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STATEMENT
BY

J. MICHAEL GILMORE
DIRECTOR, OPERATIONAL TEST AND EVALUATION
OFFICE OF THE SECRETARY OF DEFENSE

BEFORE THE
SENATE ARMED SERVICES COMMITTEE

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J. Michael Gilmore
Director, Operational Test and Evaluation (DOT&E)
Office of the Secretary of Defense

Chairman McCain, Ranking Member Reed, and distinguished members of the Committee, thank you for the opportunity to discuss my assessment of USS *Gerald R. Ford* (CVN 78). The Navy intends to deliver CVN 78 early in calendar year 2016, and to begin initial operational test and evaluation (IOT&E) in late calendar year 2017. However, the Navy is in the process of developing a new schedule, so some dates may change. Based on the current schedule, between now and the beginning of IOT&E, the CVN 78 program is proceeding on an aggressive schedule to finish development, testing, troubleshooting, and correction of deficiencies for a number of new, complex systems critical to the warfighting capabilities of the ship. Low or unknown reliability and performance of the Advanced Arresting Gear (AAG), the Electromagnetic Aircraft Launch System (EMALS), the Dual Band Radar (DBR), and the Advanced Weapons Elevators (AWE) are significant risks to a successful IOT&E and first deployment, as well as to achieving the life-cycle cost reductions the Navy has estimated will accrue for the *Ford*-class carriers. The maturity of these systems is generally not at the level that would be desired at this stage in the program; for example, the CVN 78 test program is revealing problems with the DBR typical of discoveries in early developmental testing. Nonetheless, AAG, EMALS, DBR, and AWE equipment is being installed on CVN 78, and in some cases, is undergoing shipboard checkout. Consequently, any significant issues that testing discovers before CVN 78's schedule-driven IOT&E and deployment will be difficult, or perhaps impossible, to address.

Resolving the uncertainties in the reliability and performance of these systems is critical to CVN 78's primary function of conducting combat operations. CVN 78 has design features intended to enhance its ability to launch, recover, and service aircraft. EMALS and AAG are key systems planned to provide new capabilities for launching and recovering aircraft that are heavier and lighter than typically operated on *Nimitz*-class carriers. DBR is intended to enhance radar coverage on CVN 78 in support of air traffic control and ship self-defense. DBR is planned to reduce some of the known sensor limitations on *Nimitz*-class carriers that utilize legacy radars. The data currently available to my office indicate EMALS is unlikely to achieve the Navy's reliability requirements. (The Navy indicates EMALS reliability is above its current growth curve, which is true; however, that growth curve was revised in 2013, based on poor demonstrated performance, to achieve EMALS reliability on CVN 78 a factor of 15 below the Navy's goal.) I have no current data regarding DBR or AWE reliability, and data regarding the reliability of the re-designed AAG are also not available. (Poor AAG reliability in developmental testing led to the need to re-design components of that system.) In addition, performance problems with these systems are continuing to be discovered. If the current schedule for conducting the ship's IOT&E and first deployment remain unchanged, reliability and performance shortfalls could degrade CVN 78's ability to conduct flight operations.

Due to known problems with current aircraft carrier combat systems, there is significant risk CVN 78 will not achieve its self-defense requirements. Although the CVN 78 design incorporates several combat system improvements relative to the *Nimitz*-class, these improvements (if achieved) are unlikely to correct all of the known shortfalls. Testing on other ships with similar combat systems has highlighted deficiencies in weapon employment timelines, sensor coverage, system track management, and deficiencies with the recommended engagement tactics. Most of these limitations are likely to affect CVN 78 and I continue to view this as a significant risk to the CVN 78's ability to defend itself against attacks by the challenging anti-ship cruise missile and other threats proliferating worldwide.

The Navy's previous decision to renege on its original commitment to conduct the Full Ship Shock Trial (FSST) on CVN 78 before her first deployment would have put CVN 78 at risk in combat operations. This decision was reversed in August 2015 by the Deputy Secretary of Defense. Historically, FSSTs for new ship classes have identified for the first time numerous mission-critical failures the Navy had to address to ensure the new ships were survivable in combat. We can expect that CVN 78's FSST results will have significant and substantial implications on future carriers in the *Ford*-class and any subsequent new class of carriers.

I also have concerns with manning and berthing on CVN 78. The Navy designed CVN 78 to have reduced manning to reduce life-cycle costs, but Navy analyses of manning on CVN 78 have identified problems in manning and berthing. These problems are similar to those seen on other recent ship classes such as DDG 1000 and the Littoral Combat Ship (LCS).

AAG

AAG has undergone testing at the Navy's land-based test site in Lakehurst, New Jersey. Planned testing over the last few years has experienced delays to address problems discovered during testing. Testing has uncovered deficiencies in major components and in software that have contributed to several redesigns of the system since 2007. In July 2013, the AAG program office provided estimates of AAG reliability in the shipboard configuration.[1] At that time, the program estimated AAG reliability to be approximately 20 Mean Cycles Between Operational

[1] Testing at Lakehurst uses a system similar, but not identical, to the CVN 78 configuration. The AAG program used data from Lakehurst to estimate AAG reliability onboard CVN 78 in the shipboard configuration.

Mission Failure (MCBOMF) in the shipboard configuration.[2,3] That estimate was well below the Navy's goal of 16,500 MCBOMF.[4] Unless resolved, AAG's low reliability will diminish CVN 78's ability to conduct flight operations and will reduce the number of sorties per day that CVN 78 can support. In particular, a typical day of flight operations requires 100 arrested landings. If the reliability of the re-designed AAG is not substantially better than prior test results, CVN 78 likely will not be able to complete a normal day of flight operations and may need to frequently divert aircraft to other airfields due to non-availability of arresting gear.

Prior test data indicate clearly that absent significant changes in its design, AAG reliability is unlikely to achieve its goal.[5] MIL-STD-189C states that the ratio of initial reliability of a system to its reliability goal must be greater than or equal to 0.30.[6] It also notes that failure to achieve a sufficiently high initial reliability in the past has resulted in an unacceptably high percentage of the Department's developmental systems failing to meet their reliability thresholds in the IOT&E. Based on this, AAG reliability should be above 4,950 MCBOMF at this point in the development to have a reasonable chance of achieving the goal of 16,500 MCBOMF.

In a December 2014 briefing to my office, the AAG program acknowledged that the AAG design at that time did not meet service life requirements, and decided to redesign the

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[2] The AAG estimate is based on reliability block diagrams, which model the overall system based on individual component analysis.
[3] A cycle represents the recovery of one aircraft.
[4] The Navy goal is for the AAG installation on CVN 78. An operational mission failure is a failure that reduces the number of available AAG engines below two. The Navy's original plan installed four AAG engines on CVN 78; however, it is currently expected that only three engines will be installed on CVN 78.
[5] This concern has been noted in my December 2013, Operational Assessment of USS Gerald R. Ford (CVN 78) Report and my FY13 and FY14 Annual Reports.
[6] MIL-STD-189C, Department of Defense Handbook for Reliability Growth Management," dated 14 June 2011.

water twister, one of three major components of AAG.[7] The redesigned water twister was installed at the Jet Car Track Site (JCTS) at Lakehurst earlier this year. The AAG program started performance testing in July to validate the new design.[8] The program does not expect to have a statistically significant number of test events for assessing performance or reliability until later this year. Consequently, I do not now have performance or reliability data on the new design, which is installed on CVN 78. If any major issues are discovered during upcoming testing, it will be difficult if not impossible to incorporate any changes onto CVN 78.

The AAG program office also notes there is schedule risk in developing the Aircraft Recovery Bulletins (ARB) for CVN 78. The ARBs provide standardized operating procedures and technical guidance, and are required to conduct AAG flight operations. The schedule, which the program office considers to be at risk, has the first ARB delivered in June 2016, which addresses F/A-18E/F aircraft. Subsequent ARBs will cover the other aircraft in the CVN 78 air wing with the final ARB scheduled for April 2017. This is shortly before the CVN 78 IOT&E is scheduled to start in September 2017. Consequently, a delay of even a few months will affect IOT&E.

EMALS

EMALS is more mature than AAG. Over the years, technical issues with the EMALS power interface and conversion systems and other deficiencies have slowed progress. However, testing at the Navy's land-based test site in Lakehurst has demonstrated performance across the

[7] AAG includes three brakes for recovering aircraft, the water twister, a brake derived from the B-52 landing gear brake, and a motor-generator. The three separate brakes provide redundancy within the AAG system to ensure the safe recovery of aircraft.

[8] In JCTS testing, AAG arrests jet-propelled vehicles that travel down a railway with different loads and speeds. The AAG arrests these vehicles to test performance before transitioning to manned aircraft.

system's envelope. Testing at Lakehurst has examined EMALS performance launching F/A-18, C-2, E-2D, F-35C, and T-45 aircraft. EMALS equipment is installed on CVN 78 and has begun shipyard testing, which includes dead load testing, to check out the installed equipment.[9]

While EMALS is more mature than AAG, EMALS reliability remains a concern. In its last report to my office in December 2014, the EMALS program office estimated EMALS reliability to be approximately 340 Mean Cycles Between Critical Failure (MCBCF) in the shipboard configuration.[10,11,12] This is well below the Navy goal of 4,166 MCBCF in the shipboard configuration, although it is above a revised reliability growth curve developed by the Navy in 2013 indicating achievement on CVN 78 of EMALS reliability a factor of 15 below the Navy's goal; that revision was necessary to generate a defensible growth curve consistent with the system's low demonstrated reliability. Following MIL-STD-189C, EMALS reliability should be above 1,250 MCBCF at this point in the development to have a reasonable chance of achieving the Navy's reliability goal. As with AAG, I am concerned about EMALS reliability and the potential effect on CVN 78 flight operations.

In addition, the EMALS program is still discovering problems during testing. For example, the program discovered last year that EMALS launches of F/A-18E/F and EA-18G aircraft will overstress aircraft attachment points for wing-mounted 480-gallon external fuel tanks. Until the problem is rectified, these aircraft cannot employ external fuel tanks, which all but eliminates the organic tanking capability of the carrier strike group as well as normal flight

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[9] Dead loads are large, wheeled steel vehicles used to simulate the weight of actual aircraft.
[10] The EMALS estimate is based on reliability block diagrams, which model the overall system based on individual component analysis.
[11] A critical failure is a failure that brings the number of available catapults below three.
[12] The EMALS land-based configuration has one catapult versus the four planned for CVN 78, and it does not include the shared electrical power configuration intended for use on the ship.

operations. I agree with the Navy's assessment that the problem can be resolved; nonetheless, it is a concern that these types of problems are being discovered so close to the ship's delivery. Because EMALS equipment is installed on CVN 78, if upcoming testing uncovers additional problems, it will be difficult to incorporate changes onto CVN 78.

AWE

The eleven AWEs on CVN 78 move ordnance and other supplies between the magazines, the hanger, the weapons handling areas, and the flight deck. The AWEs on CVN 78 are a new design. They are high capacity rope-less elevators each utilizing four Linear Synchronous Motors (LSMs). To date, only engineering analyses of AWE reliability are available, which do not include significant test data. The early evidence from testing on CVN 78 in the shipyard raises concerns. Developmental testing on CVN 78 AWEs has required substantial contractor support suggesting that the system has poor reliability. If the AWEs on CVN 78 are unreliable, it will degrade the ship's ability to conduct combat operations.

DBR

DBR is composed of two radars, the Volume Search Radar (VSR) and the Multi-Function Radar (MFR). The DBR is currently undergoing land-based testing at Wallops Island, Virginia using a configuration that is similar to the CVN 78 shipboard configuration. However, engineering development hardware is being used in some areas instead of production hardware, shore based power and cooling are used rather than shipboard power and cooling, and the radars each have one face versus the three faces each on CVN 78.[13] Consequently, some DBR

[13]The VSR and MFR operate in different frequency bands. VSR has three radar faces and MFR has three radar faces, for a total of six faces.

capabilities cannot be tested in a live environment until testing occurs onboard CVN 78 including, for example, the radar's ability maintain track on a target as the target transitions from one radar face to another.

The ongoing developmental testing at Wallops Island is in the problem discovery phase. Tests in the past year have revealed significant issues with tracking and supporting intercept missiles in flight, excessive numbers of clutter/false tracks, and track continuity issues. Since DBR provides CVN 78 with its ability to support air traffic control, it is noteworthy that some of the problems, such as close range clutter and dropping aircraft tracks that are in holding/marshalling patterns, critically degrade air traffic control functionality. The program is working on fixes to the problems identified so far; but, because testing is in the early stages, the program has had limited opportunity to verify the efficacy of the fixes.

The Navy is concerned about the amount of testing that remains to be completed as the DBR is integrated with the rest of the CVN 78 combat system. Consequently, the Navy has developed a plan to extend testing at Wallops Island. Under the Navy's previous plans, the MFR at Wallops Island was to be moved to the Self-Defense Test Ship (SDTS) in June of this year to conduct self-defense testing. The Navy's new plan leaves MFR at Wallops Island for approximately another year, providing valuable time to conduct DBR and combat system integration testing. While the new plan will have ripple effects on other testing efforts, I agree that it is necessary to extend testing at Wallops.

Unfortunately, the new plan will not relieve CVN 78's aggressive test and deployment schedule. Under the CVN 78's current program schedule, the ship will not complete its Combat System Ship Qualification Trial (CSSQT) until December 2017, which is after IOT&E begins. It is during the CSSQT that CVN 78 will fire its first missiles in self-defense scenarios and the ship's crew will first demonstrate combat system safety and crew proficiency. To have this key event ending after IOT&E begins, raises the likelihood that additional problems will be discovered during IOT&E or that problems discovered during the CSSQT affect self-defense testing during the IOT&E.

I also note that only engineering analyses of DBR reliability are currently available, which do not include significant test data. Although the Wallops Island land-based test site is not fully production representative, some reliability data are expected to be collected during testing that is currently ongoing. To date, some reliability problems have been observed at Wallops Island, for example with low voltage power supplies and with Transmit/Receive Integrated Multichannel Modules (T/RIMM) that form the radar antenna. The Navy has developed some fixes, for example, for the low voltage power supplies, but the problems with the T/RIMM modules, in particular, are a significant concern that, while progress is being made, are not fully resolved. Similar to EMALS and AAG, DBR equipment has been installed on CVN 78. Therefore, it will be difficult to correct performance or reliability problems that are discovered in upcoming testing of DBR, which is a critical system for both air traffic control and ship self-defense.

Sortie Generation Rate (SGR)

One of CVN 78's Key Performance Parameters is Sortie Generation Rate (SGR), but for a variety of reasons, CVN 78 is unlikely to achieve the required SGR. SGR measures the number of aircraft that CVN 78 can launch and recover each day. The Navy designed CVN 78 to have a higher SGR than the *Nimitz*-class carriers. CVN 78 has features intended to provide this enhanced capability that include a slightly larger flight deck, dedicated weapons handling areas, and increased aircraft refueling stations. CVN 78 requirements specify an SGR of 160 sorties per day during sustained operations (12-hour flight day) and 270 sorties per day (24-hour flight day) during surge operations. In comparison, *Nimitz*-class has demonstrated an SGR of 120 sorties per day in sustained operations and 240 sorties for surge.

As described above, I have concerns related to the performance and reliability of AAG, EMALS, AWE, and DBR. These systems are critical to CVN 78 flight operations and are being tested for the first time in their shipboard configurations after they have been installed in CVN 78. I assess the poor or unknown reliability of these critical systems and the performance issues outlined above, which clearly have the potential to diminish CVN 78's SGR, as the most significant risk to CVN 78's successful completion of IOT&E.

In addition, there are also problems with the SGR requirements themselves because they are based on unrealistic assumptions. The SGR requirements are defined through a 35-day wartime scenario known as the Design Reference Mission (DRM).[14] The DRM and the CVN 78 program office SGR assessments assume fair weather and unlimited visibility and that aircraft emergencies, failures of shipboard equipment, ship maneuvers (e.g., to avoid land), and manning shortfalls will not affect flight operations. These assumptions are unrealistic and CVN 78 is unlikely to meet the SGR requirements in an operational environment where these factors do affect flight operations.

Combat System Performance

Due to known problems with current aircraft carrier combat systems, there is a substantial risk CVN 78 will not achieve its self-defense requirements. Although the CVN 78 design

[14] The Navy released the current version of the DRM, version 6.0, on 4 March 2015. Version 6.0 incorporates a handful of changes, including a transition from an air wing with a mix of Joint Strike Fighters and F/A-18s to an all F/A-18 air wing (plus E-2s and other aircraft).

incorporates several combat system improvements relative to the *Nimitz*-class, these improvements are unlikely to address all of the known shortfalls. In past reports, I have noted that the "CVN 68 class continues to have several problems that hinder it from successfully conducting ship self-defense. Specific problems include deficiencies in weapon employment timelines, sensor coverage, system track management, NATO Evolved Sea Sparrow Missile performance, as well as deficiencies with the recommended engagement tactics."[15] Most of these limitations are likely to affect CVN 78 and I continue to view these limitations as a significant risk to CVN 78's ability to defend itself.

The CVN 78 combat system for self-defense is derived from the combat system on current carriers and amphibious ships. The combat system is used for self-defense against cruise missiles, small boats, and other threats. The combat systems on aircraft carriers and amphibious ships integrates several legacy shipboard systems, as well as several major acquisition programs including Ship Self-Defense System (SSDS), Rolling Airframe Missile (RAM), Evolved Sea Sparrow Missile (ESSM), Cooperative Engagement Capability (CEC), and Surface Electronic Warfare Improvement Program (SEWIP). On CVN 78, this integration effort includes DBR. While the integration of sensor and weapon systems with the command and decision system enhances a ship's self-defense capability relative to the use of non-integrated combat systems, the Navy has not successfully demonstrated the ability to effectively complete the self-defense mission against the types of threats and threat scenarios for which the overall system was designed. These problems affect CVN 78, as well as other Navy ships.

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[15] My unclassified conclusions are reported in the FY11 through FY14 Annual Reports, and classified conclusions are documented in the March 2011 and the November 2012 Ship Self-Defense Operational Mission Capability Assessment Reports.

The combat system improvements incorporated for CVN 78 should reduce some of the sensor coverage problems historically seen on carriers, but other shortfalls in combat system integration and weapon limitations will remain. The most significant improvements involve upgrades to the sensors. The Navy will replace several legacy sensors used on *Nimitz*-class carriers with the new DBR.[16] In addition, CVN 78 will receive a new SEWIP electronic warfare system, which is an upgrade from the current SLQ-32 passive radio frequency sensor. These changes should improve sensor coverage, which has been a deficiency on *Nimitz*-class carriers. To confirm these improvements, however, realistic operational testing on CVN 78 and on the Self-Defense Test Ship (SDTS) is required. (SDTS testing is required to examine CVN 78's ability to defend itself in scenarios that are unsafe to conduct on manned ships.)

Some have argued that the self-defense limitations of aircraft carriers are not important because destroyers and cruisers escort carriers in combat and will handle these threats, but this argument ignores the fact that the CVN 78 self-defense requirements assume that these escorts are present. For example, the CVN 78 requirements to defend itself against enemy cruise missile attacks assume that the escorts will defeat most of an incoming raid and that only a portion of the raid, that will nonetheless be a challenge to defeat, will leak through to the CVN 78's self-defense systems. The Navy's most recent classified analysis examined a variety of tactical scenarios and confirmed the need for CVN 78 to be able to defend itself against cruise missiles that leak through the escorts.[17]

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[16] Legacy sensors on Nimitz-class carriers include SPS-48, SPS-49, SPQ-9, and Mk 9 tracking illuminator.
[17] *Surface Ship Theater Air and Missile Defense Assessment (SSTAMDA) Study Report (U)*, 9 July 2008, N86/8S177518

In addition to the historic problems with carrier combat systems mentioned earlier, there are other known limitations with the CVN 78 combat system design. These limitations include disconnects between the CVN 78 requirements and current tactics for surface threats; performance limitations against surface swarm attacks; known limitations involving torpedoes and the Nixie torpedo decoy; and concerns with mine warfare and degaussing. While these problems affect many of the Navy's surface combatants, they represent risks to CVN 78's self-defense capabilities.

Program Schedule and Test Risks

Some have expressed concerns that the CVN 78 post-delivery program is too lengthy and comprises an excessive number of independent steaming events (ISEs) and other activities. In fact, the program of testing and other activities leading up to the ship's deployment is determined almost entirely by the Navy's own safety and training requirements. In particular, the program schedule and number of ISEs subsequent to the ship's delivery are not driven by a mandate from testers to obtain hundreds of thousands of cycles on arresting or launch equipment, which was never expected to occur prior to the ship's deployment, as all involved in the program have known for many years. The program schedule is driven by the need to complete numerous training events, Aircraft Recovery Bulletins (ARBs, which provide standardized operating procedures and technical guidance for the arresting gear and are required by the Navy to conduct flight operations), and carrier flight qualifications. For example, under the Navy's own plans, CVN 78 will not complete air-wing carrier qualifications with all of the aircraft types expected on CVN 78, until the 29th ISE. Completion of the ARBs necessary to conduct air-wing qualifications has been delayed by the poor reliability and subsequent re-design of the AAG. Carrier strike operational testing, which cannot be conducted until the air-wing has finished workups and completed carrier air-wing qualification, will be conducted as part of the CVN 78's Joint Task Force Exercise (JFTX), which is an integral part of the Navy's planned training evolution for the ship and her crew. This plan was developed to enable cost-effective testing of CVN 78's new capabilities at the earliest possible times by using data from the Navy's already-planned exercises. The common theme of the test plan is to test systems as early as possible to provide early feedback to the program office, and to combine training and testing.

Nonetheless, CVN 78 currently has a post-delivery schedule driven by the ship's deployment date and leaves little time to fix problems discovered in developmental testing before IOT&E begins. The aggressive schedule has pushed significant portions of developmental testing beyond the start of the first phase of IOT&E. Developmental Test/Integrated Test-5 (DT/IT-5), a major system integration test period, overlaps the beginning of IOT&E. Major at-sea combat system developmental tests, such as Combat System Shipboard Developmental Test events, also are scheduled to occur after IOT&E begins.[18] This aggressive schedule increases the likelihood that problems will be discovered during CVN 78's IOT&E that could delay the successful completion of testing, and may delay CVN 78's first deployment.

Full Ship Shock Trial (FSST)

CVN 78 survivability will be assessed as part of CVN 78's Live Fire Test and Evaluation (LFT&E) program, which includes a Full Ship Shock Trial (FSST). Historically, FSSTs for each ship class have identified previously unknown mission-critical failures that the Navy had to

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[18] Combat System Shipboard Developmental Test (CS SBDT) #9 and #10 occur after IOT&E begins.

address to ensure that the ships would be survivable in combat. I have documented these issues in classified memoranda.[19]

In combat, even momentary interruptions of critical systems can be catastrophic when those systems are crucial to defending against incoming threats. This is why the Navy has historically required mission-essential systems to remain functional before, during, and after shock. The Navy's shock qualification specification states that a momentary malfunction is acceptable only if it is automatically self-correcting and only if no consequent derangement, mal-operation, or compromise of mission essential capability is caused by the momentary malfunction. Thus, arguments made by some that deferring the shock trial presents acceptable risk because the trial will find problems that crews can fix miss the point---unanticipated failures requiring minutes, let alone hours or days to fix are unacceptable in combat, by the Navy's own admission. The Deputy Secretary of Defense directed in August 2015 that the FSST be conducted on CVN 78 prior to her maiden deployment. The FSST will provide critical information regarding CVN 78's ability to survive and continue to conduct combat operations after absorbing hits from enemy weapons: understanding these vulnerabilities is essential. Discoveries made by conducting the FSST on CVN 78 will enable timely modification of future ships of the *Ford*-class to assure their survivability.

Some have indicated that shock trials are expected on new ships, but have yet to be done on the first ship of the class, which is incorrect. History shows that shock trials have regularly been conducted on first-of-class ships including PGH 1, LCC 19, DD 963, CV 59, LHA 1, FFG

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[19] 13 August 2012 memorandum, *Value of Conducting Full Ship Shock Trials (FSST) (U)* and 5 May 2014 memorandum, *GERALD R. FORD Class CVN 78 Full Ship Shock Trial (FSST).*

7, DDG 993, LSD 41, MCM 1, LHD 1, and MHC 1. However, on occasion, various circumstances have caused some shock trials not to be conducted on the first-of-class, with the primary reason being to ensure testing is conducted on the most representative ship of the class. For example, FSSTs will not be conducted on the first-of-class Littoral Combat Ships (LCSs) because numerous significant design changes are being incorporated in later ships. Nonetheless, the preference is to perform the FSST on the first-of-class ship, so as to identify and mitigate mission-critical failures as soon as possible.

Some have argued component-level testing and modeling and simulation are sufficient to identify and correct shock-related problems on fully-integrated ships. If that were the case, no mission critical failures should ever occur during FSSTs, which are conducted at less than the design-level of shock; however, mission-critical failures are always observed. For CVN 78, the FSST is particularly important given the large number of critical systems that have undemonstrated shock survivability. These systems include AAG, EMALS, DBR, the 13.8 kilovolt Electrical Generation and Distribution Systems, AWE, a new reactor plant design, and a new island design and location with a unique shock environment.

It is noteworthy that the conduct of an FSST on CVN 78 prior to her first deployment had been a part of the program of record since 2004; therefore, the Navy has had ample time to plan for this event. Nonetheless, a number of claims have been and are being made regarding the potential delay in CVN 78's deployment caused by conducting the FSST prior to the ship's first deployment. These claims span months to years; however, only the former is consistent with the Navy's conduct of the FSST on CVN 71, USS *Theodore Roosevelt*. Commissioned in October 1986, CVN 71 was underway most of January and February 1987 conducting crew and flight operations as part of shakedown. From March to July 1987, CVN 71 underwent a postshakedown availability. The month of August was used to prepare for the FSST, which was conducted during the period spanning August 31, 1987 to September 21, 1987. Upon completing the FSST, CVN 71 returned to Norfolk Naval Station for a two-week period to remove specialized trial equipment and to complete repairs to systems essential to flight operations. After completing those mission-critical repairs, CVN 71 returned to sea to conduct fleet carrier qualifications. From November 1987 to January 1988, the ship underwent a restricted availability to complete all post-FSST and other repairs. CVN 71 was then underway for most of the remainder of 1988, conducting independent steaming exercises and other activities, departing on its first deployment on December 30, 1988. The effect of conducting the FSST on CVN 71's availability for operations following the shock trial was two weeks to conduct mission-critical repairs, and the total time required to prepare for, conduct, and recover fully from the FSST was about five months, including the restricted availability.

Manning

I recommend that manning and berthing be reexamined for the CVN 78-class so that lessons learned can be incorporated into CVN 79. To reduce total ownership costs, the CVN 78 manning requirement is 500 billets below the *Nimitz*-class.[20] This manning requirement focuses on the ship's company and does not include the carrier air wing or embarked staffs. To achieve reduced manning, the Navy has relied upon technologies that have not been fully developed, tested, or fielded and emerging Navy-wide policies for moving workload to shore support. Similar assumptions were applied to the DDG 1000 and LCS programs. For those ship classes,

[20] *Nimitz* is allocated 3,291 billets in the 2002 CVN 68 Draft Ship's Manning Document. The CVN 78 manning threshold is 2,791 billets.

the Navy has increased the size of the crews beyond the original estimates. On LCS, for example, this led to significant berthing changes. Similar manning growth could occur for CVN 78 with related berthing issues.

In its manpower analyses, the Navy has highlighted several concerns:[21]

- CVN 78's manning must be supported at the 100 percent level, although that is not the Navy's standard practice on other ships and the ability of the Navy's personnel and training systems to provide 100 percent manning is unclear;
- CVN 78 is extremely sensitive to manpower fluctuations, and in several areas a shortfall of one or two crew members creates unsustainable workloads;
- Current Navy constructs for training will not work for new and unique CVN 78 systems;
- Berthing shortfalls for Chief Petty Officers (CPO) exist;
- Officer berthing is very tight and must be managed closely;
- Berthing during some training evolutions that require a significant number of evaluators and ship riders onboard CVN 78 is inadequate;[22]
- Who is in charge of managing and maintaining CVN 78's network is not defined, a network which is much more complex than historically seen on Navy ships;
- Workload estimates for AAG, EMALS, and DBR are not well-understood.

In addressing these concerns on CVN 78, some changes are relatively easy, others are more difficult. Addressing the CVN 78's atypical requirement for 100 percent manning and the

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[21] The Navy holds regular CVN 78 manpower assessments. The last, *USS Gerald R. Ford (CVN 78) War Game III*, was held 28 July – 01 August 2014.

[22] Inadequate berthing is identified as an issue for the Composite Training Exercise (COMPTUEX) integrated phase.

training shortfalls for CVN 78 unique equipment will likely require changes to the Navy support structure. With respect to increasing the ship berthing, typical berthing areas on CVN 78 have berthing racks that are two bunks high; it is relatively easy to replace two-high racks with three-high racks. This has been done on other ships such as LCS. However, it is relatively hard to provide additional showers and water closets. This requires identifying additional areas for showers and water closets and significant work for plumbing. Since habitability is a major concern for Navy ships and because these factors will inevitably have an effect on CVN 78 habitability, the Navy should reexamine manning and berthing for CVN 79.

Summary

There are significant risks to the successful completion of the CVN 78 IOT&E and the ship's subsequent deployment due to known performance problems and the low or unknown reliability of key systems. For AAG, EMALS, AWE and DBR, systems that are essential to the primary missions of the ship, these problems, if uncorrected, are likely to affect CVN 78's ability to conduct effective flight operations and to defend itself in combat.

The CVN 78 test schedule leaves little or no time to fix problems discovered in developmental testing before IOT&E begins that could cause program delays. In the current program schedule, major developmental test events overlap IOT&E. This overlap increases the likelihood problems will be discovered during CVN 78's IOT&E, with the attendant risk to the successful completion of that testing and to the ship's first deployment.

The inevitable lessons we will learn from the CVN 78 FSST will have significant implications for CVN 78 combat operations, as well as for the construction of future carriers incorporating the ship's advanced systems; therefore, the FSST should be conducted on CVN 78 as soon as it is feasible to do so.