Production Hardware-in-the-Loop Missile Testing:
Past, Present, and Future

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Agenda

- Traditional QALVT Approach
- Longbow HELLFIRE STAF
- Process Improvements
- AMSTAR Production Facility
Traditional QALVT Approach

- QALVT – Quality Assurance Lot Verification Testing
  - Sampling-based test program to determine if production lots of munitions meet quality standards (“Fly-to-buy”)
  - Both non-destructive and destructive testing can be very expensive
- More complex missiles led to two problems:
  - Increased cost – more expensive missiles to buy and destroy
  - Increased risk/Decreased confidence – a missile with multiple modes of operation can only be fired in one of those modes
Alternate QALVT Approach

• Leveraging Simulation-based Hardware-in-the-Loop (HWIL) techniques could reduce risk and volume of flight tests
  • Provides a system-level test without energetics
  • Missiles are developed using HWIL simulations – utilize the development testability features for acceptance testing
  • Can never completely replace live fire testing
• First facility to explore this QALVT approach was the Longbow HELLFIRE Simulation Test Acceptance Facility (STAF) at Redstone Arsenal
First All-Up-Round Missile Hardware-in-the-Loop Production Acceptance Facility

- Tactically Configured Missile with Energetics (Warheads and Motor)
- Simulated MMW (Ka band) Scene & 3-Axis Missile Motion
- QALVT (1997-2006)
  - QALVT Tested 746 Rounds Total
  - Performed all Lot Acceptance Testing on Longbow Missile (6 Missiles / Month)
  - Saved U.S. Army Approximately $8M / Year over Traditional Fly-to-Buy Acceptance
SRP (2006 – Present)

- Stockpile Reliability Testing of over 1800 Missiles Since 2006
- Throughput Steadily Increasing – Many Lessons Learned for Doing Large Quantity HWIL with Explosive Items
- Tested over 500 Rounds in FY15
- Can Test at Temperature Extremes
Process Improvements

Challenges:

• Stockpile Reliability Program (SRP) Plan specified a 350 round/year workload to recertify Longbow to extend shelflife
  • Substantially more than 6/month for QALVT testing
• Had been sufficient to only test 3 rounds at a time during QALVT
• All missile handling including instrumentation handled outside of STAF
• Too many steps in process
Process Improvements

Solutions:

• STAF requires that an instrumentation board be installed in missile prior to test
  • Upgraded instrumentation design away from obsolete design and mass produced so that more than 3 rounds could be modified at a time
    • Increased spares, reduced coupling between steps in the logistics chain
  • Consolidated all missile movement operations to a single group – removed process steps
• Later started doing all instrumentation installs and removal at STAF
  • Retests with new instrumentation no longer required movement.
The AMSTAR Project

- Army Test and Evaluation Command (ATEC) invests in the Advanced Multispectral Test Acceptance Resource (AMSTAR) Major Instrumentation Project

- 2002-2009

- Based on the success with STAF

- Partnership between AMRDEC and RTC

- Three AMSTAR test bays are built and outfitted for upcoming multi-mode missile testing

- Performance Bay in the RF3 facility in building 5400
  - Cutting edge performance bay to feed test technology into the configuration controlled production bays.

- 2 Production Bays inside Redstone Arsenal Test Area 10
AMSTAR is 3 Separate HWIL Facilities

- Tri-Mode Performance Bay in 5400
  - Millimeter Wave Radar (MMW)
  - Semi-Active Laser (SAL)
  - Passive Infrared – Midwave (MWIR) or Longwave (LWIR)
- Dual-Mode (SAL & LWIR) Production Test Bay at TA10
  - Designed to do Tri-mode in custom building
- Second Skeleton HWIL Bay at TA10

Jointly Developed by

AMSTAR Production Facility

Dual-Mode Production Test HWIL

Skeleton HWIL Bay

Control Building

AMSTAR Dual Mode Production Bay Interior
AMSTAR Dual-Mode Concept

- MMW Transparent SAL Projection Screen in Front of MMW Array
- FMS Equipped with Climatic Enclosure for Hot/Cold Testing during HWIL
- Already have LWIR and MWIR optics necessary to augment with an IR projector to complete the Tri-Mode setup
Conclusion

- Production HWIL is a proven test technique as seen by the Longbow HELLFIRE program
- Production HWIL generates more system-level data in all modes of operation versus live fire testing in only one mode of operation, but cannot completely replace live fire
- With good processes, high quantity throughput can be achieved
Questions?