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EFFECTS THAT A FIVE-YEAR PROCUREMENT CYCLE  
WOULD HAVE ON COST, AVAILABILITY, AND  
SHIPYARD MANPOWER AND WORKLOAD

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# CHANGING AIRCRAFT CARRIER PROCUREMENT SCHEDULES

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## Summary

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Nuclear aircraft carriers, the centerpiece of the naval forces of the United States, are one of the most complex weapon systems the military buys. At present, it takes more than seven years to authorize, construct, and deliver an aircraft carrier. There are also several years of advance funding before the contract for a new aircraft carrier is signed for the procurement of long-lead-time items and some advance construction work at the shipyard. Because of their size and complexity and the time it takes to construct aircraft carriers, it is difficult to quickly change the number in the fleet and, especially, to increase it. The August 2008 30-Year Shipbuilding Plan (SBP)<sup>2</sup> sought to stabilize the long-term number of aircraft carriers, each with a 50-year operational life, by establishing a cycle of approximately four years for the authorization of a new aircraft carrier.

In April 2009, the Secretary of Defense suggested extending this acquisition cycle to five years. Ultimately, this extension will result in a force of ten aircraft carriers by 2040. Such a cycle could affect the Navy's ability to meet forward-presence goals for aircraft carriers, as well as the acquisition costs of *Ford*-class aircraft carriers. Recognizing the need to understand these potential impacts, the Program Executive Office (PEO) for Aircraft Carriers asked RAND to examine the impact that a five-year acquisition cycle would have on various force-structure metrics and on current and future aircraft carrier acquisi-

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<sup>2</sup> Office of the Chief of Naval Operations, Director, Warfare Integration (OPNAV N8F), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for FY2009*, Washington, D.C., February 2008.

tion costs. To do so, RAND researchers worked with PEO Carriers; Northrop Grumman Shipbuilding—Newport News (NGSB-NN), the sole shipyard that builds aircraft carriers; and the major vendors that support aircraft carrier construction and maintenance. They also modified existing models that predict various operational metrics of the aircraft carrier force and estimated the impact that changes to production schedules would have on the shipyard and vendor workforces. This document summarizes RAND research findings on the future aircraft carrier force, shipyard and vendor workforces, and the public shipyards that perform aircraft carrier maintenance.

## Summary Comparison of the Two Plans

Table S.1 summarizes various force-structure metrics and changes in shipyard labor and overhead costs under the 30-year SBP and the five-year authorization plan.

**Table S.1**  
**Metrics for the 30-Year Shipbuilding Plan and the Five-Year Plan, 2015–2045**

Metric	30-Year SBP	5-Year Cycle
Percentage of years in which force $\geq$ 12 carriers	61	35
Percentage of years in which force $\leq$ 11 carriers	39	65
Percentage of years in which presence goals were met (average 2.6 deployed)	55	48
Percentage of years in which readiness goals were met (6 carriers deployed or deployable in 30 days)	97	97
Percentage change in CVN 78 to CVN 81 shipyard labor and overhead costs <sup>a</sup>	—	-3 to +2
Percentage increase in CVN 71 to CVN 75 RCOH shipyard labor and overhead costs <sup>a</sup>	—	-2 to +6

NOTE: CVN = nuclear-powered aircraft carrier. RCOH = refueling and complex overhaul.

<sup>a</sup> Average percentage cost change (in constant fiscal year [FY] 2009 dollars) compared with the expected cost under the 30-year SBP.

In this summary, we discuss these findings on operational metrics and on constant-dollar shipyard labor and overhead costs, along with the research findings on the potential impacts that inflation, the vendor base, and the workload at the public shipyards could have on total aircraft carrier acquisition costs.

## **Effects on the Future Aircraft Carrier Operational Metrics**

The plans provide the same force structure and ability to meet presence and readiness goals until the early 2020s because the first carrier affected by the five-year plan (CVN 79) is not scheduled for delivery until 2019 under the 30-year SBP and 2020 under the five-year plan. Beyond that point, the 30-year SBP provides a force of 11 or 12 aircraft carriers, even climbing to a force of 13 aircraft carriers in 2023 and 2024. The five-year plan provides a force of 11 or 12 aircraft carriers the majority of the time but ultimately reduces to a ten-carrier force in 2042. The five-year plan results in a force of one fewer aircraft carrier than the 30-year SBP for 13 of the 23 years between 2023 and 2045. For presence and readiness metrics, the lower force structure of the five-year plan is partially offset by the increased operational availability of the *Ford*-class aircraft carriers.

Both plans show the challenges the Navy faces in meeting the goal of having an annual average of 2.6 aircraft carriers deployed with an 11-carrier force. The presence goal will prove difficult to meet until 2021 when the carrier force grows to 12 carriers under both plans. From 2021 to 2040, both plans can meet the goal of an average of 2.6 deployed aircraft carriers the majority of the time. Beyond 2041, both plans again have problems meeting the goal due to a reduction in the aircraft carrier force. Overall, the 30-year SBP can meet the deployed goal 55 percent of the time between 2015 and 2045, and the five-year plan can meet the goal 48 percent of the time. Slight changes to the future availability schedule might overcome some of the problems in meeting deployed goals.

Both plans can meet the fleet response plan (FRP) goal of having six carriers deployed or deployable in 30 days almost 100 percent of the time.<sup>3</sup>

The five-year authorization plan will ultimately result in a force of ten aircraft carriers. Unless other changes lead to increased aircraft carrier operational availability or reduced presence and readiness goals, a ten-carrier force will present challenges in meeting the current presence and readiness goals. The problems in meeting forward-presence needs that the Navy faces when the aircraft carrier force shrinks to ten between the retirement of the USS *Enterprise* and the operational availability of the USS *Gerald R. Ford* reflect the limits of a ten-carrier force.

Increasing the aircraft carrier force structure takes many years due to the long-duration build schedule and the gap between authorization years. Therefore, reversing the readiness and presence challenges presented by a force of ten aircraft carriers cannot happen quickly.

## Effects on Construction Shipyard Labor and Overhead Costs

The 30-year SBP and the five-year plan yield similar total workload demands at NGSB-NN. The five-year plan would yield a lower total workload from 2012 to 2020 as a result of the start of construction for CVN 79 being delayed from 2012 to 2013 and that for CVN 80 being delayed from 2016 to 2018. Beyond 2020, it is difficult to estimate the effect of a change in aircraft carrier construction schedules on total workload at NGSB-NN given the unavailability of long-term data for submarine work also done there.

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<sup>3</sup> The Navy recently modified the FRP goal to 3-2-1, in which the Navy has three carriers forward deployed, two carriers ready to deploy in 30 days, and one carrier ready to deploy in 90 days (see U.S. Marine Corps and U.S. Coast Guard, *Naval Operations Concept 2010: Implementing the Maritime Strategy*, Washington, D.C.: Department of the Navy, NOC 2010, 2010). In terms of readiness, the former 6 + 1 objective was more difficult to achieve than the new 3-2-1 objective (basically, 5 + 1). However, the goal of three carriers forward deployed is more difficult to achieve than the goal of 2.6 we used in the analysis.

Labor costs for CVN 78 under the five-year plan might actually decrease due to a lower peak workforce demand in the 2013–2015 time period. There should be lower hiring and training costs and greater average worker proficiency associated with the smaller increase in workforce. However, labor costs for CVN 79 could go up slightly as the workforce experiences a larger decline in the 2015–2016 time period under the five-year plan.

The five-year plan might have a bigger impact on the costs of future RCOHs because the new plan results in higher peak workforce demands when the RCOHs are currently scheduled in the shipyard. For example, the cost of the CVN 73 RCOH could increase by as much as 6 percent. If operational schedules and remaining core life permit, changing the RCOH schedule by a year or two in either direction (earlier or later) would help mitigate these cost increases.

The plans could differ more substantially in their effects on specific types of workers. For example, under the 30-year SBP, demand for welders in future years would experience fluctuations of up to 400 workers. Under the five-year plan, demand for welders would experience increases and decreases of only 200 workers, suggesting less fluctuation in the overall demand.

Overall, in constant-dollar terms, there would be little difference between the 30-year SBP and the five-year plan in labor and overhead costs for future aircraft carrier construction. The cost of some carriers might increase by 1 or 2 percent; the cost of other carriers would decrease by a like percentage. The cost of future midlife RCOHs might see a larger impact as the five-year plan lays some peak RCOH workload demands on peak new-construction demands. Even the slight cost differences the research found are well within any margin of error associated with data used in the models. Shipyard managers could further reduce differences by making slight alterations to construction and maintenance schedules.

## Impact on Total Acquisition Costs Due to Inflation

The preceding section's analysis of cost focuses only on carrier-related labor and overhead costs at the shipyard and does not weigh the impact of inflation. The five-year cycle moves the full authorization date for CVN 79 one year in the future and, for CVN 80, two years in the future, compared with the 30-year SBP. Thus, the funding for advance procurement (AP) and full authorization shifts to the right in time, with the total acquisition costs for the carriers experiencing additional years of inflation. Future inflation rates are uncertain, but, if the annual inflation rate is 2 percent, the total acquisition costs for CVN 79 and CVN 80 could increase by slightly more than \$600 million (approximately 3 percent). The impact of inflation climbs to more than \$1.5 billion (approximately 8 percent) if the annual inflation rate is 4 percent.

The projected increase in total acquisition cost for CVN 79 and CVN 80 from this analysis is in line with the Navy's estimate of the impact that the five-year plan would have on acquisition costs of the future aircraft carriers. In its report to Congress, PEO Carriers estimates a 3-percent increase in CVN 79 basic construction and the government-furnished equipment (GFE) costs and an 8-percent increase in those costs for CVN 80.<sup>4</sup> The most-recent selected acquisition report for CVN 78 shows no increase in cost for the CVN 78 and cost increases in then-year dollars of \$521 million for CVN 79 and \$1,277 million for CVN 80 as a result of shifting to the five-year plan.<sup>5</sup> Our estimate of the impact on the acquisition costs of CVN 79 and CVN 80 is less than the cost impacts suggested by NGSB-NN. The

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<sup>4</sup> Program Executive Office, Aircraft Carriers, *Report to Congress on Effects of Five-Year Build Intervals for Ford Class Aircraft Carriers*, February 2010.

<sup>5</sup> See Defense Acquisition Management Information Retrieval, *Selected Acquisition Report: CVN 78 Class*, RCS: DD-A&T(Q&A)823-223, as of June 30, 2010. The \$521 million cost increase for CVN 79 is a 5.3-percent increase in then-year dollars and a 3.7-percent increase in constant FY 2011 dollars. The \$1,277 million cost increase for CVN 80 is 10.4 percent in then-year dollars and 7.0 percent in constant FY 2011 dollars.

shipyard estimates that costs for CVN 79 and CVN 80 will increase by 9 to 15 percent due to the five-year plan.<sup>6</sup>

The five-year plan might also have some impact on the overhead costs charged to the *Virginia*-class program because shipyard workload will decrease in some years, possibly leading to an increase in overhead costs. PEO Carriers estimates the increase to *Virginia*-class overhead at \$30 million to \$50 million per hull. NGSB-NN estimates the increase in overhead cost for the programs currently under contract (*Virginia*-class submarines and CVN 78) in the range of \$100 million. Finally, the shipyard suggests that the change to the five-year plan will incur some additional nonrecurring engineering costs for further planning.

## Effects on Aircraft Carrier Vendors

To assess the effect that a shift in the aircraft carrier authorization cycle would have on vendors supporting construction, RAND researchers received survey responses from 18 suppliers of goods and services for aircraft carrier construction. Though the number of firms surveyed cannot be considered representative, the responses from these firms do not appear to indicate that a shift in aircraft carrier construction would threaten the survival of suppliers. Only one of the 18 vendors reported deriving more than 40 percent of its revenue from aircraft carrier construction. All but one reported deriving income as well from other Navy work, including that on submarines and surface combatants. Finally, the majority of the responses suggested that the firms would not be greatly affected by the five-year plan.

These findings are consistent with the Navy's view of the five-year plan's impact on the supplier base. In its report to Congress, PEO Carriers suggests that there will not be a big impact on the vendor base and

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<sup>6</sup> See Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, Washington, D.C.: Congressional Research Service, RL32665, August 17, 2010a, pp. 7–8.

notes how the vendor base responded to the seven-year gap between the start of CVN 77 and CVN 78 with little increase in costs.<sup>7</sup>

Extending the aircraft carrier construction cycle could cause problems for these firms if the resulting fluctuations in work cause vendors to reduce but later rebuild production capacity. Most of the vendors responding to the survey indicated that they need more than a year to hire and train new staff to be fully productive. Many also indicated having older workforces in some key areas. This raises questions of how well older workers might be able to share their experience with newer, younger ones if new employees are not hired due to changes in demand.

## Effect on Public Shipyards

Any changes to the aircraft carrier construction schedule will ultimately affect the amount of work at the public shipyards that maintain the fleet by affecting the size of the fleet and the timing of the introduction of new vessels, and their subsequent maintenance needs, to it. Nevertheless, both plans would result in virtually identical workloads through 2024 at the two public shipyards, the Norfolk Naval Shipyard (NNSY) and the Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS & IMF), which perform aircraft carrier maintenance. In subsequent years, some differences would appear, but shipyard managers might mitigate these with slight alterations to the depot-maintenance schedules of specific aircraft carriers.

## Conclusions

This analysis suggests that shifting from the 30-year SBP to a five-year authorization cycle for acquiring aircraft carriers should have almost no impact on force-structure and industrial-base metrics in the next decade. This should not be surprising. The five-year plan would extend

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<sup>7</sup> PEO Carriers, 2010.

the authorization plan of the 30-year SBP only slightly, resulting in relatively minor changes, especially in the next ten years. Beyond the early 2020s, the five-year plan results in an increasingly smaller aircraft carrier force structure and a lower probability of meeting deployed-carrier goals. Aircraft carrier labor and overhead costs at the construction shipyard could vary by less than 5 percent, increasing for some future aircraft carriers and decreasing for others.

The five-year plan will have an impact on the total acquisition costs of CVN 79 and CVN 80 due to the effects of inflation. For a constant 2-percent inflation rate per year, the acquisition costs of CVN 79 and CVN 80 increase by slightly more than \$600 million. If the inflation rate grows to 4 percent per year, the increased costs could total more than \$1.5 billion. The estimate of cost increases is somewhat conservative in that we do not account for any increased overhead costs to the *Virginia*-class program or for additional planning at NGSB-NN to adjust to the new five-year authorization cycle.

The five-year plan could have a larger effect on any subsequent desire to increase the number of aircraft carriers in the fleet. Although the number of aircraft carriers can be rather quickly reduced through early retirements,<sup>8</sup> a construction cycle of at least four years, coupled with seven or more years between authorization and delivery, as recent aircraft carriers have required, means that it can take decades to add an aircraft carrier to the fleet. Policymakers might wish to consider this inability to rapidly expand the aircraft carrier force more than any of the metrics we consider here.

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<sup>8</sup> Aircraft carrier inactivation requires advance planning and extensive industrial preparation at NGSB-NN and PSNS & IMF. Although aircraft carriers can be decommissioned fairly quickly, the actual inactivation process can take several years.