THE OXY-GASOLINE CUTTING TORCH: A FERNALD PLANT 1 LARGE SCALE TECHNOLOGY DEMONSTRATION TRIUMPH

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ABSTRACT

The Decontamination and Decommissioning (D&D) Large Scale Technology Demonstration Projects (LSTDPs) are intended to find and validate D&D technologies that are "safer, better, faster, and cheaper." One project chosen for the LSTD is incorporated into the existing Plant 1 D&D Project at the Fernald Environmental Management Project (FEMP) in Fernald, Ohio which has been selected to host a LSTDP. The LSTDP was incorporated into an existing ongoing D&D Project, Fernald Plant 1 D&D Project, at the FEMP. The LSTDP is managed by an Integrating Contractor (IC) Team made up of Fluor Daniel Fernald, including teaming partners, as the operating contractor for FEMP; B&W NESI, as the D&D subcontractor for the Plant 1 D&D Project; and Foster Wheeler Environmental Corporation, as the representative of the United States Army Corps of Engineers. The IC Team has approved 12 technologies for demonstration. One of these technologies, the oxy-gasoline cutting torch, is the subject of this paper.

The oxy-gasoline cutting torch recommended for demonstration was developed as an improvement on the existing oxy-gasoline torch. These torches have been around for many years, but have not been widely used due to safety concerns, including backflash. The torch recommended has been designed to make backflash essentially impossible. In addition, several other design features resulted in the cooler operation of the head assembly, promoting longer tip life and improved cutting performance. The oxy-gasoline torch does a more complete oxidation of the metal, thus removing the material as a vapor, rather than as molten metal slugs. The result of the demonstration shows that the oxy-gasoline torch is indeed *safer*, reducing metal splatter; *better*, having the torch tip farther from the material being cut; *faster*, cutting at least 50% quicker than the oxy-acetylene torch; and *cheaper*, consuming fuel at one-tenth the cost.

INTRODUCTION

This paper presents the results of a technology demonstration of the oxy-gasoline cutting torch conducted as part of the Fernald LSTDP and integrated within the Fernald Plant 1 D&D Project. It was selected as an innovative method of cutting materials. The LSTDP was planned to be integrated within an ongoing D&D Project so that the innovative technologies could be directly compared to the baseline (method or tool selected by the subcontractor) technology. For the Plant 1 D&D Project, the baseline technology is the oxy-acetylene cutting torch, commonly used at D&D sites for segmenting steel materials. A description of the innovative technology, its performance, and results of the performance are included. Comparisons with the baseline technology are included where appropriate.

This paper is organized into six sections. The first section is a description of the LSTDP at Fernald, including a background on the D&DFA and the implementation of the project at Fernald. The next section is a technical description of the innovative technology, the Oxy-Gasoline Safety Torch, manufactured by Petrogen International, LTD. The third section discusses the specific technology demonstration of the oxy-gasoline torch, including the setup (training), the demonstration itself, the results of the demonstration, and the debriefing following the demonstration. The fourth section presents the experiences that B&W NESI, the D&D subcontractor for the Plant 1 D&D Project, had before and during the demonstration. The next to last section briefly discusses the communication of the success of the oxy-gasoline torch and other demonstrated technologies. The last section, conclusions, rounds out the findings of the technology demonstration.

LSTDP AT FERNALD

In January 1994, the Department of Energy's (DOE's) Office of Environmental Management introduced a new integrated approach for addressing waste issues, based on six focus areas and a series of

crosscutting technology areas supporting those six focus areas. One of these focus areas, the Decontamination and Decommissioning (D&D) Focus Area (D&DFA), was initiated at the Morgantown Energy Technology Center, now part of the Federal Energy Technology Center (FETC). The D&DFA is charged with bringing technologies to bear that will make D&D "safer, better, faster, and cheaper." This is being done by showing that available technologies can be used in innovative ways and that new innovative technologies can perform the same tasks or new tasks not currently performed.

In July 1995, solicitations were requested from DOE organizations for ongoing projects that could support D&D technology demonstrations in a side-by-side cost comparison to determine the economics of the new/innovative D&D technologies. Eight demonstration projects were evaluated for incorporation into the D&DFA Large Scale Technology Demonstration (LSTD) Program. Three of the eight projects were selected for immediate action. The three projects selected were the CP-5 Reactor D&D, located at the Argonne National Laboratory near Chicago, Illinois; the Fernald Plant 1 D&D Project, located at the Fernald Environmental Management Project (FEMP) near Cincinnati, Ohio; and the 105-C Reactor D&D at the Hanford Reservation near Richland, Washington. The three projects began approximately six months apart in the above order.

The demonstration of a technology as part of the LSTD Program is planned to be done only once; it is not FETC's intention to demonstrate one technology performing the same task twice. Therefore, if a technology is known to be demonstrated at another DOE site or at another D&DFA project, then it should not be considered for other projects performing the same task. However, if the tasks are sufficiently different, then multiple demonstrations of the same technology are, in fact, encouraged.

The LSTD at FEMP's Plant 1 D&D Project consists of applying at least twelve technology demonstrations into the ongoing D&D project to decontaminate and demolish the buildings within the Plant 1 complex. Any technologies to be demonstrated had to meet one of the needs identified by the site personnel at the beginning of the LSTD Project. The needs identified require technologies to meet any of five objectives, which are:

- the technology should improve safety and/or reduce the probability for work related injuries or accidents,
- the technology should reduce contaminant mobility and/or control airborne radioactivity,
- the technology should reduce the volume of waste requiring disposal,
- the technology should reduce the size of the labor force required to perform the targeted activity since this is the most effective way to reduce D&D costs, or
- the technology should support the potential recycling/reuse alternatives.

In addition to describing the needs of the technology to be demonstrated at Plant 1, the site personnel also provided twelve D&D tasks, the performance of which would meet at least one of the above objectives. Selection of demonstration technologies that perform the identified tasks will support the overall D&DFA objectives. The identified tasks are:

1. a method of shearing pipes and conduit (preferably from a stand-off distance),
2. improved personal protective equipment (PPE) to reduce personnel heat stress conditions,
3. improved power washing of structures,
4. aggressive scabbling of concrete,
5. methods of cleaning process pipe designated as containing process materials,
6. a new means of inspection to determine the presence of process materials in pipes and equipment,
7. improved ways of fixing contamination in process pipes,
8. enhanced techniques for the removal of the mineral wool between the interior and exterior transite building walls,
9. new methods for the removal of both transite wall panels and concrete/masonry walls,
10. improved *in situ* (real-time/near real-time) characterization,
11. innovative processes for total waste container characterization, and
12. respirator cartridge recycling.

The oversight and/or management of the Fernald LSTDP is by an Integrating Contractor (IC) Team made up of representatives from several companies. The overall management of the IC Team is by Fluor Daniel Fernald, the operating contractor of the FEMP. A major player on the IC Team is B&W NESI, the D&D subcontractor for the Plant 1 D&D Project. DOE is represented on the team not only by DOE personnel, but also by the United States Army Corps of Engineers (USACE) Huntington District. The USACE contracted with Foster Wheeler Environmental Corporation to provide the IC Team another experienced D&D firm to provide independent expertise to the IC Team. Other members of the IC Team include the parent and teaming companies (Fluor Daniel, Jacobs Engineering, and Halliburton NUS) of the operating contractor, Florida International University, University of Cincinnati, and WPI/SAIC.

The Fernald LSTDP and its IC Team are organized along three levels. The top level is the LSTDP DOE oversight team, composed of DOE, USACE, and, supporting DOE, WPI/SAIC. The second level is the IC Team itself, composed of the Integrating Core Team (FDF and B&W NESI) and the strategic alliances (Foster Wheeler Environmental Corp., Fluor Daniel, Jacobs Engineering, and Halliburton NUS). The third level are the project teams from the individual companies performing the work in support of the IC Team.

In practice, technologies are identified that may be applicable to Plant 1 D&D needs through either the IC Team itself or through individual knowledge and searches. Each technology is assigned to a team member for evaluation. The project team member evaluates the technology according to a standardized evaluation form. The technology is evaluated on its applicability to Plant 1 D&D needs as well as the other criteria described above. If the technology will indeed support Plant 1 D&D, then the technology is recommended for further investigation in a technology proposal. The technology is

presented to the IC Team, which decides on the merits of the technology. If it appears to be a useful technology, then the team member is instructed to develop the technology proposal and to outline the cost benefits to Plant 1 as well as the overall site and complex wide. The IC Team reviews the technology proposal, recommends changes or rejection, and reviews revisions to the technology proposal before approving the technology for demonstration. After the IC Team approves a technology for demonstration, a formal recommendation is sent to DOE Fernald for their concurrence. At this point, the technology proposal is given to FDF for development into a statement of work that will be given to the D&D subcontractor for their proposal (cost, schedule, impacts on existing D&D project, etc.) preparation.

In the case of the Oxy-Gasoline Safety Torch, Foster Wheeler Environmental personnel identified this technology through a journal article in the *Welding Journal* and identified it as a good candidate for the technology demonstration. After contacting the vendor and determining its usefulness, an evaluation recommending pursuit of a technology proposal was prepared. At the next scheduled IC Team meeting, this technology was presented and recommended for further investigation. The team concurred, and a technology proposal was begun.

A six-page technical proposal was prepared describing the oxy-gasoline torch, the baseline technology (oxy-acetylene torch), its expected benefits, suggested success criteria, demonstration information, and an estimate of the comparison of the technologies. After some revisions, the IC Team approved the technology for demonstration, and that demonstration was scheduled for the fall of 1996.

OXY-GASOLINE SAFETY TORCH TECHNICAL DESCRIPTION

The concept of using a combination of gasoline and oxygen to fuel a cutting torch has been around for more than 40 years. The original technology design, however, charged the gasoline while still in the fuel supply tank and then pumped the highly volatile vapor to the cutting torch head. Backflash could occur, during which the flame ignites the gasses in the nozzle and travels back through the torch mixing chamber to the hose, potentially reaching the fuel tanks and causing a disastrous explosion. Because of the safety questions, and an almost visceral public reaction to using gasoline in a flame, the original oxy-gasoline torch was not widely used.

In recent years, a small company in California, called Petrogen International Ltd., began working on and improving the technology for the torch. Because gasoline is much less expensive than acetylene or propane, a cheaper cutting technology would be possible if the safety concerns could be successfully addressed. The result of this effort was the Oxy-Gasoline Safety Torch, an innovative, versatile and safe alternative to traditional acetylene or propane torches.

Oxy-Gasoline Safety

Addressing the issue of backflash required the redesign of the fuel delivery and cutting tip system. Gasoline in its liquid state is inert—it does not burn. It is the vapor of gasoline mixed with air that is volatile. By keeping the gasoline liquid until it reaches the tip, the problem of backflash can be all but eliminated. The Petrogen Oxy-Gasoline Safety Torch accomplishes this by delivering the gasoline to the tip in the form of a confined liquid. The gasoline tank is pressurized by either a self-contained hand pump or by an external source of compressed air. The liquid gasoline then moves through a special hose to the mixer, which is in the head of the torch at the base of the tip. The liquid gasoline travels around the wick on the mixer and this is where the oxygen vaporizes the gasoline. Since the gasoline is liquid to this point, it is virtually impossible to have a gasoline backflash more than the length of the cutting tip. Flame fronts cannot travel back up the gasoline lines because they are blocked by a wall of liquid gasoline. A flame front traveling back up the oxygen line is a possibility with the oxy-gasoline torch, as it is with all oxygen-fuel torches, but this can be prevented by purging the oxygen line until emission at the tip is devoid of spray or by the use of oxygen line flame arrestors.

A major contributor to backflash is clogging and subsequent failure of the cutting tips. Except for abuse (using the tip for tapping) and accident, the two reasons for failure of conventional tips are clogging and melting. In a typical acetylene torch system, the acetylene torch tip is often damaged when molten steel blows back and lodges in one of the tip holes. The hot steel causes the holes to melt shut and ruin the tip. This occurs because the acetylene is only 70% oxidizing, leaving unoxidized molten steel in each cut. Gasoline, however, produces a 100% oxidizing flame. This means that there is no molten steel during or after a cut. The slag is 100% oxidized so the sparks are lightweight, relatively cool and do not lodge in the tip. The force behind the pre-heat flame of the oxy-gasoline torch also allows for cutting with the tip held at a distance from the molten metal pool initially formed during a cut. In addition, the expansion of the gasoline into a vapor, which occurs in the tip of the oxy-gasoline torch, is a refrigeration process. This cooling provides resistance to melting and can contribute to a longer tip life. The expansion of the gasoline into a vapor also results in a significant volume expansion. The force of the liquid to vapor expansion helps remove any molten metal from the cutting area.

The use of gasoline as a fuel also has a few inherent safety advantages over the use of acetylene. Gasoline is a stable compound which cannot explode by shock and does not burn while a liquid. Dropping a gasoline tank does not create a hazard of explosion. Gasoline must have oxygen or air to burn, and vapors of gasoline will burn only in a comparatively narrow band of concentrations—between 1.3% and 7.8%. In comparison, a tank of acetylene may explode due to heat or shock without oxygen or air. Acetylene vapors will burn in a much broader band of concentrations than gasoline—between 2.5% and 80%.

In addition, acetylene is an odorless, colorless gas which makes leaks in an acetylene system difficult to detect and locate. A gasoline leak, however, is very visible and odorous. Problems from open valves, pierced hoses or loose hose nuts result in wet spots, which are easily seen and smelled. A gasoline leak can generally be found and corrected immediately before it becomes a hazard.

Additional safety features have also been incorporated into the overall oxy-gasoline torch system. Among the features is an automatic gasoline shutoff valve in the tank. When the tank is pressurized, this fast-flow ball check valve senses any sudden surges in the flow of gasoline and will snap shut and cut off flow in the case of a gasoline hose rupture. The filler cap also has two safety features. The first is a pressure relief when the cap is being unscrewed. The second feature

safety relief valve set at 35 psi. This prevents excessive pressure when exposed to external heat.

Another significant safety advantage of oxy-gasoline cutting is the portability of the tank. Even when full, the tank weighs only 30 lb., and it will do the same amount of cutting as a No. 5 acetylene cylinder weighing approximately 200 lb. This contributes to safety by reducing the hazards of strain and back injury and by speeding up of system set-up and movement. The fuel tank is built to ASME code for unfired pressure vessels and carries UL, U.S. Coast Guard and U.S. Navy approvals.

Oxy-gasoline Speed

In addition to potential safety advantages, the oxy-gasoline torch offers faster segmentation and improved labor productivity. Depending on the thickness and conditions of the material, the manufacturer states that the oxy-gasoline torch can cut steel 30% to 300% faster than the oxy-acetylene torch. The actual speeds for the oxy-gasoline and oxy-acetylene torches recorded during the demonstration are described in the Results section.

The 100% oxidation discussed above also contributes to the cutting speed of the oxy-gasoline torch. Because there is no molten metal to re-solidify in the cut, a single pass of the torch is normally sufficient to make the cut. Grinding and chipping are not required to clean out the cut. With an oxy-acetylene torch, workers must frequently go back over a cut to remove the resolidified materials.

In addition, gasoline vapor is four times heavier than acetylene vapor. During operation of the torch, the weight of the vapor contributes to the speed of the torch. With the pre-heat flame lit, pressing the cutting oxygen lever reduces oxygen supply to the pre-heat flame. Therefore, some of the gasoline vapor remains unburned in the pre-heat flame but travels down into the cut with the cutting jet oxygen. As the fuel travels down the jet, it continues to burn, giving off more heat while deep into the cut. With acetylene, this secondary combustion is limited in depth, but with the heavier gasoline fuel, secondary combustion goes deep into the steel providing superior performance on thick materials. Oxy-gasoline cutting is well suited for difficult cutting jobs such as laminations, manganese, armor plate, and dirty or rusty metals. The cutting speed of the oxy-gasoline torch is also enhanced because gasoline flames release their heat energy faster than acetylene, and therefore heat the steel to ignition faster. In addition, as the gasoline changes from liquid to vapor, its volume increases over 160 times. This rapid expansion of the gasoline into a vapor also contributes to the velocity of the preheat flame.

LSTD TECHNOLOGY DEMONSTRATION ACTIVITIES

The technology demonstration for the oxy-gasoline torch was scheduled for the fall of 1996. Prior to the actual site demonstration, the manufacturer came to the site and provided a training session on the use of the oxy-gasoline torch. This training is described in the Setup section below. The actual demonstration occurred in September and October 1996 and is described in the Demonstration section. Finally, the debriefing of the laborers involved in the demonstration was held immediately following the conclusion of the demonstration.

Setup

The technology provider (Petrogen) came to the Fernald site to demonstrate the operation of the oxy-gasoline torch in a training session for the B&W NESI laborers that would be using the torch during the demonstration. This training session involved a description and discussion of the equipment included in the standard torch system package as well as tips for operating a cutting torch that uses gasoline. Following the discussion, the operation of the torch was demonstrated by Petrogen on various steel components. During the live demonstration, the B&W NESI laborers had the opportunity to use and become familiar with the torch.

The standard package includes both red gasoline (fuel) hose, green oxygen hose, whip line, a 20-inch torch with a 90º head, a three gallon capacity fuel tank, a box of special tools, a spark striker, and a box of spare parts.

The gasoline hose is a ¼-inch, 2-braid, UL approved hose designed specifically to include gasoline service. The oxygen hosing is a single braid, 5/16 inch, Type “S”, Grade “T”, and is resistant to fire, abrasion and oil. Both hoses can be ordered in custom lengths, but the ones supplied with the standard package used during the demonstration were 20 feet and 25 feet respectively. Short lengths of flexible whip line (5 feet) can attach the torch to heavier, stiffer, standard hoses and allow the operator to control the torch more easily.

The model of torch used for this demonstration was a hand-held, 20-inch torch with a 90º head angle. The cutting lever on the torch operates the high pressure oxygen valve directly underneath. After the pre-heat flame has started to melt the steel, pressing the cutting lever permits the oxygen (at regulator pressure) to enter the work and cut the steel. The torch gasoline valve controls the rate at which gasoline is fed into the torch head mixer.

Above the gasoline valve is the mixer which fits into the torch head. The mixer receives both the pre-heat oxygen and the gasoline and combines them into a fuel mixture which is then fed into the tip assembly. Around the mixer are four grooves. In these grooves, the mixer incorporates two O-rings and a sintered bronze wick. The wick contains engineered capillaries that carry the gasoline uniformly around the mixer to give an even flame.

Seated on the mixer in the torch head is the cutting tip, a two-piece assembly, with an inner brass core with stainless steel tube center and an outer tellurium copper shell. During operation, the liquid fuel is vaporized, directed down to the base of the core, and then re-directed out of the tip through the flutes of the core. As the gasoline changes from liquid to vapor, its volume increases about 160 times. This rapid expansion imparts a high velocity to the pre-heat flame. Because the gasoline vaporizes inside the tip, the oxy-gasoline tip runs remarkably cool. This permits the tip to operate longer in hot environments and is one of the factors that give the oxy-gasoline tip an extraordinary long life. Tips are available in a variety of opening sizes for cutting various thicknesses of steel.

The gasoline fuel tank provided for the LSTD was a three gallon tank manufactured to ASME standards for unfired pressure vessels. For operation, the tank is filled with 2-1/2 gallons of gasoline and pressurized using the hand pressure pump. Air compressors can be used in place of the hand pump to provide uninterrupted constant pressure. Because the oxy-gasoline torch system operates on a very low pressure, between 10 psi and 20 psi, light pumping charges the system. A worker initially pumps the tank to 20 psi, and pumps again

when the pressure falls to 10 psi. During a full day of operation, pumping will be required only about two or three times. The tank is pressurized to deliver the gasoline to the cutting tip mixer in a liquid state, but the pressure is also necessary to insure activation of the fast flow check valve. For this reason, and as a safety margin, pressure should not be allowed to fall below 10 psi during operation.

The tool kit included with the basic oxy-gasoline torch package contains special tools for maintenance. A jackscrew, packing nut wrench and hex allen wrench are included for tightening and removing various parts of the system. Other tools include a tip drill for cleaning dirt out of the center bore of the cutting tip, a tip reamer to clean the inside section of the tip shell of carbon deposits, and a tip brush to clean the flutes of the tip core, the tip seat at the bottom of the core, and the inside taper of the shell where the flutes mate. A spark striker is included in the basic package, and the spare parts kit includes various replacement items such as valves, O-rings, wicks, gaskets, pump cup, and extra flint.

Demonstration

The oxy-gasoline torch was demonstrated and used for cutting steel plated, shafts, bolts, and a shield wall within the Plant 1 building as well as an auxiliary building to Plant 1, Building 66. The demonstration itself occurred from late September to early October, a total of eight work days. The first work day was a mobilization effort, followed by seven days of demonstrations. In most cases, the oxy-gasoline torch was used essentially alongside the oxy-acetylene torch, resulting in a very effective side-by-side demonstration of the speed of the oxy-gasoline torch. It is especially dramatic on the videotape of the cutting of one of the parts of the "Jaw Crusher."

A total of four major pieces of equipment were cut apart using both technologies. The first component was a shield wall two inches thick, 10 feet high, by 12 feet long. This wall was cut into 2' × 4' sections. The second component was a Jaw Crusher—cutting its 4.5-inch diameter main axle was a good demonstration event. The third component was a Drum Crusher/Bailer, which ranged from 1-inch thick to 2-inches thick, with tight cutting angles and configurations. The final component was a base to a Pulverizer. The base was composed of cast iron, between four inches and six inches thick.

Table 1 is a tabulation of the data for these demonstrations, as well as an overall summary of the demonstration efforts. Figure 1 shows the cutting activities on the Jaw Crusher.

Results

The demonstration of the oxy-gasoline torch was considered a resounding success even before its conclusion, The oxy-gasoline performed at least as well as the oxy-acetylene torch, and usually better. The overall results in terms of lengths and times of cuts and costs of the two technologies is provided in Table 2. This table shows that despite the oxy-gasoline torch's initial price, it will pay for itself in fuel savings in a short time. From this data, one sees that the fuel consumption for the oxy-gasoline torch is one-tenth the cost for the oxy-acetylene torch. In addition, it will save on cutting time as well. This is best seen in the data in Table 3, a selection of data representative of the whole. For example, for the one-inch thick portion of the drum crusher, the oxy-gasoline torch cut only 30% faster than the oxy-acetylene torch. However, for the axle of the Jaw Crusher, the oxy-gasoline torch took only five minutes to cut, while the oxy-acetylene torch took 15 minutes to cut, for a speed three times as fast as the oxy-acetylene. For the average of the six data points tabulated, the oxy-gasoline torch was twice as fast as the oxy-acetylene torch.

Debriefing

As with all of the technology demonstrations, a debriefing of the laborers involved in the operations of the new technology was held at the conclusion of the demonstration. Some of the important highlights of this debriefing are described here.

During the demonstration, one oxy-gasoline torch tip was destroyed. This was primarily due to the operator's unfamiliarity with the equipment, causing the operator to hold the tip too close to the cut (consistent with the distance required for the oxy-acetylene [the baseline technology] torch), which allowed the tip to be burned. After the operator became more familiar with the operation of the torch, this problem went away. This is most dramatically seen in the time line. The torch tip was destroyed in the first day of the demonstration, with no other torch tips being ruined throughout the rest of the demonstration.

The operator using the oxy-gasoline torch kept commenting on the need to keep the torch tip away from the cut, as opposed to the necessity of keeping the oxy-acetylene torch tip close to the cut. This, coupled with the short torch purchased for the demonstration, caused the operator to rate the torch handling aspects lower. It was stated, however, that use of the longer torch (available at a slightly higher price) would have prevented these problems.

The laborer commented very favorably on the speed of the cutting with this torch as compared to the oxy-acetylene torch. Indeed, the operator would voluntarily use the oxy-gasoline torch, if available, over the oxy-acetylene torch on thicker or more difficult cuts.

The assessments of the laborers involved in the demonstration were captured in a questionnaire. The scores on the questionnaire range from one (1), representing a poor rating to four (4), representing an excellent rating. The results of the questionnaire range from a low rating of 2 for the eye hazard to 3.5 for ease of learning and understanding the manual. Overall, the results lean toward the excellent. This is a good result whether the rating is considered relative to the baseline technology or as absolute.

B&W NESI EXPERIENCES WITH THE OXY-GASOLINE TORCH

From B&W NESI's perspective, all experiences with the oxy-gasoline torch were positive. At a minimum, the oxy-gasoline torch cut as quickly as the acetylene torch on thinner materials, and was a great deal faster for cutting thicker or rusty material. The training session offered by the manufacturer was excellent and provided a solid four hours of indoctrination on the equipment. This included opportunities for workers to use the torch in cutting plates. As described below, B&W NESI used the oxy-gasoline torch at another location at Fernald, and is using the oxy-gasoline torch at other D&D projects.

As one would expect and similarly react to, B&W NESI management was skeptical about the torch and its advertised

capabilities. As more information was gathered and given to the field personnel, they began to consider possible applications for the torch if it were able to "live up to its claim." Considering the potential benefits of a faster cutting torch, B&W NESI saw an immediate use for this equipment at another Fernald D&D project, Plant 4, for which they were also the subcontractor. The Plant 4 D&D Project required that a large ammonia storage tank (~1.25' thick) be segmented. With the knowledge of the oxy-gasoline torch, B&W NESI purchased an oxy-gasoline torch package in late August, 1996, for the express purpose of segmenting the Plant 4 ammonia tank. Since this task was not a part of the LSTDP, the oxy-gasoline torch would still be demonstrated at the Plant 1 D&D Project later in the year, regardless of the outcome of the Plant 4 tank segmenting. The segmentation of the ammonia tank, however, was an opportunity for B&W NESI's laborers to obtain more experience with the oxy-gasoline torch and to prove or disprove its value. In fact, the successful experiences gained from cutting the ammonia tank only increased B&W NESI's confidence in the oxy-gasoline torch's capabilities.

During the demonstration, there was, surprisingly (despite the skill and experience of the workers and the extensive training session), a learning curve associated with using the oxy-gasoline torch. During the introduction, workers were instructed to use only "new" gasoline–and no ethanol mixes. Ethanol is an alcohol and it does not evaporate easily, resulting in a preheat flame that sputters yellow and is difficult to adjust. Ignoring this caveat, the workers first used gasoline that had been stored for more than five weeks. This older gasoline caused the oxy-gasoline torch to sputter and give an inconsistent flame. The laborers started complaining about the torch, but as soon as fresh gasoline was used, the oxy-gasoline torch performed as advertised.

Another minor learning curve difficulty occurred due to the differences in flame properties of the two technologies, as described above in the torch description section. The laborers were used to acetylene torches that require keeping the torch cutting tip close to the material being cut to bring the metal to ignition. Because gasoline releases its heat energy faster and heats the steel faster than acetylene, and due to the velocity of the pre-heat flame, it is not necessary to keep the torch tip near the metal as it is cut. As a result, the laborers consciously had to keep the tip pulled back from the steel, which was different from what they were accustomed. This tendency to use standard oxy-acetylene cutting form resulted in the melting of one tip. This happened because the tip was operated in or near the molten metal pool and became plugged many times before it finally melted enough to fail.

Plant 4 Ammonia Tank

The ammonia tank at Plant 4 was located outside the building being demolished and was, for all intents and purposes, ignored until near the end of the D&D work for Plant 4. Originally it had been assumed that the tank could be segmented by using the track mounted hydraulic shear during the same time the building structural steel was being size-reduced. The fall back position was that the tank could be size-reduced by acetylene torch cutting if necessary. During enlargement of a manway opening to allow the shear-jaws enough room for insertion into the tank, it was discovered that the tank walls, approximately 1.25 inches, were too thick for the shear to cut. The enlarging of the manway using an acetylene torch had taken approximately 60 workhours (crew of three, for two days) to make a three-foot diameter hole. A search for a better way to cut the ammonia tank started. The search ended when the oxy-gasoline torch was introduced to the field management team. The oxy-gasoline torch was used intermittently over a two-week period to segment the ammonia tank. After a somewhat rough start, as described above, the torch worked as well as the vendor claimed it would and above the initial expectations.

Figure 2 shows activities on this tank.

Expectations and Results

B&W NESI's initial expectations and gauge for success of the oxy-gasoline torch could best be described as: "if the oxy-gasoline torch cuts materials even slightly better than an acetylene rig, it will be worth the cost." It far exceeded B&W NESI laborer's expectations and performed up to all of the vendor's claims. For example, there was no slag, the physical residue was cooler than with acetylene, cutting times were as fast as claimed and the thicker the metal the greater increase in productivity over acetylene. Fuel consumption was as stated (about three-gal.-per-day of normal operation).

COMMUNICATION OF DEMONSTRATION RESULTS

Communication of the results of this LSTDP demonstration consists of written reports, video tapes, oral presentations and live demonstrations. The major items that have been or will be produced along with a short description of the format, content, and availability are a technology fact sheet, a detailed technology demonstration report, an Innovative Technology Summary Report, a home page on the Internet, a technology video, and live demonstrations at conferences or meetings.

Technology Fact Sheet— This is a one-page color narrative brochure with pictures that describes the need for a particular technology, a description of the technology itself, the demonstration that was conducted, a summary of the technology demonstration results and contact names and phone numbers for additional information. This is currently available for distribution.

Detailed Technology Demonstration Report— This report will consist of 75 -100 pages. It will provide a detailed description of the technology demonstration. Included in the body of the report will be a summary, conclusions and recommendations, description of the baseline technology and innovative technology, demonstration plan, technology performance, technology applicability and alternatives, cost benefit analysis, regulatory/policy issues, lessons learned, figures and tables. There will also be an appendix with the actual data package and other appropriate information. As of August 1997, this report is being written.

Innovative Technology Summary Report— This report will consist of 10 -15 pages. It will provide an overview of the innovative technology. Included will be a summary, technology description, performance, technology applicability and alternatives, cost, regulatory/policy issues and lessons learned. There will also be an appendix with references. This report will be written upon completion of the detailed technology report.

Home Page— The LSTD Project home page will be part of the Fernald Site home page (www.fernald.gov). The home page will

include a description of the Plant 1 D&D Project, the LSTD Project Organization, the process for selecting technologies, a list of technology needs, a list of the technologies selected for demonstration and their vendors, results of technology demonstrations, current status, and upcoming activities. The home page is online.

Technology Video— This video (10 -15 minutes) will show the baseline technology in operation, the innovative technology in operation, and it will describe the demonstration results, benefits and lessons learned. It will also provide contacts and references for additional information. As of August 1997, the video is in production.

Where appropriate (meetings, conferences), technologies will be demonstrated "live" to the audience. The demonstrations will be conducted so that the innovative technology is being used right alongside the "baseline" technology.

CONCLUSIONS

The oxy-gasoline torch has been successfully demonstrated as part of the Fernald LSTDP and was considered a resounding success. Not only did the oxy-gasoline torch perform *safer*, with cooler sparks and minimal metal slag, but it also was *better* for several reasons. One of these reasons was that it cut materials *faster*–a minimum of 30% in our tests, up to 300% faster than the baseline technology of the oxy-acetylene torch. It also cut a tank that had not successfully been segmented. The oxy-gasoline torch is also *cheaper*, using inexpensive gasoline rather than more expensive acetylene. Indeed, the cost of the fuel for the oxy-gasoline torch used was only one-tenth that of the oxy-acetylene torch. Prior to the LSTDP, B&W NESI did not carry the oxy-gasoline torch in its D&D “tool box.” As a result of the LSTDP technology demonstration, it has been added to the “tool box.”

Therefore, the oxy-gasoline cutting torch is indeed considered a Fernald Large Scale Technology Demonstration Project triumph. The success of the demonstration has been communicated to other “end users,” that is, those companies and DOE sites that are involved in D&D activities. At this time, six Oxy-Gasoline Safety Torches have been sold in response to this technology demonstration.

Table 1. Technology demonstration data.

Component	Cuts	Type of Demonstration	Result
Shield Wall	2” thick × 10’ tall × 12’ long	side-by-side demonstration	successful
Jaw Crusher	segmenting, 4.5” diameter axle	side-by-side demonstration some individual	successful
Drum Crusher/Bailer	1’-2” thick	side-by-side demonstration	successful
Pulverizer Base	4”-6” cast iron	sequential	unsuccessful

Table 2. Overall results of technology demonstration.

Demonstration Summary	Baseline Technology Oxy-acetylene	Innovative Technology Oxy-gasoline
Equipment Cost	$299	$845
Overall Length Cut, feet	225	250
Overall Cut Time, minutes	130	97
Overall Cutting Rate, ft/hr	104	155
Fuel consumed, cost	6 bottles $192	15 gallons $18

Table 3. Examples of outting demonstrations.

Item Description	Baseline Technology Oxy-acetylene Torch # Cuts	Length	Time	Rate	Innovative Technology Oxy-gasoline Torch # Cuts	Length	Time	Rate
Shield Wall (2” thick)	1	24	13	< 2	3	72	20	>3.5
Shield Wall (2” thick)	1	48	27	< 2	1	48	13	>3.5
axle shaft (4.5” diam)	1	4.5	15	< 1/3	1	4.5	5	~ 1
Drum crusher (1” thk)	2	16	8	2	1	16	6	2.67
Drum crusher (1.75”)	3	19	12	~ 1.5	3	19	10	< 2
Drum crusher (2” thk)	3	20	15	~ 1.33	2	24	8	3
Pulverizer Base (cast)	-	-	-	-	-	-	-	-
Totals	*11*	*131.5*	*90*	*~1.5*	*11*	*183.5*	*62*	*~3*

Figure 1. Activities at the jaw crusher.

Figure 2. Activities at the ammonia tank.