BAE Systems Land & Armaments

Development and Verification of the DDG-1000 Anti-Fratricide Munitions Container for 155mm LRLAP

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DDG-1000 Zumwalt Class Destroyer

**Characteristics**
- Length: 600 ft
- Beam: 80.7 ft
- Draft: 27.6 ft
- Speed: 30 kt
- Displacement: 14,564 LT
- Installed Power: 78 MW
- Crew Size: 142
- Incl. Aviation detachment

**Sensors**
- Dual Band Radar
- S-Band VSR
- X-Band MFR
- HF & MF Bow Sonar Arrays
- Multi-Function Towed Array
- EO/IR System
- ES System

**Weapons**
- (80) Advanced vertical launch cells for Tomahawk, ESSM, Standard Missile
- (2) AGS 155 mm guns
- (600) 155 mm rounds
- (2) 57 mm Close In Guns
- Torpedo Defense (Space Reservation)
- Anti-Terrorism (Space Reservation)

**Superstructure**
Composite structure

**Integrated Power System**
- (2) Main Turbine Generators (MTG)
- (2) Auxiliary Turbine Generators (ATG)
- (2) 34.6 MW Advanced Induction Motors
- Integrated Fight Through Power

**Aviation**
- MH60R and (3) VTUAVs
- (Capacity for 2 MH 60Rs)

**Boats**
- (2) 7m RHIBs
- (sized for (2) 11m RHIBs)

**Hull**
Wave-piercing tumblehome
155mm Long Range Land Attack Projectile

**LRLAP System Overview**

**GN&C**
- DII
- Radome
- Thermal Battery
- DIGNU2
- CCU
- GPS Antennas
- Canard covers
- SES (2)
- HOB Sensor
- DII
- GNC Networks

**Payload**
- ESAD with PD sensor
- HE Warhead
- Warhead ESAD-ISD Interconnect

**Propulsion**
- Case and bulkhead(s)
- Insulation
- Motor ESAD-ISD Interconnect

**Tail**
- Housing
- Hinge plate
- Fin locks
- Fin cap
- Obturator
- Blast tube/nozzle
- Initiation train
- ISD
- Tail Fins
Unitary Charge Warhead

Warhead Section

- ESAD
- Booster
- Warhead
- Main Fill
Munitions Container

• Designed for automated handling in ship magazine
• 8 LRLAP projectiles
• 8 propelling charge
• 2700 kg fully loaded container gross wt.
Initial Trade Study and Inert Acceptor Test

Hydrocode Simulation

C4 Filled Donor and 3 Instrumented Inert Acceptors
Anti-Fratricide System Development

Initial Munitions Container Anti-Fratricide Liner

Engineering SD Demonstration of Initial Concept

Engineering test scored as failure, acceptor WH detonated
Alternate Concept

- Failure Review Board (FRB) was formed
- Multiple failure paths evaluated and examined
  - CTH hydrocode analysis at NAWC, China Lake, CA
  - HULL hydrocode analysis at GD-OTS, Niceville, FL
- Modified diamond bar from initial trade study showed greatest potential
- Repeat engineering test at NTS, Camden, AR Oct 2007
  - Success!
IM and Hazard Class SD Test

- Tactical donor and two acceptor warheads in container
- Mass equivalent steel GNC and RM sections used for confinement
- Conducted SD-1 test at NTS, Camden, AR June, 2012
SD-1 Results

- Above: Aft Container, post test
- Upper Right: Forward view, post test
- Right: Acceptor WH case
Hydrocode Modeling

Initial Concept at 20 μ-second Intervals

Simulation of Diamond Bar at 20 μ-second Intervals
Conclusions

• Munitions container well positioned to pass SD test with Warhead, Rocket motor, and Propelling Charge
  • Munitions Reactions Evaluation Board (MREB) scored SD-1 as a PASS in October 2012
• IPT FRB collaborative effort with U.S. Navy and contractors was a success
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