Research Brief

RAND NATIONAL DEFENSE RESEARCH INSTITUTE

Aircraft Carrier Maintenance Cycles and Their Effects

The U.S. Navy currently maintains a fleet of 11 aircraft carriers. These ships allow the Navy to undertake a wide variety of tasks, ranging from bringing airpower to bear against opponents to humanitarian missions. These ships, which are among the most complex weapon systems the Navy operates, require continuous and regularly scheduled maintenance. Their crews require a great deal of training to attain and sustain readiness levels. The *length* of the training, readiness, deployment, and maintenance cycle (defined as the period from the end of one depot maintenance period to the end of the next), the *type* of maintenance needed (i.e., docking or non-docking), and the *timing of events* within the cycle affect the carrier's availability to meet operational needs.

In a given cycle, a ship may be deployed, in maintenance, or not deployed but able to provide additional forward presence as requested by theater commanders (i.e., able to "surge"). An aircraft carrier's surge readiness depends on the carrier and crew's level of training. When training for deployment is complete, the carrier can be surged within 30 days. Aircraft carriers undergoing basic training immediately after a maintenance period are at a lower readiness level and normally can be surged in 90 days. The length of the cycle has changed several times in the last two decades. Currently, the Navy uses a 32-month cycle. Given one deployment per cycle, this has reduced the time a carrier is actually deployed but increased the amount of time it is able to surge. The Navy asked RAND to assess how differing cycles would affect the amount of time a ship is able to deploy or be deployed.

Abstract

This research explores the impact of varying maintenance cycles on the ability of aircraft carriers to meet the U.S. Navy's operational needs. It finds that cycles shorter than the current 32-month, one-deployment cycle could increase the time a carrier is deployed and providing forward presence but decrease the time it is available to deploy to meet emerging needs. A longer, two-deployment cycle could boost the ability of a ship to deploy or be deployed but place unmanageable demands on shipyards providing maintenance.

Cycles and Operational Availability

Given a fixed number of months for maintenance, deployments, and time between deployments (consistent with personnel quality-of-life goals), Navy planners face a three-sided trade-off in setting ship schedules. They must balance goals of

- deploying carriers and generating forward presence
- holding a carrier in reserve and keeping it surge-ready to meet emerging needs
- maintaining the materiel condition of the ship.

This is a zero-sum trade-off in which improving the ability to meet one goal can adversely affect the ability to meet the others (see Figure 1).

Under the current 32-month, one-deployment cycle, for example, in which both the deployment and maintenance periods typically last six months, a carrier is deployed 19 percent of the time, able to surge within 30 days 46 percent of the time and within 30–90 days an additional 11 percent of the time, and in depot maintenance 24 percent of the time. A shorter, 18-month cycle would see a carrier deployed 31 percent of the time, able to surge within 30 days 15 percent of the time and within 30–90 days 18 percent of the time, and in depot maintenance 36 percent of the time.

A longer, 42-month cycle featuring two 6-month deployments would see a carrier

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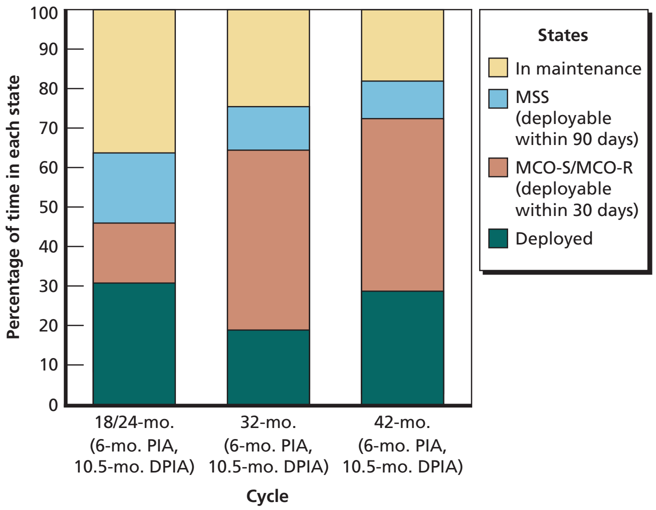
Figure 1.
Summary Operational Measures for 18/24-, 32-, and 42-Month Cycles (Over the Life of a Notional Carrier)



NOTE: MSS = Maritime Security Surge; MCO–S = Major Combat Operations–Surge; MCO–R = Major Combat Operations–Ready; PIA = planned incremental availability; DPIA = docking planned incremental availability.

deployed 29 percent of the time, able to surge within 30 days 44 percent of the time and within 30–90 days 9 percent of the time, and in maintenance 18 percent of the time. A longer cycle would help meet the "6+1 fleet" goal of having at least six carriers deployed or able to deploy within 30 days and an additional one able to deploy in 90 days. It is not clear, however, whether required depot maintenance can be completed in one 6-month period every three and a half years.

Cycles and Shipyard Workload

RAND researchers also assessed the technical feasibility of maintenance cycles of varying lengths. Prior to the current 32-month cycle, *Nimitz*-class carriers operated on cycles of 24–27 months. This suggests that shorter cycles, by offering more-frequent opportunities to accomplish depot work, are technically feasible.

Shorter cycles may also help in level-loading work at the shipyards, with more-frequent depot visits resulting in smaller work packages. Currently, the two public shipyards that perform depot-level maintenance for carriers can efficiently execute about 30,000 man-days per month. We assume that depot maintenance periods required by a shorter 18-month cycle would require 15,000 to 25,000 man-days per month, and therefore could perhaps be accomplished in less than the six months for which they are now scheduled.

Longer cycles could, as noted, raise several questions of feasibility. The extension of time between depot availabilities and conducting two deployments per cycle will increase maintenance demands and make it more challenging to level-load shipyards. Certain maintenance tasks must be performed at specified times to ensure that an aircraft carrier reaches its operational life of approximately 50 years. Some of these tasks could perhaps be moved, but engineering studies (such as those conducted when the cycle was extended to 32 months) will be required. Furthermore, moving some of these tasks could result in depot work packages of up to 375,000 man-days, or more than twice what the public shipyards could accomplish in six months.

Longer cycles with larger work packages would also cause wide fluctuations in workload, making it difficult to efficiently manage the depot workforce and possibly leading to higher costs. Stretching work beyond the notional 6-month depot maintenance period could help level shipyard workload over time and increase the time available to accomplish required maintenance. It would also, however, reduce the time a ship is deployed or deployable and require more time for training and certification of crews after ship maintenance.

Findings and Recommendations

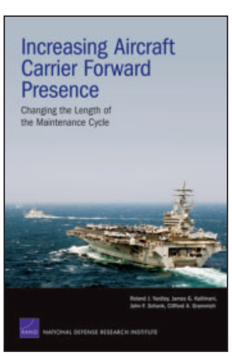
On balance, our analysis suggests that shortening the one-deployment cycle will increase the forward presence of the carrier fleet but reduce its ability to meet the 6+1 fleet goal. Shorter cycles can also help level workload at the shipyards. Longer, two-deployment cycles will increase forward presence while sustaining higher levels of readiness for longer periods of time only if the workload management challenges they raise are addressed. As noted, the Navy needs to perform engineering studies to examine the impact of increased maintenance demands in two-deployment cycles. Table 1 summa-

Table 1
Effects of Cycles Shorter or Longer Than the Baseline 32-Month Maintenance Cycle

Metrics	Shorter Cycle (e.g., 18/24-month, one-deployment)	Longer Cycle (e.g., 42-month, two-deployment)
Time a carrier is deployed	Increased	Increased, if maintenance workload can be managed
Surge readiness (deployable within 30–90 days)	Decreased	Increased
Ability to meet 6+1 fleet goal	Decreased	Increased
Ability to level-load work across time at shipyards	Increased	Decreased
Maintenance demands	More frequent	May create deferred-work backlogs

rizes the advantages and disadvantages of each notional cycle mentioned above over the current 32-month cycle.

The Navy has recently adjusted personnel tempo policies to better provide carriers where and when needed. Current plans to meet demands for aircraft carrier presence include extending deployment lengths, reducing turnaround times, and, in some cases, including two deployments per cycle. Our analysis offers options for increasing carrier forward presence while keeping previous personnel tempo policies intact. ■



This research brief describes work done for the RAND National Defense Research Institute documented in *Increasing Aircraft Carrier Forward Presence: Changing the Length of the Maintenance Cycle*, by Roland J. Yardley, James G. Kallimani, John F. Schank, and Clifford A. Grammich, MG-706-NAVY (available at http://www.rand.org/pubs/monographs/MG706/), 2008, 90 pp., $23, 978-0-8330-4407-5. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors. RAND® is a registered trademark.