Long-term storage has played a substantial role in the Navy-MARAD approach to managing their fleet of inactive ships and has by default become the primary management tool in recent years. This chapter examines the costs of maintaining the inactive fleet of 358 ships in storage for 100 years and the environmental concerns that might undermine long-term storage as an option. Of course, long-term storage is not actually a disposal option, since it only defers disposal. But it does represent the consequences of not taking some other action to dispose of the 358 ships.

We selected a duration of 100 years to highlight the fact that the Navy and MARAD must treat long-term storage as a deliberate decision that will bring with it costs beyond those that either is encountering with their current storage of ships awaiting disposal. To remain safely and securely afloat for 100 years, the ships will have to be protected within and without from corrosion attack with cathodic protection (CP) systems, dehumidifying (DH) systems, periodic dry dockings for inspections, hull preservation, and repairs. Most of the 358 ships are not presently maintained in this manner. All of this costs money.

**THE COSTS OF PRESERVATION MAINTENANCE**

Preservation costs for ships in long-term storage comprise the direct labor and material costs for maintaining these vessels’ long-term integrity while waterborne and the indirect facility and support costs associated with this maintenance. These costs are higher than what either the Navy or MARAD presently expends in passive storage of ships awaiting disposal. In addition, ships are subject to regularly scheduled inspections and tests of their critical systems (e.g., CP and DH equipment and fire and flood alarms), and ships require physical security.

Periodically (we assumed once every 15 years, as recommended to us by MARAD) these ships undergo maintenance in dry dock. This involves costs as-
sociated with docking and undocking; hull cleaning; hull survey; replacement of hull zincks, shaft seals, and rudder seals; hull repairs; and similar items.

We also assumed that annual costs for preservation maintenance would increase by 0.5 percent to account for ship aging and the likelihood that as the ships age they will require slightly more such maintenance each year. Table 2.1 summarizes the cost factors for the long-term (100-year) storage option.

Note in the table the difference in costs for long-term storage versus short-term storage in anticipation of disposal. The Navy’s long-term cost is about 15 percent higher than its short-term cost; MARAD’s long- and short-term costs differ by a factor of 2.5. Selection of the long-term storage option thus will require each agency to increase its present storage budgets, although we cannot say by how much at this point because we have not analyzed the agencies’ current budgets.

Based on the assumptions in Table 2.1, the baseline cost for long-term storage of the 358 ships in a 100-year program is $4.9 billion in undiscounted constant dollars. The annual cost ranges from $45 million to $60 million and averages

<table>
<thead>
<tr>
<th>Table 2.1</th>
<th>100-Year Storage Option Cost Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor</strong></td>
<td><strong>Value</strong></td>
</tr>
<tr>
<td><strong>Navy</strong></td>
<td></td>
</tr>
<tr>
<td>Annual preservation maintenance for &quot;scrap&quot; ship</td>
<td>$57,000</td>
</tr>
<tr>
<td>Annual preservation maintenance for long-term storage</td>
<td>$65,500</td>
</tr>
<tr>
<td>Dry dock cost</td>
<td>$1,230,000</td>
</tr>
<tr>
<td><strong>MARAD</strong></td>
<td></td>
</tr>
<tr>
<td>Annual preservation maintenance for &quot;scrap&quot; ship</td>
<td>$20,000</td>
</tr>
<tr>
<td>Annual preservation maintenance for long-term storage</td>
<td>$50,000</td>
</tr>
<tr>
<td>Dry dock cost</td>
<td>$900,000 first dry dock, $800,000 thereafter</td>
</tr>
<tr>
<td><strong>Both</strong></td>
<td></td>
</tr>
<tr>
<td>Cost growth</td>
<td>0.5% per year</td>
</tr>
</tbody>
</table>

\(^{a}\) Costs are associated with various ship types: FF = $1,103,000 (one shaft), CG = $1,230,000 (two shafts), CV = $2,156,000 (four shafts).

\(^{1}\) Note that total cost is in constant FY00 dollars with no consideration of inflation. In the out years, inflation will increase the actual budget required.
$50 million during the 100-year interval. The breakdown between the total 100-year Navy and MARAD annual preservation maintenance and dry dock maintenance for the existing distribution of ships between Navy and MARAD facilities is shown in Figure 2.1.

The annual Navy and MARAD costs for the long-term storage option are illustrated in Figure 2.2. The higher cost for both agencies in the first year results from the installation of CP and DH systems in ships not presently equipped with these features, which we believe are necessary for long-term storage. The slight dip in MARAD costs at year 16 represents the slightly lower cost of the second and subsequent MARAD dry dock maintenance periods.

Note that excepting the first year, the total cost for both agencies is fairly flat at about $45 million per year. In the out years, the budget will gradually increase to about $55 million per year total as the growth factor of 0.5 percent per year slowly builds.

We assumed for our analysis that of the 358 ships in the inventory, 225 are in MARAD storage and 133 are in Navy storage, because that distribution approximates the current situation. From the detailed calculations in the model, MARAD's storage costs for their ships will thus be about $2.7 billion while the Navy's will be about $2.2 billion. Dividing the total costs by the number of ships held by each agency shows that the cost of storing a ship for 100 years will be

![Figure 2.1—Navy and MARAD Annual Preservation and Dry Dock Maintenance for the Long-Term Storage Option](image-url)
Figure 2.2—Navy and MARAD Annual Costs for Long-Term Storage, First 20 of 100 Years

about $12 million in a MARAD facility and about $17 million in a Navy facility. Thus, for the storage option, MARAD facilities are preferred. In fact, if all 358 ships were stored in MARAD facilities and maintained in accordance with MARAD practices, the total estimated long-term storage program cost would drop from $4.9 billion to about $4.3 billion.

MAJOR CONCERNS

We have two major concerns related to our estimated costs for long-term storage (regardless of storage agency): (1) that leaks will discharge harmful materials into the waterways where the ships are stored, and (2) that corrosion will ultimately penetrate the ships’ hulls or topsides, causing them to sink or become unsafe to work aboard. The Navy is addressing the first issue by removing fuels and lubricants from the ships in its custody. However, we understand that MARAD has no current program of this nature and have noted from a brief review of liquid loading logs for some MARAD ships that many still contain po-

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2We have not determined the basis for the difference between the Navy and MARAD storage costs. The difference could reflect genuine differences in work, different accounting practices, and/or other factors. The cost figures were provided by each of the agencies and are used at face value in our evaluation.
tential pollutants. As the current inactive ships age and corrosion takes its inevitable toll, accidental spills and discharges become more likely. Corrosion alone is a severe problem in these ships, regardless of concerns for potential pollutants. Corrosion of hulls and topsides has already damaged some ships to the point that repairs have been needed simply to keep the ships afloat and adequately safe to work aboard. The ultimate toll of corrosion is unknowable.

With careful and continuous preservation and periodic dry dockings, ships could be kept afloat indefinitely. But the cost and extent of the needed preservation cannot be accurately predicted. We included in our estimates an escalation of 0.5 percent per year for added general maintenance over the duration of the storage period. The actual escalation in maintenance cost for long-term storage, if any, is unknown. Maintenance costs for operating warships escalate at 1 or 2 percent per year of ship age, but maintenance of an inactive ship is very much different from maintenance of an operating ship. We judge that 0.5 percent is a fair estimate. The cost model also has a dry dock maintenance interval of once every 15 years for each of the 358 ships, based on MARAD’s recommendation. The required dry dock interval may be different.

The variable that will have the most pronounced effect on total program cost is the aging factor. If it is 2 percent rather than 0.5 percent, the total cost of the long-term storage option nearly doubles, going to $8.6 billion. The dry dock cost and interval factors have a lesser, but still notable impact—each could increase total program cost by another $1 billion.

The ultimate cost of this option is of course difficult to predict: a long-term program of 20 years, to say nothing of 100 years, involves so many unknowable events. However, we estimate that the best case for this option is represented by zero aging growth (essentially assuming that all aging effects will be taken care of during periodic dry dock maintenance), no sudden natural events (such as hurricanes), and no transforming legal changes (such as prohibitions on storage afloat of the materials and substances incorporated in the ships). This best-case estimate also assumes that all 358 ships are stored in MARAD facilities, whose storage costs appear to be lower than those of Navy facilities. With these assumptions, the best-case estimate of total cost for the long-term storage option falls to $3.8 billion. We also estimate that the worst-case cost, which is for a 1 percent aging factor, dry docking repair costs 25 percent higher than those for the baseline estimate, and dry docking intervals every 10 rather than 15 years, would be $7.7 billion.

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CONCLUSIONS

According to our assessment, then, the long-term storage option not only is very expensive but also has a large amount of cost uncertainty. Furthermore, this option does nothing more than defer the problem of how to dispose of these ships, leaving some other generation to deal with it. No matter how long the ships are stored—20, 50, or 100 years—there will still be 358 ships for disposal.

For these reasons, we concluded that long-term storage was not a viable course of action and thus not a sound policy option. However, it should be noted that if circumstances were to compel the Navy and MARAD to store the 358 ships for the indefinite future, the MARAD facilities, which appear to offer a lower cost than the Navy facilities do, are the preferred storage location.