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Pentagon Renovation and Terrorist Destruction Highlight Lessons Learned

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By: Rachel Decker

Frank Probst, an information management specialist for the Pentagon Renovation Program, left his trailer near the Pentagon's South Parking lot on September 11 at 9:35 a.m. He headed north, walking along VA-Route 27, which was backed up with commuters heading into Washington, D.C. Minutes later, the 6'2" Vietnam Veteran looked up, directly into the right engine of a Boeing 757. "Had I not hit the deck, the plane would have taken off my head," exclaimed Probst.

American Airlines Flight 77 slammed into the western face of the Pentagon, penetrating the first and second floors, just north of the fourth corridor in Wedge 1, and traveled at a forty-five degree angle through the building's three outer-most rings, E, D and C, before stopping just shy of the fifth corridor in Wedge 2. The nose of Flight 77 punched out into A-E Drive, a roadway between the B and C rings. The fireball and explosion that resulted upon impact was significant but was impeded in Wedge 1 by a sprinkler system that was recently installed as part of a building-wide renovation project first begun in 1993.

A portion of the building at the point of impact withstood collapse for nearly 35 minutes thanks to the newly installed reinforced structural steel and blast resistant windows, allowing thousands of personnel in the area to escape. Although the loss of life was tragic, "the Pentagon performed magnificently. Our building was hit by a Boeing 757 loaded with 20,000 gallons of jet fuel and traveling at 350 miles an hour," said Lee Evey, program manager of the Pentagon Renovation Program. "Yet," he stated, "only 125 Pentagon personnel of the 2,600 people in the vicinity were killed."

The Renovation Saved Lives

Wedge 1, the area first penetrated by Flight 77, had just undergone a three-year renovation, which brought the nearly one million square feet of office space down to its core and shell, allowing for the abatement of hazardous materials, reconstruction and installation of new utilities. The Pentagon, the headquarters of the Department of Defense, has never undergone a major renovation in its 60-year history. When the $1.2 billion renovation began in 1993, hazardous materials plagued the building and its utilities were on the brink of catastrophic failure. Many of its 25,000 personnel worked in poorly circulated offices with leaky ceilings and in dark, dank conditions.

Wedge 1 was the first-fifth of above-ground space in the Pentagon to undergo renovation and the only section of the building to have blast-resistant windows and a sprinkler system, two factors that

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On September 11, 2001, a Boeing 757 struck the Pentagon's Wedge 1 on an angle and penetrated into an interior office ring in Wedge 2. Wedge 1 was just five days from completion, but the plane impacted areas that were only partially occupied.

aided in saving lives. The blast-resistant windows, installed on the outer E-Ring of Wedge 1, weigh 1,600 pounds each with glass that is an inch-and-a-half thick. The blast resistant windows sit within a web matrix of reinforced structural steel that is bolted to the slabs of each of the five floors. Stretched between the reinforced structure is a Kevlar-like, geo-technical mesh that, in the event of an exterior explosion, would keep debris away from personnel inside the building. The resiliency of this Kevlar-like material was conveyed during debris removal in November 2001, when a hydraulic excavator struggled to remove a dangling, 4,000 pound chunk of reinforced concrete.

The old windows in Wedge 2 were shattered by the impact. Blast resistant windows in Wedge 1 were still in place directly above where the plane entered the Pentagon.

Despite the huge impact of the plane on September 11 and the resulting fireball that erupted as the plane's debris exited the C-ring, the blast resistant windows on the third and fourth floors, directly adjacent to the area which eventually collapsed, remained intact. Several old windows in the not-yet-renovated Wedge 2 blew out. Lives were saved because of the steel reinforcement that surrounds the windows.

In Wedge 1, water from the sprinkler system squelched the flames that were not directly fed by jet fuel and contained the fire. However, without sprinklers, Wedge 2 had significant fire and smoke damage. Extensive water damage resulted from the thousands of gallons of water dumped into the impacted area. In all, approximately two million square feet of office space was affected.

Loss of life was further prevented because both Wedge 1 and Wedge 2 were partially occupied, with Wedge 1 being populated following its renovation and Wedge 2 being vacated so renovation could begin. In all, the two wedges at full occupancy can accommodate 10,000 personnel; however, only 4,600 resided in the combined two million square feet when the plane pierced the building's historic facade.

Enhancing Resistance

In the aftermath of this terrorist attack, the U.S. Army Corps of Engineers conducted a structural analysis, the "Pentagon Rebuild Retrofit Study," to determine how the building and its components performed. After examining building design, materials and operations following the attack, the need for significant change, specifically in areas of fire response and safety, became apparent.

Similarly, the Pentagon Renovation Program convened with the Pentagon Building Management Office (PBMO), Federal Facilities Division (FFD), and responding rescue and fire personnel in an effort to evaluate the building's performance and enhance emergency preparedness. Deemed the "Building Performance Evaluation Task Force," this group of building operators, industry experts and rescue and fire technicians immediately solicited all persons that were near the impacted area to share their experiences and give suggestions. The primary goal: What was the evacuation experience? Did they encounter problems or obstacles? How could we prepare for future fire or disaster situations?

Exposed blast-resistant window.

The information gathered from the task force interviews were consolidated into 26 primarily fire-related recommendations that will be integrated into the performance specification requirements for future Pentagon Renovation contracts.

A second multi-agency task force, the Pentagon Force Protection Project Action Team (PFPPAT), including members of the Pentagon Renovation Program, is also reviewing lessons learned and formulating ways to better enhance the Pentagon's force protection.

Significant in the dialogue is the fact that the Pentagon does not comply with any current building codes. In fact, the building has not met electrical code since 1953. Renovation will require all force protection enhancements to be "Code Plus," thus exceeding required fire and life safety codes, including Life Safety Code, Building Industry Code, National Fire Protection Association Standards and Department of Defense standards.

As a terrorist target and international symbol of American military might, the Pentagon is not a typical office building. Nevertheless, there are several force protection enhancements that might be of interest to building managers and owners reviewing their buildings' own emergency plans:

Fire: After Flight 77 blasted inside the Pentagon with 20,000 gallons of jet fuel, primary power was significantly impeded and brightly lit exit signs in the area became encased by black smoke so thick, personnel could not see their hands in front of their faces. Even before the plane pierced the Pentagon's exterior, it hit the Wedge 1 back-up generator, taking out emergency power. With victims typically crawling along floors in fire events, luminescent signs along baseboards make better sense than electric exit signs over doorways. They also don't require electricity, which often is turned off during fire situations. Photo luminescent arrows and exit signs, which could better aid in way-finding in the event of heavy smoke or fire, will be installed in Wedge 1 and retrofitted into the not-yet-renovated Wedges 2-5.

Flames rage through the Pentagon September 11, 2001.

Smoke walls installed in the renovated Wedge 1 operated appropriately, deployed from side closets as smoke filled the hallways and retractable with the touch of a waist-high handle. Unfortunately, only the fire safety officers knew how to operate the walls. Wedge 1 personnel who met with the smoke walls became disoriented by the unfamiliar barriers. Even if all personnel were trained on their operation, the handle to retract the wall should probably be located near the floor, where victims are likely trying to escape.

Short-term, the PFPPAT is developing an "Integrated Emergency Plan," which couples the existing Pentagon fire emergency plan with a larger, better-equipped Incident Response Team. This larger Incident Response Team will be composed of Pentagon personnel who are experienced in techniques including pressurization and are trained to Firefighter 2 level. This Incident Response Team will additionally develop a collaborative relationship with external organizations such as area fire and rescue teams through a Memorandum of Understanding or Mutual Aid Agreement, which will clearly outline the person in charge. The Incident Response Team - as experts in Pentagon operations and maintenance - will also report in the event of an incident to the Incident Commander of the local county fire department.

"People get too comfortable. You never realize the value of regular equipment inspection and evacuation drills until a tragic event happens to your building," said Ken Catlow, operations group leader of the Pentagon Renovation Program and lead member of the PFPPAT.

Damage inside an E-Ring office that lacked blast-resistant windows and steel reinforcement was much greater.

Too often, emergency plans are developed and then shelved until an emergency occurs. As a result, they become outdated as tenants change and building plans are altered. It is pertinent to hold fire and evacuation drills regularly and update tenants if emergency egress patterns change. Equally as important, the PFPPAT determined the Pentagon needs more trained area fire wardens with access to better equipment. Operating under the existing Emergency Fire Protection Plan, these wardens will be responsible for ensuring their designated personnel, including handicapped individuals, escape safely and are accounted for during an evacuation. To ensure accuracy, personnel rosters should be checked regularly, perhaps with immediate supervisors. The area fire wardens will be charged with coordinating building fire drills, frequently inspecting stairwell standpipes and ensuring a surplus of working fire extinguishers.

The Pentagon recently hired a full-time Fire Marshall to oversee equipment inspections and fire emergency operations. "I realize most commercial buildings may not be able to afford a full-time Fire Marshall. However, maybe two or three buildings could share a Fire Marshall who would oversee equipment maintenance and ensure regular emergency evacuation drills. I promise you, as recent events have shown, Fire Marshalls are worth their weight in gold," added Catlow.

Also apparent after September 11 was the desperate need for an upgraded emergency notification system. The Public Address (PA) System on September 11 was inaudible in many areas of the Pentagon. Already installed in Wedge 1, the Pentagon Renovation Program is looking at installing stand-alone PA systems within every room in the Pentagon and implementing an automatic messaging system that delivers the emergency announcement via telephone. "It is imperative that all personnel have an immediate, audible notification during an emergency situation," explained Catlow.

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Long-term, the Pentagon Renovation Program will harden all 10 radial corridors with Concrete Masonry Units (CMUs) and make them better resistant to fire with one-hour fire-rated wall board. The building will thus be broken into a series of compartments, making it more difficult for fire to spread. These hardened corridors will additionally serve as areas of refuge and enhance blast resistance and CBR/NBC protection.

The resulting blast of Flight 77 additionally took out several fire mains on September 11, thus lowering water pressure to the building significantly. Consequently, the PFPPAT is studying the merits of a river water fire-suppression loop. This will provide back-up fire suppression if a domestic main breaks or pressure drops severely. Similarly, the PFPPAT is going to create zones and redundant fire suppression mains around the Pentagon to supply the sprinkler systems.

Although thousands escaped the point of impact unharmed on September 11, the Renovation Program realizes the access and egress capacity of the Pentagon needs improvement. The Renovation Program is going to conduct a time egress analysis to determine the existing egress capabilities while also studying methods of removing windows during emergencies. Improvements will be made to handicapped access and egress as renovation continues.

Blast: The Pentagon Renovation Program is working with agencies, including the U.S. Army Corp of Engineers, the Defense Threat Reduction Agency (DTRA) and Arlington County, to better harden building components. In the short term, the Pentagon Renovation Program is working with Defense Protective Services (DPS) to increase stand-off distances from the face of the Pentagon.

Long term planning involves hardening and strengthening mission critical facilities and support utilities.

"There is no such thing as a blast or fire-proof facility. It can't be built. What you can do is take reasonable and prudent measures to ensure our personnel are safe," Evey concluded.

http://renovation.pentagon.mil

Rachel Decker is the communications specialist for the Pentagon Renovation Program in Arlington, Va.