

BENEFITS OF INNOVATIONS ON DEACTIVATION AND DECOMMISSIONING PROJECTS AT DOE'S PANTEX PLANT

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ABSTRACT

The use of innovative technologies and approaches has played a key role in improving safety, minimizing waste, and reducing overall costs associated with the Deactivation and Decommissioning of excess facilities at the Department of Energy's (DOE) Pantex Plant in Amarillo, Texas. In 2002, the Deactivation and Decommissioning Program at Pantex was comprised of the deactivation and decommissioning (D & D) of fuel systems, a former sewage treatment plant, and high explosive processing complexes. Innovations in these projects included decontamination and reuse of material potentially contaminated with listed wastes; remote methods of explosive equipment disassembly; and onsite recycling of demolition materials.

D & D of explosive processing facilities have inherent hazards due to the accumulation of raw explosives and explosive dust in equipment, piping, ducting and wall cavities, which can detonate through shock, friction, or other heat producing devices. At inactive facilities, specially designed explosive charges are often used to desensitize, disassemble and decontaminate explosive process equipment and piping. Due to the Pantex Plant's proximity to working weapons facilities, the use of explosives is strictly prohibited for D & D activities. An approved method using hydraulic oil to lubricate saws generates a mixture of waste oil and explosive material that has the potential to create friction, should the hydraulic oil not provide sufficient lubrication. Therefore, at Pantex, a high-pressure, low-volume water jet cutter was operated remotely to disassemble explosive equipment and piping. The high-pressure system also aided in the decontamination of the equipment and piping. This significantly reduced the amount and types of waste produced, while safely completing an inherently dangerous operation successfully.

As an alternative to transporting concrete to an offsite commercial recycler, a remote control, track-mounted, concrete crusher, with a magnetic belt, was used to crush the concrete onsite as part of the demolition process. The remote control crusher operated in tandem with the demolition excavator. Concrete was loaded directly into the crusher, avoiding the creation of large stockpiles. The crushed concrete was loaded directly into trucks from a belt loader. The concrete was immediately used in the construction of onsite roads. The magnetic belt separated out metal rebar. Metal separated from the concrete was loaded into roll-off bins for metal recycling. By crushing the concrete onsite, more concrete could be loaded into each truck, thus reducing the number of trucks that were escorted in and out of the security area, and saving as much as 30 minutes travel time per load. Therefore, this process safely reduced costs while maximizing recycling.

The former sewage treatment plant had processed wastewater from the Plant, including wastewater from an historic plating operation. In accordance with the Resource Conservation and Recovery Act (RCRA), the plating operation was considered an industrial source, and waste generated from that

process was F006 listed waste. Since all the wastewater treatment plant structures were constructed of concrete, the concrete was considered a listed waste under the “contained in” rule for porous media. Due to the high volume of concrete that would be generated from the demolition activities, alternatives to offsite shipment and disposal as a listed hazardous waste were evaluated. The only RCRA-approved method of adequate decontamination of porous media is the complete removal of approximately ¼-inch (0.6 cm) of material from the surface. The project team sandblasted the concrete structures prior to demolition and recycled the concrete, saving nearly \$700,000. It reduced the amount of hazardous waste generated from the project by over 5,200 tons (over 4,700 metric tons).

INTRODUCTION

The Pantex Plant (Pantex) located northeast of Amarillo, Texas is a government-owned, contractor-operated facility, managed for the U.S. Department of Energy (DOE) by BWXT Pantex, LLC, (BWXT Pantex). As an operating contractor for the DOE Pantex Plant, BWXT Pantex strives to comply with the DOE Order 450.5, Line Environment, Safety and Health Oversight and is committed to continued excellence, leadership, and stewardship in protecting the environment through its environmental management system. Within the framework of Integrated Safety Management (ISM), BWXT Pantex manages, operates, and maintains the Pantex plant with the highest regard for the protection of human health and the environment within Pantex and the surrounding community.



Fig. 1 Pantex Plant, Amarillo, Texas

The U.S. Army first built and used Pantex for the production (loading) of conventional ammunition shells and bombs from 1942 to 1945. In 1951, rehabilitation of portions of the original Pantex and construction of new facilities began for nuclear weapons operations. Current Pantex missions are:

- Assembly of nuclear weapons for the nation's stockpile
- Disassembly of nuclear weapons being retired from the stockpile
- Evaluation, repair, and retrofitting of nuclear weapons in the stockpile
- Sanitization of components from dismantled nuclear weapons
- Interim storage of plutonium components from retired weapons
- Development, fabrication and testing of chemical explosives and explosive components for nuclear weapons to support DOE initiatives.

Pantex is composed of several functioning areas commonly referred to as numbered zones. These zones include: a weapons assembly/disassembly area (Zone 12), a weapons staging area (Zone 4), an area for experimental explosive development (Zone 11), a storage area (Zone 10), a drinking water treatment plant, a sanitary wastewater treatment facility, vehicle maintenance, and administrative areas. Other functional areas include an explosive test-firing facility, a burning ground for thermal treatment and sanitization of explosives, and an area of landfills north of Zone 10. The present wastewater treatment facility was placed into service in 1988, replacing an older facility built in 1942 and located in Zone 13. In 1995, there were over 400 buildings at Pantex, many of which were constructed in the 1940s and 1950s.

DEACTIVATION AND DECOMMISSIONING PROGRAM

In 2002, BWXT Pantex initiated a formal Deactivation and Decommissioning Program to eliminate safety and health hazards of vacant and deteriorating buildings. In doing so BWXT Pantex can reduce the ongoing operation and maintenance costs associated with the upkeep of these facilities by at least a \$1 million a year. As an added bonus to the Pantex D & D program, deactivation and decommissioning reduces the overall footprint of the facility. In keeping with the DOE mandate of zero growth, the Pantex D & D program frees up space to allow the construction of new, modern facilities to implement the facility mission. Facilities demolished under the D & D program in 2002/2003 included an emergency fuel storage system, a former sewage treatment plant, a high explosive preparation complex, a high explosive synthesis complex, an explosive mixing building, and a number of miscellaneous structures.

Consistent with the BWXT Pantex commitment to continued excellence, leadership, and stewardship in protecting the environment and human health, each element of the D & D Program --including concept, design, development, and implementation--adhered to the ISM and environmental management systems. Each element specifically ensured that each and every aspect of the D & D Program would comply with the ISM and environmental management systems.

BWXT Pantex Health and Safety management is organized according to the seven safety functions of ISM, adopted from the DOE's five step Integrated Safety Management System, that are essential to planning and safely performing hazardous work. As illustrated in Fig. 2, the BWXT Pantex ISM is a continuous system of planning, analyzing hazards, identifying controls, implementing controls, confirming readiness, performing the work, and providing feedback and improvements.

This system builds on a working knowledge of past experience in performing similar work to improve safety. Adding to the safety challenges facing the BWXT Pantex D & D Program, the facilities selected for D & D were selected primarily to eliminate specific safety hazards associated with the facilities. Therefore, by definition, the facilities selected for D & D had inherent safety hazards including, but not limited to, exposure to hazardous materials, explosive hazards and structural instability.

To comply with BWXT Pantex's environmental management program, the D & D Program was designed to fully comply with federal and state environmental statutes, regulations, and permits, and with other requirements, as applicable, including DOE orders and Pantex Plant standards. Specifically, preventing pollution, with emphasis on waste minimization, was a prime consideration in process design and implementation of the D & D Program. The key elements of the environmental management of the D & D included the following elements:

- Environmental reviews to support compliance with the National Environmental Policy Act
- Cultural, historical, and natural resource management
- Pollution prevention (waste elimination, material substitution, waste minimization, recycling, energy conservation, water conservation), water, and RCRA/TSCA (waste management) permitting and compliance
- Environmental monitoring
- Environmental restoration (solid waste management unit remediation, technical development, CERCLA integration)
- Quality assurance
- Communication (internal and external)

Similar to the implementation of the ISM with a new program, the goal of total environmental compliance on a new program presented several challenges. In particular, BWXT Pantex's emphasis on waste minimization with a year over year waste reduction goal would be more difficult to achieve when adding a program that would generate waste such as demolition activities. It is even more difficult to achieve reduction when the facilities selected for the D & D program were chosen for specific health hazards associated with the materials handled in the facilities. Examples are hazardous and potential infectious wastes at the sewage treatment plant, or explosive wastes at the high explosive complexes.

To fulfill the needs of the D & D Program while meeting the overall goals of the Pantex facility, BWXT Pantex solicited bids from contractors who had specific experience in the decontamination and demolition of facilities similar to those selected for D & D at Pantex. Since the D & D Program was not only new to Pantex, but new to the DOE as a whole, contractors with the specialized expertise in the D & D of hazardous and explosive facilities typically did not have substantial DOE experience. The following sections will describe how safety and environmental management challenges were met through the use of innovation and teamwork.

SAFETY INNOVATION IN EXPLOSIVE FACILITY DEMOLITION

Cleanup of ordnance and explosives (OE) facilities is a relatively new activity, within the U.S. Therefore, until recently, the available technologies to safely perform cleanup of OE facilities had not been developed. The Environmental Protection Agency (EPA), working in conjunction with the Department of Defense (DoD), prepared the first comprehensive guidance documents to address the cleanup of OE. These documents are currently in draft form out for public comment. The draft EPA guidance states: "OE may present an imminent hazard and can cause immediate death or disablement, to those nearby." Due to these imminent hazards, the EPA document specifies the requirements for specially trained personnel, typically with extensive military training and experience in explosive ordnance disposal to support and conduct OE cleanup operations. DOE Explosive Safety Manual, Pantex version, references DoD OE guideline documents mandating the same level of training and experience. Two of the D & D projects at Pantex involved the deactivation and decommissioning of high explosive processing facilities.

In planning for the D & D of these facilities, BWXT Pantex project management recognized the need for specialized expertise in the D & D of explosive processing facilities and required detailed technical proposals for the execution and detailed descriptions of explosive decontamination efforts. Under two separate "best value" procurements, MKM Engineers, Inc. (MKM) was selected to implement the D & D of the two explosives facilities.

The High Explosives (HE) Preparation Complex was constructed during World War II for the production of conventional weapons and consisted of eight buildings within Zone 12. It was specifically designed to blend boxes of explosives into larger batches for melting and pouring into bomb cases. World War II ended before the complex became operational. In 1952, the complex was converted into an explosive blending facility in support of Pantex's new mission. TNT and RDX were off-loaded from rail cars into the facility. From there, the boxes were transferred to the second floor via an overhead conveyor system. The explosives were blended and dried in preparation for transport to the melt and cast operations located in another complex within the Pantex Plant. One of the buildings was used to collect and store empty HE boxes for recycling. After the blended explosive became available commercially, three of the buildings were converted to other uses. The buildings in this complex were in "poor" condition and no future use was identified for the complex.

The second facility, the HE Synthesis Complex located in Zone 11 was constructed during World War II for production of high explosives (HE) used in conventional ordnance. When the Pantex mission was changed to support nuclear weapon programs during the Cold War, this complex was placed into service to synthesize various types of explosives. The complex consisted of five buildings, ramps and infrastructures, and five abandoned building slabs. Production and research/development activities were performed primarily in one building. The other buildings were used for storage and operations support. Operations in this building were discontinued in the mid 1990s. Prior to demolition, the buildings were vacant or used for storage. The buildings in this complex were in "poor" condition and no future use was identified for the complex.

Using the ISM process, the scope of work for these two facilities was organized into specific tasks or activities. Safety hazards were analyzed and control measures identified for each of these activities. The activities associated with explosive facility D & D included:

- Assessment of the area for explosive, asbestos, and chemical hazards
- Decontamination of surface explosive residue and flaking paint
- Decontamination and removal of non-explosive chemical storage tanks, and other non-explosive contaminated equipment
- Inspection of explosive process equipment
- Dismantling explosive equipment, piping and ducting
- Decontamination of explosive-contaminated equipment
- Demolition of building
- Site Restoration.

Of the various activities identified, dismantling and explosive decontamination of the process equipment were identified as the tasks posing the greatest hazards. The simple act of unscrewing a bolt can add enough shock and/or friction to generate an unplanned detonation in a confined area. Using past knowledge of explosive facility D & D, the team identified that explosive hazards at Pantex could result from:

- Accumulation of raw explosives in the confines of process equipment and piping
- Accumulation of raw explosives in ventilation ducting, cooling systems, air compressors
- Build-up of explosive dust on surfaces, in open piping, and wall cavities
- Degradation of explosive constituents into less stable explosive compounds
- Accumulation and concentration of explosives in clean-out sumps and drains.

The most commonly used and safest method of explosive equipment and facility dismantling as specified in the U.S. Army Technical Bulletin 700-4, *Decontamination of Facilities and Equipment Publication*, employs the use of specially designed explosive shape charges to remotely dismantle, desensitize, and decontaminate the equipment. Highly trained experts are utilized with extensive knowledge of explosives and the process equipment design for explosive shape charges to provide just enough explosive energy to sever piping and process equipment. Equipment is then inspected with a Borescope™ to identify build-up of explosive residue inside. Explosive shape charges are then set at intervals to dismantle the equipment in manageable pieces, avoiding areas with extensive explosive build up.

Raw explosives are removed from the dismantled pieces of equipment. DoD and DOE guidance documents have defined this step as 1X Certification. The equipment is then desensitized with detonation cord in a secure open detonation area. The explosive residue inside the equipment is consumed in the detonation allowing the equipment to be transported without the risk of an unplanned detonation. This step is designated as 3X Certification. As a final step in the decontamination process, all metal is thermally treated in a flashing furnace to destroy any residual explosive residue, allowing the metal to be released by the government for salvage and is defined as 5X Certification.

While the use of explosive shape charges by highly trained professionals is the safest way to dismantle explosive contaminated equipment, there are a number of situations where explosives cannot be used. Specifically these include:

- Areas where the explosive detonation cannot be fully contained because the extent of explosive residue is widespread or undefined.
- Areas where the detonation pressure and/or the control of fragment debris cannot be fully contained within an exclusion boundary.
- Areas where sensitive operations preclude the use of explosives due to the noise and/or shock wave
- Areas where the use of explosives is strictly prohibited due to operational constraints.

Another accepted method of dismantling equipment is with the use of a remote controlled lubricated saw. After decontamination of the facility for surface explosive residue, a remote-controlled lubricated saw is used to cut process equipment into pieces that will allow complete and thorough decontamination. Equipment and piping must be cut into a sufficient number of pieces to allow complete access to all internal surfaces where explosive residue may accumulate.

Raw explosives are removed from the equipment and placed in appropriate containers for thermal destruction (1X Certification). The pieces of equipment and piping are then carefully removed and transported to a decontamination area, where visible explosive residue is removed through the use of high-pressure steam and hot water (3X Certification). As a final decontamination step, metal pieces of equipment are transported to a flashing furnace where residual explosive residue is thermally destroyed (5X Certification) allowing offsite recycling or reuse. Materials that cannot be thermally treated are properly disposed.

Tables I and II summarize the activity hazards of these two acceptable methods of explosive facility decontamination. In evaluating the safety hazards and mitigation measures associated with these options, it must be stated that both alternatives pose a potential risk of detonation. In Alternative 1,

the detonation is planned and controlled. As a planned and controlled detonation, a maximum credible event (MCE) is calculated based on the maximum amount of explosives anticipated within a given pipe or piece of equipment and the added explosive energy from the shape charge. From the MCE, a quality-distance (QD) is calculated. The QD serves as a radius for determining an evacuation zone boundary that would be established prior to and during each planned detonation.

In Alternative 2, because of the potential for momentary lubrication failure and more likely the failure to sufficiently lubricate raw explosives inside a pipe or ducting as the cut is being made, detonations have historically occurred using this method. Due to the risk of detonation, both a MCE and a QD are calculated for this alternative. As in Alternative 1, each time a cut is made, personnel are evacuated from the area prior to and during the remote-control cut.

In addition, due to proximity of the HE Preparation Complex and HE Synthesis Complex, demolition projects to active operational facilities, security requirements prohibit the use of cameras

Table I Activity hazard analysis for Alternative 1 – Explosive dismantling/decontamination

| Activity | Process | Hazards | Mitigation Measures |
|----------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assessment | Field Screening for explosive residue | Disturbing raw explosives | Use only trained OE specialists familiar with hazards. Use non-sparking tools and static-free clothing. |
| Surface Decontamination | Sweep/Hot water wash of surfaces testing positive for explosives | Disturbing raw explosives. | Use only trained OE specialists familiar with hazards. Use non-sparking tools and static-free clothing. |
| Assessment of Equipment, Piping, and Ducting | Use shape charges to create openings in closed systems. Inspect with bore scope. | Explosive hazards associated with setting and blowing shape charges. Risk of “blindly” creating first opening in an area with excess explosive build-up. | Calculate MCE and QD separation. Use only trained OE specialist to set shape charges. Evacuate area within QD & establish perimeter security. Remotely detonate shape charges. Inspect area prior to re-entry. |
| Equipment dismantling | Dismantle equipment into manageable pieces with shape charges based on inspection results. | Explosive hazards associated with setting and blowing shape charges. | Calculate MCE/QD based on inspection results. Use only trained OE specialists to set shape charges. Evacuate area within QD & establish perimeter security. Remotely detonate shape charges. Inspect are prior to re-entry. |
| 1 X Certification Removal of Raw Explosive | Manually place raw explosives in containers suitable for transportation. | Explosive safety hazards. Raw Explosive chemical hazards. Explosive transportation hazards. | Use only trained OE specialists to package raw explosives. Use appropriate PPE to handle raw explosives. Secure transportation route. Transport material using explosive escorts. |
| 3 X Certification Removal of Visible Residue | Use explosive detonation cord to detonate areas explosive build up inside pipes and ducting. | Explosive hazards associated with planned detonation. | Calculate MCE based on inspection results. Use only trained OE specialists to set detonation cords. Evacuate area within QD & establish perimeter security. Remotely detonate piping to desensitize piping. Inspect are prior to re-entry. |
| 5 X Certification Thermal Destruction | Transport desensitized piping to flashing furnace. Treat using flashing furnace. | Transportation hazards. Explosive hazard inside furnace if equipment is not thoroughly decontaminated. | Inspect all surfaces prior to shipment to flashing furnace. Secure transportation route. Transport material using explosive escorts. Place material in flashing furnace, evacuate area. |
| Building Decontamination | Thermally treat building prior to demolition. | Hazards associated with open fire and setting explosive charges. | Calculate MCE based on inspection results. Use only trained OE specialists to set shape charges. Evacuate area within QD & establish perimeter security. Remotely detonate thermal decontamination of building. Inspect are prior to re-entry. |

Table II Activity hazard analysis for Alternative 2 – Manual dismantling/decontamination

| Activity | Process | Hazards | Mitigation Measures |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assessment | Field Screening for explosive residue | Disturbing raw explosives. | Use only trained OE specialists familiar with hazards. Use non-sparking tools and static-free clothing. |
| Surface Decontamination | Sweep/Hot water wash of surfaces testing positive for explosives | Disturbing areas with raw explosives. | Use only trained OE specialists familiar with hazards. Use non-sparking tools and static-free clothing. |
| Assessment of Equipment, Piping, and Ducting | Use remote-controlled lubricating saw to create openings in closed system. | Slip, fall hazards from lubrication. Momentary lapse in lubrication causing heat, shock or friction and unplanned detonation. Risk of “blindly” creating first opening in an area with excess explosive build-up. | Must assume possible detonation. Calculate MCE and QD separation. Use only trained OE specialist to set lubricating saw. Evacuate area within QD & establish perimeter security. Remotely operate lubricating saw. Inspect area prior to re-entry. |
| Equipment dismantling | Dismantle equipment with remote-controlled lubricating saw based on inspection results | Slip, fall hazards from lubrication. Momentary lapse in lubrication causing heat, shock or friction and unplanned detonation. | Must assume possible detonation. Calculate maximum MCE and QD separation. Use only trained OE specialist to set lubricating saw. Evacuate area within QD & establish perimeter security. Remotely operate lubricating saw. Inspect area prior to re-entry. |
| 1 X Certification Removal of Raw Explosive | Manually place raw explosives suitable for transportation and destruction. | Explosive safety hazards with handling raw explosives. Chemical hazards with handling raw explosives | Use only trained OE specialists to package raw explosives. Use appropriate PPE to handle raw explosives. Secure transportation route. Transport material using explosive escorts. |
| 3 X Certification Removal of Visible Residue | Take sections of piping with explosive residue to decontamination area. Steam clean to remove residue. | Slip, fall hazards from use of lubrication in area. Explosive hazard when moving dismantled pieces to decontamination area. | Clear path from work area to decontamination area. Evacuate all non-essential personnel. Use slip proof footing. Use proper PPE when steam cleaning. |
| 5 X Certification Thermal Destruction | Transport desensitized piping to flashing furnace. Treat using flashing furnace. | Transportation hazards. Explosive hazard if equipment is not thoroughly decontaminated. | Inspect all surfaces prior to shipment to flashing furnace. Secure transportation route. Transport material using explosive escorts. Place material in flashing furnace, evacuate area. |
| Building Decontamination | Remove raw explosives and explosive residue prior to demolition. | Risk from accumulation of raw explosives in areas not visible prior to demolition and unplanned detonation from shock and friction during demolition. | Calculate MCE based on inspection results. Use only trained OE specialists to set shape charges. Evacuate area within QD & establish perimeter security. Demolish building with harden and armored equipment. |

and video recording devices. Since the bore scope records video information as it travels along the inside of a pipe, ducting and equipment, it is considered a video recording device and is not permitted within the Pantex site. As a result, each cut or detonation would have to be treated as a "blind" cut, assuming the maximum probable amount of explosives within a piece of pipe or equipment, creating the largest evacuation zone.

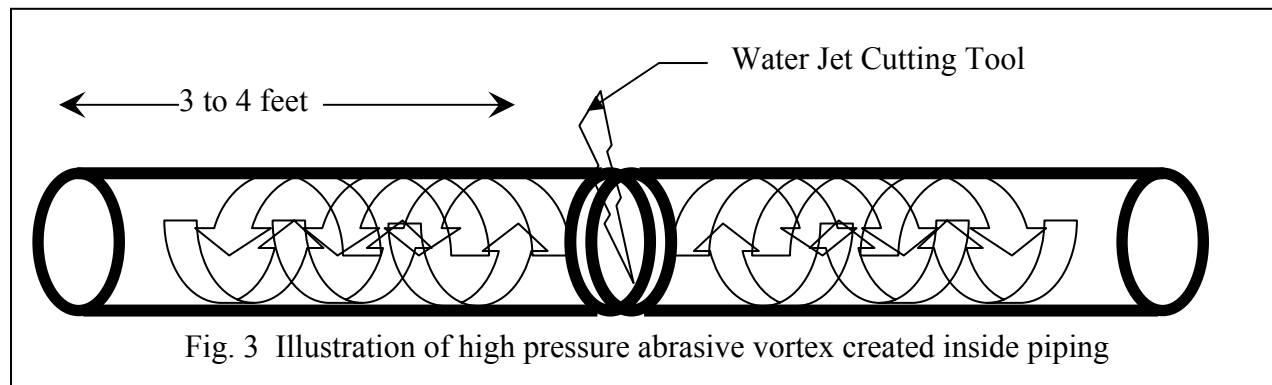
In evaluating the MCE and QD, the D & D contractor, MKM, recognized that the evacuation zones could include active production and explosive experimental areas within the Pantex Plant. Realizing that evacuation of the production areas would not be acceptable, MKM proposed alternative technologies to the accepted and proven approaches.

Abrasive Water Jet Cutting Technology

A cold cutting technology using high-pressure abrasive water jets to safely dismantle potentially dangerous HE components was proposed. Originally developed in the 1980s, high-pressure abrasive water jet cutting technology had been used in precision machining where the heat from other types of precision machining could warp or distort metals. However, the technology to produce an industrial size, portable unit capable of producing the required 50,000 psi (345,000 kilopascals) of water pressure was not readily available until the mid-1990s. Industrial high-pressure abrasive water jet cutting tools were first used in Europe in the chemical, shipping and coal mining industries. This technology is now being used on a limited basis in the United States in the chemical industry where hot work cutting is not an option. Recognizing the advantage of low-heat, water-based cutting tool, MKM worked with the manufacturer to build a portable unit that could be used in the D & D of the Pantex explosive facilities.

Since the system uses water to cut metal, the hazard of an unplanned detonation during equipment dismantling was eliminated. This also eliminated the need for evacuation during explosive equipment dismantling. Initially set up with a custom designed remote control assembly, the intrinsically safe nature of the abrasive water jet cutter allowed manual operation with a custom designed directional lance. Using the lance, the operator is able to reach areas, which could not have been previously accessed with either a remote control lubricating saw or shape charges. In addition, this allowed the operator to discontinue a cut if raw explosives were identified as the cut was being made. By having an operator controlling the cutting, it reduces the risks associated with "blind" cuts.

Perhaps the greatest advantage of the high-pressure abrasive water jet cutter was discovered during field-testing. With an operating pressure of between 20,000 to 50,000 psi (138,000 to 345,000 kilopascals), the water mixed with very fine abrasives not only easily cut through high-strength piping and explosive production vessels, but in the process of cutting the piping and ducting, the high-pressure water jet created a vortex inside piping and ducting being cut. The vortex with its high-pressure water and fine abrasive grit not only cleaned but also polished the interior walls of the pipe removing explosive residue in the process. Depending on the diameter of the pipe and the pressure used, the vortex polished between 3 and 4 linear feet (0.9 to 1.2 meters) of the inside of the pipe in both directions, as illustrated in Fig. 3.



5 lbs (2.3 kg) of Raw Explosives Found in Ducting

Fig. 4 Raw explosives found in ducting

By cutting pipe and ducting in 6- to 8-foot (1.8 to 2.4 meters) sections, the high-pressure water jet cutter was not only used to dismantle the equipment, but also to decontaminate it to 3X Certification standards during the disassembly process. With the high-pressure low-flow system, very little water was generated during the disassembly and decontamination process. What little water that was generated quickly evaporated, leaving an explosive residue waste stream that had a stable paste-like consistency that could be containerized and thermally treated, significantly minimizing the amount of explosive waste generated from the demolition project.

Fig. 4 shows the location of where our team found five pounds (2.3 kilograms) of raw explosives in ducting during the course of demolition of the HE Synthesis Complex.

In total, the project team found and removed a total of 15 pounds (6.8 kilograms) of raw explosives from ducting, filters, process equipment, and the air scrubber. Given the quantity of raw explosives found within confined systems of this building, the safety program would have called for evacuation of a large area (thus shutting down adjacent facility operations) or worse yet, serious injury could have occurred from failure to evacuate a large enough area.

Onsite Concrete Recycling

The emphasis on plant-wide waste minimization with waste reduction goals presented challenges to the new D & D Program, since the program had the potential of generating a significant amount of waste from demolition activities. To help reduce the volume of waste generated, program planning included the requirement for reuse and/or recycling. Equipment that could be used by the plant was initially marked for reuse, while project specifications required that concrete, steel and wood be

recycled. Pantex had established an area onsite for wood recycling; however, concrete and steel would have to be shipped to an offsite recycler.

As an alternative to transporting concrete generated during the demolition of the HE facilities to an offsite recycler, the use of an onsite mobile concrete crusher was proposed. The proposal was based on explosive safety concerns, effective project execution and meeting the waste minimization requirements. Experience has shown that raw explosives and explosive residue have the potential for accumulating in a number of places throughout an explosive processing building, including hollow wall cavities in masonry block structures, cracks in concrete slabs, in and around floor drains and sumps.

For explosive facilities on inactive plants, MKM thermally treats the structures after all the equipment, piping, ducting and hazardous and toxic materials have been removed from the buildings. This thermal treatment heats the structures to 1700 degrees Fahrenheit (930 degrees Centigrade) and thermally destroys any explosive residue in wall cavities, concrete slabs, wood beams and other building structural elements. However, thermal treatment of the explosive facilities requires evacuation of a very large area for an extended period of time and would not be feasible or practical within the confines of the Pantex production areas.

The use of the high-pressure water-jet cutter was able to address explosive contamination in process equipment, piping and ducting as well as sections of the concrete slab and walls with known explosive contamination. The bigger concern was the possibility and/or presence of explosive contamination in small cracks in the concrete slab and/or masonry walls that had not been identified. Since the act of crushing the concrete would add sufficient friction and shock to detonate explosive residue and/or raw explosives that were not addressed during the decontamination process, any explosive residue would be addressed. However, there was a greater concern that the crushing process would be operated by offsite recyclers, who do not have the training and experience to identify and/or address explosive contamination. MKM proposed performing the concrete crushing operation onsite under the supervision of trained explosives experts of its own.

In addition to the safety concerns, onsite crushing provided several advantages to off-site recycling when working in the high security zones of the Pantex Plant, including:

- Reducing if not eliminating the creation of concrete stockpiles, which can pose added security concern and cause double-handling of material
- Increasing the capacity of trucks with reduced material sizing
- Greatly reducing the number of trucks hauling concrete that will have to be escorted out of the security area
- Optimizing waste streams of recycled material by separating metal from concrete allowing maximum recovery of steel
- Allowing concrete to be used onsite.

BWXT Pantex and MKM worked together to identify and address permitting and environmental protection requirements for using the crusher onsite. Upon implementation of environmental protection measures, a remote control, track-mounted, C-12 concrete jaw crusher equipped with a magnetic separation belt was mobilized to the site. The concrete crusher worked in tandem with the demolition process. The crusher moved along with the excavator and the demolished concrete was loaded directly into the crusher, avoiding the creation of concrete stockpiles. The crushed concrete

was loaded directly into trucks that hauled the crushed material to Zone 10 for onsite staging and reuse. Working with onsite plant maintenance personnel, concrete was crushed to specific size requirements for either erosion control rock or road base, depending on specific plant needs.

A total of 5,000 tons (4,500 metric tons) of concrete was crushed and reused onsite from the high explosive demolition projects. An additional 500 tons (450 metric tons) of rebar separated from the concrete and loaded into roll-off bins for offsite salvage.

Decontaminating Concrete to Minimize Waste

The emphasis on plant-wide waste minimization with waste reduction goals presented challenges to the new D & D Program, since the program had the potential of generating a significant amount of waste from demolition activities. To help reduce the volume of waste generated, program planning included the requirement for recycling demolition materials. Of the 2002 proposed D & D projects, the deactivation and decommissioning of the Zone 13 Old Sewage Treatment Plant (OSTP) presented significant challenges in waste minimization.

The Zone 13 OSTP was constructed in 1942 and served the original Pantex Plant and Amarillo Air Force Base. The facility was initially deactivated in 1946. In 1952, a chlorinator building was added to the facility and the facility was reactivated. The Zone 13 OSTP served Pantex until 1988, when the current sewage treatment plant was built. Located on 15 acres (6 hectares) in the northeast corner of the Pantex Plant, the Zone 13 OSTP consisted of:

- Two below-grade, open-topped, reinforced-concrete clarifiers that were 12-feet (3.7 meters) deep, 40-feet (12.2 meters) wide and 100-feet (30.5 meters) long
- Two above-grade, open-topped, reinforced-concrete trickling filters that were 75-feet (22.9 meters) in diameter and 12-feet (3.7 meters) high
- A below-grade, reinforced-concrete digester with a floating roof that was 80 feet (24.4 meters) in diameter, 22-feet (6.7 meters) deep
- Above-grade, reinforced-concrete sludge drying beds that had overall dimensions of 3- feet (0.9 meters) high, 150-feet (45.7 meters) wide and 240-feet (73.2 meters) long, separated by concrete walls into six separate dry beds
- A two-story masonry control building that was 39 feet by 39 feet (11.9 meters by 11.9 meters)
- A one-story masonry chlorinator building that was 20 feet by 39 feet (6.1 meters by 11.9 meters)
- Approximately 4,000 linear feet (12.9 meters) of interconnecting pipe
- A tail water pit

All six concrete structures and the basement of the control building contained water, wastewater, sludge, and/or filter media. The project plan required sampling of wastewater, sludge and filter materials during the planning phase. Disposal of the waste would then be based on the sample results, steam cleaning of concrete structures to remove biological materials and demolition and recycling of the concrete. Plant records indicated that the wastewater in clarifiers had been previously removed and the water currently in the clarifiers was rainwater that had accumulated.

The trickling filters were the final process in the treatment plant prior to discharge through the chlorinator building. The trickling filters contained filter rock and drain tiles. Representative samples

of the filter rock and drain tiles within the trickling filters could not be taken while the rock was still inside the trickling filters. The work plan called for removal of the drain rock and tile from the trickling filters and placement of this material in the sludge beds once the sludge bed material had been removed and then sampling of the trickling filter material occurred during field construction activities.

Discovery of historical records of the facility operations after the contract had been awarded, but before construction began, indicated that plating waste had been discharged to the OSTP during early operations of the facility. Based on these findings, the following waste determinations were made:

- Since the clarifiers had been previously cleaned, the rainwater that accumulated within these structures could be treated at the onsite wastewater treatment plant.
- The sediment in the clarifiers would be treated as Class I waste, based on sampling results.
- Sludge and wastewater in the control building and digester would have to be treated as F006 listed hazardous waste.
- The gravel and sludge in the sludge beds would have to be treated as F006 listed hazardous waste.
- Representative samples of the filter rock would be taken during construction and waste determination would be based on the sampling results as planned.
- Any structures that had been used to store, process or treat F006 listed waste fell under the RCRA "contained in" rule and as a result the porous concrete structures were also considered hazardous waste.

Through regulatory research, it was determined that there was an approved method for porous media decontamination. The method called for the removal of approximately 1/4-inch (0.6 cm) on concrete from all inside surfaces of the containers using scabbling, sandblasting, or similar techniques. Concerns about the added safety hazards, cost, schedule, and environmental impacts associated with sandblasting the structures appeared to out-weigh the benefits of waste minimization efforts associated with conventional decontamination and recycling of the concrete.

BWXT Pantex and MKM jointly worked on a cost-benefit analysis for decontaminating the concrete. The analysis compared the cost and schedule impacts of sandblasting versus the cost of loading, transporting and offsite disposal of the demolished concrete. Despite initial concerns regarding cost and schedule impacts, the analysis showed that a significant savings could be realized by sandblasting the structures. Using the ISM process, the existing site safety plan was modified to address the added safety hazards associated with the sandblasting operation and put environmental protection measures in place to minimize particulate emissions from the sandblasting operation.

A sandblasting crew was mobilized to the site and was able to decontaminate the structures as soon as the waste materials were removed with minimal impact to the project schedule. A total of 5,200 tons (4,700 metric tons) of concrete was demolished, hauled to an offsite concrete recycler and recycled. This saved approximately \$700,000 over offsite disposal of the concrete as a hazardous waste.

CONCLUSION

Through innovation and teamwork, a total of 230,000 square feet (21,400 square meters) of facilities were deactivated, decommissioned and demolished at Pantex in 2002-2003. There were no reportable

safety or environmental incidents while adhering to DOE's safety and environmental policies. In addition, the program had over \$700,000 in cost savings and provided over 5,200 tons (4,700 metric tons) of usable recycled road base and erosion control rock to plant.