How Clean Is Safe
(Risk-Based Recycling Program)

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Key Issues

"3X" Items Can Be Inspected and Safely Sent Directly to a Steel Melter Using Risk Management

- Munitions demilled by non-thermal processes (i.e., washout and meltout) have an explosive residue.
- Some items demilled by non-thermal processes could be safely recycled without further processing by using risk management.
- Some installations have sent "3X" items directly for recycling, but many installations have had to further demil these items to a "5X" standard before they can disposition the items.
- Buy-in and support is needed from DDESB and the safety community.

Overview of Presentation

- Demilitarized Scrap Certification Project
- How Clean Is Safe Project
- Typical Melter Requirements for Recycling
- The Changing Environment
- Suggested Process Steps

Demilitarized Scrap Certification Project

- Funded by DAC and executed by TVA
- Quantified the amount of energetic material left on scrap metal from munitions and munitions-related items demilled by a variety of processes
- Completed in April 2001

Demil Scrap – Scope

- 7 demil installations visited
- 13 demil processes evaluated
- 37 sets of demil items sampled
- Thermal and non-thermal treatment processes, as well as disassembly activities, sampled
- Samples analyzed and statistically evaluated

Demil Scrap – Items Sampled

- Projectiles
- Bombs
- Rockets
- Cartridges
- Cartridge cases
- Fuze well-liners
- Munitions components
- Propellant drums
- Armor plating
- Range scrap
- OD scrap

Demil Scrap – Demil Processes Sampled

- Flashing furnace
- Hot-gas decontamination
- CWP
- White phosphorus conversion
- OD/OB
- Static burn
- Meltout
- High-pressure washout
- Hot-water washout
- Disassembly of munitions
- Demolition on ranges (as munitions or targets)

Demil Scrap – Energetics Sampled

- TNT
- Tritonal
- Comp B
- Comp A-3
- PETN
- Tetryl
- White phosphorus
- Smokeless powder
- Propellants: single-, double-, and triple-based

Demil Scrap – Non-thermal Process Results

- Meltout of 105mm projectiles, 8-inch projectiles, and 750-lb bombs: 0.2 – 1.6 g/kg (residue/metal)
- High-pressure washout of 5-inch, 38-cal projectiles and 155mm ogives: 0.001 – 0.02 g/kg
- Hot-water washout of 105mm and 8-inch projectiles: 0.04 – 0.1 g/kg

105mm Projectiles – TNT or Comp B

How Clean Is Safe (HCIS) Project

- Funded by DAC and executed by TVA
- Initial objective was to determine how clean scrap metal from demilled munitions has to be in order to safely disposition the scrap metal for recycling outside of DoD
- Began in April 2006

HCIS – Safety

- Safety is the top priority
- Goals are: no deaths, no injuries, and no loss of equipment
- Explosives are inherently dangerous
- Demil and inspection processes must support documentation that items are “free from explosive hazards” before dispositioning outside of DoD, or DoD contractor control
- **The need is to manage risk, not to avoid action instead of determining the risk**

HCIS – Primary Contacts

- CAAA and NSWC – Crane
- BGAD
- MCAAP
- TEAD
- HWAD
- NSWC – Indian Head
- RIA
- ARDEC
- DAC
- Commercial melters

HCIS – Objectives

- Identify relevant existing documentation
- Survey rapid quantification options
- Expand data from Demil Scrap Project
- Determine recycler/steel melter requirements
- Develop process steps for dispositioning suitable munitions from an installation to steel melters
- Determine acceptable level of contamination

HCIS – Existing Documentation

- Sensitivity Testing of Contaminated Surfaces to Establish Non-Reactivity Levels of Ammonium Perchlorate, Cyclotrimethyenetritramine, and Trinitrotoluene on Wood, Concrete, and Metal (NSWC, Indian Head)
- Los Alamos Series on Dynamic Material Properties, Los Alamos Data Center for Dynamic Material Properties, Section 3.5, Detonation Failure Thickness
- Explosive Sensitivity of Soils and Metal Fragments at TEAD OBOD Grounds, ENF/FAB Report 03-92

HCIS – Rapid Quantification

- GC/TID (thermionic detector)
- Expray® kit
- Ion mobility mass spectrometry
- Raman spectrometry
- Mid-range infrared spectrometry
- Near-infrared spectrometry
- Neutron analysis/nuclear techniques
- Electronic “nose”
- Optical recognition

HCIS – Expand Demil Scrap Data and Evaluate Risk from Residue

- Calculated energy and gas release from Demil Scrap data
- Evaluated ability to propagate an explosion based on thin film of residue based on LANL data
- Submitted data to Paul Cooper, Sandia NL (retired)
  - One of the leading U.S. experts in the field of explosives
  - Author of text books on explosives technology
  - Lecturer/educator in explosives technology
- All Demil Scrap “3X” residues were well under limits for propagation of an explosion or fracture of projectiles
- Gas releases from all “3X” residues were inconsequential

HCIS – Potential for "3X" Munitions from the Scrap Demil Project to Explode

Conservatively Estimated Based on 1% Strain to Munition Body

Munition	Explosive	Non-Thermal Process	Explosive Residue on Demil Scrap		Explosive Residue to Cause 1% Strain
			Mean (grams)	Maximum (grams)	Calculated (grams)
5-Inch Projectile	Comp A-3	HP Washout	0.5	**2**	**664**
8-Inch Projectile	TNT	Meltout	16	**20**	**2,990**
		Hot-Water Washout	3	5	
105mm Projectile	Comp-B	Meltout	18	**29**	**402**
		Hot-Water Washout	2	3	
	TNT	Hot-Water Washout	2	3	
750-lb Bomb	Tritonal	Meltout	94	**103**	**12,550**

Note: 340 – 450 grams was required for a lump of explosive to breach the munition wall.

HCIS – Potential for "3X" Munitions from the Scrap Demil Project to Move

Conservatively Estimated Based on Instantaneous Combustion of All Residue to Propel the Munition 6 Inches Vertically

Munition	Explosive	Non-Thermal Process	Explosive Residue on Demil Scrap		Explosive Residue to Lift Munition 6"
			Mean (grams)	Maximum (grams)	Calculated (grams)
5-Inch Projectile	Comp A-3	HP Washout	0.5	**2**	**116**
8-Inch Projectile	TNT	Meltout	16	**20**	**1,230**
		Hot-Water Washout	3	5	
105mm Projectile	Comp-B	Meltout	18	**29**	**60**
		Hot-Water Washout	2	3	
	TNT	Hot-Water Washout	2	3	
750-lb Bomb	Tritonal	Meltout	94	**103**	**10,100**

HCIS – Typical Melter Requirements

- No radioactive source
- Limits on copper, tin, zinc, lead, etc.
- No water, ice, fluids
- Metallurgy of metal defined
- No explosive hazards

Video of an Electric Arc Furnace Charge

Typical Electric Arc Furnace

- Scrap metal is segregated by type (8–25 types).
- Each batch follows a recipe to achieve a desired metal product.
- Clamshell drops 40–80 tons of proportioned scrap.
- Receiving vessel has an open top and contains a heel of molten steel from the last batch.
- Fireball forms as new material is introduced.
- Batch melts at 3000°F for about 30 minutes (~1 hour from tap to tap).
- Melted steel is tapped and final adjustments are made to polish the chemical content to meet specifications.

Changing Environment for Recycling "3X" Munitions

- 10 USC Chapter 443 – Disposal of Obsolete or Surplus Material – Allows the Secretary of the Army to sell "excess, obsolete, or unserviceable ammunition and ammunition components…outside DoD."

- AEC efforts to reconcile MPPEH regulations:
  - DoDI 4140.62 – Management and Disposition of MPPEH
  - DoD 4160.21-M, C4.9 – Defense Material Disposition Manual
  - DoD 6055.9-STD, Chapter 16 – DoD Explosives Safety Standards
  - Development of a new Guidance Manual for Proper Management of MPPEH

HCIS – Recommended Process Steps for Dispositioning “3X” Material

The following steps are suggestions for how to safely disposition scrap metal from munitions demilled by “3X” processes based on transfer to a steel melter.

Proposed Process Steps

1. Identify quantity and type of munitions to be processed.
2. Use MIDAS to identify the metallurgy.
3. Determine if special contract language is required, such as for trade security risks.
4. Identify a steel melter to participate.
5. Review the demil process SOP.
6. Evaluate the demil inspection process.
7. Develop a flowchart for the demil, inspection, transfer, and melting processes.

Proposed Process Steps (cont.)

8. Develop a risk assessment matrix for the entire process.
9. Involve the designated explosives safety office in conducting the risk assessment.
10. Optionally, sample demilled scrap metal to quantify residuals if there is uncertainty.
11. Confirm that shipment of the demilled scrap metal will meet DOT requirements.
12. Coordinate scheduling.
13. Initiate demil operations.

Proposed Pilot Process (cont.)

14. Bring industrial receiver onsite to observe.
15. Demil the munitions.
16. Inspect demilled scrap metal.
17. Document that the demilled scrap metal does not represent an explosive safety hazard for recycle.
18. Ship the scrap metal to the steel melting facility.
19. Melt the scrap metal.
20. Observe the steel melting operations.

Why Have Accidents Occurred?

- What is the problem?
  - 5 grams vs. 0.5 grams of residual, or
  - Full/partially-full munition vs. demilled residuals?
- What is needed?
  - Validated/certified demil processes
  - Thorough inspections –Inspectors should be certified as able to visibly determine safe residual levels, and items must be exposed to allow inspection
  - Segregation of inspected materials
  - Maintaining the chain of custody
  - Risk assessments on the entire process

DoD Instruction 4140.62

Management and Disposition of Material Potentially Presenting an Explosive Hazard (MPPEH)

December 3, 2004

Effective management of MPPEH shall “Establish a process that provides assurance that unknown explosive hazards shall not be present when transferring MPPEH or materials documented as safe with the Department of Defense or when releasing MPPEH or materials documented as safe to the public.”

How Is Acceptable Risk Determined?

- Establish risk assessment guidelines
- Possible risk factors
  - What energetics were in contact with the item?
  - How was the item demilled?
  - What is the maximum residual quantity from the demil process?
  - Can the item be inspected?
  - Are inspections adequate to avoid full-up rounds?
  - Are segregation of demilled items ensured and chain of custody maintained?
  - How will the items be recycled?

Conclusion: Manage the Risk

- LTC Raftery requested suggestions for reducing costs for demil (2006 Symposium).
- Measured residual levels on melt-out and wash-out items are below calculated values for safe recycling.
- Thermal treatment at installations and melting of scrap metal at smelters are redundant.
- Melting scrap metal also removes the “appearance of being a munition”.
- Reduce costs and handling by using Risk Management to evaluate demilled “3X” items and disposition these items directly to smelters when appropriate.

Comments and Suggestions Are Welcomed

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