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Civil Engineering and Environmental Department

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Scholarly Paper

“Terrorism and its Impact on the Construction Industry”



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CHAPTER 1 INTRODUCTION

On September 10th, 2001 the United States enjoyed one of the most dynamic time periods in world politics. In the 90's, the Cold War as was known by the baby boomer generation had ended and the United States established itself as the lone true superpower in the world. Despite a slight slowing of its economy when compared to the 90's and several low level terrorist attacks American's felt a sense of world calmness. Most of America's political and economic focus was on domestic and economic issues.

Meanwhile, in Afghanistan a place that few Americans could identify on a map, there stood a Muslim extremist whose name was synonymous with the construction industry of the Middle East. Osama Bin Laden whose father created the largest construction company in the Middle East the Bin Laden Group was planning a jihad against all Americans. His hatred for westerners in particular Americans can be traced to the removal of the Soviets from Afghanistan and the continued American presence in the Middle East after the liberation of Kuwait. To fundamentalists like Bin Laden the presence of non-Muslims in the two holiest sites of Mecca and Medina was incomprehensible. Bin Laden clearly expresses these feelings in a 1998 interview for ABC News:

"Allah ordered us in this region to purify the Muslim land of all non-believers and especially in the Arabian Peninsula... We believe that the biggest thieves in the world and the terrorists are the Americans ... We do not differentiate between those dressed in military uniforms and civilians; they are all targets in this Fatwa (religious ruling)." (Miller)

Despite attacks on the World Trade Center (truck bomb '93), American embassies in Tanzania and Kenya, the Al-Khobar Towers in Saudi Arabia, and the USS COLE Americans at the very highest level of government did not comprehend the global reach capability of Bin Laden's organization. The United States on September 10th had a very loose attitude toward homeland security much of which continued to be based on a Cold War position.

This attitude would change drastically on September 11th, 2001. These most horrific of attacks would forever change the lives of nearly all Americans. Some of the more easily linked results of the attacks are the war on terrorism and America's firm stance related to homeland security but this event touched much more than that to include the construction industry. The attacks had an immediate and forever lasting impact on the construction industry.

When American Airline flight 77 hit the Pentagon it left a wake of destruction in its path that was incomprehensible to those that worked there. Not only were 184 individuals killed at the Pentagon that day but the tip of America's military spear had been badly damaged. With a renovation project already ongoing the importance of which increased ten-fold. Following the attacks contractors quickly moved to restore the facility's full

capability, this action was critical to the ongoing execution of military operations throughout the world.

The focus of this paper will be on some of the more subtle impacts that the attacks have had on project management and the construction industry. Every construction project has a project life cycle. This paper will break the project lifecycle down into three phases Initiation, Design, and Procurement / Construction. For each of these phases it will examine the impact terrorism has had on it and what these impacts may hold for the future.

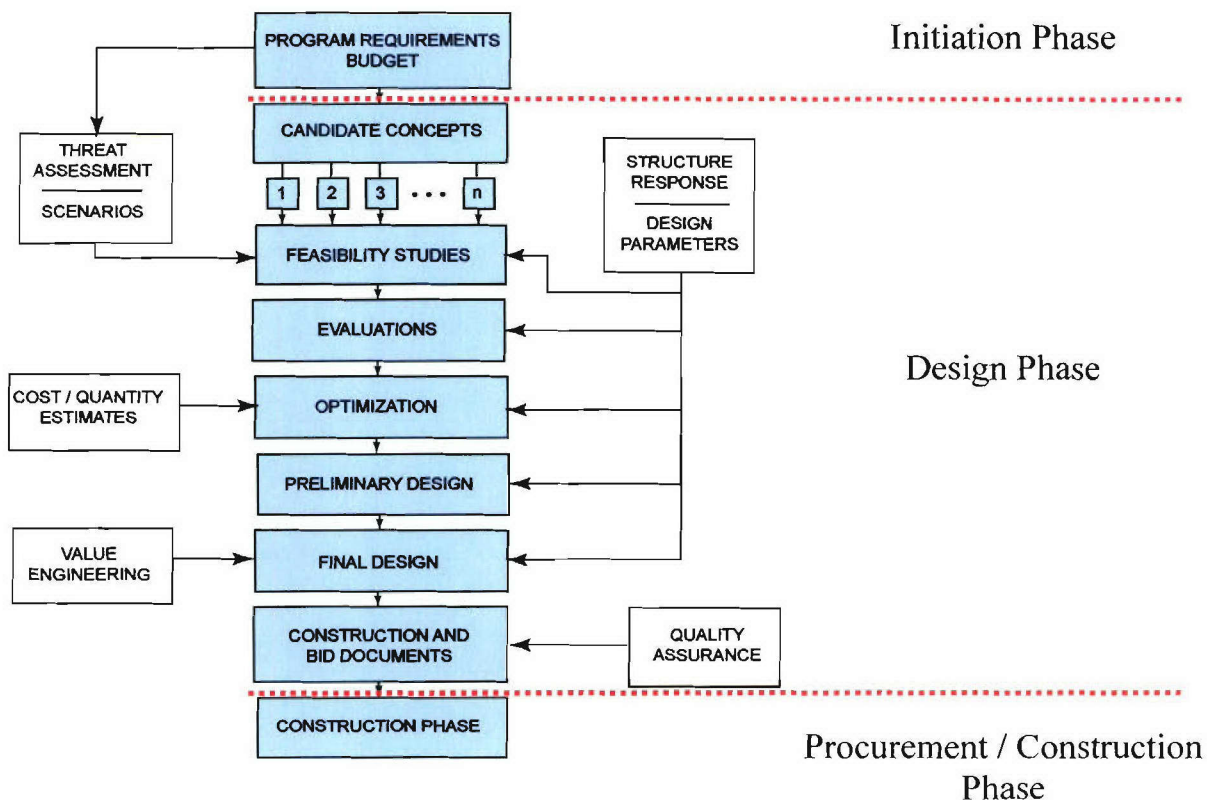


Figure 1.1: Project Life Cycle to include Security Review

(Courtesy of FEMA 427 Primer for Design of Commercial Buildings to Mitigate Terrorist Attack p. 6-17)

The figure above shows the three phases of a project life cycle and what actions are occurring in each of those phases. It also shows, that at the earliest stages of project development concerns with respect to terrorism and security are part of the project planning and must continue throughout the life of the project.

The Initiation Phase will look at the impact on what projects are being funded today as a result of the attacks. There are sectors of the construction industries such as force protection specialists whose workloads have increased exponentially since 9/11. In

addition, there are other impacts to this phase such as how contracts are structured to protect the interests of certain contractual parties.

In the Design Phase we'll review the changes that are being incorporated into building design to help mitigate the effects of a terrorist attack. Often looked at as being too costly to incorporate considering the risk, many new high visibility projects are including design modifications to increase the survivability of the building patrons. The excuse used in the past that an attack will never happen here in the United States is no longer valid. Both public and private organizations are feeling the need to protect their workers.

The Procurement / Construction Phase has also seen changes as a result of the events of 9/11. In the federal government there was an immediate reaction to improve the security surrounding many of its facilities. The fastest method to accomplish this was not using some of the more traditional contractual approaches rather to use procurement strategies such as design-build which allow projects to be fast tracked. Also, stemming from this was a sharp increase in secured construction. This increase brought about the need for more contractors to have the capability to perform secured facility construction which presents unique challenges often not considered on normal unsecured construction.

There is no doubt that the 9/11 terrorist attacks have impacted many industries throughout the United States. The construction industry like many others is certainly operating under a different set of pretenses that could have never been conceived by the average American prior to the attacks. Both public and private projects have been impacted but even four years removed from the attacks the long-term impacts have yet to be truly determined.

CHAPTER 2 INITIATION PHASE

2.1 INTRODUCTION

The start to all construction projects is the initiation phase. This phase begins with the owner, either a corporation or government body, recognizing the need for a facility to meet a specific need or requirement. Private corporations are often driven by economic factors which decide what facilities are necessary to allow expansion in business activities. Conversely, government bodies often use different criteria having more to do with meeting the needs of its constituents.

This initial phase is the first of several “go / no go” decision points. At each of these decision points the owner must determine if the project is still required given the data which has been collected. The impact of terrorism has generated a huge workload for the construction industry. Projects which were being cancelled because the owner felt the money could be better spent elsewhere are now at the forefront. The reason for this change in attitude is directly related to terrorism and the new perceived threat here within the borders of the United States. Despite the earlier terrorist attacks of the 90’s the attitude of Americans which was reflected in the government was that terrorism is an overseas problem not a homeland security issue. For that reason the government was spending money overseas to improve the security at U.S. embassies and military installations but was not spending any money within the U.S. to protect its borders. Following the attacks of 9/11 there was a huge shift in this attitude toward homeland security.

2.2 NEW PROJECT DEMANDS

New project demands have been created as a result of terrorist activity. The resulting projects are in a wide variety of areas and have created a significant opportunity for contractors and design professionals.

2.2.1 Utilities: Water, Power and Pipelines

Congress has required every community water system serving more than 3,300 persons to conduct an assessment of its vulnerability to a terrorist attack. For large systems (those involving populations of 100,000 or more), such assessments were required to have been completed by March 31, 2003. Medium-sized systems (serving populations of 50,000 to 100,000) were required to be completed by December 31, 2003. All others covered by the law must be completed by June 30, 2004 (De Van).

Congress also has appropriated funds to upgrade community water systems to make them less vulnerable to attack. The type of work which resulted from the review included purchasing security systems (such as fencing) and making certain system components tamper-proof.

The vulnerability of our power grid was clearly demonstrated by the Northeast blackout in 2003. Thankfully this condition was not as a result of terrorism but it did show the devastating impact this condition can have on a region. New York City saw its public transportation fail, water supplies impacted, cell phones shutdown, and the closing of major financial institutions to include the stock exchange.

As a result the electric power industry has initiated programs to increase security. The Nuclear Regulatory Agency is assessing reactor vulnerabilities. The North American Electric Reliability Council recently hosted a conference to explore conventional power plant vulnerabilities. The Federal Energy Regulatory Commission has proposed regulations relating to cyber-security for the electrical grid (De Van). As these programs progress, new standards will evolve, and numerous plants will need to be upgraded.

In 2002, Congress also enacted the Pipeline Safety Improvement Act (P.L. 107-355), which requires the Departments of Transportation and Energy, together with other agencies, to use their expertise in consultation with industry representatives to carry out a program of research, development and standardization regarding pipeline safety (De Van). One aspect of the research is finding ways to improve and standardize security against terrorist threats. The initiative seems certain to lead to increased spending by pipeline owners.

2.2.2 Transportation

While airport security has gotten the most public attention, the construction industry likely will be more affected by provisions of the Maritime Transportation Security Act of 2002 (MTSA). As with water systems, MTSA requires a vulnerability assessment for each port. This assessment, however, is to be conducted by the Coast Guard. Once the assessment is completed, the Department of Transportation can grant up to 75 percent of the cost of making improvements to ports to secure them from terrorist attack. Unfortunately, Congress has yet to fully fund this program, but the current cost estimate for completing the assessments and upgrades is \$7.9 billion over the next 10 years (De Van).

2.2.3 Secure Facility Construction

The construction of secure facilities has recently become a reenergized form of construction. During the Cold War of the 50's and 60's bomb shelter were built across America by individuals and local and national governments to protect citizens and critical government assets against a possible nuclear attack by the Soviet Union. Today the construction of these facilities has begun again with the threat spectrum expanded from not only nuclear devices but also chemical, biological and other unconventional weapon systems. The possibility of a rogue nation launching a nuclear warhead against the Washington, DC metropolitan area is still a concern but there are additional threats to include the possibility of a terrorist group using smaller, difficult to detect, mobile weapons platforms to strike. The desire of such organizations is often to inflict the most

damage to create hysteria as was seen in New York City and Washington, DC area during and immediately following the attacks on 9/11.

The construction of bunkers to support critical government functions became well known during World War II when Hitler operated from his Berlin bunker in the final days of the Third Reich. One of America's most famous bunkers which had been exposed in the last 10 years was the congressional bunker located at the Greenbrier Resort in White Sulphur Springs, West Virginia. Located roughly five hours southwest of Washington, DC the truly amazing construction feat accomplished is the fact that in 1960 a facility which required over 4,000 truckloads of concrete over a two and one half year period in the middle of rural West Virginia was able to be built without exposure by the media and the community (Gup). The facility which has walls two feet thick and buried 20 feet below grade contained an infirmary, sleeping quarters, kitchen, television studio, generators capable to supply all power requirements, and assembly rooms which were strategically located to allow there unsuspected use during normal resort operations. The resort employed maintenance workers who held a normal hotel staff repairmen position but who also had additional responsibilities to maintain and operate the facility. The secrecy of construction and operation of such a facility allowed it to be ready and waiting in the event of a national attack for over 30 years.

During the terrorist attacks on 9/11 the President was at a Florida Elementary School and the Vice President was at the White House. Following the second plane striking the World Trade Center the Secret Service relocated Vice President Cheney to the underground White House shelter (CNN.COM). The location of this bunker was unknown to most but became an essential operation center from which the Vice President made critical decision throughout the day. In addition, helicopters landed at the capitol as essential government staff were taken to undisclosed locations to ensure continuity of government. It was the feeling of vulnerability experienced by those individuals in Washington, DC and New York which has once again generated interest in constructing and modifying exiting protective shelters to match the threat in the post Cold War era.

Much like the secrecy which surrounded the Greenbrier construction in the early 60's, facilities are being constructed across America today to protect vital government interests. The true extent and costs of such construction probably will never be known. The fact is the support of the engineering and construction industry is critical to maintaining a government which is prepared to operate under the most difficult conditions.

2.2.4 Anti-Terrorism Force Protection

Anti-Terrorism Force Protection has always been a concern most specifically for military installations around the world. Recent terrorist activities have resulted in a real focus in this area for all armed services' facility program managers. The applicable Department of Defense (DoD) instruction states:

"DoD Antiterrorism Standards," requires DoD Components to adopt and adhere to common criteria and minimum construction standards to mitigate antiterrorism vulnerabilities and terrorist threats. The philosophy behind these building standards is to build greater resistance to a terrorist attack into all inhabited buildings. That philosophy affects the general practice of designing inhabited buildings. While these standards are not based on a known threat, they are intended to provide the easiest and most economical methods to minimize injuries and fatalities in the event of a terrorist attack. The primary strategies to achieve this outcome are to maximize standoff distance, to construct superstructures to avoid progressive collapse, to reduce flying debris hazards, to provide effective building layout, to limit airborne contamination, and to provide mass notification. These and related design issues are intended to be incorporated into standard design practices, and facilitate future requirements in a dynamic threat environment. (UFC 4-010-01)

Final standards have been developed by the DoD Security Engineer Working Group and were approved by the DoD Engineering Senior Executive Panel on Oct 8, 2003. These standards are not based on a specific threat, but are intended to provide the easiest and most economical methods to minimize injuries and fatalities in the event of a terrorist attack.

Requirements for AFTP standards in DoD construction are included in construction programming documents in accordance with DoD guidance. Incorporating AFTP standards into new buildings where required standoff distances are available increases construction cost by three to five percent (UFC 4-010-01). Costs vary considerably where sufficient standoff is not available or when upgrading existing buildings. Site and interior building layout are low/no cost means to meet requirements. Cost increases are generally based on upgraded windows, structural detailing for the prevention of progressive collapse, and modifications of the building interior to minimize hazardous flying debris.

The importance of AFTP measures and the funding currently being spent has resulted in contractors and designers who specialize in force protection assessments and corrective measures. This sector of work has greatly expanded over the past several years and will continue to be a strong industry to be working in the foreseeable future.

Infrastructure, transportation, secure facilities and AFTP are just a couple of the many areas whose construction workload has expanded exponentially since 9/11. The workload is only expected to increase as more and more facilities perform surveys to examine vulnerabilities resulting in retrofitting current facilities with the proper protection or constructing new facilities with improved safeties in design. Either way design and construction will remain strong in this field.

2.3 CONTRACTUAL IMPACTS

During the initiation phase there is a large amount of information that the owner must consider when deciding whether to continue with a project. One of the most important, if not the most important, items to look at is the financial status of the project. Owners both public and private must ensure that the cost to perform the project is necessary to meet an established objective. The cost breakdown at this early phase of the project is a rough estimate with a rough order of magnitude for design and construction estimates as well as costs associated with the financing the project.

The process of reviewing inputs to make the “go / no go” decision is never an easy task. Nearly every choice which is made has a direct impact on the bottom line cost of a project. The addition of risk as a result of terrorist activity has only complicated this process. Several additional contractual responsibilities must be considered given the current state of world affairs and the possibility of additional attacks.

2.3.1 Force Majeure Clause

The following clause was pulled from the Federal Acquisition Regulations (FAR):

Excusable delays - The Contractor shall be liable for default unless nonperformance is caused by an occurrence beyond the reasonable control of the Contractor and without its fault or negligence such as, acts of God or the public enemy, acts of the Government in either its sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, unusually severe weather, and delays of common carriers.

This clause is associated with those acts which are out of the control of the contractor such as fires or floods. The question becomes are terrorist attacks considered an act of war or public enemy. The courts have suggested through case law (*Pan American World Airways, Inc v. Aetna Casualty & Surety Co.*) that such acts are not considered acts of war and therefore not considered an excusable delays.

The government took a different approach at the Pentagon crash site. The Pentagon is undergoing a major renovation project and in fact the wedge where the plane hit was nearing completion and tenants had begun to move back into spaces. Fortunately at this location the structure had been reinforced and fire sprinklers installed which limited the overall damage to the facility. In accordance with case law and the clause listed above if the government had not accepted ownership of the newly completed wedge then the contractor would have no recourse to pursue for costs and time to reconstruct all that was damaged. But, given the importance of the facility from a national security standpoint as well as from a public confidence standpoint it was critical for the federal government not to place this heavy burden on the contractor.

The idea of contractors not being protected by this clause is a large risk for the contractor in relation to project schedules. A solution for contractors is to have language written into the contract which specifically refers to acts of terrorism. Though this may not have been an issue on the Pentagon project if there was a smaller attack against say a non-government agency the owner may not be so understandable and the contractor legally could be held to the original project timeline.

2.3.2 Insurance

The previous clause discussed an excusable delay related to time only and having nothing to do with costs which are often an even bigger concern to the contractor. The costs of reconstruction after an attack could more than double the cost of a project. The contractors would have no alternative but to try to pass the increased costs on to insurance companies through their general liability coverage. This coverage is essentially property insurance for the construction site while it is under the control of the contractor. Where the excusable delay clause protects the contractor on a time basis from fire, floods, etc., the general liability insurance policy protects them on a cost basis. A contractor would use this coverage if for example a project site was hit by a voltage spike resulting in a fire which caused severe damage to the facility under construction. The contractor could recover the cost to make the necessary repairs to the site to bring it back to the state it was in prior to the event occurring.

As a result of 9/11, the insurance industry incurred an estimated \$40.2 billion in associated losses. In reaction to these losses, insurers quickly revised coverage for risks associated with terrorism. Many insurers added terrorism exclusions to both pre-existing and new policies, and those that continued to provide coverage did so under substantially higher premiums. In response, and in an effort to temporarily ensure the ability of businesses and individuals to obtain property and casualty insurance at reasonable prices, as well as the ability of the insurance industry to cover unprecedented financial risks while developing private terrorism risk insurance, the United States Congress enacted the Terrorism Risk Insurance Act of 2002 (TRIA) (Hannah).

TRIA, which became effective November 26, 2002 and is effective through December 31, 2005, establishes a temporary federal program under which the federal government shares with the private insurance industry the risk and compensation for future "acts of terrorism," as defined by TRIA. Under the law the federal government covers 90 percent of the losses above a company's deductible, while the insurers provide the remaining 10 percent (Hannah). Nearly every insurer who offers commercial property and casualty insurance policies, including worker's compensation policies, must participate in the Program and offer coverage for "acts of terrorism." As of November 26, 2002, all policy exclusions that excluded coverage for losses resulting from "acts of terrorism" were voided and such losses became covered under the Program upon the policyholder's acceptance of related premiums. In order to be able to participate in the Program, insurers were required, as of February 24, 2003, to "clearly and conspicuously" disclose to policyholders the premium charged for these now covered losses (Hannah).

Although TRIA requires insurers to offer coverage for "acts of terrorism," policyholders are not required to purchase it, and in fact many policyholders have thus far opted not to do so. Many are not due to the extremely high premiums and the fact that policyholders do not believe they are exposed to particularly high risk for terrorism-related losses. Limitations on the available coverage play an additional role in many decisions to forego coverage. In order for an "act of terrorism" to be covered under the Program, it must be committed by a foreign person or interest and result in greater than \$5 million in damage. Domestic acts of terrorism and destruction committed in the course of war are not covered. Any act must be certified as an "act of terrorism" by the Secretary of the Treasury, the Secretary of State, and the U.S. Attorney General in order for resulting losses to be covered. This limitation makes policyholders wary, even more so because certification of an act as an "act of terrorism" covered under the Program is a determination which is not subject to judicial review (Hannah).

Whether to purchase terrorism coverage is a business decision, based on risk management principles. Currently, most businesses are foregoing terrorism coverage, either refusing -- or unable -- to pay for coverage that can increase premiums by up to 200 percent, and in extreme cases, by as much as 2,000 percent (Hannah). In the end, those businesses that are buying terrorism coverage seem to be doing so only because their lenders require it.

Although the Program is only in its early stages of implementation, it does not appear that all of TRIA's goals are being met. In the absence of state regulation of insurance premiums, insurers can charge as much as they wish for terrorism coverage. The unregulated cost of terrorism coverage continues to be higher than most businesses and individuals are willing or able to pay. Because risk is not being spread over a large number of policyholders, premiums remain high. Only time will tell if this will change, depending on whether insurers learn how to price this risk and whether the threat of terrorism escalates, diminishes or stabilizes. For now, TRIA provides little actual relief in terms of ensuring the coverage is readily available to protect against terrorism related losses.

2.4 OVERALL IMPACT

This section looked at the impact terrorism has had on the initiation phase of a project lifecycle. It can be seen that certain sectors of the trade most notably AFTP has received a substantial influx in funding and as a result there are many public and private projects to either establish or improve facility security. Meanwhile, the construction industry as a whole has taken a turn downward since the attack. The industry data shows a decrease by 2.6 percent in 2002 and 0.3 percent in 2003 when comparing by industry its contribution to the gross domestic product. These numbers are made worse by the fact that from 1995 – 2000 the construction industry had been increasing on average by about 3 percent (Bureau of Economic Analysis). Knowing this information it's essential for companies to understand the changing face of the construction industry and develop a plan which ensures they are prepared to take part in the change.

The other important item to note is that there are new concerns contractors and owners must have when entering into a contract which probably would not have been an issue before. That is the risk of additional attacks and how that risk will be shared between owner, contractor and insurer. The insurance industry took a large hit because of 9/11 as a result the federal government stepped in to help in accepting some of the risk. The risk of attack and how it will be allocated must now become part of the initial project decision making process.

CHAPTER 3 DESIGN PHASE

3.1 INTRODUCTION

Most fundamentally, owners, designers and contractors now will be held to a higher standard of care in performing their work. Negligence is the failure to use such care as a reasonably prudent and careful person would use under similar circumstances to prevent harm to others. As a general rule, reasonableness is determined by foreseeability -- i.e., what a reasonably prudent person could be expected to foresee as a possible consequence of his or her acts or omissions. Until 9/11, no reasonable person could have foreseen an event involving the coordinated highjackings of four airliners for the sole purpose of flying them into landmark buildings such as the World Trade Center and the Pentagon. After 9/11 experience requires us to contemplate just such an attack.

Fast on the heels of 9/11, an unidentified person or group mailed a series of letters containing anthrax to members of Congress. These letters contaminated congressional offices, the postal facility where the letters were sorted and cross-contaminated other mail processed through the postal facility. This bio-terrorist attack killed several postal workers, and the cross-contaminated mail randomly infected scores of other mail recipients. Yet again, what was once unforeseeable has become foreseeable.

3.2 NEW DESIGN REQUIRMENTS

Because such acts now are foreseeable owners, designers and contractors arguably have a duty to take the possibility of terrorist attacks into consideration when designing new projects. To stop a terrorist physical attack on a building is very difficult; any building or site can be breached or destroyed. However, the more secure the building or site and the better the building is designed to withstand an attack, the better the odds the building will not be attacked or, if attacked, will suffer less damage. There are two parameters which define the design threat: the weapon size, measured in equivalent pounds of TNT, and the standoff. The standoff is the distance measured from the center of gravity of the charge to the facility of interest. The following information looks at design criteria developed to help in protecting a facility against a terrorist attack.

3.2.1 Evaluation Procedure

Part of the design review process for each new project of any significance should include some evaluation of the potential terrorist threats to that project. Considerations that should be taken into account include:

- Whether the project has any landmark significance, i.e., does the project have sufficient symbolic significance to merit terrorist attention?
- Will the project have a government tenant and what is there mission?

- Will an attack on the project have a significant ripple effect on the economy or a region? For example, a pipeline could pose a more attractive target than a warehouse because an attack on a pipeline could affect millions of people and the entire economy while an attack on a warehouse might affect only a few people.
- Would an attack on the facility have a secondary physical impact? For example, an attack on chemical plant could release a toxic plume killing or injuring thousands of people.
- Is the project near an attractive terrorist target? Recall that many neighboring buildings were damaged in the World Trade Center attack. (FEMA 427)

Once the potential threats have been identified, designers should take into consideration features necessary to eliminate or mitigate the loss from an attack. While it may not be possible to design a building to withstand the impact of a Boeing 767 loaded with jet fuel, it may be possible to mitigate the impact by adding more stairwells than required by code or bridging twin towers (as in the Petronas Towers) so that tenants can move to another structure if their escape route is cut off. Similarly, if the project is near a chemical plant, prudence may require that the ventilation systems be designed to allow for the filtering of toxic chemicals released in an attack.

Any determination of what a reasonably prudent person should do to guard against a terrorist attack must be made on a case-by-case basis factoring in the use of the facility, the surrounding circumstances, regulations particularly applicable to the project and, of course, costs.

3.2.2 Site Planning

The primary design strategy if afforded the opportunity of placing the location of a building is to incorporate a proper standoff distance. The benefit to a proper standoff distance is it cost nothing to implement (assuming building location has sufficient space) and because air-blast pressure decreases rapidly with distance it is one of the most effective means of protecting facilities. The best way to accomplish this is to provide a continuous line of security along the perimeter of the facility to protect it from unscreened vehicles. The distance from the facility to the security line can vary by facility, location, risk, and threat. In suburban areas, 100ft is considered a desirable standoff distance, although this is often unrealistic in urban settings (FEMA 427). The standoff zone can also be combined with other devices such as bollards, plaza setbacks, landscaping, trees and boulders to restrict vehicular access.

3.2.3 Physical Protective Barriers

Passive barrier systems are those which are fixed in place and do not allow vehicle access. Examples of such barriers are large planters, bollards, or knee walls. These barriers must be constructed to be as high as a vehicle bumper which is between two to three feet and of sufficient weight or depth to prevent movement in the event of a vehicle collision. At vehicle access points active anti-ram systems must be used. These systems

which require an operator are designed to resist various levels of car and truck impacts. These systems are often composed of crash gates, retractable bollards, or rotating-wedge systems. There are several factors to consider when installing these systems to include architectural concerns, manning requirements, and underground conflicts which can direct which type of system is installed.

3.2.4 Building Exterior

The focus of a building exterior is not on deterring or delaying an attack instead its purpose is to mitigate damage resulting from a blast. The choice of exterior material is important for several reasons: it's the portion of the building closest to the blast, it's often made from brittle materials which can fragment, and is a critical barrier between occupants and the blast (FEMA 427). Another important factor to consider is the building shape which can have a contributing effect on the overall damage to the structure. Overhangs and re-entrant corners are likely to trap blast waves having an amplifying effect. Generally simple geometries with minimal ornamentation (which can become flying projectiles in a blast) are recommended unless advanced structural analysis is performed. The types of ornamentation recommended if used are lightweight materials such as timber or plastic, which are less likely to become lethal projectiles when compared to brick, stone, or metal.

Windows are typically the most vulnerable portion of any building. Though it may be impractical to design all the windows to resist a large scale explosive attack, it is desirable to limit the amount of hazardous glass breakage to reduce the injuries. Typical annealed glass windows break at low pressure and impulse levels and the shards created by broken windows are responsible for many of the injuries incurred during a large-scale explosive attack. In designing windows to mitigate the effects of explosions they should first be designed to resist conventional loads and then be checked for explosive load effects. The glass is designed to be no stronger than the weakest part of the overall window system (frame, anchorage, and supporting wall system). If the glass is stronger than the supporting members, then the window is likely to fail with the whole panel entering into the building as a single unit, possibly with the frame, anchorage, and the wall attached. Using this approach allows the extent of collateral damage to be controlled.

3.2.5 Building Interior

The functional layout on the interior of a building has a huge impact on the overall security of a facility. As shown in Figure 2 below, unsecured areas such as lobbies, loading docks, mail rooms, garages, and retail areas should be separated from secured areas of the facility. Ideally these areas would be located outside the main footprint of the secured building. This is of particular importance when looking at vehicle parking areas as a truck or car bombs placed within the building footprint has a much higher probability of resulting in a catastrophic building collapse. If this separation cannot be made then the next best approach is to look at unsecured and secured area within the building itself. Unsecured areas should be placed to the exterior of the building and

should not be above or below secured / critical areas. The lobby area should be large enough to allow proper screening (if necessary) of personnel out of the weather when entering the building and the design should minimize exposed structural columns in such unsecured areas. Internal elevator shafts should be placed away from parking areas, loading docks, and vehicle access points. These shafts can become chimneys and send smoke and heat from the explosion to all levels of the building. Smoke inhalation was the most common medical injury which resulted from the 1993 World Trade Center bombing due to the elevators venting smoke throughout the building. Finally, the placement of workstations should be as far from exterior windows as practical with monitors being orientated away from the windows to prevent injury due to impact from a monitor (FEMA 427).

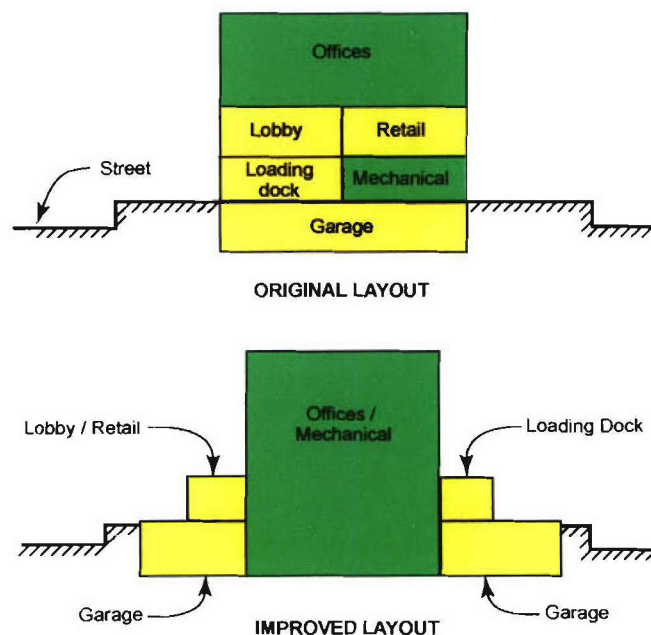


Figure 3.1: Improved Building Layout
(Courtesy of FEMA 427 Primer for Design of Commercial Buildings to Mitigate Terrorist Attack p. 6-10)

3.2.6 Structural

The World Trade Center collapse brought to everyone's attention the engineering principle of progressive collapse. Progressive collapse occurs when a structure has its loading pattern, or boundary conditions changed such that structural elements are loaded beyond their capacity and fail. The residual structure is forced to seek alternative load paths to redistribute the load applied to it. As a result, other elements may fail, causing further load redistribution. The process will continue until the structure can find equilibrium either by shedding load, as a by-product of other elements failing, or by finding stable alternative load paths (FEMA 427). Because of the catastrophic consequences of progressive collapse, incorporating these measures into the overall

building design should be given the highest priority when considering structural design approaches for mitigating the effects of attacks.

Historically, the preferred material for explosion-mitigating construction is cast-in-place reinforced concrete. This is the material used for military bunkers, and the military has performed extensive research and testing of its performance. Reinforced concrete has a number of attributes that make it the construction material of choice. It has significant mass, which improves response to explosions. Members can be readily proportioned and reinforced for ductile behavior. The construction is unparalleled in its ability to achieve continuity between the members. Finally, concrete columns are less susceptible to global buckling in the event of the loss of a floor system (FEMA 427). Testing programs are investigating the effectiveness of various other building systems and materials but to date none prove to provide the level of protection as achieved with cast-in-place reinforced concrete.

3.2.7 Mechanical and Electrical Systems

The key concepts for providing secure and effective mechanical and electrical systems in a building are the same as for other building systems: separation, hardening, and redundancy. Keeping critical mechanical and electrical functions as far from high-threat areas as possible (i.e. lobbies, garages, and retail spaces) increases their ability to survive an event. Separation is perhaps the most cost-effective option. Additionally, physical hardening or protection of these systems provides increased likelihood that they will be able to survive the direct effects of the event. Finally, by providing redundant emergency systems that are adequately separated, there is a greater likelihood that emergency systems will remain operational post-event to assist rescuers in the evacuation of the building.

Structurally, the walls and floor systems adjacent to the areas where critical equipment is located need to be protected by means of hardening. Other areas where hardening is recommended include primary egress routes, feeders for emergency power distribution, sprinkler systems, fire alarm system wiring, and ducts used for smoke-control systems (FEMA 427). From an operational security standpoint, it is important to restrict and control access to air-intake louvers, mechanical and electrical rooms, telecommunication spaces and rooftops. An emergency generator should be provided as an alternate source of power should utility power become unavailable to critical life-safety systems such as alarm systems, egress lighting fixtures, exit signs, emergency communications systems, smoke-control equipment, and fire pumps.

3.2.8 Developing Technologies

The development of new technology to support building safety has always been important. But given the current world conditions it has taken on a new sense of urgency. There are a wide variety of areas which are currently being studied to help designers and contractors build the most cost effective secure facility given the risk. Here are a few of the areas currently being studied (NIST):

- Increasing Structural Integrity - Structural integrity will be increased through the development and implementation of performance criteria for codes and standards, tools and practical guidance for prevention of progressive structural collapse. System design concepts, retarded collapse mechanisms, built in redundancy, and hardening structures though retrofit are being considered.
- Enhancing Fire Resistance - Fire resistant steels exist and are in use elsewhere in the world. More efficient and accurate tests for performance of steels under building fire conditions are needed and are being developed to help industry incorporate fire resistant steels into U.S. construction practice.
- Improving Emergency Egress and Access - By working with the primary stakeholders (elevator and construction industries, fire services, professional societies and code making bodies), the role of elevators in providing access by the fire service to a fire in a high rise building is being greatly enhanced over current practice. The development of hardened fire service elevators and new emergency operation procedures/controls will also lead to improved egress capabilities from tall buildings, especially for mobility-impaired or injured occupants.
- Developing Building and Emergency Equipment Standards and Guidelines - Partnering with ASHRAE and other federal agencies, National Institute of Standards and Technology developed indoor air quality simulation tools extended to analyze and guide the assessment and subsequent reductions in the vulnerability of buildings to chemical, biological, radiological aerosols. A user-friendly tool is being developed for building owners and managers to aid in the selection of cost-effective strategies for the management of terrorist and environmental risks.

3.3 OVERALL IMPACT

This section looked at the impact terrorism has had on the design phase of a project lifecycle. As a result of 9/11 more and more owners are concerned about the security of their facilities. With the wide range of terrorist threats against everything from schools to financial institutions it's important that more and more public and private owners incorporate security measures into their designs. Designers are quickly realizing the importance of these measures and if included early in the design the cost impacts can be minimized. Ultimately it is decided by the owner if he or she wants to fund the increased security measures. There are many options and degrees of protection but the important decision is to pick that option which gives the owner the most for his money given the threat level.

CHAPTER 4 PROCUREMENT / CONSTRUCTION PHASE

4.1 INTRODUCTION

Soon after the design phase has been completed the owner will procure construction services to perform the work. There are several different approaches an owner can take to obtain these services. The first method that could be used is the tradition method of design-bid-build. With this method the owner hires an architect / engineer to design the project and then takes the completed drawings to hire a contractor to perform the work. Another option is professional construction management which treats the project planning, design, and construction phases as integrated tasks. This approach creates a three party team consisting of owner, designer, and construction manager in a non-adversary relationship, and it provides the owner with the opportunity to participate fully in the construction process. The final option is design-build where the designer and builder are a team working together with only one contract with the owner. The design build option has become a popular approach to contracting to include projects similar in nature to those presented earlier. This section will examine why this approach works for these project types as well as look at the challenges these projects present to the contractor.

4.2 PROJECT DELIVERY STRATEGIES

During the life of a project there are many decisions and challenges that are encountered. It is the team of owner, designer, and contractor which must be working in harmony to get the best result possible. This section will look at some of the decisions and challenges which are presented to this team while performing projects with special requirements such as those presented earlier.

4.2.1 Design-Build

Many factors go into choosing the type of delivery method to be used to perform a project. The three most common methods are the traditional method (design-bid-build), professional construction management method, and design-build method. Though each of these methods has their own advantages and disadvantages the design-build method is probably the one best suited for this type of work. Listed below are some advantages to this approach and how that correlates to improving projects of this nature.

- There is only one contract for the owner to manage to include both the designer and contractor. It creates a one stop shop for the owner to ask either design or construction related questions. It also creates a better working relationship with all parties involved in the project which reduces the risk of litigation.

This type of arrangement is important to the owner for a couple reasons. These projects are often unique in nature with unique requirements. The structures

being built may be one of a kind or remotely located so having the designer and contractor on the same team greatly reduces communication challenges between the two teams given the unusually difficult nature of the work. It's also important to develop a team approach to projects such as these. Given the importance of the decisions being made it's critical that all sides are freely communicating. The added benefit to the owner is that a heavy emphasis is put on the designer and contractor to resolve problems without the owner having to be involved which tends to minimize the number of design discrepancy change orders.

- Can be fast tracked through a phased construction approach.

The design-build approach major advantage is that it allows the contractor to begin work prior to the design being completed. This was very important for certain projects immediately following 9/11. First, this ability to immediately mobilize a design / contractor team soon after the attacks demonstrating progress was critical in showing key government leadership that actions were being taken to protect government continuity during this time of great uncertainty. Secondly, by starting the construction prior to a completed design the project can be completed earlier thus allowing the owner to utilize these facilities much faster than if other delivery methods were chosen.

- Considerable opportunity for the contractor to become involved during the planning and designing phase. This can pay huge dividends in both time and money.

Due to the nature of this work sometimes being "one of kind" type construction it is important to have the contractor involved earlier to be part of the design process. The contractor is able to interject ideas in design review meetings as well as review schematic designs from a constructability standpoint that design engineers just don't have the field experience to perform. This early involvement is a huge time savings and allows the contractor to price design options more on the fly which supports the owner in determining what options will be accepted or rejected.

- Probably the easiest method to incorporate changes because the designer and contractor are working so closely.

Changes are an unavoidable part of construction. For this reason it's important that the system is able to quickly respond to all forms of changes from customer requested to design omissions. The design-build method has the flexibility to quickly react as a result of the designer and contractor being part of the same team with both having a financial incentive to rectify changes.

With any method used in contracting there are always disadvantages which must be recognized and dealt with. The key is to understand these disadvantages, how they

impact the project being performed, and have contingency plans to deal these challenges. Below are several disadvantages to this contracting method:

- There are no firm project costs prior to the start of the project. The owner is not afforded the “go / no go” decision based on total project costs prior to the start of construction.

This is a risk that the owner takes when entering into this type of delivery method. If project cost is secondary to project execution then this may not be an issue but for many projects the cost of completion is instrumental in the decision process. If the scope of work is clearly defined early then a reasonable estimate can be made. The problem becomes as a project progresses and cost escalate how does the project team keep the budget in check. There are a several options available to the team such as reducing quality, cutting scope, or removing some of the building safeties discussed in this paper. Removing such safeties increases the owner’s exposure to risk but that is a decision that will have to be well thought out by the owner.

- There are few checks and balances and the owner is sometimes not advised or aware of design or construction problems that may greatly affect cost or schedule.

In other delivery methods there is a natural tendency for the designer to keep the contractor in check as well as the contractor to watch the designer with the owner somewhere in the middle. Under this arrangement the designer and contractor are one and the same from the owner’s perspective so there aren’t necessarily those same checks and balances. For that reason the owner can either put all their faith in the design-build team, use knowledgeable in-house assets to oversee construction, or hire an independent third party. This decision by the owner is based on the type of construction and the level of comfort with the design-build team. Given the sensitivity of many of these types of a project it is advisable that the owner use independent oversight either in-house or third party to supervise the project.

- The speed of execution of this method can be fast so the owner must be knowledgeable and involved to ensure project objectives are met.

A positive as well as a negative is the speed at which these types of projects can be completed. Understanding this, the owner needs to be prepared to make necessary decisions with more speed than when compared to say the traditional method. The speed at which these decisions are made will greatly impact the overall construction schedule.

4.3 CONTRACTOR CONSIDERATIONS

Construction is a planning intensive process. Plans must be comprehensive and complete to ensure that contractors don’t miss anything in bids or schedules. The failure to account

for a major work activity could result in poor performance or even worse bankruptcy. For this reason contractors are very good at building work plans. On a secure project there are sometimes different challenges which aren't seen on typical construction projects. The items listed below are just a few of the additional activities that must be accounted for in a work plan.

4.3.1 Clearances

Many of these projects present unique and unusual challenges to the contractor not seen on typical construction projects. These challenges can have huge impacts on both cost and schedule so it is very important that the contractor takes these items into account when presenting estimates. It is a contractor's ability to overcome these challenges which will determine the success of a project.

One of the biggest challenges that a contractor has when performing secured construction is the ability to maintain a large enough workforce with security clearances to perform the work. Many of the projects, especially federal projects, require contractors and employees to have the necessary security clearance level to perform a project. The three common clearance levels and what determines the level at which the work is classified are as follows:

Top Secret shall be applied to information the unauthorized disclosure of which reasonably could be expected to cause exceptionally grave damage to the national security that the original classification authority is able to identify or describe.

Secret shall be applied to information the unauthorized disclosure of which reasonably could be expected to cause serious damage to the national security that the original classification authority is able to identify or describe.

Confidential shall be applied to information the unauthorized disclosure of which reasonably could be expected to cause damage to the national security that the original classification authority is able to identify or describe.

Clearances for individuals are granted by the agency which is providing the work. The required background information necessary to grant a clearance is agency and sometimes project specific. In DoD generally a secret / confidential clearance can be granted relatively quickly (1-3 months) and requires a limited investigation. A top secret clearance is very involved and costly endeavor in which an individual's background is fully reviewed to ensure they can be entrusted with sensitive national security information. This process can take on average from six to eighteen months to complete therefore the contractor will need to already have managers and workers with a top secret clearance prior to bidding. The other challenge with projects of this type is everyone on the jobsite will need to have the appropriate clearance level to include subcontractors. Finding some of the specialized subcontractors such as fire protection who have clearances can sometime be difficult and may completely limit any chance of competition between subs. The other problem may be that workers with clearances have to work in

construction trades which they aren't familiar with. For example a carpenter who is accustomed to performing vertical construction may have to lay carpet due to there being no cleared carpet installers and the time and effort to get one cleared is not feasible. It is for this reason that the owner must closely scrutinize the clearance requirements of all projects because the pool of individuals available to perform the work decreases as the level of clearance increases.

4.3.2 Material Procurement

Purchasing of material on a classified project can be much different than simply going to the local supply store. For certain federal agencies the threat of espionage and the sensitivity of discussions are so great that extraordinary measures are taken to ensure that material is not compromised. One approach is the use of random purchase. This method requires that the buyer of material (either contractor or government) purchases material at as many different suppliers as practical. It also means choosing randomly which items are selected off the shelf (i.e. some from the front and some from the back). Other times the purchase of material may have to be done so the material purchased isn't connected with either the agency or the function. In this case a third party who has no linkage to either the contractor or agency is used to purchase the material. This may be done so the capabilities of the material cannot be tied to the agency or the facility at which it is being installed.

4.3.3 Subcontractor Coordination

Unlike most projects where it is important for all parties to understand the overall project on a classified project there may in fact be few individuals who have a complete set of drawings. Each subcontractor is given only those drawings which apply to their trade. Despite having a clearance there is still the idea of "need to know". Though this may be counter to good construction practices the need to limit the security risks become more important. The fewer people who see the complete set of drawings and understand the complete scope of work the lesser the chance for a security compromise. The other challenge with classified drawings is they must be in kept in an approved secure location. Depending on the nature of the site this may mean that drawings have to be viewed in a separate area from where the work is occurring or the drawings may have to be modified in order to declassify them.

4.3.4 Communication

All communication on a project will be of a sensitive nature. Therefore communication can not occur via email or telephone. Instead the project team must use some form of a classified computer exchange (DoD uses SIPERNET) and special secured telephone communications (STU – III) which encrypts the dialog. Any communications of a sensitive nature must also be held in a location that has been approved for that clearance level. The communication restrictions that are applied can be extremely challenging for a project manager but are necessary to ensure the security of the overall project.

4.4 OVERALL IMPACT

This section looked at the impact terrorism has had on the procurement / construction phase of a project lifecycle. The need to perform unique projects has created a larger demand for the design-build approach. This method of delivery has gained increased support and will continue to do so in the future. Another challenge facing a project team is the difficulty of working on classified projects. Certain activities which are second nature like open and honest communication are not necessarily the norm on projects which are of a secured nature. In fact it may be just the opposite where the goal is to provide the minimal amount of information to project stakeholders to complete the project. Working in this type of environment can make the job of project manager much more difficult.

CHAPTER 5 CONCLUSION

The definition of terrorism *is the unlawful use or threatened use of force or violence by a person or an organized group against people or property with the intention of intimidating or coercing societies or governments, often for ideological or political reasons*. Using this definition it can be seen that the attacks on 9/11 was clearly terrorism in its purest form. An organized group in the form of Al Qaeda performed violent attacks with the hopes of intimidating the American people and beginning a campaign of global religious war. It is certainly true that American society was intimidated following the attacks creating a wave of hysteria that reached across the United States.

As a result, the government and other private industry moved swiftly to protect themselves against further attacks. The construction industry, as the builders of society, was called upon to fix many of the security lapses which existed throughout the country. Accordingly, certain sectors of the industry flourished in the post 9/11 world while other projects became less attractive to investors in such uncertain times were put on hold or scrapped all together. Either way many in the industry adapted to the needs of society. Security and force protection projects were on the rise. Owners were tasked to evaluate project priorities and consider what responsibility they owed to their employees to ensure a safe working environment. Designers were being asked to design protective measures into buildings helping to prevent or mitigate possible damage as a result of an attack. Finally, constructors were asked to quickly mobilize following the attacks and were often working within a secured construction environment in which they may or may not have been accustomed to.

It's is therefore critical for the construction industry to gather their collective resources and work jointly to help in securing the nation against future attacks. Some of the lasting memories from this most difficult time in American history will be those construction crews who worked around the clock at the World Trade Center and the Pentagon to help heal the scars of this Nation. It was the effort of these workers as well as other less notable crews which were standing tall in the face of terrorism.

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