ACTODEMIL™ Technology
A Novel R3 Approach for Neutralization of UXO and Range Scrap

Presented at:

The 29th Environmental and Energy Symposium & Exhibition, Richmond, Virginia

April 9, 2003

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Neutralization of Ordnance and Ordnance Scrap - Statement of Problem

- More than 11 million acres of land contaminated with range scrap.
- More than 733 Formerly Utilized Sites and BRAC installations
- Several hundreds more training ranges

◆ Safety and Environmental Hazard

Neutralization of Ordnance and Ordnance Scrap - Statement of Problem

- UXO and remnant ordnance materials present significant explosive hazard
- Dud ordnance may still contain bulk explosives and other energetics.
- Fragments may contain unconsumed explosives and other energetics not found during physical inspection.
- Physical inspection, while valuable is insufficient

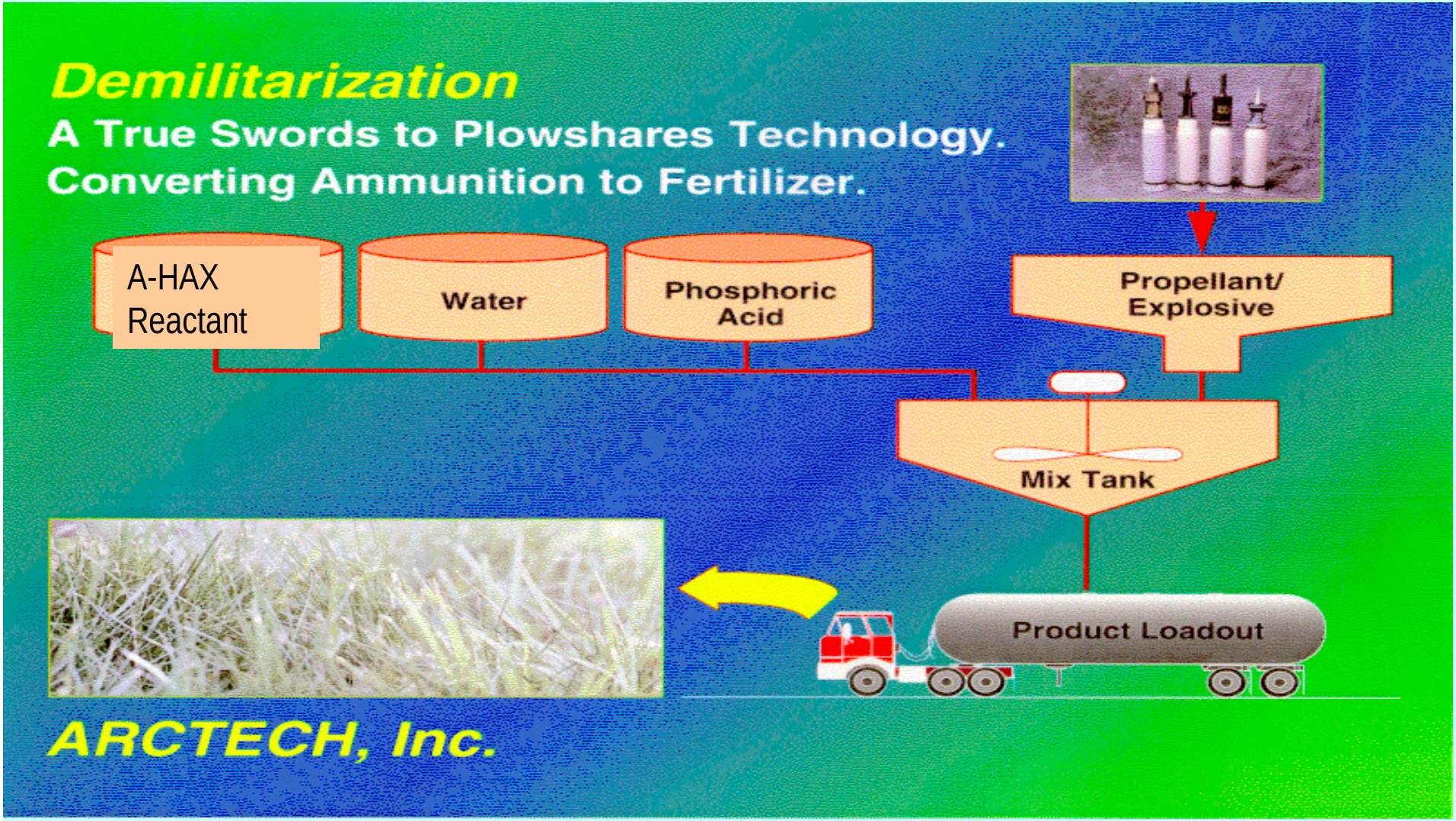
◆ Simple, effective, safe, and easily implementable decontamination technology is required to address the enormity of the problem

Neutralization of Ordnance and Ordnance Scrap - Statement of Problem

- Current approach based on thermal treatment by heating at 900 degree C for 45 minutes.
- Thermal processes, while effective, are costly and very difficult to permit.
- Thermal processes require significant environmental controls
- Thermal processes are not popular with public opinion.

Solution – Actodemil® Technology is a one step R3 process that recycles energetics to a fertilizer while decontaminating metal surfaces.

THE ACTODEMIL™ TECHNOLOGY



DEVELOPMENT HISTORY

- 1995 - Laboratory-Scale Tests
- 1996 - 100-Pound Scale
  Greenhouse Testing with Products
- 1997-98 One-Ton Scale Testing
  Products Field Applied
- Today - Mobile Plant Deployment

Actodemil® Technology Tested on Variety of Materials

Actodemil™ TECHNOLOGY SUCCESSFULLY TESTED ON:

Energetics

Large-Bore Gun Propellants

- 3”/50, 6”/47, M6 (NC based)
- 105 MM (NC/NG based)
- 106 MM - M30, M30A1(NC/NG/NQ)

Rocket Propellant

- 2.75” AA (NC/NG based)

Other Explosives - HMX, RDX, TNT, DNT, Lead Azide, PETN, and AP

Chemical Agents

Nerve Agents

GB, VX

Blistering Agents

HD, HT, H

Biological Agents

E. coli

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Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

Project Objectives

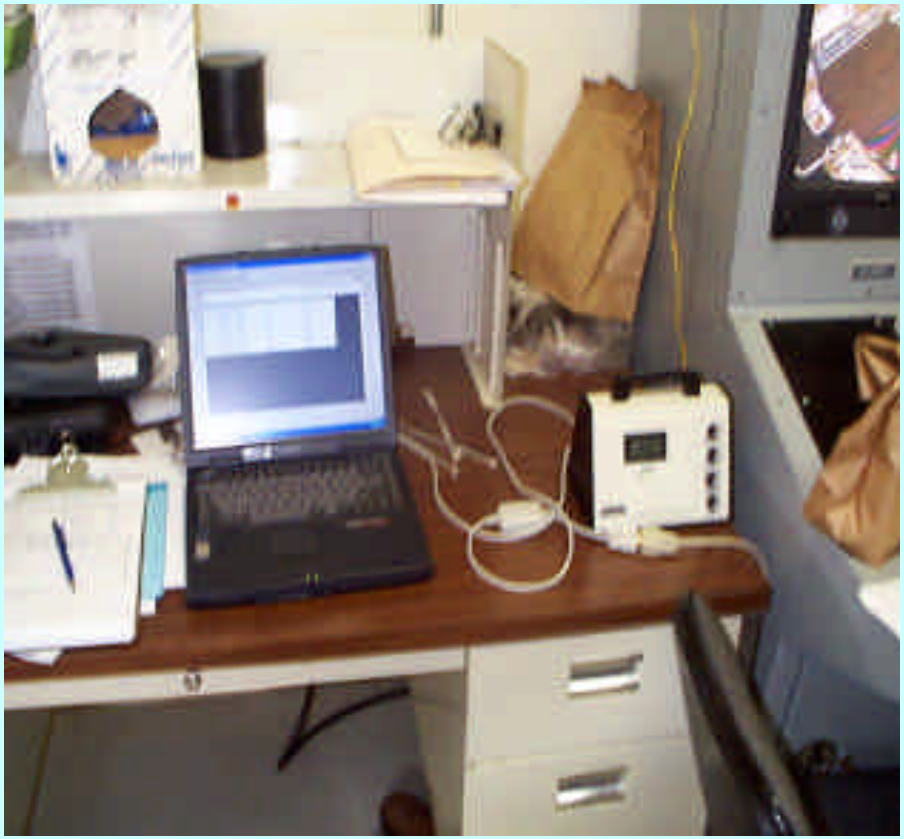
- Establish effectiveness of technology to neutralize bulk explosives
- Establish effectiveness of technology to decontaminate range scrap metal containing residual energetics
- Ensure compliance with regulatory requirements for land application of liquid end product
- Conduct tests with a variety of bulk explosives and metal scrap pieces.

Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

Five Batch Tests Conducted

- Bulk RDX
- Bulk TNT
- Bulk HMX
- Bulk Comp B
- Metal Contaminated with HMX

Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV



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Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

- **Residual Explosives Analysis Conducted by NAVEODTECHDIV lab**

- **Environmental Parameters analysis conducted by independent lab – NEL Labs, Reno, Nevada.**

Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

Samples of Liquid Product Collected at:

- 4-hour interval
- 6-hour interval
- 24-hour interval (for TNT test only)

Gas samples collected and analyzed onsite using Drager tubes

- NO_x
- CO
- NH_3

- **Continuous monitoring for temperature**

Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

- Lab Analyses of Liquid Product from all tests showed no evidence of energetic compounds
  - Even samples collected at 4-hour interval showed no energetics

- Scrap metal piece completely decontaminated – no evidence even at nano gram levels
  - Potential 5X decontamination level

- Fertilizer product meets TCLP and UTS requirements

ALL SUCCESS CRITERIA MET

Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

Preliminary Economics

(Not including Revenues from Sale of Product)

Scrap Metal decontamination

- Thermal Treatment - $0.2 to $0.5/Lb
- Actodemil® technology - less than $0.06/Lb
- Savings - 70 to 88% lower

Bulk Explosives Treatment

- Thermal Treatment - $2 to $4/Lb
- Actodemil® technology - $1/Lb
- Savings - 50 to 75% lower

Actodemil® Technology for Safe Neutralization of Ordnance and Ordnance Scrap - NAVEODTECHDIV

Conclusions

Actodemil® Technology Effective and Provides Following Benefits:

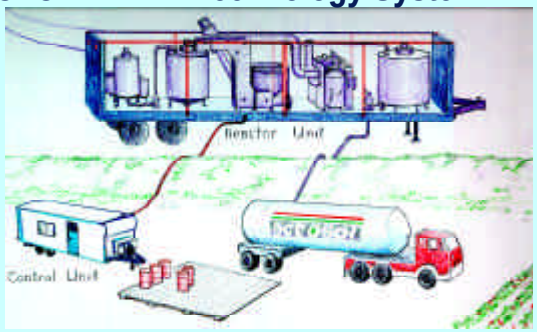
- **More Safer**
- **More Easily Implementable**
- **Higher Protection of Environment**
- **More Cost Effective**

Fabrication and Demonstration of Prototype Unit for U.S. Defense Ammunition Center (DAC)

- **Fabrication of Mobile Prototype Unit Completed**
  - **1 to 2 ton per day facility**
  - **Self-contained and Transportable**
  - **Fully Automated and Fail-Safe**
- **First Phase of Demonstration of Prototype Unit Completed in 2002.**
- **Second Phase of Demonstrations to Be Completed by June 2002.**
- **Long-Term Vision to Integrate ACTODEMIL™ technology into the IOC's Demilitarization Scheme**

Actodemil® Technology Unit Progression

Concept of ACTODEMIL™ Technology System



Actodemil® Mobile Unit

Actodemil® Technology Prototype unit at McAlester Army Ammo Plant, Oklahoma

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Actodemil® Technology Prototype Unit at McAAP

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Major Conclusions from Actodemil® Technology Demonstration Tests

- All Tested Propellant/Energetic Chemicals (NC, NG, NQ, DNT, etc) Completely and Irreversibly Destroyed
- Applicable to Single, Double, and Triple Base Propellants, High Explosives, Chemical Agents, Primary Explosives, Energetic manufacturing wastes
- Different Grain Sizes (up to 1-inch in length) Tested
- Process is Safe
- Propellant Conversion Complete in 1-2 Hours at 180-190^{o}F

Major Conclusions from Actodemil® Technology Demonstration Tests

Final Product Regulatory Compliant

- Complies with TCLP requirements
- Is not Reactive (as Defined by RCRA regulations)
- Complies with UTS Requirements
- Friction, Impact Tests showed no Energetic Response
- Complies with U.S. EPA's Munitions Rule Requirements
- Is Not Mutagenic as Determined by Ames Assay Test

Final Product Useful for Plants

Is not Phytotoxic to Plants
Enhances Plant Growth and Yield

Actodemil® Technology Approval from Nevada EPA

STATE OF NEVADA
KENNY C. GUINN
Governor

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION
333 W. Nye Lane, Room 138
Carson City, Nevada 89706-0851

February 25, 1999

Dear Mr. Kaushik:

The Division first became aware of the ARCTECH study during an inspection at HWAD in March/April 1997. The Division later learned in July 1997 that fertilizer produced during the study was ultimately applied to the land as a fertilizer at the Gomes property in Fallon, Nevada. In response to concerns regarding the suitability of the product as fertilizer and adequate treatment of the waste munitions, the Division reviewed data provided by ARCTECH, as well as soil samples taken by the Division, and determined that the **"Actosol" product did not exhibit any of the characteristics of a 'hazardous waste."** However, because the waste munitions were being recycled in "a manner constituting disposal" (i.e., placed on the land), the Division was concerned that the laboratory data did not adequately demonstrate compliance with the applicable treatment standards of 40 CFR 268 Subpart D (see 40 CFR 266 Subpart C). ARCTECH later provided data indicating that the presence of the underlying constituent(s), specifically Barium, could be adequately addressed during the fertilizer manufacturing process.

Because waste munitions do share many of the same components of common fertilizers, the Division **commends ARCTECH's efforts** to develop fertilizers from this otherwise discarded material. Notwithstanding the potential merits of your process, the Division wishes to reiterate the importance of demonstrating compliance with 40 CFR 266 Subpart C and the applicable state requirements as conveyed in my letter to HWAD (dated November 18, 1998).

Actosol® Product for Soil Erosion Control
Fort Bragg, North Carolina

- **Sandy Soils made it difficult to grow anything**
- **Soil erosion is very significant**
- **Actosol® product applied as a hydroseed mixture**
- **In less than 6 weeks growth equivalent to 2-year stand of Bermuda grass**

Not Treated with Actosol

Treated with Actosol

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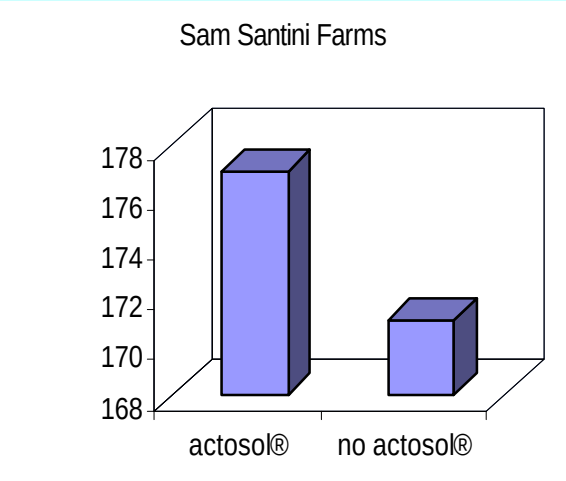
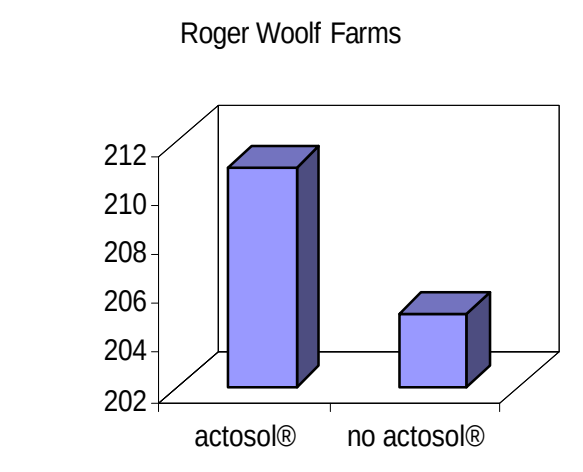
Actosol® Product from NC Fines Increases Corn Yield

- NC fines recycled to yield a 5-5-15 NPK actosol® product.
- Actosol® product tested on growth of corn at two farms in New Jersey.
- Actosol® product applied at 2 gal/acre.
- Increase in yield - 6 bushels an acre at each farm.





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END PRODUCT ENHANCES ALFALFA GROWTH

1:40 1:80 1:160 Control 1:40 1:80 1:160 Control

Mixed Single, Double and Triple base products applied to pots in the indicated dilutions. The control is Hoaglands solution

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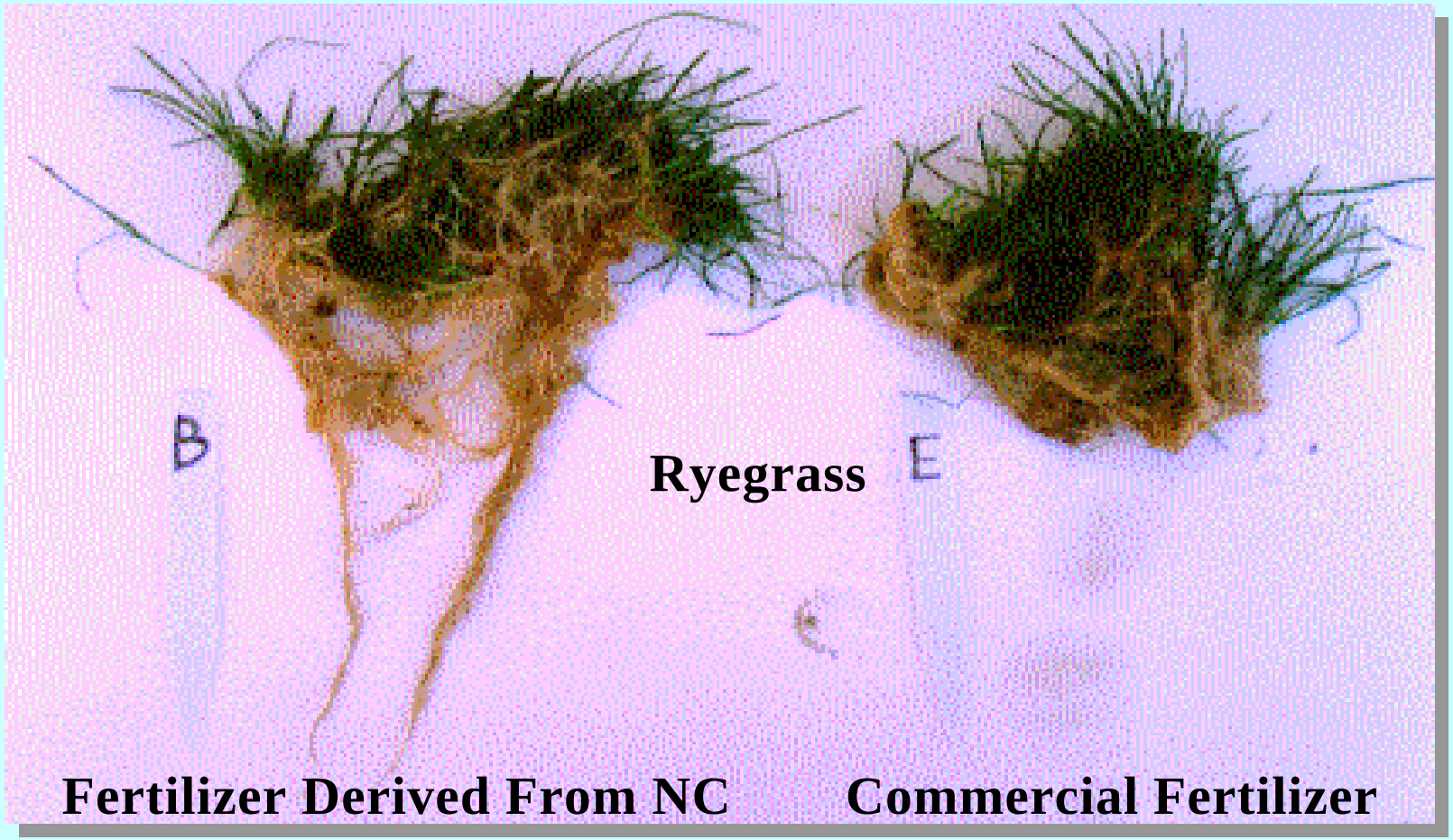
PRODUCT IS BENEFICIAL FOR TURF GRASS GROWTH



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Actodemil® Technology - Egyptian Armament Authority

Actodemil® Technology Recycling Facility for

- Provide Turnkey Program for Actodemil® technology Deployment
- Facility to be Integrated with Existing Demil Facility in Egypt
- Scope of Activities
  - Design, Fabricate, and Transport Actodemil® technology Unit
  - Provide a-HAX Reactant and all other Required Chemicals
  - Conduct Operator Training
  - Provide Technical Support During Processing
  - Fertilizer Application Support
- Initial Survey Completed; Deployment Anticipated During FY 2002/2003 Timeframe

Actodemil® Technology - Kobe Steel Company, Japan

Application of Actodemil® Technology for Destruction of Chemical Munitions

- Established Complete Destruction of Picric Acid with a-HAX
- Removal of Toxic Heavy Metals with HUMASORB®

SUMMARY

- Actodemil® Is an effective technology for neutralization of bulk energetics and range scrap
- The process is safer, more easily implementable, more environmentally protective, and more cost effective than conventional thermal treatment techniques
- The technology is applicable to a variety of high explosives and other energetic materials commonly found on contaminated ranges
- Because of the liquid a-HAX reactant scrap metal of different configuration and with nooks and crannies can be effectively treated
- Cost Savings for 70 to 88% for decontamination of range scrap and cost savings of 50 to 75% in neutralization of bulk energetics.