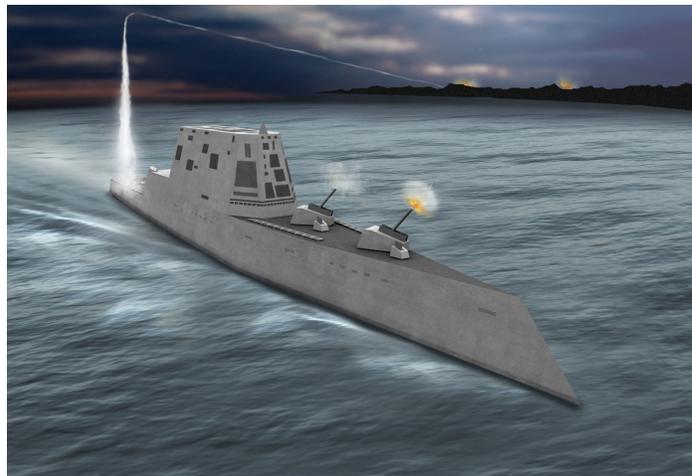


DDG 1000 *Zumwalt* Class Destroyer

Executive Summary

- The first ship in the *Zumwalt* class of destroyers was launched on October 28, 2013. The Navy accepted delivery of DDG 1000 in an incomplete condition. In September 2016, the ship set sail for the west coast in order to begin, upon arrival, an 18-month post-delivery availability to complete installation, integration, and shipyard testing of its combat systems. The Navy plans to conduct a second Acceptance Trial when that availability has been completed and expects IOT&E to commence in 3QFY18.
- The Navy is concerned with the high cost of projectiles for the Long Range Land Attack Projectile (LRLAP) for the DDG 1000 Advanced Gun System (AGS) and has not funded LRLAP rounds required to evaluate AGS performance during IOT&E. Without these projectiles, the destroyers' primary mission capability of land attack will be limited to strike with Tomahawk Land Attack Missiles (TLAMs) until a replacement land attack projectile is identified and the AGS is modified to fire the new projectile.
- The roles and missions of DDG 1000 are under review. The Navy expects to complete a study to determine the concept of operations for DDG 1000 by 2QFY17.
- The Navy has requested funding in FY18/19 to execute a reduced scope component shock qualification program, and is going through the process to identify the equipment/systems and shock grade to which these will be qualified.
 - Indications are that the number of components undergoing shock qualification will be a reduced set, which will introduce risk for the shock trial. Additionally, by reducing the number of components undergoing shock qualification, the assessment of the vulnerability and recoverability capability of the ship at design levels for underwater threats will be limited. The Navy had indicated in prior years that the component shock testing would be funded and conducted prior to installation of any equipment on the first ship, which is the normal, common-sense approach. However, the Navy diverted that funding to other uses; thus, the component shock testing was not done and now cannot be done in the normal sequence.
 - Despite these limitations, the shock trials currently scheduled for FY20 must be performed at the traditional severity levels for a surface combatant. These trials will now be the sole source of comprehensive data on the survivability of mission-critical ship systems to shock, and are therefore critical to the success in combat of the ship and her crew.
- Additional AN/SPY-3 multi-function (X-band) radar development and testing at the Wallops Island test facility has significantly compressed the schedule for self-defense



testing of both the *Zumwalt*-class destroyer and the CVN 78 *Gerald R. Ford*-class nuclear aircraft carrier on the Navy's self-defense test ship (SDTS). The completion of this live-fire testing, and the subsequent use of the Probability of Raid Annihilation test bed, is essential to be able to evaluate the self-defense and survivability of the *Zumwalt*-class destroyer. The Navy must identify how the required ship self-defense testing will be completed prior to deployment of a *Zumwalt*-class destroyer. This may mean delaying the AN/SPY-3 radar installation on DDG 1002.

System

The *Zumwalt*-class destroyers are new surface combatants with a wave-piercing tumblehome hull form designed both for endurance and low-radar detectability. The Navy currently plans to acquire three ships of the class. The *Zumwalt*-class destroyer is equipped with the following:

- Total Ship Computing Environment Infrastructure that hosts all ship functions on an integrated and distributed computing plant.
- Two 155 mm AGS designed to fire LRLAPs.
- AN/SPY-3 Multi-Function (X-band) radar modified to include a volume search capability. (The Navy removed the Volume Search Radar (S-band) from the ship's baseline design for cost reduction in compliance with an Acquisition Decision Memorandum of June 1, 2010.)
- Eighty vertical launch cells that can hold a mix of TLAMs, Standard Missiles, Vertical Launch Anti-Submarine Rockets, and Evolved SeaSparrow Missiles.
- An integrated undersea warfare system with a dual frequency bow-mounted sonar and multi-function towed array sonar to detect submarines and assist in avoiding in-volume mines.

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- Two MK 46 30 mm close-in gun systems for self-defense against small boat swarms. The MK 46 30 mm close-in gun system replaces the MK 110 57 mm close-in gun system. (Configuration change resulted from a Gate 6 Configuration Steering Board of June 2012.)
- An ability to embark and maintain MH-60R helicopters and vertical take-off unmanned aerial vehicles.
- An Integrated Power System that can direct electrical power to propulsion motors, combat systems, or other ship needs.
- In addition to the self-defense features installed on the ship (hard and soft kill), the following survivability features are included in the design:
 - Improved ballistic protection for magazines and other vital compartments and shock hardened systems/components
 - Installed and portable damage control, firefighting, and dewatering systems intended to support recoverability from peacetime shipboard fire and flooding casualties, and from damage incurred during combat
 - Tele-robotic fire nozzles that cover selected areas of the ship

Mission

- The Joint Force Maritime Component Commander intends to employ *Zumwalt*-class destroyers to provide:
 - Joint surface strike/power projection
 - Joint surface fire support
 - Surface warfare
 - Anti-air warfare
 - Anti-submarine warfare
- The Navy expects *Zumwalt*-class destroyers to operate independently or in conjunction with an Expeditionary or Carrier Strike Group, as well as with other joint or coalition partners in a Combined Expeditionary Force environment.

Major Contractors

- General Dynamics Marine Systems Bath Iron Works – Bath, Maine
- Huntington Ingalls Industries – Pascagoula, Mississippi
- BAE Systems – Minneapolis, Minnesota
- Raytheon – Waltham, Massachusetts

Activity

- In September 2015, the Navy completed a formal study that identified capability gaps in currently available torpedo surrogates and presented an analysis of alternatives for specific investments to improve threat emulation ability. The Navy has since taken the following actions to address the identified capability gaps:
 - The Navy received approximately \$1.0 Million through an FY16 Resource Enhancement Project (REP) proposal and is currently in development of a threat-representative high-speed quiet propulsion system.
 - The Navy submitted an FY17 REP proposal for \$6.2 Million to develop a General Threat Torpedo (GTT) that will expand upon the propulsion system under development and provide representation of threat torpedoes in both acoustic performance and tactical logic.
- In June 2016, the Navy elected to delay installation of the AN/SPY-3 radar on the Navy's SDTS in order to conduct additional development and testing of the AN/SPY-3 radar at the Wallops Island test facility. The AN/SPY-3 array at the Wallops Island test facility is used for system development and testing of the radar systems of both the *Zumwalt*-class destroyer and the CVN 78 *Gerald R. Ford*-class nuclear aircraft carrier. Further, the same AN/SPY-3 array will ultimately be installed on the DDG 1002.
- The Navy ceased planning for live fire events using LRLAP due to concern with the high cost of projectiles for the LRLAP for the DDG 1000 AGS. The Navy continued planning for structural firings and reliability testing of AGS on DDG 1000 using inert firing shapes. The Navy is investigating options to replace the LRLAP land attack capability.
 - The roles and missions of DDG 1000 are under review. The Navy expects to complete a study to determine the concept of operations for DDG 1000 by 2QFY17.
 - The Navy revised the Test and Evaluation Master Plan (TEMP) and is currently routing it within the Navy for approval.
 - The Navy continued development of the DDG 1000 Probability of Raid Annihilation test bed. The test bed is a high-fidelity modeling and simulation (M&S) tool that will be used, in conjunction with live fire testing conducted aboard DDG 1000 and the SDTS to assess *Zumwalt*-class destroyers' capability to defeat hostile anti-ship cruise missiles and aircraft.
 - In October 2015, the SECDEF directed the Navy to conduct the *Zumwalt*-class destroyers shock trial prior to the first deployment of any ship of the class. The Navy is developing a plan of action to shock qualify a limited amount of equipment prior to the shock trial to ensure the trial can be safely conducted. The focus of the reduced effort will be on shock qualifying equipment that is critical to personnel safety prior to conducting the shock trial; it is unclear how much of the mission-critical equipment (hull; mechanical; electrical; and command, control, communications, computers, combat systems, and intelligence) will be shock qualified and to what level.

Assessment

- The threat torpedo surrogates currently available for operational assessment of the *Zumwalt*-class destroyer have significant limitations in their representation of threat

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torpedoes. The proposed development of a GTT addresses many of the DOT&E concerns; however, the GTT's capability to support realistic operational testing is dependent upon future Navy decisions to procure sufficient quantity of GTTs.

- All three ships of the *Zumwalt* class share significant new designs, including the unique wave-piercing tumblehome hull form, as well as the new Integrated Power System, Total Ship Computing Environment (software, equipment, and infrastructure), Integrated Undersea Warfare System, Peripheral Vertical Launching System, the AGS, and the associated automated magazines. These systems and equipment have not been subjected to shock testing on previous ship classes. Moreover, the significant automation and relatively small crew may limit the sailors' ability to conduct repairs needed to enable recovery from shock-induced damage.
- Additional AN/SPY-3 radar development and testing at the Wallops Island test facility has significantly compressed the schedule for self-defense testing of the *Zumwalt*-class destroyer and the *Gerald R. Ford*-class nuclear aircraft carrier on SDTS. The completion of this live-fire testing, and the subsequent use of the Probability of Raid Annihilation test bed, is essential to be able to evaluate the self-defense and survivability of the *Zumwalt*-class destroyer. The Navy must identify how the required ship self-defense testing will be completed prior to deployment of a *Zumwalt*-class destroyer. This may mean delaying the AN/SPY-3 radar installation on DDG 1002.
- The Navy has requested funding in FY18/19 to execute a reduced scope component shock qualification program, and is going through the process to identify the equipment/systems and shock grade to which these will be qualified.
 - Indications are that the number of components undergoing shock qualification will be a reduced set, which will introduce risk for the shock trial. Additionally, by reducing the number of components undergoing shock qualification, the assessment of the vulnerability and recoverability capability of the ship at design levels for underwater threats will be limited. The Navy had indicated in prior years that the component shock testing would be funded and conducted prior to installation of any equipment on the first ship, which is the normal, common-sense approach. However, the Navy diverted that funding to other uses; so, the component shock testing was not done and cannot now be done in the normal sequence.
 - Despite these limitations, the shock trials currently scheduled for FY20 must be performed at the traditional severity levels for a surface combatant. These trials will now be the sole source of comprehensive data on the survivability of mission-critical ship systems to shock, and are therefore critical to the success in combat of the ship and her crew.
- The Program Office and the Navy Technical Community encountered problems when attempting to upgrade the survivability M&S tools, which led them to an off-ramp decision to perform the DDG 1000 vulnerability analysis using the existing M&S tools and methods with known shortfalls. The Navy could benefit largely from existing improvements in specific M&S modules by troubleshooting the upgraded M&S modules in a stand-alone mode before integrating them into the over-arching survivability M&S tool that has demonstrated module interface and integration issues. The Navy should also develop a long-term investment strategy to improve the confidence and fidelity levels of its vulnerability and recoverability M&S tools.
- If the *Zumwalt*-class destroyers are not outfitted with LRLAP because of the high cost of the projectiles, the ships will have no capability to conduct Joint Surface Fire Support missions until replacement projectiles are acquired and the AGS is modified to fire the new projectiles. Thus, *Zumwalt*-class destroyers' land attack capability will be limited to TLAMs.
- The currently approved version of the TEMP does not address significant changes to the *Zumwalt*-class destroyer baseline, test strategies and delays in the production schedule. The TEMP revision in Navy routing is required to support operational test.

Recommendations

- Status of Previous Recommendations. The Navy should address the following open recommendations from FY15 and earlier:
 1. Fund and schedule component shock qualification to support the *Zumwalt*-class destroyers' requirement to maintain all mission essential functions when exposed to underwater explosion shock loading.
 2. Develop and conduct an accreditation plan to assess the acceptability of the Probability of Raid Annihilation test bed to support operational testing of the ship's air defense effectiveness.
- FY16 Recommendations. The Navy should:
 1. Complete the revision to the TEMP that accounts for *Zumwalt*-class destroyer baseline changes and system delivery schedule.
 2. Acquire a sufficient quantity of GTTs, when developed, to support testing and fully characterize *Zumwalt*-class destroyer capability to defeat threat torpedoes during FOT&E.
 3. Develop and implement a strategy to address the current limitations with damage predictions in the underwater and air explosion vulnerability assessment tools.
 4. Update DOT&E on the details of the component shock qualification program.
 5. Develop and implement a strategy to complete self-defense testing of the *Zumwalt*-class destroyer on the SDTS.

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