

## DDG 1000 *Zumwalt* Class Destroyer

### Executive Summary

- The first ship in the DDG 1000 *Zumwalt* class destroyers was launched on October 28, 2013. The Navy initiated pre-delivery testing in FY13 on DDG 1000 (lead ship), and testing will continue in FY16. The Navy plans to accept delivery of DDG 1000 in an incomplete condition and sail the ship to the West Coast in FY16. After the ship arrives on the West Coast, it will begin an 18-month post-delivery availability to complete installation, integration, and shipyard testing of mission systems. The Navy plans to conduct a second Acceptance Trial when that availability has been completed and expects IOT&E to commence in FY18.
- The Navy removed funding for the planned Full Ship Shock Trial (FSST) on DDG 1000 in September 2014, unilaterally deciding to conduct the event on DDG 1002. In October 2015, the Navy revised their decision and agreed to conduct FSST (specific ship to be determined) prior to the first deployment of any DDG 1000 *Zumwalt* class destroyer.
- To complete the survivability analysis, the Navy needs to restore funding and complete the component shock qualification program that is used to verify if the equipment installed in all three hulls meets the design requirements. The Navy also needs to address the shortfalls associated with the models that support the overall survivability evaluation.

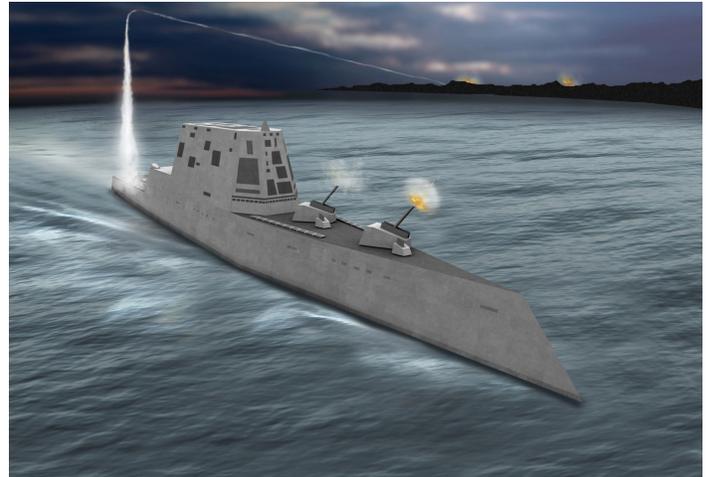
### System

The DDG 1000 *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 DDG 1000 *Zumwalt* class destroyer is equipped with the following:

- Total Ship Computing Environment Infrastructure that hosts all ship functions on an integrated, distributed computing plant.
- Two 155 mm Advanced Gun Systems that fire Long Range Land Attack Projectiles (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 Tomahawk Land Attack Missiles, Standard Missiles, Vertical Launch Anti-Submarine Rockets, and Evolved Sea Sparrow Missiles.

### Activity

- The Navy continues to revise the Test and Evaluation Master Plan (TEMP). The most significant changes being addressed in the TEMP revision are:



- 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 mines.
- 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.

### Mission

- The Joint Force Maritime Component Commander intends to employ the DDG 1000 *Zumwalt* class destroyer to provide:
  - Joint Surface Strike /Power Projection
  - Joint Surface Fire Support
  - Surface Warfare
  - Anti-Air Warfare
  - Anti-Submarine Warfare
- The DDG 1000 *Zumwalt* class destroyer is intended 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

- Modification of the AN/SPY-3 Multi-Function Radar (X Band, horizon search radar) to provide the volume search capability that would have been provided by the

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Volume Search Radar (S-band), which has been removed from the baseline design.

- Replacement of two MK 110 57 mm close-in gun systems (integrated with the ship's combat system), with two standalone MK 46 30 mm guns (not integrated with the ship's combat system).
- Incorporation of schedule adjustments that reflect shipyard delays and the Navy's plan to complete component installation, integration, and mission system testing on DDG 1000 during an 18-month availability at a West Coast shipyard. The Navy plans to conduct a second Acceptance Trial when that availability has been completed and expects IOT&E to commence in FY18.
- Inclusion of detailed test designs for major mission areas, including Anti-Air Warfare, Anti-Submarine Warfare, Surface Warfare, fire support, and mine avoidance.
- The Navy completed LRLAP lethality testing in FY14. Modeling and simulation will be used to assess LRLAP performance against multiple targets in 2017.
- The Navy continues development of the DDG 1000 Probability of Raid Annihilation test bed, which is modeling and simulation that will be used, in conjunction with live fire testing using the Self-Defense Test Ship, to assess DDG 1000's capability to defeat threat anti-ship cruise missiles and aircraft.
- In January 2013, DOT&E sent a memorandum to the Assistant Secretary of the Navy (Research, Development, and Acquisition) outlining the need for a threat torpedo surrogate to support operational testing of DDG 1000 and other ships/submarines, and requesting the Navy's plan to address this need.
  - In June 2015, DOT&E sent a follow-up memorandum that reiterated the need for adequate torpedo surrogates in operational test and noted that DOT&E has yet to receive the Navy's plan.
  - In September 2015, the Navy completed a formal study to identify capability gaps in the currently available torpedo surrogates and to present an analysis of alternatives for specific investments to improve threat emulation ability.
- In September 2014, the Navy requested DOT&E concurrence to move FSST from the first ship of its class, DDG 1000, to the last of its class, DDG 1002. DOT&E disapproved the deferral request and opposed changing the schedule and test article resourcing within a TEMP revision. The Navy unilaterally removed the funding for the FSST and proceeded with their unfunded plan to conduct FSST on DDG 1002. In October 2015, the Navy revised their decision and agreed to conduct FSST (specific ship to be determined) prior to the first deployment of any DDG 1000 *Zumwalt* class destroyer. However, the component shock qualification program for DDG 1000 *Zumwalt* remains incomplete and is unfunded for completion.
- In April 2015, the Navy notified DOT&E that the underwater explosion (UNDEX) vulnerability assessments would be

delayed due to problems with the full ship finite element analysis model. In addition, DOT&E was notified that the recently developed blast module for the air explosion (AIREX) vulnerability assessment of the as-built configuration of the ship cannot be operated within the Advance Survivability Assessment Program (ASAP) simulation due to integration problems with the two sets of computer code. The Navy intends to use available model and simulation tools and resultant vulnerability predictions that it previously concluded have significant limitations, as cited in a 2005 Verification and Validation Assessment Report of ASAP. The Navy report identified several measures that cannot be determined at the necessary accuracy or confidence using ASAP.

## Assessment

- The Navy study on threat torpedo surrogates confirmed DOT&E's concerns that current torpedo surrogates have significant gaps in threat representation for operational testing and the study provided recommendations for improving current threat torpedo emulation. However, the Navy has yet to provide its plan to obtain adequate torpedo surrogates to effectively characterize DDG 1000 *Zumwalt* class destroyer performance in operational test.
- Conducting FSST on DDG 1000 is critical to finding and correcting failures in mission-critical capabilities prior to the classes first deployment and prior to placing this class of ships in harm's way. FSSTs routinely uncover mission-critical vulnerabilities that were not identified by component testing, analysis, and/or modeling and simulation alone.
- A component shock qualification program for assessing ship vulnerability to below-water threats is necessary for accurate damage simulations. However, the shock qualification program remains unfunded.
- All three ships of the DDG 1000 *Zumwalt* class have in common a significant amount of 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 Advanced Gun System, and the associated automated magazines. These systems and equipment have not been subjected to shock on previous ship classes. Moreover, the previously untried automation and small crew for a ship this size, limit the sailors' ability to conduct repairs to enable recovery from shock-induced damage.
- UNDEX and AIREX vulnerability assessments currently lack credible damage prediction models. The challenges and limitations in predicting ship vulnerability reinforce the need to complete FSST and component shock qualification before the first operational deployment of a DDG 1000 *Zumwalt* class destroyer. DOT&E will provide additional recommendations to mitigate or limit the unknown vulnerability of the

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DDG 1000 *Zumwalt* class destroyer after completing a more detailed evaluation of the available model and simulation tools and their limitations.

## Recommendations

- Status of Previous Recommendations. The Navy should address the following open recommendations from FY13 and earlier:
  1. Develop tactics and training that optimize employment of the MK 46 gun systems against surface threats.
  2. Fund and schedule component shock qualification to support the DDG 1000 *Zumwalt* class destroyer requirement to maintain all mission essential functions when exposed to UNDEX shock loading.
  3. Determine a development and test strategy that mitigates the risk of delivering substantial mission capability after ship delivery and transit to the West Coast.
- FY15 Recommendations. The Navy should:
  4. Develop a strategy to validate reliability of the accelerometers used in LRLAP prior to shipboard operational test.
  5. Develop and conduct an accreditation plan that validates the acceptability of the Probability of Raid Annihilation test bed to support operational test.
- FY15 Recommendations. The Navy should:
  1. Fund and schedule FSST prior to the first deployment of any DDG 1000 *Zumwalt* class destroyer and formalize this plan within revisions of the TEMP and LFT&E Management Plan.
  2. Complete the revision to the TEMP that accounts for DDG 1000 baseline changes and system delivery schedule.
  3. Develop torpedo surrogate(s) that can be used to characterize DDG 1000 *Zumwalt* class destroyer capability against threat torpedoes during operational test.

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