IMX-101 HE LOADING OF 155MM PROJECTILES
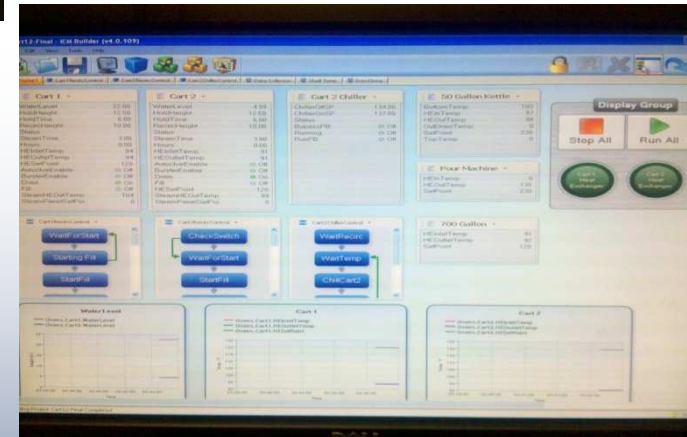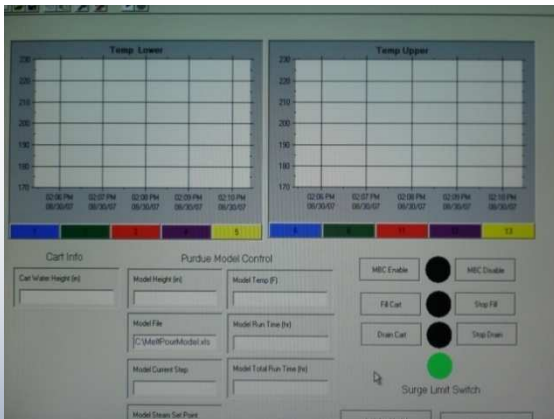## Erik Boykin
NDIA-IMEM 2010

OUTLINE

- ➢ **IM Loading Equipment**
- ➢ **Historical Data**
- ➢ **DoE IM Loading Processes**

ARDEC LOADING EQUIPMENT

> ➤ **Modern melt pour equipment with Intelligence Control Modeling System (ICM) which utilizes cart water level sensors, thermocouples, data collectors, and real time control screens to develop loading processes.**

Historical IM loading data

➢ **Data derived from 57 loading trials**
  ✓ **Loaded 478 projectiles**
  ✓ **262 each X-ray acceptable**

➢ **Analysis of the data**
  ✓ **No direct correlation between a single parameter and quality of rounds.**

➢ **Review of X-ray data shows porosity present in all rounds, including acceptable rounds**
  ✓ **Issue was not completely resolved**
  ✓ **Acceptable rounds were on the margin**

Path Forward - Objective

➢ **Establish a robust IMX-101 melt pour process for 155mm M795 projectiles.**

➢ **Conduct DoE to obtain data that provides information regarding the cause and effect relationship between L/A/P process parameters and porosity.**
  - ✓ **Conduct confirmation runs**

➢ **DoE developed in conjunction with**
  - • **American Ordinance (Loading contractor for high volume production)**
  - • **BAE (Explosive manufacturer)**

DoE Parameters

- **Factors**
  - ✓ **Pour Temperature**
  - ✓ **Cooling water Temp**
  - ✓ **Cart water height**
  - ✓ **Funnel design**

- **DoE Design Full Factorial - 2^4 – 16 runs – 4k lbs of IMX-101 + 2 midpoints**

  - ✓ **Each run consists of 8 rounds**
    - • **Thermocouple round will be in all runs**
  - ✓ **4 each 1,200 Lbs IMX Lots will be required**
    - • **4 lots will be blended to eliminate lot variances**

Full Factorial DOE w/ Center PT

Factors:

		L	H
A - Pour Temp		L	H
B - Cooling Water Temp		L	H
C - Cart Water Height		L	H
D – Funnel design		S	T

Std Order	Run Order	Center Pt	Blocks	Pour Temp	Cooling Water Temp	Cart Water Ht (in)	Funnel
2	1	1	1	Hi	L	L	S
9	2	1	1	L	L	L	T
11	3	1	1	L	H	L	T
5	4	1	1	L	L	H	S
13	5	1	1	L	L	H	T
18	**6**	**0**	**1**	**M**	**M**	**M**	**T**
4	7	1	1	H	H	L	S
7	8	1	1	L	H	H	S
15	9	1	1	L	H	H	T
6	10	1	1	H	L	H	S
17	**11**	**0**	**1**	**M**	**M**	**M**	**S**
12	12	1	1	H	H	L	T
10	13	1	1	H	L	L	T
16	14	1	1	H	H	H	T
8	15	1	1	H	H	H	S
3	16	1	1	L	H	L	S
14	17	1	1	H	L	H	T
1	H	1	1	L	L	L	S

IMX-101 Thermocouple Round
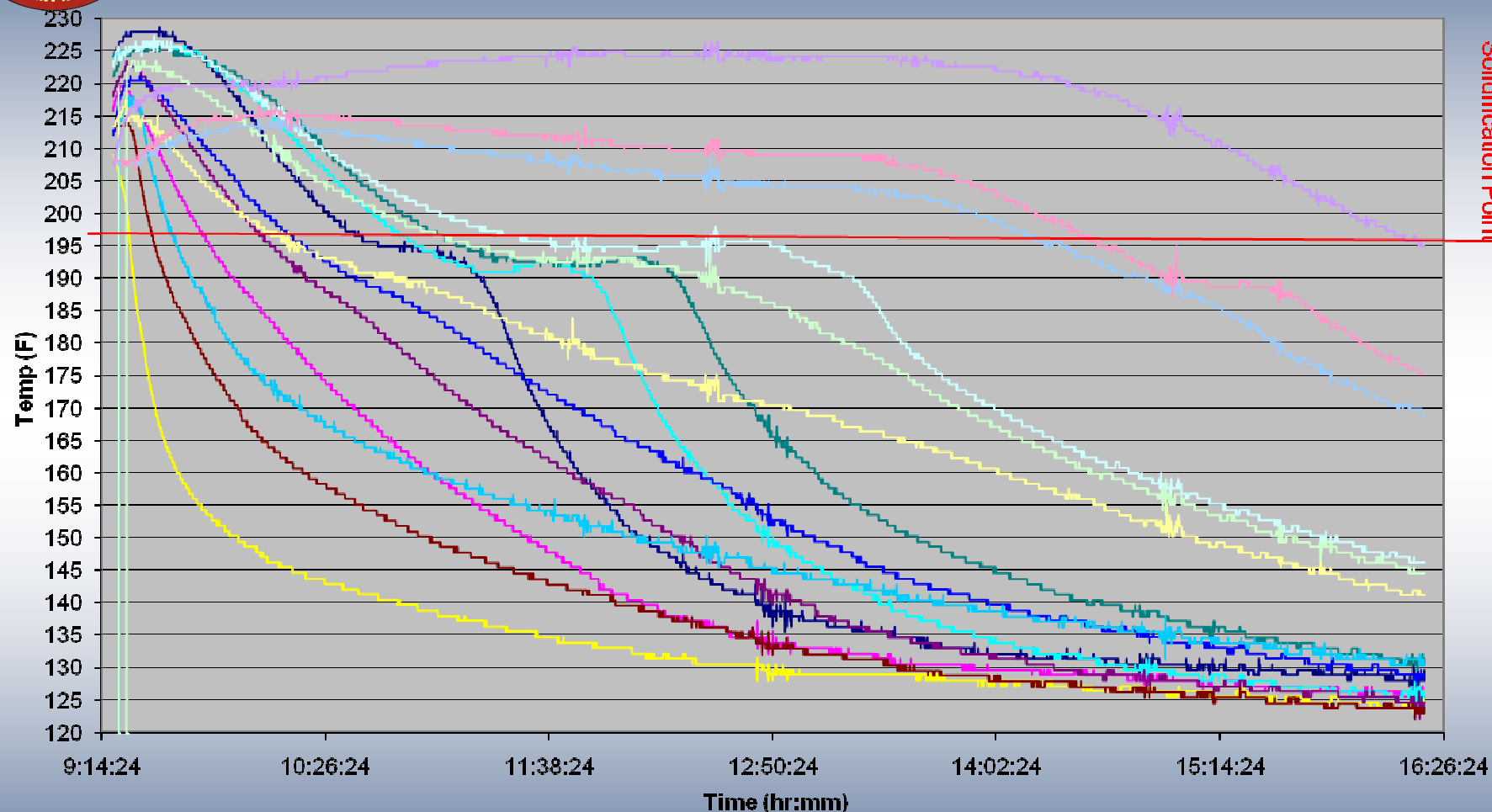
DoE Observations

➢ **Process adjustments made the IMX-101 DoE material significantly smoother**

➢ **Material exhibited less porosity defects (4 of 112)**
  ✓ **Material was heated and mixed at higher temps**

➢ **No significant difference can be made utilizing the different funnel designs**
  ✓ **Results indicate that the existing funnels at loading contractor are adequate.**

DoE Confirmation

➢ **DoE data analysis established confirmation parameters**

➢ **2 confirmation runs of 8 rounds each**
➢ **2 confirmation runs of 16 rounds each**

  ✓ **All 48 rounds were acceptable**

➢ **Loading parameters transitioned to American Ordnance**

Summary

➢ **To establish optimum loading parameters for explosive formulations the use of data acquisition and tightly monitored process control is required**

➢ **A systematic approach to solve casting defects was successfully demonstrated**

➢ **DoE resulted in development of loading parameters for IMX-101 that can transitioned to the industrial base**