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CBO

A Historical Survey of Ship Reactivations

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Notes

Unless otherwise indicated, the years referred to in this report are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end.

All costs are expressed in 2017 dollars and have been adjusted to account for inflation using the Bureau of Economic Analysis's gross domestic product price indexes.

On the cover: The former USS *Robert G. Bradley* and other decommissioned Oliver Hazard Perry class frigates at the Philadelphia Inactive Ship On-Site Maintenance Office, October 17, 2017. Photo by Edward G. Keating.

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Summary

In December 2016, the Navy released a new force structure assessment that called for a fleet of 355 ships—substantially larger than the current force of 283 ships.[1] The Navy can increase the size of its fleet using some combination of three broad approaches: increasing the number of new ships it purchases, delaying the retirements of currently active ships, or reactivating decommissioned ships.[2] This report focuses on the third pathway, drawing insights from past experiences with reactivating decommissioned ships that might inform lawmakers' decisions about reactivating retired ships in the future.

What Past Reactivations Did the Congressional Budget Office Examine for This Analysis?

CBO examined the cases in which the Navy has reactivated combat ships since 1940. Before entering World War II, the United States reactivated 50 destroyers, which it shortly thereafter transferred to the United Kingdom. A decade later, the Navy reactivated several hundred combat ships to support operations in the Korean War. During the Vietnam War, the Navy reactivated the battleship USS *New Jersey*, and in the 1980s, as part of the Reagan-era buildup to a 600-ship fleet, it again reactivated the USS *New Jersey*, along with three other Iowa class ships (the USS *Iowa*, the USS *Missouri*, and the USS *Wisconsin*).

In addition to those reactivations, CBO examined three other types of cases: two large-scale renovations of active warships that the Navy undertook in the past 25 years, renovations and reactivations recently completed by two U.S. allies, and reactivations of cargo ships by the Department of Transportation's Maritime Administration (MARAD).

What Insights Can Be Drawn From Those Past Experiences?

The history of ship reactivations suggests that the costs of reactivating a ship vary widely depending on the extent of combat system modernization that is required. Although reactivation costs were lower during the Korean and Vietnam Wars, since the 1980s, reactivating a combat ship has cost at least 10 percent of the cost of replacing the ship (that is, building a new one with the same general specifications), and significantly more when the reactivation involved considerable modernization of the ship's combat systems.[3]

Reactivated combat ships tend to be less capable than new ships and to remain in service for significantly shorter periods. Whereas new ships typically serve for 25 to 40 years, reactivated ships generally serve for only 5 to 7 years.

Reactivating cargo ships is more straightforward than reactivating combat ships. In general, the reactivation of a cargo ship has been faster and less expensive the better maintained that ship has been. However, during the Vietnam War, the Navy determined that reactivating some cargo ships would not be cost-effective and instead scrapped them.

1. Department of the Navy, *Executive Summary, 2016 Navy Force Structure Assessment (FSA)* (December 14, 2016), http://tinyurl.com/zgdk5o7.

2. For CBO's analysis of the approach of purchasing additional new ships, see Congressional Budget Office, *Costs of Building a 355-Ship Navy* (April 2017), www.cbo.gov/publication/52632. For the agency's analysis of the approach of extending the service lives of the ships in the Navy's current fleet, see Congressional Budget Office, *Comparing a 355-Ship Fleet With Smaller Naval Forces* (March 2018), www.cbo.gov/publication/53637.

3. The costs that CBO presents in this study are those reported in the referenced sources. CBO did not independently verify those costs; the sources may have used different methods to estimate them. The agency used the Bureau of Economic Analysis's gross domestic product price indexes to adjust all reported costs to fiscal year 2017 dollars so that meaningful comparisons can be made between ships reactivated or renovated in different years.

Any reactivation, regardless of the type of ship being reactivated, involves some degree of uncertainty about whether it can be completed on time and within budget.

How Might Reactivation Work for Oliver Hazard Perry Class Frigates?

Recently, there have been calls to reactivate Oliver Hazard Perry class frigates, the last of which was retired in September 2015. As of August 2017, the Navy had 22 inactive Oliver Hazard Perry class frigates, 10 of which were in the best-maintained state, termed foreign military sales (FMS) hold status. Navy officials estimate that reactivating Oliver Hazard Perry class frigates without making large-scale upgrades to their weapon systems would cost about $200 million per ship (or roughly 25 percent of the cost of replacing the ship) and take about nine months to complete. But they could play only limited roles. If the Navy chose to upgrade the weapon systems, those reactivations could cost considerably more and take longer to complete.

The Navy's Process for Retiring and Reactivating Ships

When the Navy retires a ship, it must decide what to do with it. Some decommissioned ships have been given or sold to allies of the United States and are therefore no longer available to the U.S. Navy.[4] Retired nonnuclear ships that have not been transferred to allies are placed on inactive status at various locations—including Philadelphia, Pennsylvania; Pearl Harbor, Hawaii; and Bremerton, Washington—where the ships are grouped together in shallow, protected anchorages.[5] Those facilities also store ships that have been designated for possible transfer to allies under the FMS program, though the Navy could reactivate such a ship for its own use if it chose to do so.

A ship in the inactive fleet might remain there almost indefinitely, but not without the Navy's incurring modest costs. While in storage, a ship is still subject to the elements (along with seawater), so it deteriorates. Basic maintenance must be performed to prevent the ship from becoming a safety or environmental hazard. Also, there may be opportunity costs associated with the dock space the ship occupies—that dock space might be used for some other purpose.

Nevertheless, the recurring storage and maintenance costs can be justified by the advantages of having inactive ships in storage. The primary value of such ships derives from the option to reactivate them if the need for ships increases. Another advantage of storing decommissioned ships is that they can be a source of spare parts for other ships that the Navy still operates.

More significant than the costs of storing the ships are the costs of reactivating them. Not only do inactive ships deteriorate while in storage, but their weapon systems and other technology become increasingly obsolete. The process of repairing and reequipping ships—referred to as a refit—can be costly, especially if the refit involves extensive upgrades of outdated equipment. That is true for *renovations* (the process of updating an aging ship that is still operating in the fleet) as well as for *reactivations* of decommissioned ships.

Once a ship enters the inactive inventory, the Navy must therefore balance the ongoing cost of storing the ship and the future cost of refitting it against the possible benefit that the ship would provide if it was reactivated. Eventually, the value of reactivating a very old, decaying, and likely obsolete ship that is missing parts diminishes so much that the Navy will decide to stop storing it and to dispose of it.

The Navy has a few options for disposing of a ship. A ship designated for disposal can often be sold to a scrapping company. (If the price of scrap metal is low, however, the Navy may have to pay a scrapping company to take the ship.) Some ships have, instead, been turned over to communities and used as nautical museums. Alternatively, the Navy might use a ship for target practice during training, or it might sink a ship to create an artificial reef.

A History of Ship Reactivations

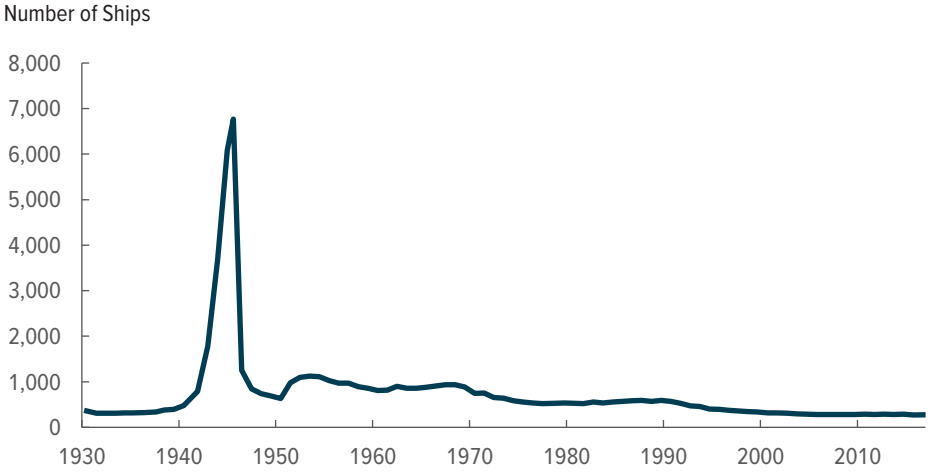
CBO examined four types of cases relevant to the determination of whether to reactivate combat ships: the Navy's reactivations of combat ships since the beginning of World War II, the Navy's large-scale renovations of aging warships, U.S. allies' recent experiences renovating and reactivating warships, and MARAD's reactivations of cargo ships.

4. This report uses the terms *deactivation*, *decommissioning*, and *retirement* interchangeably. Likewise, *reactivation* and *recommissioning* have the same meaning.

5. Decommissioned nuclear-powered ships are handled separately and are not a focus of this report. The Navy has never reactivated a decommissioned nuclear-powered ship.

Figure 1.

The Size of the U.S. Navy's Active Fleet Since 1930



The Navy had far more active ships in its fleet during World War II than it has had at any time since.

Source: Naval History and Heritage Command.

The Navy's Reactivations of Combat Ships

CBO reviewed cases in which the Navy reactivated combat ships from the beginning of World War II to the end of the Cold War by drawing on historical literature as well as interviews with current and retired Navy officials.

World War II. In 1940, before the United States entered the war, the Navy transferred 50 destroyers built during or shortly after World War I to the United Kingdom's Royal Navy in exchange for leases on British bases in the Western Hemisphere in what is known as the destroyers-for-bases deal. Those ships, which had been decommissioned for much of the interwar period, had only recently been reactivated and were in various states of disrepair. Several ships had minor mishaps and mechanical troubles on the way to the United Kingdom. Upon arrival, they underwent extensive refits to upgrade them to the Royal Navy's standards.

After the refits, the destroyers served in the war, most often as escorts protecting merchant ships against German U-boats in the North Atlantic. Three of them were sunk by U-boats. Although Royal Navy officials differed in their appraisals of the reactivated ships, after the war, most agreed that despite the ships' shortcomings, they "gave invaluable service at a time of really desperate need."[6]

The U.S. Navy engaged in a massive shipbuilding program during the war to increase the size of its fleet. After considering a large-scale reactivation program, Secretary of the Navy Charles Edison recognized by May 1940 that relying on reactivating ships was not a viable path to military preparedness. Left in storage without regular maintenance or inspection, the decommissioned ships had deteriorated more than Navy officials had realized and would take much longer to prepare for reactivation than anticipated.[7]

Through its extensive shipbuilding program, the Navy increased the size of the fleet from fewer than 500 active ships in 1940 to more than 6,700 active ships when the war ended in 1945 (see Figure 1).[8] At that point, the fleet exceeded any anticipated peacetime needs and the Navy's expected operating budget. Although the Navy transferred some ships to U.S. allies and scrapped others, it put hundreds of decommissioned ships into storage.

The Korean War. The fact that a large number of warships had recently been put into storage proved to be beneficial when the Korean War broke out in June 1950. By April 1951, the Navy had reactivated 381 warships to participate in the conflict: 13 aircraft carriers, 2 battleships (the USS *New Jersey* and the USS *Wisconsin*), 2 heavy cruisers, 77 destroyers and

6. For more details on the ships transferred as part of the destroyers-for-bases deal, see Philip Goodhart, *Fifty Ships That Saved the World: The Foundation of the Anglo-American Alliance* (Doubleday & Company, 1965). The quotation, attributed to Admiral of the Fleet Sir George Creasy, is from page 237.

7. See Daniel Madsen, *Forgotten Fleet: The Mothball Navy* (Naval Institute Press, 1999), pp. 7–8.

8. Naval History and Heritage Command, "U.S. Ship Force Levels: 1886–Present" (accessed May 10, 2018), https://go.usa.gov/xnt9f.

destroyer escorts, 13 submarines, 31 minesweepers, 7 patrol vessels, and 236 amphibious and auxiliary ships.[9] Those reactivations accounted for most of the increase in the size of the fleet in the early 1950s (see Figure 1). In the years following the conflict, the reactivated warships were deactivated anew. The USS *New Jersey* was decommissioned in 1957, and the USS *Wisconsin*, in 1958.[10]

The reactivations during the Korean War represent a very favorable scenario. The reactivated ships had only recently been put into storage—some just a few months before they were reactivated—so there had not been much time for them to deteriorate or to become technologically obsolete. Reactivating each ship took 30 days, on average, and is estimated to have cost an average of 2.5 percent of the replacement cost.[11]

The Vietnam War. When the Vietnam War escalated in the mid-1960s, the Navy's situation was considerably different from what it had been at the outset of the Korean War. Stored World War II–era ships were now roughly 20 years old, so they were in worse condition and more outdated in terms of their capabilities than they had been in 1950. Also, fewer ships were available for reactivation because many had been scrapped after the Korean War.

In 1968, the Navy again reactivated the battleship USS *New Jersey*. The reactivation took nine months and cost an estimated $127 million, or about 3 percent of the estimated cost to replace the ship.[12] The ship's propulsion plant had a number of problems, and there was a paucity of spare parts with which to fix it. But those challenges were overcome, and the ship rejoined the Pacific Fleet in April 1968 and engaged in combat off the coast of Vietnam a few months later. In December 1969, the USS *New Jersey* was decommissioned and returned to the inactive fleet.[13]

The Reagan-Era Buildup. The USS *New Jersey* and three other Iowa class battleships (the USS *Iowa*, the USS *Missouri*, and the USS *Wisconsin*) were reactivated between 1982 and 1988 under the Reagan Administration, which had called for increasing the size of the Navy's fleet to 600 ships. The reactivation process for each ship lasted roughly two years and cost $775 million ($3.1 billion in total for the four ships), or about 20 percent of the estimated replacement cost.[14] Those reactivations were more expensive than that of the USS *New Jersey* in 1968 because they included large-scale modernization of the ships' combat systems: Electronic warfare equipment, Harpoon antiship missiles, and Tomahawk cruise missiles were installed on the ships.[15]

Three of the four Iowa class battleships served without any major incident. In 1983, the newly reactivated USS *New Jersey* was once again involved in combat, this time off the coast of Lebanon, firing its 16-inch guns at Syrian forces. The USS *Wisconsin* and the USS *Missouri* participated in Operations Desert Shield and Desert Storm from 1990 to 1991.

The USS *Iowa*, however, experienced a catastrophe. On April 19, 1989, a gunpowder explosion inside a turret on the ship killed 47 sailors. Although at first the Navy's investigators asserted that the explosion

9. Michael T. Isenberg, *Shield of the Republic: The United States Navy in an Era of Cold War and Violent Peace*, *Volume 1, 1945–1962* (St. Martin's Press, 1993), p. 223.

10. For detailed histories of those two ships, see Home Port Alliance for the USS *New Jersey*, "Full History" (accessed May 10, 2018), www.battleshipnewjersey.org/the-ship/full-history; and USS *Wisconsin* Association, "Ship's History" (accessed May 10, 2018), www.usswisconsin.org/wp/ships-history.

11. Michael T. Isenberg, *Shield of the Republic: The United States Navy in an Era of Cold War and Violent Peace*, *Volume 1, 1945–1962* (St. Martin's Press, 1993), pp. 223–224. The 2.5 percent estimate is Isenberg's; no details are provided on how that estimate was derived. A common approach to estimating the cost of reactivation as a percentage of replacement cost is to take the ship's original acquisition cost, translate it into constant dollars, and then divide the constant-dollar cost of reactivation by that amount. An alternative approach is to identify a named replacement ship and use that ship's acquisition cost as the denominator; that is the approach that CBO used for the USS *Ponce*, which is discussed later in the report.

12. CBO used the acquisition cost of the battleship (in 2017 dollars) as the denominator when it calculated the percentage of replacement cost for the reactivation.

13. Daniel Madsen, *Forgotten Fleet: The Mothball Navy* (Naval Institute Press, 1999), p. 117–118.

14. The estimate of the reactivation cost is from a database of naval procurement costs that CBO maintains.

15. For more information on the reactivation of the Iowa class battleships in the 1980s, see Daniel Madsen, *Forgotten Fleet: The Mothball Navy* (Naval Institute Press, 1999), pp. 175–179; and Robert Mackay, "Navy Wants to Mothball USS *Iowa*, *New Jersey*" (United Press International, January 4, 1990), https://tinyurl.com/yahhnfcp.

was a deliberate act caused by one of the sailors, an independent investigation could not prove or disprove those allegations or identify the ultimate cause of the explosion.[16] The USS *Iowa* never returned to service, and the other three battleships were retired again in the early 1990s as the Cold War ended.[17]

The Navy's Large-Scale Renovations of Two Warships

In the past 25 years, two warships, the USS *Inchon* and the USS *Ponce*, underwent large-scale renovations at a point in their service lives when they might otherwise have been retired. Those renovations are thus broadly analogous to a warship reactivation, but the analogy between ship reactivation and renovation is not perfect. An inactive ship sits unmanned for an extended period and undergoes only limited maintenance. As it sits, it deteriorates from exposure to the elements, becomes increasingly technologically obsolete, and may regularly have parts removed for use on other ships. Like an inactive ship, a renovated ship is typically an older ship that has been exposed to the elements and has aging technology, but it has been manned by personnel who maintain the ship and is unlikely to have been used as a source of spare parts for other ships.

The USS *Inchon*. The USS *Inchon* was commissioned in 1970 as an amphibious assault ship. It provided helicopter support to troops in the Vietnam War and Operations Desert Shield and Desert Storm. In 1995, the ship was returned to the Ingalls shipyard in Pascagoula, Mississippi, where it had been built, and was converted into a mine countermeasures command and support ship. The renovation involved upgrading the ship's command, control, communication, computer, and intelligence systems; its close-in weapon system; and its radars. The ship was reconfigured to support, resupply, and repair Avenger class mine countermeasure ships and Osprey class coastal minehunters. The renovation cost $223 million (about 30 percent of the estimated replacement cost) and took 15 months to complete. After about five years of postrenovation service, on October 19, 2001, there was a fire in the ship's main boiler room that killed one sailor. The ship was inactive after that fire, and it was formally decommissioned on June 20, 2002.[18]

The USS *Ponce*. The USS *Ponce* was on track to be decommissioned as a dock landing ship when, in 2011, the Navy decided to renovate it and place it into service on an interim basis as an afloat forward staging base. The refit replaced the ship's navigation systems, reconfigured spaces to support staff, restored several engineering shop spaces, reconfigured aviation systems to support the mine countermeasures mission, and installed the ScanEagle drone surveillance system. Additionally, the ship's main propulsion boilers were overhauled, the main and auxiliary condensers were cleaned, and the galley and berthing spaces were refurbished. In all, the process took five months and cost $70 million (about 10 percent of the cost of the ship that eventually replaced it).

After the refit was completed in mid-2012, the USS *Ponce* acted as a floating base for helicopters, coastal patrol ships, and Special Forces in the Arabian Sea. The ship tested new antimine technologies and was the first ship to feature an operational laser weapon system. The USS *Ponce* operated for a little more than five years in its new status before the Navy decommissioned it on October 14, 2017.[19]

The USS *Ponce* was replaced in the Persian Gulf by the USS *Lewis B. Puller*, an expeditionary sea base.

16. See General Accounting Office (now the Government Accountability Office), *U.S.S.* Iowa *Explosion: Sandia National Laboratories' Final Technical Report*, NSIAD-91-4S (August 1991), www.gao.gov/products/NSIAD-91-4S; and *Battleships: Issues Arising From the Explosion Aboard the U.S.S.* Iowa, NSIAD-91-4 (January 1991), www.gao.gov/products/NSIAD-91-4.

17. The retirement dates of U.S. Navy ships are published in Naval Sea Systems Command, Shipbuilding Support Office, "Non Active Vessels," *Naval Vessel Register* (accessed May 10, 2018), https://go.usa.gov/xntyt.

18. For additional information on the USS *Inchon*, see Thoralf Doehring, "USS *Inchon* (MCS 12)" (accessed May 10, 2018), www.navysite.de/ships/mcs12.htm; and Stephanie L. Jordan, "*Inchon* Will Be Retired: Focus Will Turn to Replacement Ship: Ship's Run Ends in 2005," *Corpus Christi Caller-Times* (October 31, 2001). The Navy reported that the renovation cost $223 million. CBO estimates that the original acquisition cost of the ship was about $800 million.

19. For more on the USS *Ponce*, see Joseph Trevithick, "The Real Story of the USS *Ponce* as the American Sea Base Sails Into Retirement," *The War Zone* (September 28, 2017), https://tinyurl.com/y7uyw737; James Marconi, "*Ponce*'s Refit Team Recognized for Outstanding Performance" (press release, U.S. Navy's Military Sealift Command, June 13, 2012), https://go.usa.gov/xntJG; and Brock Vergakis, "Navy Sends Unique Retrofitted Ship to Middle East" (Associated Press, June 1, 2012).

The USS *Lewis B. Puller* incorporated many of the innovations that were tested on the USS *Ponce*.[20]

Two U.S. Allies' Recent Renovations and Reactivations of Warships

The navies of U.S. allies operate warships under standards that are different from the U.S. Navy's. Nevertheless, two recent cases of allies' refitting ships provide general insights into the reactivation process.

Australian Adelaide Class Frigates. In 2009, the Royal Australian Navy finished upgrading four Adelaide class frigates at a total cost of $1.4 billion (about 45 percent of the estimated replacement cost).[21] The Adelaide class frigates, which are Australia's version of the U.S. Navy's Oliver Hazard Perry class frigates, entered service in the 1980s and early 1990s. In the mid-2000s, the Australian navy decommissioned two Adelaide class ships (HMAS *Adelaide* and HMAS *Canberra*) and upgraded its other four (HMAS *Darwin*, HMAS *Melbourne*, HMAS *Newcastle*, and HMAS *Sydney*). The case of the Adelaide class ships is more analogous to that of the USS *Inchon* or USS *Ponce* than it is to the reactivations of the World War II–era ships in the sense that the Adelaide class ships were renovated when they might have been retired rather than reactivated after being decommissioned for an extended period of time.

The Australian frigates spent approximately two years each in refit. The renovation added SM-2 Block IIIA missiles to the ships, dramatically improving their ability to fight against enemy aircraft. The ships also received a new combat management system, upgraded radar, new hull-mounted and towed sonar, and an eight-cell MK41 vertical launch system for the Evolved Sea Sparrow missile. The upgrade project was described as "one of the most sophisticated and extensive undertaken of a modern surface combatant."[22] The Australian navy has indicated its intent to operate at least one of the upgraded Adelaide class frigates until 2021. As of May 2018, two of the upgraded ships have been decommissioned—the HMAS *Sydney* on November 7, 2015, and the HMAS *Darwin* on December 9, 2017.[23]

Taiwanese Frigates. In 2016, Taiwan purchased two retired Oliver Hazard Perry class frigates from the United States, the former USS *Taylor* and the former USS *Gary*. It spent $90 million per ship (about 12 percent of the estimated replacement cost) to reactivate them sufficiently to sail them to Taiwan. Of that amount, $48 million covered necessary refurbishment of the ship's hull, mechanical, and electrical systems, and $33 million went to partially refurbishing the combat system. That part of the reactivation process occurred in the United States, at the VSE Corporation's shipyard in Charleston, South Carolina, and took about nine months to complete. The Taiwanese navy is undertaking further upgrades to the ships' combat systems in Taiwan; the costs of those upgrades are not included in the $90 million per ship cost estimate. According to U.S. Navy officials, Taiwan's navy intends to operate the two frigates for the next 30 years.[24]

MARAD's Reactivations of Cargo Ships

Reactivating cargo ships is fundamentally different from reactivating combat ships. Whereas the Navy rarely reactivates combat ships, MARAD intends for the cargo

20. Megan Eckstein, "Navy to Commission Middle East–Based Expeditionary Sea Base *Lewis B. Puller* as a Warship," *USNI News* (August 16, 2017), https://tinyurl.com/y7jcbz7d.

21. The estimate is based on the cost reported by Julian Kerr in "Air Defence Regained in Difficult Frigate Upgrade," *Weekend Australian* (October 24, 2009). Kerr reports that the program cost 1.5 billion Australian dollars, but converting that cost into 2017 U.S. dollars is problematic because the exchange rate has varied widely. During 2009 alone, the value of an Australian dollar in U.S. dollars ranged from $0.65 to over $0.90. Using a 2009 median exchange rate of about $0.80, CBO converted the total cost of the project into $1.4 billion (in 2017 U.S. dollars), or about $340 million per ship. Because of the volatility of the exchange rate, that estimate is more uncertain than the others presented in this report.

22. Chris Lloyd of Thales Australia, the primary contractor on the project, quoted in Julian Kerr, "Air Defence Regained in Difficult Frigate Upgrade," *Weekend Australian* (October 24, 2009).

23. For more information on the Adelaide class frigates, see Gabriel Dominguez, "RAN Decommissions Adelaide-Class Frigate HMAS *Darwin*," *Jane's Defence Weekly* (December 11, 2017), https://tinyurl.com/y7hjokp7; "Ex-HMAS *Sydney* Retires to Western Australia," *Navy Daily* (May 18, 2017), https://tinyurl.com/y85waqpd; Julian Kerr, "Air Defence Regained in Difficult Frigate Upgrade," *Weekend Australian* (October 24, 2009); and Lee Cordner, "Aussie Frigates Reborn," *Proceedings* (United States Naval Institute, March 2009), https://tinyurl.com/y74nd3en.

24. See Matthew Strong, "Two Perry-Class Frigates to Arrive in Taiwan May 13," *Taiwan News* (May 9, 2017), www.taiwannews.com.tw/en/news/3159263; Richard Tomkins, "VSE Reactivating Mothballed Frigates" (United Press International, July 21, 2016), https://tinyurl.com/y8bkxmz8; and VSE Corporation, "VSE Awarded $74M Delivery Order to Support Taiwan's Maritime Defense Efforts" (press release, July 21, 2016), https://tinyurl.com/yaovaz2o (PDF, 82 KB).

ships in its Ready Reserve Force (RRF) to be reactivated quickly for contingencies and deactivated shortly after the contingencies end. Because the RRF ships regularly cycle between active and inactive statuses, MARAD has considerable experience with ship reactivation, which the agency's officials shared with CBO in interviews.

Background on Cargo Ship Reactivation. In a large-scale contingency operation in a distant location (such as Southeast Asia or the Middle East), the military's need for cargo shipping increases dramatically and can be challenging for the Navy's active ships and commercial shipping firms to fully accommodate. To ensure that there was a reserve of cargo ships that could respond to national emergencies, the National Defense Reserve Fleet (NDRF) was established in 1946, and 30 years later, the RRF was organized as a subset of cargo ships within the NDRF that could be mobilized more quickly than the NDRF as a whole. When contingencies arise, MARAD reactivates cargo ships in the RRF that it keeps in inactive status during peacetime. Unlike deactivated combat ships, MARAD's inactive RRF ships go through occasional reactivation drills, including sea trials.[25]

Not only are cargo ship reactivations more common than combat ship reactivations, they are also generally easier to complete. Although reactivating cargo ships involves a variety of tasks, including inspections, cleaning, and testing, cargo ships do not have complex combat systems (such as guns, missiles, and combat radar systems) that would need to be updated and replaced. They also have much smaller crews than combat ships, so reactivating a cargo ship requires addressing significantly fewer habitability issues. Because the reactivation process is generally easier for cargo ships, MARAD's reactivation schedules for RRF ships are far tighter than the Navy's reactivation schedules for combat ships: The reactivation of RRF ships is intended to be completed within 5, 10, or 20 days.[26]

When a military conflict ends, RRF ships are deactivated and returned to long-term storage. That practice is another point of difference from combat ship reactivation: A reactivated combat ship's operational duration is generally open-ended.

The Korean War. As with combat ships, the number of active cargo ships after World War II far exceeded the peacetime needs for such ships. Many of the ships were sold, but 2,277 remained in the NDRF at the end of fiscal year 1950. Over an 18-month period during the Korean War, 778 cargo ships in the NDRF were repaired, refitted, and placed into service at an average cost of about $1 million per ship. Because the ships were fairly new and required little preparation, they were reactivated quickly, fulfilling military requirements.[27]

The Vietnam War. Between 1965 and 1968, 172 cargo ships in the NDRF were activated to support U.S. operations in Southeast Asia. NDRF ships transported a significant portion of the materiel the U.S. military used in the conflict.[28] Reactivating those ships cost an average of $3.2 million per ship. The first reactivations during the war took about 20 days to complete, but the average reactivation time later grew to more than 60 days. Of the 51 NDRF ships activated in 1965, about 70 percent encountered mechanical problems,

25. See Owen J. Doherty, "Ready Reserve Fleet: Ship Maintenance and Activations," *Journal of Ship Production*, vol. 13, no. 3 (August 1997), pp. 188–197; and General Accounting Office (now the Government Accountability Office), *Ready Reserve Force: Ship Readiness Has Improved, but Other Concerns Remain*, NSIAD-95-24 (November 1994), www.gao.gov/products/NSIAD-95-24.

26. See Department of Transportation, Maritime Administration, Office of Ship Operations, *The RRF in Operation Iraqi Freedom: Lessons Learned* (prepared by I. M. Systems Group and Marine Design and Operations, February 2004), p. 14.

27. See Louis Francis Harlow, "An Analysis of the National Defense Reserve Fleet, the Ready Reserve Force Component and Their Capability to Meet National Emergency" (M.A. thesis, Naval Postgraduate School, Monterey, Calif., 1979), https://calhoun.nps.edu/handle/10945/18600.

28. See Salvatore R. Mercogliano, *Fourth Arm of Defense: Sealift and Maritime Logistics in the Vietnam War* (Naval History and Heritage Command, 2017), p. 24, https://go.usa.gov/xnzrH; Louis Francis Harlow, "An Analysis of the National Defense Reserve Fleet, the Ready Reserve Force Component and Their Capability to Meet National Emergency" (M.A. thesis, Naval Postgraduate School, Monterey, Calif., 1979), https://calhoun.nps.edu/handle/10945/18600; and Elmer B. Staats, Comptroller General of the United States, *The National Defense Reserve Fleet, Can It Respond to Future Contingencies?* Report to Congress LCD-76-226 (October 1976), www.gao.gov/products/LCD-76-226. There are modest factual discrepancies between the sources. Mercogliano states that MARAD activated 172 ships from the reserve fleet between 1965 and 1968, whereas Harlow earlier had asserted that 161 cargo ships were reactivated between 1965 and 1970. Harlow indicated that those 161 ships moved more than 30 percent of all cargo to Southeast Asia, and Staats, providing the estimate for 1967 alone, stated that NDRF ships transported 40 percent of the materiel moved to Vietnam that year.

most of which involved ships' boilers. A significant amount of unanticipated work was required to reactivate those ships. For other ships in the NDRF—28 in all—reactivation would not have been cost-effective, and the ships were scrapped. The problems encountered while activating ships in the NDRF during the Vietnam War led to the creation of the NDRF's higher-readiness subset, the RRF, in 1976.

Operations Desert Shield and Desert Storm. The RRF's first large-scale reactivation was for Operations Desert Shield and Desert Storm in 1990 and 1991. During that conflict, 78 of the 96 RRF ships were reactivated and engaged in sealift operations. Most of the first 45 ships reactivated did not meet their reactivation schedules, primarily because they had deteriorated and were in poor condition. A few ships with major problems contributed disproportionately to total delays.[29] Once returned to operating condition and reactivated, however, the RRF ships generally fulfilled their missions, maintaining a 93.5 percent reliability rate.[30] A typical reactivation of an RRF ship cost about $2.6 million, though costs varied by the type, age, and condition of the ship.[31]

In 1996, MARAD addressed the problems it encountered while reactivating ships during Operations Desert Shield and Desert Storm by placing 9- or 10-person reduced operating status (ROS) maintenance crews onboard most RRF ships to reduce the time required to reactivate a ship.[32]

Operations Enduring Freedom and Iraqi Freedom. In 2002 and 2003, 40 RRF cargo ships were reactivated in support of Operations Enduring Freedom and Iraqi Freedom. The 35 reactivations of RFF cargo ships that took place in fiscal year 2003 cost an average of about $5.4 million each. In contrast to what had happened a decade earlier during Operations Desert Shield and Desert Storm, 37 of the 40 ships met their reactivation timelines; the 3 that did not were identified as having major deficiencies and needing major repairs at the time of reactivation. Of the 40 ships reactivated, 18 had previously been reactivated for Operations Desert Shield and Desert Storm. Those ships were generally reactivated more quickly for Operations Enduring Freedom and Iraqi Freedom. Experts credited the ROS maintenance crews with having significantly improved the ships' readiness.[33]

Insights From Past Reactivations

As the Congress considers approaches for expanding the size of the Navy, past reactivations can provide useful insights.

Frequency and Timing

Although the Navy undertook a large-scale reactivation of combat ships for the Korean War, it has reactivated only a few combat ships since then. Whereas by April 1951, 381 World War II–era combat ships were reactivated to serve in the Korean War, only the USS *New Jersey* was reactivated during the Vietnam War. Later, during the Reagan Administration, 4 Iowa class battleships were reactivated. No combat ships were reactivated in support of Operations Desert Shield, Desert Storm, Enduring Freedom, or Iraqi Freedom, although more than 100 cargo ships were reactivated in support of those operations.

The combat ship reactivations that have occurred have taken several months to—in the cases of the battleships—two years to complete. Although combat ships take much longer to reactivate than cargo ships, reactivating decommissioned combat ships still takes far less time than building new combat ships, which can take several years (and even longer if the Navy asks shipbuilders to build additional ships when they are already busy filling

29. See Department of Transportation, Maritime Administration, *Final Report: Ready Reserve Force Activation Analysis, Operation Desert Shield/Desert Storm* (prepared by George G. Sharp, October 1991).

30. James K. Matthews and Cora J. Holt, *So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Desert Shield/Desert Storm* (Office of the Chairman of the Joint Chiefs of Staff and United States Transportation Command, 1996), https://go.usa.gov/xnzst (PDF, 28.3 MB).

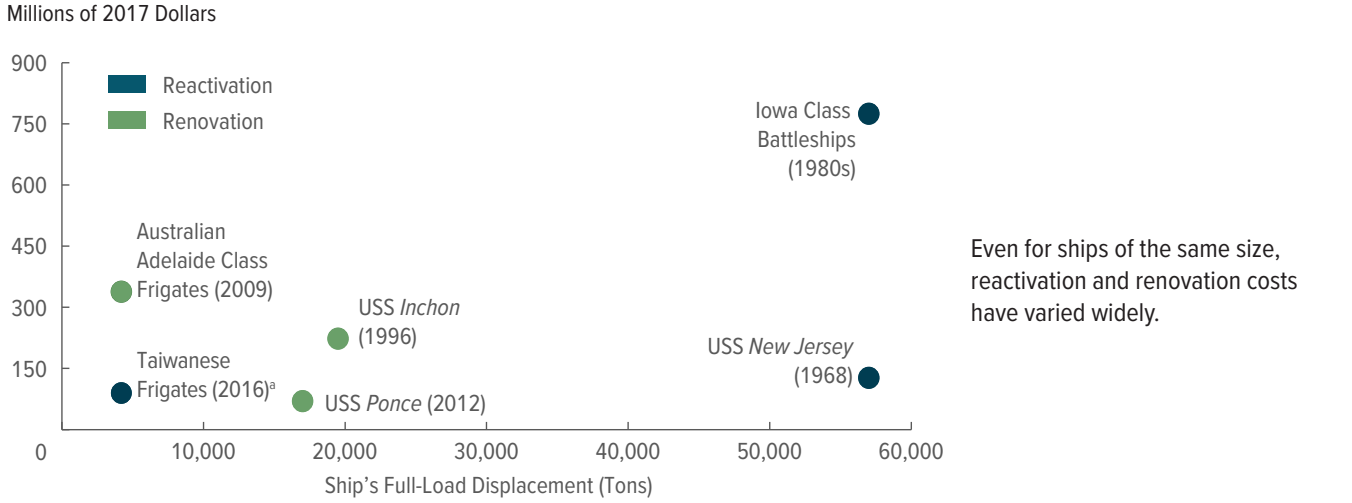
31. Timothy R. Anderson, "A Financial Analysis for the Acquisition of Ready Reserve Force Ships" (M.A. thesis, Naval Postgraduate School, Monterey, Calif., 1992), www.dtic.mil/docs/citations/ADA260897.

32. See Owen J. Doherty, "Ready Reserve Fleet: Ship Maintenance and Activations," *Journal of Ship Production*, vol. 13, no. 3 (August 1997), pp. 188–197.

33. See Department of Transportation, Maritime Administration, Office of Ship Operations, *The RRF in Operation Iraqi Freedom: Lessons Learned* (prepared by I. M. Systems Group and Marine Design and Operations, February 2004).

Figure 2.

Per-Ship Cost of Reactivation or Renovation, by Ship Size



Source: Congressional Budget Office.

A ship's size is traditionally measured as displacement—the weight of the water it displaces. Full-load displacement is the weight displaced by the ship with its contents, including crew, stores, ammunition, and fuel and other liquids.

Years shown in parentheses indicate when the reactivation or renovation was completed.

a. The per-ship cost shown for the reactivation of frigates by Taiwan's navy in 2016 represents the cost of the initial reactivation in the United States; it does not include the cost of the combat system upgrades that the ships received in Taiwan.

the Navy's existing orders). For example, a new destroyer typically takes five years to build once construction starts.

Costs

Costs of the refit activities required to reactivate or renovate a combat ship have varied widely, even for a specific type of ship (see Figure 2). The Taiwanese and Australian frigates are Oliver Hazard Perry class ships, but the reported cost per ship of Taiwan's 2016 reactivation was less than one-third of the cost of Australia's refits completed a few years earlier. (However, the cost reported for Taiwan's reactivation does not include the additional expense incurred to upgrade the ships' combat systems after the United States delivered them.) Likewise, in constant-dollar terms, the Reagan-era reactivation of the four Iowa class battleships cost more than six times as much per ship as the 1968 reactivation of the USS *New Jersey*.

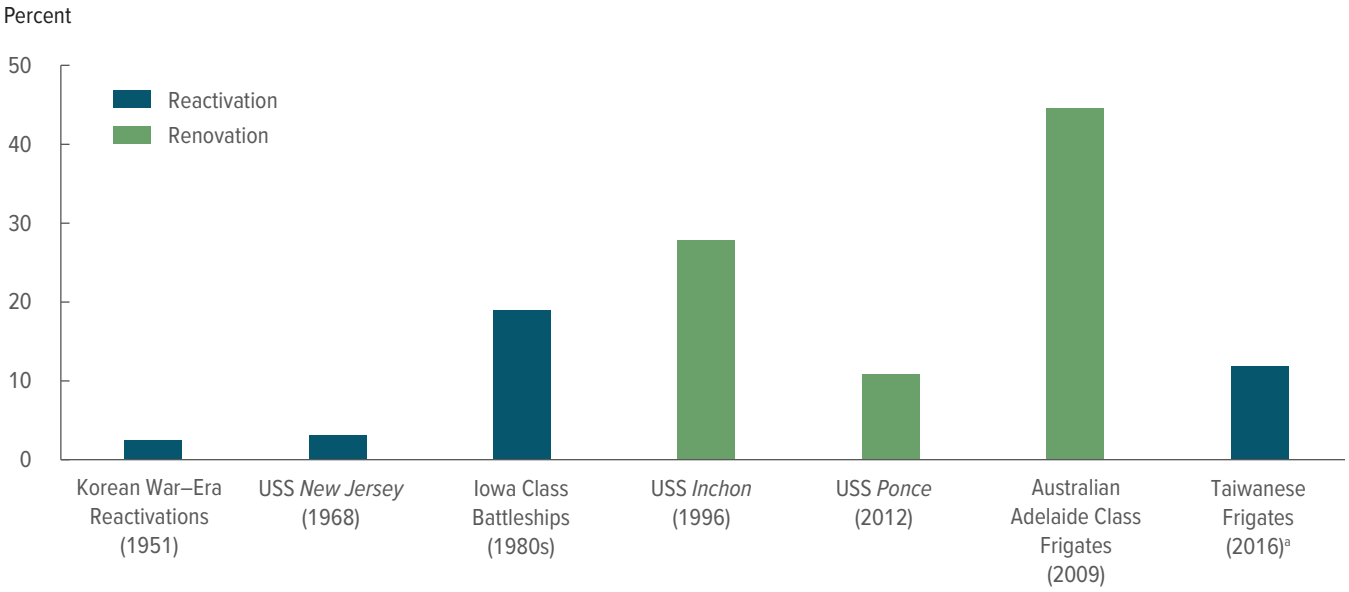
Although larger ships tend to cost more to reactivate than smaller ships, a ship's size alone does not serve as a good predictor of the cost to reactivate it. Rather, the degree to which the combat systems will be upgraded seems to drive the reactivation cost and to explain the variation between costs of past reactivations of similar ships. Still, any ship reactivation comes with some uncertainty surrounding how much it will cost, how long it will take, and whether it is even possible at a price that the Navy is willing to pay.

On the whole, reactivations have become more costly over the years. The most recent reactivations cost between 10 percent and nearly 45 percent of the ship's estimated inflation-adjusted replacement cost (see Figure 3). In contrast, the Korean War reactivations reportedly cost only about 2.5 percent of the ships' replacement costs, and the 1968 reactivation of the USS *New Jersey* reportedly cost about 3 percent of its replacement cost. But the four Reagan-era reactivations of battleships, the renovation of the USS *Inchon*, and the renovations of the Australian frigates cost significantly more because of the upgrades to combat systems that those reactivations involved.

Although cargo ship reactivations differ from combat ship reactivations in many respects, it is worth noting

Figure 3.

Per-Ship Cost of Reactivation or Renovation, Measured as a Percentage of Replacement Cost



Source: Congressional Budget Office.

Percentages were calculated using constant-dollar amounts.

Years shown in parentheses indicate when the reactivation or renovation was completed.

a. The per-ship cost shown for the reactivation of frigates by Taiwan's navy in 2016 represents the cost of the initial reactivation in the United States; it does not include the cost of the combat system upgrades that the ships received in Taiwan.

that during the Vietnam War, some NDRF ships were scrapped rather than reactivated.

Operational Life Spans

Although the length of time that reactivated ships have served in the active fleet has varied, reactivated combat ships have typically operated for five to seven years before being retired again (see Figure 4). The Vietnam-era service of the USS *New Jersey* was the shortest: The ship served less than two years after it was reactivated. By contrast, a new nonnuclear combat ship might be expected to operate for 25 years or more.

A ship's being retired does not necessarily mean that it could not have operated longer. The end of a conflict often reduces the need for combat ships, especially those that were reactivated. The four Iowa class battleships, for example, were retired in the early 1990s because the Cold War ended. If Taiwan's navy operates the former USS *Taylor* and the former USS *Gary* for the next 30 years, as it currently plans to do, those ships' postreactivation service lives will be considerably longer than those of most reactivated combat ships.

Prospects for Reactivating Oliver Hazard Perry Class Ships

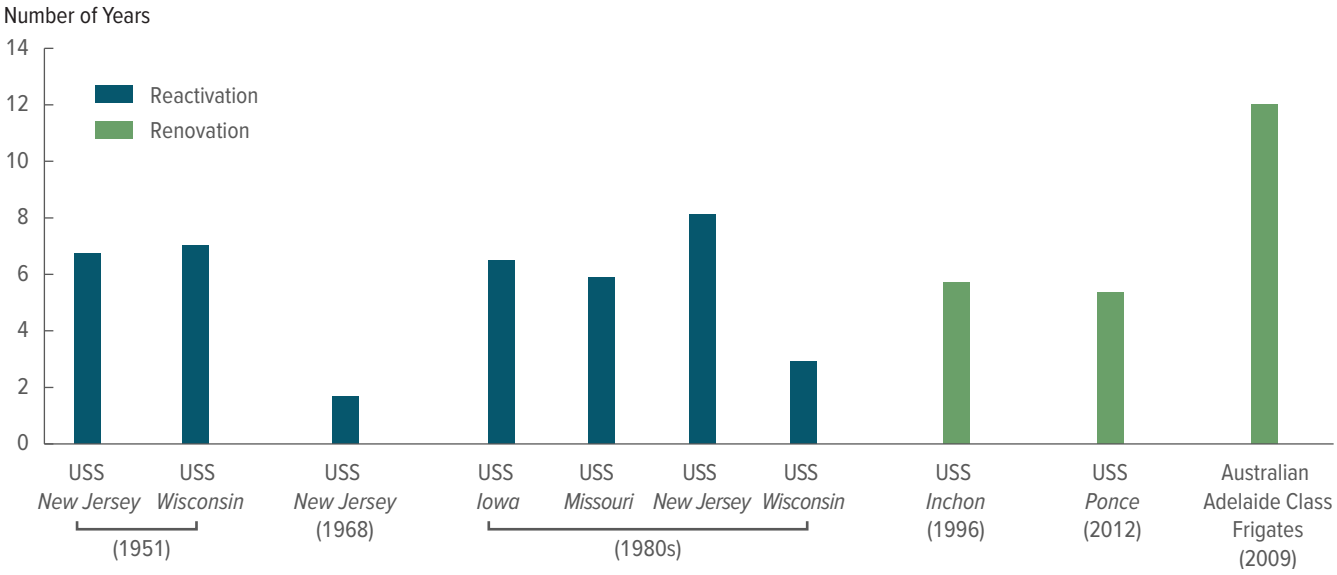
Some advocates of expanding the size of the Navy's fleet have called for reactivating Oliver Hazard Perry class frigates as a means to quickly do so.[34] As of August 2017, the Navy had 22 inactive Oliver Hazard Perry class

34. See, for instance, David B. Larter, "Don't Reactivate the Old Frigates, Internal U.S. Navy Memo Recommends," *Defense News* (November 12, 2017), https://tinyurl.com/yaz4bpjw; Ben Werner, "SECNAV Spencer: Oliver Hazard Perry Frigates Could Be Low-Cost Drug Interdiction Platforms," *USNI News* (September 20, 2017), https://tinyurl.com/ybwqaojt; and Jacqueline Klimas, "Spencer: 'Everything on the Table' to Grow Fleet, Including Reactivating Frigates," *PoliticoPro* (September 6, 2017). The Navy also looked into reactivating the retired nonnuclear aircraft carriers USS *Kitty Hawk* and USS *John F. Kennedy* but concluded that doing so would involve significant risks with minimal returns. The Navy estimated that the cost would be more than $3 billion per ship.

Figure 4.

Years of Operation After Reactivation or Renovation

Typically, reactivated and renovated ships have operated for five to seven years before being retired again.



Source: Congressional Budget Office, using data from the Naval Vessel Register.

Years shown in parentheses indicate when the reactivation or renovation was completed.

frigates, 10 of which were in FMS hold status, the best-maintained state.[35] If Oliver Hazard Perry class ships were reactivated, they would be the first combat ships that the Navy has reactivated since the 1980s. (The USS *Inchon* and USS *Ponce* were active when they were refitted.)

Navy officials estimate that reactivating an Oliver Hazard Perry class frigate without undertaking large-scale weapon system upgrades would cost on the order of $200 million per ship, or about 25 percent of the ship's estimated replacement cost. That cost would be roughly double the amount that Taiwan spent per ship but less than what Australia paid to upgrade its Adelaide class frigates.

U.S. Navy frigates were primarily designed for antisubmarine warfare, though the Oliver Hazard Perry class ships also provided an antiship capability and limited air defense for amphibious and replenishment groups and convoys.[36] In 2000, the Navy removed the limited air defense capability from the frigates. A $200 million reactivation would not improve the residual antisubmarine warfare or general peacetime patrol-interdiction capabilities of the class. Secretary of the Navy Richard V. Spencer suggested that, without an extensive upgrade of combat systems, reactivated frigates might assist drug interdiction efforts or patrol the Arctic.[37] But if the Navy wanted those ships to perform more demanding missions, more extensive upgrades would be needed, which could considerably increase the cost to reactivate the ships.

If no large-scale upgrades to combat systems were undertaken, reactivating an Oliver Hazard Perry class frigate could, on the basis of the Taiwanese navy's experience, be expected to take about nine months. Australia's two-year timeline for renovating its frigates

35. Of the remaining inactive Oliver Hazard Perry class frigates, 8 were scheduled to be dismantled, and 4 were scheduled to be sunk as part of fleet training. Those 12 ships were in worse condition than the 10 FMS hold ships, so the 10 FMS hold ships would, presumably, be reactivated first.

36. Norman Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, 18th ed. (Naval Institute Press, 2005), p. 161.

37. Ben Werner, "SECNAV Spencer: Oliver Hazard Perry Frigates Could Be Low-Cost Drug Interdiction Platforms," *USNI News* (September 20, 2017), https://tinyurl.com/ybwqaojt.

would be a better model if large-scale upgrades to combat systems were undertaken. Reactivations could occur at a number of shipyards, so they could occur concurrently rather than sequentially.

The cost and benefits of reactivation would depend on the role the ships would play in the Navy's long-term plans. Most previously reactivated warships operated for only a few years before being retired again. Would the Navy view the Oliver Hazard Perry class frigates as fulfilling a need temporarily until a long-term replacement ship was available (as it did with the USS *Ponce*)? Or would it view the ships as playing a more permanent role (as the Taiwanese navy does with its frigates)? The Navy would probably need to spend more to upgrade the ships and their combat systems if its intention was to operate the ships further into the future.

About This Document

This Congressional Budget Office report was prepared at the request of the Chairman of the Senate Armed Services Committee. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Edward G. Keating of CBO's National Security Division prepared the report with guidance from David Mosher. William Carrington of CBO's Microeconomic Studies Division provided helpful comments on the report, as did Jerry Hendrix of the Center for a New American Security, Bryan McGrath of the FerryBridge Group, and Salvatore Mercogliano of Campbell University. (The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.) Bernard Kempinski (formerly of CBO) fact-checked this report. Further assistance was provided by Cynthia Cleveland, Mark Hadley, and Eric J. Labs of CBO and by Jonathan Kaskin, former Director, Strategic Mobility/Combat Logistics (OPNAV N42), United States Navy. CBO thanks officials at the Maritime Administration, the Naval Sea Systems Command, and the Philadelphia Inactive Ship On-Site Maintenance Office for their time and assistance.

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Director
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