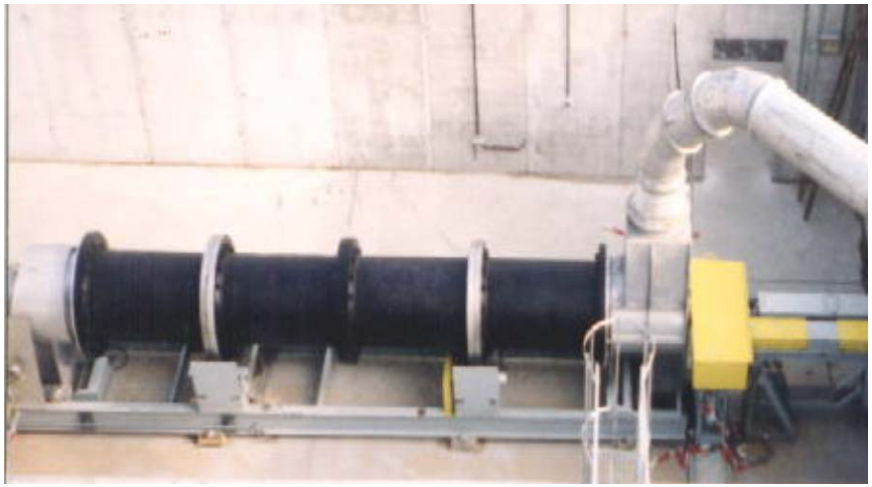
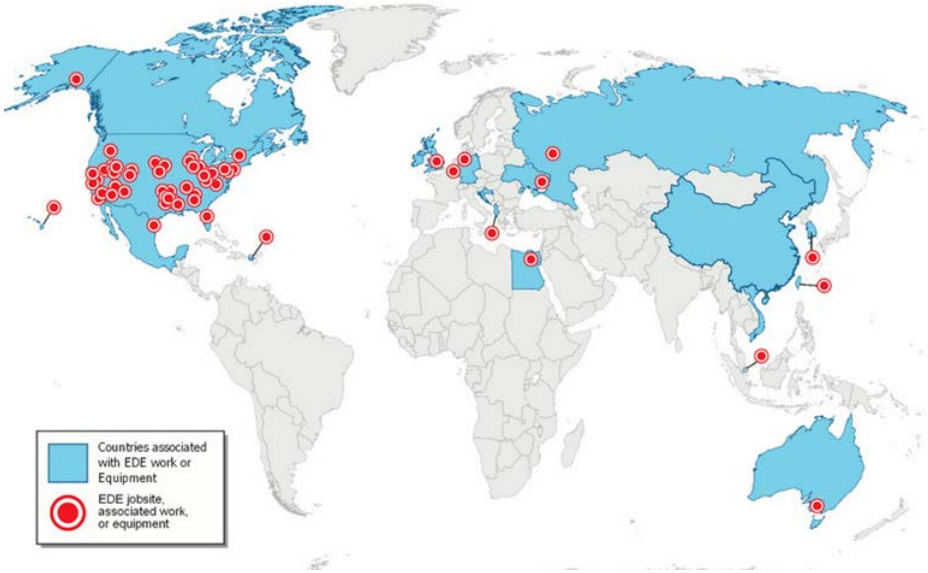
El Dorado Engineering
Technology Solutions



Contact: Bob Hayes / 801-966-8288 / bhayes@eldoradoengineering.com

El Dorado Engineering

- **Founded in 1981, Over 35 Yrs. Experience**
- **HQ in Salt Lake City, UT USA**
- **Employee Owned, Small Business**



Capabilities Include:

- Professional Engineering & Design
- Consulting
- Fabrication/Construction/Installation
- Commissioning/Training
- Permitting

Specialize in

- Demilitarization of Conventional & Chemical Munitions, Rocket Motors, Propellants, Explosives, and Pyrotechnics (PEP)
- Recycling/Conversion of Energetics and Munition Materials
- Thermal Treatment and Combustion Related Systems
- Pollution Control Systems
- Environmental Consulting, Permitting and Restoration
- Machine Design, Robotics, & Disassembly Equipment
- Automation & Controls (In-House Custom Control Panel Shop & PLC/HMI Programming)
- Electrical Systems in Hazardous Locations

We Take Pride in our Record of Safety, Project Cooperation, & Client Satisfaction

Example Projects

- Flashing Furnace (TFF) systems/Contaminated Waste Processors (CWP): Ravenna AAP, Eglin AFB, Hill AFB, Anniston AD, China Lake NWS, Letterkenny AD, Vieques Puerto Rico, Kaho'olawe Hawaii, Old Talon site WV, Albania, Belgium, Australia
- Rotary Kiln Explosive Waste Incinerators (EWI) worldwide, including international facilities in: Taiwan, Germany, Albania, U.K. , South Korea, Ukraine, Belgium
- Used our understanding of combustion processes & atmospheric dispersion to consult for NASA on go/no-go launch criteria for space shuttle launches
- RCRA & Air permitting for mfg., demilitarization, & testing facilities
- Turnkey small-scale contained burn facilities for disposal of commercial energetic wastes for numerous private commercial clients
- Turnkey induction heating melt out system for explosives recycling
- Turnkey contained burn systems to dispose of small tactical rocket motors (<50 lbs NEW)
- Turnkey facility to demilitarize flares, reclaiming and recycling high grade magnesium
- Design/build turnkey large scale contained burn system for bulk single base propellant for emergency response removal action at Camp Minden, Louisiana
- Design/build turnkey facility for contained burn of large tactical rocket motors (e.g., MLRS) for U.S. Army at Letterkenny Army Depot, Pennsylvania
- Countless technology evaluation studies, engineering analyses

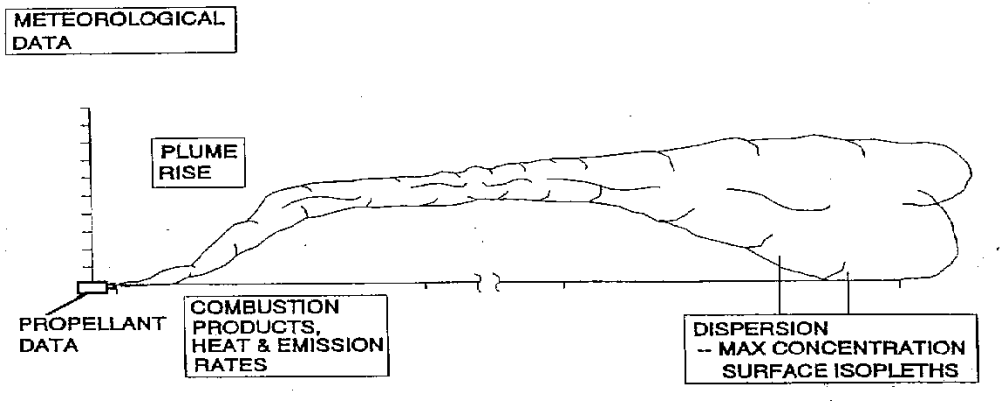
Demilitarization Technology Methods

- Destruction/Disposal
  - Thermal Treatment
  - Chemical Neutralization/Conversion
- Recovery/Reuse
  - Energetic Materials
  - Metal Components
- Disassembly/Preparation

Demilitarization Technology Considerations

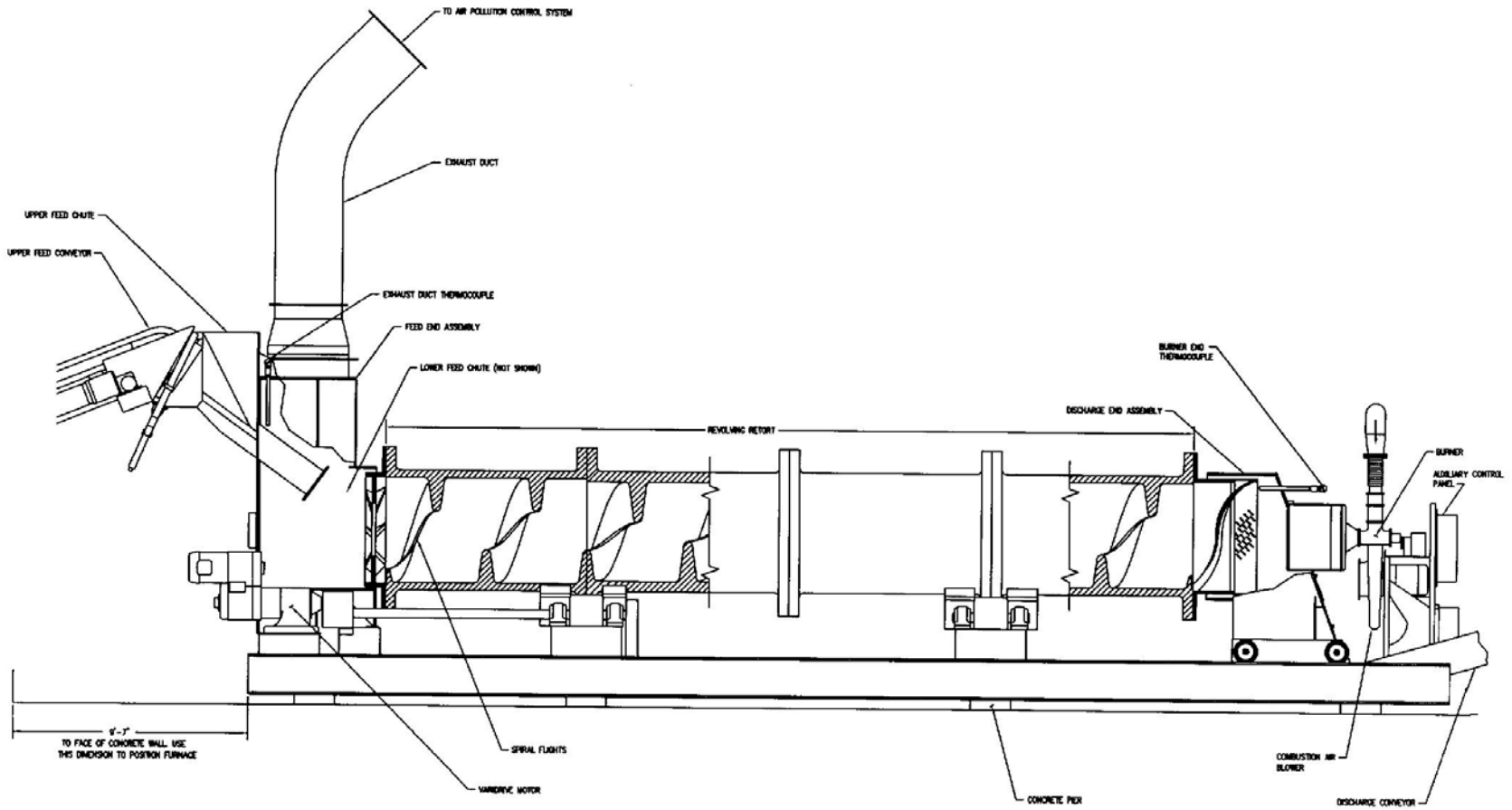
- Safe
- Effective
- Environmentally Responsible
- Versatile
- Robust
- Simple
- Proven
- Cost

OB/OD: PCAD Model
Products Of Combustion and Dispersion



EDE Rotary Kiln
Explosive Waste Incinerator

THEORY OF OPERATIONS
RETORT CUTAWAY

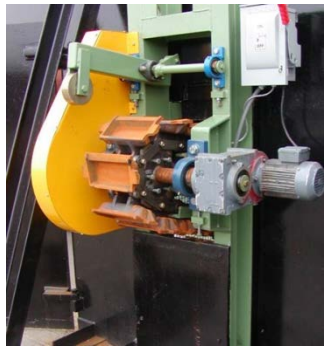


EDE: Explosive Waste Incinerator

- Versatile workhorse of demil sector
- VERY HIGH THROUGHPUT
  - Lowest Life Cycle Cost
- Handles configured items up to 30mm HE
  - SAA
  - Primers
  - Fuzes
  - Projectiles
  - Initiators, CADs/PADs
  - Bulk PEP
  - Airbag assemblies
- Handles larger munitions, if explosive exposed by munition preparation (e.g. punch grenades, saw large projectiles)
- Discharged metals are suitable for public release (MDAS or old 5x standard) Recycling of steel, brass, lead
- Off Gas Treatment - Tailored to Waste Materials and Local Applicable Requirements

EDE: Explosive Waste Incinerator

Technology Highlights



- Positive Feed System (Bulk Materials)
- Automated Punch/Feed Systems
- Automated Lead Removal/Recovery
- Automated Magnetic Separator
- Heat Recuperator
- Advanced Pollution Controls
  - Afterburner
  - Low-Temperature Baghouse
  - HEPA Filter System
  - SNCR/SCR
    - NOx Reduction
    - Dioxin/Furan Destruction
  - Mercury Removal System

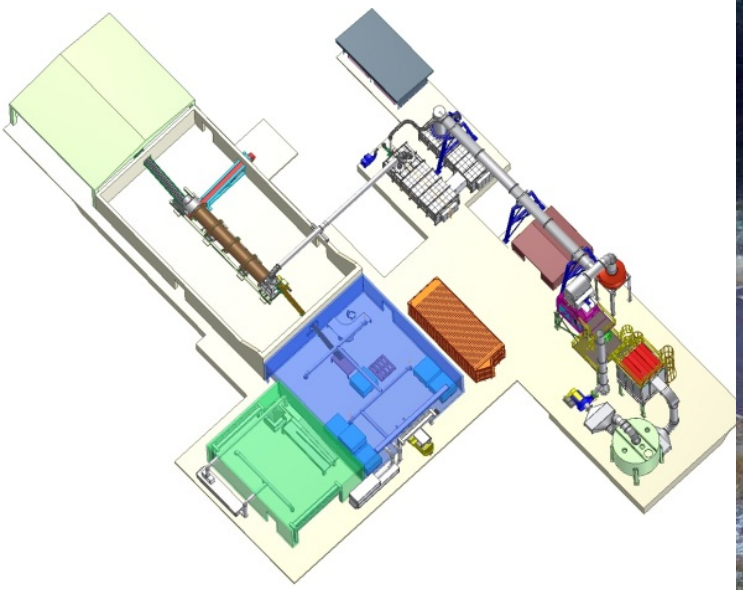
- Advanced Controls: Limits, Warnings, Alarms, Interlocks

Rotary Kiln Incineration

Challenges

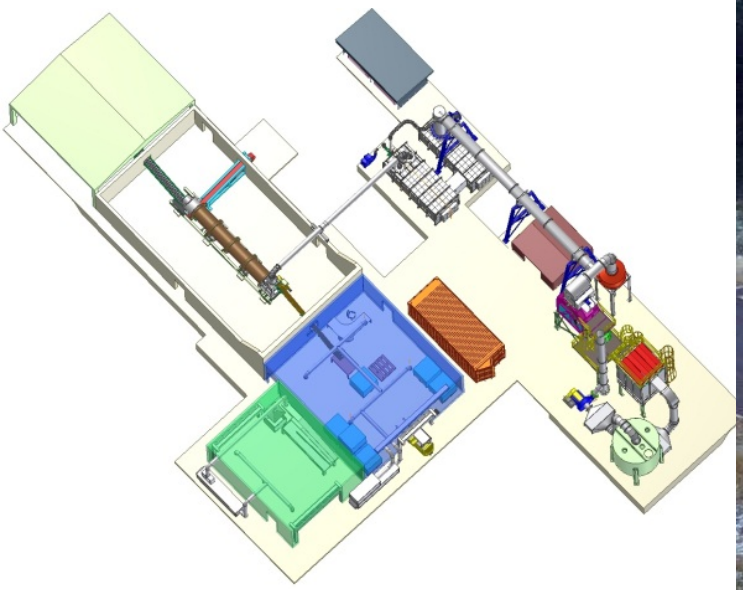
- Regulatory/Public Perception
  - Cumbersome Permitting Process
  - NIMBY
- APE 1236
  - High operating/maintenance costs
    - Permit constraints
    - QA/QC Inspections
    - Operational Constraints
  - Older Technology
  - Less efficient pollution controls

El Dorado Engineering
Turnkey Belgium EWI - INES



ITEM	Average Feed Rate Items/Hr	Max Feed Rate Items/Hr	CEMS Average Daily Values				Stack Sampling Data	
			NOx (mg/m^3)	CO (mg/m^3)	TOC (mg/m^3)	Dust (mg/m^3)	Heavy Metals (mg/m^3)	Dioxin/ Furan (ng TEQ $/m^3$)
EU Directive Limits			200	50	10	10	0.5	0.1
20mm HE-I-T	900	1250	0.2	0.7	0.4	N/D	N/D	N/D
20mm SAP-I	1200	1250	0.0	2.1	0.4	N/D	N/D	N/D
7.62mm Ball	22700	25000	0.0	1.3	0.3	N/D	N/D	N/D
12.7mm API	5000	6600	40.0	0.1	1.1	N/D	N/D	N/D
PD Fuze M51 w/Booster	400	400	0.4	0.9	0.5	N/D	N/D	N/D
TNT Block	89 kg/hr	120 kg/hr	2.6	0.7	0.4	N/D	N/D	N/D
Bulk M6 Propellant	66 kg/hr	90 kg/hr	0.4	1.7	0.4	N/D	N/D	N/D

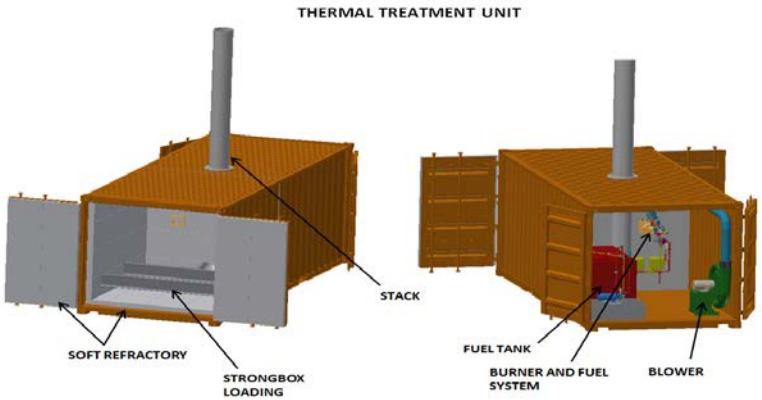
El Dorado Engineering
Turnkey Belgium EWI - INES

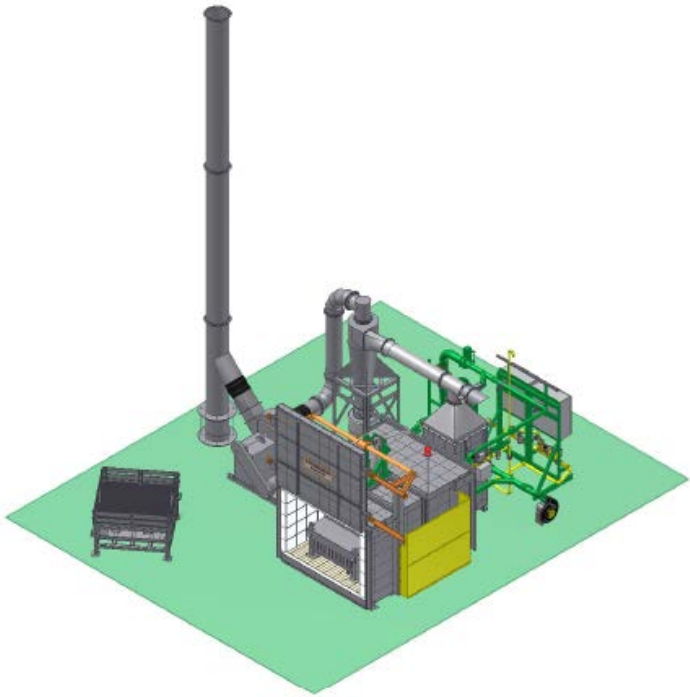


Recovered Value from Recycled Metals

	steel	brass	lead	mixed	Total
2016	€ 10,291	€ 422,272	€ 35,174	€ 39,295	**€ 507,032**
					$ 598,298

EDE: Flashing Furnace Technology





Transportable Flashing Furnace: TFF

- Fully Transportable
- Thermally Decontaminate material to 5X
- Rate: 2 tons/hr explosive cont. metal
- Quick heat up/cool down cycle
- Rolling Hearth (Car Bottom)
- Max. Load: 10,000 lbs
- Combustion Design to minimize emissions
- Strongbox used to pop live items
- Safety: remote control pendant
- Designed to survive unplanned explosions
- Off Gas Treatment Options

Contaminated Waste Processor

Example EDE Applications

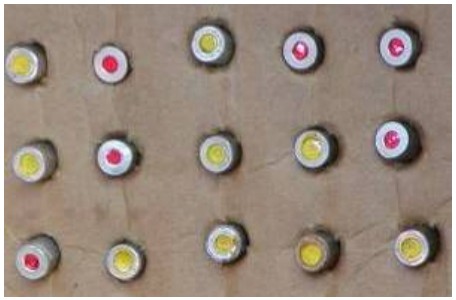
- Kaho'olawe Island, HI
  - >12 million lbs range scrap UXO reclamation project
- Anniston Army Depot
  - Used to treat rocket motor bodies from missile recycling center prior to metals recycling
- Eglin Air Force Base
  - SAA :5.56, 7.62,& 9mm, 12 gage, .50 &.30 cal, 20mm & 30mm TPT, CADs/PADs
- Hill AFB
  - 20mm & 30 mm TPT, misc. UXO, and range scrap
- Talon WV Cleanup (MARID)
  - Treated >50 different types of live fuze components
- Letterkenny Army Depot
  - SAA: 5.56mm, 7.62mm, 9mm, .50 cal, .30 cal,
- Ravenna Army Ammunition Plant
  - remediation operations:PEP contaminated eqpt.
- Other Locations include: China Lake, Puerto Rico, Mexico, Albania, Ukraine, England, Belgium

TFF-EM - Talon Cleanup Items

- Variety: (M524,M532, M521, M501, MK27, M524, M577, M513, MK90, M572, M48, M125A1, etc)
  - Detonators
  - Rotors
  - Delays
  - Plungers
  - Leads
  - Tracer
- Energetics:
  - Tetryl,
  - RDX,
  - PETN
  - Pb Azide,
  - Pb Styphnate







Talon Cleanup, West Virginia

Hazardous Mess

Safe and Clean

Hill AFB Application

- Established batch limits
  - 25 lbs NEW
  - No mass detonating materials
- Startup Testing
  - Determine load rates
  - Confirm treatment times
- Load Rates & Configurations:
  - 150 lbs 20mm AUR TPT (25 lbs NEW)
  - 450 lbs AUR mix & 1400-2000 lbs brass
  - 2000-3000 lbs steel & 2000 – 3000 lbs steel
- Material Disposition
  - Brass recycled
  - Low value steel landfill

Contained Burn Technology

- Bulk Propellant, Explosives
- Tactical Rocket Motors
- Igniters, Detonators
- PEP Contaminated Waste
- Air Bag Propellants

Contained Burn Technology Highly Scalable

10 Pounds per Burn Cycle

50,000 Pounds per Burn Cycle

EDE Contained Burn Technology

Example Applications

Small Tactical Rocket Motors (2 Projects)

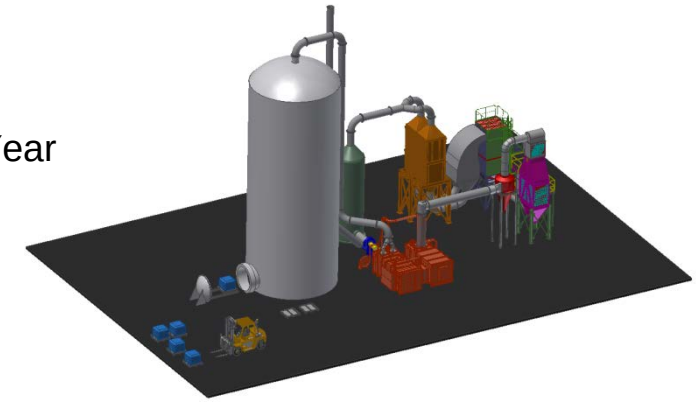
- Small Tactical Rocket Motors (<20 lbs propellant)
- Design Throughput: >40 motors per day
- Multi Stage (dual grain) double based propellant
- Dry scrubber PAS (OGT) for particulate

Ammonium Perchlorate Rocket Motor Demil (ARMD)

- Flexibility for Wide Variety of Tactical Rocket Motor Types
- 60 – 1605 lbs propellant per RM
- Design throughput: 2-3 motors per hour (dependent on size)
- Off Gas Treatment for HCl, particulate, and dioxin/furan
- Full-Scale demonstration performed for:
  MLRS (216 lbs NEW) and PHX (365 lbs NEW)
- Production Facility Under Construction, Startup Spring 2016

Camp Minden M6/CBI Bulk Propellant

- Throughput >15 million lbs of M6 propellant and CBI in One Year
- Off Gas Treatment similar to Belgium EWI
- Emergency Response: Design/Build < 8 months
- Production Facility Under Construction, Startup Spring 2016



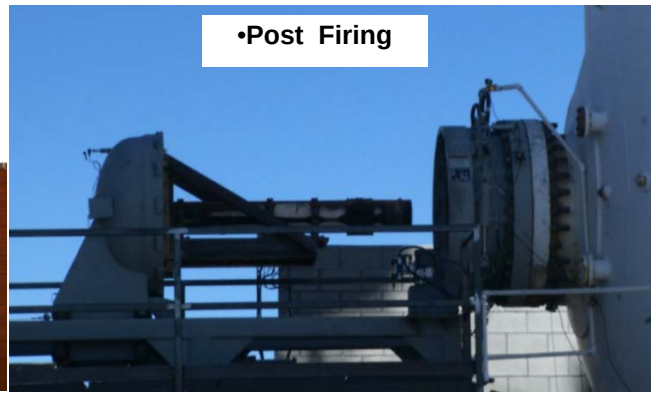
AP Rocket Motor Demilitarization (ARMD) Project

- Large Workload
  - 60 to1605 lbs Propellant/Motor
  - Challenging Chemistry
- Thorough Technology Evaluation
  - Non Open Burning
  - Numerous Stakeholders
- Contained Burn Selected
- Construction Completed
  - Letterkenny, PA
  - DDESB Approval Received
  - RCRA Permit Approval Received
  - Air Permit Approval Received
  - First Stack Test Completed (Sidewinder)

ARMD Pilot Testing

PROCESS DESIGN

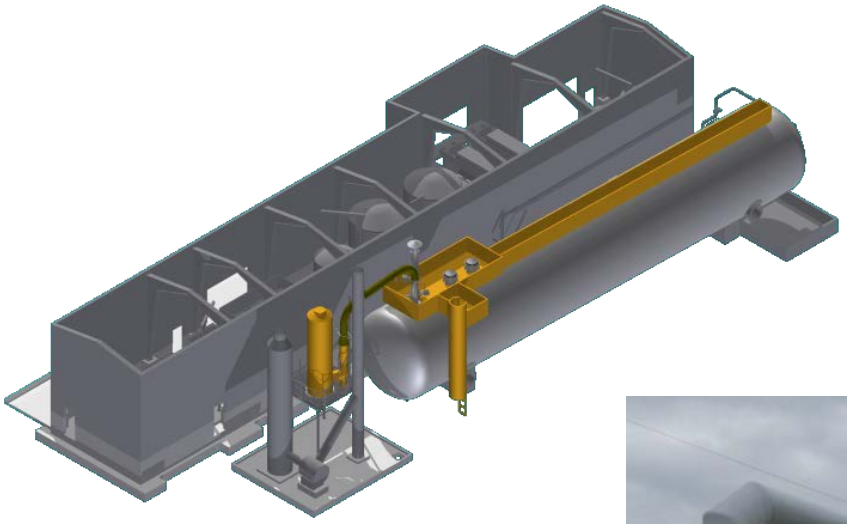
- RM's are placed on firing stand
- RM's are remotely loaded into system
- Remote automated chamber sealing with ignition interlock
- RM's are static fired intact
- Propellant burns as designed
- Gases are contained in chamber
- Gases cool and are metered through economical pollution abatement system



Particulate Samples

PAS INLET PAS OUTLET

ARMD Production Facility Design



ARMD Sidewinder Motor Environmental Test Results

Stack Emissions

- Total Particulate= 0.006 gr/dscf (Relevant Limit = 0.04 gr/dscf)
- HCl = < 2.4 ppm
- Opacity = 0%, no visible emissions

Neutralized Brine

- Passes TCLP
- Perchlorate Non-Detect
- Non-Hazardous Material

Alumina Solids (Filter Cake)

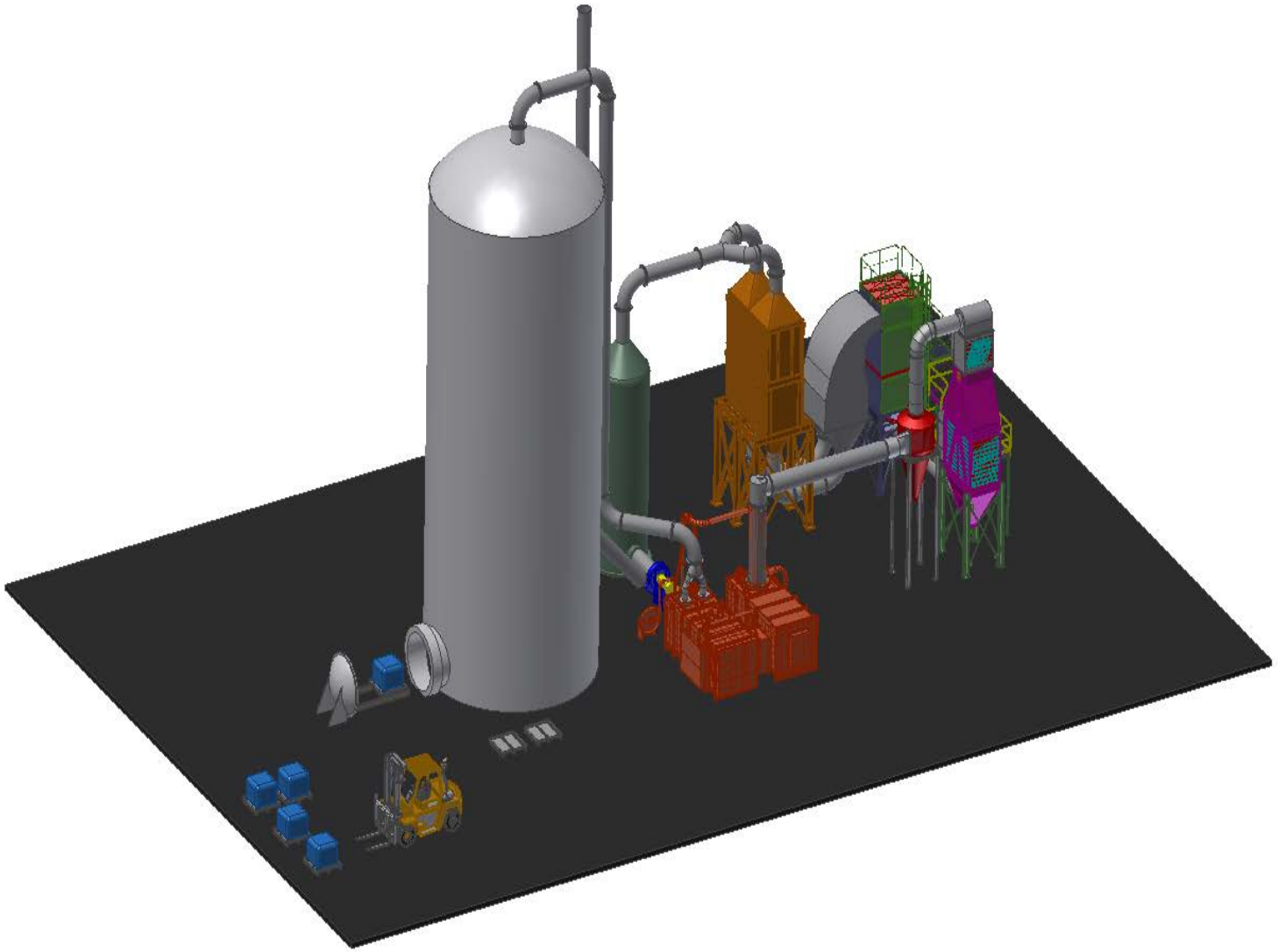
- Passes TCLP
- Perchlorate Non-Detect
- Non-Hazardous Material

Camp Minden Project

Challenge:

- Intense Public Scrutiny
- First-of-a-Kind Facility
  - Extremely High Throughput
  - Ultra Low Emissions
  - Safety Considerations are Paramount
- Safely Destroy Approximately 15.7 Million Pounds of Propellant <1 year after startup
- Design, Build, Commission in < 9 Months

Camp Minden
Contained Burn System Concept



Camp Minden
Contained Burn System Facility

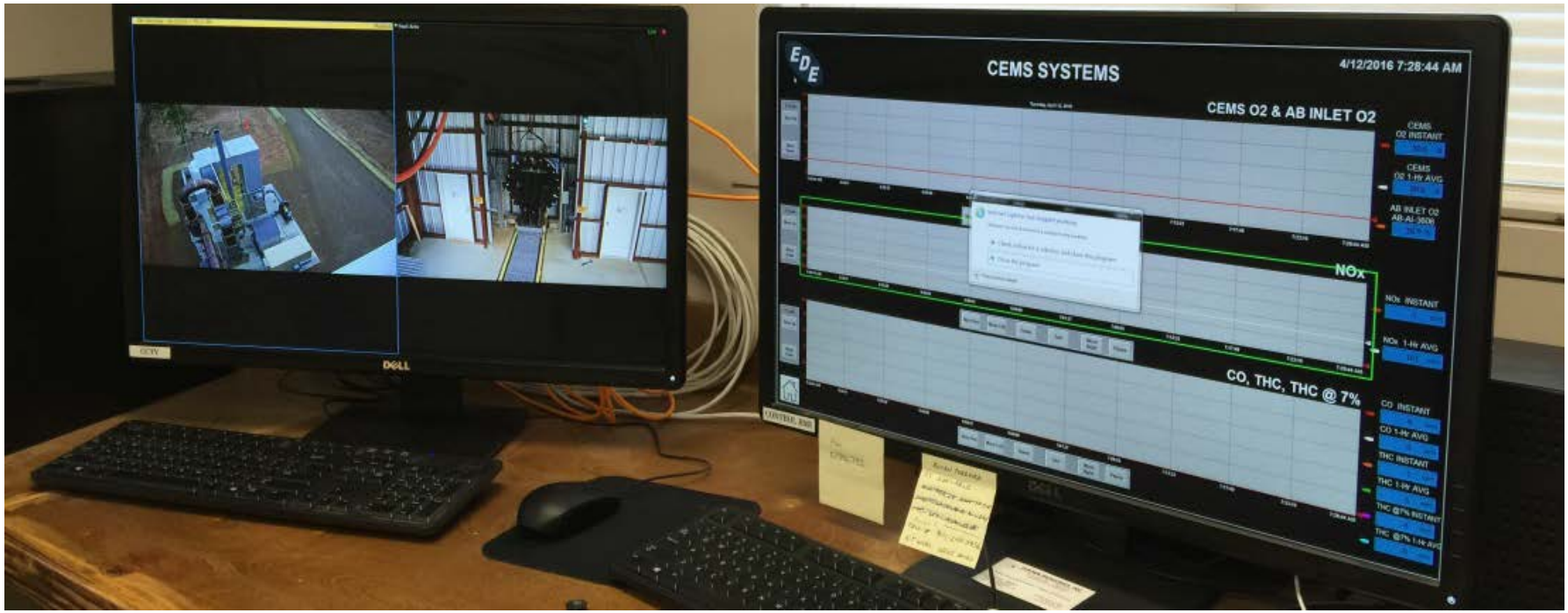
- < 9 Months After Contract Award - First Burn
- Within 4 days - Commence 24/7 operations

Camp Minden
Contained Burn System

- Process Rate: 880 lbs. M6 per Cycle (20-25 minutes)
- After Loading Tray All Operations are Remote for Safety
- Facility Designed to Operate 24/7
- Safely Destroys 50,000 – 60,000 lbs. per day

Camp Minden
Contained Burn System

- Remote Controls: PLC, HMI, CCTV
- Redundant Safety & Environmental Interlocks



Camp Minden
Particulate Removal

Camp Minden
Contained Burn System

Stack Emissions Testing

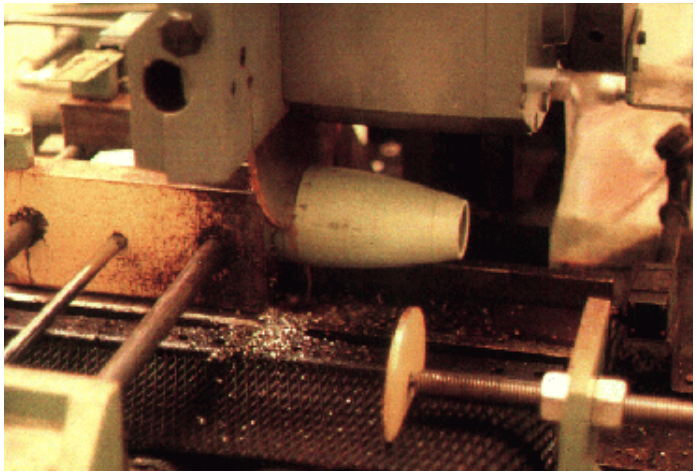
- VOCs: Allowable 10 ppm, actual <0.01 ppm
- CO: Allowable 20 ppm, actual <0.01 ppm
- NOx: Allowable 250 ppm, actual <0.01 ppm
- All POHCs: Non detect
- DRE >>99.999%
- PM: << 0.0016 gr/dscf
- No Visible Emissions

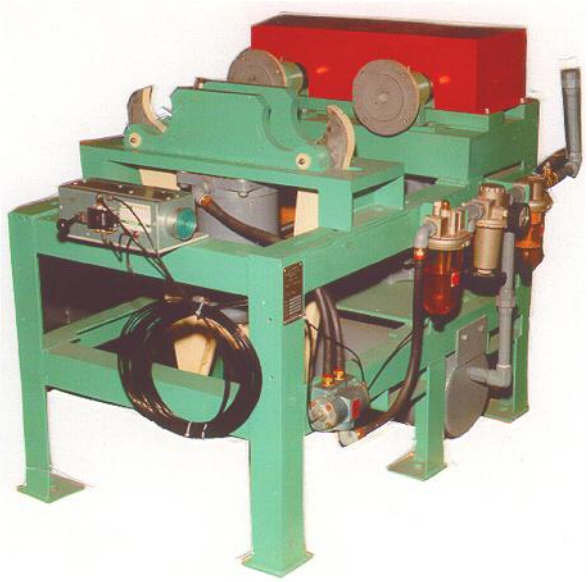
Camp Minden
Contained Burn System

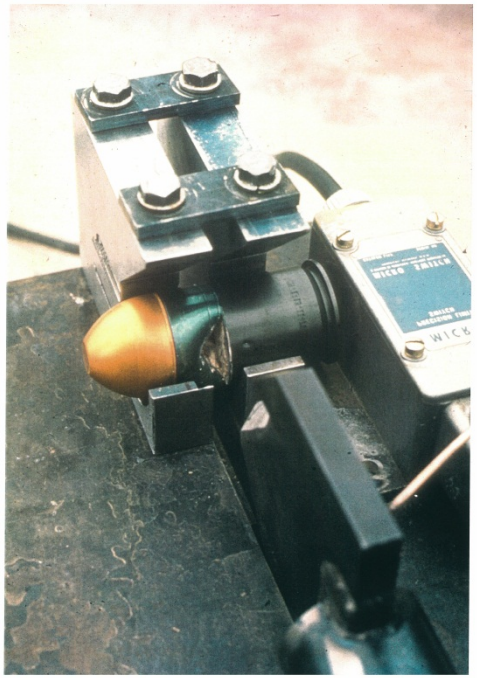
- April 2017: Facility has Safely Disposed of All Propellant
- Approximately 15.7 million lbs. Safely Destroyed in < 1 yr.
- Emissions Well Below Allowable Levels
- Safe/Simple/Reliable
- Environmentally Responsible Solution

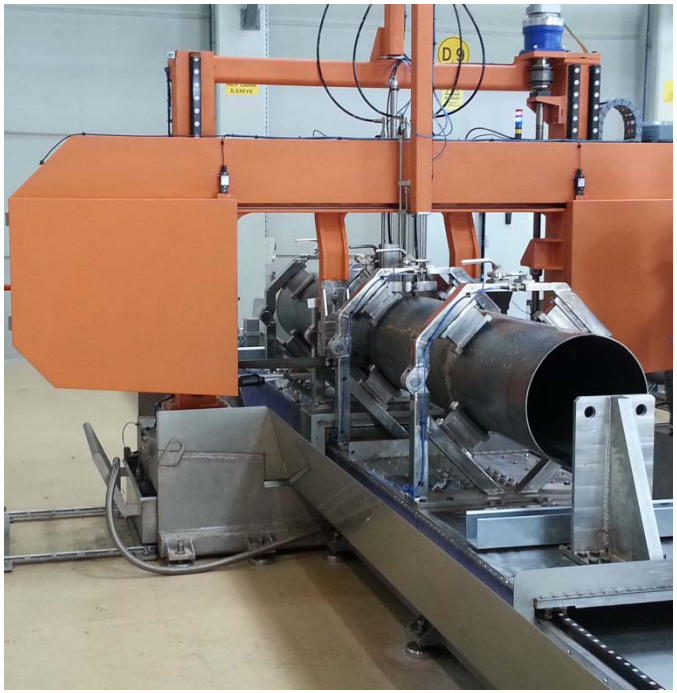
Disassembly Equipment

- Projectile Saws
- Rocket Motor Segmenting
- Bomb Segmenting
- Pull-Apart Machines
- Debanding/Defusing/Depriming
- Shear Machines





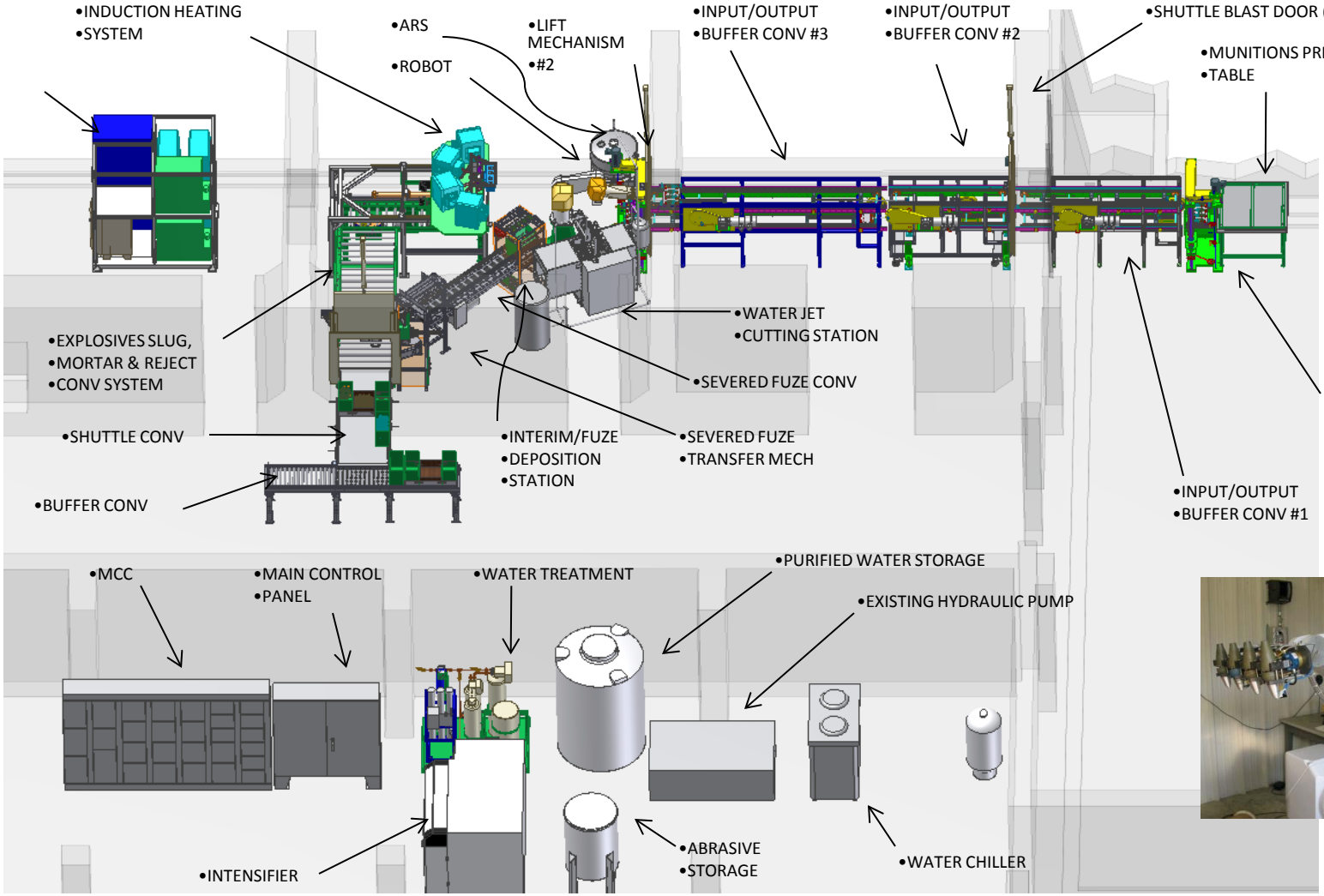


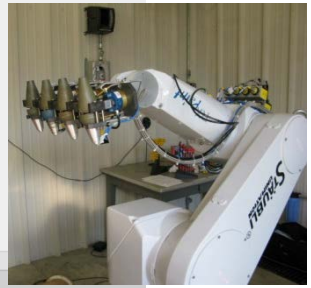


PEP Washout & Meltout Systems

- Autoclaves
- Explosive Flaker Belts
- Hot Water Washout Plants
- High Pressure Water Jet Technology
- Slug Out (no steam contamination)

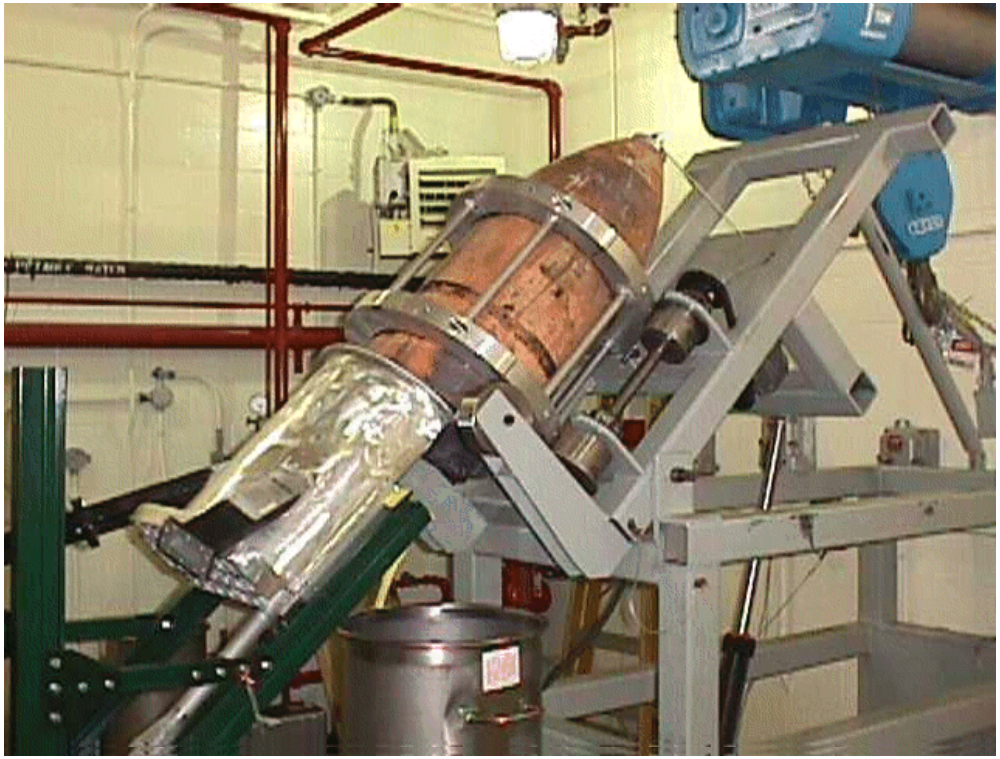
Explosives Recovery/Recycling
DIHMES – Induction Heating Melt Out

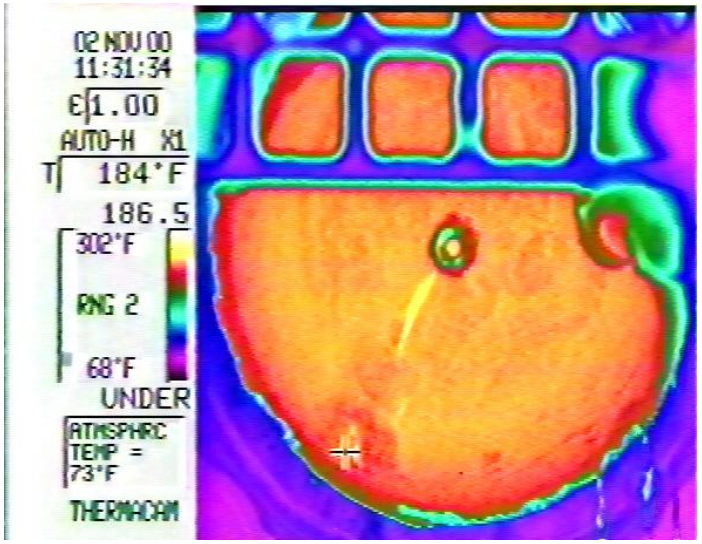


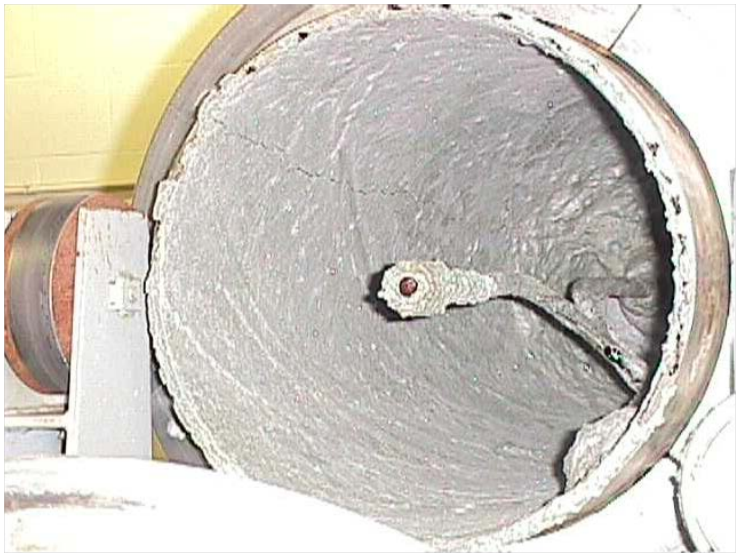


Microwave Meltout

- Demonstration Optimized for 750 lb bombs
- Little contamination
- Yields higher value explosive product





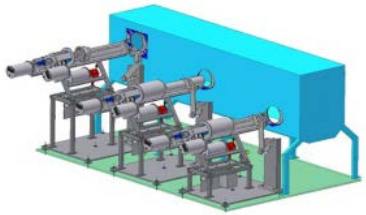


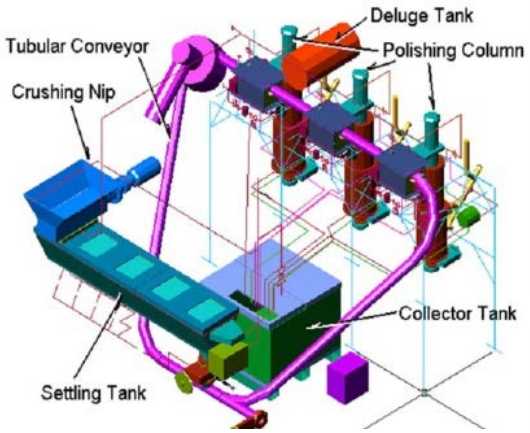
Magnesium Recovery Prototype Plant MRPP

- 60mm through large LUU2 flares
- 300 pounds per day

Process Steps

- Candle Preparation and Washout
- Refining Process Yields High Purity Mg
    - Separation
    - Polishing
    - Rinsed
    - Classified
    - Dried
    - Packaged For Shipment





Alternatives to OB/OD Summary

Primary Drivers

- Safety
- Proven, Robust, Versatile
- Throughput
- Cost
- Recycling: Economics/Logistics
- Permitting
- Acceptance

INDUSTRIAL DEMIL TECHNOLOGIES SOLUTION PROVIDER

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