CVN 78 *Gerald R. Ford*-Class Nuclear Aircraft Carrier

In FY24, USS *Gerald R. Ford* (CVN 78) completed a 262-day deployment, returning to home port in January 2024. While deployed, CVN 78 and its embarked air wing executed operational missions in support of combatant commander requirements. After its return to home port, the ship entered its post-deployment maintenance availability, and in March 2024, the Navy completed pierside cyber survivability testing, an operational test event. CVN 78 will resume IOT&E in FY25 with sortie generation rate (SGR), Ship Self-Defense System (SSDS), and Total Ship's Survivability Trial (TSST) testing. These tests will be critical to evaluating the ship's effectiveness and survivability, along with accrediting high-fidelity flight operations and Probability of Raid Annihilation (P_{RA}) models, which are essential for evaluating platform performance requirements.

SYSTEM DESCRIPTION

The *Ford*-class is a new class of nuclear-powered aircraft carriers based on the *Nimitz*-class hull, with significant design changes intended to enhance the *Ford*-class's ability to launch, recover, and service aircraft while reducing required manning capacity by approximately 15 percent. CVN 78 includes a new nuclear power plant that increases electrical capacity to power ship systems, including new Electromagnetic Aircraft Launch System (EMALS) catapults and electromechanical Advanced Arresting Gear (AAG). The originally planned arresting gear engine and wire positioning (consisting of four engines and three wires) was similar to the USS *Ronald Reagan* (CVN 76) and USS *George H. W. Bush* (CVN 77) flight decks. However, the fourth AAG engine has not been installed on the *Ford*-class to date as a cost savings measure. The *Ford*-class also incorporates a larger and more efficient flight deck layout with additional aircraft fueling stations, along with redesigned weapons elevators, weapons handling spaces, and magazine stowage to reduce manning, improve safety, and increase weapons throughput compared to *Nimitz*-class aircraft carriers. The *Ford*-class combat system incorporates the following systems:

- Dual Band Radar (DBR) that combines the phased-array SPY-4 Volume Search Radar and the SPY-3 Multi-Function Radar. CVN 78 is the only ship with DBR; it will eventually be replaced with the SPY-6(V)3 Enterprise Air Surveillance Radar (EASR) fixed variant, the SPQ-9B horizon search radar, and Mk 9 Tracker Illuminator System, as will be installed on PCU *John F. Kennedy* (CVN 79) and follow-on carriers.
- SSDS Mk 2 Mod 6 with Baseline 10 combat management system, which will be upgraded to the new capability build, Baseline 12, on CVN 79 and follow-on *Ford*-class ships.
- AN/USG-2B Cooperative Engagement Capability (CEC) tracking, data fusion, and distribution system, which will be upgraded to CEC Block II and follow-on *Ford*-class ships.
- AN/SLQ-32B(V)6 electronic warfare system equipped with the Surface Electronic Warfare Improvement Program (SEWIP) Block 2.
- Rolling Airframe Missile (RAM) Block 2 and Evolved Sea Sparrow Missile (ESSM) Block 1. CVN 79 and beyond will be upgraded to a mix of new RAM variants Block 2A and 2B, plus a mix of ESSM Block 1 and Block 2.
- The Close-In Weapon System search radar, which operates in stand-alone mode on CVN 78, but will be integrated with AN/USG-2B CEC and SSDS on follow-on *Ford*-class ships.

Ford-class ships also have enhanced survivability features, including improved protection for magazines and other vital spaces; shock-hardened mission systems and components; and installed and portable damage control, firefighting, and dewatering systems intended to expedite response to and recovery from fire, flooding, and battle damage.

MISSION

Carrier strike group (CSG) commanders will use *Ford*-class ships to:

- Provide credible, sustainable, independent forward presence during peacetime without access to land bases;
- Operate in a supported or supporting role with a joint and/or allied maritime expeditionary force in response to crises; and
- Carry the war to the enemy, independent of forward-based land facilities, through joint multi-mission offensive operations by:
  - Operating and supporting aircraft to attack enemy forces ashore, afloat, or submerged;
  - Protecting friendly forces from enemy attack through the establishment and maintenance of battlespace control; and
  - Engaging in sustained operations in support of the United States and its allies.

PROGRAM

The CVN 78 *Gerald R. Ford*-class is an Acquisition Category IC program. DOT&E approved Revision E of the TEMP in September 2022 and Revision B of the LFT&E Management Plan in September 2023. The first ship in the *Ford*-class, CVN 78, was delivered to the Navy in 2017. It completed Post Delivery Test and Trials in April 2021 to demonstrate the basic functionality of the carrier, certify the flight deck, and embark an air wing. CVN 78 also completed Full Ship Shock Trials (FSST) in August 2021 and a Planned Incremental Availability in February 2022. DOT&E approved the first of two planned phases of the IOT&E test plan, and IOT&E began in September 2022. IOT&E is expected to complete in FY27.

The Navy deployed CVN 78 in May 2023, which was earlier than the scheduled timeline for first deployment in TEMP Revision E. In preparation for the first deployment, CVN 78 completed its first Composite Training Unit Exercise (COMPTUEX) in April 2023. DOT&E approved Revision 1 to the IOT&E test plan in March 2023 to include IOT&E data collection opportunities during the COMPTUEX. The Navy's operational requirements necessitated changing CVN 78's original test plan timeline around the operational deployment, and in July 2024, the Navy delivered to DOT&E a revised test plan which replaced the IOT&E original two-phase structure with a more incremental approach. DOT&E

approved an imminent test event within that test plan revision, but withheld full test plan approval due to an insufficiently articulated reliability, maintainability, logistics, and availability (RMLA) data collection strategy. The Navy should submit to DOT&E a test plan revision that contains an improved RMLA data collection strategy.

CVN 79 delivery is scheduled for late FY25. CVN 79 will be capable of supporting F-35 operations at delivery. *Enterprise* (CVN 80) construction began in August 2017 and is expected for delivery to the Navy in FY29, 18 months later than reported in the FY23 Annual Report. This delay is due to complications with material availability and industry/supply chain performance. *Doris Miller* (CVN 81) construction began in August 2021 and is expected for delivery to the Navy in FY32. The most significant changes to CVN 79 and beyond are related to the combat system and design changes to support F-35. The Navy is updating the TEMP to include operational testing of the *Ford*-class's capability to support F-35 and CMV-22, along with the self-defense capabilities of CVN 79 and follow-on carriers. The Navy expects to update the TEMP in FY25 before CVN 79 is delivered.

» MAJOR CONTRACTOR

- Newport News Shipbuilding, a division of HII – Newport News, Virginia

TEST ADEQUACY

The Navy began *Ford*-class IOT&E in September 2022 and is conducting it in accordance with TEMP Revision E and the DOT&E-approved portions of the IOT&E test plan Update 1. However, the RMLA data collection gaps identified in the FY23 Annual Report remain. If not rectified, these gaps could result in insufficient data to inform conclusive assessments of RMLA for some key subsystems. In addition to affecting suitability assessments, these data gaps could also affect effectiveness assessments, due to the on-demand nature of many key subsystems and the reliance upon accurate RMLA data in both the self-defense and SGR models.

In FY24, the Navy improved data collection for EMALS reliability and is actively working to improve data collection for AAG reliability. The Navy has not yet shown progress for data collection on the other shipboard systems, but has implemented procedural changes designed to improve data collection within shipboard work centers in support of the FY25 scheduled test events. The Navy will continue to update the IOT&E test plan for the major remaining tests such as SGR, self-defense, and cyber survivability tests.

In March 2024, the Navy conducted pierside shipboard cyber survivability tests to assess *Ford*-class overall cyber survivability and enable post hoc accreditation of the test facilities used in completed

land-based cyber survivability testing of EMALS and AAG. This included some testing of the ship's industrial control systems.

Between February and March 2024, the Navy's Operational Test and Evaluation Force (OPTEVFOR) conducted cyber survivability testing aboard CVN 78, in accordance with a DOT&E-approved test plan and with DOT&E observation. The test occurred with CVN 78 pierside and was informed by the land-based test site evaluation detailed in the FY23 Annual Report. The CVN 78 cyber survivability test supported evaluations of the CVN 78 variations of the following programs of record: the SSDS integrated combat system, CEC, and SEWIP. OPTEVFOR will use final analysis of the pierside cyber test of CVN 78 in the planning of the remaining cyber survivability testing with CVN 78 underway; the Navy expects to complete this remaining cyber survivability testing in FY25.

In FY24, the Navy published two vulnerability assessment reports examining the *Ford*-class survivability against above-water and underwater kinetic threats. These reports were based on survivability testing and ship modeling. However, the Navy's ship models require updating to incorporate changes to the as-built *Ford*-class from original design, so their use for survivability assessment is limited. The Navy intends to issue a final survivability assessment report that will include the findings from testing conducted since 2020 and update

model-based survivability analysis by 4QFY25. The updated ship models are necessary to support DOT&E's report on the survivability of the *Ford*-class against threat weapons. DOT&E has requested the Navy provide a roadmap for *Ford*-class ship model updates that will support representative survivability assessments.

Evaluation of the *Ford*-class's anti-air warfare capability is coordinated between the CVN 78 TEMP Revision E and the Capstone Enterprise Air Warfare Ship Self-Defense (AW SSD) TEMP 1714 of March 2008. The evaluation includes a series of live missile fire events aboard CVN 78 against a variety of anti-ship cruise missile (ASCM) threat surrogates. In April 2024, DOT&E approved a modified test strategy for these missile fire events that incorporates refined fleet-representative defensive employment tactics against threat ASCMs. Unplanned post-deployment maintenance requirements for various ship systems will delay these tests until early FY25. These tests will demonstrate *Ford*-class ship self-defense capability and are required to validate modeling and simulation (M&S) used to predict CVN 78 performance across the spectrum of threat ASCMs.

The *Ford*-class SGR evaluation is composed of M&S (for both *Ford*- and *Nimitz*-class), a four-day sustained test on CVN 78, a one-day surge test on CVN 78, and observation of flight operations on a *Nimitz*-class carrier. Development of the M&S suite intended to evaluate the SGR,

the Sea Strike/Sea Basing Aviation Model (SSAM), is ongoing. The *Ford*-class sustained SGR test is scheduled to occur in late FY25. The Navy plans to apply lessons from the sustained SGR test to the surge SGR test, which is currently unscheduled. DOT&E approved these deferments in Revision 1 to the IOT&E test plan, and the Navy needs to provide an updated test plan for DOT&E approval, prior to conducting these events.

In FY24, the Navy collected flight operations data during the USS *Harry S. Truman* (CVN 75) COMPTUEX to support a *Nimitz*-class SGR M&S suite (part of SSAM) for comparative analysis. The Navy and DOT&E are dependent on SSAM for SGR key performance parameter (KPP) evaluation. However, limited test data places the validation of SSAM at risk, and the two SGR demonstrations are the only planned opportunities to collect high-tempo validation data in a requirement-representative scenario. The Navy can mitigate this risk by adequately resourcing the two SGR demonstrations, maximizing data collection during these events, and characterizing model performance to focus on the most critical live data needs.

The Navy remains in development of an enterprise test strategy that will coordinate ship self-defense evaluation of multiple ship classes, including the *Ford*-class, as modified in CVN 79 and follow-on carriers. The new enterprise test strategy for the CVN 79 and follow-on ships will be coordinated between the CVN

78 TEMP Revision F and the yet-to-be-approved Enterprise TEMP 1910. CVN 79 includes an updated combat system, SSDS Baseline 12, and the new SPY-6(V)3 radar system. The details of this enterprise approach are in the SSDS article of this Annual Report. The Navy has yet to finalize the replacement self-defense test capability for ship self-defense against threat ASCMs following the deactivation of the current self-defense test ship, ex-USS *Paul F. Foster*, expected in FY30. To avoid delays in determining *Ford*-class capability and survivability, the Navy should finalize enduring test capabilities, similar to those provided by ex-USS *Paul F. Foster*, in FY25.

PERFORMANCE

» EFFECTIVENESS

Insufficient data are available to determine the *Ford*-class's operational effectiveness due to IOT&E being incomplete. Observations based on testing to date are below.

Combat System

Self-defense testing against unmanned aerial vehicles and high-speed maneuvering surface targets (small boats) was conducted in July 2022. Details can be found in DOT&E's classified early fielding report (EFR) dated April 2023. The Navy is developing fixes to combat system deficiencies identified in DOT&E's classified interim assessment report dated

April 2022. However, the fixes remain largely unfunded to date.

SGR

During USS *Gerald R. Ford*'s FY24 deployment, the ship and its embarked air wing maintained sortie generation rates that were sufficient to meet combatant commander operational taskings. Although the sortie generation rates sustained during particular evolutions, such as Carrier Qualification, have numerically approached those required by the KPP, the aircraft configuration and tempo of these operations did not match the Design Reference Mission and were therefore not representative of the KPP requirement. The reliability and maintainability of CVN 78's EMALS and AAG continue to adversely affect sortie generation and flight operations, which remains the greatest risk to demonstrating operational effectiveness and suitability in IOT&E.

Electromagnetic Spectrum Compatibility

Developmental testing identified significant electromagnetic radiation hazard and interference problems. The Navy implemented some mitigation measures and conducted follow-on characterization testing during independent steaming events in developmental test, but improvements have not been assessed in operational testing. The Navy should verify electromagnetic spectrum compatibility during operational test, particularly when integrated

with CSG operations in an advanced electronic attack environment. This will enable capability assessments at differing levels of system use to inform decisions on system employment. The Navy should apply lessons learned from CVN 78 to the future EASR configuration.

» SUITABILITY

Insufficient data are available to determine the *Ford*-class's operational suitability. However, the following five CVN 78 systems are new to the class and are highlighted as the most significant challenges to flight operations.

AAG

The Navy reported that during CVN 78's 262-day deployment, the ship and its embarked air wing completed 8,725 arrested landings utilizing the AAG. However, DOT&E has not received sufficient data to update the reliability statistics reported in the FY23 Annual Report. Naval Air Systems Command (NAVAIR) continues to work on short- and long-term improvements to address AAG reliability degraders. However, challenges in obtaining replacement parts and the reliance on off-ship technical support remain an issue. The Navy is also using IOT&E to inform the decision of whether to retrofit the fourth AAG engine on *Ford*-class aircraft carriers. The fourth AAG engine was incorporated into the *Ford*-class design, but not installed as a cost savings measure. The fourth engine would improve the reliability and availability of AAG, improve

the pilot boarding rate, and restore a redundant capability to rig the barricade in the event of AAG engine failure, which the current configuration does not support.

EMALS

The Navy reported that during CVN 78's deployment, the ship and its embarked air wing completed 8,725 catapult launches using the EMALS. However, DOT&E has not received sufficient data to update the reliability statistics reported in the FY23 Annual Report. Despite engineering upgrades to hardware and software, reliability has not appreciably changed from prior years and reliance on off-ship technical support remains a challenge. NAVAIR is continuing development on improvements.

Advanced Weapons Elevators (AWEs)

The Navy reported that, during CVN 78's deployment, the ship's weapons department conducted 11,369 AWE runs, moving 1,829,580 pounds of ordnance to the flight deck. However, the Navy has yet to build and transfer ordnance to the flight deck at rates reflective of the Design Reference Mission. Of note, the crew is reliant on off-ship technical support for correction of hardware and software failures. DOT&E expects the SGR tests to be the first operationally representative demonstration of high ordnance throughput.

DBR

Details on DBR suitability can be found in DOT&E's classified EFR from April 2023. DBR availability declined during the FY23 COMPTUEX with the continuous demand for radar coverage and an intermittent failure observed during operations. Due to the one-of-a-kind nature of the DBR, its availability will depend on the Navy's access to replacement parts throughout the remaining life of the system. The Navy should acquire sufficient DBR replacement parts for the interim period prior to the scheduled replacement of DBR with EASR.

Manning and Berthing

Per the Navy's Shipboard Habitability Program, all new ships are required to have a growth allowance of 10 percent of ship's company when the ship delivers. This Service Life Allowance provides both empty bunks to allow for changes in the crew composition over the ship's life and berthing to support crew turnover, visitors, and personnel temporarily assigned to the ship for repairs, inspections, test, and training. However, sufficient berthing is not installed for the *Ford*-class to conduct combat operations with all hands assigned a bed, due to a lack of berthing capacity for embarked units. If the ship and its embarked units were each at 100 percent manning, the ship would have a shortfall of 159 beds. These berthing shortfalls will affect quality of life onboard and could reduce the Navy's operational flexibility in employing

the ship across its full spectrum of missions and logistical support roles for the CSG. Furthermore, there is potential that the berthing shortfalls could increase as the air wing diversifies to include CMV-22, F-35, and MQ-25, none of which are embarked on the *Ford*-class today.

» SURVIVABILITY

The survivability assessment of the *Ford*-class against kinetic threats is based on a combination of FSST, TSST, and related modeling of the class supported by component and surrogate testing. To date, the Navy has completed all planned LFT&E, except for TSST and the final survivability assessment. The TSST is the last scheduled LFT&E event for the ship and will provide critical data on the damage control and recoverability design of the ship.

From June to August 2021, the Navy conducted FSST on CVN 78, including three shock events of increasing severity. In December 2022, DOT&E published a classified FSST report that details findings from the trial, and in July 2023, the Navy published its own FSST report. Both reports identify deficiencies that, if addressed, will improve the class's survivability against kinetic threats. The Navy has yet to issue a Shock Deficiency Correction Plan that will detail the corrective actions planned to rectify adverse findings from the FSST.

The survivability evaluation of the *Ford*-class in a cyber-contested environment was evaluated in March 2024 testing, and

earlier land-based testing for EMALS and AAG. DOT&E's full assessment will be published following the underway test.

The survivability of the *Ford*-class in contested and congested electromagnetic spectrum environments is ongoing. Discussions on how to evaluate CVN 78 survivability in these environments are continuing with the Navy.

RECOMMENDATIONS

The following recommendations remain as stated in the FY23 Annual Report. The Navy should:

1. Improve the suitability of AAG, EMALS, AWE, and DBR while minimizing the requirement for off-ship and/or contractor technical support.

2. Reevaluate the timeline and better define the criteria for a decision to retrofit the fourth AAG engine.

3. Resource and execute the testing per Enterprise AW SSD TEMP 1714 and CVN 78 TEMP 1610, including the planned SGR testing, along with completing, verifying, validating, and accrediting the SGR M&S suite; underway cyber survivability testing; and self-defense tests and PRA modeling.

4. Re-examine manning and berthing for future ships of the class to ensure sufficient berthing is available and that 10 percent Service Life Allowance is allocated for future growth.

5. Prioritize and correct deficiencies identified in DOT&E's classified FSST report of December 2022.

6. Submit an update of the *Ford*-class TEMP for DOT&E approval in FY25 that is aligned with the new Enterprise TEMP 1910 and provides the test strategy and test resources to determine operational effectiveness of new and/or upgraded capabilities on CVN 79.

7. Verify electromagnetic spectrum compatibility during operational test to better inform effectiveness and survivability, particularly when integrated with CSG operations in an advanced electronic attack environment.

The following recommendations from the FY23 Annual Report have been updated. The Navy should:

1. Develop an effective strategy to collect data in accordance with the test plan for the remainder of IOT&E.

2. Continue to address the recommendations in DOT&E's classified self-defense interim assessment report from April 2022, and the additional recommendations in DOT&E's classified EFR from April 2023.

3. Continue to fully fund the scheduled replacement of DBR on CVN 78 with the EASR configuration.

4. Continue to develop more robust capabilities to test the cyber survivability of shipboard industrial control systems, similar to those capabilities

demonstrated during the March 2024 cyber survivability testing.

5. Provide a strategy to update the survivability assessments included in the vulnerability assessment reports to reflect the ship as built to support delivery of the final survivability assessment report in 4QFY25.

6. Identify, fund, and deliver a replacement for the Navy's self-defense test ship, ex-USS *Paul F. Foster*, to support planned testing of CVN 79 capability.

The Navy should address the following recommendations, which are new:

1. Characterize and validate performance of the SSAM model for SGR.

2. Continue to update the IOT&E test plan for major remaining tests such as SGR, self-defense, and cyber survivability tests and submit to DOT&E for approval.