Progress on Recovery of Magnesium from Obsolete Pyrotechnic Flares

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2007 Global Demilitarization Symposium and Exposition
14-17 May 2007
Reno, NV

Project Team

- **Joint Service Partners:**
  - U.S. Army RDECOM-ARDEC
  - U.S. Navy NSWC, Crane Division
  - U.S. Army Crane Army Ammunition Activity
- **Industrial Partners:**
  - TPL, Inc.
  - El Dorado Engineering, Inc.
- **Program Sponsors:**
  - U.S. Army Product Manager for Demilitarization
  - U.S. Army Defense Ammunition Center

Project Objectives

- **Design, build, and operate a prototype process for the recovery of magnesium (Mg) from obsolete or unserviceable illuminating rounds**
- **Requalify and use recovered Mg in new munitions**

Goals

- Reduce demil backlog of illuminating candles
  - Approximately 110,000
- Implement an R^3 effort
  - 350,000 pounds of Mg for reuse or sale
  - 240,000 pounds of sodium nitrate (NaNO3) by-product to sell instead of dispose

Benefits

- Lowers the cost of Mg to DoD customers
  - Estimated savings is up to $10 per pound of Mg
- Avoids incineration and potential environmental impact
- Eliminates single point failure in Mg supply
- Supports PM Demil's R^3 strategic goal

Project Background

- Under a Navy Phase 1 SBIR Project initiated in 1996, TPL developed a bench-scale process to recover Mg from illuminating flare compositions
  - Used anhydrous ammonia to extract $NaNO_3$ and binder
- Process continued to evolve under Phase 2 SBIR, but problems persisted
  - Working with ammonia at required temperatures and pressures
  - Removal of flare composition from candle cases

Project Background (con't)

- **Multi-service interest in recovered Mg fostered Army/Navy partnership in 2000 on Phase III SBIR project funded under Army Demil R&D Program**
  - **Developed pilot-scale waterjet process to remove flare compositions from candle cases**
  - **Switched from ammonia extraction to water extraction; there was no Mg loss to oxide as long as temperature was kept low and contact time was short**
  - **All process steps demonstrated at the pilot-scale by TPL (Waterjet by NSWC)**
  - **Data used to develop a conceptual design for a prototype process**
  - **Recovered Mg successfully tested in M127 Hand Held Signal.**

Results of Waterjet Washout Testing at NSWC-Crane

4.2-inch and 60-mm Illum Flares

Magnesium Recovered in TPL Pilot Plant

Current Program

- **Under the continuing Phase III SBIR Project, a 3-stage effort has been undertaken**
  - **Stage 1: Detailed design of the prototype process**
  - **Stage 2: Procurement, fabrication and shipment of prototype process equipment to CAAA**
  - **Stage 3: Installation, start-up, demonstration and validation**
- **El Dorado Engineering selected as the engineering contactor**
- **Process will transition to support demil workload in FY 09.**

General Requirements for Prototype Process

- One or two ten-hour shifts per day
- Recover 300 lbs of specification grade Mg for each shift
- Capability to process candles from 14 types of munitions

60-mm Mortars	155-mm Projectiles
81-mm Mortars	2.75” Rockets
4.2” Mortars	Mk 45 Aircraft Flares
105-mm Projectiles	LUU 2B/B Aircraft Flares

- Safely handle any hydrogen generation as well as all waste streams

Current Status

- Building at CAAA has been selected
- Detailed design is complete
- Procurement and fabrication of prototype equipment is nearly completed
- Equipment arriving at CAAA
- Installation at CAAA targeted for Q1 of FY08
  - Delayed due to change in building location

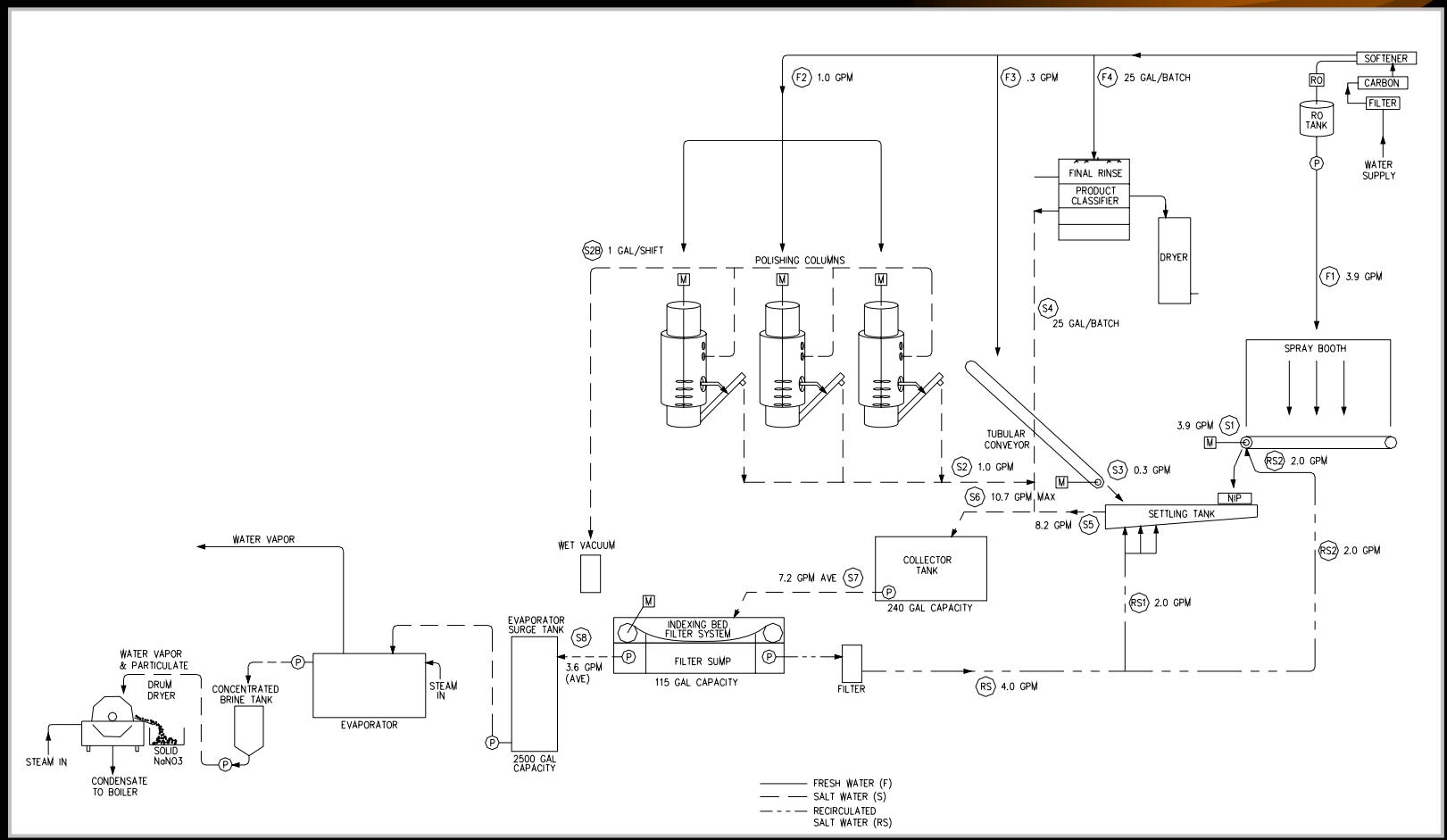
Magnesium Recovery Prototype Plant

- **The MRPP consists of all the required equipment to:**
  - **Remove illuminant from a wide variety of military flares**
  - **Separate & recover magnesium in a directly usable form**
  - **Separate & recover sodium nitrate for reuse**

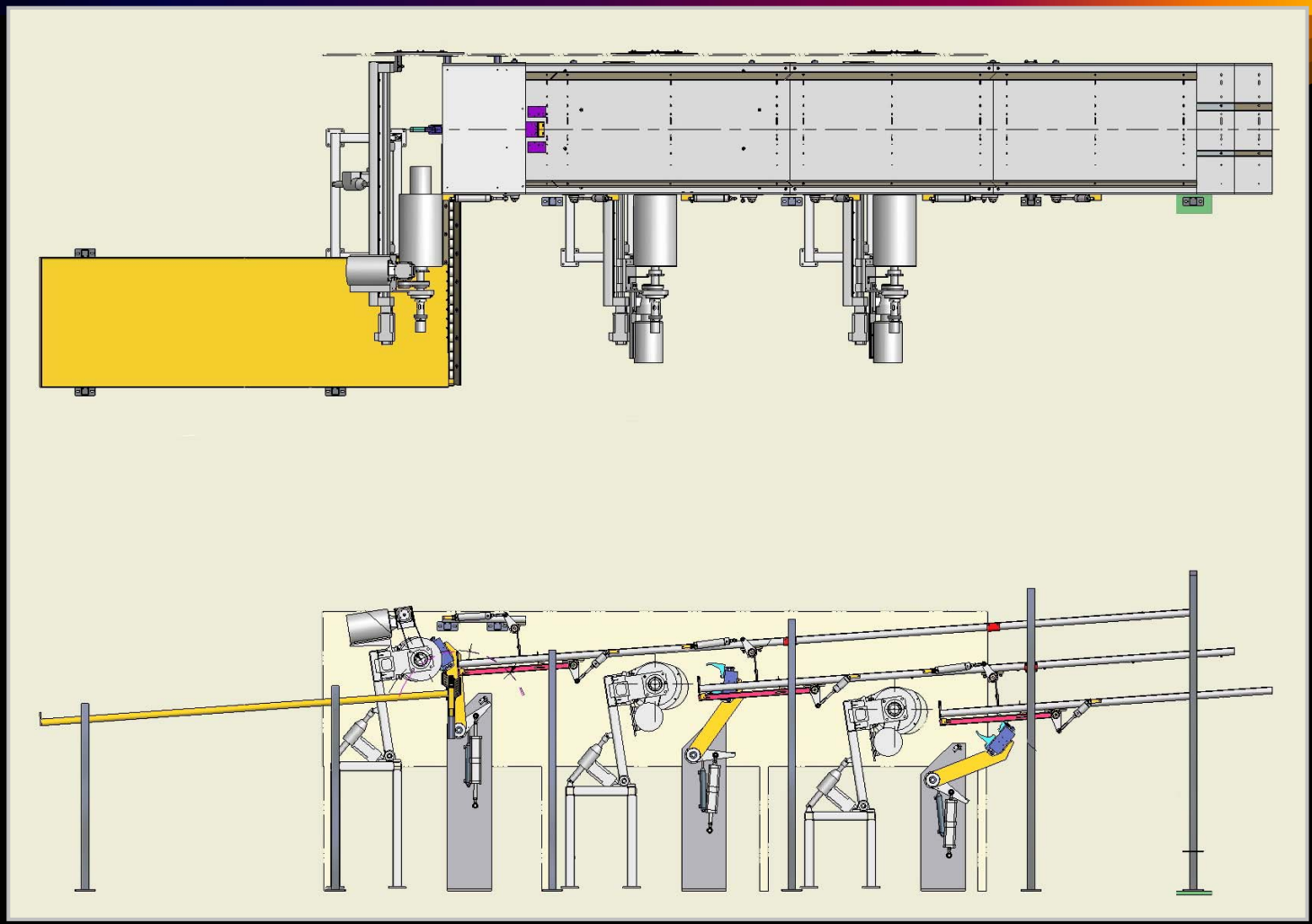
Magnesium Recovery Prototype Plant

- The MRPP equipment is sized to produce 300 lbs of Mg / shift
- This requires a wide range of production rates
  - 60 mm M83A3 — 1,129 / shift
  - 4.2 M335A2 — 276 / shift
  - 105 mm M314A2 — 372 / shift
  - 155 mm M118A2 — 129 / shift
  - LUU2 — 26 / shift

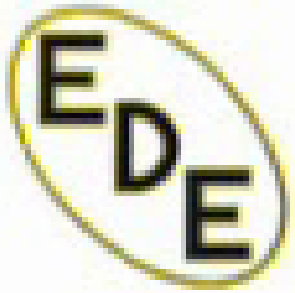
Magnesium Recovery Prototype Plant Equipment Layout



Magnesium Recovery Prototype Plant
Candle Handling System



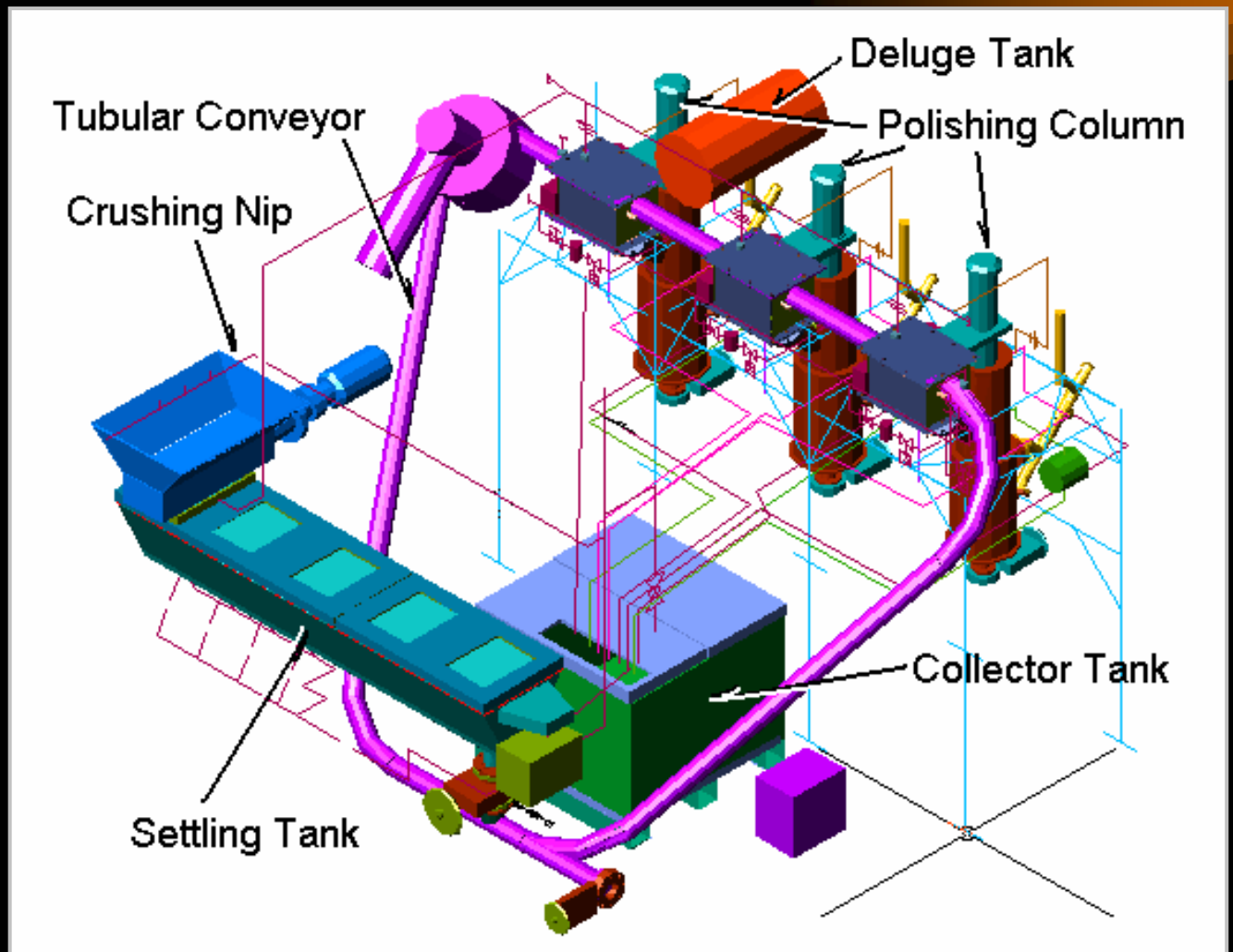
TPL CANDLE HANDLING SYSTEM AND ROTARY CHUCK



EL DORADO ENGINEERING, INC.
SALT LAKE CITY, UT

19 April 2006

Magnesium Recovery System Plant
Tubular Drag Conveyor



Polishing Columns

Polishing Columns

Settling Tank

MRPP Project Status

• Polishing Columns/Mixer Motors	Complete	Shipped
• Settling Tank	Complete	Shipped
• Tubular Conveyor	Complete	Shipped
• Spray Booth	Complete	

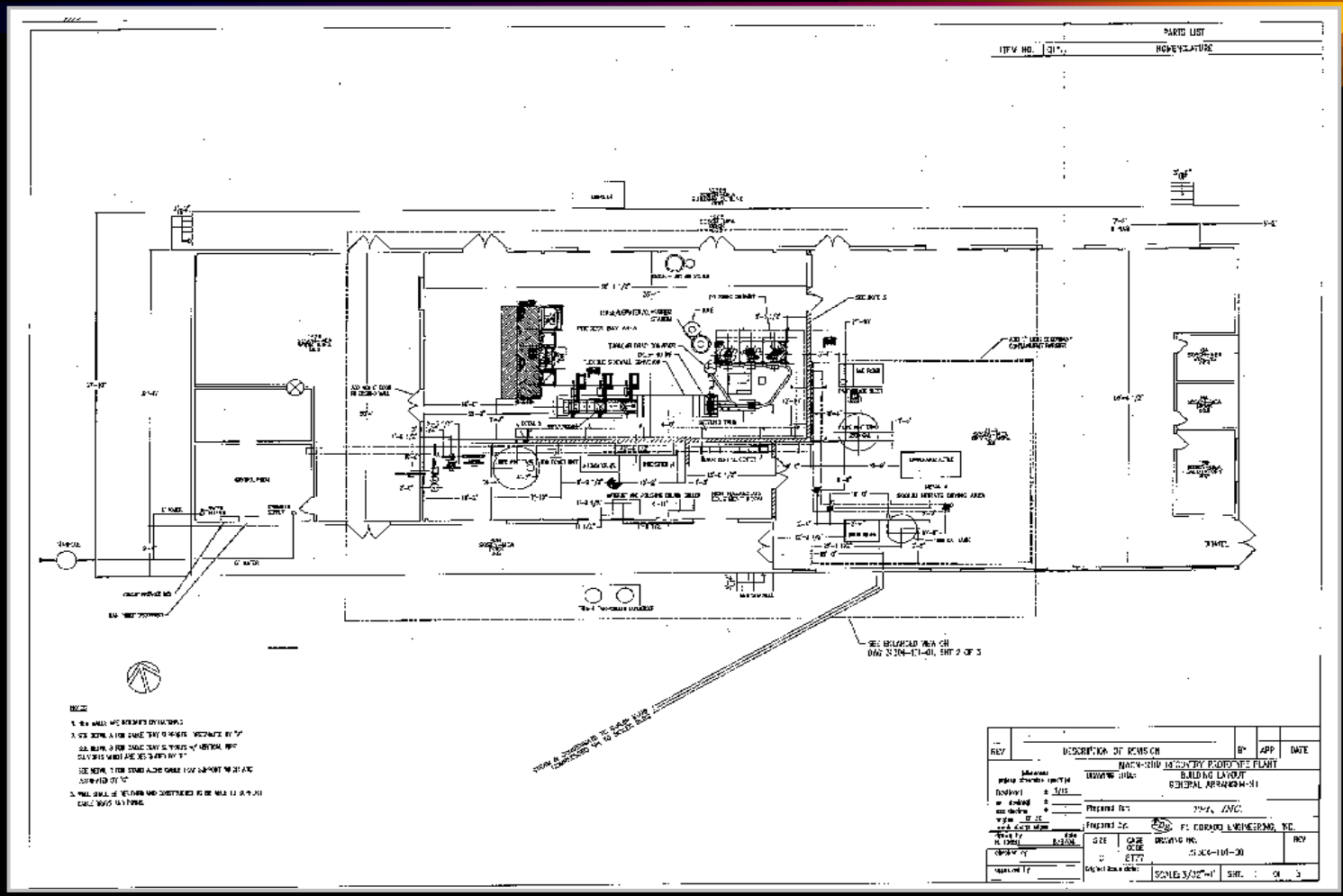
  – *Items above assembled and mechanical fit up completed*

• Preparation Area	In Production
• Candle Handling & Rotary chuck	Being Fabricated

MRPP Project Status (Con't)

- Water Treatment System — Ordered
- Waterjet Cutting
  - Pumps — Ordered
  - Chiller — Complete
- Flexible Sidewall Conveyor — Ordered
- Metal Separator — Ordered
- Crushing Nip — Ordered
- Deluge Tank — Complete
- Final Rinse/dewater/classifier — Mostly Ordered
- NaN03 Recovery — Mostly Ordered
- Hydrogen System — Complete

Old Layout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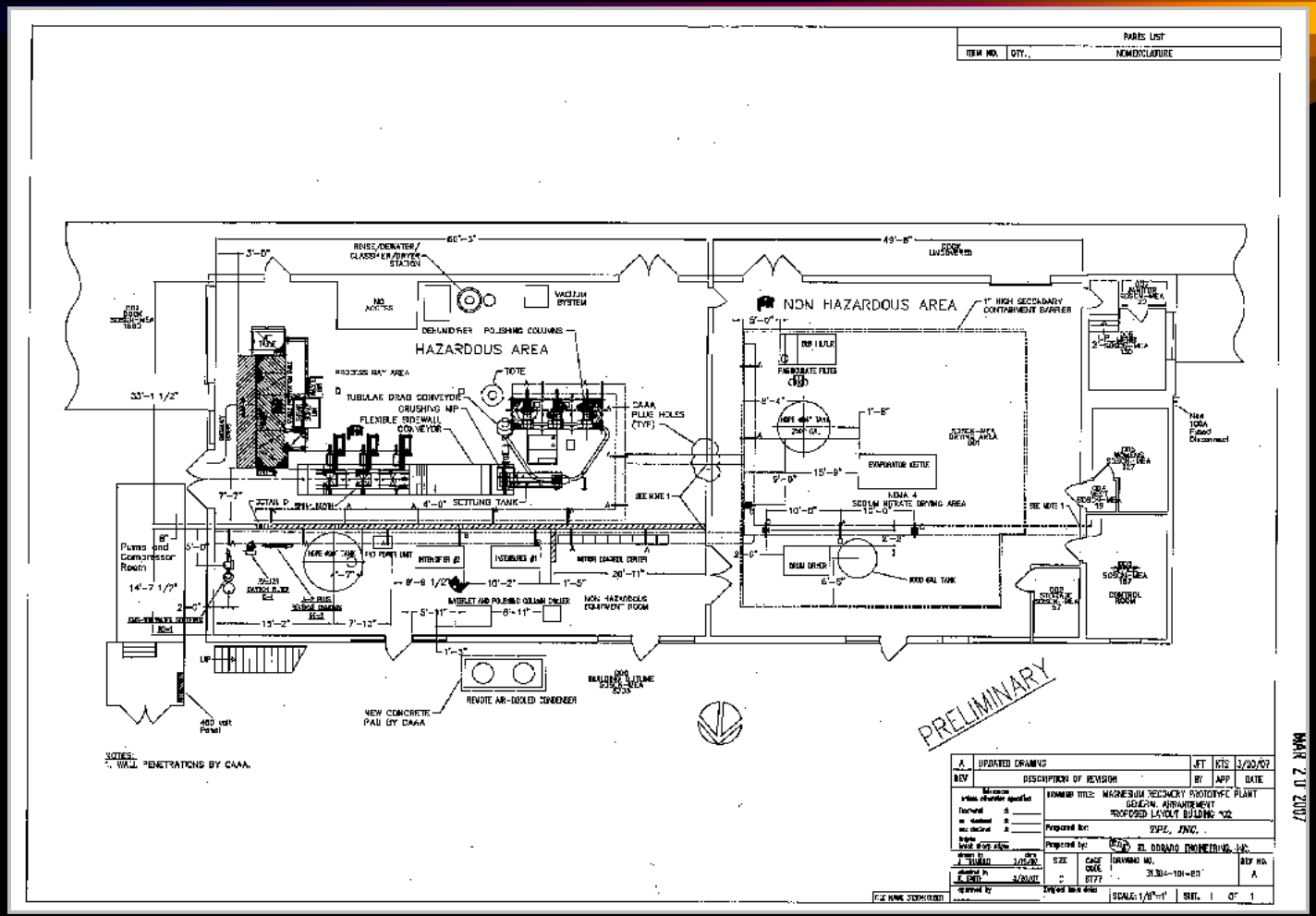
ITEM NO.
NOMENCLATURE
BUILDING LAYOUT
GENERAL ARRANGEMENT
SCALE 3/32"=1'

New Layout


PARTS LIST
ITEM NO.
QTY.
NOMENCLATURE
HAZARDOUS AREA
NON HAZARDOUS AREA
1" HIGH SECONDARY CONTAINMENT BARRIER
DEHUMIDIFIER
POLISHING COLUMNS
VACUUM SYSTEM
TOTE
TUBULAR DRAG CONVEYOR
CRUSHING MP
FLEXIBLE SIDEWALL CONVEYOR
CAAA PLUG HOLES (TYP.)
4'-0" SETTLING TANK
EVAPORATOR KETTLE
SODIUM NITRATE DRYING AREA
DRUM DRYER
WOOD GAL TANK
Pump and Compressor Room
480 volt Panel
NEW CONCRETE PAD BY CAAA
REMOTE AIR-COOLED CONDENSER
NON-HAZARDOUS EQUIPMENT ROOM
CONTROL ROOM
PRELIMINARY
NOTES:
1. WALL PENETRATIONS BY CAAA.
UPDATED DRAWING
DESCRIPTION OF REVISION
DRAWING TITLE: MAGNESIUM RECOVERY PROTOTYPE PLANT
GENERAL ARRANGEMENT
PROPOSED LAYOUT BUILDING 102
Prepared for: TPE, INC.
Prepared by: EL DORADO ENGINEERING, INC.
DRAWING NO. 31304-101-E01
SCALE: 1/8"=1'
SHT. 1 OF 1
MAR 20 2007

Summary

- Mg can be recovered via water extraction and purified by agitation in water
- Optimization of the pilot plant has reduced cost to recover Mg
- Customer support has been obtained in both Army and Navy for reuse in illumination rounds, signals, trip flares, and tracers
- Prototype facility start-up is planned for CAAA in FY 08
- Implementation of this technology avoids incineration, implements R^3 and provides the Services with cost-effective source of Mg that is no longer dependant on a sole source of supply.