Safety Management Services, Inc.

SUCCESSFUL INTEGRATION OF HAZARDS ANALYSIS METHODOLOGY INTO THE DESIGN, STARTUP, AND OPERATION OF A CRYOFRACTURE DEMILITARIZATION FACILITY

Presented by

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Presentation Outline

- PHA Team and Process Description
- Integration of Hazards Analysis into Process Design and Operations
- Issues and Resolutions
- Summary

PHA Team and Process Description

PHA Team Members

Armament Research, Development and Engineering Center

Defense Ammunition Center

General Atomics

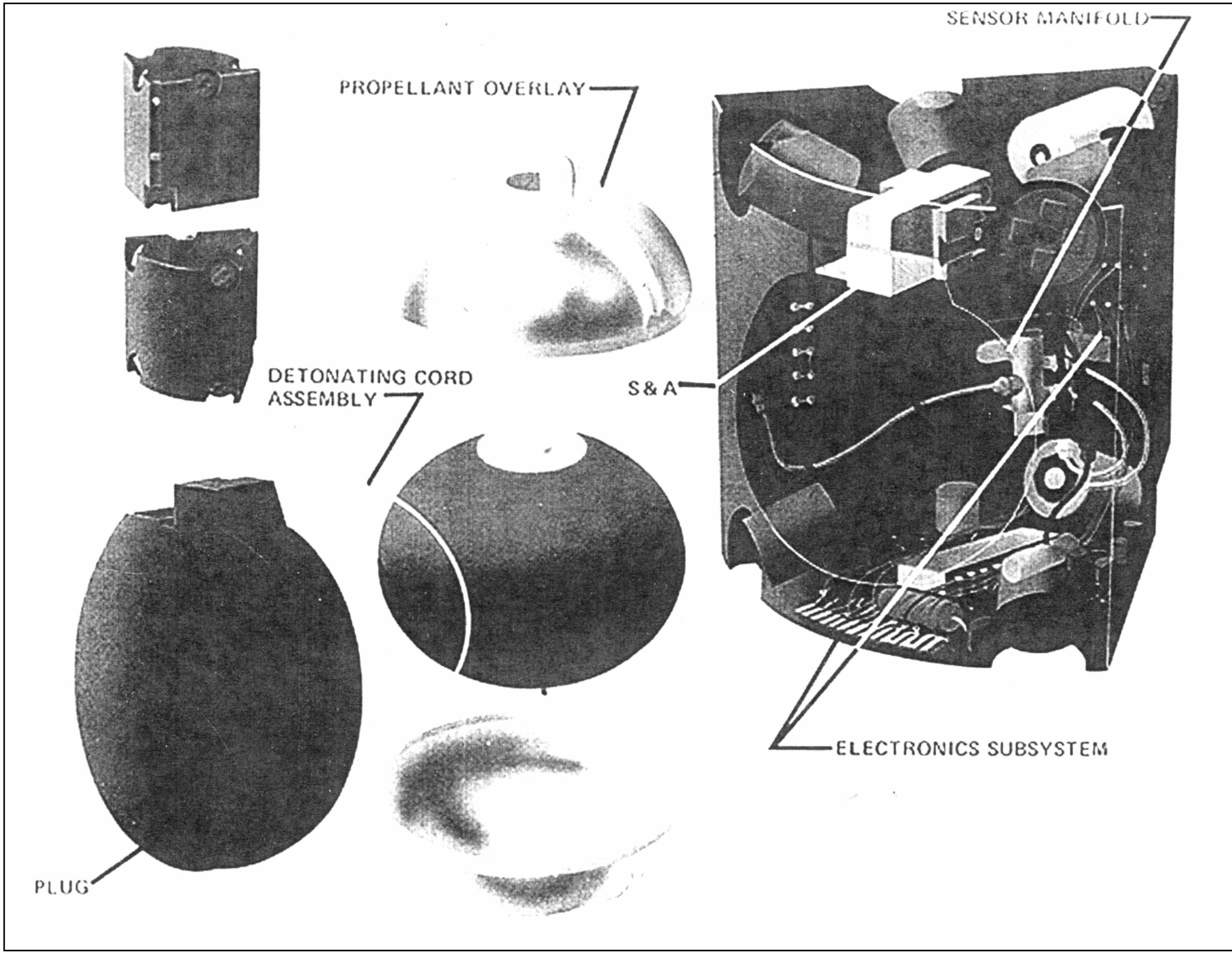
Joint Munitions Command

McAlester Army Ammunition Plant

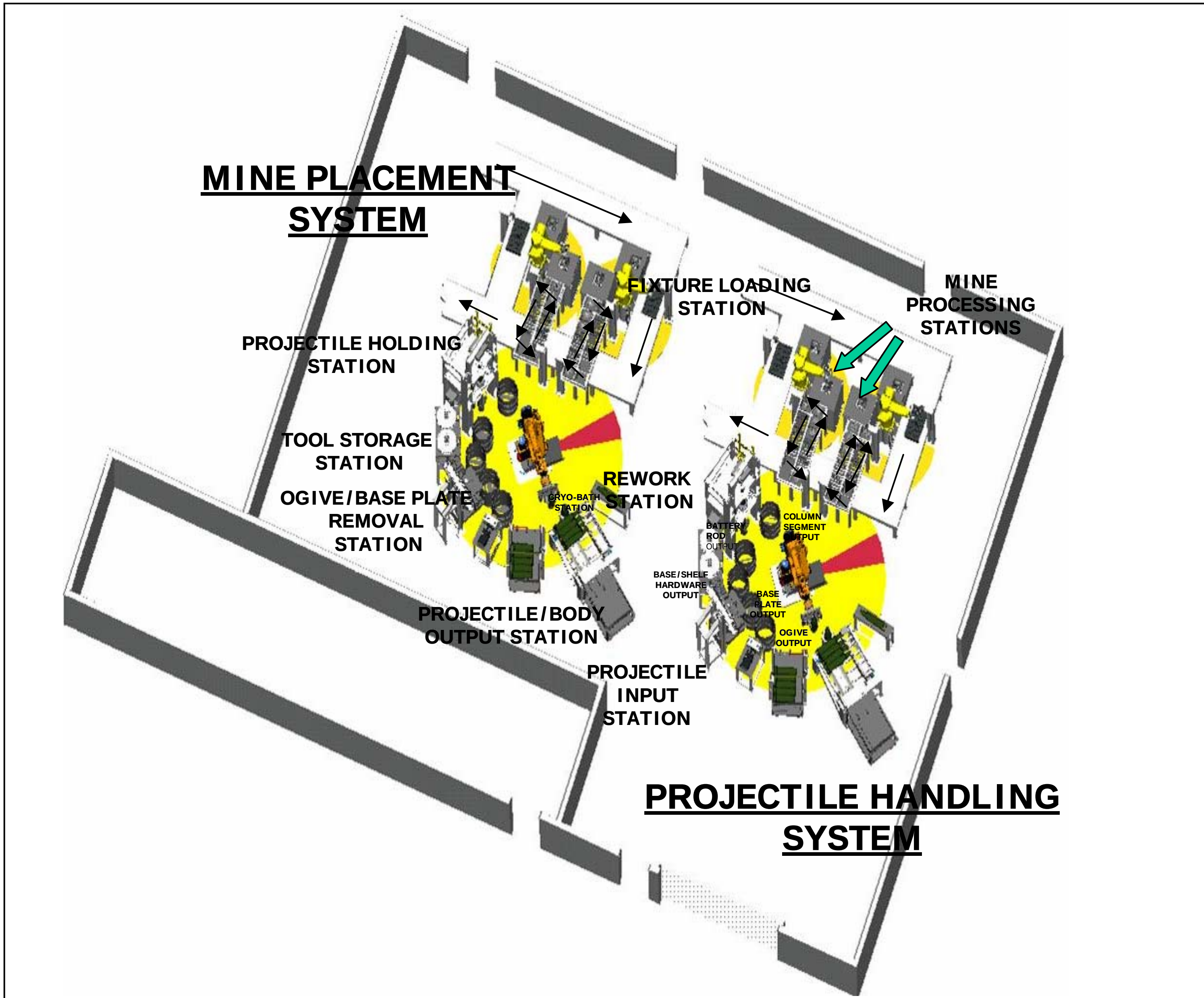
Safety Management Services, Inc.

Sandia National Laboratory

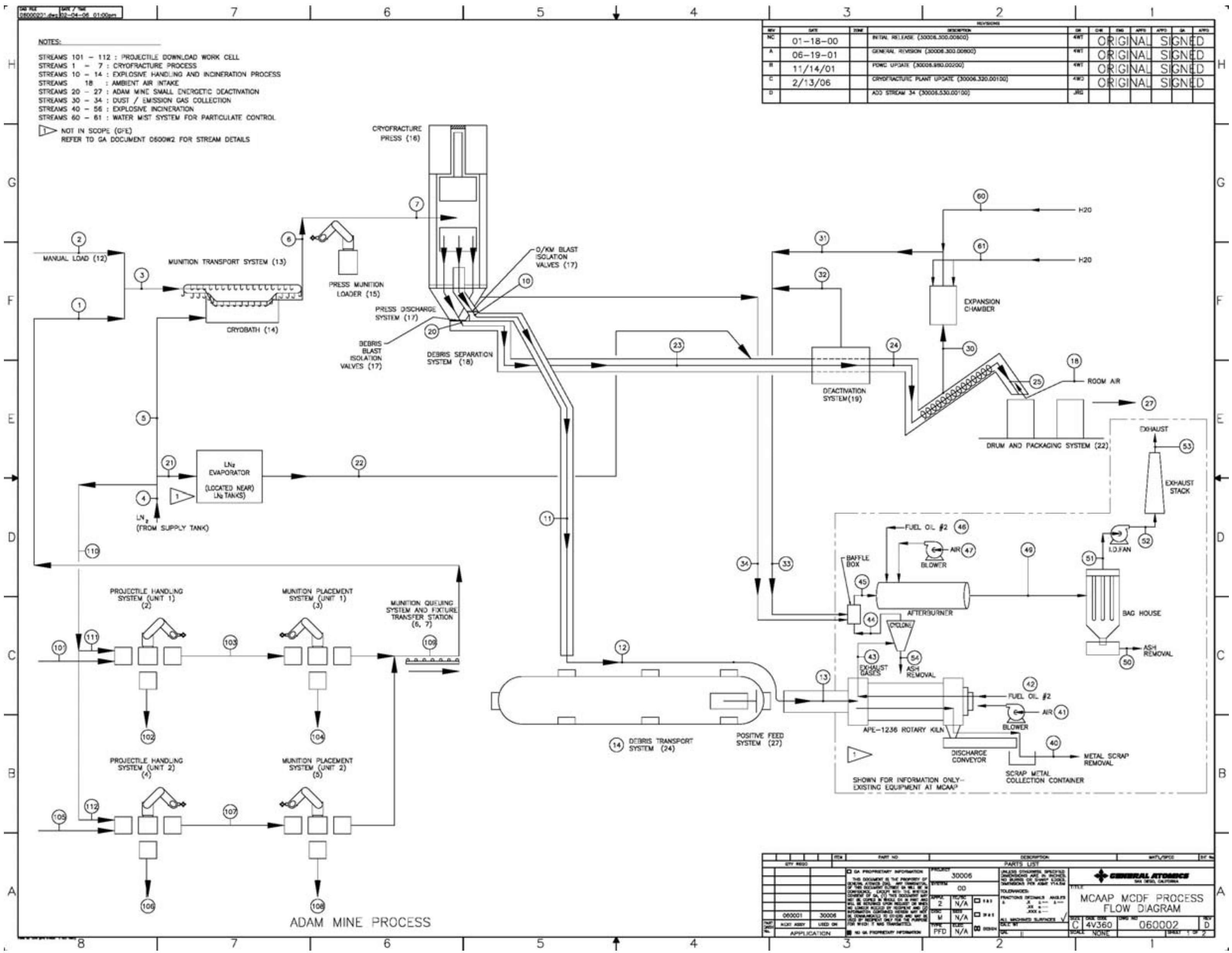
Area Denial Artillery Munitions (ADAM)



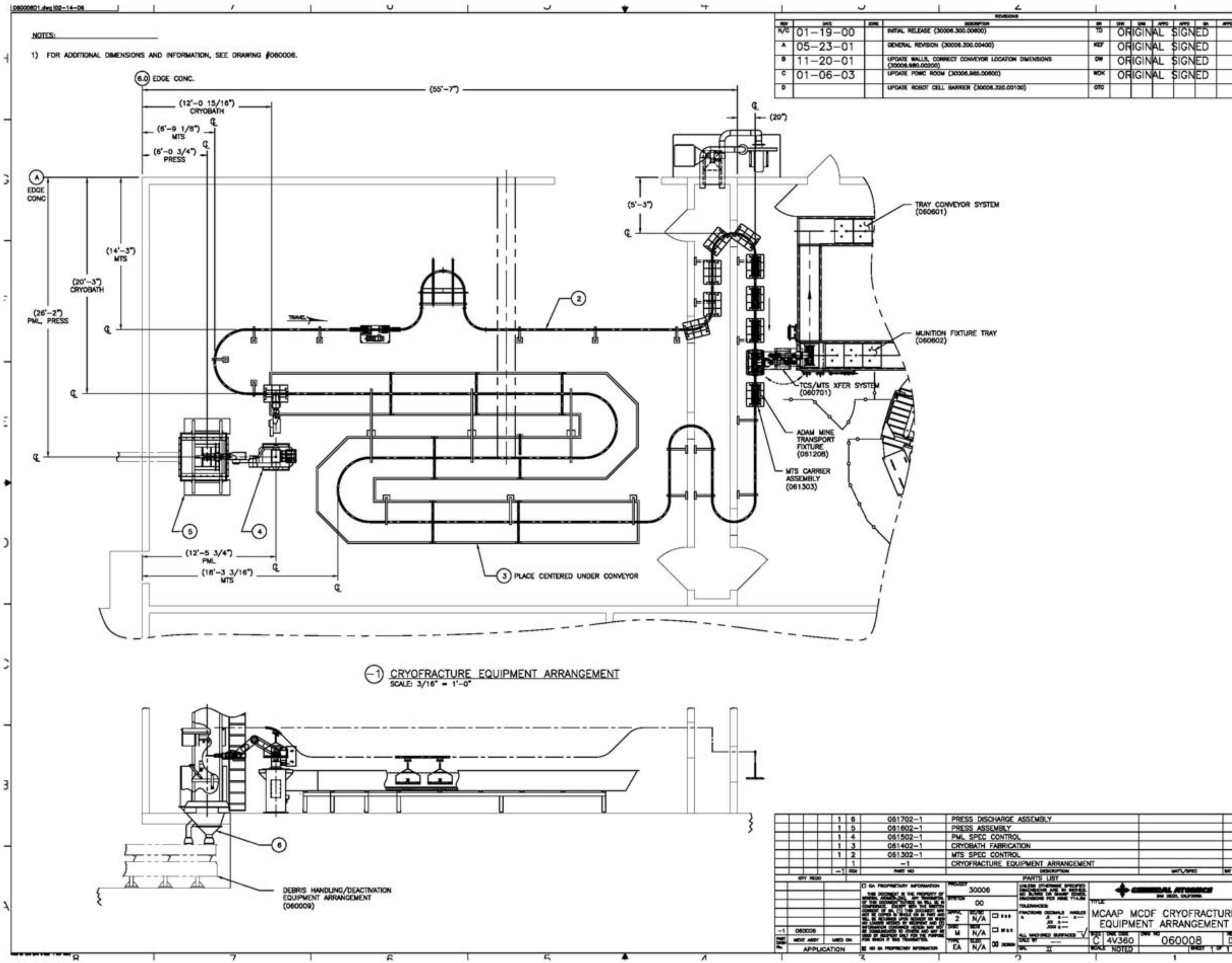
Projectile Download Work Cell



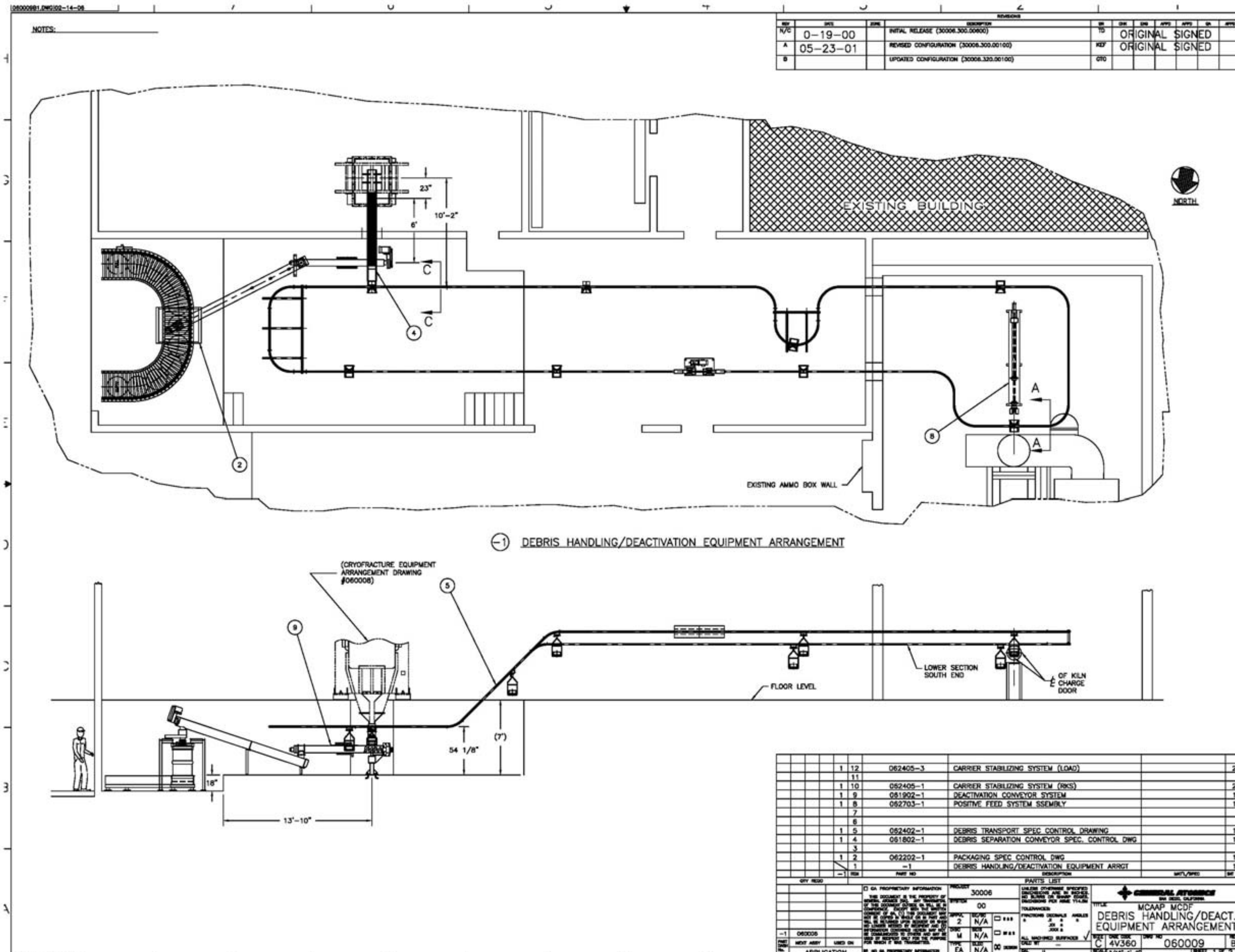
ADAM Mine Cryofracture Process



Cryofracture Equipment Arrangement



Debris Handling/ Deactivation Equipment Arrangement



Integration of Hazards Analysis into Process Design and Operations

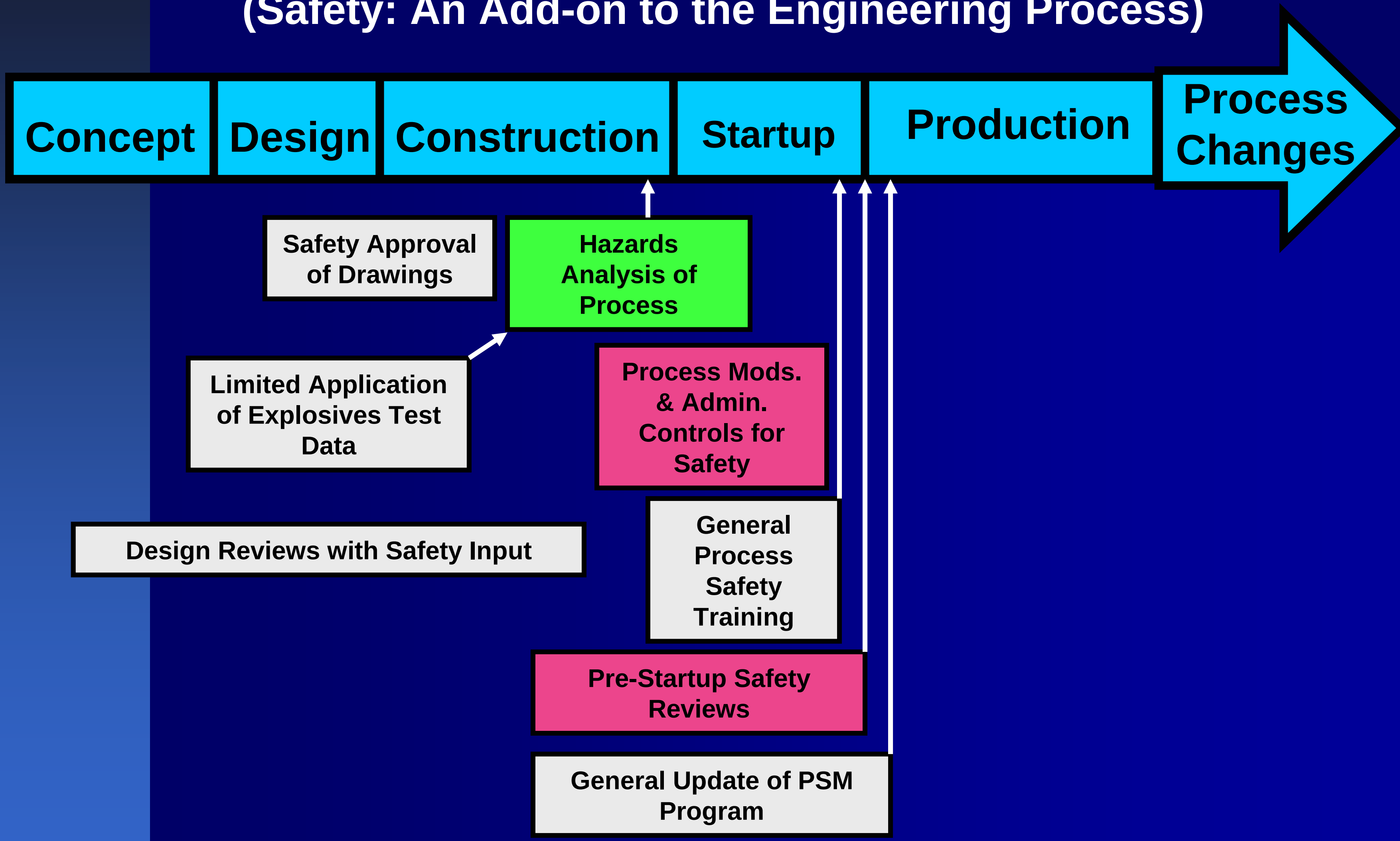
Preliminary Hazards Analysis (PHA)

Objective: Accident Prevention

- Systematic approach to identify, evaluate, and eliminate (or minimize) process hazards
  - Identify potential normal and abnormal failure scenarios
  - Identify risk minimizing solutions that are based on sound engineering principles
  - Ensure these solutions are incorporated into the design and operations of the process

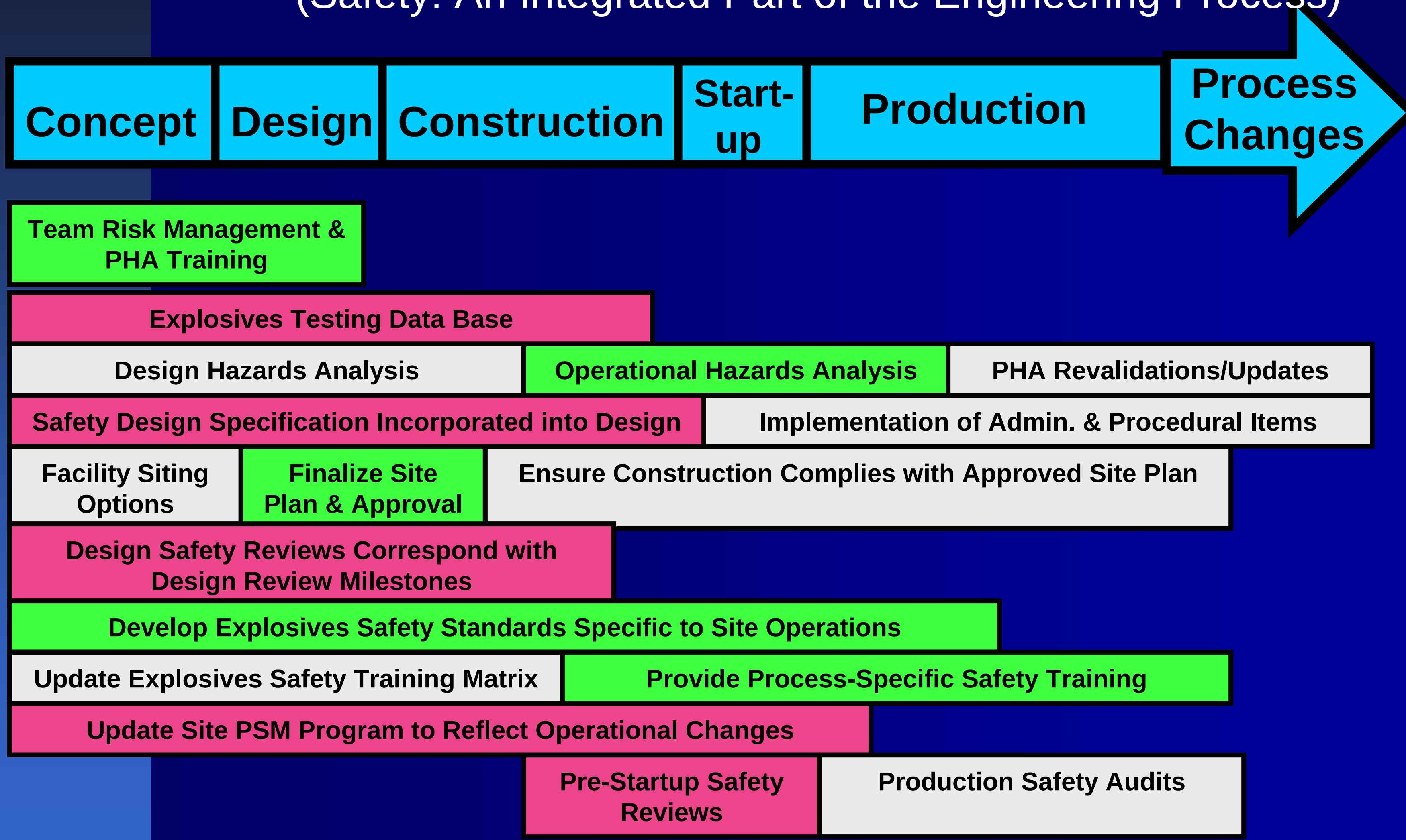
Common Industry Approach

(Safety: An Add-on to the Engineering Process)



The Proactive Systems Approach

(Safety: An Integrated Part of the Engineering Process)



This approach allows for tailoring of design and operation specifications to inherently provide safe operations rather than safety add-ons

PHA Phases of MCDF

Process Phases

Concept | Design | Construction | Start-up | Production | Process Changes

Design Hazards Analysis
DHA

Team Meetings in February 2000, December 2001, and October 2004

Operational Hazards Analysis
OHA

Team Meetings in January 2006

Updated PHA

Team Meetings in May 2006

DHA + OHA = PHA

PHA Team Philosophy

"Safety by Design"

- Minimize Exposure of Personnel
- Minimize Quantities of Hazardous Materials
- Safety Specifications
- Engineering Controls

Standards & Procedures

Training

Approach

1. Utilized Logic Diagrams (Deductive Logic):
   - Identify “Critical Equipment/Components”
   - Evaluate System Interactions
2. Applied HAZOP Methodology (Inductive Logic)
   - Identification of Failure Scenarios & Causes
   - Evaluation of Potential Effects
   - Documentation of System Safety Features
   - Utilized Risk Acceptance Criteria to Prioritize Recommendations
3. PHA Teams Incorporated Safety Design Specifications “Real Time” with Design/ Operation Development
4. Updated PHA and Risk Acceptance Criteria as Design/ Operations Progressed

PHA Focus

- Normal Operations/Conditions
- Abnormal Operations/Conditions
- Human Factors
- Engineering Controls
- Procedures (Including Contingencies)
- Maintenance
- Facility Design & Siting
- Blast Calculations on Press

Potential Failure Scenarios Included:

- Friction
- Impact
- ESD
- Thermal
- Electrical
- Impingement
- Injury of Personnel
- Propagation of Fire/Explosion
- Shock
- Incompatibility
- etc…

Hazard Ranking: Risk Assessment Codes

Hazard Probability	Hazard Severity			
	(I) Catastrophic	(II) Critical	(III) Marginal	(IV) Negligible
(A) **Frequent**	1A	2A	3A	4A
(B) **Likely**	1B	2B	3B	4B
(C) **Occasional**	1C	2C	3C	4C
(D) **Seldom**	1D	2D	3D	4D
(E) **Unlikely**	1E	2E	3E	4E

Risk Categories:

	Extremely High		High		Medium		Low

Issues and Resolutions

Safety Issues

- ***ISSUE***
  - Detonation of mines in the cryofracture press
- ***RESOLUTION***
  - Detonations not likely due to accurate positioning of munitions in press (avoid detonators – just access the energetics)
  - Blast calculations performed to determine the ability of the cryofracture press to withstand detonations

Safety Issues

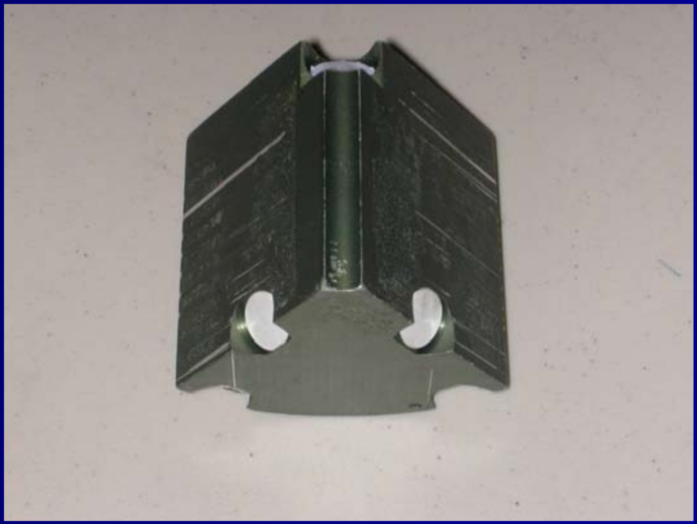
- ***RESOLUTION (cont.)***
  - Design and Procedural requirements
    - Press components were evaluated and all components are within the elastic region during a detonation
    - Establish a formal step-by-step procedure for inspection of the press and supporting equipment after a detonation

Press Blast Calculations

- 6 O/KMs detonating inside the press
- Design press to withstand multiple detonations
- Design containment of fragments

Press Blast Calculations (cont.)

- **Calculations to simulate:**
  - Blast Pressure (Shock Pressure)
  - Quasi Static Pressure (Gas Pressure)
  - Impulses



Press Blast Calculations (cont.)

- **Equipment Response**
  - Die Discharge chutes (including all bolts)
  - O/KM discharge chute (including all bolts)
  - O/KM blast valve (including all bolts)
  - Debris discharge chute (including all bolts)
  - Stop blocks (including all bolts)
  - Press slide
  - Press upper fragmentation shields (2) (including all bolts)
  - Press lower fragmentation shields (2) (including all bolts)
  - Tooling dies

Safety Issues (cont.)

- ***ISSUE***
  - Accumulation of energetic material in the press
- ***RESOLUTION***
  - Initial testing performed to show that while a very small amount of material coating of the interior of the press did occur, buildup and accumulation did not increase over time and remains at a steady state.

Safety Issues (cont.)

- ***ISSUE***
  - Exposure of personnel to liquid nitrogen
- ***RESOLUTION***
  - Remote cryobath operations
  - Oxygen sensors throughout operation including load/unload room
  - Oxygen alarm locally and in control room
  - PDWC cryobath station fill valve has level control to prevent an overfill

Safety Issues (cont.)

- ***RESOLULTION (cont.)***
  - Procedural requirements
    - Only certified and trained individuals may work with liquid nitrogen
    - Procedure for bath maintenance is required including inspection requirements
    - Consider munition cryofracture room as a controlled access at all times
    - Ensure that the oxygen sensors are regularly inspected and verified to be accurately calibrated
    - Ensure that the seals or seam areas of the cryobath are regularly inspected to ensure integrity and that no leaks are present

Safety Issues (cont.)

- ***ISSUE***
  - Dropped munitions or similar problem requiring entry of personnel
- ***RESOLULTION***
  - Two man rule followed to allow operators to monitor each other
  - Proper PPE as determined by MCAAP Safety
  - Only certified explosives and munitions handlers to work in the area
  - Oxygen level monitored and alarmed if low
  - Alarms and lights prevent unauthorized entry into area

Safety Issues (cont.)

- ***RESOLULTION (cont.)***
  - SOP requirements for handling dropped munitions after shutdown, as well as recovery of specific munitions and debris (including if a spool is detected missing, decontamination of munitions, equipment, and area, proper lock-out/ tag-out procedures for entering munition cryofracture room, and a door interlock to alarm and shutdown operations if munition cyrofracture door is opened)

Safety Issues

- ***ISSUE***
  - ESD initiation of mines

- ***RESOLULTION***
  - Ground path associated with anodized aluminum transport fixtures; measurements verify that the fixtures have adequate grounding when in transport.
  - Anti-static belts for conveyor systems and static dissipative brushes in the Mine Processing Station and conveyor systems

Summary

- All engineering design enhancements are <u>incorporated into the design</u> and <u>documented in the HAZOP</u>
- The PHA Team successfully integrated <u>hazards analysis protocol into the design and operation process</u>.
- Accurate & systematic hazards analysis is "KEY" to <u>improve processing</u> and <u>isolate causes of potential mishaps.</u>
- Hazard analysis in parallel with all phases of process development has significant <u>safety and cost avoidance benefits</u>.
- The cryofracture demilitarization facility project reflects <u>"Safety by Design"</u>.

Summary (Cont.)

- Success of project allowed for additional cryofracture demilitarization facilities:
  - Transportable Cryofracture Demilitarization Facility (PHA Team Meetings held in November and December, 2006; DHA submitted in January 2007)
  - Cryofracture Demilitarization Facility at Hawthorne Army Depot (PHA Team Meetings held in February, 2007; DHA submitted in April 2007)