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# Development of a Reproducible Process for Loading Spider Grenade Bodies with Picatinny Arsenal Explosive (PAX) – 41

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# Outline

- Background
  - Picatinny Arsenal Explosive (PAX) – 41
  - Spider Grenades
  - MANTECH Program
- Full Factorial Design of Experiments (DOE)
- The Melt Pour Process
- Test & Results
- Summary
- Questions

# Background

- Picatinny Arsenal Explosive (PAX) – 41
  - A melt pour High Explosive was developed under the U.S. Army's Insensitive Munition (IM) Program by ARDEC and Thiokol Corporation
  - BAE Systems at Holston AAP qualified a process for its manufacture on a large scale
  - The Project Manager for Close Combat Systems (PM CCS) executed a program to utilize PAX-41 in the Spider grenade system
  - MANTECH program provided funding to evaluate the impact of processing parameters on cast quality and to develop a robust process for loading PAX-41. The intent is to transition this technology to Milan AAP in support of production.

# Picatinny Arsenal Explosive (PAX) - 41

PAX-41 nominal formulation

DNAN

MNA

RDX (coarse)

RDX (fine)

PAX-41 Key Property

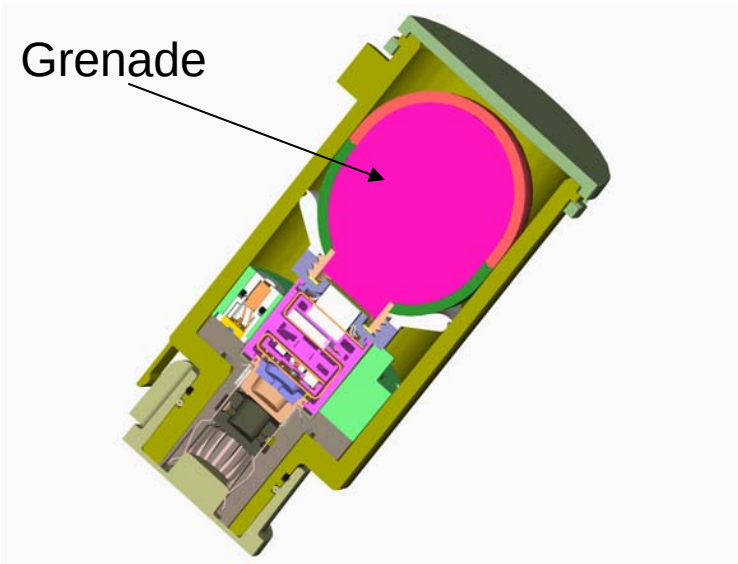
M.P. 90±5 ºC

*Specified by AR-PD-138, dated 21 Jun 05*

# Background (Cont'd.)



- Spider Grenades
  - Utilize PAX-41 Fill
  - Component of the Spider System



# Background (Cont'd.)

- MANTECH Program
  - Ensure Seamless Transition of PAX-41 Loading Development to High Rate Production
  - Initiated by ARDEC and PM CCS to Perform Full Factorial Load Study
  - Load Study to Optimize Cast Quality, Cost and Performance
  - Loading Process Key Considerations
    - Robustness
    - Reproducibility
    - Production Rate
    - Minimization of Riser Scrap
  - Follow-on effort to reduce pour fixture weight and to increase throughput

# Full Factorial Design of Experiment Matrix

| Explosive Pour Temp | Fixture/Metal Part Preheat Temp | Controlled Cooling Temp | Cooling Cycle Time |
|---|---|---|---|
| High | High | High | Slow |
| Low | High | High | Slow |
| High | Low | High | Slow |
| Low | High | High | Fast |
| High | High | Low | Slow |
| Low | Low | Low | Slow |
| Low | Low | High | Slow |
| High | Low | Low | Fast |
| Low | Low | High | Fast |
| High | High | Low | Fast |
| High | Low | High | Fast |
| Low | Low | Low | Fast |
| High | Low | Low | Slow |
| Low | High | Low | Slow |
| Low | High | Low | Fast |
| High | High | High | Fast |

# The Melt Pour Process
## (In Conjunction with Radiographic Inspection)



- **Conditioning**
  - **Grenade Bodies and Loading Fixtures Pre-heated to Ensure PAX-41 does not Drop below Melting Point Before it Fills the Grenades are Completely Filled**
- **Melting**
  - **PAX-41 Heated and Melted to Desired Temperature to Ensure a Smooth Pour into Grenade Bodies**
- **Pour**
  - **PAX-41 Poured from Kettle Nozzles Into Conditioned Fixture at a Rate to Ensure that it Flows Evenly Throughout the Fixture**
- **Cooling**
  - **Optimum Controlled Cooling Cycle Parameters will be Determined to Ensure Good Cast Quality**
- **Radiographic Inspection**
  - **Requirements Based on Load Study**

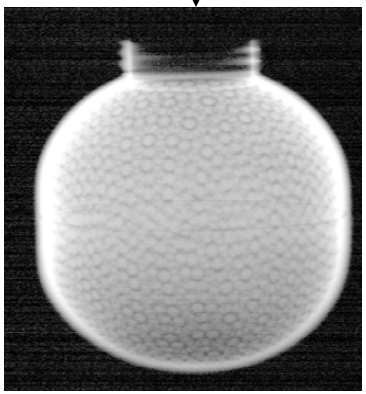
# The Melt Pour Process

Melting

Conditioning

Pouring

Cooling



Inspection

# Test Parameters & Results



Test Parameters

- Explosive Pour Temperature
  - 215.4 °F
- Fixture/Metal Part Preheat Temperature
  - 211.0 °F
- Controlled Cooling Temperature (Mortar Oven)
  - 252.0 °F (Left), 250.0 °F (Top), 254.0 °F (Right)
- Cooling Cycle Time
  - 30 Minutes

# Test Parameters & Results (Cont'd.)



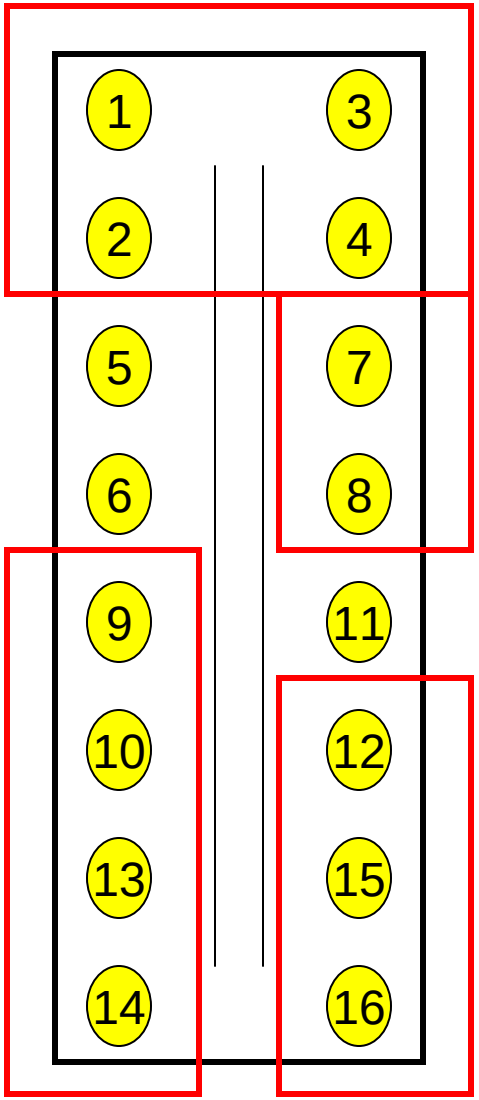
## Results

- Radiographic Inspections Performed
  - Sixteen (16) Spider Grenade Bodies with PAX-41
  - GE-150 Titan Unit
  - 0° and 90° Orientations
- Fine explosive cast details were difficult to see because of Moiré interference patterns from the Fragmentation Liner

# Test Parameters & Results

| Spider S/N | Observations |
|---|---|
| 1 | (1) Small Cavity Top Half |
| 2 | (1) Small Cavity Top Half |
| 3 | (1) Small Cavity Middle |
| 4 | (1) Small Cavity Top Half |
| 5 | No Indications |
| 6 | No Indications |
| 7 | (1) Large Cavity Top Half |
| 8 | (1) Medium Cavity Top Half |
| 9 | (1) Medium Cavity Middle, Low Fill |
| 10 | (1) Medium Cavity Top Half |
| 11 | No Indications |
| 12 | (1) Small Cavity Top Half |
| 13 | (1) Small Cavity Top Half |
| 14 | (1) Small and (1) Medium Cavities Top Half |
| 15 | (1) Small Cavity Top Half |
| 16 | (2) Medium Cavities Top Half |

# Fixture Layout (Top View)



# Summary

- Test Results will Identify All Parameters to Effectively and Efficiently Load SPIDER Grenades with PAX-41
- Test Results May Reveal Necessary Enhancements to Equipment as well as Loading Techniques
- Preliminary Study Necessary for Baseline
- ARDEC Assist with Development of Optimized Production Process for American Ordnance that will Ensure High Quality Casts, Allowing for On-Time Delivery with Minimal Scrap and Rework
- American Ordnance in Process of Facilitizing to Load Spider Grenades
- ARDEC to Provide PAX-41, Grenade Bodies and Funding to Repeat Full Factorial Design of Experiments to Optimize Pour Parameters

# Questions