



**RDECOM**



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

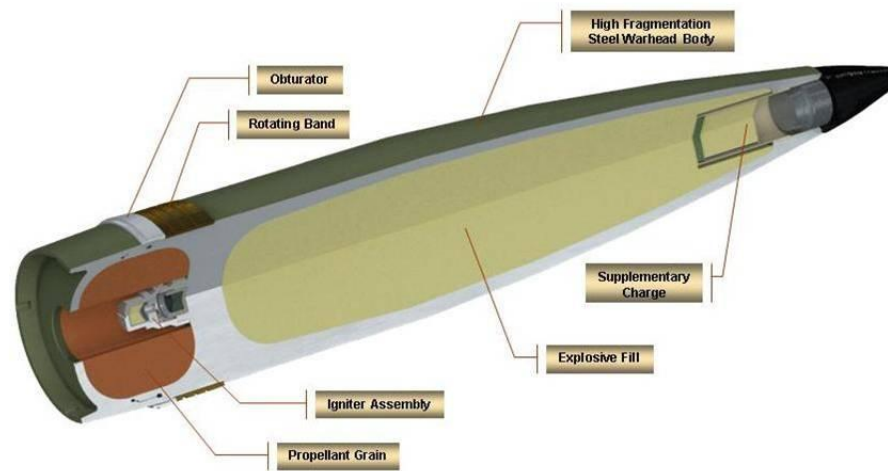
## **XM1128 Insensitive Munition High Explosive Base Burn Projectile**

Presented by: Ductri Nguyen  
NDIA Guns & Missiles Conference – 30 Aug 2011

Department of the Army  
Office of the Project Manager for Combat Ammunition Systems  
Attn: Mr. Ductri Nguyen  
Tel: 973-724-9087  
ductri.nguyen@us.army.mil  
Picatinny Arsenal, New Jersey 07806-5000

**DEVELOPMENT OBJECTIVE:** The XM1128 is a US Government developed solution to achieve a maximum range of 30 km. It is used for fragmentation and blast effect against personnel and materiel.

**ITEM DESCRIPTION:** The XM1128 consists of a high fragmentation steel body with a streamlined ogive and a drag reducing base burner. The projectile body is filled with insensitive explosive and a supplementary charge. On gun launch propellant gases enter the base burner cavity and ignite the dual tracer cups in the igniter assembly. The tracer cups then light the composite propellant grain and sustain the burning at muzzle exit. The base burner gases fill the vacuum at the base of the projectile, reducing the base drag and resulting in extended ranges.



# XM1128 IM HE BB Projectile



## Background:

- M549/A1 projectiles are approximately 30 years old (shelf life is 20 years)
- Double based rocket motor is inefficient (lower ISP)
  - Rocket motor infrastructure no longer exists
  - Significant investment required to bring M549A1 back into production
    - Last one was delivered in 1987
    - Majority of stockpile was delivered before 1981
  - Ammunition Stockpile Reliability Program (ASRP) indicates less than desirable accuracy

## M795E1 development began in 2003

- Integration of modified M864 Base Burner into the M795 projectile body
- TRL6 M795E1 achieved 29.3 km

## M795E2 range demonstration in 2008 includes a revised projectile body shape

- PMCAS Funded RDT&E to achieve additional range
- TRL-6 XM1128 achieved over 30 km

## XM1128 program establish in FY11

- Requires RDTE funds due to increased range capability
- Improves delivery accuracy
- Leverages IMX-101 explosive fill sponsored by OSD TTI funding
- Comply with statutory IM requirement
- Carries a larger payload than M549A1

## Overview of capability gap:

- Addresses Munitions capability gap created by the aging M549/A1 Extended Range Projectile
- TRADOC in process of adopting USMC requirement [155mm Cannon Artillery Munitions Suite CPD (USMC)]
- M549 Required Operational Capability not certified by Joint Capability Integration and Development System (JCIDS)

## Capability delivered by program:

- Increased ranges: Base Burn (BB) – Range 30+ km
- Improves Performance
  - Greater range, accuracy and explosive fragmentation than the M107 HE (17 km)
  - Greater accuracy and explosive fragmentation than the M549A1 (HE RAP)
  - Greater range than the M795 HE (22 km).
- Logistics footprint reduction: 1 round potentially replaces 3 types in current inventory.
- Expected to achieve all 6 IM certification criteria
- Potential to be compatible with Precision Guidance Kit (PGK)

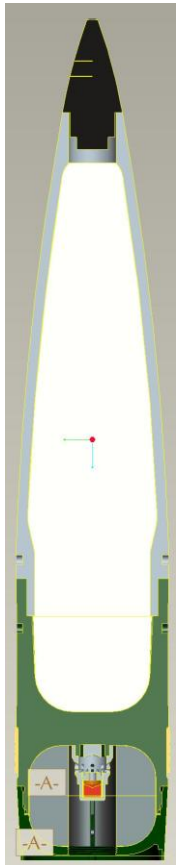


- M795E1 was designed to extend the range of the M795 HE projectile
  - Length of ogive increased, ogive radius increased, and length of cylindrical section decreased
  - Modified M864 Base Burn grain and modified igniter assembly integration
  - Achieved 29.3 km
  - Exhibited larger Range Probable Error (RPE) than desired
- M795E2 was designed to exceed 30km range
  - Additional modification to projectile body and ogive
  - Analysis of previous iterations and testing showed base grain size and port hole were optimized
  - Successfully demonstrated in less than six months
- Preliminary Data shows M795E2 to be stable and “Zoneable”
- Gyroscopic stability factor adequate
- M795E2 fired in Dec 08 to demonstrate 30 km range capability
- Fired two rounds with DFUZE at transonic mach numbers with induced yaw to determine transonic stability characteristics

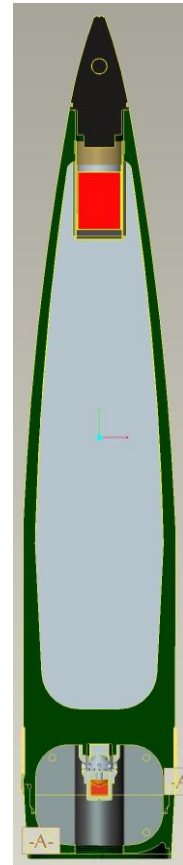
**XM1128 (M795E2) has a very low technical risk through production qualification**



- M795E2 Development continued in 2008
- Fired two M795E1 (MACS 5) along with M795E2 to compare with previous data
  - Corrected range was 28.9 km, 400 m lower than rounds fired in 2003
  - BB performance similar to 2003
  - Lower than expected muzzle velocity accounts for 200 m
  - Other factors contributed to slightly shorter ranges
- Fired two M795E2 with inert grain (MACS 3) to obtain “burner-off” drag
  - Overall projectile drag includes wave drag, base drag, and skin drag
  - Base drag can not be directly measured
  - Overall drag lower than predictions
- Fired four M795E2 (MACS 5) to determine max range
  - Corrected range was over 30 km
  - $PE_R = .15\%$ ,  $PE_D = .67$  mil
- Fired four M795E2 at transonic Mach numbers with induced yaw to get preliminary indication of stability
  - All four rounds damped nicely
  - All rounds had sufficient dynamic stability
- In this test, **the M795E2 demonstrated a range of over 30 km**, when fired from a M198 howitzer with MACS 5 charge and corrected to standard sea-level conditions.
- XM1128 program addresses producibility and improvement to system accuracy.



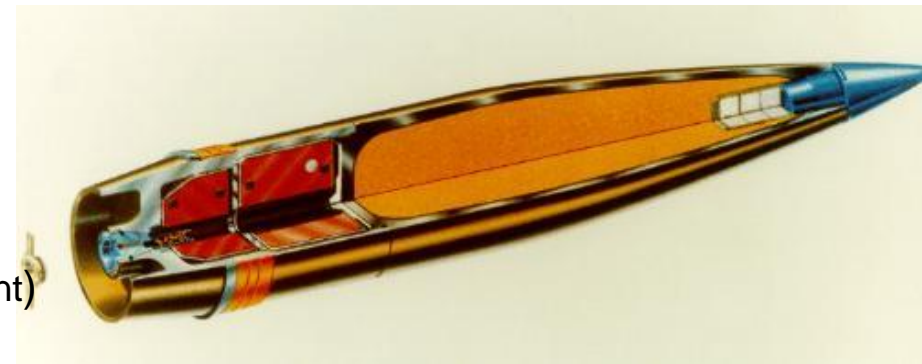
M795E2



XM1128



- Replaces M549A1 Rocket Assisted Projectiles (RAP)
- Head of family for 30 km projectiles
- Use of Base Burn (BB) improves target engagement effectiveness over M549A1 RAP
  - Larger payload
  - IM Compliant (Leverages M795 IM)
  - Composite base burner is more efficient than double base rocket
- Decreased Range Probable Error (RPE)
  - Yields a more consistent ballistic performance compared to rocket assist
  - Flexible design allows for future performance improvements
- Lower estimated Program Acquisition Unit Cost (PAUC) than restarted M549A1
  - Leverages existing M795 manufacturing methods (body forging, main fill, rotating band and IM lifting plug)
  - Lower Manufacturing Costs
    - State of the art tooling
    - Base Burn is simpler/easier
- Fits easily into existing Industrial Base
- IM Compliant (Leverages M795 IM development)
  - IMX-101 main fill
  - Plastic supplementary charge liner
  - PBXN-9 supplementary charge



**M549A1 Projectile**

## EMD Phase

### Program Risks

5	Yellow	Yellow	Red	Red	Red	
4	Green	Yellow	A	Red	Red	
3	Green	C	Yellow	D, G	Red	
2	Green	Green	F	Yellow	Yellow	
1	Green	Green	B, E	Green	Yellow	
		1	2	3	4	5

**Likelihood**

- (1) Not Likely – Probability of Occurrence (~10%)
- (2) Low Likelihood – Probability of Occurrence (~30%)
- (3) Likely – Probability of Occurrence (~50%)
- (4) Highly Likely – Probability of Occurrence (~70%)
- (5) Near Certainty – Probability of Occurrence (~90%)

**Cost Consequences**

- (1) Minimal – 1% to 5% of EMD phase allocated funds
- (2) Minor – 5% to 15% of EMD phase allocated funds
- (3) Moderate – 15% to 25% of EMD phase allocated funds
- (4) Significant – 25% to 40% of EMD phase funds may jeopardize program.
- (5) Severe – Greater than 40% of EMD phase funds, will jeopardize program.

**Performance Consequences**

- (1) Minimal – Minor performance degradation, meets all KPPs and KSAs.
- (2) Minor – Performance degradation, meets all KPPs.
- (3) Moderate – Performance outside allocated requirements.
- (4) Significant – Reliability failure, Mission failure, May jeopardize program.
- (5) Severe – Danger to the user, mission failure, will jeopardize program.

- **Risk A:** Range Probable Error (RPE)
- **Type:** Performance
- **Description:** XM1128 uses an enlarged M864 base burn. Base Burn grain must continue to burn through gun exit to obtain consistent RPE
- **Mitigation Approach:** Utilize residual M795E1 hardware and conduct additional igniter reliability test at YPG in FY10.

- **Risk B:** Lethality
- **Type:** Performance
- **Description :** There has been no lethality test conducted to date.
- **Mitigation Approach:** Modeling and Simulation have been conducted. USMC provided funding to conduct initial lethality test.

- **Risk C:** Projectile Body Fabrication
- **Type:** Producibility
- **Description:** The XM1128 has a revised M795E1 ogive. The forged nosing operation has not been done to date.
- **Mitigation Approach:** Modeling and Simulation yielded a baseline heat profile for the projectile, but the operation will still need to be refined. Scranton Army Ammunition Plant conducted a prototype forge operations in Aug 2010.

- **Risk D:** Base Burn Heat Transfer
- **Type:** Performance
- **Description:** The burning base Burn will conduct heat through the projectile body into IMX-101 HE. IMX-101 has a lower critical temperature than TNT.
- **Mitigation Approach:** Heat transfer model had been conducted. Talley will conduct static burn test in FY11 to validate model, and igniter will incorporate insulator if necessary.

- **Risk E:** Range
- **Type:** Performance
- **Description:** XM1128 to achieve 30 km range.
- **Mitigation Approach:** XM1128 ballistic flight test demonstrated over 30 km corrected range. Additional optimization of the base Burn can be done in EMD to achieve additional range with minimal changes to hardware

- **Type:** Performance
- **Description:** XM1128 compatibility with PGK is unknown
- **Mitigation Approach:** ARDEC drafted a CRADA with ATK to conduct analysis and test XM1128 with PGK.

- **Risk G:** Long lead raw material acquisition
- **Type:** Schedule
- **Description:** Projectile base closure is made of 4340 steel. Only very limited quantity is currently available
- **Mitigation Approach:** Initiate DOTC OTA or utilize task order contracts to forge base closure components. Effort should be funded incrementally

- **Schedule Consequences**
- (1) Minimal – ~1/2 month schedule slip.
- (2) Minor – ~1 month schedule slip.
- (3) Moderate – ~2 month schedule slip.
- (4) Significant – ~4 month schedule slip, may jeopardize program success.
- (5) Severe – ~8 month schedule slip, will jeopardize program success.

- Firing train mimics that of M795 IM
  - XM1128 HF-1 body was loaded with IMX-101
  - Cast quality control will be similar to that of M795 IM
  - Pressed PBXN-9 Supplementary charge used as in M795IM
- To address lethality risk, USMC funded water pit test conducted at ARL
- Static Detonation of XM1128 under water to collect fragments
- Recovered >93% of body mass
  - Fragments were collected, separated, and categorized
  - ARDEC team conducted system effectiveness analysis
  - Fragment sizes and counts were within anticipated performance envelop
- HF-1 steel provides structural integrity to withstand high-G gun launch while fragmenting in a predictable manner
- Improved lethality over M549A1 at all ranges

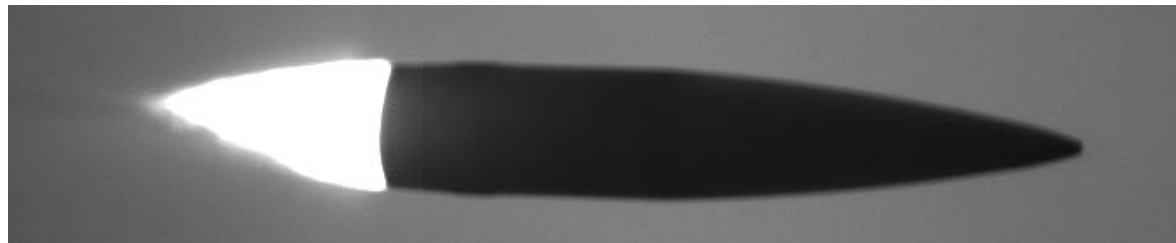




# XM1128 Igniter Evaluation Test



- Due to larger than desired RPE observed in 2003 test, two different igniter assemblies were evaluated in 2010 to determine the baseline XM1128 Base Burner System
- Both igniter configurations utilized dual igniter cups; the forward cup remained the same, while the aft cup is enlarged to hold roughly three times the amount of igniter material
- A total of 20 test rounds were tested. The rounds were arranged into two groups and fired successively to minimize meteorological effects
- During testing, the M864 igniter yielded equal or better performance to that of the enlarged igniter concept. Utilizing the M864 igniter will yield a large cost savings when the XM1128 projectile enters production
- Range Probably Error was less than 0.27% based on small sample size

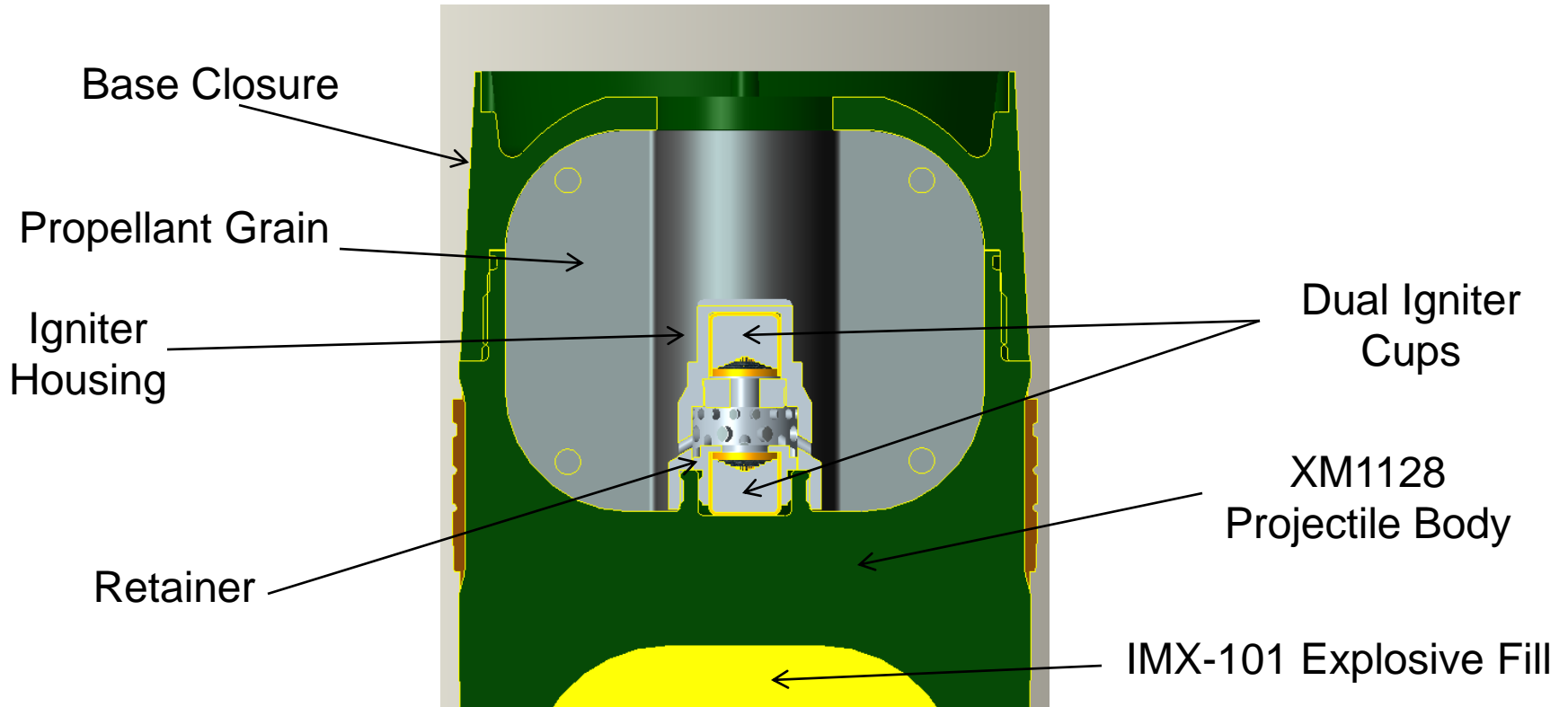


XM1128 In Flight with Igniter Burning

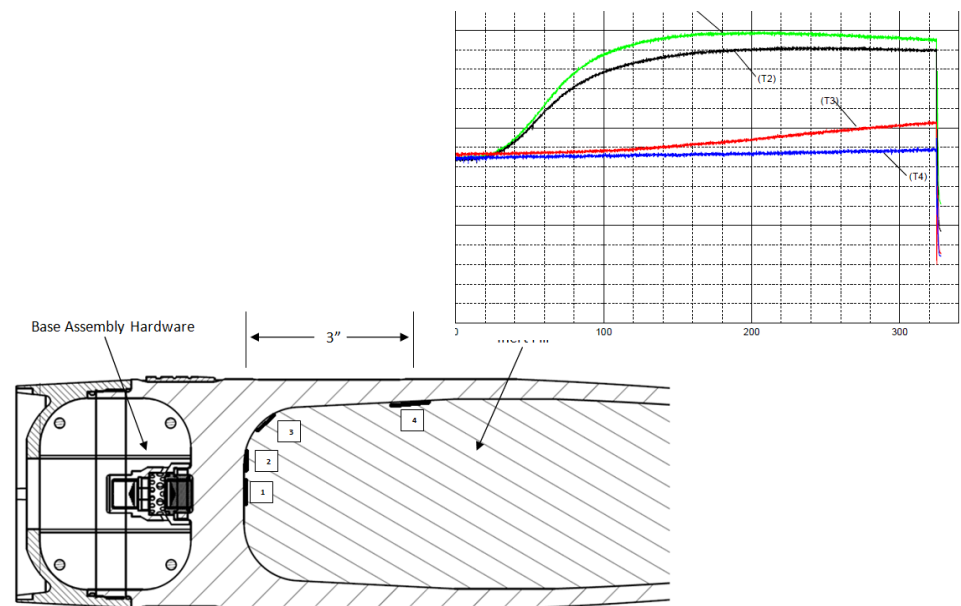
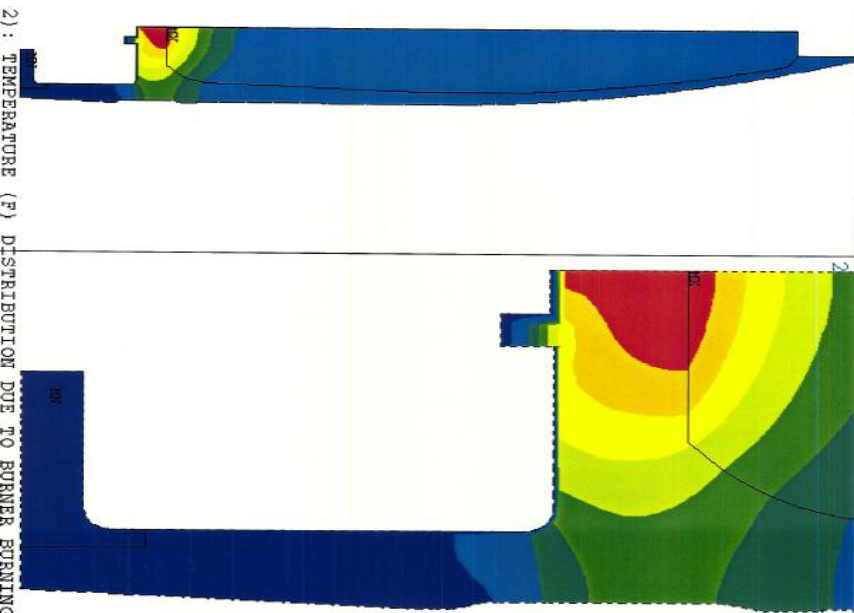
# Base Burn Evaluation



- M864 base burn system was designed to be fully zonable but was limited to higher zones due to cargo disbursement
- During the December 2010 testing, the base burn system was also evaluated at low temperature and low zone charges
- Range results and post-firing round inspection demonstrated full functionality of all components under both extreme circumstances

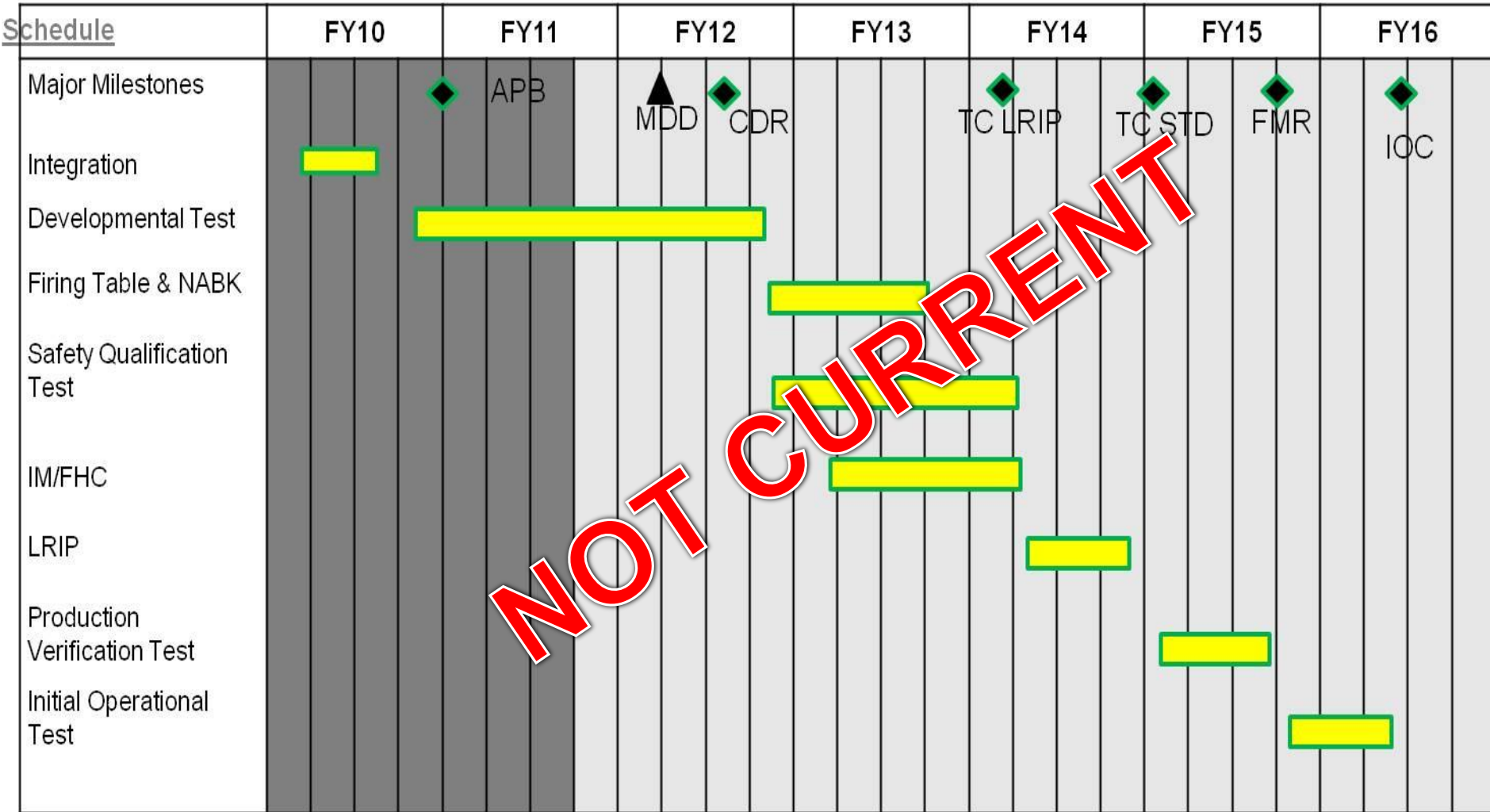


- To address technical risk of thermal transfer into HE Fill
- Modeling and simulation was conducted on the M795E1 hardware design
- The purpose of this test was to confirm, through testing, the temperature that is transferred during combustion of the propellant grain and igniter assembly into the projectile body
- Inert fill was chosen to match IMX-101 specific heat and mass
- Four thermocouples measured heat soak over time
- Verified that design is sufficiently robust to distribute the thermal energy generated by base burn grain
  - Peak measured temperature is well below critical temperature of IMX-101
  - Test is conservative without aero cooling effects





# XM1128 Notional Program Schedule



**NOT CURRENT**



***Questions?***