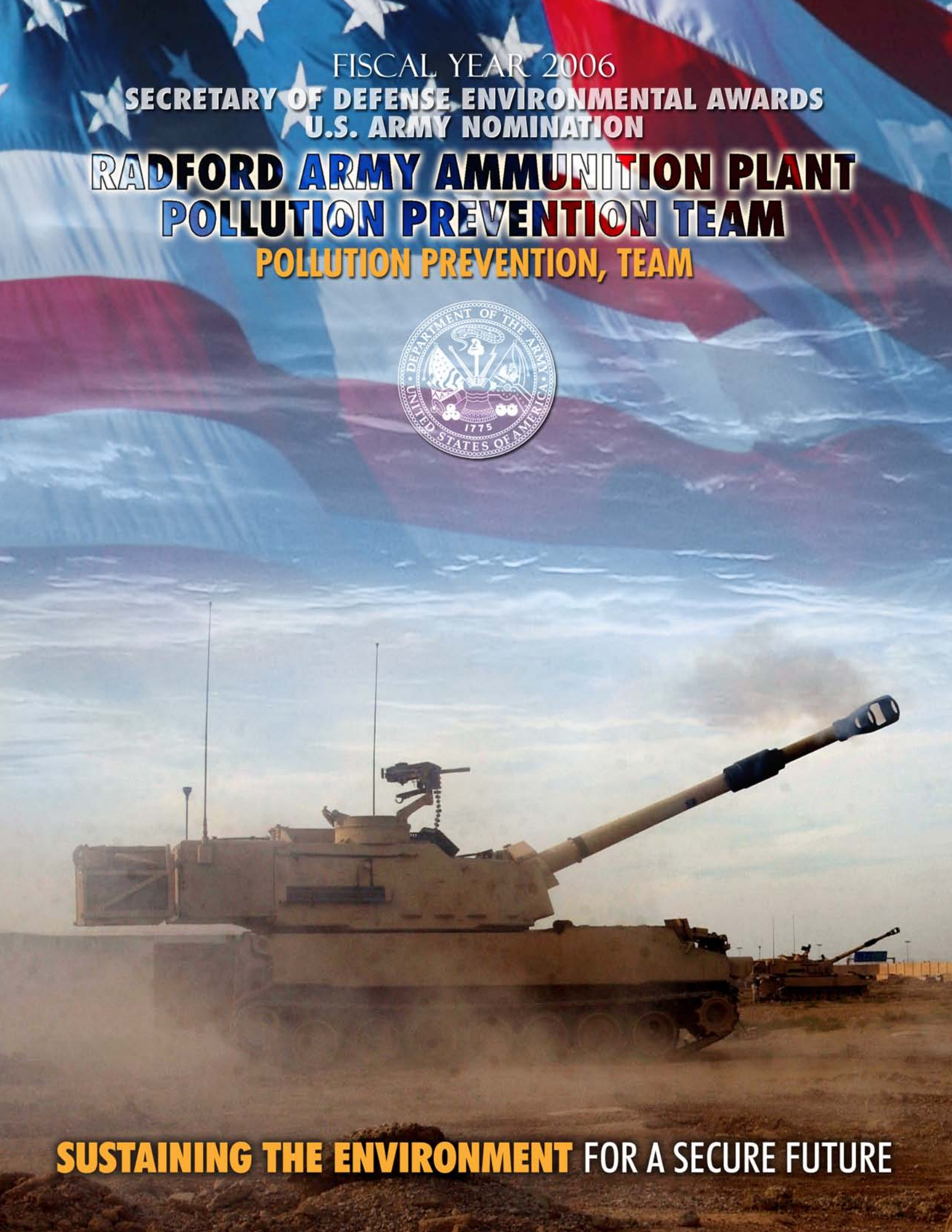
FISCAL YEAR 2006

SECRETARY OF DEFENSE ENVIRONMENTAL AWARDS
U.S. ARMY NOMINATION

RADFORD ARMY AMMUNITION PLANT
POLLUTION PREVENTION TEAM

POLLUTION PREVENTION, TEAM



SUSTAINING THE ENVIRONMENT FOR A SECURE FUTURE

INTRODUCTION

Located in the mountains of the New River Valley in southwest Virginia, Radford Army Ammunition Plant (Radford Main Plant) is situated in Pulaski and Montgomery counties and covers 4,080 acres. The area surrounding the installation is mostly agricultural and rural residential. As the third-largest employer in the New River Valley, Radford plays a key role in the local economy.

Radford Army Ammunition Plant is the largest facility of its type in the United States.

Radford is the largest active facility of its type in the United States. The installation is capable of manufacturing a wide variety of products for national defense. Radford is owned by the U.S. Army and operated by Alliant Techsystems, Inc. (ATK) for the Joint Munitions Command. To achieve effective, long-term pollution prevention (P2), government staff members work closely with the Alliant staff and representatives of the United Steel Workers Union as "Team Radford."

Since the facility's inception in the closing months of 1940, propellant and explosives produced at Radford have been a mainstay in every U.S. combat operation through the present day. The Department of Defense (DoD) depends on Radford to efficiently use its resources to provide all Services with the firepower needed to be ready and effective on the battlefield.

BACKGROUND

The production of 2,4,6-Trinitrotoluene (TNT), the Army's most widely used military explosive, is one of the plant's primary areas of expertise. TNT has numerous military uses and the demand for this product has grown due to the ongoing Global War on Terrorism.

The original Radford TNT manufacturing facility began operation in 1968, supporting the Vietnam War effort. It was the first continuous TNT manufacturing process in the world. The TNT facility was shut down in 1974 after an accident, resumed production again in 1983 and had been idle since 1986 when an inventory surplus was obtained.

A consequence to the prior production methods of TNT was the generation of K047/D003 hazardous waste in the form of "red water." The former process produced TNT at a rate of 50-55 tons per day. Toluene, a highly toxic and environmentally hazardous chemical, was used as the base feedstock material in the manufacturing process. Red water, the primary environmental concern and also the most costly to manage, was generated at a rate of 0.1 gallons per pound of TNT manufactured. Up to 60,000 lbs. of red water was generated per day. Additionally, significant quantities of air contaminants were emitted from various sources within the nitration/purification processes including nitrogen oxides (NOx), carbon dioxide (CO), trinitromethane (TNM) and volatile organic compounds (VOCs). Finally, considerable quantities of various byproduct wastes were generated from TNT production, which degraded the purity of TNT and required costly off-site hazardous waste disposal. If generated today, the cost for treating and disposing of the K047/D003 hazardous waste is estimated to be $1 million annually.

Since the cessation of TNT production at Radford in 1986, environmental regulations became increasingly more stringent. When a new requirement for U.S.-produced TNT emerged, it became apparent that the former Radford TNT process would need to be modified. The Radford P2 Team was formed to work with the TNT process designers to attack the challenges ahead and design a more modern production method with the intent of producing high quality, low cost TNT with greatly reduced environmental impacts and risks.

Radford's P2 Team consisted of:

- Dick Rentfrow - Technical Director, ATK
- Earl Lemon - Program Manager, TNT, ATK
- Andrew Sanderson, Ph.D. - Chief Scientist, TNT, ATK
- Pete Wesson - Chief Engineer, TNT, ATK
- Paige Holt, Ph.D. - Environmental Manager, ATK
- Jerry Redder - TNT Environmental Engineer, ATK
- Jeff Pack - P2 Program Coordinator, ATK
- Brad Jennings - Environmental Coordinator, U.S. Army, Civilian

Significant input provided by the Radford P2 team contributed to the reduced environmental impact and risk of the new TNT process.

POSITION DESCRIPTION

Radford began proactively planning for P2 at the project inception. Members of Radford's P2 Team were engaged early in the planning process to identify environmental media permitting and overall process compliance issues. The team worked effectively in a collaborative effort to modify the existing TNT production process, and also contributed as individuals by providing their expertise in the following areas:

- Mr. Rentfrow served as the TNT technical director and was responsible for the specification, design, procurement, construction and check-out functions of the TNT project – including ensuring all technical, scheduling and cost goals, and safety and environmental requirements were met.
- Mr. Lemon served as the TNT program manager and was responsible for the general administration and management program including cost, scheduling and ensuring quality conformance.
- Dr. Sanderson served as chief scientist overseeing all TNT process design functions including coordinating the process chemical development activities throughout the design and startup effort.
- Mr. Wesson served as the deputy program manager/chief engineer, managing all of the facility engineering design and construction.
- Dr. Holt served as the environmental manager on the project and was responsible for ensuring that the myriad of environmental compliance requirements were met from design through construction and operation of the facility.
- Mr. Redder served as the assigned environmental engineer working with members of the TNT process team to identify environmental requirements. He was also responsible for coordinating the P2/waste minimization efforts.
- Mr. Pack served as the facility P2 and waste minimization program coordinator, initiating P2/waste minimization opportunity assessments and integrating the appropriate departments into the effort to accomplish the reduction goals.
- Mr. Jennings served as the U.S. Army's environmental coordinator at Radford and was responsible for the general oversight of environmental compliance and coordination between ATK and the Department of the Army.

The Radford P2 Team has had two technical papers published on the new TNT manufacturing process since the beginning of the project. These papers were presented at the 2004 National Defense Industrial Association Insensitive Munitions/Energetic Materials (NDIA IM/EM) Technical Symposium in San Francisco, Calif. and the 2006 NDIA IM/EM Technical Symposium in Brigham City, Utah.

ACCOMPLISHMENTS

ATK invested approximately $20 million into the design, renovation and construction of the new TNT production facility. As part of Team Radford the P2 team played a key role in taking an outdated, costly and environmentally challenged process and completely transformed U.S. TNT production with true green design. The combination of base material substitution, nitric acid crystallization and the installation of new fume abatement and acid recycling facilities created the potential for complete elimination of costly hazardous waste streams and air emissions, while producing ultra pure TNT. This new design has opened the door for transferability opportunities among other munitions plants and TNT manufacturers.

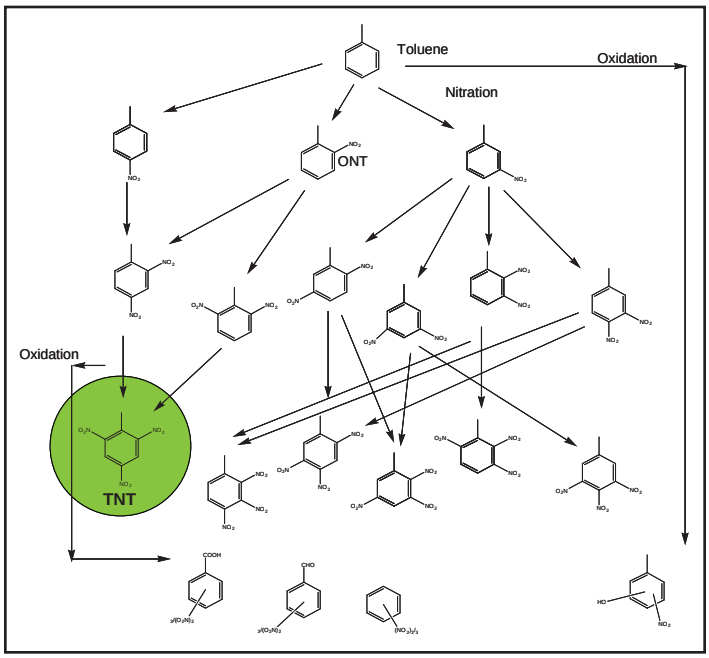
The TNT Fume Abatement System is part of a larger system that almost completely eliminates hazardous waste streams and air emissions.

PROCESS MODIFICATION

The Radford P2 Team implemented a modified TNT production process that was downsized to a facility capable of producing TNT at a rate of 27 tons per day, considerably less than the previous 50-55 tons per day. The team substituted ortho-nitrotoluene (ONT), a much less hazardous and less stringently regulated chemical, for toluene, the original hazardous base feedstock material. This substitution reduced localized environmental hazards immensely and allowed TNT to be produced at a purity of 99.5-100 percent. The new TNT process using ONT generates virtually 100 percent pure TNT.

Graphic 1 illustrates the old TNT process using toluene, which generated many byproducts and off-isomers, as well as the new TNT manufacturing process using ONT, which generates virtually 100 percent pure TNT with no waste products or off-isomers.

The largest benefit of the new TNT process resides in a major purification process change. The former process that generated the red water has been replaced with a highly robust weak nitric acid crystallization process. The new process captures all air emissions (NOx, CO, TNM and VOCs) that were formerly released into the air, sending them through a new fume abatement tower and CO



Graphic 1: Synthetic TNT Nitration

oxidizer. A maintenance tank was also installed to collect nitrator vessel dumps. This eliminated the former procedure, which required dumping to a drowning tank. Use of the drowning tank generated significant quantities of NOx emissions that were emitted during the previously frequent drowns.

TNT weak nitric acid crystallizer vessels eliminate the generation of hazardous red water.

REDUCING WASTES AND RECYCLING CHEMICALS

Radford's P2 Team focused its efforts on incorporating waste reduction and recycling opportunities into the new TNT production process. The elimination of the sizeable quantities of hazardous K047/D003 red water is by far the most important benefit, saving an estimated $1 million annually. Along with the high quality TNT that is produced, the new process generates a byproduct called isotrioil. Isotrioil, a mixture consisting of approximately 70-90 percent TNT and 10-30 percent 2,4-Dinitrotoluene (DNT), has the potential to be marketed to buyers in the mining industry. An estimated 650,000 lbs. of isotrioil is expected to be generated per year, providing the potential to bring in an estimated $650,000 annually.

Recycling the byproduct isotrioil by selling it to the mining industry where it is needed could provide a significant reduction in hazardous waste and bring in an estimated $650,000 annually.

The installation of a new denitration tower also increased waste reduction and created another recycling opportunity. The tower removes the hazardous nitric acid content from the spent sulfuric acid stream, allowing the spent acid to be recovered as a sellable product to off-site explosives manufacturers or recycled back into the process. It is expected that production will generate six to 10 million lbs. of spent acid, with the potential to reduce costs by up to $200,000 annually. Table 1 compares the environmental benefits and cost savings realized through the Radford P2 Team's process improvement and waste reduction efforts.

PARTNERSHIP AND OUTREACH EFFORTS WITH THE SURROUNDING COMMUNITY

The Radford P2 Team consulted with various local agencies and entities throughout all phases of the modernization of the TNT production process. The team partnered with the state and federal environmental regulatory community, as well as with many other key parties, during project planning and implementation.

During the design phase of the process, a National Environmental Policy Act (NEPA) evaluation was conducted to study community impact. The evaluation concluded that the new operations (as designed) would significantly lessen the environmental impacts to the surrounding community vs. the former Radford process. The facility's Risk Management Plan was revised to incorporate the changes brought about by the modernization of the TNT manufacturing process.

Further support was obtained from the Virginia Polytechnic Institute and State University Chemical Engineering Department to assist in the new TNT process infrastructure design. The university, located in close proximity to the Radford Army Ammunition Plant, provided academic and technical resources to assist in the design of the new TNT process.

In a show of Congressional support, Senator John Warner and Congressman Rick Boucher made visits to tour the TNT facility to see first hand how the new process was capable of providing an important element in support of the mission of the nation's Armed Forces.

Table 1. Environmental Benefits Comparison of the Old and New TNT Production Process

	Old Process	New Process
Base Material:	**Toluene:** a highly toxic, flammable, and hazardous chemical. Regulated as a hazardous air pollutant (HAP) and Superfund Amendments and Reauthorization Act (SARA) Title III listed chemical.	**Ortho-Nitrotoluene (ONT):** non-toxic, less flammable, and less hazardous chemical. Not regulated as a HAP or SARA Title III listed chemical.
Purification Process:	Sodium Sulphite (Sellite)	Weak Nitric Acid Crystallization
Hazardous Waste Generated:	• **K047/D003 red water:** 0.1 gal/lb TNT produced • **Off-Isomers of TNT:** Significant quantities of material that reduced purity of TNT	• **None generated** • **Eliminated K047/D003 red water:** savings of $1 million annually • **Alternative Use - Potential sales of isotrioil byproduct:** $650,000 annually • **Alternative Use - Potential sales of spent acid:** $120,000-$200,000 annually
Air Emissions Generated:	• **NOx:** 239 Tons Per Year (TPY) • **CO:** 157 TPY • **TNM:** 15 TPY • **VOCs:** Significant, but not quantified	• **NOx:** Reduced from 239 to 0.9 TPY • **CO:** Reduced from 157 to 8 TPY • **TNM:** Reduced from 15 TPY to 1.0 TPY • **VOCs:** Reduced to 3.4 TPY
Cost of Hazardous Waste Generation/ Savings:	Cost of disposal at today's rates: • **red water:** $1 million annually • **Off-Spec Waste/Loss of Product:** $500,000 annually	Cost Savings: • **$1 million (annual):** Eliminated red water • **$650,000 (annual):** Potential isotrioil sales alternate use • **$200,000 (annual):** Potential spent acid sales alternate use • **$1 million (one time):** No PSD Permit/ No OLD MACT requirements

CONCLUSION

Radford's new TNT manufacturing process is a model of how legacy weapons and munitions systems can be redesigned in a socioeconomic and environmentally responsible manner while creating a safer working environment. Radford's TNT is now produced much more economically with the potential for recurring savings of $3 million annually, primarily as a result of the elimination of environmental risk, pollution and waste. The dedication and hard work of the Radford P2 Team resulted in benefits to the surrounding community and environment while producing a TNT manufacturing process that can be replicated in other military munitions plants and by private TNT manufacturers. Due to the innovations of the Radford P2 Team, TNT production at the Radford Army Ammunition Plant has virtually eliminated hazards to the environment while opening the door for potential cost savings. Radford Army Ammunition Plant is now able to continue its important role of contributing to the nation's defense in the most environmentally safe manner possible.

On the cover: Soldiers fire an M109A6 Paladin howitzer during a section certification and live-fire exercise near Baghdad, Iraq. The Soldiers are assigned to Battery C, 4th Battalion, 1st Field Artillery Regiment. (DoD photo)