U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (ARDEC)

DEVELOPMENT OF A TRANSPORTABLE SYSTEM THAT INTEGRATES CRYOFRACTURE AND PLASMA DEMILITARIZATION TECHNOLOGY

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Participating Organizations

- **Office of the Product Manager for Demilitarization**
  - Program sponsorship and oversight
- **Defense Ammunition Center**
  - Program integration and coordination
- **Armament Research, Development, and Engineering Center**
  - Technical management and technical support
- **General Atomics**
  - Cryofracture subsystem design
- **MSE Technology Applications, Inc.**
  - Plasma subsystem design
- **Yuma Proving Ground**
  - Cryofracture Tooling Verification Testing site

Presentation Outline

- Program Objective
- Cryofracture Technology Overview
- Plasma Technology Overview
- System Design Basis
- Cryofracture Tooling Verification Testing
- Design Development
- Project Status and Future Plans
- Summary

Program Objective

- **To combine cryofracture and plasma arc demilitarization technologies on a transportable platform in order to provide a complete self-sufficient munitions demilitarization facility that is capable of relocation by tractor trailers to enable rapid response to site-specific demil requirements for small stockpiles of selected munitions as well as to be able to process a variety of "ash and trash" normally found at munitions processing/storage facilities.**

Background

- DOD Reducing Dependence on OB/OD
- Existing Closed-Disposal Technologies may not be Suitable for the Demilitarization of Certain Types of Munitions
  - Munitions with little recovery value but significant quantities of high explosive material (ICM's, CBU's, shaped charges, etc.) that could damage other closed-disposal treatment processes
- Through Integrating Cryofracture and Plasma Arc Technology, These Munitions can be Safely Processed with no Unacceptable Environmental Impacts
  - Energetic materials in munitions are accessed in the cryofracture portion of process to prevent detonation upon thermal treatment of material
  - Fractured debris is then treated in plasma portion of process
- Transportable Capability Offers Additional Benefits
  - Packaging and transportation costs for munitions eliminated through bringing system to treatment site

Cryofracture-Plasma Demilitarization System (CPDS) Potential Feedstock

Other Candidate Items

- ICM's,
- 40mm Grenades
- Riot Control, Incendiary, and Phosphorous Items
- Fuzes and Fuze Components
- Pyrotechnic Items With Rocket Motors
- Propellant & Cartridge Increments
- Cartridge Activated Devices (CADs) & Propellant Activated Devices (PADs)
- Munitions with up to 3 lbs. NEW (TNT Equivalent)
- By-products of R^3 Processes

Cryofracture Technology Overview

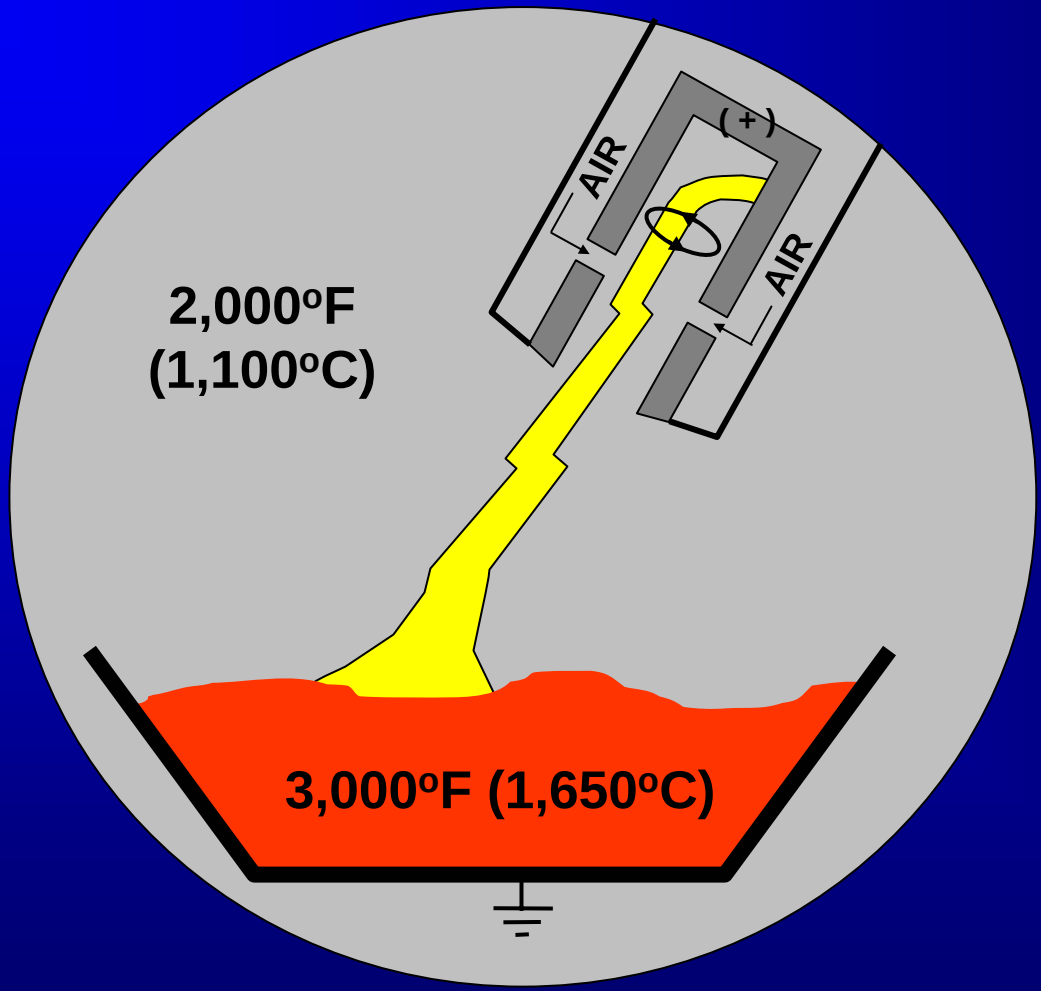
- **Cryofracture subsystem of CPDS utilizes the same underlying technology as the MCDF**
- **In addition, the cryofracture subsystem of CPDS has been designed to allow for greater flexibility as a demilitarization asset:**
  - **Transportable design to enable relocation to various demilitarization facilities**
  - **Generic tooling to enable treatment of a wide range of munitions**

Cryofracture Technology Overview (cont'd)

Plasma Technology Overview

- **Plasma subsystem of CPDS utilizes the same underlying technology as the PODS and is a 2nd generation version of the Mobile Plasma Treatment System, which was previously built and tested under a separate effort**
  - Three major components: feed system, primary chamber/plasma torch, and pollution control and monitoring system
  - Design enhancements to feed system and primary chamber/plasma torch to increase capability of system to process high explosive material
  - Pollution control and monitoring system upgrades to increase system reliability

Plasma Technology Overview (cont'd)



CPDS Design Basis

- Transportability
- Processing Capacity of up to 3.0 lbs. NEW (TNT equivalent) per cryofracture press cycle
  - Cryofractured debris separated into four chutes
- Generic cryofracture tooling to enable fracture of a variety of munitions types
- Plasma chamber designed to process up to 0.75 lbs. NEW (TNT equivalent) per feed increment every 15 seconds
- Automatic feed interface for cryofractured debris and manual loading station for fully-assembled munitions that require plasma treatment only

Cryofracture Tooling Verification Testing (TVT)

- **The objective of this testing was to demonstrate the effectiveness of generic cryofracture tooling for use in the CPDS by:**
  - Evaluating tooling configurations and operating parameters for the cryofracture press
  - Determining operating parameters for cryofracturing munitions
  - Assessing the suitability of selected munitions for cryofracture processing
  - Test burning cryofractured munitions to determine if explosive materials have been adequately accessed
- **All munitions selected for testing were successfully evaluated**

Cryofracture TVT

- Munitions Tested -

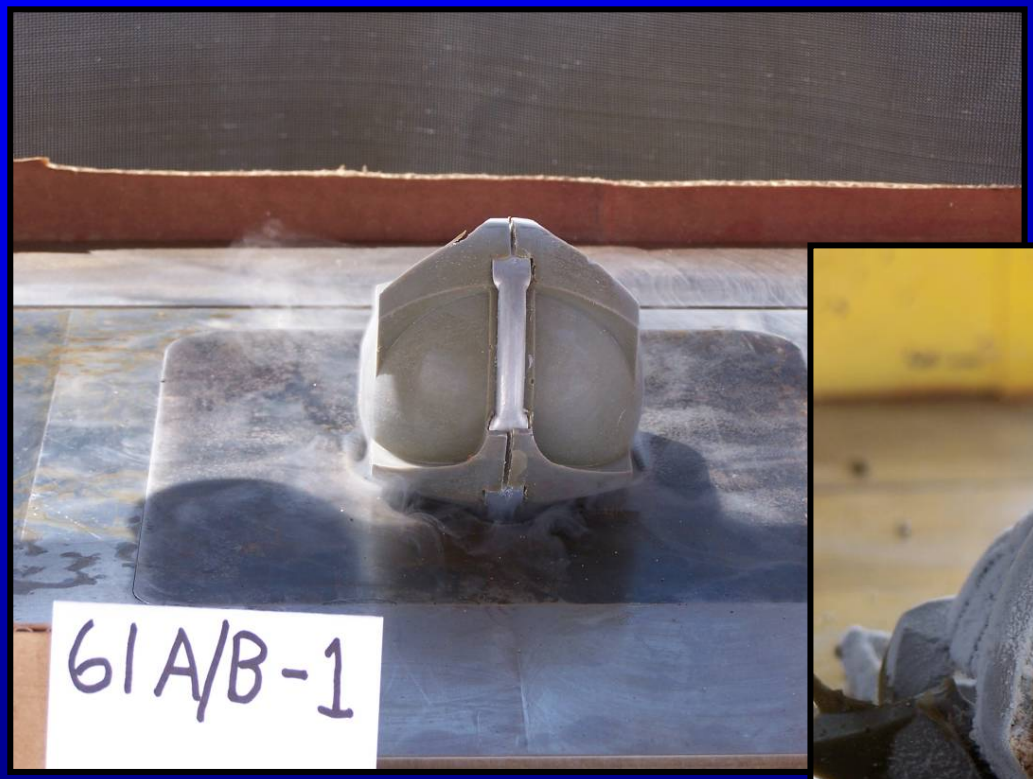
Test Number	DODIC	Munition	NEW	Proposed Press Tooling	Item Weight*	Number of Tests per Item	Total NEW	Total Weight of Fractured Test Material*
1	B568	M406	0.08 lbs	Punch/Die	1.63 lbs	12	0.96 lbs	19.59 lbs
2	B546	M433	0.10 lbs	Punch/Die	0.50 lbs	12	1.21 lbs	5.94 lbs
3	M241	M10	0.29 lbs	Punch/Die	0.83 lbs	12	3.44 lbs	9.97 lbs
4	N230	M379	0.46 lbs	Punch/Die	1.57 lbs	12	5.52 lbs	18.90 lbs
5	K010	M4	0.20 lbs	Punch/Die	2.42 lbs	12	2.45 lbs	28.99 lbs
6	E803	BLU-63/B	0.28 lbs	Flat Plate	1.98 lbs	12	3.37 lbs	23.76 lbs
7	E828	BLU-86/B	0.26 lbs	Flat Plate	2.40 lbs	12	3.13 lbs	28.79 lbs
8	E800	BLU-61A/B	0.61 lbs	Flat Plate	2.58 lbs	12	7.36 lbs	30.97 lbs
9	ML05	MK24	1.14 lbs	Flat Plate	1.54 lbs	12	13.72 lbs	18.51 lbs
10	G890	M26	0.37 lbs	Punch/Die	1.04 lbs	12	4.43 lbs	12.50 lbs
Total						**120**	**45.59 lbs**	**197.92 lbs****

*** Weight includes NEW**

**** Total weight of items to be tested is equal to total weight of fractured test material**

Cryofracture TVT

- Test Results -



Cryofracture TVT

- Test Results -

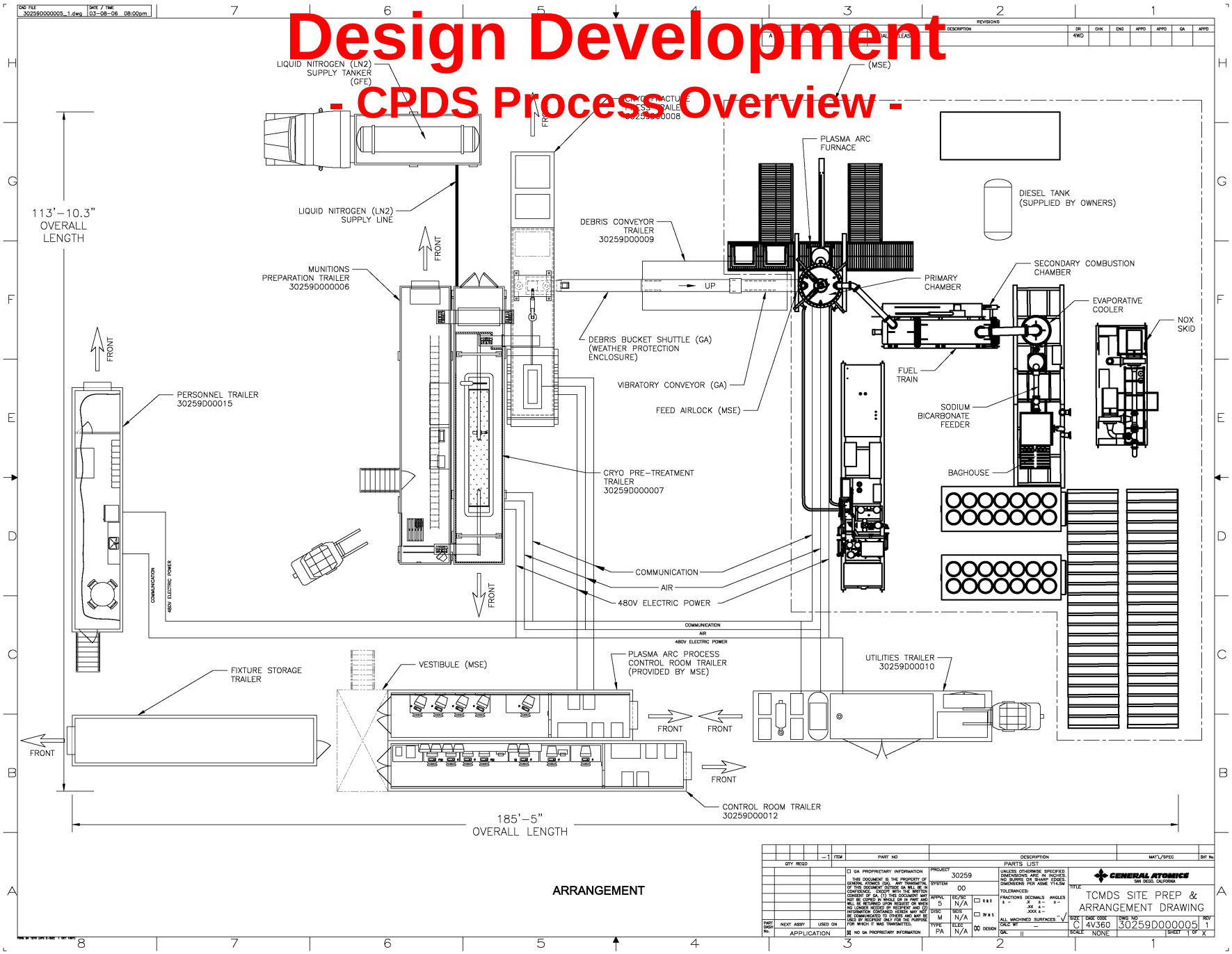
Cryofracture TVT

- Test Results -

Design Development
- CPDS Process Description -

- **Three major subsystems**
  - Cryofracture Subsystem
  - Feed Interface and Control System
  - Plasma Arc Treatment Subsystem
- **Transportable, modular design capable of being relocated on tractor trailers**
  - Integrated utilities (electrical power, compressed air, etc.)
  - Integrated lighting and remote surveillance cameras
  - Closed-loop cooling circuits
  - Automated handling of all cryofractured munitions
  - Integrated weather protection

Design Development
- CPDS Process Overview -



ARRANGEMENT

GENERAL ATOMICS
SAN DIEGO, CALIFORNIA

TCMDS SITE PREP & ARRANGEMENT DRAWING

CAGE CODE 4V360 | DWG NO 30259D000005 | REV 1 | SCALE NONE | SHEET 1 OF X

Design Development
- Cryofracture Subsystem -

- **Munitions Preparation Trailer**
  - Munition loading fixtures to ensure proper orientation
  - Conveyor to transfer loaded fixtures to Cryofracture Pre-treatment trailer
- **Cryofracture Pre-treatment Trailer**
  - Overhead robot to manipulate loaded fixtures in cryobath
  - Empty fixture return heater
  - Conveyor to transfer munitions to Cryofracture Press Trailer
- **Cryofracture Press Trailer**
  - 3.0 lbs. (TNT equivalent) processing capacity (0.75 lbs./feed chute) with integrated blast shielding
  - Hydraulic press with four tooling stations, tilt table, and diverters to separate fracture munitions into four feed chutes
  - Press munitions loader robot to transfer munitions to press

Design Development
- Feed Interface and Control System -

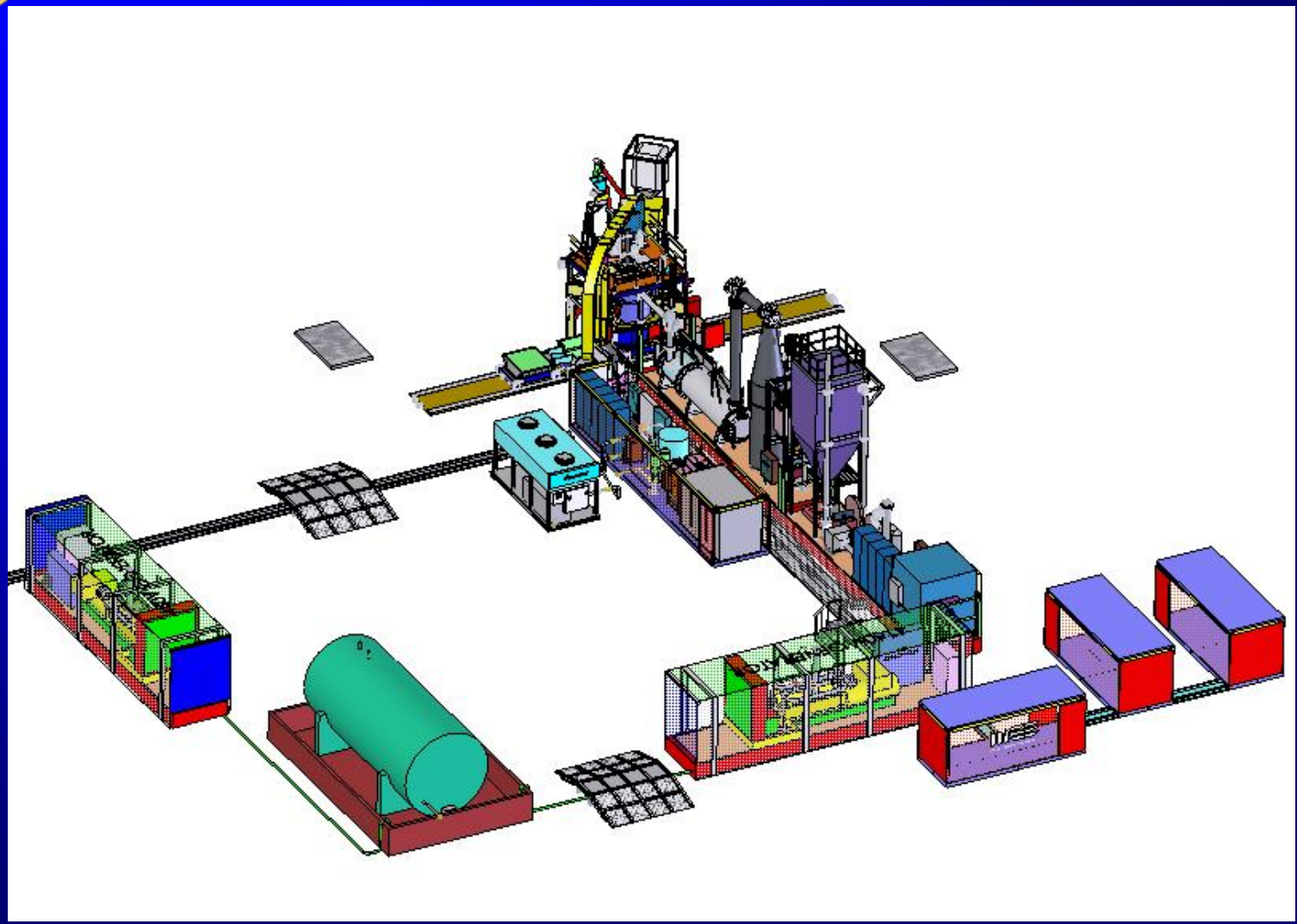
- **Feed Interface**
  - Automated transfer of cryofractured munitions to feed chute of Plasma Arc Treatment Subsystem
  - Manual loading station for feeding munitions that do not require cryofracture processing
  - Soil feed located at top of feed interface
- **Control System**
  - Single, integrated control room
  - Two stand-alone control systems for cryofracture and plasma arc thermal treatment subsystems exchanging control signals using Modbus TCP design
- **Utilities Trailer**
  - 480 Volt power, compressed air, etc. located on common utilities trailer

Design Development
- Plasma Arc Treatment Subsystem -

- **Feed Chute**
  - Two water-cooled isolation valves designed to withstand detonations of 0.75 lbs. NEW (TNT Equivalent)
  - Designed to maintain temperature at lower valve below ~125^{o}F
- **Plasma Processing Chamber**
  - Designed to withstand detonations of up to 0.75 lbs. NEW (TNT Equivalent)
  - Water cooled, refractory lined vessel with temperature monitoring at several locations in vessel
  - 30 cubic foot slag capacity/automated slag tapping system
- **Pollution Control and Monitoring System**
  - Diesel-fired Secondary Combustion Chamber
  - Evaporative cooler, dry scrubber, NO_x reactor
  - Remote CEMS in climate controlled enclosure

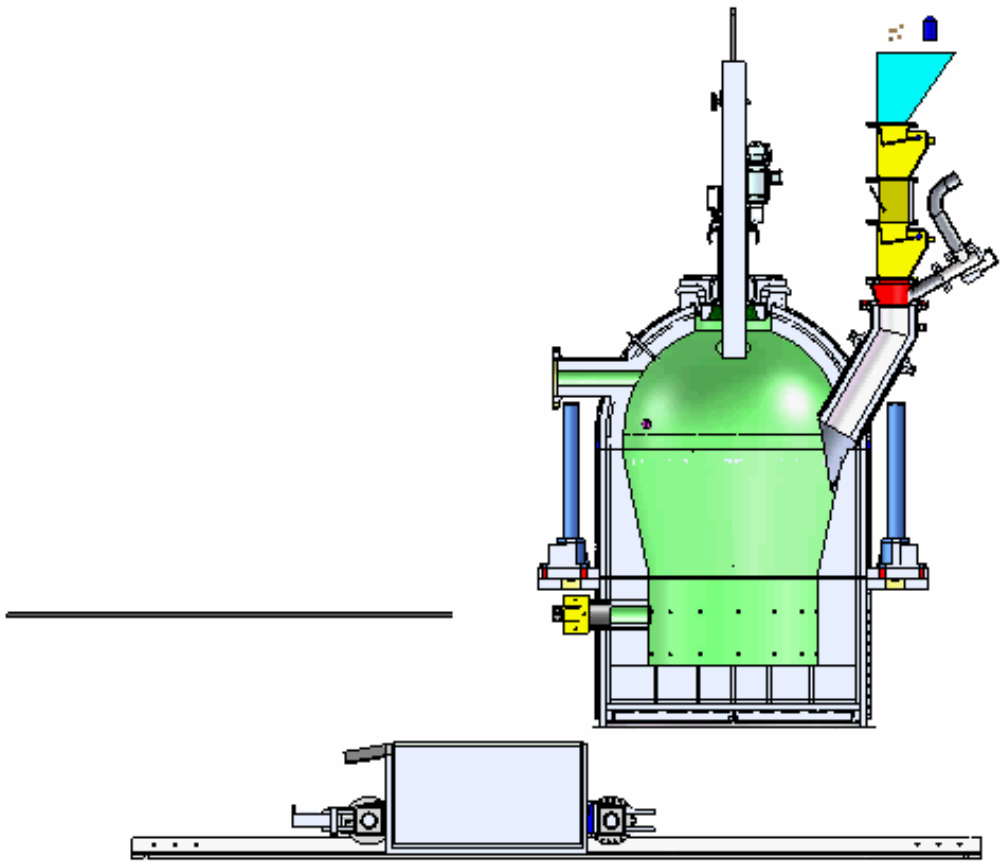
Design Development

- Plasma Arc Treatment Subsystem -



Design Development

- Plasma Arc Treatment Subsystem -



Project Status

- **Tooling Verification Testing**
  - Completed Mar – Apr 06
  - Generic Tooling Successfully Validated
- **CPDS Design Development**
  - Conceptual Designs Completed
  - HAZOP review conducted Nov 06
  - Detailed Designs completed Apr 07
- **Interface Testing**
  - Procurement of feed interface and plasma chamber initiated
  - Development of feed interface test plan undertaken

Future Milestones*

- **FY07-FY08**
  - Procure CPDS feed interface and plasma processing chamber
  - Assemble feed interface and plasma processing chamber and perform interface reliability and maintainability testing
  - Procure remaining system components
- **FY09-FY10**
  - System installation
  - Acceptance Testing
  - CPDS Demonstration/Validation Testing

*Depending on Availability of Funding

Summary

- A prototype system that integrates cryofracture and plasma arc technology for the demilitarization of conventional ammunition has been designed. The system will provide the U.S. Army with the following unique demilitarization capabilities beyond those of Open Burning/Open Detonation, conventional incineration, and other closed-disposal technologies:
  - **Transportable capability to address a variety of site-specific demilitarization requirements**
  - **Safe, environmentally compliant process**
  - **More thorough and reliable destruction of organic and energetic constituents when processing many types of munitions**
  - **Capability to treat a wide variety of munitions with up to 3.0 lbs. NEW (TNT Equivalent) for which other closed-disposal technologies may not be suitable**
- Fabrication and testing efforts are underway