Explosive Devices

Conventional explosive devices used in terrorist attacks on buildings are called improvised explosive devices (IEDs). IEDs vary in size, design, and material. The means by which an IED reaches its target has broad implications for the type and extent of damage it can cause; for this reason, IEDs are often characterized by delivery mechanism: vehicle-borne or man-portable devices.

Vehicle-Borne Improvised Explosive Devices

A vehicle-borne improvised explosive device (VBIED) has the capacity to hold enough explosive material to significantly damage or even destroy a building. Because the extent of damage a VBIED can cause depends largely on its proximity to a target, terrorists have chosen to detonate VBIEDs in vehicles parked outside of buildings or within garages, or in vehicles that strike buildings. The mass-casualty potential of a VBIED became clear in 1983, after two deadly terrorist attacks on U.S. government buildings in Beirut, Lebanon: on April 18, a VBIED delivered by a pickup truck destroyed the U.S. Embassy in Beirut, killing 63 people;[1] and, on October 23, a truck believed to have been carrying a 12,000-pound TNT-equivalent VBIED crashed into the U.S. Marine Corps Barracks at the Beirut International Airport, killing 241 American service personnel.[2]

VBIED attacks have also been carried out in the United States. On February 26, 1993, Ramzi Yousef led a terrorist cell that detonated a 900-pound TNT-equivalent urea-nitrate VBIED delivered in a rented Ryder van in the underground garage of the World Trade Center.[3] The attack killed six, injured more than 1,000, and caused significant structural damage that resulted in over $858 million in insured property losses.[4] On April 19, 1995, Timothy McVeigh detonated a 4,000-pound TNT-equivalent VBIED delivered in a rented truck outside the Alfred P. Murrah Federal Building in Oklahoma City, causing progressive collapse of part of the building and killing 168 people.[5]

U.S. Marine Corps Barracks, Beirut, Lebanon 1983

VBIED attacks in urban environments have the potential to cause considerable financial loss. In 2006, for instance, the American Academy of Actuaries estimated that a truck bomb attack in New York City could produce $11.8 billion in insured losses.[6] Successful attacks can also have unintended

Box 2: Port Authority Liability in 1993 World Trade Center Bombing

In the aftermath of the 1993 World Trade Center bombing, the victims and their families sued the Port Authority of New York and New Jersey for failing to implement security enhancements in response to known vulnerabilities. From 1984 to 1986, five separate reviews of the World Trade Center site, including reviews conducted by the Port Authority and Scotland Yard, found that the underground public parking garage presented a potential risk. At the Port Authority's request, three reports on the site's security were written, each providing risk mitigation recommendations. On April 29, 2008, the New York State Appellate Division upheld a 2005 New York County Supreme Court ruling, finding the Port Authority liable for failing to meet "its basic proprietary obligation to its commercial tenants and invitees" by not securing its facilities in the face of "ample notice" that a VBIED attack was possible in the public parking garage. The 2005 and 2008 decisions held the Port Authority liable for damages potentially upwards of $100 million.

References: *Nash v. Port Authority of New York and New Jersey,* 51 A.D. 3d 337 (First Dept, NY 2008); Anemona Hartocollis, "Port Authority Liable in 1993 Trade Center Attack," *The New York Times*, April 30, 2008, http://www.nytimes.com/2008/04/30/nyregion/30bombing.html.

financial implications, such as exposing building owners to liability for failure to enact sufficient protective security design measures.

Man-Portable Improvised Explosive Devices

Man-portable improvised explosive devices (MPIEDs) are generally used to target people rather than structures. They tend to be significantly smaller than VBIEDs, and may be concealable in backpacks and suitcases, allowing for ease of entry into a building. Victims of such attacks are often injured by shrapnel and projectiles, including furniture fragments and shattered glass, rather than building collapse. MPIEDs range in size from under five pounds to as much as 100 pounds and are generally used against soft targets, such as shopping malls, nightclubs, and trains. They can cause extensive property damage and produce significant casualties. For example, on November 9, 2005, a team of suicide bombers carried out near simultaneous attacks on three hotels in Amman, Jordan, killing 58 people and injuring over 100 others.[7] One device alone killed 38 people at the Radisson SAS Hotel. The blasts also caused considerable damage to the hotels' interiors. MPIEDs used in the attacks were responsible for collapsed pillars, buckled ceiling panels, and shattered glass doors and windows.[8]

Although MPIEDs are unlikely to cause building collapse, when multiple MPIEDs are simultaneously employed against primary structural elements, such a result is theoretically possible.[9]

Blast Effects

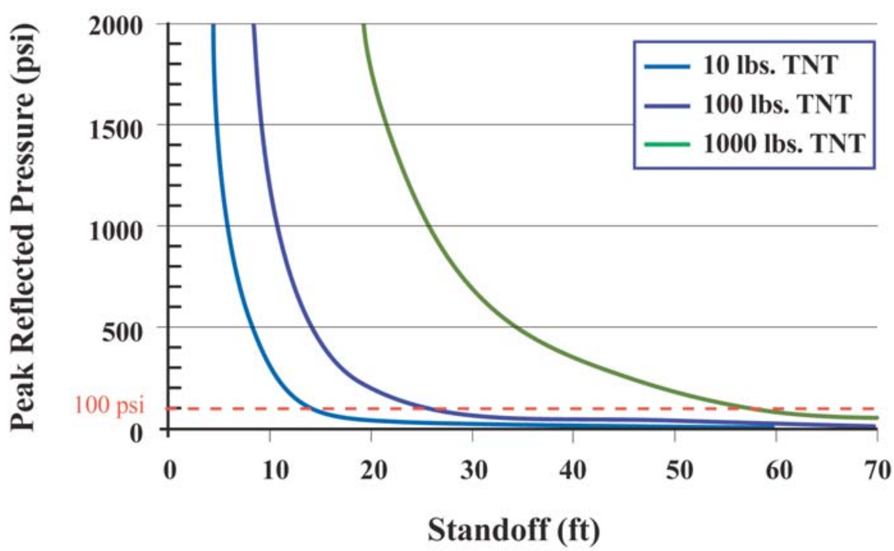
The physics of explosive blasts may be used to determine the types of protective security design measures that buildings should employ. An explosives attack creates significant pressures and impulses that vastly exceed normal loads. Unlike environmental conditions such as high winds, which can exert sustained pressure on buildings, explosions damage buildings by exerting tremendous air-blast pressure over a relatively short time span – on the order of milliseconds. This tremendous pressure and its associated impulse can affect primary structural elements, such as columns and beams, which contribute to overall structural stability, potentially leading to structural failure.[10] One type of structural failure is progressive collapse, which occurs when abnormal loading causes individual structural elements to fail locally, shifting the loads to remaining structural elements unequipped to provide the requisite structural support; the result is catastrophic failure of the entire building or significant portions of the structure.[11] The same pressures can also impact non-structural elements, leading to facade fragmentation, shattered windows, and flying glass.[12]

A building subjected to an explosion is affected by several types of pressures that occur in two phases. The positive pressure phase refers to the rapid outward expansion of energy as the shock waves radiate in all directions from the source of the explosion; these waves are amplified by waves that reflect off the ground or surrounding buildings. The pressure envelopes the structure, loading the sides and the roof; it may be further amplified if the waves are stagnated by the structure. The pressures in the positive phase push on the building's exterior and may induce the localized failure of exterior walls, windows, floor systems, columns, and girders. Narrow freestanding columns may benefit from pressures wrapping around their surface and minimizing the net loading. Downward pressure directly beneath the explosion leaves a crater below the source, potentially damaging underground structural elements and creating intense vibrations through the ground similar to the effects of an earthquake. The negative pressure phase refers to the low intensity, longer duration inward movement of air that fills the void created by the positive phase. The pressures in the negative phase reverse the positive phase loading, pulling structural elements towards the source of the blast, which may dislodge windows and sloped roofs. Once the applied pressures deform building components, the elements attempt to rebound back to their original shapes, which may result in additional structural damage.[13]

Standoff

Standoff is defined as the distance between the explosive threat location and the nearest building element that requires protection.[14] Increasing this distance improves a building's ability to withstand an explosives attack because the peak pressure per square inch (psi) associated with such an attack decreases significantly as standoff increases.[15] Specifically, the peak pressure falls roughly by the cube of the ratio of increased distance. For example, if standoff is doubled, the peak pressure reduces by a factor of 2^3, or 8; this means that the peak pressure from an 800-pound blast 10 feet

Figure 1: Peak Reflected Pressure and Standoff



Note: Fatalities and structural failure may occur between 50 and 100 psi.

away from a structure is approximately equivalent to the peak pressure from a 100-pound blast five feet away. The effects of standoff are further illustrated in Figure 1.

Design Basis Threat

Design basis threat (DBT) is the magnitude of the blast from an explosive device that a building or particular building element should be designed to withstand at a specified distance. The magnitude of this threat is expressed in TNT-equivalent charge weight, and the distance in feet. For example, a building's DBT may be stated as a 500-pound TNT-equivalent explosive charge at 20 feet of standoff, meaning the building, or the particular building element to which the DBT is assigned, must be able to withstand the loading associated with a 500-pound TNT-equivalent explosive charge, from 20 feet away. Increasing standoff and using building design techniques to harden structures may allow buildings and particular building elements to resist explosive threats that present abnormal loading.

The load a specific building element must withstand varies with both the distance and magnitude of the threat from an explosive device. The distance component of DBT takes into account the most probable scenario: that attackers will get as close to their targets as possible. For this reason, the distance component of DBT tends to be no more than the standoff afforded the building or the particular building element under consideration. The magnitude component of DBT takes into account the different types of threats in urban environments, ranging from small pipe bombs to explosives in quantities large enough to fill a cargo van.

Figure 2 presents a summary of the NYPD's DBT coding system, referenced in subsequent chapters as M-values. Each M-value represents a distinct order of magnitude, corresponding to the range of explosive threats buildings or particular building elements should be designed to withstand. The NYPD provides a range rather than specific values for DBT charge weights to avoid disclosure of sensitive security information to potential terrorists and to account for variations among buildings in factors such as: amount of available standoff, type of access control, threshold for screening procedures, and site orientation.

Threats from the true perimeter generally come from VBIEDs, containing potentially large amounts of explosives. For a building that has protection from a hard perimeter,

Figure 2: NYPD Design Basis Threat Coding System			
DBT Code	**Order of Magnitude**	**Charge Weight***	**Potential Threat**
M1	10^1	10 - 99 lbs.	Pipe Bomb Suicide Belt/Vest Satchel/Suitcase
M2	10^2	100 - 999 lbs.	Duffel Bag Luggage Compact Sedan
M3	10^3	1000 - 9,999 lbs.	Standard Sedan Cargo Van Delivery Van

*** Expressed in TNT-equivalent weight**

the true perimeter is defined as the anti-ram barrier line. For a building that lacks protection from a hard perimeter, the true perimeter is generally defined as the building's envelope. For threats from the true perimeter, the NYPD recommends that primary structural elements in High Tier buildings "satisfy" M3 standards – a threat in the thousands-of-pounds range ("satisfy" means the element in question is adequately robust that the building: does not engage in progressive collapse; meets an industry standard definition of non-disproportionate damage; and performs to a level that allows for evacuation, rescue, and recovery operations). By contrast, threats at zero feet of standoff, representing contact with the column, generally come from MPIEDs, containing an amount of explosives limited to what an individual can carry. Therefore, for threats from a contact charge, the NYPD recommends that columns in High Tier buildings satisfy M1 standards – a threat in the tens-of-pounds range.

The design loads necessary to meet the NYPD's recommended DBT standards will almost certainly be greater than the load requirements set out in applicable local building codes. Building owners should consult with blast engineers and the NYPD Counterterrorism Bureau to determine building-specific DBT standards. Once DBT levels are established for a site, building owners, in consultation with appropriate experts, must decide on specific methods to achieve sufficient design performance. The specific DBT levels determined for each building are sensitive security information and should be strictly controlled and protected.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CHAPTER TWO

THE NYPD RISK-TIERING SYSTEM

All buildings face a variety of risks, from weather to fire to seismicity to terrorism. Since terrorism risk varies from building to building, any coherent set of protective security design recommendations should be based on a building-specific risk assessment. In determining a given building's terrorism risk level, industry experts often employ a variation of an equation incorporating three important factors – threat, vulnerability, and impact.[1]

Risk = Threat × Vulnerability × Impact

This equation reflects an underlying assumption of risk analysis: terrorism risk only exists when a person or group has the capacity and intent to present a *threat* of attack, on a *vulnerable* target, in a manner that would produce a discernible *impact*.

New York City's unique risk environment is characterized by dense concentrations of people, buildings, and resources, including some of the largest underground transportation and utility systems in the world. Accordingly, in developing a risk assessment system, the NYPD has tailored the standard equation to meet the City's particular needs. Specifically, the NYPD's risk assessment system sets out nine sub-factors categorized by threat, vulnerability, and impact. "Threat" is defined by a building's threat profile and its attractiveness as a terrorist target. "Vulnerability" is determined by a building's adjacency, accessibility, and structural performance. "Impact" is based on a building's maximum occupancy or height, economic criticality, transportation criticality and proximity, and critical infrastructure proximity. Each building receives a score of Limited, Moderate, or Significant for

Figure 3: NYPD Risk Factors	
Threat	1) Threat Profile 2) Target Attractiveness
Vulnerability	1) Adjacency 2) Accessibility 3) Structural Performance
Impact	1) Maximum Occupancy or Height 2) Economic Criticality 3) Transportation Criticality and Proximity 4) Critical Infrastructure Proximity

each sub-factor. The NYPD takes the scores determined for each of the nine sub-factors together to calculate a building's overall risk tier – Low, Medium, or High. Appendix A elaborates on this risk assessment and risk-tiering system and includes a worksheet to assist in performing the relevant calculations.

The NYPD recommends that after determining the appropriate risk tier, the owner of a Medium or High Tier building should follow the specific recommendations outlined in subsequent chapters to better protect the building and its occupants. For this reason, building owners should conduct a risk assessment and risk-tier calculation during the design process, prior to construction. In general, Medium and High Tier buildings will warrant protective security design features that go beyond those set out in municipal codes.

The NYPD offers its risk assessment system as a first step in the protective security design process. Building owners should enlist the help of protective security design experts to conduct more refined and detailed assessments.

Risk Assessment

Threat

The first factor in the NYPD risk assessment is the "threat" of attack a particular building faces, measured by its threat profile and target attractiveness. These sub-factors attempt to quantify threat levels in a systematic way.

Threat Profile. A building's threat profile is determined by the various threats that affect it, including past and present threats, and possible future trends. Such information is often available from open sources. Law enforcement may be able to provide access to more sensitive materials.

Engineering Security distinguishes between two types of threats: specific threats, targeting particular buildings, by terrorists individuals or groups with the capacity to cary out an attack; and general threats, targeting types of institutions, structures, networks, or neighborhoods, based on their nature of occupancy or operation.[2] To determine a building's threat profile, owners should work in concert with law enforcement to evaluate both the credibility of specific threats and the applicability of general threats.

The vast majority of buildings in New York City have limited threat profiles, meaning they face no general or credible specific threats and have no threat history. A building with a moderate threat profile currently is or has been the subject of a past or present general threat, but is not and has not been the target of a credible specific threat. A building with a significant threat profile currently is or has been the target of one or more credible specific threats.

Target Attractiveness. A building's attractiveness as a terrorist target depends on its level of visibility. Terrorists generally select targets that possess at least one of the following characteristics: widely recognizable architectural design, high-profile occupants, and essential services. Buildings that are widely recognizable for their architectural design tend to be fixtures of the New York City skyline. Buildings that have high-profile occupants or essential services include certain government facilities, prominent commercial or financial institutions, and transportation hubs.

The average building in New York City has limited target attractiveness, meaning that neither its architectural design nor the nature of its occupancy or operations is recognizable on a local or national level. Moderate target attractiveness applies to buildings with occupants or operations that are nationally recognizable. Significant target attractiveness applies to buildings with architectural design that is nationally recognizable.

Vulnerability

The second factor in the NYPD risk assessment is a building's "vulnerability," which accounts for the circumstances that make a building susceptible to damage or destruction from a terrorist attack.[3] A building is particularly vulnerable when a successful attack is capable of producing a disproportionately large effect because of a physical or functional weakness or lack of redundancy. Vulnerability is measured by adjacency, accessibility, and building design.

Adjacency. Adjacency takes into account the risk levels of structures in a building's immediate vicinity because a building may suffer collateral damage from an attack on a neighbor. For example, on September 11, 2001, debris from the attack on and collapse of WTC1 ignited fires in neighboring WTC7, ultimately causing the building's collapse.[4]

The average building in New York City has limited adjacency, meaning that there are no High Tier buildings located within 300 feet of it. A building has moderate adjacency when there is at least one High Tier building located less than 300 feet, but more than 150 feet from it. A building has significant adjacency when there is at least one High Tier building located within 150 feet of it.[5]

Accessibility. Accessibility refers to the ease with which people and vehicles can approach or access a building. Generally, building accessibility depends upon: the amount of available standoff distance; the type of screening, detection, and access control systems employed; and the presence of hard or soft perimeters.

A building has limited accessibility when the movement of people in it is controlled to a significant degree, including limited access to sensitive areas, and vehicles cannot enter the building and must be screened or otherwise obstructed before approaching. A building has moderate accessibility when the movement of people in a building is controlled, or vehicles are screened or otherwise obstructed before approaching. If vehicles are able to enter the building (e.g., through an internal parking garage or, in a handful of cases, on a street that cuts through the building), the building is considered moderately accessible when vehicles are screened prior to entry. A building has significant accessibility when the movement of people in a building is not controlled or controlled only to a limited degree and vehicles are neither obstructed nor screened before approaching or entering.

Structural Performance. Structural performance refers to a building's capacity to physically withstand an attack that presents abnormal loading. For this reason, it is measured by assessing the blast loads that structural elements can withstand at varying amounts of standoff.

A building has limited structural performance vulnerability when: for threats from the true perimeter, its primary structural elements satisfy M3 standards; and for threats from a contact charge, its columns satisfy M1 standards. A building has moderate structural performance vulnerability when: for threats from the true perimeter, its primary structural elements satisfy M3 standards; or for threats from a contact charge, its columns satisfy M1 standards. A building has significant structural performance vulnerability when: for threats from the true perimeter, its primary structural elements do not satisfy M3 standards; and for threats from a contact charge, its columns do not satisfy M1 standards.

Structural performance is perhaps the most adjustable component of the risk equation because building designers and engineers have the ability to "build-in" features, such as hardened columns or increased standoff from specific building elements, which may make a building less vulnerable to attack.

Impact

The third factor in the NYPD risk assessment is the "impact" of an attack on a particular building, measured by the building's maximum occupancy or height, economic criticality, transportation proximity and criticality, and critical infrastructure proximity.

Maximum Occupancy or Height. The maximum occupancy and height of a building can be used to predict the human costs of a successful terrorist attack, including fatalities and serious injuries. The terms “maximum occupancy” and “height” are often correlated – taller buildings tend to have higher occupancy levels – and therefore they are categorized together.

Engineering Security contemplates three types of occupancies: those that are consistent over time (e.g., commercial high-rises); those that are event-driven (e.g., public assembly venues); and those that depend on transient populations (e.g., train stations). The gradations identified in the following paragraph apply equally to all three.

The majority of buildings in New York City fall into the limited tier: they have maximum occupancy levels of fewer than 5,000 people and are shorter than 600 feet in height. Buildings that fall into the moderate tier have maximum occupancy levels that range from 5,000 to 10,000 people or measure between 600 and 800 feet in height. Finally, buildings that fall into the significant tier have maximum occupancy levels of more than 10,000 people or are taller than 800 feet in height.

Economic Criticality. Economic criticality represents the potential economic losses resulting from a successful terrorist attack, including: the specific costs incurred by building owners and occupants, such as lost revenue due to disruption of normal business operations; and the effects on local, regional, or national economies more broadly, including declines in tourism and disruption of financial markets.

A building has limited economic criticality if a successful attack is capable of impacting the local or regional economy, with limited or no effect on the national economy (total economic losses estimated at less than $1 billion). A building has moderate economic criticality if a successful attack is capable of considerably impacting the local or regional economy, or affecting the national economy in the immediate aftermath of the attack (total economic losses estimated between $1 billion and $10 billion). Finally, a building has significant economic criticality if a successful attack is capable of severely impacting the local or regional economy, or affecting the national economy for an appreciable period of time beyond the immediate aftermath of the attack (total economic losses estimated in excess of $10 billion).[6]

Transportation Criticality and Proximity. Transportation criticality and proximity are used to measure the effect of a successful attack on casualties to the commuter population and patterns of mobility. Specifically, transportation criticality and proximity refers to New York City's extensive network of underground transit lines, which comprise its subway and rail systems, as well as tunnels and bridges used by motor vehicles.

Proximity takes into account how close a building is to transit lines, hubs, stations, tunnels, or bridges. Given the shallow depth of underground transit tunnels in New York City, proximity often reflects vertical distance: a building is considered proximate if a subway or rail line or vehicle tunnel runs underneath it, regardless of the location of the relevant transit station. Proximity also reflects horizontal distance: a building is considered proximate if it is adjacent to the footprint of a transit station, hub, or entrance to a bridge.

Criticality takes into account a building's proximity to sets of transit lines; its significance increases as the number of sets grows. A "set of lines" is defined as those lines running through the same tunnel or along parallel tracks. For example, the No. 4/5/6 subway lines in Manhattan comprise a single set of lines. Similarly, a stand-alone line, such as the No. 7 line, is also referred to as a single set of lines.

Passengers navigate a crowded transit hub.

A building with limited transportation criticality and proximity sits atop as many as one set of lines, or is located adjacent to the footprint of a

Box 3: New York City Transit System

The New York metropolitan area is served by a massive public transportation system, including a subway and bus system run by NYC Transit and MTA Bus Company, as well as ferries and several commuter rails, namely Amtrak, Metro-North, Port Authority Trans-Hudson (PATH), New Jersey Transit (NJ Transit), the Long Island Railroad (LIRR), and the Staten Island Railroad. Approximately 10 million riders use these systems on an average weekday.

New York City has one of the most extensive and complex subway networks in the world. The subway carries approximately 1.563 billion riders annually and over 5 million riders on an average weekday. By contrast, U.S. passenger aircraft across the United States carry approximately 2 million riders on an average weekday. The Lexington Avenue subway line alone has a daily ridership of 1.3 million, which is greater than the combined riderships of the Boston, Chicago, and San Francisco subway systems. The New York City subway system includes an extensive network of 26 express and local subway lines serving 468 subway stations, only 35 fewer stations than the combined total of all other subway systems in the United States. The system comprises 660 miles of in-passenger service track, and an additional 180 miles of track used for non-revenue purposes. Laid end to end, the tracks would stretch from New York City to Chicago.

NJ Transit, Metro-North, and LIRR account for three of the four largest commuter rails in the nation, carrying approximately 800,000 passengers on an average weekday. The PATH, which connects New Jersey to Manhattan, serves 250,000 commuters daily. These commuter rails are served by several major transit hubs, including Penn Station, Grand Central Station, and Jamaica Station. Penn Station, the main terminal for LIRR and NJ Transit, is the busiest rail station in the western hemisphere, serving 550,000 passengers per day, more than LaGuardia, John F. Kennedy, and Newark airports combined. Manhattan is also home to Grand Central Station, a major commuter rail hub, and the Times Square subway station, the busiest subway station in the United States. Jamaica Station in Queens and Atlantic Terminal/Flatbush Avenue in Brooklyn each serve as major hubs for the LIRR.

New York City's public and private bus system is the largest in the nation, serving more than 2.5 million riders daily. An extensive maritime-based public transportation operation also serves the metropolitan area, with the Staten Island Ferry and numerous private ferry companies carrying nearly 100,000 riders around New York Harbor daily.

transportation station servicing as many lines. A building with moderate transportation criticality and proximity sits atop two to four sets of lines or is located adjacent to the footprint of a transportation station servicing as many lines. Finally, a building with significant transportation criticality and proximity sits atop five or more sets of lines or is located adjacent to the footprint of a transportation hub or transfer point servicing as many lines; in addition, a building that sits atop a vehicle tunnel or adjacent to the entrance to a bridge is considered to have significant transportation criticality and proximity.

Critical Infrastructure Proximity. Critical infrastructure proximity is used to measure damage to critical infrastructure caused by a successful attack against a building. For purposes of this document, critical infrastructure is defined as major utility systems, including gas, oil, electricity, water, steam, and telecommunications. These systems provide essential services and therefore any collateral damage to them must be considered in a risk assessment.

A building has limited critical infrastructure proximity if it is not located so close to critical infrastructure that a successful attack against the building would affect service beyond the building itself. A building has moderate critical infrastructure proximity if it is located so close to critical infrastructure that a successful attack against the building would have implications for – but would not severely disrupt – service beyond the building itself. A building has significant critical infrastructure proximity if it is located so close to critical infrastructure that a successful attack against the building would severely disrupt service beyond the building itself.

Risk-Tiering System

The NYPD's risk-tiering system weights the importance of threat, vulnerability, and impact differently. Threat is the least heavily weighted factor, largely because terrorists are thought to be strategic thinkers that will pick targets based on perceived impact and vulnerability levels. Impact is more heavily weighted than vulnerability because in free and open societies, there is greater variation in impact than in vulnerability. In addition, protective security design measures that address vulnerabilities mitigate the potential impact of an attack.

Box 4: New York City Water, Electricity, and Steam Systems

Water
The New York City water supply system provides more than 1.3 billion gallons of water daily to approximately eight million City residents and one million residents in Westchester, Putman, Ulster, and Orange counties. The system's watershed includes a complex network of reservoirs, controlled lakes, dams, and tunnels that sit on approximately 2,000 square miles in New York State. Water from the 19 reservoirs is divided into three separate systems and water reaches the City through two major tunnels, completed in 1917 and 1936. Construction of a third tunnel commenced in 1970, with completion scheduled for 2020.

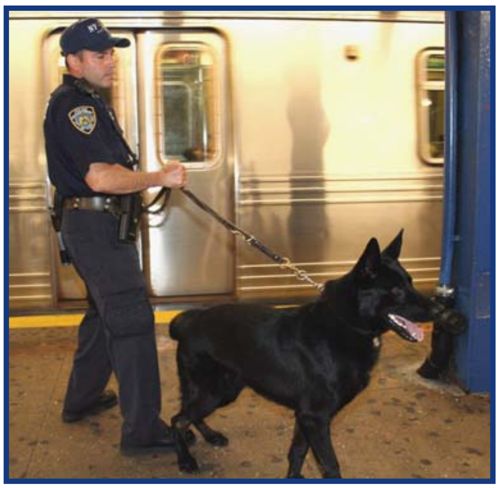
Electricity
New York City is considered a "transmission load" area for electricity because in-City generation resources by themselves are not sufficient to meet peak electricity demand. Although the City imports most of its electrical power, for reliability purposes it maintains sufficient local generation capacity to meet at least 80 percent of peak electricity demand. The City's distribution network includes 94,000 miles of underground cable, 264,000 manholes and service boxes, 35,000 underground transformers, 36,500 miles of overhead cable, 207,500 utility poles, 47,000 overhead transformers, and 60 substations.

Steam
New York City's steam system is the largest steam system in the world, generating approximately 30 billion pounds of steam per year. Its capacity is more than double that of Paris' steam system, which is the largest such system in Europe. The New York City steam system includes 105 miles of steam mains and service pipes, 3,000 manholes, and seven generating plants.

Members of the NYPD Threat Reduction Infrastructure Protection Section survey construction progress of City Water Tunnel No. 3.

The failure of a 24-inch steam pipe caused an explosion in Midtown Manhattan on July 18, 2007, killing one person and injuring more than 40 others.

A mathematical process for assessing the scores for threat, vulnerability, and impact, and then converting those scores into an overall risk tier is outlined in Appendix A. Determining a building's risk tier is the first step toward implementing protective security design. Subsequent chapters set out a series of recommendations specific to Medium and High Tier buildings.



CHAPTER THREE

GUIDELINES ON PERIMETER SECURITY

When sufficiently far from a building, effective perimeter security measures can significantly reduce explosive blast effects. This chapter addresses the type of analysis that owners of Medium and High Tier buildings should conduct to achieve such a result. It also surveys the circumstances in which certain perimeter security measures, including the establishment of hard or soft perimeters, may be appropriate. Because perimeter security measures may implicate levels of pedestrian service and complicate access for disabled persons, the recommendations presented in this chapter must be balanced with the realities of urban living. Nevertheless, when considering perimeter security solutions, building owners should be mindful that the best way to minimize the impact of an attack is to keep the threat away from a building.

Generally, owners of Medium and High Tier buildings should seek to maximize the amount of protected standoff surrounding a structure. However, available standoff in dense urban areas generally does not exceed the width of a sidewalk; moreover, this distance is only guaranteed if the building is protected with a hard anti-ram perimeter. In New York City, zoning resolutions setting street-to-wall requirements significantly limit the amount of standoff available to certain buildings.[1] In such circumstances, the NYPD recommends that building owners consult with professionals about the possibility of applying for waivers, variances, or exemptions to allow appropriate protective design measures. When such exceptions are unavailable, or when protected standoff is insufficient, protective security design methods are crucial for achieving blast protection for key structural and facade elements.

Box 5: Structures that Abut Waterways

Owners of High Tier buildings that abut waterways should institute protective security design measures that account for the unique threats associated with such structures. Although the U.S. Coast Guard has certain regulatory authority to create security zones in special circumstances, security zones are only appropriate in the most extreme cases. Therefore, the NYPD recommends that owners of High Tier buildings limit the use of exposed structural elements on the waterfront side of the site, and apply the same analysis to waterways as they would to roadways adjacent to buildings. Additionally, owners of High Tier buildings that abut waterways should provide for the ability to actively monitor potential threats from the waterfront exposure and set up physical barriers preventing unauthorized access from the water.

Vehicle Threat Vector Analysis

Vehicle threat vector analysis evaluates a building's vulnerability to a moving VBIED attack in light of surrounding street geometries, including the alignment and curvature of surrounding roads. Ultimately, the analysis identifies unobstructed vehicle approaches to buildings and determines the effectiveness of anti-ram perimeter protection measures.[2]

A VBIED is most likely to penetrate a building's perimeter while moving at high speed along a straight approach that is perpendicular to a target; such an approach may allow a vehicle to achieve a velocity sufficient to overcome obstacles. For example, the 1983 VBIED attack against the U.S. Marine Corps Barracks at the Beirut International Airport in Lebanon caused significant casualties because the vehicle carrying the explosive device took a straight approach to the target. According to witnesses, the truck used in the attack was moving westward along a wire barricade on the camp's perimeter when it made an abrupt right turn northward and crashed through wire obstacles. The truck cleared a variety of other obstacles and crashed into the entrance to the barracks. The driver detonated the explosive, producing a blast that was estimated to have a more than 12,000-pound TNT-equivalent yield.[3]

The NYPD recommends that owners of High Tier buildings conduct vehicle threat vector analyses – assuming realistic traffic scenarios – to determine vulnerabilities and develop solutions to mitigate associated threats. Ultimately, the purpose of such an analysis is to identify approach vectors and maximum attainable speeds in a VBIED attack and to use this information to design or select hostile vehicle mitigation measures.[4]

K-rated bollards create a hard perimeter.

Hard Perimeter

A hard perimeter is composed of an uninterrupted ring of anti-ram barriers, generally in the form of rated bollards, which prevents vehicles traveling at prescribed speeds from penetrating a building's available standoff. The NYPD recommends that owners of new High Tier buildings incorporate hard perimeters into their design plans. Depending on the circumstances, it may also be appropriate for owners of existing High Tier buildings to install hard perimeters.

Figure 4: Department of State Impact Rating for Barriers

Rating	Speed	Vehicle Weight
K4	30 mph	15,000 lbs
K8	40 mph	15,000 lbs
K12	50 mph	15,000 lbs

The Department of State has established standards for rating physical security barriers based on their performance, generally in live crash tests. For a perimeter to be considered a hard perimeter, Department of State-rated barriers must be installed around the building to protect against threats from vehicular intrusion. A Department of State-certified barrier receives one of three K-level ratings (K4, K8, or K12) depending on its ability to successfully stop a vehicle with certain associated kinetic energy levels.[5] Kinetic energy levels vary with vehicle weight and speed at impact, assuming the vehicle takes a perpendicular approach, as described in Figure 4.[6] The NYPD recommends that owners of High Tier buildings use a site-specific vehicle threat vector analysis to determine requisite K-ratings and design of active and passive barriers.

Box 6: New York City Revocable Consent Process

A revocable consent grants the right to construct, use, and maintain certain structures, such as security barriers, on City streets and sidewalks. This consent generally expires after 10 years and is renewable. However, the City retains the right to revoke such consent at any time.

To obtain a revocable consent, an applicant must first submit a petition form, a business certificate, site plans, and site photographs to the New York City Department of Transportation (DOT) for review by a group of city agencies, including the NYPD, the FDNY, the Department of Buildings, the Department of City Planning (DCP), and the Design Commission. The applicant must also seek approval from agencies that maintain subsurface structures near the proposed security device(s), such as the New York City Department of Environmental Protection and the Metropolitan Transportation Authority (MTA).

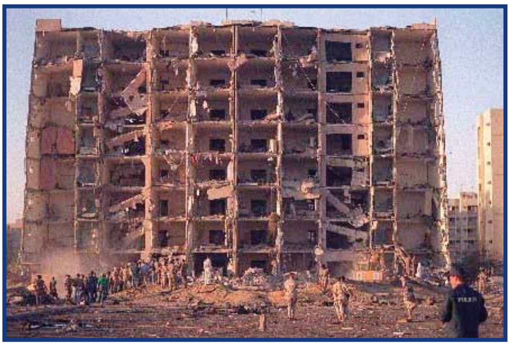
If DCP determines that a proposed installation would have land-use impacts, the application is also subject to the Uniform Land Use Review Procedure, under which the application is reviewed by the appropriate community board, the Borough President, the City Planning Commission, the City Council, and the Mayor. Structures proposed within a designated New York City Historic District or adjacent to a designated New York City landmark require the approval of the New York City Landmarks Preservation Commission.

The review covers many factors, including: pedestrian access and movement, emergency access and egress, the presence of sub-grade utilities and structures, and handicap accessibility. Overall, the approval process weighs the potential intrusion into public space against the type of threat against the building, its value, and the increase in building protection attributable to barrier installation.

After all necessary approvals are obtained, DOT holds a public hearing. If no issues arise at the hearing or during the subsequent 10-day comment period, DOT prepares a revocable consent agreement that is sent to the applicant for signature. Once executed, the agreement is subject to the additional approval of the Mayor.

Reference: New York City Department of Transportation, "Permits/Franchises: Franchises, Concessions & Consents," http://www.nyc.gov/html/dot/html/permits/revconif.shtml.

New York City regulations mandate that barriers on sidewalks leave a clear path of the greater of eight feet or 50 percent of the sidewalk.[7] With respect to bollards, the NYPD recommends four feet of clear spacing, bollard sleeve to bollard sleeve.[8] In



Khobar Towers, Dhahran, Saudi Arabia 1996

general, New York City recommends that bollards measure between 30 and 36 inches in height. Although the installation of physical security barriers on private property usually does not require official approval, placement of such barriers on City property requires the execution of a revocable consent agreement. This process is outlined in Box 6.

The NYPD discourages the use of surface barriers like unpinned jersey barriers or concrete planters as permanent solutions for High Tier buildings. Such barriers do not constitute hard perimeters, and can impede emergency access by first responders and emergency egress by building occupants. Jersey barriers and concrete planters may also become hazardous in the event of an explosion that is powerful enough to cause fragmentation because shattered pieces of concrete can turn into harmful projectiles. For example, on June 25, 1996, an explosion caused extensive secondary blast effects damage at the Khobar Towers in Dhahran, Saudi Arabia. Standoff of approximately 80 feet separated the building's facade from its parking lot, where the bomb was detonated; and a row of jersey barriers stood adjacent to a chain link fence, separating the facility from the parking lot. Accounts indicate that the explosive force of the bomb, which was reported to have a 20,000-pound TNT-equivalent yield, shattered the jersey barriers, sending fragments directly into the facade of the building. The incident significantly damaged the first four floors and ultimately led to facade failure.[9]

Soft Perimeter

Soft perimeters are composed of unrated bollards and common streetscape elements, which serve as obstacles for vehicles attempting to target a building. The NYPD recommends that owners of Medium Tier buildings install soft perimeter solutions to create unsecured standoff without obstructing pedestrian traffic or emergency access. Although soft perimeters are less effective than hard perimeters at defending against terrorist attacks involving VBIEDs, they present a relatively cost-effective means of creating a static defense in an aesthetically appealing way.

Whenever possible, soft perimeter elements should be secured or reinforced so that they do not become harmful projectiles in the event of an explosion powerful enough to cause fragmentation.[10] Additionally, although parked vehicles are not permanent fixtures, and are therefore not independently sufficient to create a soft perimeter, they can provide an extra several feet of standoff between a building's facade and a potential VBIED, based on the width of the vehicles.

Because common streetscape elements are not designed to serve as anti-ram barriers, they may be overwhelmed either by an approaching vehicle with sufficient velocity and weight, or by multiple vehicles attempting to clear a path for an explosive-based payload. For this reason, the NYPD encourages owners of Medium Tier buildings to consider developing hybrid security perimeters, which employ hard perimeter barriers at particularly vulnerable approaches and locations, such as building entrances.

Regardless of the type of physical security barrier solution a building owner decides to implement, the NYPD recommends that owners of Medium and High Tier buildings use current roadway designs and other traffic-calming measures to minimize potential vehicle velocity, to the extent possible.[11]

CHAPTER FOUR

GUIDELINES ON BUILDING DESIGN

Building design is a crucial part of protective security, particularly in densely populated urban environments where post-attack casualties may be greater than the damage caused by the blast itself. This chapter reviews site layout and orientation choices that can affect the impact of an explosives attack and presents recommendations designed to mitigate the hazards associated with debris in large explosions and to prevent collapse.

Site Layout and Orientation

Designing space within buildings to direct people and locate critical facilities away from vulnerable locations can help mitigate the effects of a terrorist attack. Accordingly, the NYPD recommends that High Tier buildings incorporate designs in which crowd surges in excess of 500 people are directed away from potential projectile sources, particularly glass atriums, windows, and curtain walls. Additionally, owners of High Tier buildings should attempt to place concession stands, newsstands, ticket windows, and concierge services away from main approaches or glass curtain walls and design the shape of buildings to help dissipate blast pressures.

The NYPD recommends that owners of Medium and High Tier buildings disperse critical facilities in order to reduce the potential for disruption of multiple critical systems during an attack. These critical facilities should be located in a building's least vulnerable areas, preferably in places that are out of public view and difficult for terrorists to observe or exploit.[1] Additionally, a backup system for critical facilities should be available and placed in a similarly secure location.

Box 7: Stadiums and Arenas

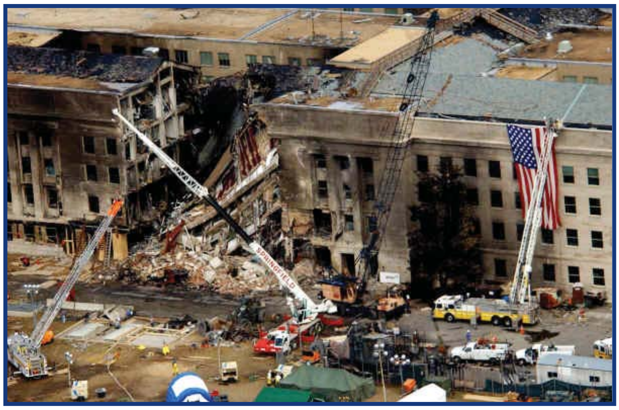
Seating bowls in stadiums and arenas present unique blast mitigation challenges because the pressure of a blast can cause seats to dislodge, leading to blunt injuries or death. Accordingly, the NYPD recommends that owners of major stadiums and arenas install primary structural elements and seating tie-down elements that achieve DBT levels in the M3 range from the true perimeter. The NYPD recommends that stadium and arena owners consult with blast engineers and the NYPD Counterterrorism Bureau to determine site-specific DBT standards within the M3 range. The determination is based on analysis of expected casualty levels given variations in occupancy, charge weight, standoff, geometry, and structural hardening.

Finally, to limit the collateral damage from an attack on a neighboring building, the NYPD recommends that owners of Medium and High Tier buildings orient glass facades away from nearby High Tier buildings, whenever possible.[2]

Reducing the Hazards of Debris in Large Explosions

An explosives attack against a building can produce casualties associated with the harmful debris caused by fragmentation. Accordingly, hazard mitigation measures aim to limit fragmentation thresholds, fragment sizes, and distances traveled by fragments. Such measures simultaneously shield occupants from injury and protect passersby and emergency responders from falling debris.

During the positive pressure phase of an explosion, secondary structural elements, such as exterior cladding, glass, and interior building walls, may break and blow away from the source of the blast.[3] As the explosion proceeds to the negative pressure phase, those same secondary structural elements are projected towards the source of the blast.[4] This chain reaction can threaten building occupants, block exits, and impede rescue attempts. Therefore, the NYPD recommends that owners of Medium and High Tier buildings ensure that secondary structural elements are designed to perform to acceptable fragmentation standards during an attack. This section proceeds from the exterior of a building to the interior, starting with the facade and exterior cladding; moving on to windows; and ending with interior walls.


The Pentagon, 2001

The structural performance of the Pentagon following the attacks of September 11, 2001, demonstrates the benefits of enhancing the resilience of secondary structural elements in High Tier buildings. Although more than 100 people were killed when American Airlines Flight 77 crashed into the western side of the Pentagon, certain blast-resistant renovations prevented a far greater number of casualties.[5] Other case studies demonstrate the drawbacks of poor secondary structural element performance during an attack, including casualties stemming from secondary blast effects. For example, in 2003, Al Qaeda-linked terrorists in Istanbul, Turkey, launched four large VBIED attacks over two days – simultaneous attacks against two synagogues on November 15, and near-simultaneous attacks against two British targets on November 20. The attacks killed at least 57 people and injured approximately 700 people. In all four bombings, most of the injuries, including lacerations and blunt trauma wounds, resulted from secondary blast effects.[6]

Facades

Because facades serve a number of important purposes, building owners should identify construction methods and materials that at once meet energy efficiency and aesthetic needs and perform well when presented with abnormal loads. Factors to consider include facade failure modes and failure limits of exterior cladding material.

When subjected to air-blast pressures, glass, masonry, stone, pre-cast concrete, and architectural metals exhibit distinctive failure modes and mechanical properties. For example, glass tends to break into small pieces following a blast event, which can cause lacerations and puncture wounds. Brick, on the other hand, tends to break from a structure in larger pieces following a blast event, which can cause blunt trauma injuries.[7] The NYPD recommends that owners of Medium and High Tier buildings take into account failure modes when selecting facade materials. Additionally, the

NYPD recommends that owners of High Tier buildings limit the use of ornamentation that is susceptible to becoming dislodged following a blast event. Building owners who decide to use such ornamentation should consider lightweight materials, which are less prone to becoming harmful projectiles, and should ensure that such ornamentation is secured.[8]

In designing facades, owners of Medium and High Tier buildings should also consider the differential failure limits of exterior cladding materials. Because facade strength has implications for structural loading, over-fortification may have the unintended consequence of making a building more susceptible to collapse in the event of an attack. Therefore, the NYPD recommends that in modeling the effects of externally applied loads, engineers of High Tier buildings should consider facade performance as it affects structural loading relative to collapse as well as debris mitigation.

Windows

Windows present the most difficult challenge for building owners attempting to mitigate the hazards associated with debris impact, because glass is brittle and inflexible, making it particularly susceptible to failure.

Treated window glazing can incrementally increase the blast resistance capability of glass. Although no commercially available glazing can fully mitigate the effects of a close-range blast event, certain glazing systems may substantially reduce blast impact at greater distances. Window glazing can also reduce the distance that glass fragments travel upon failure. For these reasons, the NYPD sets out recommendations for performance levels of glass: as a general rule of thumb, for a blast in the M2 range, owners of High Tier buildings should ensure that windows achieve a performance condition of 3b on the General Services Administration's (GSA's) Performance Conditions for Window System Response Table; and for Medium Tier buildings, a performance condition of 4.[9] However, specific design levels may vary from this range based on the particular conditions at each site; professional security consultants should be retained to resolve these issues.

The type of protective glazing system used informs a window's performance level. Common types of glazing systems include: annealed, heat strengthened, fully thermally tempered, and laminated. Office buildings commonly incorporate annealed and fully thermally tempered glass, which pose fragmentation hazards.[10] Accordingly, the NYPD recommends that owners of Medium and High Tier buildings avoid the use of annealed glass completely, and limit the use of fully thermally tempered glass to windows on upper floors, where increased distance from street level reduces potential blast pressure and glass fragmentation danger. For windows on lower floors, the NYPD recommends that owners of Medium and High Tier buildings use laminates. Generally, owners of Medium and High Tier buildings should consider occupancy type, glazing location, and the physics associated with the explosive threat when deciding between the use of laminates and fully thermally tempered glass.

To the extent that glass does not meet the applicable GSA performance conditions, the NYPD recommends the use of competent systems to protect against the hazards associated with glass fragmentation, including catch bar systems or blast curtains, in High Tier buildings.

The NYPD recommends limited fenestration on lower floors of High Tier buildings, to the extent possible. However, in certain districts, New York City zoning resolutions related to transparency and glazing may not allow for this practice.[11] In such situations, building owners should consult with professionals about the possibility of applying for waivers, variances, or exemptions to permit appropriate protective design measures. When such exceptions are unavailable, building owners should consider complementary protective security design measures to mitigate the associated risks, such as the installation of punched windows and the use of bollards to create increased standoff.

Window frames must hold glass in place long enough for the window to properly fail. Otherwise, a blast event can cause an entire pane of glass to dislodge from its frame before shattering. Accordingly, the NYPD recommends that owners of Medium and High Tier buildings ensure that the capacity of the frame system to resist blast loading exceeds the capacity of the glazing.[12] In the absence of a fully engineered blast resistant curtain wall detail, the NYPD recommends a bite depth for glass in a frame of at least ½-inch for Medium and High Tier buildings.[13] Window frames should be properly anchored to buildings to avoid the hazards associated with the dislodgement of entire frames containing intact panes of glass.

Interior Walls

Interior walls, particularly those that are not designed to be blast resistant, may become potentially harmful projectiles following a blast event. Fragmentation of interior walls can cause blunt trauma injuries and create debris that hampers access by first responders and blocks emergency egress routes.

The NIST report of 2005 noted that falling debris and fire rendered certain stairwells impassable in WTC1 and WTC2.[14] The New York City Building Code requires stairwells and elevator shafts in high-rise buildings to have impact resistant walls, but it leaves the establishment of minimum impact resistance standards to agency rulemaking.[15] Accordingly, to enable evacuation and life safety operations, the NYPD recommends that owners of all High Tier buildings and Medium Tier buildings taller than 600 feet reinforce egress routes, preferably with concrete encasements or other solutions engineered to achieve exit route survivability.

Additionally, owners of High Tier buildings should ensure that walls surrounding critical and sensitive areas are made of strong material, such as concrete, as opposed to weaker material, such as sheetrock. For existing buildings, certain walls that are not reinforced may be retrofitted with a sprayed-on polymer coating to improve air-blast resistance. This technique uses modern polymer materials to dissipate the energy from a blast, preventing shattering or, at a minimum, containing debris.[16]

Preventing Collapse

Beyond mitigating the hazards associated with debris in large explosions, building design criteria should account for the prevention of collapse. Specifically, certain design principles can effectively minimize the unique risks associated with progressive collapse. Progressive collapse is of

Alfred P. Murrah Federal Building, Oklahoma City 1995

Box 8: Cantilevers

The term "cantilever" describes a structure that is supported on only one end, without external bracing. Engineers and architects use cantilevers to create large open lobbies, covered passenger discharges, balconies, and roadways under buildings. Because cantilevers lack alternate load paths, they present unique challenges in blast mitigation; failure at the sole support leads to failure of the structure. Additionally, when a blast occurs under a cantilever, reflective pressure magnifies the initial blast pressure. Accordingly, the NYPD recommends that owners of Medium and High Tier buildings generally limit the use of cantilevers and avoid their use altogether over roadways. Instead, engineers should create fully supported structures that provide alternate load paths.

special concern because of its potential to cause damage that is disproportionate in magnitude to the initial damage caused by the blast event.[17]

On April 19, 1995, Timothy McVeigh detonated a powerful VBIED in front of the Alfred P. Murrah Federal Building in Oklahoma City, killing 168 people. With less than 20 feet of standoff, the force of the blast caused the progressive collapse of part of the building, leaving occupants who were otherwise unharmed by the blast itself no time to evacuate.[18] It has been estimated that approximately 80 percent of the fatalities in the attack resulted not from the initial blast itself, but from the progressive collapse of the building.[19]

Buildings with effective structural design will resist progressive collapse following an attack. Generally, buildings designed to resist progressive collapse incorporate certain features: robust primary structural elements capable of withstanding initial air-blast pressures; and redundant load path systems that allow the entire structure to remain standing in the event that a critical structural element becomes compromised.[20] Therefore, the NYPD recommends that owners of High Tier buildings incorporate certain features into structural designs to prevent collapse and enable rescue, including: ductile primary and secondary structural elements that are capable of deforming beyond the elastic limit without collapsing; sufficient primary and secondary structural element capacity to resist load reversals in the event of structural element failure; sufficient primary structural element capacity to resist an abnormal loading event that could lead to a shear failure; location of splices away from explosive threat zones; and other approved blast mitigation strategies.[21]

Design Methods

The American Society of Civil Engineers defines two general approaches to reducing the risk of progressive collapse for a building: Indirect Design and Direct Design.[22] Indirect Design is a prescriptive, event-independent approach to preventing progressive collapse that does not take into account the removal of structural members as a result of abnormal loading.[23] Direct Design is a more sophisticated approach to preventing progressive collapse that takes into account abnormal loading, and, in some instances, the removal of structural members as a result of those loadings.[24] Direct Design approaches include the Specific Local Resistance Method, which is threat-dependent, and the Alternate Path Method, which is threat-independent. The Specific Local Resistance Method designs specific primary structural elements to withstand abnormal loading events. The Alternate Path Method is a holistic approach that accounts for the interrelationships between failed columns and other primary structural elements; it designs the structure to localize damage to primary load-bearing structures by shifting the load to an alternate path.[25]

The New York City Building Code requires Direct Design for certain categories of buildings, including buildings greater than 600 feet in height or more than 1,000,000 square feet in gross floor area.[26]

The resilience of a column in the aftermath of the 1993 World Trade Center attack.

The NYPD recommends that all High Tier buildings incorporate Direct Design. Engineers of High Tier buildings using Direct Design should ensure that primary structural elements satisfy M3 standards for threats from the true perimeter; and M1 standards for threats from a contact charge, with events not occurring simultaneously. Engineers of High Tier buildings should also consider the use of threat-independent design methods, including the Alternate Path Method, informed by threat profile and the architectural and structural design of the building.

The NYPD recommends that engineers of Medium Tier buildings ensure that primary structural elements satisfy M1 standards for threats from a contact charge or account for the loss of a column using the Alternate Path Method.

CHAPTER FIVE

GUIDELINES ON ACCESS CONTROL, SCREENING & MONITORING

Access control, screening, and monitoring systems can play an integral role in securing a building and its immediate surroundings. Access control systems limit who can enter a building; screening systems limit what can enter a building; and monitoring systems observe the people and things in and around a building. This chapter outlines various recommendations for the use of such systems to enable them to deter terrorist attacks and generally improve building security.

Access Control Systems

To mitigate the risks associated with terrorist penetration of buildings, the NYPD recommends that owners of Medium and High Tier buildings implement access control systems. As a rule, building owners should design access control systems that do not obstruct or impede egress or emergency evacuation. For the purposes of access control, the NYPD distinguishes between buildings with controllable population flows and buildings with inherently non-controllable population flows. The latter category encompasses transportation hubs that accommodate large volumes of travelers and visitors.

The recommendations presented in this section fall into two general categories: those related to general building access and access to sensitive areas, including parking garages and locations with large pedestrian populations; and those related to sensitive security information and critical facilities, such as rooms housing electrical, mechanical, and telecommunications equipment. The former apply only to buildings with controllable population flows, and the latter apply equally to buildings with controllable and non-controllable population flows.

General Building Access and Access to Sensitive Areas

Access control systems keep track of who enters and exits a building. On the most basic level, these systems distinguish between building "insiders" – including tenants and employees – and building "outsiders" – including invited guests and the general public. The NYPD created the following recommendations to address the threat from unknown, potentially dangerous "outsiders."

For High Tier buildings, the NYPD recommends the implementation of access control systems that incorporate identity authentication and turnstiles to enforce entry authorization. "Insiders" should access High Tier buildings using access control cards, biometric devices, or badges that support multi-layered technology (e.g., smart cards with biometrics); and "outsiders" should access these buildings using time-sensitive temporary passes or proxy cards. Additionally, the NYPD recommends that these systems limit access to sensitive areas within High Tier buildings based on personnel category (e.g., tenant, non-tenant employee, visitor, general public, etc.). Owners of High Tier buildings should configure access control systems to comply with the NIST standards issued pursuant to Homeland Security Presidential Directive 12 to rapidly and electronically authenticate secure, reliable forms of identification.[1]

For Medium Tier buildings, the NYPD recommends the implementation of perimeter access controls, such as badge or identification card systems, to quickly process "insiders" at all entrances and exits. "Outsiders" should access Medium Tier buildings using temporary guest passes, and security personnel should continually man security stations within the building, with open sight lines to entry and exit points to allow effective monitoring by security personnel.

Although the NYPD tailored the preceding recommendations to meet the specific security needs of Medium Tier buildings, owners of Low Tier buildings who desire to implement access control systems may find these recommendations useful. Regardless, security personnel at Low Tier buildings should develop standard operating procedures and protocols for access control that can be implemented pursuant to an incident or at elevated threat levels.

Access to Critical Facilities and Sensitive Security Information

Although access control systems may effectively mitigate the threat to buildings from "outsiders," history has demonstrated the potential for "insider" exploitation of building vulnerabilities and sabotage. For example, in March 2004, British authorities disrupted a homegrown terrorist cell planning to use 1,300 pounds of ammonium nitrate fertilizer to launch one or more unspecified attacks in Britain. While employed as a sub-contractor for the Transco gas company, one of the cell members, Waheed Mahmood, stole sensitive CD-ROMs that detailed the layout of gas pipelines in southeast England.[2] In a separate incident in 2007, British authorities arrested Omar Rehman, who took a job working at a hotel in order to obtain security system plans and diagrams of security posts.[3]

Owners of Medium and High Tier buildings should establish control mechanisms to ensure that terrorists do not gain access to certain documents, including those containing sensitive security information, which may be used to exploit specific vulnerabilities and in attack planning. The NYPD recommends that owners of Medium and High Tier buildings limit access to blueprints and floor plans, and that all building owners further limit access to documents containing sensitive security information. This may be accomplished by establishing requirements for storage, disclosure, reproduction, transmission, shipment, disposition, and labeling of these documents. Additionally, owners of Medium and High Tier buildings should allow access to documents containing sensitive security information only on an as-needed basis, and should conduct background checks on all individuals granted such access.

For Medium and High Tier buildings, the NYPD recommends that access control systems limit access to critical facilities, including building security, building engineering, and fire-control rooms. Accordingly, security personnel in High Tier buildings should conduct background checks on all individuals with access to critical facilities both during and after construction, with recurring screenings of individuals involved with critical building functions. For Medium Tier buildings, the NYPD recommends that security personnel conduct background checks on all post-construction employees with access to critical facilities. To the extent possible, access to critical facilities in Medium and High Tier buildings should only be granted on an as-needed basis.

Screening Systems

To mitigate the risks associated with explosive or other devices detonated within a building, the NYPD recommends that owners of Medium and High Tier buildings with controllable population flows implement screening systems. The NYPD's recommendations relating to screening systems span three general categories: people and hand-held bags, delivered packages, and vehicles. The NYPD's recommendation for screening threshold levels applies equally to all three categories.

Generally, the level to which security personnel should screen for explosives depends on the DBT levels for threats from a contact charge, measured in TNT-equivalency, of the building's structural columns. To ensure that an attack from within a building does not result in its collapse, the NYPD recommends that owners of High Tier buildings set screening thresholds at levels no higher than the DBT level for threats from a contact charge on a structural column. For example, if the DBT level of structural columns in a garage is 90-pounds TNT-equivalent, all persons, packages, and vehicles accessing that garage should be screened such that no bomb with a 90-pound TNT-equivalent yield or larger can gain access. This recommendation represents only a minimum standard: owners of High Tier buildings should consider setting screening thresholds at levels significantly lower than determined DBT levels for threats from a contact charge on structural columns.

With respect to people and their hand-held bags, the NYPD recommendations distinguish between screening "insiders" and "outsiders." For High Tier buildings, "outsiders" should pass through magnetometers and their bags should be x-rayed; "insiders" need not pass through magnetometers, but their bags should be subject to search. Beyond these minimum standards, owners of High Tier buildings should consider the use of additional screening technologies, including walk-through explosives detection portals and radiation detector portals or pagers. The

Magnetometers and x-ray machines screen people and their hand-held bags.

NYPD also recommends that owners of High Tier buildings create secondary screening areas where security personnel can resolve anomalies using explosive trace detection equipment, handheld magnetometers, pat downs, and manual searches.[4] For Medium Tier buildings, the NYPD recommends that security personnel x-ray all "outsiders'" bags upon entry and store magnetometers on-site for use as circumstances require.

With respect to delivered packages, the NYPD recommends universal screening at Medium and High Tier buildings with stationary x-ray equipment and explosives detection canines or equipment. Building owners should post signage, indicating that all packages are subject to search. The NYPD also recommends that security personnel at Medium and High Tier buildings develop package screening standard operating procedures and protocols that can be implemented pursuant to an incident or at elevated threat levels.

With respect to vehicles, the NYPD recommends screening for High Tier buildings at direct entry points as well as at the entrances to underground parking areas and loading docks. Effective vehicle screening requires an adequate number of well-lit vehicle entrances to accommodate peak flows of vehicular traffic and to provide sufficient visibility of vehicles at the true perimeter.[5] The NYPD recommends that security personnel at High Tier buildings ensure that vehicle access points are securely locked when not operational, illuminated during off-hours, and inspected periodically by a roving patrol. Additionally, barrier systems should be put in place to thwart any attempt to "rush" the checkpoint.[6]

The NYPD recommends that owners of High Tier buildings provide for off-site screening of vehicles;[7] when no such design is feasible, building owners should create hardened on-site areas sufficiently removed from critical facilities and occupied spaces. Because underground parking areas and loading docks may create significant vulnerabilities based on their proximity to the base of a building, owners of High Tier buildings should harden them as much as possible, and design them to both limit damage to adjacent areas and vent explosive forces outward.[8] The NYPD recommends that Medium Tier buildings maintain signage noting that all vehicles are subject to search.

In all areas used for screening of people and their hand-held bags, delivered packages, and vehicles, lighting levels should conform to the standards set by the Illuminating Engineers Society of North America.[9]

To ensure both expediency and efficacy in all parts of the screening process and in all screening categories, security personnel at High Tier buildings should receive training that goes beyond the basic requirements needed to perform their functions. In certain instances, local law enforcement presence combined with judicious deployment of facility K-9 teams may be used to augment security staff capabilities. In general, system designers at High Tier buildings should consider and incorporate all appropriate screening technologies.[10]

Monitoring Systems

Monitoring systems can play an important role in protecting a building from terrorist attack. For example, an effective monitoring system may deter terrorists conducting reconnaissance from targeting a building. Monitoring capabilities, such as closed-circuit television (CCTV) systems, give security personnel enhanced domain awareness and improve their ability to detect suspicious activity. Monitoring systems may also serve as an important tool for investigating attacks, crimes, and other security incidents after they occur.

Sophisticated terrorists will take the existence of monitoring systems into consideration when conducting pre-attack planning and assessing operational risk. For instance, between 2000 and 2004, Dhiren Barot (a.k.a. Issa al-Hindi) carefully scrutinized the positions and features of CCTV cameras while conducting surveillance missions in the United States. While casing the New York Stock Exchange, he reported in his notes that, "there are round, tinted opaque (black) glass ones [CCTV cameras] – thus allowing freedom of rotation without public knowledge of which direction they are turning… it should never be assumed that all the cameras have been accounted for as there may be hidden cameras." Barot even acknowledged in his notes that he, "took many chances" in conducting such overt reconnaissance.[11]

The NYPD recommends that owners of Medium and High Tier buildings install comprehensive CCTV systems. All other buildings planning to install CCTV systems or security lighting should also follow the NYPD recommendations described in this chapter.

Furthermore, owners of buildings utilizing CCTV systems should post signage stating that the area is being monitored for security purposes.

CCTV cameras in many shapes and sizes.

Incorporating CCTV systems into a security plan requires state-of-the-art technology as well as well-trained personnel to monitor and operate the cameras. The NYPD recommends that security personnel at High Tier buildings establish monitoring posts with detailed operating instructions. Monitoring personnel should not be assigned any additional duties and should be rotated intermittently between 30 minutes and one hour to avoid end-user fatigue.[12] Implementing robust monitoring practices increases the likelihood that security personnel will detect suspicious behavior. Monitoring personnel and other security personnel should bear in mind that terrorists change tactics in order to outmaneuver static defenses. For instance, based on his observation that limousines are common in commercial districts with large numbers of corporate executives, Barot developed the "Gas Limos Plot" to detonate gas cylinders packed in as many as three limousines parked in the underground garages of various targets.[13]

The NYPD recommends that owners of Medium and High Tier buildings implement comprehensive CCTV camera coverage in critical facilities and sensitive areas within and around buildings, operated 24 hours a day. All CCTV cameras should be Underwriters Laboratories-listed to ensure that the devices are electrically sound and properly grounded to avoid shock and fire hazards; and FCC-compliant to ensure that the devices do not create interference with other electronic components utilized in the building.

Additionally, the NYPD recommends that building owners take steps to prevent tampering with CCTV systems and their associated video signals, including: installing cables and wires in a manner that will prevent unauthorized access;

transmitting video signals via secure mediums; positioning exterior CCTV cameras at high elevations; and placing pan-tilt-zoom and fixed cameras in tamper- and weather-resistant housings.

In positioning CCTV cameras, systems installers at Medium and High Tier buildings should avoid blind spots and use proper lighting to ensure clear visibility. To avoid a "washout" of the image until excess light is dimmed or removed, systems installers should seek to minimize the direct exposure of CCTV camera lenses to light. Additionally, the NYPD recommends that owners of High Tier buildings ensure that lighting for CCTV systems is proprietary and under the exclusive control of building personnel. Lighting should be operated by an automatic photocell controller or timing circuit to provide an extension of daylight hours and guard against human error. Additionally, to ease transitions on pan-tilt-zoom cameras, the NYPD recommends that owners of High Tier buildings ensure uniformity of lighting throughout a site.

To the extent that video from CCTV cameras is to be used for purposes beyond real-time viewing, the NYPD recommends that it be recorded at a speed of no less than 15 frames per second; and at an image size of no less than 2 CIF. Recorded video should be archived for a minimum of one month for review of security incidents not immediately evident.

Additionally, the NYPD recommends that owners of High Tier buildings ensure that CCTV systems are interfaced with current alarm points and access control systems to allow for remote assessment of alarm conditions. CCTV cameras should be specified with alarm and incident presets and should be programmed to automatically focus on the point in alarm.

NYPD Lower Manhattan Security Coordination Center

Looking to the future, it will increasingly be possible to network CCTV systems to local law enforcement coordination centers. Multiple cities have begun to introduce such cutting-edge integrated security systems. For example, in the

Box 9: Lower Manhattan Security Initiative

In order to help ensure public safety and security and to detect, deter, and prevent potential terrorist activities, the NYPD developed the Lower Manhattan Security Initiative (LMSI), a networked domain awareness project covering 1.7 square miles of Manhattan, from Canal Street to Battery Park, and from river to river. As part of this effort, the NYPD has partnered with several Stakeholders, including numerous public agencies and private companies, located in Lower Manhattan.

LMSI's integrated approach to security consists of an increased patrol presence on the streets, and the use of domain awareness technologies deployed in public areas, including CCTVs owned by the NYPD and the LMSI Stakeholders, LPRs, and chemical, biological, radiological, and nuclear detectors. The technologies are networked and supply critical supplemental assistance to officers' ongoing security and public safety efforts.

The Lower Manhattan Security Coordination Center, which serves as the aggregation point for data gathered by officers and the various domain awareness technologies deployed as part of LMSI, opened on October 31, 2008. It is staffed by uniformed members of the NYPD Counterterrorism Bureau and has workstations for representatives from the various public and private Stakeholders.

fall of 2008, the NYPD opened a state-of-the-art coordination center in Lower Manhattan in cooperation with private stakeholders and federal, state, and local government partners. The coordination center furthers the NYPD's efforts to detect, deter, and prevent potential terrorist activities by integrating data collected by CCTV cameras, license plate readers (LPRs), and other domain-awareness technologies. The cities of London and Chicago have also introduced advanced domain awareness systems with coordination centers for information collection.[14] The integration of private CCTV systems into law enforcement coordination centers supplies critical supplemental assistance to officers' ongoing security and public safety efforts, and enhances the collaborative nature of those efforts by leveraging the resources of the private sector.

CHAPTER SIX

GUIDELINES ON EMERGENCY PREPAREDNESS

Escalating fires can cause extensive destruction and significant casualties. To mitigate the potential effects of arson, incendiary attacks, and post-attack fires, both in terms of loss of human life and structural damage, the NYPD recommends that Medium and High Tier buildings adhere to strict emergency preparedness standards related to fire resistance, emergency egress, and communication systems. Adherence to fire-resistance standards, including requirements related to fire-resistance ratings and thermal insulation of primary and secondary structural elements, can contribute to a building's structural stability. Adherence to communication system standards and emergency egress standards, including requirements related to the width, navigability, location, and impact resistance of stairwells, can enhance the potential for an orderly and safe evacuation.

Although the attacks of September 11, 2001, were the most dramatic example of an act of terrorism generating intense fires, terrorists have a long history of staging incendiary attacks. For example, a group of Islamist radicals launched an arson attack against Hotel Madimak in Turkey in July 1993, causing 37 deaths and 56 injuries.[1] On June 30, 2007, two terrorists attempted to deploy an incendiary-based VBIED against Glasgow Airport in Scotland; their jeep caught fire but failed to either detonate or penetrate the front entrance. And, on September 20, 2008, at least 40 people were killed and hundreds more wounded when attackers detonated a large VBIED along the security perimeter of the Marriott Hotel in Islamabad, Pakistan. Although the hotel's vehicle barrier provided some standoff between the VBIED blast and the hotel's facade, the device generated an intense fire that quickly engulfed and destroyed the hotel, dramatically increasing the casualty count.[2]

As for the attacks of September 11, 2001, the Introduction to *Engineering Security* references two NIST reports that detail the role that fire ultimately played in the collapse of WTC1, WTC2, and WTC7. The first report, published in 2005, found that although WTC1 and WTC2 successfully withstood the initial impacts of the two planes, the intense heat generated from fires stoked by the planes' fuel loads eventually compromised the buildings' primary steel structures.[3] The second report, published in 2008, found that the fires that followed the impact of debris from the collapse of WTC1 spread to WTC7, causing the failure of a key structural column and, ultimately, progressive collapse of the entire building.[4] Noting that the fires in WTC7 burned out of control, largely as a result of water-main failure following the collapse of WTC1 and WTC2, the NIST report of 2008 concluded that the collapse of WTC7 represented the first recorded instance of fires primarily causing the total collapse of a tall building.[5]

In addition to detailing the collapse of WTC1, WTC2, and WTC7, the NIST reports also set out a series of recommendations designed to enhance building and fire safety.[6] The 30 recommendations contained in the NIST report of 2005 identify specific improvements both to the way buildings are designed, constructed, maintained, and used; and to evacuation and emergency response protocols.[7] Although the NIST recommendations are not legally compulsory, the NYPD supports the adoption of many of them in High Tier buildings. Because municipal codes are written for general applicability, not tailored to the specific needs of High Tier buildings, the NIST recommendations impose more rigorous building and fire safety standards than most, if not all, municipal codes.

A handful of cities have updated their municipal codes to reflect some of the practices recommended in the NIST report of 2005. In fact, the New York City Building Code and Fire Code mandate improved fire protection, emergency egress, and communication system standards.[8] The Building Code, effective July 1, 2008, was modeled on the International Code Council's 2003 edition of the IBC, which was published prior to the finalization of the NIST report of 2005. While the New York City Building Code incorporates several of the recommendations of the NIST report, those not incorporated are being actively considered for incorporation in the upcoming round of revisions to the Building Code. Appendix B includes a table summarizing the extent to which the NIST recommendations have been incorporated into the IBC and the New York City Building Code.

This chapter addresses certain NIST recommendations related to fire resistance, emergency egress, and communication systems in greater detail. Specifically, it focuses on the general principles contained in Recommendations 4, 7, 18, 19, and 22 of the NIST report of 2005. To the extent that the New York City Building Code and Fire Code do not yet incorporate these standards, the NYPD recommends their adoption in High Tier buildings.

Fire Resistance

The NYPD's fire-resistance recommendations fall into two general categories: those related to the fire-resistance rating of structural elements; and those related to the adhesion of thermal insulation. Both sets of recommendations contribute to a building's ability to withstand incendiary incidents, and its occupants' ability to safely evacuate in the event of an attack.

Fire-Resistance Rating

In accordance with the principles presented in Recommendation 4 of the NIST report of 2005, the NYPD recommends that High Tier buildings meet fire-resistance rating requirements that provide for the time required either for burnout without partial collapse or for full evacuation of building occupants;[9] this typically entails fire-proofing all primary and secondary structural elements based on the amount of time necessary for a building to be fully evacuated. For example, if a full evacuation requires three hours to complete, structural elements in the building should be fire-rated for as much time. The NYPD recommends that fire protection consultants assess fire-proofing requirements on a building-specific basis.

Furthermore, the NYPD recommends that both Medium and High Tier buildings employ the "structural frame" approach to fire-resistance ratings described in Recommendation 7 of the NIST report of 2005.[10] This approach requires building owners to ensure that all secondary structural elements having direct connection to primary structural elements achieve the traditionally higher fire-resistance ratings set for primary structural elements. The "structural frame" approach ensures “consistency in the fire protection provided to all of the structural elements that contribute to overall structural stability.”[11]

Thermal Insulation

The safety provided by a fire-resistance rating becomes meaningless when thermal protection or insulation does not remain in place during an attack. For example, on September 11, 2001, the impact of the planes on WTC1 and WTC2 dislodged a significant portion of the thermal insulation from structural elements.[12] Flying debris from an explosives attack can also dislodge thermal insulation. Without insulation, steel heats quickly, losing both its strength and stiffness.[13] Therefore, to ensure adequate protection of structural elements, the NYPD recommends the use of impact-resistant fire-proofing in High Tier buildings, to the extent that such fire-proofing can be commercially provided.

Emergency Egress

A swift evacuation of a building may be the single most important life-saving step in an emergency, but is a major challenge in any high-rise structure, particularly with regard to disabled or limited-mobility persons. The NYPD’s emergency egress guidelines include recommendations related to stairwells and emergency elevators.

When installed and maintained properly, stairwells may serve as lifelines for occupants of high-rise buildings during emergencies. In the event of an attack, elevators may be shut down for fire service or rendered inoperable; but stairwells should always be available for egress by building occupants and ingress by emergency responders. Accordingly, the NYPD recommends that owners of Medium and High Tier buildings ensure compliance with certain requirements related to width, navigability, location within the building’s core, and impact resistance of stairwells.

The NIST report of 2005 noted that descending evacuees in WTC1 reported slowing of their travel due to ascending first responders, suggesting that wider stairwells would have allowed for faster evacuation.[14] Moreover, both WTC1 and WTC2 were designed only for partial evacuation; had the buildings been fully occupied at the time of the attacks, complete evacuations would have taken as much as three hours, assuming access to all stairwells.[15] While the New York City

Building Code requires a stairwell width of not less than 44-inches, the NYPD recommends for all High Tier buildings and for Medium Tier buildings taller than 600 feet, a stairwell width of at least 66 inches, or a stairwell width informed by a time motion egress study that provides an equivalent building exit time.[16]

The NIST report of 2005 also addressed problems with stairwell navigability, noting that dense smoke limited visibility in the stairwells in WTC1 and WTC2. Several factors contribute to a stairwell's navigability, including signage, lighting, and layout. To facilitate rapid egress and building evacuation, the New York City Building Code requires stairwells in all high-rise buildings to have certain way-finding features, including illuminated exit signs and photo-luminescent exit path markings.[17] In terms of lighting and layout, the NYPD endorses Recommendation 18 of the NIST report of 2005, suggesting that egress systems should be designed with consistent layouts and standard signage and guidance so that systems become intuitive and obvious to building occupants during evacuations.[18]

With respect to stairwell location, the NIST report of 2005 found that the clustering of stairwells in the building core at impact level prevented many people above the impact floors from evacuating in WTC1.[19] By contrast, because the stairwells at impact level in WTC2 were more dispersed, located along different boundaries of the building core, evacuees had access to a greater number of stairwells, allowing more people to escape.[20] For all High Tier buildings and Medium Tier buildings taller than 600 feet, the NYPD endorses Recommendation 18 of the NIST report, which outlines the importance of remoteness and physical separation of stairwells on each floor without negatively impacting the average travel distance.[21] Additionally, the NYPD recommends that building owners incorporate two or more remotely located stairwells on each floor so that in the event the primary core stairwell becomes compromised, the other stairwells can be used for egress.[22]

The New York City Building Code provides for the use of emergency elevators, connected to emergency power supply, as an "accessible means of egress" to ensure adequate evacuation opportunities for disabled persons.[23] Additionally, the inclusion of smoke-proof elevators as part of a building's emergency egress design may enhance building evacuation efforts and facilitate emergency response.

Communication Systems

Communication systems that promote swift information sharing are vital to saving lives in the event of an attack on a large building. Some communication systems allow emergency-service personnel to give instruction or relay important safety information to building occupants (e.g., "shelter in place" or "evacuate"). Other communication systems allow emergency service personnel to coordinate a response and to better understand the nature of the damage to a building and the dangers they face.

Recommendation 19 of the NIST report of 2005 advises building owners, managers, and emergency responders to work together to develop a joint plan to ensure the accurate and timely communication of emergency information to building occupants and emergency responders in the event of an attack. According to the report, this can be accomplished through: better coordination of information among emergency responder groups; efficient sharing of information between emergency responder groups and building occupants; a more robust design of emergency public address systems; improved emergency responder communication systems; and the use of the Emergency Broadcast System (now known as the Integrated Public Alert and Warning System) and Community Emergency Alert Networks.[24]

With respect to emergency-responder radio communication, the NYPD, the New York City Fire Department (FDNY), and the Port Authority Police Department all reported difficulties with their hand-held units in the immediate aftermath of the attacks of September 11, 2001.[25] Recommendation 22 of the NIST report of 2005 addresses the installation, inspection, and testing of emergency-communication systems, radio communications, and associated operating plans to ensure their effective use in large-scale emergencies and their functionality in buildings with problematic radio-frequency propagation.[26] The vast majority of buildings in New York City have sufficient radio signal at and above grade for NYPD radios to function properly in case of emergency. Owners of Medium and High Tier buildings experiencing significant attenuation of radio signals, or owners of High Tier buildings with significant below grade estate, should consult with the NYPD Communications Division and FDNY before designing or installing in-building radio systems utilizing bi-directional amplifiers that retransmit NYPD and other emergency responder frequencies. To be authorized to install or activate an in-building radio system, a building owner must develop a proposal that complies with NYPD and FDNY requirements as well as FCC regulations. The NYPD and FDNY will consult on whether installation of an in-building radio system is necessary; and if so, the design and installation standards that can minimize interference to incumbent outdoor FCC-licensed public safety and commercial land-mobile radio systems. Additionally, the NYPD recommends that critical emergency-responder radio systems installed in commercial buildings be connected to emergency power systems.


POLICE
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HAZMAT

CHAPTER SEVEN

GUIDELINES ON AIR HANDLING & AIR MONITORING SYSTEMS

To date, most terrorist attacks have involved small arms or conventional explosives. There is, however, increasing evidence of terrorist interest in unconventional weapons. The intentional release of hazardous material is particularly dangerous in urban environments due to the dense concentrations of people and buildings. This chapter addresses the threats from chemical, biological, and radiological (CBR) weapons and recommends certain detection and mitigation methods. Specifically, it presents general guidelines for High Tier buildings pertaining to HVAC systems. It covers access to HVAC systems, as well as HVAC system air intakes, filtration, and ventilation. The chapter also covers detection technologies as they relate to CBR threats. Because this field is rapidly changing, the NYPD's recommendations related to countering CBR threats will continue to evolve as new technologies and countermeasures emerge.

CBR Threats

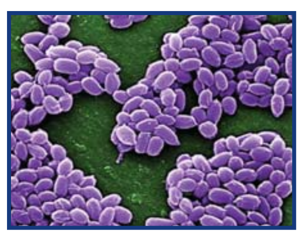
Chemical, biological, and radiological weapons have distinct characteristics and carry varying consequences. Each category of weapon encompasses a wide variety of agents. In general, chemical weapons are extremely lethal, highly toxic poisons that move in a gaseous or liquid form. Chemical agents are especially dangerous when deployed in confined spaces. For example, whereas cyanide vapor released in an open space may be diluted rapidly, resulting in minimal impact, the same amount of vapor released in an enclosed space may be lethal.[1]

Biological weapons are pathogenic micro-organisms or biologically produced toxins which cause serious illness or death. Biological attacks involve the deliberate release of large quantities of infectious organisms against a target population, generally as an aerosol (i.e., a collection of small particles suspended in the air). A few kilograms of effectively disseminated biological agents can cause tens to hundreds of thousands of casualties.[2] However, without an effective system for aerosol dissemination, biological weapons cannot easily cause casualties on a mass scale.

Radiological weapons are often grouped with nuclear weapons but are fundamentally different. Nuclear weapons release vast amounts of energy either through nuclear fission or through a combination of fission and fusion. If a nuclear weapon were deployed in a dense, urban environment, the damage would be catastrophic.[3] Radiological weapons disperse radioactive substances but do not produce a nuclear explosion. The simplest radiological weapons would consist of a conventional explosive surrounded by radioactive material; this is commonly referred to as a "dirty bomb." Crude radiological weapons are unlikely to produce mass casualties but could create public fear if deployed.

Although terrorist groups have to date failed to successfully deploy a radiological weapon, they have attempted to acquire, and in a few cases have successfully deployed, chemical and biological weapons. For instance, in 1995, members of the Aum Shinrikyo religious cult carried out five coordinated chemical attacks in Tokyo, Japan. The group dropped plastic bags filled with sarin solution, punctured to allow the agent to leak into train cars and station platforms. The incident killed a dozen people and injured several thousand.[4] Six years later, a series of letters containing *Bacillus anthracis* (the causative agent of the disease anthrax) were sent to addresses in New York City, Washington, D.C., and Florida, including to several news outlets and two U.S. Senators. Over the course of two months, exposure to *B. anthracis* killed five people and sickened nearly two dozen.[5]

Al Qaeda has shown interest in the use of unconventional weapons. In 2002, the U.S. military discovered a laboratory in Kandahar, Afghanistan, in which Al Qaeda is believed to have been producing *B. anthracis*.[6] In 2003, a Saudi cleric affiliated with Al Qaeda issued a *fatwa* declaring the permissibility of the use of weapons of mass destruction against



B. anthracis spores

"infidels."[7] In another instance, Al Qaeda attempted to produce a compact chemical dispersal device called a "*mubtakar*" for disseminating cyanogen chloride and hydrogen cyanide in an enclosed space.[8] In 2007, insurgents in Iraq used cylinders of chlorine in conjunction with explosive devices in at least ten attacks.[9]

HVAC Systems

HVAC systems are important tools for limiting the effects of a CBR attack since they are capable of handling, filtering, and treating air after an event. Effective HVAC-system design for High Tier buildings requires consideration of how best to prevent the intake of contaminated air; how to filter contaminated air once it is introduced; how to control and ventilate contaminated air; and how to contain air within certain zones of a building.

Access

The NYPD recommends that owners of High Tier buildings locate HVAC system controls away from public areas, such as lobbies, loading docks, or mailrooms.[10] System designers should also position return-air grilles in locations that are in view of security personnel but inaccessible to the public.[11] If the building's HVAC system is on the roof, the NYPD recommends the use of magnetic contacts at roof access points as part of an intrusion-detection system to detect unauthorized entry.[12] As covered in detail in Chapter Five, owners of High Tier buildings should restrict access to mechanical rooms housing HVAC systems to authorized and credentialed personnel and strictly limit access to HVAC schematics, which are considered sensitive security documents.[13]

Air Intakes

Industry standards consistently recommend that designers place air intakes above ground to guard against the introduction of CBR agents into the building. However, the prescribed optimal height for air intakes varies by agency. The New York City Mechanical Code requires air intakes to be positioned at least 20 feet above ground level.[14] At a minimum, the NYPD recommends that owners of High Tier buildings position air intakes higher than the second story of a building.[15] If feasible, owners of High Tier buildings should position air intakes 100 feet above ground level or higher, to protect against the threat from a ground release of a

CBR agent propelled upward by the "urban street canyon effect," common in urban environments with tall skyscrapers.[16] For existing buildings, designers may be able to retrofit at grade air intakes with ducts to raise intake points.[17] Finally, the NYPD recommends that owners of High Tier buildings ensure that all intakes are covered with non-magnetic screens to prevent the attachment or entry of hazardous objects.[18]

Filtration

High efficiency filtration can provide a certain level of defense against unconventional terrorist threats. HVAC systems can capture hazardous particulates in their filters, including some CBR agents, and thus prevent dissemination throughout the building. Accordingly, the NYPD recommends that owners of High Tier buildings invest in advanced filtration systems that can afford a measure of protection against CBR threats.[19]

Chemical materials generally move in a gaseous form and necessitate adsorption filters; these filters operate through a chemical process which attracts the hazardous molecules to activated carbon within the filter.[20] Airborne biological and radiological materials move in the form of small particulates, and thus require solid particle filters; these filters operate by capturing particles that are smaller than a certain pore size.

Particle filters are assigned a value called the minimum efficiency reporting value (MERV) rating. Higher MERV ratings reflect more efficient and effective filters. For example, a MERV-13 filter captures less than 75 percent of particles between the size of 0.3 and 1.0 micron, whereas a MERV-16 filter captures greater than 95 percent of particles within that range.[21] The NYPD recommends that owners of High Tier buildings incorporate solid particle filters with high MERV ratings.[22] In particular, High Tier buildings should use multiple MERV-16 filters, at least one MERV-17 filter, or a high-efficiency particulate air (HEPA) filter.[23] MERV-17 filters and HEPA filters are 99.97 percent effective at removing particulate matter greater than 0.3 micron in size, including biological agents such as *B. anthracis*.[24] However, hazardous particles less than 0.3 micron in size are likely to pass through the recommended filters.

Ultraviolet (UV) radiation technology can be coupled with filtration systems to maximize the effectiveness of HVAC systems in eliminating hazardous particles.[25] Biological agents are vulnerable to UV radiation, because a certain level of exposure is lethal to micro-organisms. Although HVAC systems equipped with UV technology may not effectively mitigate every CBR threat scenario, owners of High Tier buildings should nonetheless consider their use, when feasible.[26] UV radiation technology may be more expensive than other particle-eliminating systems; therefore, the NYPD recommends that owners of High Tier buildings analyze the costs and benefits of such solutions.

Ventilation and Emergency Response Plans

The NYPD recommends that owners of High Tier buildings prepare protocols to manage CBR release events through a process of detection, assessment, and fan and damper operations. This process should exploit fan-system zoning and manipulate supply, return, and pressurization fans to isolate airborne hazards and establish areas of refuge. As an additional precaution, owners of High Tier buildings should install dedicated and independent HVAC systems for interior spaces and public areas, such as lobbies, loading docks, cargo-screening areas, and mail rooms.[27] In the event of a CBR attack, these segregated HVAC systems may reduce the chance of contaminants spreading throughout the building.

CBR agents have distinct characteristics and thus necessitate distinct ventilation responses in the event of an attack. Therefore, owners of High Tier buildings should devise comprehensive and detailed response procedures that are guided by specific CBR threats. The NYPD recommends that owners of High Tier buildings ensure that building managers prepare instructions that indicate when building operators should shut down HVAC systems or increase air circulation in certain zones.[28] Additionally, redundant emergency HVAC controls should be readily available in High Tier buildings for trained personnel to control air flow, if necessary, and to enhance survivability.[29] In emergency situations, system operators should take direction from emergency response personnel.

The NYPD recommends that owners of High Tier buildings use HVAC systems capable of rapidly ventilating interior air to the outside if the threat necessitates such a response.[30] Building owners should coordinate occupant evacuation plans with emergency HVAC protocols to ensure that ventilation systems do not pump contaminated air into evacuation areas in the event of an attack.

CBR Detection Systems

An effective strategy for countering CBR threats requires early and reliable detection capabilities. Accordingly, the NYPD recommends that owners of High Tier buildings monitor chemical, biological, and radiological detection technologies and carefully study the benefits of implementing such systems.[31] Unfortunately, there is currently no all-inclusive or standardized CBR detection suite; building owners must make individual decisions about whether to purchase chemical, biological, and radiological detectors, and must do so with the knowledge that these technologies are rapidly evolving. When possible, owners of High Tier buildings should attempt to have the detectors they select certified by a national or independent laboratory and should maintain records of such tests.

For chemical agents, owners of High Tier buildings should consider installing detection technology in air ductwork systems and remote sensing systems in areas with large occupancy populations.[32] Additionally, optical sensors, such as CCTV cameras, may be able to detect gross symptomology immediately following a chemical attack. For radiological agents, owners of High Tier buildings should consider the use of screening technologies such as portal monitors, spatial detectors, handheld detectors, and personal pagers. For biological agents, detection systems are mostly in the research and development stage.[33] The NYPD recommends that owners of High Tier buildings consider the use of effective biological pathogen detectors, as the technology advances and becomes commercially available.

Because releases of CBR agents outside of a building can also affect building occupants, owners of High Tier buildings should consider placing detection technology on the exterior of the building, as well as on the interior. Upon detection, building managers can close off air intake into the building.[34] Owners of High Tier buildings employing such technology should notify emergency-response agencies of the location and capability of their outdoor detection sensors.

NYPD CBRNE Information Center

The NYPD recommends that owners of High Tier buildings integrate CBR detection equipment into central security management control and building management systems so that building personnel are immediately notified of intentionally released hazards.[35] In all cases, owners of High Tier buildings should inform local law enforcement and first responders of the building's CBR countermeasures and associated emergency protocols.

The threat of CBR terrorist attacks is constantly evolving. The technical expertise required to produce CBR weapons has become increasingly widespread and many of the materials needed to construct these weapons have become more readily available on the open market.[36] However, by implementing the most advanced countermeasures available, building owners can prevent casualties and mitigate property damage in the event of a CBR attack.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CONCLUSION

The purpose of *Engineering Security* is to provide a forward-looking, informative reference for building owners, developers, architects, and engineers seeking to manage the terrorist threat to buildings. With the incredible diversity and complexity of modern construction projects, security is only one concern among a range of important considerations facing the building community. The recommendations set forth in this document are not mandatory; they are voluntary and apply only to a small subset of buildings facing the greatest risk of terrorism.

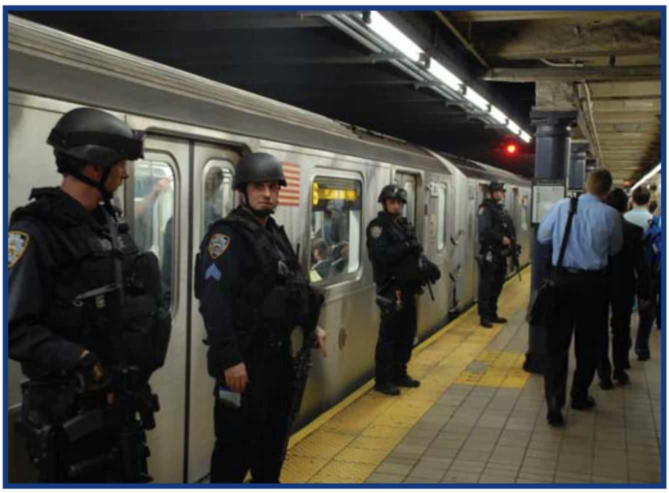
Each building faces a unique set of security concerns that requires owners and designers to devise specifically tailored security plans. Chapter One provided an overview of the threat to buildings from explosive devices. Most of the recommendations presented in *Engineering Security* focused on measures to counter threats from vehicle-borne and man-portable improvised explosive devices.

No single strategy or approach is suitable for protecting all buildings from all potential threats. Thus, the first step in devising an effective strategy for protective security design involves calculating the risk of terrorism facing a particular building. Accordingly, Chapter Two presented a risk assessment system and provided a methodology for determining whether a building falls into a Low, Medium, or High Tier. The subsequent chapters presented a series of recommendations corresponding to risk tier.

Chapter Three covered the use of a vehicle threat vector analysis to determine whether a building should design for a hard or soft perimeter, emphasizing the importance of standoff for securing buildings. Chapter Four focused on site layout and orientation as well as design methods to minimize the hazards from debris and prevent collapse. Chapter Five discussed access control, screening, and monitoring systems and procedures. Chapter Six covered emergency preparedness, with recommendations related to fire resistance, emergency egress, and communication systems.

Engineering Security also reflects a desire to identify emerging threats and preempt future attack scenarios. Because terrorist organizations have shown an increasing interest in using chemical, biological, and radiological agents, Chapter Seven focused on CBR detection and mitigation techniques with the acknowledgement that unconventional weapons technology is rapidly evolving.

Overall, the protective security design approach offered by the NYPD seeks to minimize the maximum potential casualties, damage, and economic loss caused by a terrorist attack. The recommendations are meant to serve as a general framework, not an exhaustive security plan, and will evolve as terrorist tactics and associated countermeasures emerge. Building owners may also choose to implement additional security measures not covered in the document. An effective plan is best achieved through a public-private partnership between security experts and the design community.



APPENDIX A

CALCULATING A BUILDING'S RISK TIER

The three steps set out in this Appendix can be used to determine whether a building falls into a Low, Medium, or High Tier. The attached worksheet can be used to perform the calculations described below.

STEP ONE: Calculating Sub-Factor Scores and Factor Ratings

The first step in arriving at a building's overall risk tier is determining a rating for each factor – threat, vulnerability, and impact. Based on the definitions outlined below, assign a score of 1, 2, or 3 to each sub-factor. Add the sub-factor scores within each factor to determine the ratings for threat, vulnerability, and impact. The NYPD has defined each factor and sub-factor as follows:

Threat

A building's threat rating is the sum of the scores of two sub-factors: threat profile and target attractiveness. Because threat consists of only two sub-factors, the threat rating should range from 2 to 6. Scores for each threat sub-factor should be allocated as follows:

Threat Profile

1: Limited – the building has no general or credible specific threats and no threat history.

2: Moderate – the building falls into a category that is the subject of a past or present general threat but is not and has not been the target of a credible specific threat.

3: Significant – the building currently is, or has been, the target of one or more credible specific threats.

Target Attractiveness

1: Limited – neither the building's architectural design nor its occupants or operations is nationally recognizable.

2: Moderate – the building's occupants and/or operations are nationally recognizable.

3: Significant – the building's architectural design is nationally recognizable.

Vulnerability

A building's vulnerability rating is the sum of the scores of three sub-factors: adjacency, accessibility, and structural performance. Because vulnerability consists of three sub-factors, the vulnerability rating should range from 3 to 9. Scores for each vulnerability sub-factor should be allocated as follows:

Adjacency[1]

1: Limited – the building has no High Tier buildings located within 300 feet of it.

2: Moderate – the building has at least one High Tier building located less than 300 feet, but more than 150 feet from it.

3: Significant – the building has at least one High Tier building located within 150 feet of it.

Accessibility

1: Limited – the movement of people in the building is controlled to a significant degree, including limited access to sensitive areas, and vehicles cannot enter the building and must be screened or otherwise obstructed before approaching.

2: Moderate – the movement of people in the building is controlled; or vehicles are screened or otherwise obstructed before approaching. If vehicles are able to enter the building (e.g., through an internal parking garage or, in a handful of cases, on a street that cuts through the building), vehicles are screened prior to entry.

3: Significant – the movement of people in the building is not controlled, or is controlled only to a limited degree, and vehicles are neither obstructed nor screened before approaching or entering.

Structural Performance

1: Limited – for threats from the true perimeter, the building's primary structural elements satisfy M3 standards; and for threats from a contact charge, the building's columns satisfy M1 standards.

2: Moderate – for threats from the true perimeter, the building's primary structural elements satisfy M3 standards; or for threats from a contact charge, the building's columns satisfy M1 standards.

3: Significant – for threats from the true perimeter, the building's primary structural elements do not satisfy M3 standards; and for threats from a contact charge, the building's columns do not satisfy M1 standards.

Impact

A building's impact rating is the sum of the scores of four sub-factors: maximum occupancy or height, economic criticality, transportation criticality and proximity, and critical infrastructure proximity. Because impact consists of four sub-factors, the impact rating should range from 4 to 12. Scores for each impact sub-factor should be allocated as follows:

Maximum Occupancy or Height

1: Limited – the building has a maximum occupancy level of less than 5,000 people and is shorter than 600 feet.

2: Moderate – the building has a maximum occupancy level between 5,000 and 10,000 people or measures between 600 and 800 feet.

3: Significant – the building has a maximum occupancy level of more than 10,000 people or is taller than 800 feet.

Economic Criticality

1: Limited – a successful attack on the building could impact the local or regional economy, with limited or no effect on the national economy (total economic losses estimated at less than $1 billion).

2: Moderate – a successful attack on the building could considerably impact the local or regional economy, or affect the national economy in the immediate aftermath of the attack (total economic losses ranging from $1 billion to $10 billion).

3: Significant – a successful attack on the building could severely impact the local or regional economy, or affect the national economy for an appreciable period of time, beyond the immediate aftermath of the attack (total economic losses in excess of $10 billion).

Transportation Criticality and Proximity

1: Limited – the building sits atop as many as one set of transit lines, or is located adjacent to the footprint of a transportation station servicing as many lines.

2: Moderate – the building sits atop two to four sets of transit lines, or is located adjacent to the footprint of a transportation station servicing as many lines.

3: Significant – the building sits atop five or more sets of transit lines, or is located adjacent to the footprint of a transportation hub or transfer point servicing as many lines; or, the building sits atop a vehicular tunnel or is adjacent to the entrance to a bridge.

Critical Infrastructure Proximity

1: Limited – the building is not located so close to critical infrastructure that a successful attack against the building would have implications for service beyond the building itself.

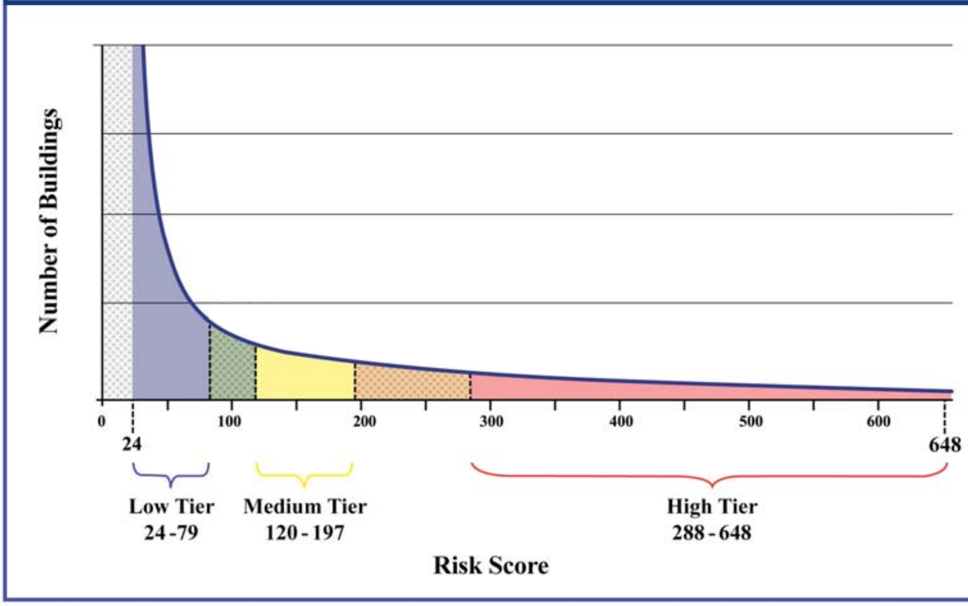
2: Moderate – the building is located so close to critical infrastructure that a successful attack against the building would have implications for – but would not severely disrupt – service beyond the building itself.

3: Significant – the building is located so close to critical infrastructure that a successful attack against the building would severely disrupt service beyond the building itself.

STEP TWO: Calculating the Final Risk Score

The second step in arriving at a building's overall risk tier is determining the final risk score. Multiply the impact, vulnerability, and threat ratings to determine the final risk score. The final risk score should range from 24 to 648.

Figure 5: Distribution of Buildings by Risk Tier



Note: This chart is an approximation meant to illustrate a general distribution of buildings in New York City.

STEP THREE: Determining the Risk Tier

Finally, to determine the overall risk tier of a particular building, use the worksheet provided in this Appendix. Generally, Low Tier buildings achieve a final risk score between 24 and 79; Medium Tier buildings achieve a final risk score between 120 and 197; and High Tier buildings achieve a final risk score between 288 and 648. There are two zones in which the appropriate tier may be determined by further analysis and consultation with the NYPD Counterterrorism Bureau: buildings that achieve scores between 80 and 119 may qualify as Low or Medium Tier; and buildings that achieve scores between 198 and 287 may qualify as Medium or High Tier. The NYPD protective security design recommendations outlined in Chapters Three through Seven apply to Medium and High Tier buildings.

Step One:

For each sub-factor, list the value (1-3) that most accurately describes your building. Sum sub-factor scores to determine factor ratings.

Threat

Threat Rating: _____

Threat Profile _____

1: Limited
2: Moderate
3: Significant

Target Attractiveness _____

1: Limited
2: Moderate
3: Significant

Vulnerability

Vulnerability Rating: _____

Adjacency _____

1: Limited
2: Moderate
3: Significant

Accessibility _____

1: Limited
2: Moderate
3: Significant

Structural Performance _____

1: Limited
2: Moderate
3: Significant

Impact

Impact Rating: _____

Maximum Occupancy / Height _____

1: Limited
2: Moderate
3: Significant

Economic Criticality _____

1: Limited
2: Moderate
3: Significant

Transportation Criticality/Proximity _____

1: Limited
2: Moderate
3: Significant

Critical Infrastructure Proximity _____

1: Limited
2: Moderate
3: Significant

Step Two:
Multiply the factor ratings to arrive at the final risk score.

Threat	x	Vulnerability	x	Impact	=	Risk Score
______	x	________	x	________	=	_________

Step Three:
Determine the building's NYPD Risk Tier using the tier chart.

Risk Score	NYPD RISK TIER
288 - 648	High
198 - 287	Medium / High
120 - 197	Medium
80 - 119	Low / Medium
24 - 79	Low

NYPD RISK TIER:

____

APPENDIX B

NEW YORK CITY BUILDING CODE & NIST RECOMMENDATIONS

The NIST report of 2005 on the World Trade Center Towers made 30 specific recommendations regarding building standards, codes, and practices, as well as the technical aspects of evacuation and emergency response. Cities around the nation, however, model their municipal building codes on the International Building Code (IBC), which is produced and updated from time to time by the International Code Council. The following table summarizes the extent to which the recommendations of the NIST report of 2005 have been incorporated into the 2009 edition of the IBC and the New York City Building Code, effective July 1, 2008.

NIST Recommendation		International Building Code	NYC Building Code
1	Structural/progressive collapse	Not yet adopted	Already adopted [key element analysis: BC 1626; continuity and ties; BC 1917, 2114, 2213].
2	Wind tunnel testing for tall structures	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
3	Sway limits for wind and earthquakes	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.

NIST Recommendation	International Building Code	NYC Building Code
4 Evaluating current fire-rating and construction classification	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
5 Revise testing and fire-rating national standard	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
6 Increase bond strength and testing for spray fire-proofing materials	Partly adopted [increased bond strength by a factor of 3 over prior requirements in buildings 75 ft. to 420 ft. and by a factor of 7 in buildings more than 420 ft.].	Not yet adopted **IBC adopted items to be reviewed in the next code cycle.**
7 "Structural frame" approach to fire-resistance ratings	Already adopted	Already adopted
8 Structural performance assuming an uncontrolled fire to burnout	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
9 Performance-based standards as an alternative to current prescriptive design methods	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
10 Development of new fire-resistant coating materials	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
11 Fire evaluation of high-performance structural materials expected in building fires	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
12 Redundancy of active fire-protection systems	Already adopted [redundancy of sprinkler system in buildings over 420 feet in height].	Not yet adopted **To be reviewed in the next code cycle.**

NIST Recommendation		International Building Code	NYC Building Code
13	Improvement in fire alarm and communication systems	Partly adopted [increasing the size of the fire command station].	Not yet adopted **IBC adopted items to be reviewed in the next code cycle.**
14	Improving fire/emergency control panels	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
15	Off-site transmission and storage of information for emergency responders	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
16	Evacuation and Emergency preparedness training	Not applicable	Not applicable
17	Egress capacity increase to accommodate full building evacuation	Partly adopted [(a) additional exit stairway for buildings more than 420 feet in height; (b) use of elevators as a means of egress; (c) increase of 50 percent in the width of exit stairways for buildings with floor areas exceeding 15,000 sq. ft.].	Not yet adopted **IBC adopted items to be reviewed in the next code cycle.**
18	Remoteness of exits; integrity/survivability of exits; and signage/guidance of egress systems	Partly adopted [(a) additional exit stairway for buildings more than 420 feet in height; (b) exit stairs measured from walls of enclosure and not the door to enclosure for buildings over 75 feet; (c) hardened stairways and elevators shafts (all buildings over 420 ft. and some buildings between 75 ft. and 420 ft.); (d) luminous egress path markings for buildings over 75 feet; (e) other various egress signage enhancements].	Partly adopted [(a) hardened stairways and elevators shafts (all buildings over 75 ft.); (b) luminous egress path markings for buildings over 75 feet]. **Other items to be reviewed in the next code cycle.**

NIST Recommendation		International Building Code	NYC Building Code
19	Communication and coordination of emergency information	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
20	Evaluation of evacuation technologies	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
21	Structurally hardened fire service elevators	Partly adopted [(a) a minimum of one fire service access elevator for buildings over 120 feet in height; (b) improved lighting for emergency hoistway; (c) protection of hoistway equipment from water intrusion].	Not yet adopted **IBC adopted items to be reviewed in the next code cycle.**
22	Emergency communications standards and testing	Partly adopted [emergency responder radio coverage].	Not yet adopted **IBC adopted items to be reviewed in the next code cycle.**
23	Emergency responder situational awareness enhancement	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.
24	Command and Control Systems for building emergencies	Partly adopted [increasing the size of the fire command station].	Not yet adopted **IBC adopted items to be reviewed in the next code cycle.**
25	Application of local building code requirements to governmental and quasi-governmental entities	Not applicable	Not applicable
26	Aggressive enforcement of codes with regard to sprinklers and egress	Not applicable	NYC already aggressively enforces building code.
27	Building document retention	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.

NIST Recommendation	International Building Code	NYC Building Code
28 Role of the "Design Professional in Responsible Charge" for complex designs	Not yet adopted	NYC does not have the concept of a "Design Professional in Responsible Charge." **Concept of a "Design Professional in Responsible Charge" be reviewed in the next code cycle.**
29 Continuing education requirements	Not applicable	Not applicable
30 Development of fire analysis tools	Not yet adopted	Not yet adopted To be reviewed after a national standard is completed and available for review.

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6. All values are expressed in 2009 dollars.

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29. FEMA 426, Ch. 2, pp. 47-49.

30. CDC, *Guidance for Protecting Building Environments*, p. 19.

31. FEMA 426, Ch. 5, pp. 26-31.

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Appendix A: Calculating a Building's Risk Tier

1. The NYPD Counterterrorism Bureau can assist in determining risk levels for neighboring buildings.

New York City Police Department
Counterterrorism Bureau
One Police Plaza
New York, New York 10038