Vard Marine Inc.

FINAL REPORT

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Joint Legislative Audit and Review Committee (JLARC)

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EXECUTIVE SUMMARY

ES-1. Background

The State of Washington's Joint Legislative Audit and Review Committee (JLARC) is conducting an independent review of Washington State Ferries' (WSF) design-build contracting process for hybrid-electric ferries. The review will compare WSF's policies and practices (P&P) for design-build contracting to best practices, both domestically and internationally, and propose best practices that would benefit the ferry system and updates to the Revised Code of Washington (RCW) needed to implement them. JLARC's review will also evaluate opportunities in the contracting process to decrease vessel construction costs and ensure operational efficiencies.

JLARC has contracted with Vard Marine Inc. (VARD) to undertake a supporting assessment of WSF's design-build contracting P&P related to the hybrid-electric ferries to answer three main questions:

1. What are WSF's policies and practices for procuring new hybrid-electric ferries through design-build contracts?
2. How do WSF's policies and practices for design-build contracts for hybrid-electric ferries compare to domestic and international best practices?
3. What design-build contracting best practices or industry standards can be used by WSF to decrease vessel construction costs or ensure operational efficiencies?

By policy, future WSF vessel procurements will be hybrid-electric. That is, they will incorporate a stored energy system (batteries) that allows them to be driven by electricity generated ashore from renewable or low-carbon sources. No existing WSF ferry uses this technology, though it is increasingly common worldwide. Two new classes of WSF ferries are currently under development – the five vessel 144-auto Hybrid-electric Olympic Class (HEOC), envisaged as an adaptation of the existing Olympic Class, and the 124-auto ferry which will follow. The HEOC was originally intended to be acquired as an extension to the existing Olympic Class newbuild program at Vigor; however, following substantive completion of the design phase, it proved impossible to agree on a build contract and so the HEOC has been re-initiated as a competitive bid process.

The two WSF ferry procurements, since 2000, have been the 64-auto Kwa-di Tabil (KDT) Class (three vessels) and the 144-auto Olympic Class (four vessels). Lessons learned from these projects are included in both WSF's policies and practices and in state legislation (Section 1.8.1).

ES-2. Methods

VARD has reviewed the applicable legislation, and the relevant policies and practices of WSF and its parent department, the Washington State Department of Transportation (WSDOT). VARD has requested and been provided with extensive documentation related to WSF's recent and ongoing ferry procurements. These materials have been supplemented by a literature review of ferry and similar vessel procurement projects worldwide, and by VARD's own experience in such work. VARD has held a series of interviews with key WSF personnel and has used regular meetings with JLARC to clarify aspects of certain processes.

ES-3. Document Overview

A series of three interim reports were generated by VARD covering elements of the three main questions, and feedback on these reports was incorporated into this final report, which consolidates all findings and suggestions. This executive summary presents high level information against recurring themes identified in the work, including:

- General procurement and contracting approach
- Cost estimating
- Risk
- Cost management/control
- Change management
- Through life cost optimization
- Independent owner's representative

Under each theme, VARD has identified current legislative requirements, WSF approaches, and general best practices in ferry procurement, and measures that could be applied to ongoing and future projects.

ES-4. General Procurement and Contracting Approach

Key points: While WSF outputs for procurement projects generally demonstrate valid approaches to aspects such as requirements definition, risk management, change management, and cost and schedule control, there is very little formal documentation of the policies or practices used to accomplish this. Success, therefore, relies very heavily on the expertise and experience of key personnel and their ability to use and adapt documentation from prior projects in appropriate ways.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices
    - WSF compliance approach
    - Requirements formulation
    - Contracting approach
- Potential improvements

ES-4.1 Legislative Requirements

WSF is a division of the WSDOT, reporting through the Secretary of Transportation to the Governor. It operates under the authority of the Executive Branch, subject to the rules put in place by the legislature. In the RCW, Title 47 applies to Public Highways and Transportation, and within that, Chapter 60 covers the Puget Sound Ferry and Toll Bridge System. The Washington Administrative Code (WAC) also has regulations specific to ferries. Finally, federal legislation from the United States Code (USC) and the Code of Federal Regulations (CFR) also apply to ferry design and procurement.

RCW Chapter 47.60 includes provisions for ferry procurement that are general in nature, and others that are highly specific. For example, WSF is required to build new vessels in Washington State (except as discussed below), using shipbuilders with state-approved apprenticeship programs, and with a certain level of Small Business Enterprise (SBE) involvement.

State law directs WSF to follow a three-phased design-build contracting approach.

- Shipbuilders are prequalified and then shortlisted to undertake a design phase and construction proposal, which may be partially funded through an honorarium approach.
- The winning builder is then selected on the basis of lowest compliant bid, as required by the RCW, or the process must be restarted (see Contracting Approach below).
- Build In Washington limits the number of prospective builders, and therefore simplifies both shortlisting and final contract award. However, if a procurement is re-initiated nation-wide (see Cost Control below) then evaluation and selection will be more challenging.

For program and project delivery, VARD developed a process flow diagram for ferry procurement and has utilized this framework to illustrate and assess WSF's approach to each element of procurement. The framework and related design phases can be summarized as follows. The full diagram is included at Section 1.3 of the report.

Planning	**Project Definition**	**Set and Implement Acquisition Strategy**	**Design-build Contract**

• Long-range plan (e.g., fleet size, need for ship)
• Identify project's high-level operational requirements (e.g., number of passengers, vehicles)
• Resource planning
	• Set and validate technical requirements (e.g., propulsion)
	• Develop concept design and cost drivers
	• Conduct internal resource planning
	• Initial cost estimate
	  ○ Trade-off studies to revise requirements
	• Initial risk assessment
		• Review internal resource planning
		• Develop contract T&C
		• Decide on qualification and evaluation processes
		• Prepare bid documents
		• Expression of interest
		• Prequalification (RCW 47.60.816, Phase I)
		• RFP process & selection (RCW 47.60.818, Phase II)
		  ○ Bidders develop the functional design for their bid
		• Final design phase is used for submittal and evaluation of bids (RCW 47.60.820, Phase III)
			• Detailed design
			• Change orders as needed
			  ○ Appropriate planning should minimize
			• Quality control
			• Construction
			• Tests, trials, and commissioning

	Concept → Preliminary → Basic → Functional → Detailed → Production		

The three-phase process prescribed by state law takes place within the "set and implement acquisition strategy" tasks. Additional laws and OFM rules address planning, predesign studies, budget requests, and the use of an independent owner's representative (IOR). The current HEOC procurement will be the first time WSF uses the three-phase approach as currently outlined in statute.

ES-4.2 WSF's P&P and Best Practices

ES-4.2.1 WSF Compliance Approach

WSF has few documented policies for compliance with legislative requirements.

- WSF has a Vessel Engineering Manual (VEM), intended for use by vessel engineering personnel for both procurement and preservation. However, it has not been updated at all since 2012, or substantively since 2002 due to resourcing constraints. It is mainly used for preservation projects, and, in many areas, it is not consistent with current legislative requirements.
- WSDOT has published many policy documents, such as its Cost Estimating Manual for Projects and Project Risk Management Guide. These documents cover topics including cost estimating, risk management, and others that are common to any engineering project. WSF is using approaches consistent with much of this guidance, but this material is tailored to civil engineering work and little of it is directly useful for ferry procurement.

VARD's review of WSF documentation shows that the contracting approach taken has complied with the legislation then in place, subject to interpretations with the assistance of the Attorney General's Office. WSF has also taken several steps to ensure that legislative requirements are identified and communicated to potential bidders and other industry stakeholders.

- The industry engagement process, in advance of the formal release of the RFP for the HEOC, has clarified for potential bidders the general legislative requirements that will be applicable.
- In current and recent Request for Information/Proposal (RFI/RFP) packages, legislative requirements are incorporated by reference and key elements are set forth in the text.
- WSF uses industry consultations to clarify the approach(es) being taken and to obtain feedback on industry concerns.

ES-4.2.2 Requirements Formulation

WSF develops detailed requirements in-house, based on long-term plans for operations and fleet renewal. It contracts with industry experts to complete predesign studies that are used to explore important attributes, such as the incorporation of new technologies. WSF's approach to project planning and requirements definition follows many best practices.

- WSF's approach to forecasting and planning is considered to be aligned well with best practices. Its decennial Long Term Plan is developed with multi-stakeholder inputs, and predesign studies are used to help define key attributes. (Sections 3.4.2.1 and 3.4.3.1) However, WSF does not have formal processes for establishing budgets for preliminary

activities, so there is some risk that future predesign work will not cover all important aspects or might not do so in sufficient depth. Under any procurement approach, it is important not to introduce unnecessary or overly expensive requirements. WSF should guard against this internally and should encourage stakeholder and industry feedback to identify any such items.

- In general, WSF's approach to staffing its projects is reasonably well aligned with best practices. In particular, this refers to WSF's practice of supplementing its in-house capabilities by making use of support contracts of different types, including with industry technology experts, like Siemens. However, to avoid potential challenges in the future, WSF should address the issue of succession planning for its in-house personnel with key project management and engineering expertise. (Sections 3.4.2.2 and 3.4.3.2)
- WSF generally follows the best practice of developing a full and mature set of requirements before initiating a design-build contract. (Sections 3.4.2.3 and 3.4.3.3)
- A useful way to convey design intent to bidders is to illustrate potential design characteristics using an owner's model. While an owner's model was developed and provided in the past to potential bidders, WSF communicated its intention not to develop one for future design-build procurements. (Sections 1.4.2 and 1.4.3) Furthermore, WSF should consider limiting the scope of the competitive phase of design development, which may reduce overall project schedule and cost, as well as reduce the burden on the owner's in-house resources who must review each technical proposal. (Sections 3.4.2.3 and 3.4.3.3)

ES-4.2.3 Contracting Approach

WSF is constrained by law to use only the design-build contracting approach for future procurements, although WSDOT, as a whole, has more flexibility to use options tailored to the specifics of a project. (Sections 1.3.5, 1.4, and 1.5)

- Design-build is used extensively, but not exclusively, for ferry projects internationally; however, in the US, it is much less common than design-bid-build.
- Design-build is particularly appropriate for "standard" projects, where bidders can be expected to have a good understanding of the requirements and potential solutions. In these cases, design-build allows for fairly complete transfer of responsibility for the project to the contractor. For more complex and unusual projects, design-bid-build or other approaches can be more appropriate. It should be noted that hybrid-electric ferries are not a standard project for most US shipyards since only a few have been built in the US and none as large as the HEOC.
- Design-build is not necessarily well-matched to low bid builder selection (see below), which does not encourage industry to offer innovative design solutions that could improve operational effectiveness or reduce through-life cost as trade-offs for capital cost. In the US context, design-build also leads to the need to pay an honorarium for the development of the design package to encourage bidders to respond, due to the large level of up-front effort required.

- The design-build approach is currently mandated for WSF newbuild programs by state legislation. It has a good record of success in a range of procurement programs. However, under certain circumstances other approaches, in particular design-bid-build, may offer more efficient options. It is suggested that for future programs, WSF should undertake a comparative analysis of approaches early in the process and provide its assessment to the legislature for consideration.

At the end of the three phase RFP process, WSF is constrained by law to accept the lowest responsible, responsive bid. (Section 1.3.4)

- Many owners prefer to select winning bids on the basis of lowest compliant offer. This has the advantage of apparent simplicity but may incur additional risk.
- Not all designs or project implementation plans will have the same level of detail and maturity, and a higher bid may identify issues that the low bid has not addressed in as satisfactory a manner.
- Bidders may be able to propose options that will reduce the vessel through-life cost by simplifying logistic support or by reducing energy consumption.
- Selection of the lowest bidder may incur additional costs for the owner for inspections and other support services.
- Using a best value evaluation approach for the build phase or for the whole life cycle can provide some flexibility.

ES-4.3 Potential Improvements

- WSF should update its internal documentation to include reference to applicable classification society notations and standards organization materials (e.g., ASTM International, the Institute of Electrical and Electronics Engineers [IEEE]) which typically apply to projects. (Section 4.2.3.2)
- WSF should develop a structured contractor selection approach for the design phase and define the criteria which they should be evaluated against. (Section 4.2.3.3)
- WSF should introduce a structured project close-out review to identify lessons learned and improvement opportunities to be applied for future projects (Section 4.2.3.6)
- The current legislated requirement to follow a design-build procurement approach should be changed to allow WSF the flexibility to adopt one of several models for future procurements, subject to using an appropriate selection methodology that reflects the procurement's characteristics. (Section 4.3.2.4)
- The current legislated requirement to accept the lowest bid should be changed to allow WSF to use a "best value" approach and accept design-build proposals which may offer a lower through-life cost, or which have a better risk profile. (Section 4.3.2.5)

ES-5. Cost Estimation

Key Points: WSF follows typical industry practices in its approach to estimating the costs of new ferries and is increasingly using WSDOT practices for some aspect and stages of the work. However, for estimation of overall project costs there is very little formal documentation of practices and a heavy reliance on the expertise and experience of key personnel. Several

legislative requirements apply very stringent requirements to overall cost estimates and to assigning contingencies to budgets. These may lead to severe impacts on future programs.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices
  - Ship cost estimation
  - Project cost estimation
  - Project contingencies
- Potential improvements

These influence work at every stage on the procurement process, where these stages can be summarized as below:

Planning	Project Definition	Set and Implement Acquisition Strategy	Design-build Contract
• Initial program cost estimation • Predesign budgeting	• Refine internal cost estimates • Initial ship cost estimation • Determine honorarium allowance	• Refine project implementation costs • Develop engineer's estimate • Refine project contingencies	• Develop design change cost estimates • Follow-on ship cost estimation
	Concept → Preliminary → Basic → Functional → Detailed → Production		

ES-5.1 Legislative Requirements

RCW 47.60.815(3) says that *"…if all responses to the initial request for proposals under RCW 47.60.814 are greater than five percent above the department's engineer's* [cost] *estimate for the project, the department must reject all proposals and issue a subsequent request for proposals that is not subject to RCW 47.60.814(1)(r)* [Build In Washington requirement]*."* This requirement will be applied for the first time to the HEOC project. It sets a very high bar as regards accuracy, as discussed below. If not achieved, the mandated US-wide recompete will itself incur substantial delay and additional cost.

Other specific legislative requirements related to cost estimation include:

- RCW 47.60.820(8), which allows WSF to provide an honorarium payment to bidders for proposal preparation costs – this requires WSF to establish an appropriate quantum for such payments.

- RCW 47.60.820(9), which limits the contingency amount in legislative appropriations to no more than 5% above contract value – this reduces WSF's flexibility in tailoring contingency to project complexity and risk.

More generally, the budgeting process in Washington State requires the approval of projected expenditures on a biennial cycle. This can be an issue for ferry construction projects, which even for single ship procurements will normally take more than two years.

ES-5.2 WSF's P&P and Best Practices

ES-5.2.1 Ship Cost Estimation

WSF follows standard practice in starting with early "top-down" estimates of future ferry cost based on a few main ship parameters and progressing into detailed "bottom-up" estimates based on more detailed information on the design. The VEM contains limited and outdated guidance on cost estimation. WSDOT documentation does not provide a useful framework for ship cost estimation. WSF therefore relies on the experience of key in-house personnel and on that of contractors engaged to assist with estimates.

WSF works within a very limited market due to Build In Washington requirements. This makes US and international market data on ship prices of limited use in establishing budgets. WSF adapts information on its own recent and current projects in early-stage cost estimation and uses predesign studies to assist in assessing the effects of cost drivers, such as the transition to hybrid-electric propulsion. It also applies large uncertainty margins, e.g., of 50% to preliminary budgetary estimates for the 124-auto ferry.

Early-stage estimates include both design and construction cost. Design cost estimates are used to support the selection of honorarium amounts for participants in the main RFP process, to support design work and project planning. The budgeted honorarium for the current HEOC program is relatively small, as WSF is providing a mature design developed under contract by Vigor as an owner's model. For the 124-auto ferry, a much larger honorarium amount is currently budgeted to account for its "blank sheet of paper" approach. In both cases, the values are set based on WSF staff judgement.

Detailed construction cost estimation, culminating in the engineer's estimate, is normally contracted out by WSF to companies with specialized expertise in this field. It is extremely difficult for any organization, no matter how experienced, to predict the price that a shipbuilder will offer (Section 3.8.4 and 3.8.5), as this price will be made up of:

- Materials and equipment costs, for which reasonable quality information exists in the public domain but which are subject to rapid market fluctuation.
- Shipyard productivity, labour rates, and overhead, which are highly confidential.
- Shipbuilder risk premium, profit expectation, financing cost, and compliance costs, which are dependent on market conditions, contract terms and conditions, and perceptions of the competitive environment.
- For multi-vessel procurements, uncertainties over future inflation, price escalation, etc.

Best practice for cost estimates at all levels is to use a probabilistic modelling approach to convey the levels of uncertainty involved (Section 3.8.2.3). The value used for budgetary, or evaluation purposes, can be set at a 50%, 20%, or other probability of exceedance, depending on the organization's preferences.

ES-5.2.2 Project Cost Estimation

Project costs normally include:

- Project planning effort
- Requirements definition
- Bid process
- Ship cost – implementation contract (design and build)
- Contract oversight
- Necessary shore-side infrastructure requirements
- Training and logistics support

Elements of training and logistics may be incorporated in the shipbuilding contract. The shore side infrastructure costs may be small, if the new ferry is a very similar ship to the one being replaced, or quite large, as is the case with the introduction of new technology such as hybrid-electric with electricity supply arrangements and potential terminal modifications. Ideally, ship related shore-side work should be treated as a single project/program to ensure both technical and schedule compatibility (Section 1.3.2.2). This is being done by WSF for electrification (Section 3.11.2), though it is not clear from materials provided how cost estimation for these elements has been factored into the HEOC costs.

WSF does not have formal P&P for estimating the costs of any elements of project cost other than the ship cost itself and there is no relevant guidance in other WSDOT documentation. Best practices include progressive refinement of estimates drawing on staff and contracted resources (Section 3.8.6)

ES-5.2.3 Project Contingencies

Project cost estimation typically includes margins or contingency allowances of different types at different project stages – the two terms are often used interchangeably. The legislative constraint cited above applies only to budget contingency for change orders following the award of a fixed-price design-build construction contract. It is discussed as part of Change Management below.

At the start of a project, there is typically a very high level of uncertainty regarding the expected cost of all components. As noted, WSF has added a 50% contingency to its early ship cost estimates for the 124-auto ferry. The VEM includes recommendations for contingencies at various project stages, but these are not currently used by WSF. WSF currently relies on staff experience and expertise to select values.

The critical cost estimates for a project are those which inform the project budget appropriations and the engineer's estimate for the expected cost of the construction contract. There are no requirements or guidance regarding expected or acceptable values for contingency in either of

these. As noted in Ship Cost Estimation above, the use of probabilistic cost models can be valuable in assessing and illustrating the levels of uncertainty in all estimates.

Contingencies can also be identified for some of the uncertainties identified in Ship Cost Estimation above, such as general inflation, material price escalation, and foreign exchange impacts on the cost of major and specialized equipment. This can be used to tailor contracts in ways that balance the risk profile for the project (see Risk Management below).

ES-5.3 Potential Improvements

- A move to adopt probabilistic cost estimation for all stages of projects would be consistent with other WSDOT approaches to risk management (see below) and would help with establishing appropriate contingencies. (Section 4.2.3.4)
- WSF should develop P&P for estimation of all project costs and should examine how best practices from other organizations and jurisdictions can be adapted to the Washington context. (Section 4.2.3.10)
- The 5% variance for engineer's estimates and the associated requirement for recompeting projects should be reviewed and interpreted. (Section 4.3.2.2)
- Contingency categories for incorporation in cost estimates should be identified and processes for their quantification should be developed. (Section 4.2.3.9)

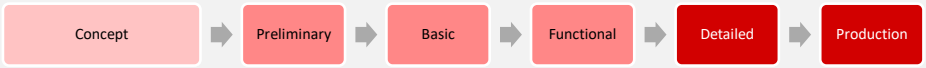
ES-6. Risk Management

Key Points: Ferries can be quite complex vessels and their procurement incurs technical, cost and schedule risk. WSF should identify and manage risks throughout projects. At present, it has a limited set of policies and practices for this. The WSF contracting approach aims to transfer almost all risk to the shipbuilder, but this may lead to higher costs and to substantial risk of overall project failure.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices
    - Project risk management: technical, cost, and schedule
    - Contract terms and conditions
- HEOC-specific project risks
- Potential improvements

Risk management is required at every stage on the procurement process, as summarized below.

Planning	Acquisition Strategy	RFP and Contractor Selection	Design-build Contract
• Establish organizational risk profile • Identify project-specific risks • Undertake predesign to mitigate technical risks	• Industry consultation • Selection of contracting approach • Develop appropriate contract terms and conditions	• Include risk in down select criteria • Require contractor risk management plan • Include risk in final selection	• Require risk-related reports and metrics • Manage retained risk items
			

ES-6.1 Legislative Requirements

There are no specific legislative requirements for risk management in WSF ferry procurement. Several requirements have been identified as significant sources or drivers of risk, including:

- RCW 47.60.810: Design-Build – mandates a particular contracting approach, removing WSF ability to tailor approach to project risk profile (Section 1.5)
- RCW 47.60.814: Build in Washington – limits pool of potential builders, with potential technical, cost and schedule risk (Section 2.3.1)
- RCW 47.60.815(3): Engineer's estimate – requires cancellation and restart of project if bids are more than 5% above estimates, incurring schedule and potentially cost risk (Section 2.3.2)
- RCW 47.60.820(6): Low bid – final contractor selection must be based on low bid, limiting WSF's ability to include risk factors in bid evaluation (Section 4.3.2.5)
- RCW 47.60.820(9): Contingency limit – constrains ability for design improvements and contract adjustments based on unforeseen circumstances, such as COVID or inflation.
- RCW 47.60.835: Small Business Enterprise participation – limits pool of potential subcontractors, with potential technical, cost, and schedule risk (Section 2.3.4)

ES-6.2 WSF's P&P and Best Practices

ES-6.2.1 Project Risk Management

Within WSDOT, Executive Order E1053 requires active risk management of large capital projects. WSF's risk management practices include some use of WSDOT's Risk Management Guide and associated documentation. WSDOT provides detailed guidance for some aspects of civil engineering projects, but very little of this is of benefit to ship procurement. The WSDOT Cost Estimate Validation Process (CEVP) provides a risk-based framework for cost estimates, and WSF

is moving to adopt this process; this has not been applied on past projects. Again, the detailed WSDOT documentation is largely civil engineering specific. At a high level, WSDOT's processes are well aligned with industry best practices, but this leaves WSF to do any necessary tailoring using its internal and contractor support expertise. (Section 2.4.3)

WSF does not have an overall organizational risk profile to outline the types or levels of risk it is prepared to accept. Risk management has been handled on a project basis. Technical risk has been managed through the use of predesign studies to explore feasibility and impacts. Other aspects of risk management have been delegated to the builder by requiring the incorporation of risk items in the build strategies provided as part of the bid.

Moving forward, the use of the CEVP, at a relatively early stage in the (re-initiated) HEOC provides an opportunity for a more comprehensive approach to risk management by WSF, supported by its general engineering contractor. This will be better aligned with general industry best practices, though it will start part-way through the overall project due to the way in which HEOC has unfolded. (Section 2.4.3.2.3)

ES-6.2.2 Contract Terms and Conditions

WSF aims to transfer as much as possible technical, cost, and schedule risk to the shipbuilding contractor through contract terms and conditions. This includes the use of fixed price contracting with limited potential for change orders, the use of liquidated damages for specific performance shortfalls, and bonding for overall performance. It was noted that WSF and Vigor were unable to agree on price for the previous iteration of HEOC due in large part to risk-related items. (Section 2.4.3.2.2) In industry consultation for the re-initiated HEOC, several concerns in these areas have been flagged by potential bidders.

Risk should be carried by the party best equipped to manage it, which depends on the nature of the party and of the program. It is important that the client, WSF, understands the perspectives of the industry side and how these will factor into pricing and other decisions.

ES-6.3 HEOC Risks

Our study does not focus exclusively on the HEOC program, but, as this is a large and current project, it is useful to flag some of its main risk factors:

- Schedule: the delays associated with the initial version of the project may make it difficult to achieve required in-service dates. The potential need to restart, if the 5% cost estimate threshold is not met, will aggravate schedule risk. (Section 3.2)
- Cost: delay and escalation costs may make current budgets inadequate. Limited competition may allow bidders to offer unfavorable pricing (Section 2.3.1.2). Bidder perceptions of risk may lead to large contingencies in price proposals. (Section 2.4.3.2.2)
- Technical: the current owner's model design does not meet weight and possibly performance requirements. The limited planned duration and value (honorarium) of the RFP phase may not allow for the development of mature design offerings, or for bidders to meaningfully accept performance responsibility. The feasibility of the battery

recharging solution remains unproven, despite predesign studies around this issue. (Section 2.4.3.2.4)

- General: the lack of competition due to Build In Washington and other constraints may lead to single or no acceptable proposals.

ES-6.4 Potential Improvements

- WSF should develop a robust system for internal project resource planning to avoid potential shortfalls that could impact schedule or quality (Section 4.2.3.1)
- WSF should establish an organizational risk profile (Section 4.2.3.8)
- A policy should be developed for a ferry-specific risk management process (Section 4.2.3.7)
- A risk assessment should be completed, and a risk register initiated at the start of every procurement (Section 4.2.3.7)
- Builders should be required to assess and manage risks during the RFP process and for the duration of the contract (Section 4.2.3.7)
- Standard terms and conditions for the builder contract should reflect responsibilities for risk management (Section 4.2.3.9)
- RCW 47.60.814(1) should be modified to reduce the technical, cost and schedule risks associated with limited competition (Section 4.3.2.1)
- RCW 47.60.815(3) should be modified to remove or lessen the risk that a relatively small difference between an engineer's estimate and a bid price leads to a cancellation and reset of the project (Section 4.3.2.2)
- RCW 47.60.820(4) should be modified to allow risk to be evaluated as a criterion for contract award (Section 4.3.2.5)
- RCW 47.60.820(9) and RCW 47.60.385(1) should be modified to allow for project contingencies to reflect risk (Sections 4.3.2.6 and 4.3.2.7)

ES-7. Cost Management and Control

Key points: Cost management for a project starts at the earliest stage by setting technical and contractual requirements with an awareness of which factors drive cost and where cost-benefit trade-offs can be made. WSF has addressed technical factors on past and current projects and understands contractual factors but has few documented processes for this. Following contract award, cost control is exercised largely through change management, as discussed in Change Management below.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices
    - Technical cost drivers
    - Contractual cost drivers
    - Project cost

- Potential improvements

ES-7.1 Legislative Requirements

Washington State legislation includes several contractual and some technical cost drivers, but few items directly related to cost management and control. The requirement for bid prices to be within 5% of the engineer's estimate for a project under RCW 47.60.815(3) is a control on overall cost, though as noted above its application may also cause increases in both cost and schedule.

Other elements of RCW Chapter 47.60 set requirements for the development of a Capital Plan (47.60.375) and Vessel Replacement Plan (47.60.377) supported by predesign studies (47.60.385). It has been recognized for some time that the ferry service cannot be sustained by fare revenues, and that additional appropriations are required for new projects. High level cost control is provided through the budgeting process, with a high degree of reliance on WSF to identify capital needs.

ES-7.2 WSF's P&P and Best Practices

ES-7.2.1 Technical Cost Drivers

WSF's levels of service and growth forecasts provide the framework for determining the capacity and speed of future ferries, which are two of the main ship cost drivers. (Section 1.3.3) The selection of propulsion plant type is another major factor, and this has been set by policy and legislation for service electrification. The more detailed selection of requirements in these areas, and of other aspects of the ship designs has been set by WSF based on predesign studies and by drawing on past practice, informed by service experience of existing vessels. WSF's approach uses the experience and expertise of in-house staff, plus that of its supporting engineering contractors. This is typical of other similar organizations.

ES-7.2.2 Contractual Cost Drivers

Legislative and policy requirements such as Build In Washington, apprenticeship programs, and Small Business Enterprise participation have substantial direct impacts on cost, by reducing competition and incurring compliance costs. These are all matters of public policy. There has recently been little or no attempt to assess the cost impacts, making it difficult to determine cost-benefit trade-offs.

The design-build contracting approach currently mandated for ferry procurement transfers performance, schedule, and cost responsibility and risk to the contractor/builder, even though RCW 47.60.810 refers to the approach as a "design and build partnership." Other terms and conditions used, for example, in the recent draft contract for HEOC, aim to confirm that the builder carries all responsibility. This may not represent the most effective form of cost management, as the builder must factor all risk premiums into pricing, and some types of risk may be costlier for builders than for an owner such as WSF. As an example, when inflation rates are substantial and uncertain, a builder needs to account for them solely through pricing. The public sector can expect to see some increases in revenues from inflation, which provides at least a partial offset.

ES-7.2.3 Project Cost

While an implementation contract is underway, it is important that the owner has good visibility into the cost and schedule performance of the builder. Although all or most direct risk may fall to the builder, the owner will suffer major impacts if the ship is delivered late, if cost pressure led to poor quality, or if the builder completely failed to perform. Currently, WSF has limited cost and schedule reporting requirements in its contracts and makes monthly progress payments rather than using progress milestones. Neither of these are in line with best practices, which often require the use of Earned Value Management (EVM) processes and/or well-defined payment milestones. It is worth noting that for the 2019 HEOC contract, Vigor required that its suppliers follow EVM processes, whereby they are allowed to report and invoice only for physical progress on deliverables as measured on the execution schedule.

Overall project cost includes the planning and preparation efforts undertaken by the client in the early stages; and the oversight and management functions undertaken during the RFP and implementation phases. Infrastructure work required, from shore-side improvements to logistic support and training, also needs to be considered. (Sections 2.4.6, 0, and 3.6)

ES-7.3 Potential Improvements

- Ensure builder is undertaking effective schedule and cost control using tools such as EVM, to provide WSF accurate visibility into project performance (Section 4.2.3.5)
- Align payment milestones to EVM metrics or physical progress (Section 4.2.3.9)
- Define standard terms and conditions that address how funding will be managed for the full class of vessel, e.g., follow-on ships, major equipment, etc. (Section 4.2.3.9)

ES-8. Change Management

Key Points: Introducing change becomes increasingly expensive as a project progresses, and particularly after the start of construction. However, changes should be encouraged at earlier stages where they offer the potential for through life cost reduction or cost-effective performance enhancement. WSF has a robust change management approach, but legislative requirements constrain its flexibility.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices
    - Pre-contract
    - Contract
- Potential improvements

ES-8.1 Legislative Requirements

An important requirement associated with change management is RCW 47.60.820, which limits contingencies in a fixed price contract to 5% to accommodate change orders. It also requires that any use of contingency be approved by the Office of Financial Management. These requirements were introduced in 2015 and have not yet been tested in a procurement. They may limit the

flexibility of WSF to adjust a contract to account for potential modifications to improve through life performance, or to account for unexpected circumstances. It is unclear how the requirements are to be interpreted for multi-ship procurements, where the first of class is normally the most likely to see significant technical changes and follow-on ships can then be essentially identical. A 5% allowance can be too small for the first ship, and excessive for the fourth ship. On the other hand, if change orders are used to account for economic fluctuations which are changes to material or labor costs, etc., then cost impacts will be greater for the later ships. It is unclear how the RCW is expected to be applied.

A second key requirement is RCW 47.60.810, which mandates the use of design-build contracts for ferry procurement. This contracting approach may limit WSF's ability to adjust technical and contract requirements to incorporate lessons learned from early-stage design. The RCW also requires the engagement of an independent owner's representative (IOR) to manage many aspects of the project, including change orders. (Section 2.3.3)

ES-8.2 WSF's P&P and Best Practices

ES-8.2.1 Pre-contract

WSF uses predesign studies to enter the RFP process with what is intended to be a mature and complete set of technical requirements, and sample contractual documentation for the implementation contract using the design-build approach. These can in principle be amended by WSF at different times during the bid process (RCW 47.60.814 Issuance of Request for Proposals 47.60.818 RFP Phase II) though in practice such changes may cause bidders to request extensions to delivery dates and to honorarium amounts. It is possible that changes that appear to favor one bidder's approach over that of competitors would be challenged. As this full process has not been tested in any recent procurement, it is unclear how any issues arising will be addressed.

Many ferry operators in the US use design-bid-build, which facilitates fixing the design before the build phase. The US Navy and US Coast Guard make use of the "industry design studies" approach, which enables potential bidders to explore aspects of the design space before moving into a design-build RFP process. Some other operators, who use design-build, such as BC Ferries, use contractors to undertake similar predesign studies to WSF. In all cases, it is important to be able to identify the project's technical challenges at an early stage, and to identify and define feasible approaches to overcoming these in advance of signing fixed scope and price procurement contracts.

ES-8.2.2 Contract

On the Olympic Class, WSF and the shipyard kept changes to a very low level throughout the project, even for the lead ship. This indicates that the requirements were mature and well-formulated, that the WSF team were disciplined in avoiding change, and that the change order process was robust. However, the process is not currently captured in well-documented policies.

The initial HEOC design phase with Vigor did not follow normal practices, but it is notable that there were substantial increases to the scope of work, schedule, and cost (close to 100% of initial value) prior to the cancellation of the contract. Technical change orders were well-managed

during this process, but there was more technical uncertainty than anticipated that required additional work. Much of this related to the impacts of introducing hybrid-electric technology. It is unclear whether this would have been easier to handle if the project had been subject to the current legislative constraints.

ES-8.3 Potential Improvements

- Clarify scope and intent of 5% contingency allowance and consider adding flexibility based in project characteristics. (Section 4.3.2.7)
- Develop documentation for change management. (Section 4.2.3.11)
- Clarify the change order management and approval process to provide more flexibility to the project team. (Sections 4.3.2.8 and 4.3.2.9)

ES-9. Through Life Cost Estimation

Key points: Most of the cost of a ferry relates to its operations over the course of its life, for crewing, fuel, and maintenance. Decisions, at the design stage, will "bake in" most of this cost, and through life cost reduction will sometimes conflict with procurement cost reduction. WSF faces conflicting requirements in estimating and controlling through life cost.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices
    - Planning and requirements definition
    - Contracting
- Potential improvements

ES-9.1 Legislative Requirements

RCWs relating in whole or part to through life cost estimation principally include 47.60.365, 47.60.385, and 47.60.386, all of which require consideration of through- life cost in aspects of requirement definition. (Section 2.2.3) There is no firm definition of the intended outcome.

Other legislation that indirectly affects the approach to through life costing includes RCW 47.60.820, which mandates the award of the build contract to the lowest fixed price bid. As has been noted in Risk Management above, this does not allow for any evaluation of offerings which could reduce through life cost while offering a higher initial build cost. (Section 1.3.4.10) Also, the limit on permissible design changes after contract award (5% of contract value) constrains the potential to incorporate any suggestions by the builder or any late-breaking developments in technology or cost that might otherwise justify reopening the design.

ES-9.2 WSF's P&P and Best Practices

ES-9.2.1 Planning and Requirements Definition

WSF undertakes predesign studies to explore aspects of the design requirements on a through life basis. Examples include outfit studies for the Olympic Class and battery sizing studies for the HEOC. (Section 2.4.7.2.1.2) Preliminary plans for the 124-auto ferry include studies in other areas with through life cost implications. (Section 2.4.7.2.1.3)

These topics are all considered valid areas for exploration, but it is not clear what the basis was for their selection in comparison with other potential study areas, and whether all features with significant promise for through life cost reduction are being explored. Also, is it not clear from the study reports how the criteria for establishing cost-benefit are established, or whether these are consistent within and between projects. This is not unusual for public sector ferry projects. Commercial vessel projects typically do use standard metrics and requirements for payback periods on these types of decisions.

ES-9.2.2 Contracting

There is no recent example of a WSF RFP for ferry construction, and older examples did not require through life cost estimates be developed. The prescribed RFP process under RCWs 46.60.816 to 46.60.820 does not mention through life considerations and the low-bid selection criterion does not favour through life cost reduction. The HEOC RFI does include reference to consideration of lowering lifecycle cost in the design, but no discussion of how such material would be used. (Section 2.4.7.2)

Other owners of ferries and similar vessel types will sometimes include through life cost as an element of best value decision-making for contract award, and bidders are frequently required to present information related to through life cost for major systems. However, it is more normal for these considerations to be built into the technical requirements.

ES-9.3 Potential Improvements

- Expand predesign efforts to address all main areas related to through life cost estimation (Section 4.2.3.12)
- Revise contract award criteria to enable through life cost estimates and cost reduction features to be considered as part of best value approach (Section 4.3.2.5)

ES-10. Independent Owner's Representative

Key points: Legislation requires that WSF engages an Independent Owner's Representative (IOR) to undertake key project management functions for ferry procurement. While WSF typically utilizes contracted support to assist with projects, the IOR's mandate is unusual and is not well-aligned with normal public sector accountability principles.

This summary addresses:

- Legislative requirements
- WSF's P&P and best practices

- Potential improvements

ES-10.1 Legislative Requirements

RCW 47.60.810 requires WSF to use an IOR for the RFP process and during the design-build contract for activities such as change management. This is based on a recommendation from a 2013 SAO report. (Section 2.3.3) The IOR shall be "a third-party intermediary between the department and the proposers, and shall:

a. Serve as the department's primary advocate and communicator with the proposers and successful proposer;
b. Perform project quality oversight;
c. Manage any change order requests;
d. Ensure that the contract is adhered to and the department's best interests are considered in all decisions;"

ES-10.2 WSF's P&P and Best Practices

This requirement is being applied for the first time to the HEOC project. WSF has engaged the services of an IOR contractor, based on an RFP listing the scope of work (Section 2.3.3.3) as (inter alia):

1. Support development of the Request for Proposal.
2. Support evaluation of pre-qualification packages.
3. Monitor development of technical proposal(s).
4. Support development of the state engineer's cost estimate.
5. Provide input to program schedule and risk register.
6. Participate in evaluation of the technical and price proposals.
7. Review contractor deliverables, including detailed design, build strategy, source selection documentation.
8. Support establishment and oversight of WSF [Quality Assurance/Quality Control] QA/QC program.
9. Monitor program cost, schedule, and performance.

This scope effectively moves the IOR from a management to a support role, which aligns with WSF's use of contractor support on past projects and follows industry best practice. (Section 2.3.3.1)

The IOR concept, as described by RCW, removes much of the authority over project management from WSF and assigns other essential functions to the IOR team. As WSF retains full responsibility for the use of taxpayer funds to provide an essential service, this could incur substantial risks even if the IOR contract aims to bind the provider very tightly to all state policies and constraints. This is a very unusual approach.

How to engage support expertise is highly dependent on the nature and location of the project, and on the capabilities of the client's organization. An organization such as WSF with relatively

infrequent newbuild procurements may need support in many areas and should develop a resource plan at an early stage in any project.

ES-10.3 Potential Improvements

- Allow WSF to determine the nature and scope of contractor support services required for all project phases (Section 4.3.2.3)

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LIST OF ACRONYMS AND ABBREVIATIONS

ABS	American Bureau of Shipping
ADA	Americans with Disabilities Act
AMHS	Alaska Marine Highway System
ASTM	American Society for Testing and Materials (former name, now ASTM International)
BC	British Columbia
BC Ferries	British Columbia Ferry Services
BERP	Bolted Equipment Removal Plates
BHP	Brake Horsepower
BLS	Bureau of Labor Statistics
CFR	Code of Federal Regulations
CER	Cost Estimate Review
CEVP	Cost Estimate Validation Process
CFD	Computational Fluid Dynamics
ClassNK	Nippon Kaiji Kyokai, the Japanese classification society
CM/GC	Construction Manager/General Contractor
CMAL	Caledonian Maritime Assets Limited
CO	Change Order
CONOPS	Concept of Operations
CR	Code Reviser
CRA	Cost and Risk Assessment
DEI	Diversity, Equity, and Inclusion
DNV	Det Norske Veritas
DOD	Department of Defense
DOT	Department of Transportation
EBDG	Elliott Bay Design Group
ECN	Engineering Change Notice

EOI	Expression of Interest
ESG	Eastern Shipbuilding Group
ESS	Energy Storage System
EVM	Earned Value Management
FHWA	Federal Highway Administration
FMEL	Ferguson Marine Engineering Limited
FSR	Field Service Representative
FTA	Federal Transit Administration
Glosten	The Glosten Associates, Inc.
GMP	Guaranteed Maximum Price
HAZID	Hazard Identification
HEOC	Hybrid-Electric Olympic Class
HVAC	Heating, Ventilation, and Air Conditioning
ICE	Independent Cost Estimator
ID	Identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFB	Invitation for Bids
IOR	Independent Owner's Representative
ISO	International Organization for Standardization
JLARC	Joint Legislative Audit and Review Committee
KDT	Kwa-di Tabil
LNG	Liquefied Natural Gas
LOA	Length Overall
LR	Lloyd's Register of Shipping
LUSV	Large Unmanned Surface Vehicle
m	meter(s)
MCS	Master Construction Schedule
MOU	Memorandum Of Understanding

MSO	Marine Safety Office
MV	Merchant Vessel
MWBE	Minority and Women-Owned Business Enterprise
NAVSEA	Naval Sea Systems Command
NC	North Carolina
NES	Norwegian Electric Systems
NMV	New Major Vessel
NPFA	National Fire Protection Association
NTP	Notice to Proceed
NVICs	Navigation and Vessel Inspection Circulars
NY	New York
NYC	New York City
OEM	Original Equipment Manufacturer
OFE	Owner Furnished Equipment
OFI	Owner Furnished Information
OFM	Office of Financial Management
P&P	Policies and Practices
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMR	Project Management Review
PPI	Producer Price Index
PRAM	Project Risk Analysis Model
PSC	Polar Security Cutter
PWIA	Public Works Investment Act
QA	Quality Assurance
QC	Quality Control
RCS	Rapid Charging System
RCW	Revised Code of Washington
RFAI	Request for Additional Information

RFEOI	Request for Expressions of Interest
RFI	Request for Information
RFP	Request for Proposal
RFPQ	Request for Pre-Qualification
RFQ	Request for Qualifications
ROM	Rough Order of Magnitude
ro-ro	roll on-roll off
SAO	State Auditor's Office
SBE	Small Business Enterprise
SEO	Secretary's Executive Order
SEP	System Electrification Plan
SHB	Substitute House Bill
SIF	Staten Island Ferry
SMART	Specific, Measurable, Appropriate (or Achievable), Realistic, and Timely (or Traceable)
SME	Subject Matter Expert
SOM	SUBSHIP Operations Manual
SSI	Single System Integrator
SSOV	Superstructure Outfitting Vendor
SSPC	Society for Protective Coatings
STQ	Société des Traversiers du Québec
SUBSHIP	Supervisor of Shipbuilding, Conversion, and Repair
TBC	To Be Confirmed
TBD	To Be Determined
TBN	To Be Named
TPS	Technical Proposal Schedule
USC	United States Code
US	United States
USCG	United States Coast Guard
USN	United States Navy

USPHS	United States Public Health Service
VARD	Vard Marine Inc.
VE	Value Engineering
VEM	Vessel Engineering Manual
Vigor	Vigor Industrial, LLC
WAC	Washington Administrative Code
WHO	World Health Organization
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries
WSIPP	Washington State Institute for Public Policy

1 VOLUME 1: INTRODUCTION AND GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 PURPOSE

The State of Washington's Joint Legislative Audit and Review Committee (JLARC) is conducting an independent review of Washington State Ferries' (WSF) design-build contracting process for hybrid-electric ferries. The review will compare WSF's policies and practices (P&P) for design-build contracting to best practices, both domestically and internationally, and propose best practices that would benefit the ferry system and updates to the Revised Code of Washington (RCW) needed to implement them. JLARC's review will also evaluate opportunities in the contracting process to decrease vessel construction costs and ensure operational efficiencies.

The purpose of Vard Marine Inc.'s (VARD) work is to assist JLARC by conducting an independent review of WSF's design-build contracting P&P related to the hybrid-electric ferries. The work is focused on procurement of hybrid-electric ferries regardless of vessel class, not specifically on the existing hybrid-electric Olympic Class (HEOC) ferry contract between WSF and Vigor Industrial, LLC (Vigor).

JLARC seeks to answer three main questions:

1. What are WSF's P&P for procuring new hybrid-electric ferries through design-build contracts?
2. How do WSF's P&P for design-build contracts for hybrid-electric ferries compare to domestic and international best practices?
3. What design-build contracting best practices or industry standards can be used by WSF to decrease vessel construction costs or ensure operational efficiencies?

This document addresses all three questions and provides VARD's Final Report for the Washington State Department of Transportation (WSDOT) hybrid-electric ferries design-build contracting process evaluation consultation, being performed on behalf of JLARC under Contract 21-11. It incorporates amendment no. 1 to the contract, which aligns the contract with changes made by the Legislature in the 2022 Supplemental Transportation Budget.

1.1.2 SCOPE

The main study questions detailed in Section 1.1.1 were further broken down as follows:

1. What are WSF's P&P for procuring new hybrid-electric ferries through design-build contracts?
   1.1. What are WSF's P&P for procuring new hybrid-electric ferries through design-build contracts?
   1.2. To what degree are WSF's P&P for ferry procurement documented?
   1.3. Is there evidence that WSF employees and consultants adhere to documented P&P for procurement of ferries?

1.4. What are the relevant state and federal statutes and regulations?
1.5. Do WSF's P&P appear consistent with state and federal statutes and regulations? For example, do policies reflect use of three-phase design-build contracting or use of owner's representative?
1.6. If P&P are inconsistent with state and federal statutes or regulations, what changes are needed?

2. How do WSF's P&P for design-build contracts for hybrid-electric ferries compare to domestic and international best practices?
   2.1. What are the best practices for design-build procurement and contracting of ferries?
      a. What are the typical and/or best practice steps for a design-build procurement and contracting process? Explain and provide a graphic of the process.
      b. Are there best practices specific to hybrid-electric ferry procurement or contracting?
      c. Is there a difference between best practices in the United States (US) versus other countries?
      d. Are there best practices for implementing a systemwide change from diesel ferries to hybrid-electric ferries?
   2.2. What are the best practices for addressing requirements or preferences for use of local or regional contractors (e.g., build in Washington) in a design-build contract approach?
      a. What are the advantages and disadvantages of various practices, including potential costs or savings?
   2.3. What are the best practices for addressing requirements or preferences for use of local, small, minority-owned, women-owned, or veteran-owned businesses in a design-build contract approach?
      a. What are the advantages and disadvantages of various practices, including potential costs or savings?
   2.4. What are the best practices or industry standards for using an owner's representative in design-build contracting?
      a. What are the advantages and disadvantages of this approach?
      b. What are the typical costs and potential savings?
   2.5. How do WSF's P&P for design-build contracts for hybrid-electric ferries compare to domestic and international best practices?
   2.6. What changes, if any, should be considered for WSF's P&P or for the Washington statutes governing WSF design-build ferry contracts?
3. What design-build contracting best practices or industry standards can be used by WSF to decrease vessel construction costs or ensure operational efficiencies?
   3.1. How do WSF's P&P for design-build contracting address the following?
      a. Risk
      b. Cost management

c. Cost estimating
d. Future operational efficiencies
e. Change management

3.2. What design-build contracting best practices are used to decrease vessel construction costs or ensure future operational efficiencies?
3.3. What steps does WSF take to ensure appropriate trade-offs are made between acquisition costs and through-life costs?
3.4. How do WSF's P&P align with industry best practices when addressing risk, cost management, cost estimating, future operational efficiencies, and change management?
3.5. How might WSF's design-build contracting P&P affect cost estimates?
    a. What best practices exist for increasing the accuracy of cost estimates?
3.6. What cost control provisions, if any, should WSF include in its design-build contracts to ensure hybrid-electric ferry procurement is efficient and economical?
3.7. What changes, if any, should be considered for WSF's P&P or for the statutes governing WSF design-build ferry contracts generally?

These more detailed questions were addressed through three tasks, each task of which resulted in an interim report. As there was some overlap in the themes addressed, the materials have been re-arranged and consolidated in this final report.

This report is laid out in the following volumes:

Volume 1	This volume introduces the purpose of this report, its scope and approach, and terminology used. It provides material that describes the context for ferry procurement and provides examples of recent projects inside and outside Washington State.
Volume 2	This volume reviews applicable legislation and WSF's policies and practices. It also discusses in more detail those legislated requirements which VARD considers the most significant to WSF procurement activities. It compares WSF's P&P against legislation. It describes WSF's P&P in five key areas: risk, cost estimating, cost management/control, change management, and through life optimization.
Volume 3	This volume describes industry best practices and how WSF aligns to those practices.
Volume 4	This volume details all proposed changes to WSF's P&P and Washington State legislation.

This report is supported by the files listed in Table 1-1.

Table 1-1: Supporting Files

Title	VARD File Number	Revision
Task 1 Interim Report	444-000-04	1
Design Build Process Baseline Process Map	444-000-04a	2
Document Log	444-000-04b	3
Interview Questions and Summaries	444-000-04c	3
Query Register	444-000-04d	3
RCW Design-build Process Map	444-000-04f	0
Regulations Log	444-000-04e	1
Task 2 Interim Report	444-000-05	1
Domestic and International Similar Ferry Projects	444-000-05a	0
Task 3 Interim Report	444-000-06	1

1.1.3 APPROACH

The bulk of the work to answer Question 1 consisted of analysis of documentation provided by JLARC to VARD, including materials supplied by WSF. Interpretation of some of these materials has been assisted by discussions between VARD and JLARC staff and through interviews with WSF personnel and their own supporting contractors. These interviews are documented in meeting minutes in supporting file 444-000-04c. VARD also undertook a literature search into other information relevant to questions posed in Section 1.1.2.

To answer the Question 2, VARD utilized the overall model for ferry procurement to provide a framework for its review. VARD examined several similar ferry procurements, in the US and internationally (see supporting file 444-000-05a). In addition to a literature search, VARD reached out to other ferry owners for interviews to get an understanding of their approach (see supporting file 444-000-04c). VARD has also considered other US procurement models where these appear relevant to WSF approaches. This work has been used to identify the policies and practices used by other ferry owners and from this to generate an overview of best practices that are potentially relevant to WSF, taking account of the constraints posed by legislation. As required by the project scope of work, VARD has given particular attention to the transition to hybrid-electric propulsion, relating this to the more general issue of introducing new technologies into vessel fleets. For the specific issues of local preferences and requirements for the inclusion of specific business types in government procurements, VARD has considered past work in Washington State and studies of the effects of similar polices elsewhere.

Question 3 expands on Questions 1 and 2 and focuses on vessel construction cost and operational efficiencies. Addressing these questions required additional review by VARD of policy documentation provided by WSF, a literature search to detail new concepts and expand on those introduced in other reports, additional interviews with WSF staff to better understand past and ongoing procurement efforts (see supporting file 444-000-04c), and VARD's corporate experience and expertise to add depth to the material presented.

All reference materials are cited as applicable in this report.

In Volume 4, VARD has provided suggestions for measures that could be considered to improve the efficiency of WSF vessel procurement and/or to reduce risks. These include potential changes to legislation and to WSF internal P&Ps.

1.2 TERMINOLOGY

To ensure this document is understandable by all readers, the following is a list of common industry terms which can be understood and used in slightly different manners. To minimize confusion, this section defines the terms used in this report, along with synonyms if WSF or legislation uses different terms for the same thing. In some cases, the definitions refer to requirements embedded in Washington State legislation, and cross reference the Revised Code of Washington (RCW), all of which is available online.

Administration	The "Administration" in the United States (US) is the United States Coast Guard (USCG). The WSF Vessel Engineering Manual (VEM) refers to USCG as a "regulatory body" in sections that describe the requirements for regulatory body approval. The USCG Marine Safety Office (MSO) has responsibility and certification authority to inspect and certify a passenger-carrying vessel's conformance to the latest requirements of Title 46 of the United States Code of Federal Regulations (CFR) and Navigation and Vessel Inspection Circulars (NVICs). CFR Title 46 requires that vessel drawings and calculations are submitted to the USCG for approval prior to installation aboard vessels. During construction, USCG inspectors will make routine visits to the shipyard to inspect work in progress. The USCG also certifies welders, welding design and procedures for work.[1]
Basic Design	"Basic design" is the same as a "class design" (see below).
Bid	In "phase three" of the proposal approach described in RCW 47.60.820, each proposer will submit a "bid" for the "detailed design" and construction of the vessels. This "bid" includes the total price for

[1] Washington State Ferries. (December 2012). *Vessel Engineering Manual* (M 68-03). Seattle, WA: author.

	all vessels based on the "technical proposal" approved in "phase two." The "bid" is equivalent to the award price referred to in the WSF VEM.[2]
Class Design	"Class design" is the third stage of design following "preliminary design" and is sometimes also called a "basic design". It includes sufficient drawings and analysis to demonstrate the ship meets the latest regulations and criteria. A "class design" has been appraised by a "classification society" or the "Administration."
Classification Society	A "classification society" is a non-governmental organization that establishes and maintains technical standards for the construction and operations of ships and offshore structures. They certify that the design or construction of a vessel complies with relevant standards and carry out regular surveys in service to ensure continuing compliance with standards, as stated in the Rules of the respective classification society. Certain societies are also authorized to undertake USCG certification activities. These include the American Bureau of Shipping (ABS), Lloyd's Register of Shipping (LR), Det Norske Veritas (DNV), and the Japanese classification society Nippon Kaiji Kyokai (ClassNK).
Concept Design	"Concept design" is the first stage of vessel design, typically resulting in a selection of overall dimensions, initial powering levels, and approximate weight.
Contract Drawings	"Contract drawings" are *drawings furnished by WSF and identified as such in the specifications. They illustrate some, but not necessarily all, of the features and arrangements of the vessel to be implemented by the Contractor. Any departure from these drawings must be specifically authorized in writing by WSF.*[3] In a design-bid-build delivery method, "contract drawings" together with "contract guidance drawings" provided by the owner should provide sufficient information for the builder to estimate construction cost.
Contract Guidance Drawings	"Contract guidance drawings" are *drawings identified as such in the specifications which illustrate certain engineering features of the vessel. These drawings do not necessarily depict, nor is it intended that they depict, all features, details and arrangements of the systems or structures to which they relate. They serve the purpose of providing*

[2] See note 1 above

[3] See note 1 above; italicized text indicates a direct quote from the cited source

	information which will assist in engineering development of Working Drawings by a Contractor.[4] In a design-bid-build approach, "contract guidance drawings" together with "contract drawings" should provide sufficient information for the builder to estimate construction cost.
Design-bid-build	"Design-bid-build" is a contracting approach used in marine procurement and has two phases: it first has a ship designed and then offers that design to builders to bid for its construction. See Section 1.5.1 for more information. Often referred to as "Build to Print."
Design-build	"Design-build" is a contracting approach used in marine procurement and requires the builder to provide their own ship design as part of its bid. An owner can provide an "owner's model" as part of the "design-build" approach. See Section 1.3 for more information.
Detailed Design	"Detailed design" is the fifth stage of design following "functional design," in which drawings provide all information on locations and relationships of equipment and systems. Level of detail can be builder dependent.
Diesel-electric	A "diesel-electric" propulsion system has diesel internal combustion engines coupled to alternators to develop electrical power that is first supplied to a common junction system, and then distributed to the main propulsion motors as well as to other electrical consumers onboard. An electrical storage system is not part of the diesel-electric propulsion design.[5] Diesel-electric propulsion is an older concept than hybrid-electric propulsion that emerged in the 1900s.[6]
Earned Value Management (EVM)	"Earned value management (EVM)" is a project management methodology that combines schedule, costs, and scope to measure project performance. Using both planned and actual values, EVM extrapolates the future of the project and therefore allows project managers to react accordingly.

[4] See note 1 above

[5] Wärtsilä. (Accessed September 2022). Diesel-Electric Propulsion Systems. https://www.wartsila.com/docs/default-source/product-files/electric-propulsion-and-drives/brochure-o-ea-diesel-electric-propulsion-systems.pdf?sfvrsn=15f6ae45_6

[6] Wärtsilä. (Accessed September 2022). Encyclopedia of Marine and Energy Technology. https://www.wartsila.com/encyclopedia/term/diesel-electric-propulsion

Engineer's Estimate	The "engineer's estimate" is the contracting agency's benchmark for analyzing bids and should aim to be at a similar level of detail to a proposer's "bid" in "phase three". According to the WSF's VEM, the "engineer's estimate" is made with the best available information prior to "bid" and is based on completed drawings, specifications, and addenda.[7]
Expression of Interest (EOI)	An "expression of interest (EOI)" is very similar to a "request for information" as defined below.
Flag State	A "flag state" is the country where a vessel is registered, and it is considered the nationality of the vessel. A vessel must be registered and it can only be registered in one country but it may change where it is registered. A vessel is subject to the maritime regulations in force in its "flag state", including those relating to inspection, certification, and issuance of safety and pollution prevention documents, and the "flag state" has the authority and responsibility to enforce them. The Jones Act requires that any vessel providing service between two US ports must be registered in the US (i.e., its "flag state" must be the US)[8].
Functional Design	"Functional design" is the fourth stage of design, following the "class design," in which all equipment has been selected and the system drawings and calculations are updated to accurately reflect all equipment size, weight, and performance parameters. The three-phase proposal approach described in RCW 47.60.818-820 is aimed at developing "functional design" level packages. Functional design often starts to include builder-specific features into the design.
General Contractor	"General contractor" is a contracting approach that is occasionally used in marine procurement. It involves the owner retaining overall responsibility for the build and bringing into the yard their own contractors with specific expertise. See Section 1.5.2 for more information.
Hybrid-electric	With reference to the most recent WSF procurement program for hybrid-electric Olympic Class, "hybrid-electric" means a vessel that

[7] See note 1 above
[8] 46 USC § 50102

	uses stored electrical energy (batteries) as the primary source of on-board power. In the broader industry there is no standard definition, but "hybrid-electric" typically refers to a range of power plant types, usually but not always involving an energy storage system (ESS). "Hybrid-electric" is a subset of "diesel-electric" as defined above.
Outline Specification	The "outline specification" is provided by WSF as part of the request for proposals in "phase one" and, as per RCW 47.60.818 (1), it is used by the proposers in "phase two" to develop their "technical proposal." As per RCW 47.60.814, the "outline specification" provides *the requirements for the vessels including, but not limited to, items such as length, beam, displacement, speed, propulsion requirements, capacities for autos and passengers, passenger space characteristics, and crew size. The department will produce notional line drawings depicting hull geometry that will interface with Washington state ferries terminal facilities. Notional lines may be modified in phase two, subject to approval by the department*.
Owner's Model	An "owner's model" is the term used to describe the design provided by the owner to potential builders for the purposes of bidding on its construction in the design-bid-build approach or as a starting point for a design-build contract. In the design-bid-build approach, the result of the design phase is a binding design. An "owner's model" used in the design-build approach provides a non-binding design with the RFP package which builders can choose to use as is, modify, or ignore. The "owner's model" is generally at the level of a "basic design". In the case of WSF's current HEOC procurement, its "owner's model" is a "functional design". In the design-build approach, the "owner's model" is sometimes referred to as an indicative design.
Parent Design	Ship design rarely starts with a blank page. A "parent design" is a ship similar in shape, size, and/or function to the major requirements and can be scaled to provide a starting point which is then modified to meet key parameters.
Phase One, Phase Two, Phase Three	"Phase one" refers to the first stage of the response to a request for proposals (RFP) for the design-build of new ferries as laid out in RCW 47.60.814 and RCW 47.60.816. Its main activities consist of the

	evaluation and selection of qualified proposers who can then participate in "phase two" of the request for proposals. "Phase two" refers to the second stage of the proposal process as laid out in RCW 47.60.818. Its main activities consist of the preparation and evaluation of "technical proposals" which comply with RFP requirements. "Phase three" refers to the third stage of proposal process as laid out in RCW 47.60.820. Its main activities consist of the submission of "bids", their evaluation, and the award of the contract to the successful proposer. This phase is like the invitation for bids (IFB) used in the WSF VEM.[9]
Preliminary Design	The "preliminary design" is the second stage of design and is an intermediate between "concept design" and "class design". It typically includes verification of key performance parameters, for example model testing for resistance and propulsion. The "outline specification" described in RCW 47.60.814 is somewhere between a concept and preliminary design.
Production Design	"Production design" is the sixth and final stage of design developing from the "detail design" of work packages for fabrication and assembly. It is specific to a particular shipyard and reflects both their facility and production methods.
Proposal	Per RCW 47.60.816, "proposals" are submitted by bidders in "phase one" in response to a request for proposal. These proposals are evaluated, and successful proposers go on to develop and submit a "technical proposal" in "phase two" and, if deemed a responsive and responsible proposer, a "bid" in "phase three."
Request for Information (RFI)	A "request for information (RFI)" is issued by an owner early in the procurement process to identify potential bidders and their level of interest in the project.
Request for Proposal (RFP)	In the three-phase proposal approach defined by RCWs 47.60.816-820, the "request for proposal" is issued in "phase one" and results in qualifying proposers who then go on to submit a "technical proposal" who, if deemed responsive and responsible, go on to submit a "bid".
Request for Proposals (Modified) or	A "request for proposals (modified)" is based on Substitute House Bill (SHB) 1680 (effective 22 July 2001) which allows WSF to procure new

[9] See note 1 above

Modified Request for Proposal	vessels via a modified RFP using a design and build partnering process.[10] This is the same process as the three-phase proposal approach defined in RCWs 47.60.816-820 (which are themselves a result of SHB 1680[11]).
Single Source	A “single source” contract is the result of a competitive procurement process where there is only one participating bidder.
Sole Source	“Sole source” is a non-competitive contracting approach for procurement that is used to direct a procurement to a particular shipyard for policy, urgency, or capability reasons. See Section 1.5.3 for more information.
Technical Proposal	Per RCW 47.60.818, “technical proposals” are submitted in “phase two” by those proposers who were successful in the “phase one” request for “proposals”. In this context, “technical proposals” are of sufficient detail to depict the ferries’ characteristics, identify installed equipment, and other details necessary for the proposer to develop a firm, fixed price bid.

1.2.1 CLARIFICATION OF TERMS CLIENT, OPERATOR, AND OWNER

In addition to the terminology above, it should be understood that client, operator, and owner have different definitions. Throughout the report, VARD has used the word that is appropriate for the context

- "Client" has a particular meaning when discussing contracting approaches. A contract is between a client and a contractor. A client is often the owner but not always. For example, WSF is the client, but Washington State is the owner.
- An "operator" is the organization that runs the ferry service. It is not always the owner, and it is not always the client. WSF is an operator.
- An "owner" is the entity that owns the asset. In the case of ferries, it is often the government that owns the vessel, and employs a public or private organization to operate it.

[10] See note 1 above

[11] SHB 1680, 57th Legislature, 2001 Regular Legislative Session, (WA 2001). https://lawfilesext.leg.wa.gov/biennium/2001-02/Pdf/Bills/Session Laws/House/1680-S.SL.pdf?cite=2001%20c%20226%20%C2%A7%207

1.3 GENERAL DESIGN-BUILD CONTRACT PROCESS

VARD has outlined a general procurement contracting process map, based on its own experience with projects of this type. For ease of reading in this report the map is split across Figure 1-1, Figure 1-2, Figure 1-3, and Figure 1-4 (for the process map in one piece, see supporting file 444-000-04a). The numbers in the figures refer to the subsections of this document in which they are discussed. Since the subsections are presented thematically, rather than sequentially, some numbers in the figures may appear out of order.

This baseline is intended to provide an overview of all the steps that may be involved in the acquisition of a new vessel, focusing on the use of a design-build approach and noting specific aspects that may be required for a ferry of any type. Steps are presented sequentially, but some activities may be undertaken in parallel, and the overall process may in practice involve loops, jumps, and resets, depending on how the project unfolds.

In principle, each step should be governed by some level of policy and practice, although these may be quite informal for some elements of the process, depending on project complexity, constraints, and other factors. Where a policy and/or practice exists, it can be compared with best practices for similar projects.

For WSF, state legislation, particularly RCW 47.60.810, provides part of the acquisition framework. Relevant elements of the legislation are referenced to this overall process in Section 2.2. In this section, some aspects of the WSF process are used as illustrations.

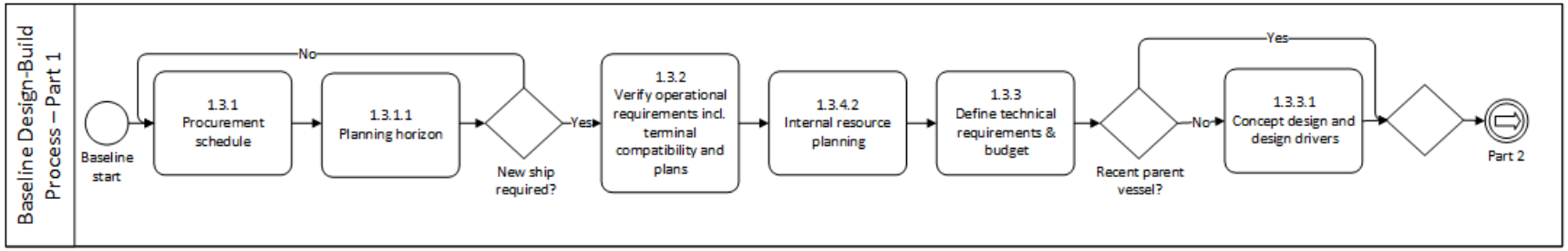

Figure 1-1: Baseline Design-Build Process, Part 1

Figure 1-2: Baseline Design Build Process, Part 2

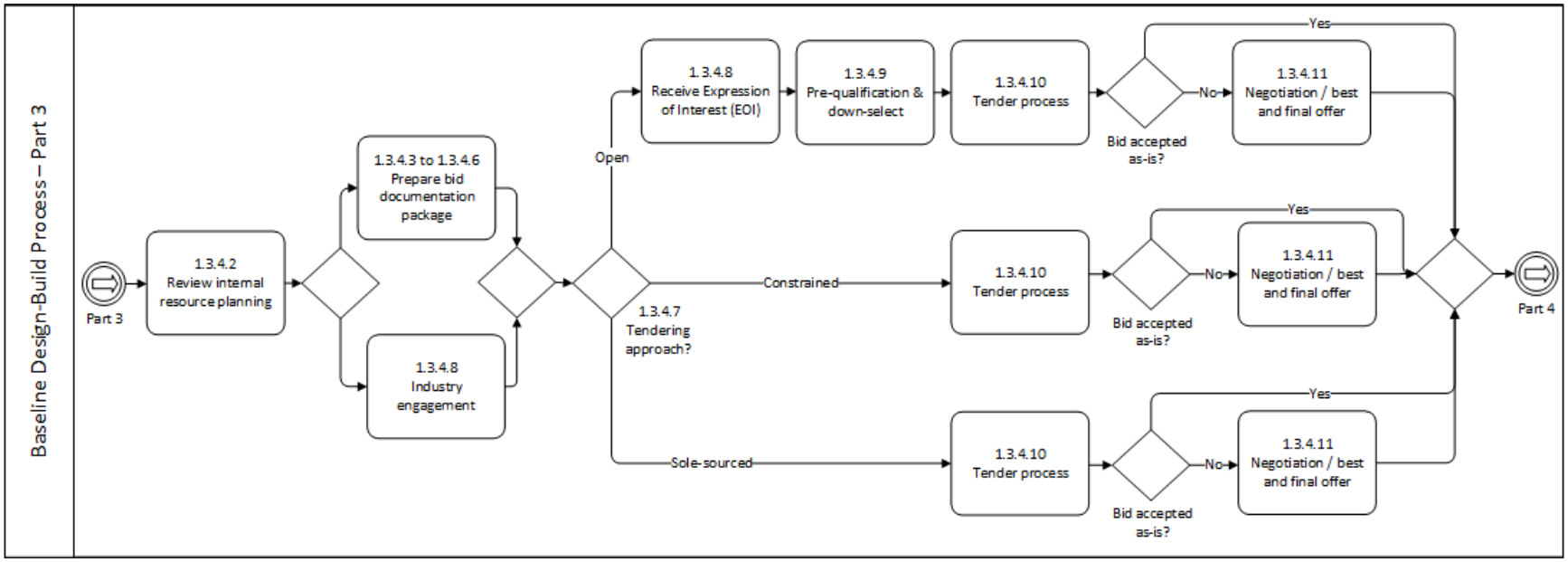

Figure 1-3: Baseline Design-Build Process, Part 3

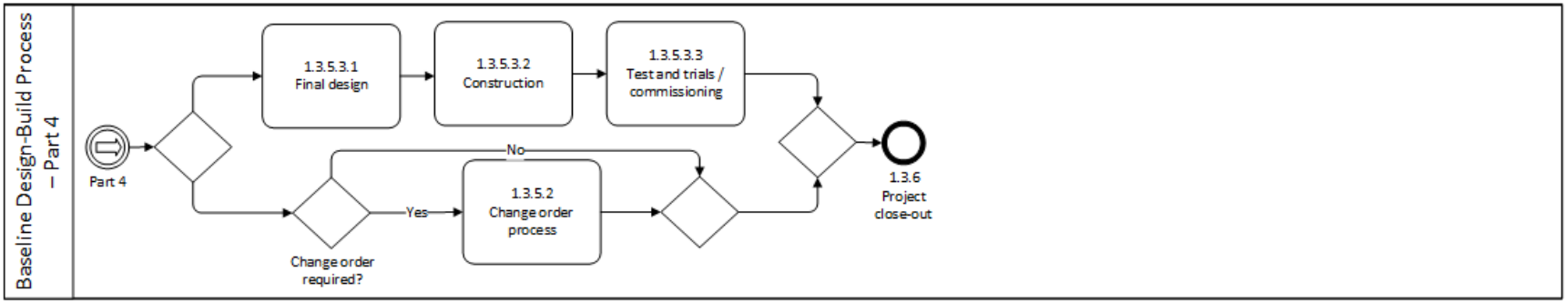

Figure 1-4: Baseline Design-Build Process, Part 4

1.3.1 PROCUREMENT SCHEDULE

Any ship acquisition will meet an overall schedule, which can be driven by factors including:

- Obsolescence – an existing ship becoming too expensive to operate, becoming non-compliant with regulations/transportation policy choices, failing to meet customer expectations, etc.
- Capacity – growth of traffic is forecast to require larger or additional vessels, or the opposite
- Competition – changes to competitive landscape require new or different vessels. In WSF's case this could include consideration of future highway construction, impacts of switch to electric vehicles, etc.

The overall duration required is only partly determined by the shipbuilding phase. Preparatory work can easily take longer than the build, especially for public sector procurements. Duration is both a direct and indirect driver of costs, particularly if there are rapid changes in the technological, social, or political environments. This can mean that decisions taken early in the process are rendered obsolete and need to be revisited.

1.3.1.1 PLANNING HORIZON

The ship owner/operator should have an overall strategic plan which extends at least to the period required to encompass a ship acquisition. Best practices include consideration of multiple scenarios for the factors listed under Section 1.3.1.

1.3.2 OPERATIONAL REQUIREMENTS/CONCEPT OF OPERATIONS

Once a need for new ships is identified in the plan, the owner/operator should document the operational requirements or concept of operations (CONOPS), such as:

- Area of operation/routes
- Operational profile – for a ferry, this can include schedules, voyage time/speed requirements, service reliability (based on environmental restrictions), etc.
- Capacity; including passenger number, vehicle type/number, total deadweight, etc.

All of these can be developed in different ways, depending on the nature of the project or service.

1.3.2.1 EVOLUTIONARY/NEW REQUIREMENTS

Often, a new ship will represent continuity from an existing vessel in many ways. Capacity may be the same or may change moderately. The ship may operate using existing terminals and handling systems (see also Section 1.3.2.2). Some changes are inevitable, as technology and, often, regulations will be different. It is desirable to analyze how these factors are likely to impact the operational requirements and how that in turn will feed into the technical requirements.

1.3.2.2 SHIP/SYSTEM LEVEL APPROACHES

A new ship can be considered in isolation or as part of an overall transportation system in which changes to one element may drive changes to others. For a ferry project, examples can be a need to increase loading speed by redesigning the ramps and/or increased holding capacity for pre-boarding parking lots. Changes to ship powering arrangements can require new fueling systems. Automation of mooring systems, changes to waste disposal, etc. may all lead to system-level changes. These should be considered at an early stage and may be significant drivers for cost and schedule. Best practice is to consider ship and terminals as an overall system to be optimized.

For major ferry projects, there is often a need for some level of consultation with potential passengers and community groups, particularly if public funds will be invested. This may happen at several points in the program.

1.3.3 TECHNICAL REQUIREMENTS AND BUDGET DEFINITION

In most cases, definition of the technical requirements both enables the definition of the overall program budget and is affected by it. Technical requirements define the project in engineering terms, as discussed further in Section 1.3.3.4. All requirements cost money. (Almost) all clients are cost-sensitive, and so requirements are normally tailored to the money that is available or a target freight rate, i.e., how much the owner intends to charge to move a ton of material, a vehicle, or some other similar metric.

1.3.3.1 CONCEPT DESIGN/DESIGN DRIVERS AND INITIAL COST ESTIMATE

Unless there is a very similar and recent vessel that can provide “parent ship” data, it is advisable to undertake some level of concept design work to:

a) Assist with technical requirements definition
b) Establish budgetary pricing
c) Illustrate the expected outcome to stakeholders.

As an example, without a concept design, the propulsion power will not be known well enough to estimate engine size, which is one major cost driver. Other design and cost drivers may not be identifiable without some level of design work. An initial cost estimate can be developed for the design, with the expected level of accuracy dependent on the level of detail, complexity of the ship, and other factors. When presenting a project proposal to funding agencies and users an illustrative design is very valuable to describe the expected characteristics.

1.3.3.2 TRADE-OFF STUDIES

Where the initial cost estimate exceeds funding limits (or for commercial vessels, will not meet expected rates of economic return) then additional trade-off studies may be undertaken to bring requirements into alignment with budgets. Concept design can be used to assist in this process. Typically, an initial concept can be stretched or squeezed by 10-20% for any attribute before it becomes necessary to develop a new design approach. For example, if a ferry speed requirement

changes by 10% it will generally be possible to retain the hull form. More than this, and the hull shape should change for efficiency reasons.

1.3.3.3 RISK ASSESSMENT

Initial technical, cost, and schedule risks should be identified at this stage and can start to be quantified using the other information now available. The level of confidence in risk quantification may still be low, depending on project characteristics. Cost and schedule estimates can use probabilistic models to help with the process. Risk assessment should be an ongoing process, with formal reviews at key milestones in the project. This can include the finalization of RFPs, the final evaluation of proposals, etc.

1.3.3.4 PRESCRIPTIVE/PERFORMANCE REQUIREMENTS

Technical requirements can be set in prescriptive or performance-based ways, or in a mix of both. For a ferry, the latter (a mix) is often the best practice to adopt, to allow the design-build organization flexibility for innovation and cost reduction, while ensuring that certain key features are provided. For example, ship speed may be set as a performance requirement, rather than stating prescriptively that the vessel must have 10,000 brake horsepower (BHP) of propulsive power. However, vehicle capacity requirements may provide better outcomes if set prescriptively. Commonality and support requirements are other areas in which prescriptive approaches may be preferred; for example, if a common engine family or radar type is to be used across a fleet, or if a field service representative (FSR) is required to be available within a fixed timeframe.

1.3.3.5 REQUIREMENTS VALIDATION/MANAGEMENT

Requirements should be tested against various considerations, which are often summarized through the acronym SMART: Specific, Measurable, Appropriate (or Achievable), Realistic and Timely (or Traceable). Best practice includes a review of requirements before a tender package (see Section 1.3.4.6 for discussion of tender package) is released, to ensure that all requirements meet such tests, and that the requirements in total are not driving costs unnecessarily. As an example, including many specific requirements for through life growth margins for a ship or its systems can lead to overdesign and unnecessary spare capacity. The concept design can assist in this, as can review of a similar parent design, as it is often difficult to evaluate requirements in the abstract.

Typically, some requirements will change during the acquisition process itself, because of influences such as questions/comments from bidders, changes to technology or regulations, etc. It is useful to have a tracking/management process for this, even prior to contract award. There are several requirements management software tools on the market which are used by organizations including the Department of Defense (DOD) and project management/engineering companies. However, these require significant investment in processes to be valuable and are not always cost-effective for smaller programs.

1.3.4 ACQUISITION STRATEGY

There are many potential acquisition strategies for a ferry (or other large assets) and selection of an effective approach should involve consideration of options. Some factors are outlined below.

1.3.4.1 CONSTRAINTS

Any program may have a range of constraints, including cost, schedule, or mandated contractual approaches. The organization should ensure that significant constraints are understood by those planning the project, and that impacts on the possible alternatives for acquisition approaches are recognized. For public sector bodies, this should include a review of the legislative framework to identify any mandates which will affect the acquisition strategy.

1.3.4.2 RESOURCE PLANNING (INTERNAL)

Different strategies/approaches will have different internal resourcing requirements, and the organization needs to ensure that it will have the necessary capacity to undertake all phases of the work in a timely manner; bearing in mind the skills, experience, and levels of effort needed. “Internal” resourcing includes the use of contracted support, such as consultants and classification societies. The costs of all these aspects should be factored into overall project budgets. Some contracted resources may be engaged very early in the project before formal budget allocation/approval. The process should have flexibility to allow for this and internal resourcing requirements should be reviewed regularly.

1.3.4.3 CONTRACT TERMS AND CONDITIONS

Public sector agencies are generally highly constrained in terms of the terms and conditions that are mandated for acquisition programs, but in all cases, there is likely to be some flexibility available and the organization should ensure that the acquisition team includes expertise in this aspect. For example, in Washington agencies are required to use small business set-asides and apprenticeship programs but can set the levels for these. This can be particularly beneficial in risk allocation, where some approaches can impose higher costs on a builder than those which can be borne internally. Liquidated damages and other potential contractual penalties should be based on items that are under the contractor’s control.

1.3.4.4 QUALIFICATION PROCESS

Depending on the number of potential bidders on a project, the owner may wish to use single-stage or multi-stage qualification processes for the distribution of a final tender package. In general, if only a few potential bidders participate in the full tender process, they will be somewhat more prepared to invest in the bid, as they will see a higher probability of success. If there is a large pool of potential bidders, then they can be winnowed down in various ways via a bid evaluation process, depending on the risk profile of the project and other major factors. While two to three bidders may be prepared to commit significant effort to a bid response, 10 or more will be unlikely to do so, due to the low probability of success.

An approach often used in complex design-build projects is to provide some funding for the bid response process, using mechanisms allowed for under applicable rules. Again, this will normally only be practical if there are relatively few bidders, as the client will not be prepared to fund a large number of parallel efforts. To develop reasonably accurate pricing, a bidder will generally need to undertake significant effort in preliminary design and project planning. This is essential to reducing the bidder's own risk and the risk to the client that a winning bid may not be technically feasible, financially viable, or deliverable in accordance with schedule needs. While contract terms may help limit the impact on the client, at the end of the day if a ship is not delivered, then the client will suffer.

1.3.4.5 EVALUATION APPROACH

For truly competitive projects, the bid evaluation process can be one of the most important elements of the success of the outcome. For any project of medium to high complexity, low cost should not be the sole determinant; this is particularly true for a ship such as a ferry, where the through life cost is likely to be much higher than the initial purchase price and it may be advantageous to give weighting to attributes that will lead to lower running costs. Technical and schedule risk factors should also be considered.

For design-build approaches, the evaluation should weight both main phases of the work. The evaluation team needs to have access to sufficient information to allow for an informed assessment of all main aspects of the proposed approach.

1.3.4.6 BID/TENDER DOCUMENTATION PACKAGE

This bid/tender documentation package will contain, at a minimum:

- Information on the bid process, including the evaluation methodology
- The proposed contract terms and conditions
- The technical requirements
- Cost and schedule requirements/expectations
- The evaluation approach.

Depending on the nature of the project, it may be useful to include additional materials that clarify the technical requirements. In particular, if external organizations (consultants or other experts) have contributed to the development of any requirements, it should also be clear whether they are excluded from supporting the bidder(s), available to support any bidder, or required to support all bidders.

1.3.4.7 DESIGN-BUILD TENDER – OPEN, CONSTRAINED, SOLE-SOURCED

This section focuses on the design-build contracting approach. Section 1.5 compares this with other approaches to ferry procurement. Under a general design-build model, several variants are

possible; for example, the Design-Build Institute differentiates between "traditional" and "progressive" models[12], the latter involving a multi-stage contractor selection process.

Another consideration for the approach is the extent of the potential bidder pool. Many ferries internationally are sourced globally, with potential builders in Europe, Asia, and elsewhere. The Jones Act means that all ferries must be built within the US. In Washington State, Build In Washington generally precludes the use of out-of-state builders. Within Washington State, additional provisions effectively restrict potential builders to a very few shipyards, giving the strong possibility that the project will be effectively sole-sourced – this can be the case for other clients where similar government policies apply. When an organization finds itself in a highly constrained acquisition environment, it should take steps to identify and manage the cost, schedule and technical risks that can be entailed.

1.3.4.8 INDUSTRY ENGAGEMENT / EXPRESSION OF INTEREST / REQUEST FOR INFORMATION

Normally, for a larger project with many potential builders, the initial external step in the process is to engage with industry. This may begin with informal discussions with builders and vendors, or it may be more formal industry days where the owner releases a short list of requirements and invites interested builders, designers, and major equipment vendors to ask questions and provide their professional opinions. This stage is followed by the issue of an expression of interest (EOI), request for expression of interest (RFEOI), or request for information (RFI) – other terminology may also be used but the general intent is much the same. In other parts of this report, only the term, RFI, will be used because it is the term used in the RCW.

An RFI typically requests a relatively limited amount of information that allows the owner/client to assess the ability of the potential bidder to deliver the vessels required based on factors such as shipyard capacity and workload, technical skills, and experience with similar vessels, etc. If there are some specific features or technologies that will be crucial to the success of the project and are unusual in other vessels of the type, then the RFI may require bidders to identify the specialists that they would use in these areas and to provide appropriate supplementary information. At this stage, it is often undesirable to require relationships to be exclusive, to avoid losing a highly capable supplier/subcontractor if the prime contractor is not selected. For example, when new technologies are introduced – e.g., marine batteries or engines that can use alternative fuels – there may be a very small number of organizations that can supply equipment or provide design integration services.

If the pool of potential builders is small, then there may not be a need for a formal RFI process, which will always add significant time to the project schedule. There may still be benefit in

[12] Design-build Institute of America. (October 2017). *Progressive Design-Build: Design-Build Procured with a Progressive Design & Price.* https://dbia.org/wp-content/uploads/2018/05/Primer-Progressive-Design-Build.pdf

undertaking some level of industry engagement dialogue to ensure that builders have insight into the intended acquisition approach and vessel type. This, or the RFI process, can provide useful feedback if any element of the project may cause particular difficulties for some or all potential builders

1.3.4.9 PRE-QUALIFICATION/DOWN-SELECT

The RFI process or general constraints may enable the owner/client to select a short list of potential builders to receive the full tender package, as described in Section 1.3.4.10. Alternatively, as in the WSF process, there may be another down-select step. The evaluation criteria used in any down-select should be developed in parallel with the formulation of the RFI and should preferably be communicated in whole or part within the RFI materials.

Here, and in the subsequent final down-select, it is important particularly for public sector clients to have a documented and robust evaluation and selection process to avoid subsequent protests.

1.3.4.10 TENDER PROCESS

A design-build process runs the risk that the builder will not have a sufficiently mature design to fully cost the ship. Potential builders may not be prepared to offer a fixed firm price for the project or alternatively may add a substantial contingency to their costing. Depending on the nature of the project and the technical requirements, some bidders may have a close parent vessel that can mitigate this risk, but this is unlikely to be the case for a large US ferry.

Developing a design in enough detail to allow for firm pricing and demonstrate compliance with all key technical requirements is expensive and many builders will not be prepared to incur the cost without a high win probability. Owners can fund some or all of the design work using various mechanisms, such as parallel design contracts, tailored design studies for certain aspects, or the award of honoraria to unsuccessful but compliant bidders. Setting an appropriate funding quantum for any of these mechanisms requires a good understanding of the probable cost to the builders, but it can be undesirable to provide full funding – the owner may wish to ensure that the builders are invested in the project and do not just treat an initial contract as a standalone contract. Payment may be made conditional in whole or part on providing a compliant proposal, even if this is not the winning bid.

Many owners/clients prefer to select winning bids on the basis of lowest compliant offer. This has the advantage of apparent simplicity but may incur additional risk. Not all designs or project implementation plans will have the same level of detail and maturity, and a higher bid may identify issues that the low bid has not addressed in as satisfactory a manner. Also, bidders may be able to propose options that will reduce the vessel through life cost by simplifying logistic support or by reducing energy consumption. Or selection of one bidder may incur additional costs for the client for inspections and other support services. Using a best value evaluation approach for the build phase or for the whole life cycle can provide some flexibility.

1.3.4.11 NEGOTIATION/BEST AND FINAL OFFER

Bids may be accepted as-is or there may be a negotiation phase leading to a best and final offer. This can arise if, for example, all bids are in excess of a project funding cap, if there are areas lacking clarity in a bid, or if a bid includes suggestions for changes to requirements to reduce acquisition or through life cost. Particularly for a public sector project, negotiation needs to respect level playing field considerations.

1.3.5 DESIGN-BUILD CONTRACT

1.3.5.1 PHASES AND APPROVAL GATES

In a design-build contract, it is unlikely that the selected design will be fully mature at contract award, though the provision of funding for bid development (see Section 1.3.4.10) can bring the level of design some way through the process. Typically, the stages in the design process are classified as:

- Concept
- Preliminary
- Basic (or “class”) – appraised by a classification society or the USCG
- Functional – all equipment selected
- Detailed
- Production – shop drawings.

Note that this terminology does not align directly with some of the wording used in WSF policies and procedures, and where necessary we have aimed to provide definitions in Section 1.2 to provide clarification.

The owner/client may wish to release funding tranches only after conclusion of some of these stages, depending on perception of project risk. For example, there may be a need to authorize purchase of some major equipment – long lead items – to maintain the overall project schedule. If a phased approval process is envisaged, this should be highlighted in the tender package.

1.3.5.2 CHANGE ORDER PROCESS

Few large shipbuilding projects avoid all change orders post-award. The cost and schedule impacts of changes increase exponentially as the project progresses, so a key objective is to capture changes as early as possible in the design and avoid them during build.

However, for a multi-ship project, it is advisable to consider whether a change needs to be implemented on the first ship, or whether it can be deferred. Depending on the nature of the change, if the shipyard and owner have a tight schedule, the needed change may be captured in drawings and manufacturing information for subsequent ships. This approach will minimize the impacts on the overall program cost and schedule.

With this approach, upon delivery, the first ship will not be identical to the subsequent ships. However, this situation would be known to the owner and shipbuilder. The needed change can be implemented to the first ship as part of a future maintenance period, or as needed.

The change order process is essentially a sole-sourced contract mechanism, and so the owner needs to have the expertise and data to assess whether the cost and other impacts are reasonable. However, it is also important to ensure that review and negotiation do not hold up the work. Processes may account for preliminary authorization followed by subsequent detailed analysis.

1.3.5.3 QUALITY CONTROL AND ASSURANCE

Quality control should be part of all processes throughout the project and be applied by the owner, builder, and all other organizations involved. This section focuses on aspects of a project where there is external review and the steps at which this occurs.

Selection of a builder should include appraisal of their quality control and assurance systems for each phase of the work, including design, construction, and tests and trials. As noted above, depending on build process and technology, the owner may need to allow for more or less effort to supplement builder in-house processes.

1.3.5.3.1 DESIGN

There are four organizations who should be involved in QC/QA for the design development:

- Builder – checking in general
- Owner/Client – compliance with technical and performance requirements
- Classification Society (“Class”, e.g., ABS) – compliance with specified notations and rules
- Administration (i.e., USCG) – compliance with federal statutory requirements.

In general, class and the administration are not interested in performance issues as their focus is on safety. The owner/client therefore must ensure that there is adequate technical review. While the builder retains overall technical responsibility and contractual responsibility for compliance with all types of requirements, it will never be acceptable to be faced with delivery of an unsatisfactory ship.

Class and administration will normally be working for the builder, but it is normal for the client to require visibility into the process. Drawings, calculations, and other documentation are submitted when complete; most typically grouped in some way. An owner may require complete approval of the design before proceeding to construction or allow for parallel activities.

1.3.5.3.2 CONSTRUCTION

The same organizations are involved in construction, with slightly different roles:

- Builder – assembly of the ship in accordance with approved drawings and construction standards
- Owner – oversight of all aspects
- Class – assurance that the build follows approved drawings and construction standards
- Administration – compliance with federal statutory requirements.

1.3.5.3.3 TESTS AND TRIALS/COMMISSIONING

Broadly, there are three types of tests and trials involved in a build:

- Factory/ship trials to verify that equipment items are in compliance with expected performance
- Dock/basin trials to commission systems
- Sea trials to verify the contractual performance of the ship.

At dock/basin trials, the shipyard conducts tests to determine the ability of the ship to safely conduct sea trials. Different equipment and systems onboard the ship need to be commissioned per manufacturer's specification, including engines, generators, fuel oil purifiers, air handling units, etc. Sometimes the participation of an approved or manufacturer's FSR is required.

In addition to the four organizations listed above, the original equipment manufacturer/supplier (OEM) will be involved in these tests and trials and the troubleshooting of any problems that may arise.

In cases where there are complex system integration challenges in a project, the factory trials may be extended to demonstrate or simulate performance at the system level. An example could be a hybrid propulsion system or the verification of a novel propulsion configuration.

1.3.6 PROJECT CLOSE-OUT

At the conclusion of the project, or potentially following delivery of a first vessel, it is generally good practice to undertake and document a lessons learned review to capture all aspects of the project from initiation to delivery. Aspects of this may include all the organizations involved in the work.

1.4 DESIGN-BUILD PROCUREMENT AND CONTRACTING PROCESS

The overall process required to procure a new vessel looks very similar whichever acquisition strategy is followed: a set of operational requirements are expressed as technical requirements, interpreted through a design, and implemented through a shipbuilding program. This has been represented as a process map under Section 1.3. Each element of the process can be accomplished in many ways, and the question of what constitutes best practice in each case is often dependent on the nature of the project, the organizations involved, and many other considerations. Best practices are discussed further in Volume 3.

1.4.1 DESIGN-BUILD VARIANTS

The general design-build methodology is often subdivided into "traditional" and "progressive" [13] or similar categorizations. In the traditional model, the client issues a request for proposal (or equivalent) which is open to a broad range of potential bidders, who then provide proposals that define the proposed approach and their (normally) fixed price. The progressive model is considered better suited to complex projects, as it reduces both client and bidder total levels of effort in achieving outcomes that are satisfactory for both parties. This decreased effort happens through down selecting to a smaller group of respondents and allowing for tailoring of technical and contract requirements. This approach normally involves an initial supplier qualification and short-listing process, following which the short-listed parties are invited to develop a costed proposal for full implementation. During this full proposal phase, the client will often have some visibility into the project design development and can suggest (or direct) changes to this to help ensure a more acceptable solution.

Both traditional and progressive design-build projects can make use of the owner's model approach (sometimes also referred to as an "indicative design"). In this approach, the client develops an in-house design to a concept or preliminary level to illustrate a potential approach to meeting the ship requirements. This can be a powerful tool for conveying design intent and expectations. (As discussed in the Section 1.3.3.1, development of the owner's model also helps the client to verify that their requirements are achievable, and to develop project budgets.) Bidders are not required to follow this design, and the client typically does not warrant any aspects of its performance, as bidders are required to take full responsibility for all aspects of the work.

The procurement approach currently used by WSF follows the progressive design-build model and has made use of the owner's model variant of this as outlined in Section 1.4.2.

1.4.2 WSF'S USE OF OWNER'S MODEL

In preparation for the Olympic Class RFP, issued in 2004, the WSF Vessel Steering Committee worked with several design consultants, including Elliott Bay Design Group (EBDG), Jensen Maritime Consultants, and The Glosten Associates, Inc. (Glosten), to develop the outline specification and an owner's model. The owner's model was developed to aid in identification of WSF requirements and preferences and consisted of a technical report and drawings. It was provided as part of the RFP package for information and for use as desired by the bidder. The owner's model was not warranted by WSF on its own or as a basis for further design effort.

According to the HEOC ferry program request for information (RFI) issued in July 2022, for the re-initiated process, WSF intends to offer the current HEOC functional design, as designed by Vigor and EBDG, as an owner's model, which proposers may use as the basis for their technical proposals. The RFI also states proposers will have the opportunity to make changes to the owner's

[13] See note 12 above

model as they see fit to assume full responsibility for the vessel's regulatory compliance and performance. Furthermore, all changes to the owner's model will need to be explained and justified in the technical proposal. While this notionally follows the design-build owner's model approach, the time and cost allowance (aka honorarium, see discussion at Section 2.3.5) are quite limited and the apparent expectation of WSF is that all bidders will use what is essentially the preferred design as the basis for their bids.

1.4.3 WSF'S FUTURE USE OF OWNER'S MODEL DESIGN

For future ferry procurement projects, WSF is currently constrained by legislation to use a design-build approach that is essentially progressive. There is limited information in either legislation or WSF's documented policies as to whether the approach will need to involve an owner's model. RCW 47.60.814 requires that WSF produce notional line drawings depicting hull geometry that will interface with Washington State Ferries terminal facilities." This would be a sub-set of expectations for an owner's model.

WSF communicated to VARD its intention not to develop an owner's model for a future design-build contract. Furthermore, WSF plans to include the following documents as part of a future design-build RFP: functional design requirements ("outline specification"), updated set of design standards, and potentially a concept design.[14]

For further discussion of the owner's model, see Section 2.3.5.

1.5 CONTRACTING APPROACH ALTERNATIVES TO DESIGN-BUILD

Design-build is the contracting approach currently mandated by Washington State legislation (RCW 47.60.810). Design-build has become a preferred approach for many public sector organizations due its perceived benefits for cost and schedule performance. However, it is advisable to consider other general approaches to ferry procurement and their comparative advantages and disadvantages. The main alternatives to design-build are often summarized as:

- Design-bid-build
- General contractor
- Sole source.

A review of recent comparable ferry procurement projects is provided in Section 1.6 and includes examples of all these contracting approaches. In some cases, owners have used several models. Where possible, VARD has used literature searches and interviews with the organizations involved to gain additional understanding of the reasons for the selections made.

[14] Von Ruden, M. (19 August 2022). [email from Matt S. Von Ruden at WSF to Eric Whitaker at JLARC with subject "Re: JLARC's Review: Replacement document request and one question"].

1.5.1 DESIGN-BID-BUILD

In design-bid-build, often also referred to as “build to print”, the owner engages the services of a design firm – architect, naval architect, or other appropriate organization – to develop a design package with sufficient information to allow any qualified bidder to develop a build proposal with fixed price and schedule. Many of the ferry projects referenced at Section 1.6 have adopted this approach.

The main advantages of this approach are:

- Flexibility – if correctly structured, the owner and designer can use the approach to explore alternatives and ensure the design is fully fit for purpose and satisfactory to all stakeholders.
- Competitive build proposals – builders (shipyards) are given enough information to develop comprehensive price proposals with low-risk contingencies, without expending a large amount of uncompensated effort on design development.
- Control – the design package constrains the potential that the builder will try to introduce low-cost but undesirable features in the detailed design stages.
- Budget – the design package can be adjusted to incorporate “design to cost” features and the quality of internal cost estimates will be as high as possible prior to final approval of project funding levels.
- Cost – developing a single design for the project rather than having multiple bidders undertake parallel design efforts (as is required in the design-build approach) can reduce overall design cost. Even when bidders are not compensated directly for their upfront design, this cost is necessarily built into their price to recover the investment, usually with an additional risk premium.

On the other hand, there can be significant disadvantages to the design-bid-build approach:

- Risk – the owner needs to accept a much higher level of responsibility/risk for design quality and performance.
- Reduced opportunity for construction efficiencies – builders have limited ability to tailor the design to their preferred construction approaches and efficiencies, which can increase build cost.
- Schedule – the overall schedule is likely to be longer, as the design phase itself can be extended and the potential builders will need to conduct due diligence reviews of the materials provided.

Design-bid-build is potentially most appropriate at both ends of the customization spectrum. When the owner has a complex set of requirements that may require trade-offs, including “system level” considerations such as shore-side infrastructure or technology changes, then breaking out the design phase can ensure an optimized solution. Alternatively, if a design already

exists that meets the majority of the owner's requirements, acquiring a license to use this design can be cost- and schedule-effective.

Many of the ferry projects described at Section 1.6 have utilized design-bid-build approaches.

1.5.2 GENERAL CONTRACTOR

The general contractor approach is used relatively infrequently in marine procurement. In this approach, the owner assigns elements of a project's overall scope to several contractors with specific expertise, retaining overall responsibility for integration. This is better suited to "on-site" type projects than to shipbuilding, where the shipyard facility is the location for the bulk of the work, and its own infrastructure and workforce are involved in most activities.

A modified general contractor approach is being utilized in Alaska for ferry procurement, as described in Section 1.6.1.1. A version of the approach is also quite common for many cruise ship upgrade and modernization projects, where an owner will bring a large external workforce into a refit yard to undertake specialized scope such as cabin outfitting, heating, ventilation, and air conditioning (HVAC) work, etc. The suppliers will often install and commission prefabricated modules as part of their scope. The owner works very closely with the yard on scheduling, which is critical to the success of the efforts.

The advantages of this type of approach include:

- Quality – specialty work is undertaken by qualified specialists
- Cost – specialists can often offer higher productivity than generalists with less experience
- Schedule – some activities on the project critical path can be shortened by applying modularity and higher productivity.

The disadvantages of the approach include:

- Project management – requirement for a high level of skill in project planning and management
- Increased liability –high potential for dispute in the event of any schedule slippage or introduction of design changes
- Fewer potential shipyards – reluctance of most shipyards to accept the model.

Increasingly, many global shipbuilders are themselves acting more as general contractors, working with suppliers who undertake the installation and commissioning of equipment and modules. Internationally, this extends to yards (or groups) who may build the entire hull in one country with cheaper steelwork labor and move it elsewhere for the more skilled outfitting work. The Jones Act[15] essentially precludes this approach in the US.

[15] 46 USC § 50101

1.5.3 SOLE SOURCE

Sole sourcing is used extensively in shipbuilding, though almost exclusively for military or similar government procurement programs. The justification normally used is the maintenance of a strategic capability at a national, or occasionally at a regional, level.

The advantages of sole sourcing are predominantly political, but if done well the approach can offer:

- Good integration of design with construction capabilities, as the builder is known and the vessel solution can be tailored to yard facilities and preferences
- Reduced timelines due to the avoidance of many steps in the acquisition process.

The main disadvantages are:

- Cost – the lack of any competition will normally mean a higher price for the vessels.
- Quality – if there are limited potential sanctions for poor performance (due to the need to maintain the yard in business) then some or all aspects of quality may suffer.
- Oversight – using a sole source approach effectively requires significantly more oversight by the owner to reduce the extent to which the builder can try to exploit its privileged position. This starts with the contractual provisions on price, permissible profit, and admissible costs, and progresses into the need to use "open book" accounting throughout the project for any items not subject to fixed, firm pricing.
- Maintaining throughput – if there is not a constant flow of work, then the sole source facility can lose its in-house capability and aggravate the other disadvantages of the approach.

Sole-source approaches are not often used for ferry construction. However, one example was the effort in British Columbia to build high-speed passenger/vehicle catamarans within the province in the 1990s, distributing the work between local contractors. This was unsuccessful on both technical and financial grounds. The project was abandoned and the vessels sold off for less than 5% of their build cost. The State of Alaska used a sole source approach by selecting only one Alaska-based shipyard to begin the procurement process for the two Alaska Class ferries.

It can be noted that several ferry operators do use in-house sole sourcing for elements of their fleet maintenance programs by utilizing an in-house facility for some types of work. For example, WSF has a facility at Eagle Harbor which provides support for both vessel and terminal maintenance[16]. This facility does not have the capacity or capabilities to undertake new construction.

In some cases, a procurement intended to be competitive may result in a single bid (or a single compliant bid) which results in a single source contract. This is not sole sourcing, though it may

[16] Subject to a statutory limit of $100,000 per project.

run into similar project management challenges depending on when and how the sole bidder is made aware of the situation.

1.5.4 SUMMARY

The design-build approach is currently mandated for WSF newbuild programs by state legislation. It has a good record of success in a range of procurement programs. However, under certain circumstances other approaches, in particular design-bid-build, may offer more efficient options as discussed in Section 1.5.1. It is suggested that for future programs, WSF should undertake a comparative analysis of approaches early in the process and provide its assessment to the legislature for consideration (see Section 4.3.2.4).

1.6 COMPARABLE FERRY PROCUREMENTS

VARD conducted a study on international and domestic (US) ferry projects to identify recent reference projects to review for best practices of design-build procurement and contracting of ferries. For the full list and details of domestic and international ferry projects see supporting file 444-000-05a.

The study considered ferries with a range of novel propulsion systems, including hybrid-electric propulsion. Data was collected on recent large hybrid-electric, plug-in hybrid, all-electric, diesel-mechanical, liquified natural gas (LNG)-hybrid, and dual-fuel ferry projects. The following key parameters were organized into columns for all ferry projects: vessel name, operator, state/country, length overall (LOA), beam overall, contract type, designer, builder, car capacity, passenger capacity, propulsion type, and in service year. These vessel parameters facilitate the comparison of the referenced ferry programs with WSF ferry programs. For example, data on the length and beam overall of ferries can be used to better understand the physical size differences between the various ferry projects. Car and passenger capacities are other important parameters for comparing the sizes of reference ferry projects, as some ferries can have multiple car and passenger decks, but a shorter length overall. The study also identified whether a ferry project was part of a single or multi-vessel program and included the details of the first and follow-on ferries.

The study's purpose was to identify ferries that are similar to the future hybrid-electric Olympic Class ferry. Only car and passenger ferries were included in the study, while dedicated trailer ferries were excluded (e.g., Damen built hybrid-LNG roll on-roll off (ro-ro) trailer ferries for Seaspan). Only newbuild ferries were considered, while those ferries that were hybridized during a retrofit were excluded.

Details of WSF ferry procurements were not included in the summary tables found in Sections 1.6.1.3 and 1.7.2.

1.6.1 UNITED STATES

1.6.1.1 ALASKA MARINE HIGHWAY SYSTEM

1.6.1.1.1 BACKGROUND

VARD's work has involved an in-depth review of Alaska Marine Highway System (AMHS) recent procurements. Like WSF, AMHS is a public transportation agency that operates a fleet of large capacity ferries and is faced with the need to replace its aging fleet.

AMHS is a public ferry service system that operates as a division of Alaska's Department of Transportation and Public Facilities. It is part of the US National Highway System and receives federal highway funding.[17] AMHS is one of the largest US public ferry operators with a current fleet of nine vessels that operate year-round to provide essential transportation services to over 35 coastal communities, many that are not accessible by road.[18] AMHS is faced with the need to replace an aging ferry fleet.

1.6.1.1.2 PROCUREMENT HISTORY

AMHS has changed its ferry procurement process over the past 25 years. Table 1-2 shows a summary of the State of Alaska ferry procurements that included design-build and design-bid-build variants. All vessels shown are monohulls, like WSF's entire fleet, except for MV Fairweather and MV Chenega, which are catamaran ferries.

The Inter-Island Ferry Authority, located in the State of Alaska, had contracted Guido Perla & Associates to design and act as owner's representative for MV Prince of Wales and MV Stikine. Both 60-meter ferries were built by Dakota Creek Industries in Washington and procured using the design-bid-build approach.[19]

Table 1-2: Summary of State of Alaska Ferry Procurements

Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Kennicott	1998	116	78/499	Diesel	Mississippi	Design-build with Owner's Model
Lituya	2004	55	15/125	Diesel	Louisiana	Design-bid-build with Full Design Package

[17] Washington State Department of Transportation. (June 2010). *A Comparison of Operational Performance: Washington State Ferries to Ferry Operators Worldwide* (WA-RD 750.1). https://wsdot.wa.gov/sites/default/files/2021-10/WSF-ComparisonofOperationalPerformancetoFerryOperatorsWorldwide.pdf

[18] Alaska Marine Highway System. (August 2022). *Our Fleet.* https://dot.alaska.gov/amhs/fleet.shtml

[19] Guido Perla Delivers Inter-Island Alaskan Ferry. (5 April 2006). *MarineLink.* https://www.marinelink.com/news/interisland-delivers309863

Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Fairweather Chenega	2004 2005	72	31/210 36/250	Diesel	Connecticut	Design-build
Prince of Wales Stikine	2002 2006	60	30/160 30/160	Diesel	Washington	Design-bid-build with Full Design Package
Ken Eichner 2	2011	36	23/149	Diesel	Alaska	Design-build with Guidance Drawings
Tazlina Hubbard	2019 2020	85	53/300	Diesel	Alaska	Construction Manager / General Contractor
"Tustumena Replacement Vessel"	-	100	52/250	Hybrid-electric	TBD	TBC

Before the Alaska Class ferries MV Tazlina and MV Hubbard were built in Alaska, the large AMHS ferries were built by out-of-state shipyards located across the US. The latest large ferry MV Kennicott was built in Mississippi by Halter Marine in 1998.[20]

The Alaska Class ferries (MV Tazlina and MV Hubbard) were procured using a different approach, designated by AMHS as the Construction Manager/General Contractor (CM/GC) project delivery method, a tailored variant of the general contractor model described in Section 1.5.2. The Alaska Class ferry contract was the first time the AMHS used the CM/GC approach on a ferry. It was also the first time any vessel in the US was built under this procurement approach. In the past, AMHS has used the CM/GC approach to build roads and buildings.[21]

[20] AMHS. (August 2022). *MV Kennicott.* https://dot.alaska.gov/amhs/fleet/kennicott.shtml

[21] Forgey, P. (7 October 2014). *New ferry contract part of effort to create shipbuilding industry in Alaska.* Eye on the Arctic. https://www.rcinet.ca/eye-on-the-arctic/2014/10/06/new-ferry-contract-part-of-effort-to-create-shipbuilding-industry-in-alaska/; Blenkey, N. (31 March 2022). *Alaska invites contractor proposals*

The CM/GC approach is approved by the Federal Highway Administration (FHWA); however, using it in Alaska in the past required a lengthy administrative review. In 2021, Alaska Governor Mike Dunleavy signed a new bill to clear these bureaucratic hurdles for the state.[22]

1.6.1.1.3 PROCUREMENT PROCESS

CM/GC is a procurement approach that was used by AMHS to acquire the two new Alaska class ferries (MV Tazlina and MV Hubbard). Details of this approach are provided in Section 1.5.2 to demonstrate how different it is from the other more common procurement approaches, namely design-bid-build and design-build.[23]

The CM/GC approach comprised of two distinct phases: preconstruction and construction.

AMHS awarded the new ferry design contract to a design consultant. The design was completed prior to the issuance of an RFP to shipyards.

As part of a competitive bidding process, AMHS awarded the selected shipyard a preconstruction services contract for the initial preconstruction phase of the project. The shipyard participated in the development of the project's design with various project responsibilities such as design validation, constructability review, cost estimating, and others. The shipyard's preconstruction responsibilities did not include provision of architectural and professional engineering services.[24]

During this phase, AMHS, its design consultant, and the shipyard formed a collaborative team. In that instance, AMHS relied on the shipyard to provide expertise on constructability, sequencing, means, and methods to better enable the project team to deliver a quality product within budget and on schedule.[25]

The CM/GC approach required an open book estimating process where the shipyard provided a detailed breakout of the cost of the work. The shipyard refined its cost estimate as the preconstruction phase progressed. At the same time, AMHS procured the services of a third-party independent cost estimator (ICE). This contractor reviewed project documents and developed a separate construction cost estimate.[26]

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for ferry replacement project services. MarineLog. https://www.marinelog.com/passenger/ferries/alaska-invites-contractor-proposals-for-ferry-replacement-project-services/

[22] Alaska Department of Transportation and Public Facilities, Office of the Commissioner. (23 March 2022). *AMHS Requests Proposals for Tustumena Replacement Vessel: State uses CM/GC project delivery method to deliver new ship on time, on budget.* https://dot.alaska.gov/comm/pressbox/arch2022/PR22-0014.shtml

[23] State of Alaska. (14 January 2022). *Pre-Solicitation Notice: for Tustumena Replacement Vessel (TRV) Project – Roll-On/Roll-Off Ferry Vessel*. https://aws.state.ak.us/OnlinePublicNotices/Notices/View.aspx?id=205086

[24] See note 23 above

[25] See note 23 above

[26] See note 23 above

At the end of the preconstruction phase, the shipyard developed its guaranteed maximum price (GMP) proposal, which represented its total price to construct the project. If the shipyard and AMHS could not come to terms on a GMP, the preconstruction services contract would have come to an end. AMHS reserved the right to pursue other procurement approaches not involving the shipyard or to simply terminate the project.[27]

1.6.1.1.4 RECENT FERRY PROGRAMS

1.6.1.1.4.1 ALASKA CLASS

The Alaska Class is intended to be a prototype for the next generation of ferries for AMHS.[28] The Alaska Class car and passenger ferries are 85-meter diesel-mechanical ships that can carry 53 vehicles and up to 300 passengers. The Alaska Class includes a total of two medium-capacity ferries.

CM/GC was the procurement approach used to procure the Alaska Class ferries.[29] This method is authorized by AMHS' federal funding agency, the FHWA.[30] In 2010, the Alaskan State Legislature appropriated $60 million[31] to pay for the Alaska Class ferries and was matched by $68 million in FHWA funds. However, later in 2010, the Alaska Governor announced that AMHS would return the federal funds to de-federalize the project and allow AMHS to control the bidding process.[32] The state planned to build the Alaska Class ferries entirely within Alaska to develop the in-state shipbuilding industry.

Only Vigor Alaska was chosen to participate in the CM/GC process, that resulted in a sole source, no bid construction contract. The shipyard successfully negotiated for a guaranteed maximum price at which it could be profitable as part of the procurement process. Construction of the first Alaska Class ferry, MV Tazlina, was completed in 2018; it was the largest ferry built in Alaska. The

[27] See note 23 above
[28] TAZLINA: Alaskan ferry designed for optimal performance in heavy seas. (2019). *Significant Small Ships of 2019,* 74-75. https://www.ebdg.com/wp-ebdg-content/uploads/2020/06/2019-Significant-Small-Ships-TAZLINA-3.pdf
[29] Forgey, P. (7 October 2014). *New ferry contract part of effort to create shipbuilding industry in Alaska.* Eye on the Arctic. https://www.rcinet.ca/eye-on-the-arctic/2014/10/06/new-ferry-contract-part-of-effort-to-create-shipbuilding-industry-in-alaska/
[30] 23 USC §112(b)(4); 23 CFR §635.501 et seq.
[31] All currency references in this report are US dollars unless otherwise noted.
[32] Washington State Institute for Public Policy. (December 2016). *Washington State Ferry Vessel Procurement* (360.664-9800). https://www.wsipp.wa.gov/ReportFile/1649/Wsipp_Washington-State-Ferry-Vessel-Procurement_Report.pdf

second Alaska Class ferry, MV Hubbard, was also delivered in 2018. The final project cost was in the order of $150 million, following various technical challenges.[33]

1.6.1.1.4.2 TUSTUMENA REPLACEMENT VESSEL

The MV Tustumena entered service in 1964 and is near the end of its design service life. AMHS has begun a program to replace the existing Tustumena with a new ferry, referred to as the Tustumena Replacement Vessel.

In 2018, the State of Alaska Department of Transportation and Public Facilities decided that the CM/GC procurement approach would be used to construct the Tustumena Replacement Vessel.[34] For this new ferry procurement, the State of Alaska will use federal aid funds and, as a result, will be subject to requirements imposed by FHWA.[35] One of these requirements is that bidding is open to all shipyards in the US.

On March 23, 2022, AMHS issued a request for proposals for the Tustumena Replacement Vessel and extended the proposal due date to June 23, 2022. The solicitation was cancelled effective July 12, 2022.[36] The RFP ended with no bidders; however, there is a plan to re-issue a new RFP after a re-evaluation of the RFP for improvements.[37] Furthermore, AMHS is planning to update the design to include space for housing batteries prior to issuing a new RFP in order to provide the new ferry with hybrid-electric propulsion. According to Greg Jennings, a special projects liaison with State of Alaska DOT, this change to the Tustumena replacement vessel design will enable the state to learn about hybrid technology in preparation for other projects in the future.[38]

1.6.1.2 STATEN ISLAND FERRY

1.6.1.2.1 BACKGROUND

The Staten Island Ferry (SIF) is a ferry route operated by the New York City Department of Transportation. The SIF is the busiest ferry route in the US by number of riders per year. The ferry's single route is 5.2 miles and runs between Manhattan and Staten Island. The route is serviced by a fleet of nine large capacity passenger-only ferries that can carry up to 6,000 passengers. The

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[33] https://alaskapublic.org/2018/12/27/how-a-missed-opportunity-and-unforeseen-costs-became-part-of-the-alaska-class-ferry-story/

[34] AMHS. (August 2022). *Tustumena Replacement Vessel.* https://dot.alaska.gov/amhs/fleet/trv.shtml

[35] See note 23 above

[36] State of Alaska. (23 March 2022). *CANCELLED - RFP: 25224020- AMHS- Tustumena Replacement Vessel-CM/GC*. https://aws.state.ak.us/OnlinePublicNotices/Notices/View.aspx?id=205962

[37] Stutes, L. (7 July 2022). AMHS funds still intact, but millions vetoed for other projects. *The Cordoba Times.*https://www.thecordovatimes.com/2022/07/07/amhs-funds-still-intact-but-millions-vetoed-for-other-projects/

[38] Angela Denning, CoastAlaska. (18 October 2022). DOT Pursues Diesel-Electric Hybrid Design for Tustumena Replacement. https://alaskapublic.org/2022/10/18/dot-pursues-diesel-electric-hybrid-design-for-tustumena-replacement/

ferries on this route operate 24 hours, seven days a week, with high frequency that is about 15 to 20 minutes during peak hours and 30 minutes otherwise.[39]

New York City has several ferry systems. The SIF is operated separately from other systems, such as NYC Ferry and NY Waterway systems. The other New York City ferry systems operate multiple routes that are serviced by large fleets of small high-speed ferries.[40] Because these vessels are distinct from WSF's fleet, they were not included in this analysis.

1.6.1.2.2 PROCUREMENT HISTORY

Table 1-3 shows the most recent ferry procurement at Staten Island Ferries. The Molinari Class has three sister ferries, Guy V. Molinari, Senator John J. Marchi, and Spirit of America, that were procured in the early 2000s. The three Ollis Class ferries, SSG Michael H. Ollis, Sandy Ground, and Dorothy Day, were procured most recently. The rest of the Staten Island ferries are approaching the end of their useful operating lives and need to be replaced.[41]

In 2014, Elliott Bay Design Group (EBDG) was selected to design the new Ollis Class ferries[42]. In 2017, through a competitive bidding process, Eastern Shipbuilding Group (ESG) won the contract for the detail design and construction of the three ferries for SIF[43].

In 2019, the passage of the New York City Public Works Investment Act (PWIA) authorized seven agencies, including the Department of Transportation (DOT), to use design-build project delivery on certain projects. The PWIA enables the DOT to use a two-step qualifications-based procurement process to select a single team of designers and builders to work on public works projects from start to finish. However, before the PWIA, the DOT was only permitted to deliver capital projects using the design-bid-build approach.[44]

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[39] The Staten Island Ferry. (August 2022). *Staten Island Ferry About.* https://www.siferry.com/ferry-about.html

[40] NY Waterway. (August 2022). *About Us.* https://www.nywaterway.com/AboutNYWaterway.aspx; NYC Ferry. (August 2022). *About*. https://www.ferry.nyc/about/

[41] The Staten Island Ferry. (August 2022). *Staten Island Ferry Current Ferries.* https://www.siferry.com/currentvessels.html

[42] MarineLog (4 August 2014). *EBDG Awarded Staten Island Ferry Design Contract*. https://www.marinelog.com/passenger/ferries/elliott-bay-design-group-gets-staten-island-ferry-design-contract/

[43] MarineLog (4 April 2017). *Eastern Shipbuilding Confirms Deal for Staten Island Ferries*. https://www.marinelog.com/passenger/ferries/eastern-shipbuilding-confirms-deal-for-staten-island-ferries/

[44] City of New York. (2021). *Design-Build Program 2021 Progress Report to the New York State Legislature*. https://www1.nyc.gov/assets/ddc/downloads/contracts/DB_Report_Final.pdf

Table 1-3: Summary of New York City Ferry Procurements

Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Guy V. Molinari	2004	94	30/4400	Diesel	Wisconsin	Design-bid-build
Senator John J. Marchi	2005					
Spirit of America	2006					
SSG Michael H. Ollis	2022	98	-/4500	Diesel	Florida	Design-bid-build
Sandy Ground	2022					
Dorothy Day	2022					

1.6.1.3 DOMESTIC FERRY PROGRAMS

Table 1-4 provides a list of recent passenger/vehicle ferry procurements across the US that were reviewed as part of this effort. These ferry procurements were selected because they are considered relevant for the purpose of analysis and comparison to the procurement practices used by WSF. These medium-size passenger and vehicle ferries are powered by conventional diesel engines, and were all recently procured using the design-bid-build contracting process by domestic ferry operators from different states. As discussed in Section 1.4.2, the Island Home design, first built for Steamship Authority (MA), served as the basis for WSF's KDT class of vessels.

Table 1-4: Summary of Domestic Ferry Procurements

Operator (State)	Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Steamship Authority (MA)	Island Home	2007	78	76/1200	Diesel	Mississippi	Design-bid-build
Steamship Authority (MA)	Woods Hole	2016	71	55/453	Diesel	Louisiana	Design-bid-build

Operator (State)	Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
North Carolina DOT (NC)	Swan Quarter	2011	67	46/300	Diesel	Louisiana	Design-bid-build
North Carolina DOT (NC)	Sea Level	2012	67	46/300	Diesel	Louisiana	Design-bid-build

1.6.2 INTERNATIONAL

1.6.2.1 BC FERRIES

VARD's work has involved an in-depth review of British Columbia Ferry Services (BC Ferries) recent procurements. This included an interview with BC Ferries senior staff[45], which contributed to a number of the insights provided below., There are extensive similarities between the WSF and BC Ferries fleets and operations; for example, the organizations have similarly sized fleets operating in adjacent waterways. Both ferry operators have also in the past procured ferries using the design-build approach, and currently have multi-vessel procurement programs underway that will utilize the design-build approach. While WSF is now in the process of procuring its first newbuild hybrid-electric ferries, BC Ferries recently added six newbuild hybrid-electric ferries to its fleet. Both ferry operators are at different stages of implementing their plans to invest in environmentally responsible technology to reduce greenhouse gas emissions.

1.6.2.1.1 BACKGROUND

BC Ferries is an independently managed, publicly owned, Canadian company that operates a diverse fleet of ferries across coastal British Columbia (BC), Canada. BC Ferries is one of the largest ferry operators in the world. The province of British Columbia provides annual funding to BC Ferries through a contract that defines routes and service levels.[46] BC Ferries raises its own capital through bond issues with which it funds ferry replacements.

BC Ferries can purchase internationally built ferries, unlike US ferry operators. In 2016, the Government of Canada removed the 25% import tariff on passenger vessels under 129 meters

[45] Vard Marine Inc. (November 2022). *Interview Questions and Summaries* (444-000-04c).

[46] British Columbia. (August 2022). *Coastal Ferry Services Contract.* https://www2.gov.bc.ca/gov/content/transportation/passenger-travel/water-travel/coastal-ferry-services-contract

imported after October 1, 2015, to facilitate the fleet renewal plans of Canadian ferry operators. Since 2010, the Government of Canada has also waived tariffs on imported large ferries that are 129 meters or more in length.

In the past, most vessels in the BC Ferries were built in BC; however, this changed after BC Ferries became an independent company. BC Ferries is now concerned primarily about its own bottom line and the interests of its passengers who pay the fares that support its capital programs, including its ferry renewal program. BC Ferries is motivated to construct its ferries where it can be done cheaper to achieve capital cost savings and to avoid upward pressure on fares.

1.6.2.1.2 PROCUREMENT HISTORY

Table 1-5 shows the most recent ferry procurements at BC Ferries. The three Coastal Class ferries and single Northern Expedition Class ferry were built by the same German shipyard. The Coastal Class are diesel-electric, double-ended vessels, while the Northern Expedition is diesel mechanical and a more open ocean design. The six hybrid-electric Island Class and four LNG-diesel dual-fuel Salish Class ferries were built and delivered in the last few years. Both vessel classes were procured using the design-build approach that included both international and Canadian shipyards. The lowest compliant bids were from European shipyards in Poland and Romania.

Table 1-5: Summary of BC Ferries Ferry Procurements

Vessel Name	In Service Year	LOA (m)	Car / Passenger Capacity	Propulsion Type	Shipyard Location	Method
Coastal Renaissance	2008	160	310/1604	Diesel-electric	Germany	Design-build
Coastal Inspiration	2008					
Coastal Celebration	2008					
Northern Expedition	2009	152	115/638	Diesel	Germany	Design-build
Salish Orca	2017	107	138/600	LNG-Diesel (Dual-Fuel)	Poland	Design-build
Salish Eagle	2017					
Salish Raven	2017					
Salish Heron	2022					

Vessel Name	In Service Year	LOA (m)	Car / Passenger Capacity	Propulsion Type	Shipyard Location	Method
Island Discovery	2020	80	47/300	Hybrid-electric	Romania	Design-build
Island Aurora	2020					
Island Nagalis	2021					
Island K'ulut'a	2021					
Island Kwigwis	2022					
Island Gwawis	2022					

1.6.2.1.3 PROCUREMENT PROCESS

As noted in Section 1.6.2.1.2, BC Ferries used a design-build, fixed-price contracting approach to procure several vessel classes in the past two decades. Recently, BC Ferries has decided to prepare and offer an owner's model design as part of its design-build procurement approach for its future large ferries program currently underway (Section 1.6.2.1.3.3 elaborates the rationale for this decision).[47]

1.6.2.1.3.1 DESIGN-BUILD

As part of its design-build process, BC Ferries consulted internal and external stakeholders to develop a detailed statement of requirements that define the scope, operational requirements, and limits of the vessel's design. They then followed a three-stage design-build procurement process[48] with the following main stages:

1) **Request for Expressions of Interest (RFEOI)**
   The RFEOI was the first step in the process to inform the Canadian and international marine industry of the vessel construction opportunities and solicit interest, capacity, and capability from all shipyards.

2) **Request for Pre-Qualification (RFPQ)**

[47] LMG Marin assigned design agent for BC Ferries new major vessels. (10 June 2022). *Shippax*. https://www.shippax.com/en/news/lmg-marin-assigned-design-agent-for-bc-ferries-new-major-vessels.aspx

[48] BC Ferries. (2018). *Shipbuilding Plan*. https://www.bcferries.com/web_image/h2b/h90/8798805065758.pdf

At this stage, the interested shipyards were invited to participate in the prequalification process to select those shipyards to participate in the follow-on RFP process. They were evaluated on qualitative criteria, including, but not limited to, construction capacity, quality, design capacity, shipbuilding experience and references, financial stability, shipyard experience with classification societies and Canadian flag state, and shipyard experience with overseas owners (if not Canadian). A concept design was required to be provided if the procurement was for a first-of-class vessel.

3) **Request for Proposal (RFP)**
At this stage, an RFP was issued to invite the pre-qualified shipyards from the RFPQ stage to participate further in the procurement process to design and build the new vessel. This proposal included a full project plan and firm pricing. A "detailed design" (this phrase is from the BC Ferries' Shipbuilding Plan, but its actual level of maturity corresponds to a basic design as defined in Section 1.2) was required to be provided if the procurement was for a first-of-class vessel.

BC Ferries provided the detailed statement of requirements, a technical package, and proforma contract to each bidder. BC Ferries evaluated RFP submissions based on the following proposal evaluation criteria: design and technical content, experience, schedule, capacity, and build strategy, price and payment terms, delivery dates to BC Ferries at Victoria, BC, and others.

After the bid evaluation, a shortlist was established with whom BC Ferries refined the design proposal and negotiated the final price that was based on the refined design. At this time, final RFP selection was driven by best overall value to BC Ferries and ferry users,[49] though BC Ferries confirmed in interview with VARD that price was the main criterion.

1.6.2.1.3.2 DESIGN-BUILD WITH OWNER'S MODEL

BC Ferries has begun work on its new ferry program, called the New Major Vessel (NMV) program, to replace the largest ferries in its fleet. It is expected to include a total of five to seven newbuilds, each of typically being able to carry more than 350 cars (2,200 lane meters vehicle capacity) and 2,100 passengers.[50] This future class of vessels is expected to be powered by a mix of LNG and hybrid-electric propulsion technology.[51] The international newbuild RFP process is expected to result in operational ferries in service by 2029.[52] For this program, BC Ferries is utilizing the design-

[49] See note 48 above
[50] See note 47 above
[51] BC Ferries. (2019). *Clean Futures Plan.*
https://www.bcferries.com/web_image/h11/h06/8798775509022.pdf
[52] See note 47 above

build approach with a modification that includes the preparation of a detailed owner's model to be included with the RFP.

In February 2022, BC Ferries issued an RFP package to find a design agent to provide design and technical support services for the development of a tender-ready design package for the construction of the NMVs.[53] This work is now underway. It will result in the development of a basic design package, which BC Ferries will offer as an owner's model during the RFP phase. Bidders are not obligated to use this model, and if they do so it will be their responsibility to independently verify the owner's model and to make any changes to ensure it will meet the requirements, which could even extend to repeating model tests undertaken during the development of the owner's model.

1.6.2.1.3.3 PROCUREMENT PROCESS DRIVERS

BC Ferries is procuring new vessels through the international market and aims to tailor its processes and expectations to the prevailing market conditions which can change considerably with time. Feedback from previous procurements has been that only shipyards with strong internal design capability and those eager for work were prepared to undertake extensive RFP design work on an uncompensated basis. Providing a mature owner's model is intended to mitigate this concern and ensure a wider pool of bidders.

Other areas of the process which are sensitive to market conditions include the process for contracting for multiple vessels. BC Ferries' preference is to use a single builder for a complete vessel class, but to allow for flexibility if problems arise. Ideally, this leads to contracting on a ship-by-ship basis, using options for follow-on ships that are part of the bid. In tighter shipbuilding markets the bidders may require that options are exercised quickly to secure pricing. BC Ferries also aims to reflect current market conditions when it develops project budget estimates, which require approval by the independent commissioner. Prices exceeding an approved ceiling require the approval process to be restarted and generate considerable program risk.

1.6.2.2 OTHER FERRY PROGRAMS

Table 1-6 shows a selection of recent international ferry programs that include ferries powered by diesel, diesel-electric, or propulsion types other than hybrid-electric or all-electric.

In recent years, Canadian ferry operators, in addition to BC Ferries, have used the design-build contracting process to renew their ferry fleets. The Newfoundland and Labrador Department of

[53] Canadian Marine Industries and Shipbuilding Association. (August 2022). https://www.cmisa.ca/articles/bc-ferries-design-agent-new-major-vessel-request-for-proposals-rfp

Transportation and Works acquired two ice-class, diesel-electric ferries, MV Veteran and MV Legionnaire, that entered service in 2015 and 2016.[54]

Stena RoRo has ordered twelve Chinese-built car and passenger ferries that will be long-term chartered by international ferry operators upon their delivery, including Stena Line (Sweden), Brittany Ferries (France), DFDS Seaways (Denmark), and Marine Atlantic (Canada). The new class of vessels is called E-Flexer and it includes several design variants that have different characteristics. Stena Line will operate the first five ferries of the new class that will be powered by diesel engines. The other ferries will be powered by either diesel, LNG/dual-fuel, or hybrid-electric propulsion systems.[55]

Table 1-6: Summary of International Ferry Procurement

Operator (Country)	Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Newfoundland Department of Transportation (Canada)	Veteran	2015	81	64/ 2200	Diesel-electric	Romania	Design-build
Ontario Ministry of Transportation (Canada)	Peel Islander II	2019	62	34/399	Diesel	Chile	Design-bid-build
Stena Line (Sweden)	Stena Estrid	2020	215	120/1000	Diesel	China	Design-build
Hankyu Ferry (Japan)	Settsu	2020	195	188/663	Diesel	Japan	Design-build

[54] Government of Newfoundland and Labrador, Department of Transportation and Works, Marine Services Branch. (n.d.) *MV Veteran*. https://www.releases.gov.nl.ca/releases/2015/tw/mv_veteran.pdf; MV Legionnaire Ro-Pax Ferry. (30 July 2015). *Ship Technology.* https://www.ship-technology.com/projects/mv-legionnaire-ro-pax-ferry/

[55] Stena Roro. (August 2022). *Stena Roro, the Company.* https://www.stenaroro.com/our-company/about-us/; Stena RoRo Orders More E-Flexer Class RoPax Incorporating Hybrid Power. (22 July 2016). *The Maritime Executive.* https://maritime-executive.com/article/stena-roro-orders-more-e-flexer-class-ropax-incorporating-hybrid-power

Operator (Country)	Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Spirit of Tasmania (Australia)	Spirit of Tasmania IV	2023	212	TBC/1800	LNG (Dual-Fuel)	Finland	Design-build

1.7 HYBRID-ELECTRIC FERRIES

1.7.1 BACKGROUND

Norway is a leader in the electrification of ferries. While many countries have a slow transition to cleaner marine solutions, Norway got its first electric ferry in 2015 and by mid-2021 had 60 electric and hybrid-electric ferries (30% of the country's ferries). A study on the accelerated electrification of ferries in Norway identified a culmination of four key factors which led to the success:

- Collaboration between public and private stakeholders
- Financial support schemes and knowledge sharing to facilitate the growth of an in-country competitive supply chain
- Ambitious country climate targets and ownership from government to provide required infrastructure
- Focus on national supply chain to minimize opposition.[56]

For example, Fjord1 in Norway has approximately 43% of their fleet as hybrid-electric ferries, having recently completed their newbuild program where 25 new ferries were built over a period of four years by four shipyards.[57]

It is important to note that the hybrid-electric technology is past the early adopter stage for ferry applications. Norway's lead in developing and deploying hybrid technology has been followed by operators and suppliers in many other countries. Ferry operators in other countries can now think of hybrid technology as a mature technology and a viable option for their fleets.

[56] Moe, E., & Sæther, S. R. (November 2021). A green maritime shift: Lessons from the electrification of ferries in Norway. *Energy Research & Social Science,* 81. https://doi.org/10.1016/j.erss.2021.102282

[57] Fjord1. (20 May 2022). *First Quarter Report.* https://www.fjord1.no/eng/content/download/7819591/74506109; Snyde, J. (22 January 2021). Fjord1 continues its electrification journey, launching a new car ferry. *Riviera Maritime.* https://www.rivieramm.com/news-content-hub/news-content-hub/with-launch-of-new-car-ferry-fjord1-continues-its-electrification-journey-62930

1.7.2 DOMESTIC HYBRID-ELECTRIC FERRY PROGRAMS

No state in the US currently operates an all-electric vehicle ferry; however, this will change when Skagit County's 54-meter all-electric ferry is built. The Washington county has fully funded the project[58] and is planning to seek a shipyard for construction of the ferry in October 2022.[59] Another notable ferry project is the 50-meter Casco Bay Lines (Portland, ME) hybrid-electric ferry that will have the highest passenger capacity of upcoming newbuilds in addition to a car capacity of 15 vehicles. The double-ended three-deck ferry is expected to enter service in 2024.[60]

Table 1-7 lists the recent hybrid-electric and all-electric car/passenger ferry procurements across the US that were not included in Section 1.6.1. The design-bid-build process was used to procure all ferries in this table. These ferry projects are all one-ship procurement programs that demonstrate US ferry operators' interest in technologies that can reduce emissions and improve fuel economy.

Table 1-7: Summary of US Hybrid-electric and All-electric Ferry Procurements

Operator (State)	Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Red and White Fleet (California)	Enhydra	2019	39	-/600	Hybrid-electric	Washington	Design-bid-build
Maine State Ferry Service (Maine)	TBN	TBC	47	23/250	Hybrid-electric	Rhode Island	Design-bid-build
Texas Department of Transportation (Texas)	TBN	2022	89	70/495	Hybrid-electric	Texas	Design-bid-build

[58] Skagit County. (August 2022). State Transportation Package passes; Guemes Ferry Replacement Project fully funded. https://www.skagitcounty.net/Departments/PublicWorksFerryReplacement

[59] Stone, B. (22 July 2022). WA: Skagit County electric ferry nearly ready for construction. *Mass Transit*. https://www.masstransitmag.com/alt-mobility/water-transportation/news/21274856/wa-skagit-county-electric-ferry-nearly-ready-for-construction

[60] Casco Bay Line's Plug-In Hybrid Ferry is Set to Start Construction. (6 July 2020). *The Maritime Executive.* https://maritime-executive.com/article/casco-bay-line-s-plug-in-hybrid-ferry-is-set-to-start-construction

Operator (State)	Vessel Name	In Service Year	LOA (m)	Car/ Passenger Capacity	Propulsion Type	Shipyard Location	Method
Skagit County Public Works (Washington)	Guemes	2025	54	28/150	All-electric	TBD	Design-bid-build
Casco Bay Lines (Maine)	TBN	2024	50	15/599	Hybrid-electric	Rhode Island	Design-bid-build
The Trust for Governor's Island (New York)	TBN	TBC	57	TBC	Hybrid-electric	Louisiana	Design-bid-build

1.7.3 INTERNATIONAL HYBRID-ELECTRIC FERRY PROGRAMS

Fjord1 is Norway's largest ferry owner that has both procured new hybrid-electric ferries and retrofitted its older ferries with battery technology. Norway's ferry services are provided by private companies to public transportation authorities based on contracts that are entered into on a competitive basis.[61] At the end of 2021, 34 of its 83 vessels were hybrid-electric, of which 28 were operated electrically.[62] In 2021, the world's largest all-electric ferry (139 meter), the Basto Electric, went into service in Norway.[63] The Norwegian experience and lessons learned are discussed in greater detail in Section 3.11.1.

In recent years, several Canadian ferry operators, in addition to BC Ferries (see Section 1.6.2.1), have used the design-build contracting process to renew their ferry fleets with hybrid-electric vessels. The Ontario Ministry of Transportation acquired two new hybrid-electric ferries that are scheduled to enter service in 2022.

Table 1-8 shows a selection of international hybrid-electric and all-electric ferry projects that were recently procured or are in an advanced stage of procurement, not including those discussed in Sections 1.6.1 and 1.6.2.

[61] Norwegian Public Roads Administration. (August 2022). *The Green Shift in the Norwegian Ferry Market.* [PowerPoint Slides]. https://www.electric-water-mobility.eu/upload/elmar/statens-vegvesen-governmental-actions-for-green-shift-on-norwegian-ferry-routes.pdf

[62] See note 57 above

[63] Randall, C. (2 March 2021). World's largest electric ferry launches in Norway. *Electrive.* https://www.electrive.com/2021/03/02/worlds-largest-electric-ferry-yet-goes-into-service-in-norway/

Table 1-8: Summary of International Hybrid-electric Ferry Procurements

Operator (Country)	Vessel Name	In Service Year	LOA (m)	Car/Passenger Capacity	Propulsion Type	Shipyard Location	Method
Torghatten Nord AS (Norway)	TBN	-	117	120/399	Hybrid-electric	Turkey	Design-bid-build
Basto Fosen (Norway)	Basto Electric	2021	139	200/600	All-electric	Turkey	Design-bid-build
Color Line (Norway)	Color Hybrid	2019	160	500/2000	Hybrid-electric	Norway	Design-build-bid
Caledonian Maritime Assets (Scotland)	TBN	2025	95	107/350	Hybrid-electric	Turkey	Design-bid-build
Wightlink (England)	Victoria of Wight	2018	89	178/1170	Hybrid-electric	Turkey	Design-bid-build
Ontario Ministry of Transportation (Canada)	Amherst Islander II	2022	72	42/300	Hybrid-electric	Romania	Design-build
Ontario Ministry of Transportation (Canada)	Wolfe Islander IV	2022	99	75/399	Hybrid-electric	Romania	Design-build
Steam Packet Company (Isle of Man)	Manxman	2023	132	TBC/949	Hybrid-electric	South Korea	Design-build

Operator (Country)	Vessel Name	In Service Year	LOA (m)	Car/Passenger Capacity	Propulsion Type	Shipyard Location	Method
KiwiRail (New Zealand)	TBN	2025	220	652/1910	Hybrid-electric	South Korea	Design-bid-build

1.8 WSF'S FERRY PROCUREMENT PROGRAMS

1.8.1 RECENT

Even for a large operator such as WSF, new ferry acquisitions are relatively infrequent events. With a fleet size of 21[64] vessels and a design life expectancy of 60 years, on average a new vessel will be acquired roughly every three years. However, as WSF normally buys ships as a class with multiple units, the build program is more intermittent.

Since 2000, two new classes have been acquired: the 144-car Olympic Class (four vessels) and the 64-car Kwa-di Tabil Class (KDT, three vessels). The timelines for these two projects are shown in Figure 1-5. The Olympic Class timeline and contracting approach were impacted by the need to insert the KDT Class into the program unexpectedly, due to the early retirement of a class of existing ships due to their poor condition. Meanwhile, the need to expedite the KDT Class construction led to the purchase of an existing ferry design as the basis for a request for proposals.[65] This approach was authorized in part through project-specific legislation[66], since repealed.

The original Olympic Class contract was signed prior to the start of the competitive bidding process for the first KDT Class ferry that awarded the contract to the same consortium of Washington shipyards, led by Todd Pacific Shipyards Corporation. The three KDT Class ferries were built under two separate contracts. The first contract 00-7595[67] was for one ferry and the second contract 00-7803[68] was for two ferries; and they were awarded in December 2008 and October

[64] Von Ruden, M. (8 August 2022). [WSF comment on Rev 0 of the Task 1 Interim Report, see *444-02 WSF Comment Register for Task 1 Interim Report*, Comment No. 112].
[65] Washington State Auditor's Office. (3 January 2013). Washington State Ferries: Vessel Construction Costs (1008884).
[66] Washington State Legislature. (2008). *New ferry vessel construction for service on routes that require a vessel that carries no more than one hundred motor vehicles - How constructed - Warranty work. (*RCW 47.56.780).
[67] WSDOT. (September 2008). *New 64 Auto-Ferries Contract* (No. 00-7595). https://www.wsdot.com/Ferries/Business/contracts/search/browse?category=6&fiscalYear=&awarded=
[68] WSDOT. (August 2009). *New 64 Auto-Ferries – B Class.* (No. 00-7803). https://www.wsdot.com/Ferries/Business/contracts/search/browse?category=6&fiscalYear=&awarded=

2009 respectively. The Olympic contract was put on hold, and then, in 2011, it was renegotiated for performance and cost as the smaller project approached its completion.[69]

[69] See note 65 above

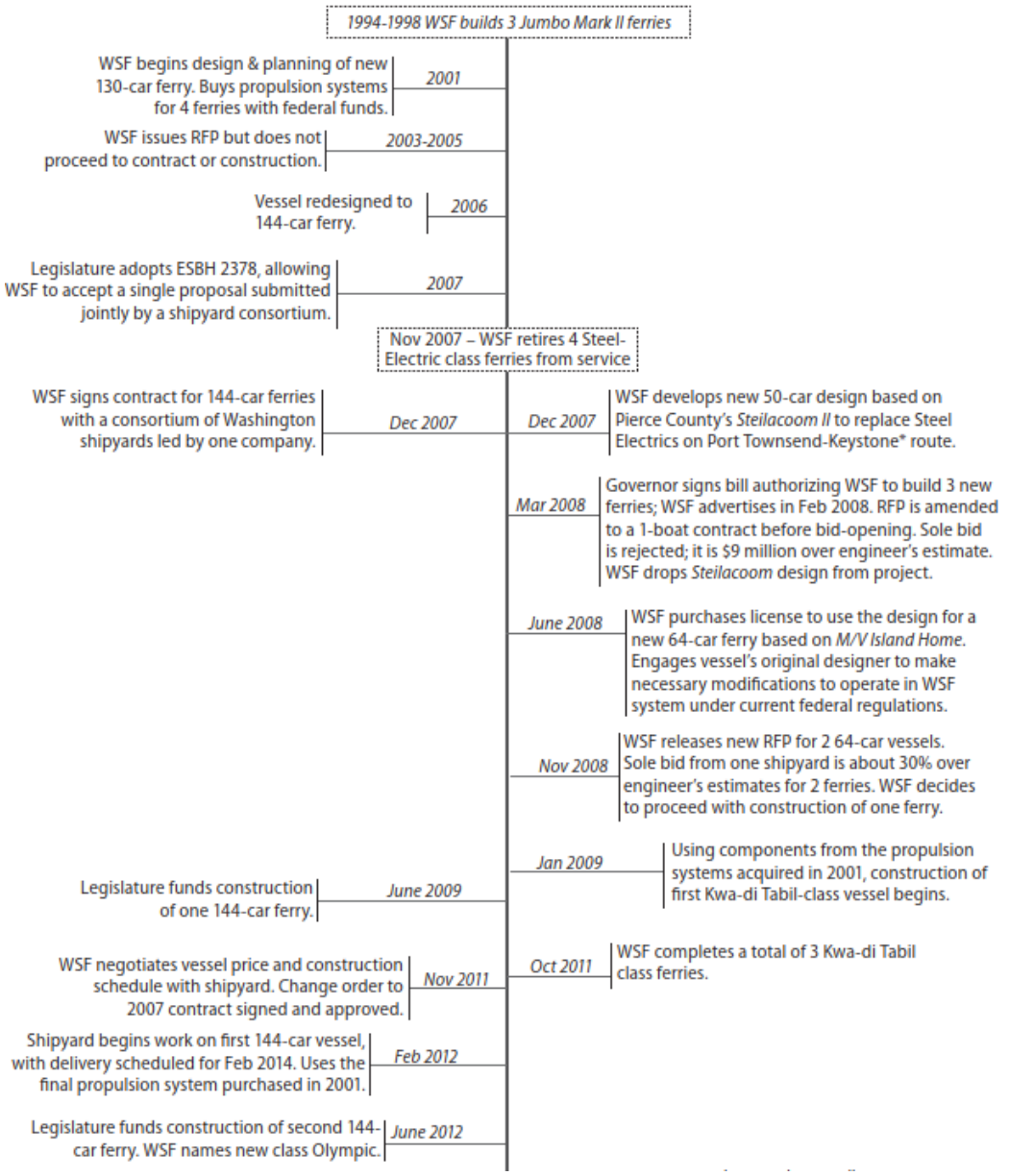

Figure 1-5: Historical Project Timelines for the Olympic and Kwa-di Tabil Classes[70]

The most recent acquisition program, now underway, is intended to procure five hybrid-electric variants of the Olympic Class (HEOC), which will be capable of operating with zero emissions by

[70] See note 65 above

using battery energy storage systems.[71] The initial approach to this program was to add it to the scope of the Olympic Class build contract, with both the redesign phase and the build phase(s) being incorporated as design changes to the existing contract. This was again authorized through project-specific legislation[72]. However, as it proved impossible to negotiate mutually agreeable terms for the build phase, WSF elected to not move forward with Part D, and instead to resolicit with a new competitive procurement process in accordance with RCW 47.60.810-824. [73]

This summary of recent and current projects is intended to illustrate a number of important considerations for WSF:

- Ferry acquisition projects are relatively infrequent, which can limit the amount of in-house technical and contractual experience available for future projects and may require adding staff or utilizing contractor support. However, WSF has indicated that a high number of its current long-term employees have worked on multiple WSF vessel procurement projects in the past, and that this expertise can be applied to future projects.[74]
- There has been no standard model for recent ferry acquisitions. The practices used in the past are not comparable to current legislative requirements due to other legislative direction or the timing of the acquisition. There is no recent experience of a project which has followed all the requirements that will apply to a future procurement process.
- The high-level process has tended to be amended as necessary to allow flexibility on contracting approaches.

1.8.2 PLANNED

Future procurements are intended to follow the WSF long range plan[75], which considers the period out to 2040 in some detail and outlines the even longer-term future. The plan recommends building 16 new vessels over this period, in several vessel classes. The two most immediate programs are outlined below.

As of December 2022, the HEOC program has been restarted, with the overall objective of procuring five new vessels under a new contract. The estimated timeline for delivery of all vessels is between July 2027 and December 2031. Industry engagement sessions have taken place and a

[71] WSDOT. (July 2022) *Hybrid Electric Olympic Class Ferry Program, Request for Information*.
[72] Washington State Legislature. (2015). *Design-build ferries—Independent owner's representative—Phases defined—Department may modify certain existing option contracts.* (RCW 47.60.810). https://app.leg.wa.gov/rcw/default.aspx?cite=47.60.810
[73] Nick Blenkey. (June 2022). *WSF to issue new RFP for hybrid-electric ferries.* https://www.marinelog.com/passenger/ferries/wsf-to-issue-new-rfp-for-hybrid-electric-ferries/
[74] McGuigan, T. (12 August 2022). [WSF comment on Rev 0 of the Task 1 Interim Report, see *444-02 Comment Register for Task 1 Interim Report*, Comment No. 112].
[75] WSF. (January 2019). *2040 Long Range Plan*.

request for information (RFI) seeking industry comment on the project has been issued.[76] An independent owner's representative has been engaged (Section 2.3.3.3), and a larger RFP for a general engineering consultant to support WSF engineering staff is also under development.

According to WSF, the design package developed by Vigor (and its subcontractors) under the extended Olympic Class contract will be provided to potential bidders for the new HEOC contract as a non-mandatory starting point. The purpose of offering this design package is to leverage the state funded design efforts to date as much as possible. Bidders will be free to use, adapt, or discard this going forward, though some elements will be required to be retained for compatibility with terminals, etc. WSF's expectations are that bidders will generally choose to stay close to the whole package and the timeline for the three phases of the down-select process can be accelerated. Similarly, the size of the honorarium offered to bidders will be tailored to a reduced level of effort in comparison to a new design.

The previous work also provides a detailed cost baseline, as Glosten has already developed this for the initial HEOC design. Glosten was provided with the vendor quotes for major systems and equipment by Vigor via WSF. Major vendors whose costs were used in this cost estimate include ABB (propulsion system), Bagby (elevator), Alexander Gow (fire safety equipment), and Trident (outfitting).[77] After Glosten's estimate was issued to WSF, these projected costs should have informed any revisions to budgets requested and allocated to the program at what is expected to be a reasonably high level of fidelity, given this unusual level of information made available by the shipyard. It should however be understood that cost and price can be quite different, depending on the perceived risk involved in a procurement and the competitive environment. Changes in market conditions since the date of these estimates are also likely to have a significant effect.

The next procurement program will be for an intended four new ferries to replace the Issaquah Class, with a capacity of 124 cars. The overall process is planned to be initiated in mid-2024, leading to delivery of the first-of-class ship in 2031 and the fourth by 2034. These vessels will also be hybrid-electric in accordance with decarbonization objectives. WSF reports that its current plan is to follow the full RCW-specified process, with an 18-month period for the development of full technical proposals by the pre-qualified bidders[78].

For both the HEOC and 124 car ferries, current expectations are that there will be a competitive bid process under Build in Washington law.[79]

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[76] See note 71 above
[77] Nathan R. Crain. (7 March 2022). *Glosten & new JLARC HEOC meeting follow-up items.* (Unpublished email communication).
[78] WSF. (May 2022). *WSF 124 Auto Ferry Estimate.* (unpublished spreadsheet).
[79] See notes 65 and 70 above

2 VOLUME 2: REVIEW OF APPLICABLE STATUTES AND REGULATIONS AND WSF'S P&P

Key points:

- While WSF outputs for procurement projects generally demonstrate valid approaches to aspects such as requirements definition, risk management, change management, and cost and schedule control, there is very little formal documentation of the policies or practices used to accomplish this. Success, therefore, relies very heavily on the expertise and experience of key personnel and their ability to use and adapt documentation from prior projects in appropriate ways.
- State law directs WSF to follow a three-phased design-build contracting approach.
    - Shipbuilders are prequalified and then shortlisted to undertake a design phase and construction proposal, which may be partially funded through an honorarium approach
    - The winning builder is then selected on the basis of lowest compliant bid, as required by the RCW, or the process must be restarted (see 4.2.3)
    - Build In Washington limits the number of prospective builders, and therefore simplifies both shortlisting and final contract award. However, if a procurement is re-initiated nation-wide (see Cost Control below) then evaluation and selection will be more challenging
- Additional laws and OFM rules address planning, predesign studies, budget requests, and the use of an independent owner's representative (IOR).
- RCW 47.60.815(3) says that *"…if all responses to the initial request for proposals under RCW 47.60.814 are greater than five percent above the department's engineer's* [cost] *estimate for the project, the department must reject all proposals and issue a subsequent request for proposals that is not subject to RCW 47.60.814(1)(r)* [Build In Washington requirement]*."* This requirement will be applied for the first time to the HEOC project. It sets a very high bar as regards accuracy. If not achieved, the mandated US-wide recompete will itself incur substantial delay and additional cost.
- Other specific legislative requirements related to cost estimation include:
    - RCW 47.60.820(8), which allows WSF to provide an honorarium payment to bidders for proposal preparation costs – this requires WSF to establish an appropriate quantum for such payments.
    - RCW 47.60.820(9), which limits the contingency amount in legislative appropriations to no more than 5% above contract value – this reduces WSF's flexibility in tailoring contingency to project complexity and risk.
- There are no specific legislative requirements for risk management in WSF ferry procurement. Several requirements have been identified as significant sources or drivers of risk, including:

  - RCW 47.60.810: Design-Build – mandates a particular contracting approach, removing WSF ability to tailor approach to project risk profile (Section 1.5)
  - RCW 47.60.814: Build in Washington – limits pool of potential builders, with potential technical, cost and schedule risk (Section 2.3.1)
  - RCW 47.60.815(3): Engineer's estimate – requires cancellation and restart of project if bids are more than 5% above estimates, incurring schedule and potentially cost risk (Section 2.3.2)
  - RCW 47.60.820(6): Low bid – final contractor selection must be based on low bid, limiting WSF's ability to include risk factors in bid evaluation (Section 4.3.2.5)
  - RCW 47.60.820(9): Contingency limit – constrains ability for design improvements and contract adjustments based on unforeseen circumstances, such as COVID or inflation.
  - RCW 47.60.835: Small Business Enterprise participation – limits pool of potential subcontractors, with potential technical, cost, and schedule risk (Section 2.3.4)
- Washington State legislation includes several contractual and some technical cost drivers, but few items directly related to cost management and control. The requirement for bid prices to be within 5% of the engineer's estimate for a project under RCW 47.60.815(3) is a control on overall cost, though its application may also cause increases in both cost and schedule.
- An important requirement associated with change management is RCW 47.60.820, which limits contingencies in a fixed price contract to 5% to accommodate change orders. It also requires that any use of contingency be approved by the Office of Financial Management. These requirements were introduced in 2015 and have not yet been tested in a procurement.
- RCWs relating in whole or part to through life cost estimation principally include 47.60.365, 47.60.385, and 47.60.386, all of which require consideration of through- life cost in aspects of requirement definition.
- Other legislation that indirectly affects the approach to through life costing includes RCW 47.60.820, which mandates the award of the build contract to the lowest fixed price bid. This does not allow for any evaluation of offerings which could reduce through life cost while offering a higher initial build cost. Also, the limit on permissible design changes after contract award (5% of contract value) constrains the potential to incorporate any suggestions by the builder or any late-breaking developments in technology or cost that might otherwise justify reopening the design.

2.1 INTRODUCTION

In order to answer the study questions detailed in Section 1.1.1, VARD began with a thorough review of the applicable state and federal statues and regulations as they apply to WSF procurement activities. VARD excluded consideration of anything that is only applicable to terminals or only applicable to preservation activities. VARD also excluded some laws and regulations that remain applicable but are not part of the procurement process. A full list is

provided in Section 2.2.3 and supporting file 444-000-04e. VARD has created a process map which details the RCW design-build approach, see supporting file 444-000-04f. Some state legislation will be applied by WSF for the first time in the re-initiated HEOC procurement currently underway; the most significant of these are discussed in more detail in Section 2.3.

VARD went on to review documentation supplied by WSF. This included internal policy documents as well as contract and project documentation from its recent procurements, as detailed in Section 1.8. All documentation received and reviewed by VARD is captured in the Document Log, see supporting file 444-000-04b.

Interpretation of both legislation and regulations and WSF's documentation was assisted by discussions between VARD and JLARC staff and by interviews with WSF personnel and their supporting contractors, see supporting file 444-000-04c.

While this literature review and analysis was the first task undertaken as part of this project, and the focus of the Task 1 Interim Report, as more information was gathered, documentation supplied and reviewed, additional interviews conducted, and the re-initiated HEOC procurement activities continued over the course of the project, this analysis has been updated and the information presented in this volume represents VARD's full review and analysis of the documentation and events up to the date of publishing.

2.2 STATE AND FEDERAL STATUTES AND REGULATIONS

2.2.1 INTRODUCTION

WSF is a division of the Washington State Department of Transportation (WSDOT), reporting through the Secretary of Transportation to the Governor as shown in Figure 2-1 in red. It operates under the authority of the Executive Branch, subject to the laws put in place by the legislature.

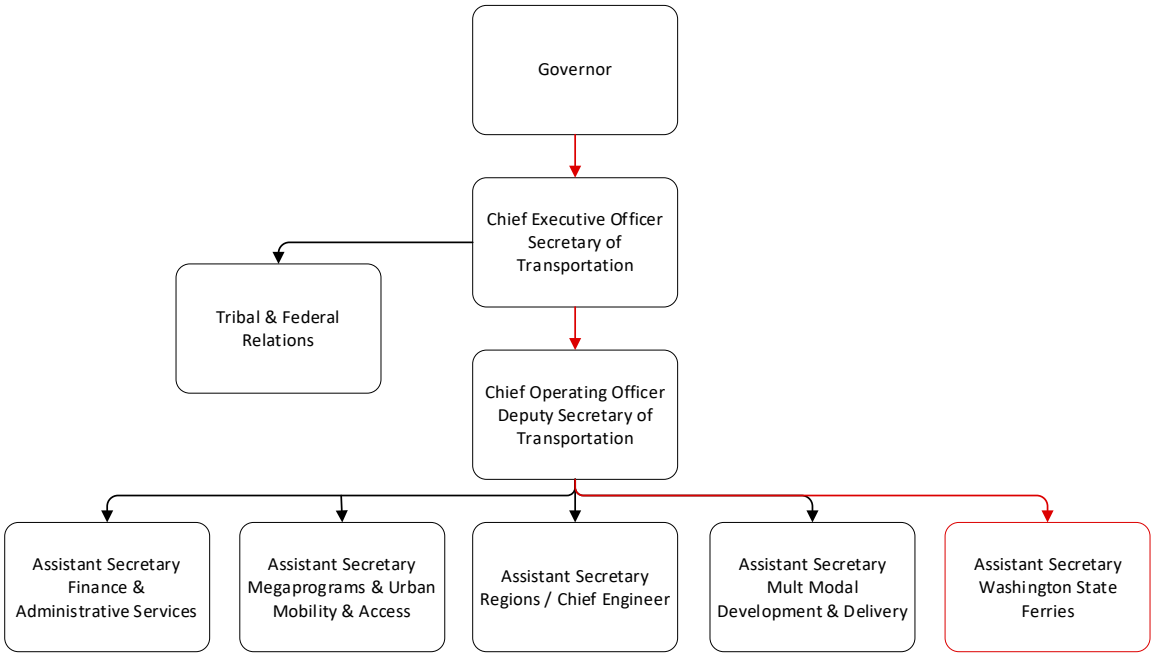

Figure 2-1: WSDOT Organization Chart[80] (July 2022)

Before analyzing how WSF applies state and federal legislation and regulations in ferry acquisition, it is necessary to bound the scope, as a very wide range of instruments have influence and impact on the activities involved. This study has therefore focused on "foreground" legislation for which WSF needs to implement specific measures in its procurement approach and considers "background" general legislative and regulatory requirements only where these need to have particular interpretations for new ferry projects.

The foreground legislation further divides into measures which WSF must apply to its own operations, and those which are wholly or partly flowed down to the shipbuilder (and in some cases its subcontractors). The latter will normally be captured in project requests for proposal and in the contractual terms and conditions that are applied.

In the RCW, Title 47 applies to Public Highways and Transportation, and within that, Chapter 60 covers the Puget Sound Ferry and Toll Bridge System. Much of the legislation considered in detail below falls under chapter 47.60 RCW. Other important state legislation covers general procurement practices and polices ranging from apprenticeship programs through small business set-asides.

[80] WSDOT (18 July 2022). *Agency Organization Chart.* https://wsdot.wa.gov/about/secretary-transportation/wsdot-organization-chart

Most standards for vessel construction are set at the federal level, and other federal requirements do or can apply, depending on whether federal funding is requested to support a procurement program.

In all cases, it is mandatory to address regulations, but in some cases the regulations themselves are conditional – they will only apply under specific circumstances. Regulations can be highly prescriptive, but also often set processes and goals with some flexibility in interpretation.

2.2.2 BUDGET PROCESS

WSF operations, including vessel maintenance, are financed by a mix of fare revenues and budget appropriations. Capital projects (new builds and major modernizations) are funded in a separate transportation budget with a separate set of appropriations.

The transportation budget process begins with agency requests to the Governor. The Governor then proposes a budget and submits it to the fiscal and transportation committees of the Legislature. The chairs of these committees write their own versions of the budget; the degree to which they mirror the Governor's budget can vary. There is a biennial (every two years) cycle for major budget items, though adjustments are made each year via Supplemental Budgets.[81]

Approved budgets may provide funds with a proviso that it is spent in a specific way; for example, the 2022 Supplemental Budget includes $200,000 assigned to the engagement of an independent owner's representative (IOR) for the HEOC project. Such funds must be used for the purpose authorized but there is no prohibition on WSF spending additional funds for the same purpose, unless expressly stated by the Legislature.

2.2.3 APPLICABLE STATUTES

With respect to Washington State legislation, RCW 47.60 is applicable to the Puget Sound ferry system and WSF. VARD excluded consideration of anything that is applicable to repair, maintenance, and terminals. VARD also excluded some other laws that remain applicable but are not part of the procurement process. The Washington Administrative Code (WAC) was also reviewed, in part, for regulations specific to ferries. The following laws and regulations apply to the current procurement process with the effective year of the most recent revision to the RCW provided in brackets:

- RCW 39.04.300 Apprenticeship training programs—Purpose (2006)
- RCW 39.04.310 Apprenticeship training programs—Definitions (2020)
- RCW 39.04.320 Apprenticeship training programs—Public works contracts—Adjustment of specific projects—Report and collection of agency data—Apprenticeship utilization advisory committee created (2018)

[81] Office of Financial Management. (July 2022). *A Guide to the Washington State Budget Process.* https://ofm.wa.gov/sites/default/files/public/publications/WaStateBudgetProcessGuide.pdf

- RCW 47.60.810 Design-build ferries—Independent owner's representative—Phases defined—Department may modify certain existing option contracts (2019)
- RCW 47.60.812 Design-build ferries—Notice of request for proposals (2001)
- RCW 47.60.814 Design-build ferries—Issuance of request for proposals (2015)
- RCW 47.60.815 Design-build ferries—Cost-benefit analysis—Engineer's estimate—Subsequent request for proposals, when required (2015)
- RCW 47.60.816 Design-build ferries—Phase one (2001)
- RCW 47.60.818 Design-build ferries—Phase two (2001)
- RCW 47.60.820 Design-build ferries—Phase three (2015)
- RCW 47.60.822 Design-build ferries—Notice to proposers not selected—Appeal (2001)
- RCW 47.60.824 Design-build ferries—Single best-qualified proposer—Incentives—Proposal negotiations—Compensation (2007)
- RCW 47.60.835 Small Business Enterprise enforceable goals program (2019)
- WAC 468-320-010 Marine contract security—General requirements (2003)
- WAC 468-320-030 Calculation of state's exposure to loss (2003).

Similar to the general procurement contracting process map detailed in Section 1.3, VARD has created a process map which details the RCW design-build approach, see supporting file 444-000-04f.

Key legislative requirements that will impact WSF's upcoming ferry procurements are discussed in Section 2.3. Some of these requirements are new, and have not impacted any previous WSF procurements program, while other RCWs have existed for a long time, and were applicable to past ferry construction projects. The current Washington state legislation has instructions related to Build In Washington law, IOR, Small Business Enterprise, honorarium and through life cost optimization.

There are also various legislative requirements that address aspects of operational efficiency, including the following, with the effective year of the most recent revision to the RCW provided in brackets:

- RCW 47.06.140(2) Level of Service Standards – to be set by WSDOT (2009)
- RCW 47.60.327 Operational Strategies for Asset Utilization (2007)
- RCW 47.60.340 Vessel maintenance and preservation program – requires use of lowest life cycle cost method, and provision of reports (2008)
- RCW 47.60.345 Life cycle cost model on capital assets – requires department to maintain an overall model for all capital assets (2008)
- RCW 47.60.365 Terminal and vessel design standards – requires most efficient balance between capital and operating investment through life cycle analysis (2010)
- RCW 47.60.375 Capital Plan – addresses overall service level considerations. (2010)

- RCW 47.60.385 Terminal improvement, vessel improvement, and vessel acquisition project funding requests – Predesign study –identifies aspects to be studied, including fuel efficiency, staffing and preservation (2010)
- RCW 47.60.386 Additional requirements for vessel acquisition funding requests – further study requirements (2010).

The RCW sections that are mainly concerned with overall planning and levels of service are not the focus of the current study and so will not be referenced extensively. However, those RCWs which can apply to through life cost optimization are presented in more detail in Section 2.3.6.

In some instances, RCWs were reviewed but found to be applicable only to specific projects or have been overtaken by events and not applicable to future or ongoing procurement programs, for example:

- RCW 47.60.810 (4) – Allowed WSF to modify an existing option contract executed prior to July 6, 2015, to allow for the purchase of up to five additional 144-auto ferries
- RCW 47.60.815 (1) – Required the Washington State Institute for Public Policy (WSIPP) to conduct a cost-benefit analysis of the state's ferry vessel procurement practices.

Key federal legislation includes the following titles from the United States Code (USC) and the Code of Federal Regulations (CFR):

- USC Title 23 – Letting of Contracts, Section 112(b)(3) – Design-build Contracting
- USC Title 41 – Public Contracts, Subtitle IV – Miscellaneous, Chapter 83 – Buy American
- USC Title 42 – The Public Health and Welfare, Chapter 126 – Equal Opportunity for Individuals with Disabilities (also know as the Americans with Disabilities Act)
- USC Title 46 – Shipping, Subtitle V – Merchant Marine, Section 55103 – Transportation of Passengers
- USC Title 46 – Shipping, Subtitle V – Merchant Marine, Section 55102 – Transportation of Merchandise (also known as the Jones Act)
- CFR Title 21 Part 1250, Subpart E–- Sanitation Facilities and Conditions on Vessels
- CFR Title 23 Part 635, Subpart D – Buy America requirements
- CFR Title 23 Part 636 – Design-Build Contracting
- CFR Title 48 Part 31 – Contract Cost Principles and Procedures

Note that this is not an exhaustive list. It covers those overarching policies that are directly relevant to the procurement process. These may not include legislation which would apply to all state or federal projects and are not specific to ferries. A full list of regulations which have been considered over the course of this research is included in the Regulation Log (see supporting file 444-000-04e).

2.2.4 FLOW DOWN

There are parts in the legislation which provide explicit direction to WSF, but there are portions of legislation which WSF adheres to by simply including it in the terms and conditions of its contract, thus requiring its contractors and their subcontractors to follow them, for example the Washington State Small Business Enterprises (SBEs) initiative per RCW 47.60.835 and the Federal Americans with Disabilities Act per USC Title 42. Another example is compliance with federal regulations, such as CFR Title 46 for ship design.

2.3 LEGISLATED REQUIREMENTS

In some cases, local requirements are similar to constraints imposed by other public sector authorities, and lessons can be learned from their experience. In other cases, the requirements are more generally applicable to marine projects, and general best practices can be derived from experience.

2.3.1 BUILD IN WASHINGTON

2.3.1.1 BACKGROUND

A Build In Washington type law has existed in Washington legislation since 1993. It was replaced in 2001 by RCW 47.60.814(1)(r), which requires that "…the vessels be constructed within the boundaries of the state of Washington". This RCW was added as part of a series of new legislation about ferry procurement. Federal laws, namely the Jones Act[82] and the Passenger Vessel Services Act[83], require that all car and passenger ferries for US routes be built within the US. In addition, certain federal funding for passenger transportation projects is provided upon the condition that competition for the ferry construction contract is open to all shipyards in the US. The Build in Washington law does make an exception that allows the use of federal funds for owner furnished equipment (OFE) as well as manufactured components and systems. WSF has used federal funding for this purpose (e.g., the Kwa-di Tabil rudders were built in Germany).[84] Other than this exception, WSF has not used federal funding for the construction costs of its ferries, thus limiting competition to in-state shipyards.

Table 2-1 shows that Washington State has procured most of its ferries from in-state shipyards from 1980 to 2021. In comparison, the other major US ferry systems have procured considerably fewer of their ferries from in-state shipyards, with the exception of Florida and Louisiana. There are considerably more shipyards with ferry experience in the Southeast US than any other region, see Table 2-2. More recently, Southeast US shipyards continued to gain experience in ferry construction. In 2016, Conrad Shipyard, located in Louisiana, completed construction of MV

[82] See note 15 above
[83] 46 USC § 55103 (b)
[84] See note 32 above

Woods Hole, a 71-meter passenger and vehicle ferry for the Steamship Authority[85] (see Section 1.6.1.3). Also, Eastern Shipbuilding Group (ESG), located in Florida, built three Ollis Class ferries for Staten Island Ferries between 2021-2022 (see Section 1.6.1.2.2). Vigor Alaska, a Westcoast US shipyard, located in Alaska, recently built two Alaska Class ferries (MV Tazlina and MV Hubbard) that were both delivered in 2018. This ferry program reversed the previous trend of Alaskan ferries being built by out-of-state shipyards (see Section 1.6.1.1.4.1).

Table 2-1: Fleet Size and Purchasing Pattern for US Ferry Systems 1980-2021[86]

State	Count of Publicly Owned Ferries*	% Built In-state
Alaska	12	42%
California	22	0%
Florida	12	92%
Illinois	5	0%
Louisiana	2	100%
Maine	10	50%
Massachusetts	5	40%
New Jersey	12	0%
New York	57	2%
North Carolina	14	0%
South Carolina	5	0%
Texas	9	78%
Virginia	2	0%
Washington**	34	97%

Notes:

* Includes city, county, and state ferries.

** Includes non-WSF ferries. The out-of-state ferry is the Keller Ferry, MV Sanpoil, which was purchased from Foss Shipyard in Oregon.

[85] Steam Ship Authority (Accessed November 2022). Vessels: The M/V Woods Hole. https://www.steamshipauthority.com/about/vessels

[86] See note 32 above; Shipbuilding History. (February 2022). http://www.shipbuildinghistory.com/

Table 2-2: US Shipyards with Experience in Ferry Construction 1980-2015[87]

Region	Count of shipyards
Southeast (Alabama, Florida, Louisiana, Mississippi, and Texas)	11
Midwest (Wisconsin)	2
New England (Maine, Massachusetts, and Rhode Island)	3
West (California, Oregon, and Washington)	5

2.3.1.2 COST AND SCHEDULE IMPACT

In 2015, the Washington State Legislature, by means of RCW 47.60.815(1), required the Washington State Institute for Public Policy (WSIPP) to conduct a cost-benefit analysis of the state's ferry vessel procurement practices. As part of this analysis, WSIPP compared in-state construction to construction at shipyards across the US, using a sample of recent projects including some of those listed in Sections 1.6.1 and 1.7.2. The analysis suggested that building a ferry out-of-state could lead to costs from 40% less to 13% more than building in state, with a mean savings estimate of 9%; the wide scatter reflecting the different natures of the projects being compared. The report also suggested that an out-of-state build would have only a short-term economic impact on the Washington State shipbuilding industry.[88]

A direct point of comparison on pricing is provided by the recent Staten Island ferry procurement, which was competed across the US with bidders including Washington shipyard Dakota Creek. The winning bid, from Eastern Shipbuilding Group (ESG) in Florida, was $250.9 million for three vessels. The Dakota Creek bid was the highest of five received, at $333.1 million, approximately 33% higher than the winning bid[89]. This is within the range suggested by WSIPP, though towards the high end.

As noted in Section 2.3.1.1, restricting build to Washington State shipyards also removes the eligibility of ferry procurements to receive federal funding, which can be substantial. For example, the Staten Island newbuilds received a $196 million grant, although this was a special case linked

[87] See note 32 above
[88] See note 32 above
[89] Parker, B. (7 February 2017). North American Ferries: Faster, Greener & Safer. *MarineLink.* https://www.marinelink.com/news/american-ferries-greener421768

to disaster relief.[90] There are usually federal programs available to provide support; for example, current programs include the Passenger Ferry Grant, Ferry Service for Rural Communities, and Electric and Low-Emitting Ferry[91]. The scope of this study has not allowed for a full analysis of the averaged benefits of such support, but an estimate in the range of 10% is considered conservative. This would be in addition to the reduction in build cost from national competition. An out-of-state build would incur some additional project management costs due to distance effects and potentially delivery charges for bringing the vessels from a remote shipyard to Puget Sound. These additional project management costs are mainly travel and living and would be unlikely to exceed 1% of the contract value for an HEOC or similar ferry. Delivery charges will normally be to the builder's account and included in their competitive bid.

An additional factor for consideration may be project schedule. Limiting the potential builders to those in-state means that the production capacity and existing workload of the shipyards may represent a significant constraint. This is a factor that should be assessed during early industry engagement activities.

In summary, prior analyses, more recent data, and normal competitive factors suggest that Build In Washington is a cost and schedule driver for WSF projects, accentuated by the loss of opportunity for federal funding support.

2.3.2 REQUEST FOR PROPOSAL NOT SUBJECT TO BUILD IN WASHINGTON

2.3.2.1 BACKGROUND

In 2015, Washington State Legislature added RCW 47.60.815(3) that required WSF to reject all bids that are 5% more than the engineer's estimate and issue a subsequent request for proposal that is not subject to RCW 47.60.814(1)(r) that requires ferries to be built within the boundaries of Washington State. This new requirement went into effect after July 1, 2017. The 2019 HEOC program was not required to follow this new RCW because that contract for five additional ferries was considered an extension of the original Olympic Class design-build contract, as per RCW 47.60.810(4). As a result, to date, RCW 47.60.815(3) has not been part of any completed ferry procurement program.

The re-initiated HEOC procurement process will be required to comply with this RCW requirement. The HEOC Ferry Program request for information (RFI) issued in July 2022 includes the following statement:

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[90] $191.6 million grant for new Staten Island Ferries. (17 September 2014). *MarineLog.*https://www.marinelog.com/passenger/ferries/1916-million-grant-for-new-staten-island-ferries/

[91] Blenkey, N. (18 February 2022). USDOT announces $45.3 million in ferry grants. *MarineLog.* https://www.marinelog.com/passenger/ferries/usdot-announces-45-3-million-in-ferry-grants/; Federal Transit Administration. (August 2022). FTA Ferry Programs. https://www.transit.dot.gov/grants/fta-ferry-programs

> "Note: Per RCW 47.60.815, if all responses to the initial request for proposals are greater than five percent above the WSF engineer's estimate for the project, WSF must reject all proposals and issue a subsequent RFP that is not subject to the "Build in Washington" requirement (RCW 47.60.814(1)(r))."

WSF has not provided additional details about how this new requirement will be implemented but indicated its intention to comply with the new RCW. As per the issued RFI, WSF held an industry day on October 6, 2022, that reviewed the procurement process and the main requirements in advance of the final release of the RFP. The re-initiated HEOC RFP package is expected to include details of the new process that incorporates the new 5% rule for evaluating the proposal. The industry day event participants represented both in-state and out-of-state firms (e.g., engineering/design, suppliers, shipyards).

2.3.2.2 DISCUSSION

The approach prescribed by the RCW means that bids for new WSF ferries will originally only be solicited from shipyards within Washington State. This means that there can be no basis for direct cost comparison with out-of-state bids unless a subsequent RFP is issued under the 5% rule, as discussed at Section 2.3.2.1.

The research into this topic has shown that the same or similar decision-making process is not used by other domestic or international ferry procurement programs. The State of Alaska has a procurement code, called the Alaska Bidder Preference Program, that applies a five percent preference to the price in the bid if the bidder maintains a place of business in the state. The State of Alaska awards the contract to the lowest bidder only after applying the 5% Alaskan bidder preference.[92] This type of in-state preference is a common practice in the US and can be applied to specific industries/products or broadly applied to any contract above a certain dollar figure (e.g., Nevada legislation allows for a 5% preference to an in-state contractor for bids over $250,000). Another form of legislated in-state preference in Alaska is to award in-state bidders an additional 10% of overall evaluation point preference if a numerical rating system is used, as would normally be the case in vessel procurement.[93] Washington State has taken a different approach with its procurement code by restricting the initial competition to in-state bidders, while only opening the competition to the out-of-state bidders in the follow-on stage if the initial bids are 5% higher than the WSF engineer's estimate. Tying the decision to an "internal" cost estimate rather than to actual bid prices adds uncertainty to the process due to the challenges of cost estimation, which are discussed further in Sections 2.4.4 and 3.8. The engineer's estimate is based on information provided by the bidders to the client in the RFP process, which is a subset of what

[92] The Alaska Procurement Technical Assistance Program. (August 2022). *Alaska Bidder Preference Program*. https://ptacalaska.org/procurement-tools/product-preference/#:~:text=Alaska%20Offerors%20Preference,of%20business%20in%20the%20state.

[93] National Association of State Procurement Officials. (August 2022). *State Preference Repository.* https://www.naspo.org/research-innovation/state-preference-repository/

each bidder will use to construct their own price proposal. As noted in Section 3.8, it is difficult for any external organization to predict the price a shipbuilder will offer.

While this approach may have other benefits (e.g., supporting the Washington shipbuilding industry), it may not necessarily result in the lowest cost bid that could be possible if competition is initially open to all interested US-based shipyards. Additional discussion can be found in a cost-benefit analysis of this provision written by WSIPP[94].

2.3.3 INDEPENDENT OWNER'S REPRESENTATIVE

2.3.3.1 BACKGROUND

Current practice for WSF vessel procurement with respect to employing an independent owner's representative (IOR) is defined by RCW 47.60.810, which requires that:

> "(2) … the department shall employ an independent owner's representative to serve as a third-party intermediary between the department and the proposers, and subsequently the successful proposer. … The independent owner's representative shall:
>
> (a) Serve as the department's primary advocate and communicator with the proposers and successful proposer;
>
> (b) Perform project quality oversight;
>
> (c) Manage any change order requests;
>
> (d) Ensure that the contract is adhered to and the department's best interests are considered in all decisions; and
>
> (e) Possess knowledge of and experience with inland waterways, Puget Sound vessel operations, the propulsion system of the new vessels, and Washington state ferries operations."

This requirement flows from the 2013 State Auditor's Office (SAO) report[95], which recommended:

> "Use an independent owner's representative as a third-party intermediary between WSF and its contractors. This practice would remove WSF staff from active management and oversight of the construction contract. The independent owner's representative serves as the primary point of communication between the purchaser and the shipyard, performing quality oversight activities, managing the change-order process, ensuring the project follows the contract requirements, and resolving differences between the two parties. This practice helps the purchaser adhere to a fixed-price contract by removing the temptation to make improvements using change orders during construction."

[94] See note 32 above
[95] See note 65 above

In WSF/WSDOT's review of the SAO recommendation, it was noted that "[w]e disagree with [this recommendation]. WSDOT uses a 'strong owner' model of project delivery. We don't believe that an independent owner's representative provides a proper level of review, oversight, and control of a large and complex project…"[96]

However, RCW 47.60.810 adopted the substance of the SAO recommendations.

WSF has signed a contract for the use of an IOR in the re-initiated HEOC procurement. The statement of work[97] includes the following work elements:

"The CONSULTANT shall:

1. Review all applicable RCW's, policies and procedures related to new vessel construction at WSF.
2. Meet with WSF to discuss the vessel new construction program and participate in route project team meetings.
3. Support development of the Request for Proposal.
4. Support evaluation of pre-qualification packages.
5. Monitor development of technical proposal(s).
6. Support development of the state engineer's cost estimate.
7. Provide input to program schedule and risk register.
8. Participate in evaluation of the technical and price proposals.
9. Review contractor deliverables, including detailed design, build strategy, source selection documentation.
10. Support establishment and oversight of WSF QA/QC program.
11. Monitor program cost, schedule, and performance.
12. Perform other related duties as assigned by the WSF Program Manager or Electrification Program Administrator."

The initial planned duration of this work is from September 2022 through June 2027.[98] The budget proviso for the use of this IOR is for a dedicated amount of $200,000, which is insufficient to account for scope and duration. Based on guidance received from the Attorney General's Office, WSF may use this amount to hire a single full-time employee in an advisory capacity, and this would meet the legislative intent. However, WSF is only required to spend at least this amount, and can use other funds and request increased amounts in subsequent budgets. It is also

[96] Hammond, P.J. & Marshburn, S. (27 December 2012). [Letter from WS DOT to Washington State Audit responding to the 2013 SAO audit of WSF vessel constructions costs]. Retrieved from https://results.wa.gov/sites/default/files/response-FerriesVesselConstruction.pdf

[97] WSF. (September 2022). *WSF Vessel New Construction Owner's Representative.* (Agreement Number Y-12704).

[98] See note 97 above

important to note that a review of the IOR's statement of work indicates that WSF is going to use the IOR primarily for support and not to lead the work elements described in RCW 47.60.810.

2.3.3.2 DISCUSSION

As discussed in Section 2.3.3.1, the IOR concept as described by RCW removes much of the authority over project management from the owner and assigns other essential functions to the IOR team. It is more common for many projects, for both government and private sector owners, to utilize external support to supplement in-house resources for some or all of:

- Engineering
- RFP development
- Bidder pre-qualification
- Bid evaluation
- Inspection and quality control of deliverables under some or all project implementation phases
- Technical, cost, and schedule review of design changes.

Most organizations do not retain sufficient in-house resources to provide all these services for any project.

Typically, if an engineering company is engaged to support the development of a vessel concept and to conduct or review feasibility/trade-off studies early in the project, it will be retained to provide engineering services during the RFP process; this provides continuity of knowledge. Naval architectural companies will normally have expertise in the development of technical specifications and cost estimates and can assist in the review of these aspects of design changes. The same type of approach can be used both in design-build and design-bid-build contracts, with a greater level of effort in the second case. These types of companies will also have familiarity with functions such as assessment of shipyard capabilities and contract terms and conditions, though not necessarily having specialized expertise in these areas. Similarly, the review of shipyard project plans and schedules can be undertaken by generalists or specialists. Depending on factors such as the complexity of the project and an assessment of its risks, specialized support can be important to address certain aspects of the work.

Construction supervision/inspection is a different skill set from engineering and requires significant shipyard experience, and most naval architecture/engineering companies do not have many resources in this area. Classification societies specialize in providing these services, but usually do so on behalf of the builder rather than the owner and focus on compliance with regulations and standards. Even when a classification society is engaged, an owner will still normally undertake some level of on-site supervision to ensure quality for aspects such as fit and finish, maintenance access, etc. Necessarily, this will take place mainly in the selected shipyard, and this may determine which organizations are able to offer support cost-effectively.

Best practices for how to engage support expertise are, therefore, highly dependent on the nature and location of the project, and on the capabilities of the owner's own organization. A large international operator such as Stena Lines, with a constant stream of newbuilding projects, may have little or no need for any support other than for aspects of the design work, particularly when introducing new technology such as future fuel systems. A smaller organization, such as many US ferry operators, may need support in multiple areas but may also accept lower levels of specialist knowledge in some of these to reduce cost.

A variant on the support approach can be for the owner's designer to switch to providing support for the shipyard during the construction phase. This is difficult to arrange in design-build projects, but more common in design-bid-build where it can be encouraged by owners to enable technology transfer and to maintain the continuity of the design intent. A recent example of this support approach on a design-build contract is the E-Flexer class ferries, a major project for its owner, Stena RoRo. Deltamarin assisted the owner with the initial concept design of the vessel. After the build contract was awarded to China Merchants Jinling, Deltamarin signed a design and engineering support contract with the shipyard to assist with many aspects of the build.[99]

In contrast, as part of the design-build process, the owner typically hires a design firm to assist with the preparation of the RFP package; and at the same time, the bidding shipyard also hires a different designer to be part of its bidding team. Due to conflict-of-interest concerns, the owner's designer is typically prohibited from supporting any of the bidders during the proposal phase, as this design firm was involved in the development of the bid design package. The bidder that wins the design-build contract will typically continue to use the services of the same designer that supported the proposal effort.

2.3.3.3 WSF IOR MODEL

The independent owner's representative (IOR) model proposed by the 2013 SAO report and adopted by the legislature is quite uncommon, in that it appears to delegate a very high level of authority to the IOR. The SAO report language notes an intent to "... remove WSF staff from active management and oversight of the construction contract." This wording is not repeated in the RCW itself, but the wording which is included adheres very closely to the SAO language.

As WSF retains full responsibility for the use of taxpayer funds to provide an essential service, this could incur substantial risks even if the IOR contract aims to bind the provider very tightly to all state policies and constraints. VARD's review has not found any examples where this much authority is given to a third party other than when public-private partnership models are used – and these are quite unusual in shipbuilding.

[99] Deltamarin. (5 April 2016). *Deltamarin designs and supports construction of Stena Ferry to be built in China*. https://deltamarin.com/2016/04/deltamarin-designs-supports-construction-stena-ferry-built-china/

It is notable that the actual scope of the IOR RFAI quoted in Section 2.3.3.1 uses rather different language to the RCW and refers to "support" and "monitor" for activities. In VARD's opinion, these are more appropriate roles for external contractors than direct management of projects. If the owner is altogether lacking in project management capability, there may be a case for hiring suitably qualified personnel directly into the organization.

According to the signed professional services agreement with Art Anderson Associates for IOR service for the HEOC program, this firm will be supporting, monitoring, providing input, participating and/or reviewing at every stage of the procurement process, in addition to any other duties that may be assigned by the WSF. However, the firm is not given any authority. This scope of work is in line with best practices for the use of an IOR as discussed in detail in Section 2.3.3.2.

2.3.3.4 COSTS AND SAVINGS

The objective of this sub-section is to quantify the typical costs and potential savings of using an IOR in design-build contracting; however, this is not a simple task.

In general, when an organization contracts out any of its functions, a main driver is to avoid the carrying cost of sustaining capability between programs or projects. For example, if a ferry operator needs to develop a concept design for a new vessel once every five years, then for four out of five years the design team will be an overhead cost. Using the same personnel for other functions is possible, but concept design is a specialized skillset which needs to be exercised regularly.

This element of the overall process is not explicitly part of the IOR's mandate as defined in the RCW or as interpreted by WSF, but this and other elements of engineering support are implied. The review of design deliverables in both the proposal and implementation phases requires a multi-disciplinary team with expertise in areas such as structural, mechanical, electrical, and outfitting design. As noted in Section 2.3.3.2, normally the same organization involved in initial design would undertake this work to provide continuity; having an IOR separate from this will not be efficient.

The level of effort involved in engineering review is not necessarily continuous but will be tied to the schedule of design reviews and submissions. Similarly, the technical and price review of shipbuilder proposals is a one-off event. It is assumed that verification of regulatory compliance will be left to USCG and/or a classification society, and any direct risks associated with non-compliance will be wholly the responsibility of the shipbuilder.

During the build phase, the level of supervision and inspection on the owner's behalf will change in nature and level of effort as the work proceeds. In early stages, most work involves steel fabrication. Later, systems installation and set-to-work predominates. For a vessel of the size and complexity of the HEOC, an on-site team of three to four personnel from various disciplines would be typical for the period of maximum shipyard activity, which could be 12-18 months.

The project management functions of the IOR will also be partly continuous and partly intermittent and will depend on the level of authority assigned. Overall, the owner can expect to require a full-time project manager assigned over the course of prequalification, RFP development, proposal, and implementation. An experienced planner/scheduler is important both for internal planning and to monitor bidder/builder progress. Administrative support is also advisable. All of these are required whether or not the IOR is "in charge", so the costs should be accounted for in overall project budgeting.

The total cost associated with all the work summarized above in VARD's experience and judgement is likely to be in the order of 5-10% of total project cost, depending on the balance between contractor and in-house effort. Using in-house resources will often appear to be the cheaper option but as noted above, this may require the owner organization to sustain a larger permanent staff to be able to provide effective project expertise.

The level of cost saving from using an IOR rather than in-house staff is also difficult to quantify. The claim from the 2013 SAO report that using an IOR "helps the purchaser adhere to a fixed-price contract" (see Section 2.3.3.1) is not necessarily valid and appears to be based on poor experience with large design changes in the Kwa-di Tabil Class. In contrast, the Olympic Class saw few major design changes and good adherence to the original, fixed price contract value. Very often, a project which is expedited and not fully planned at its outset, such as the Kwa-di Tabil Class, will present more challenges.

The other elements of work assigned to the IOR and/or owner should be considered necessary costs for risk management and mitigation. It is essential that for WSF ferry projects:

i. Technical, schedule, and quality requirements are properly defined
ii. Capable builders are pre-qualified
iii. The selected builder demonstrates a feasible design, schedule, and project plan
iv. The resulting vessels meet the technical and performance requirements
v. Cost and schedule are maintained.

While direct responsibility for items (iii) to (v) can be assigned to the builder, the impacts of failure to perform will still be borne by WSF and its clients, potentially over the whole life of the vessels. A competent owner's team – under whatever approach is adopted – should be considered as prudent insurance against major failures in the builder's cost, schedule, and quality control.

2.3.4 SMALL BUSINESS ENTERPRISE REQUIREMENT

2.3.4.1 BACKGROUND

Many governments (at all levels of government) have requirements in their procurement approaches to set aside some level of involvement for targeted types of businesses. These types of provision have proven success in expanding the participation of chosen groups in the types of

economic activity covered by the approach.[100] In Washington State, the Roadmap to Contracting Equity provides an overall framework within which agencies operate, see Figure 2-2. This provides the goals which procurement contracting approaches are expected to achieve.

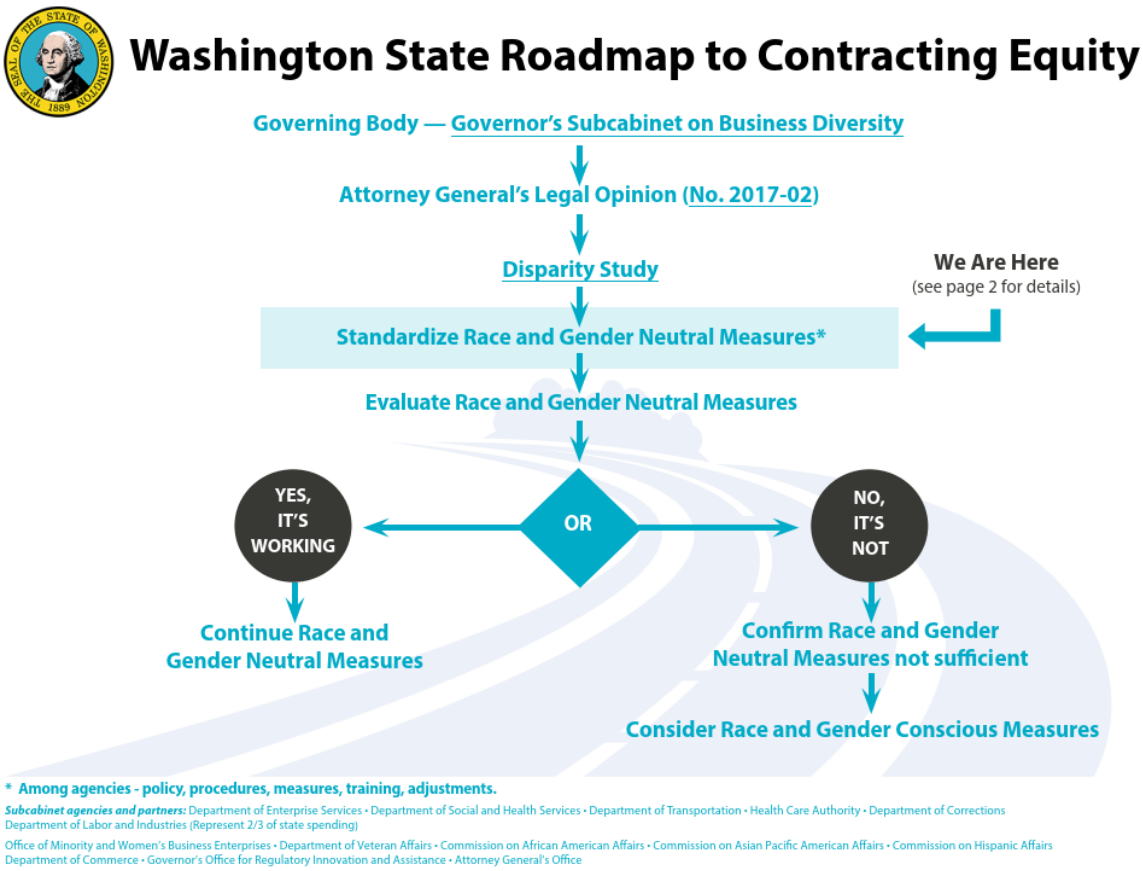

Figure 2-2: Washington State Roadmap to Contracting Equity[101]

In 2019, the Washington State Legislature established the Small Business Enterprise (SBE) program with enforceable goals via RCW 47.60.835. In the case that the prime contractor cannot meet the enforceable goal, evidence must be collected and submitted that demonstrates good faith efforts to meet the established contract goal. The Olympic Class contract (parts A and B) was

[100] The White House. (1 December 2021). *The Benefits of Increased Equity in Federal Contracting*. https://www.whitehouse.gov/cea/written-materials/2021/12/01/the-benefits-of-increased-equity-in-federal-contracting/

[101] Office of Minority and Women's Business Enterprises, Washington State. (August 2022). *Washington State Roadmap to Contracting Equity* [PowerPoint Slides]. https://omwbe.wa.gov/sites/default/files/Roadmap-to-Contracting-Equity.pdf

not subject to the SBE program because it was signed before this RCW requirement came into force. It is important to note that the Olympic Class ferries contract did include in the general conditions, in Exhibit 8, the clause about Minority and Women-owned Business Enterprise (MWBE) participation. However, this was a voluntary participation program, while the SBE program is mandatory.

The 2019 HEOC project was subject to small business preference requirements. In the proposed Vigor contract these were set at an overall enforceable goal of 8%, with a more detailed breakdown as shown in Table 2-3. The RFI for the re-initiated HEOC project retains the same overall 8% goal but does not include a breakdown at this stage in the procurement process.

Table 2-3: Proposed SBE Goals, Vigor HEOC[102]

	SBE Goal Percent
Detailed Design	19%
Long Lead Materials	1%
Construction	10%

As part of the Washington State approach, qualifying SBEs are limited to those headquartered in the state and registered under the specific state criteria.

2.3.4.2 DISCUSSION

Any system of preferences imposes constraints and may increase costs.[103] The impacts can be minimized, particularly in the longer term, if programs are designed to create a sustainable ecosystem for the businesses involved. This can be difficult for any aspects of ship procurement. Many world-leading shipbuilders are vertically integrated and handle the great majority of work in-house. Breaking out elements of this to incorporate SBEs can be disruptive and runs the risk of replacing experienced personnel with others unfamiliar with shipyard practices. As an example, the Fincantieri/ VARD Group shipyards, based in Europe, undertake most engineering in-house in all project phases, including detailed design. Replacing experienced designers with SBE subcontractors would not work well. By contrast, many US shipyards contract out much of their engineering work and so are better placed to accommodate SBE requirements for this element of a project.

Equipment is generally procured from suppliers external to the shipbuilder. However, most major equipment that will be installed on many vessels will come from international suppliers, where just a few large companies compete in most segments of the market. They are not particularly

[102] WSF. (11 December 2021). New 144 - Auto Ferries Design-Build Contract No. 00-6674 Part D (Draft).
[103] Hoffer, A.J. and Sobel, R.S. Preference policies: perpetual costs of distributive policies. *Journal of Public Finance and Public Choice*, Vol 33.2 pp183-196.

interested in adjusting their supply chains to accommodate relatively small projects in a small market, such as WSF shipbuilding. Therefore, it can be more effective to handle some issues of diversity, equity, and inclusion (DEI) at the shipyard's corporate hiring, training, and human resource development levels, potentially including apprenticeship programs such as that in place at Vigor.[104]

It is notable that in the negotiations for the HEOC under the initial strategy of continuation of the build program with Vigor, the shipyard considered this to be a very high-risk area (highest scored risk) for project implementation, despite meeting the 8% target during the functional design phase of the project and having considerable lead time to develop its strategy in this area while in dialogue with the client.[105]

Creating supply chains with SBE participation requires continuous procurement activity, which is not the case for WSF. WSF may be able to use its maintenance and preservation programs to create SBE capacity for certain types of work and could then encourage or require the use of these companies in newbuilding programs, where appropriate. As much of the shipyard work in Washington is for the federal government, it may also be advisable for the state to consider allowing both federal and state certified SBEs to participate in WSF contracts, which would also mitigate problems if a project moves from Build In Washington to nationwide as a result of cost or other issues.

2.3.5 HONORARIUM

2.3.5.1 BACKGROUND

RCW 47.60.820(8), passed in 2001, states that WSF may provide an honorarium to reimburse each unsuccessful phase three proposer for a portion of its technical proposal preparation costs at a pre-set, fixed amount that will be specified in the RFP package. RCW 47.60.824, added in 2007 and specific to the case of a single bidder or joint bidders, states that WSF may provide an honorarium to those who submitted a final, approved technical proposal and with whom WSF has engaged in unsuccessful negotiations.

The Olympic Class RFP package included a document called "Volume II Phase II - Technical Proposal Requirements" that contains a section called "Proposer's Honorarium". This section states the conditions that must be met to receive an honorarium, a fixed amount of $500,000 to each proposer. [106] It is unclear if an honorarium was previously paid out by WSF.

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[104] Vigor Industrial LLC. (August 2022). *Workforce Development*. https://vigor.net/workforce-development
[105] Vigor Industrial LLC. (May 2021). *Project Management Review (PMR) WSF HEOC Project – ME MAY 2021* [PowerPoint slides].
[106] WSF, WSDOT. (July 2006). 144-Auto Ferries Design and Build No. 00-6674 - Volume II Phase II Technical Proposal Requirements.

The HEOC Ferry Program RFI issued in July 2022 requested industry feedback on the adequacy of honorarium for unsuccessful proposers.[107] The 2022 HEOC RFI also includes the following statement about the planned honorarium:

> "Honorarium: Proposers may include the costs of Technical Proposal development in their Phase Three price proposals. Proposers that deliver an approved Phase Two Technical Proposal and Phase Three bid, but are not awarded a contract, will be awarded an honorarium intended to cover a portion of their costs. The honorarium amount will be specified in the RFP but is tentatively planned to be $2 million for each acceptable Technical Proposal."

According to the WSF preliminary budget estimate from May 2022, the honorarium for the next 124-auto ferry procurement is going to be around $8 million per technical proposal, and, for budgeting purposes, it was assumed that two proposers will receive this amount each.[108]

2.3.5.2 DISCUSSION

The purpose of the honorarium payment is to partially compensate the unsuccessful bidders for the design work that was required to develop the bid in phase three. This financial incentive is meant to promote more competition as far into the procurement process as possible to ensure that the owner receives the best value possible.

According to the 2022 HEOC Ferry Program RFI, the bidders for the HEOC production design and construction contract will receive the USCG-approved drawings, an owner's model shipyard specification, and other relevant design data. This is a mature functional design developed under the since-cancelled contract, and it is not expected that the same level of design will be provided to the bidders for the 124-auto ferry program with the RFP package[109]. For this reason, the eligible unsuccessful bidders for the re-initiated HEOC contract will receive a much smaller honorarium based on the lesser design effort that is expected of them.

In general, the cost to develop a bid goes up with the level of detail that is required. The level of design that WSF expects from bidders is greater compared to other ferry operators, like BC Ferries, that also use the design-build approach. WSF expects functional design level details to be developed for its bids. However, BC Ferries, for example, does not expect the same design level from bidders. Furthermore, although BC Ferries can offer honorariums, historically, this ferry operator has only done so for a recent major upgrade program, not newbuilds. Also, BC Ferries has a planned approach to offer an owner's model in the next major procurement program to reduce the bidder's upfront cost and make an honorarium unnecessary.

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[107] See note 71 above

[108] WSF. (May 2022). *WSF 124 Auto Ferry Estimate* [Unpublished spreadsheet].

[109] USCG typically does not review/approve plans at the proposal development stage. The HEOC functional design drawings were reviewed and approved by USCG under the previous Vigor contract signed in 2019.

The market conditions are not the same for US and international shipyards. BC Ferries accepts international bids, and, as a result, can choose not to offer an honorarium, while still expecting to receive enough bid responses. WSF, however, can only accept bids from Washington shipyards, and is allowed to accept bids from out-of-state US-based shipyards only if the in-state procurement exceeds the 5% threshold, as discussed in Sections 2.3.1 and 2.3.2. These requirements significantly limit the number of potential bidders. This limitation means that WSF has to offer an honorarium to get enough competitive bid responses from US shipyards that typically do not have large in-house design teams with a concept design skill set. For a US shipyard, it is typically more challenging and expensive to respond to design-build contracts. To effectively estimate the work and develop a bid, the US shipyards employ an outside design agent to develop a design to a suitable level for costing and risk assessment.

2.3.6 THROUGH LIFE COST OPTIMIZATION

2.3.6.1 LIFE CYCLE COST MODEL

RCW 47.60.345 (introduced in 2008) requires that WSF maintain a life cycle cost model on capital assets that are replaced in a cycle (such as ferries) so that it is possible to estimate the life expectancy of the asset and adjust that estimate when condition surveys are complete. It requires that the assets be inspected, and the estimate updated at least every three (3) years. That life cycle cost model should be used to estimate future preservation work and associated budget requests.

WSF maintains a life cycle cost model as required, however, each ferry in the fleet is broken down into a number of line items with costs determined by the major cost drivers, but which does not include every piece of equipment and outfitting on the ships which must be maintained. This model is mostly used for preservation funding requests and to prioritize investments. However, use of the life cycle cost model has informed future vessel requirements by highlighting high-cost drivers, reliability, and commonality.[110]

2.3.6.2 VESSEL DESIGN STANDARDS

RCW 47.60.365 (introduced in 2010) requires that WSF develop vessel design standards that:

> "(1) Adhere to vehicle level of service standards as described in RCW 47.06.140;
>
> (2) Adhere to operational strategies as described in RCW 47.60.327; and
>
> (3) Choose the most efficient balance between capital and operating investments by using a life-cycle cost analysis."

As noted in Section 2.4.6.2, the WSF VEM includes a number of design standards, but these are not a very complete or current list.

[110] See note 45 above

While in some cases a design standard may be able to balance capital and operating cost for a series of projects, it can often be more appropriate to consider this balance on a project-specific basis. Section 2.4.7.1.2 gives examples of both approaches.

2.3.6.3 PREDESIGN STUDY REQUIREMENTS

RCW 47.60.385 (introduced originally in 2007 and updated in 2010) requires that vessel acquisition project funding requests be submitted with a predesign study that:

> "(a) Includes all elements required by the Office of Financial Management;
>
> (b) Separately identifies basic terminal and vessel elements essential for operation and their costs;
>
> (c) Separately identifies additional elements to provide ancillary revenue and customer comfort and their costs;
>
> (d) Includes construction phasing options that are consistent with forecasted ridership increases;
>
> (e) Separately identifies additional elements requested by local governments and the cost and proposed funding source of those elements;
>
> (f) Separately identifies multimodal elements and the cost and proposed funding source of those elements;
>
> (g) Identifies all contingency amounts;
>
> (h) Identifies any terminal, vessel, or other capital modifications that would be required as a result of the proposed capital project;
>
> (i) Includes planned service modifications as a result of the proposed capital project, and the consistency of those service modifications with the capital plan; and
>
> (j) Demonstrates the evaluation of long-term operating costs including fuel efficiency, staffing, and preservation."

RCW 47.60.386 (introduced in 2010) requires predesign studies in addition to those specified in RCW 47.60.385 for initial requests, and substantial modification requests to, vessel acquisition funding that:

> "(1)(a) Includes a business decision case on vessel sizing;
>
> (b) Includes an updated vessel deployment plan demonstrating maximum use of existing vessels, and an updated systemwide vessel rebuild and replacement plan;
>
> (c) Includes an analysis that demonstrates that acquiring a new vessel or improving an existing vessel is more cost-effective than other alternatives considered. At a minimum, alternatives explored must include:

(i) Alternatives to new vessel construction that increase capacity of existing vessels;

(ii) Service level changes in lieu of adding vessel capacity; and

(iii) Acquiring existing vessels or existing vessel plans rather than wholly new vessels or vessel plans; and

(d) Demonstrates that the vessel proposed for improvement, construction, or purchase, if intended to replace an existing vessel or to place an existing vessel into inactive or reserve status, is consistent with the scheduled replacements in the rebuild and replacement plan."

"(2)(a) An explanation of any regulatory changes necessitating the improvement;

(b) The requirements under subsection (1) of this section, if the improvement modifies the capacity of a vessel;

(c) A cost-benefit analysis of any modifications designed to improve fuel efficiency, including potential impacts on vessel maintenance and repair; and

(d) An assessment of out-of-service time associated with making the improvement and ongoing preservation of the improvement."

The processes that have been used by WSF to comply with these RCWs are discussed in Section 3.6.4.

2.4 WSF'S P&P

2.4.1 INTRODUCTION

WSF has documented and undocumented polices and practices for ferry procurement. Where documentation of policies does exist, it was assessed and categorized in Section 2.4.2 as being either consistent, partially consistent, or inconsistent with RCW legislation and WAC regulations. VARD has used the legislation identified in Section 2.2.3 to help identify where it is expected some P&P would exist and then reviewed WSF documentation to see where and if these are described. The results of this gap analysis are presented here in Section 2.4.2.1.

In many organizations, standard practices include the use of current or recent project documentation as templates for planned projects, adapting these to changes in project scope and circumstances. This can be an efficient use of resources, provided that changes to underlying requirements are identified by the project team. This project documentation, like the RFP instructions for different procurement phases, is not considered a part of WSF documented policies; however, it was developed by WSF in accordance with the applicable legislation and regulations. VARD has used this project documentation from the recent acquisition programs detailed in Section 1.8 to compare WSF's demonstrated practices to the legislation and regulations identified in Section 2.2.3. The results of that gap analysis are presented in Section 2.4.2.2.

WSF is a division of WSDOT. The department has published many policy documents, such as the Cost Estimating Manual for Projects and Project Risk Management Guide, and these cover topics including cost estimating, risk management, and other policies and practices that are common to any engineering project. In general, this documentation contains policies and practices that are compliant with the state and federal statutes and are applicable to all construction projects. The WSDOT P&P also contain a substantial amount of more specific guidance and examples, but all of this material is related to civil engineering work and little or none of it is directly useful for ferry procurement.

Some of WSF's own P&P are laid out in its Vessel Engineering Manual (VEM). This is a WSF-specific manual meant to be the primary guidance document for use by vessel engineering personnel for both procurement and maintenance. Elements of the manual are currently in use; however, it has not been updated at all since 2012, or substantively since 2002 due to resourcing constraints.[111] WSF has provided VARD a list of the chapters that are most relevant to new vessel projects, and in the materials below additional relevant elements are reviewed in more detail.

Section 2.4.2.1 groups the documented WSF policies found in the VEM into four areas:

- Consistent – meaning documented WSF policies are consistent with the RCW
- Partially Consistent – meaning part of the legislative requirements were found in documented WSF policies but some were missing
- Inconsistent – meaning documented WSF policy differs from the RCW
- Not Documented – meaning no content found in documented WSF policies which aligned with RCW or WAC.

2.4.2 COMPARISON TO LEGISLATION

2.4.2.1 WSF'S DOCUMENTED POLICIES

Table 2-4, Table 2-5, and Table 2-6 provide the documented WSF policies found in the WSF Vessel Engineering Manual (VEM). This analysis focused on the review of key RCW statutes 47.60.810 through 47.60.824.

2.4.2.1.1 CONSISTENT

Table 2-4: WSF Documented Policies Consistent with Legislation

Legislation	WSF's P&P	Summary
RCW 47.60.810 (1) WSF must use 3-phase design build process	VEM, Chapter 4,	VEM specifies that auto ferries should be purchased through a modified RFP using a Design and Build Partnering Process.

[111] WSF. (December 2012). *Vessel Engineering Manual* (M 68-03). Seattle, WA: author.; See above 45 note

Legislation	WSF's P&P	Summary
	Section 3-2, B-2	
RCW 47.60.818 (3) WSF can modify RFP elements with written addenda.	VEM, Chapter 3, Section 3-4, B-2	VEM requires that substantive bidder questions shall be issued as an addendum to the bid package.
RCW 47.60.820 (7) In phase three, if the proposer fails to enter into contract and furnish satisfactory contract security required by chapter 39.08 RCW, its deposit is forfeited.	VEM, Chapter 3, Section 3-4, C	VEM requires security to be completed in accordance with RCW 39.08 and that the bidder has 20 days.

2.4.2.1.2 PARTIALLY CONSISTENT

Table 2-5: WSF Documented Policies Partially Consistent with Legislation

Legislation	WSF's Document	P&P Summary
RCW 47.60.815 (2) When developing the engineering estimate, WSF must identify significant cost drivers.	VEM, Chapter 2, Section 2.8, E	VEM includes the requirement to complete an engineer's estimate but does not include reference to the cost drivers.
RCW 47.60.816 (2) In phase one, the RFP must require that each proposer prequalify under chapter 468-310 WAC, which states in Section 050 (3) that each proposer will provide a letter of commitment.	VEM, Chapter 3, Section, 3-2, A	VEM requires that contractors should pre-qualify in accordance with RCW and WAC requirements, although it does not state when in the process this should be carried out.

Legislation	WSF's Document	P&P Summary
RCW 47.60.820 (6) In phase three, WSF may award the contract to the lowest priced responsive and responsible proposer; if that doesn't work out, award the contract to the next lowest responsive and responsible proposer; if that doesn't work out, repeat for each proposer until the list is exhausted.	VEM, Chapter 3, Section 3-4, C	VEM includes detail that the lowest responsible proposer should be selected, however it does not include the additional detail on what to do if proposer does not sign.

2.4.2.1.3 INCONSISTENT

Table 2-6: WSF Documented Policies Inconsistent with Legislation

Legislation	WSF's P&P	Summary
RCW 47.60.812 WSF shall publish a notice of its intent once a week for at least two consecutive weeks in at least one trade paper and one other paper, both of general circulation in the state. Select content must be included in the notice.	VEM, Chapter 3, Section 3-4, B VEM, Chapter 3, Section 3-6	Both VEM sections have different requirements for duration and number of locations that an intent to issue RFP should be published. No detail on the required content of notice.
RCW 47.6.815 (3) If all responses to the initial RFP are greater than 5% above the engineer's estimate, the department must reject them all and issues a new RFP.	VEM, Chapter 3, Section 3-4, C	The VEM is inconsistent, discusses 10% rather than 5% and does not mention having to restart without the in-state build requirement.

2.4.2.1.4 NOT DOCUMENTED

The following RCWs are not addressed within WSF's documented P&P:

- RCW 47.60.810 (2), Throughout the three phases, WSF shall employ an IOR.
- RCW 47.60.810 (3), Defines phases one, two, and three.
- RCW 47.60.810 (4), Allowed WSF to modify an existing option contract executed prior to July 6, 2015, to allow for the purchase of up to five additional 144-auto ferries.
- RCW 47.60.814 (1), WSF shall issue an RFP that includes these 20 items.
- RCW 47.60.814 (2), WSF shall not issue an RFP for the procurement of vessels without specific authorization from the legislature. Includes an exception for the HEOC 2019 program.
- RCW 47.60.816 (1), In phase one, WSF shall issue an RFP.
- RCW 47.60.816 (3), WSF may use some or all of the nonfinancial prequalification factors as part of the evaluation factors in phase one to enable the selection of best qualified proposers for phase two.
- RCW 47.60.816 (4), In phase one, WSF shall evaluate submitted proposals in accordance with the selection criteria stated in the RFP.
- RCW 47.60.816 (5), In phase one, upon concluding its evaluation of proposals, selection of the best qualified proposers must be made in accordance with the selection criteria state in the RFP.
- RCW 47.60.818 (1), In phase two, proposers develop technical proposals in accordance with the RFP and must include these 4 items.
- RCW 47.60.818 (2), In phase two, WSF shall conduct periodic reviews with each proposer to consider and critique their design, drawings, and specification.
- RCW 47.60.818 (4), In phase two, proposers must submit final technical proposals for approval and WSF shall reject those that modify, fail to conform to, or are not fully responsive and in compliance with the RFP.
- RCW 47.60.820 (1), In phase three, WSF shall request bids for detailed design and construction of the vessels after review of the technical proposals in phase two is complete.
- RCW 47.60.820 (2), In phase three, each proposer must submit its total bid price for all vessels.
- RCW 47.60.820 (3), In phase three, a deposit in an amount specified in the RFP must be accompany each bid.
- RCW 47.60.820 (4), In phase three, WSF shall evaluate the bids.
- RCW 47.60.820 (5), In phase three, WSF may waive informalities in the proposal and bid process, accept a bid from the lowest responsive and responsible proposer, reject any or all bids, republish, and revise or cancel the RFP.
- RCW 47.60.820 (8), WSF may provide an honorarium to each unsuccessful phase three proposer.

- RCW 47.60.820 (9), In phase three, to accommodate change orders on a fixed price contract, WSF shall request that the legislative appropriation include a contingency of 5-10% of the contract price, depending on the vessel type.
- RCW 47.60.822 (1), WSF shall immediately notify those proposers that are not selected to participate in the development of technical proposals in phase one and those proposers who submit unsuccessful bids in phase three.
- RCW 47.60.822 (2), Aggrieved proposers may file an appeal with the superior court of Thurston County within five days of receiving notice of WSF's award decision in phase three.
- RCW 47.60.824, Directions for negotiations if there is only a single best-qualified proposer participating prior to the submission of bids in phase three, or if there is only a single responsive and responsible bit submitted in phase three, or if the current best-qualified proposer elect to jointly submit a single proposal.
- WAC 468-320-010, General requirements for contract security for the construction, maintenance, or repair of a marine vessel.
- WAC 468-320-030, Calculation of the state's exposure to loss.

2.4.2.2 WSF'S PRACTICES

In this chapter, past compliance with legislation was assessed using available project documentation that was developed and used for completed and ongoing procurement programs, as provided by WSF, and reviewed by VARD.

It is important to note that evidence of the existence of compliant project documentation and the completion of procurement programs was not interpreted as sufficient evidence that WSF fully complied with relevant legislation and regulations. Sections 2.4.2.2.2 and 2.4.2.2.3, which detail partial compliance and where compliance is inconclusive, respectively, note what additional evidence is required to confirm compliance. According to WSF, some additional evidence may exist only in hard copy. As per JLARC's direction from 9 September 2022 to "focus on leading practices and 'what should be' going forward"[112] and to complete the remaining work without the hard copies, VARD reviewed the documents provided so far and updated this section according to the latest evidence on hand as of December 2022.

This gap analysis focused on the review of key RCW statutes 47.60.810 through 47.60.824.

The sections and tables below group evidence of WSF's documented P&P into four categories:

- Compliant – WSF's practices are compliant with the given RCW and/or WAC
- Partially compliant – WSF's practices are partially compliant with the given RCW and/or WAC
- Non-compliant – WSF's practices are noncompliant with the given RCW and/or WAC

[112] Whitaker, E. (9 September 2022). [email from Eric Whitaker at JLARC to Angelique Davis at VARD with subject "*Outstanding Items*"].

- Inconclusive – the compliance of WSF's practices with the given RCW and/or WAC cannot be determined.

The major pieces of evidence used to demonstrate WSF's compliance in the following sections and tables include the following procurement programs (see Section 1.8 for more detail):

- 130/144-car Olympic Class ferries awarded in 2007 ("144")
- 64-car Kwa-di Tabil Class ferries awarded in 2008 and 2009 ("64")
- Hybrid-electric Olympic Class ferries awarded in 2019 ("HEOC 2019")
- Hybrid-electric Olympic Class ferries to be re-bid in 2022 ("HEOC 2022").

Interviews were also conducted with WSF staff and others with knowledge of the recent procurement programs to assess actual practice and answer questions arising from the documentation. As detailed in Section 1.1.2, see supporting file 444-000-04c for more information about the interviews conducted as part of this project.

WSF is currently beginning a new procurement program for the HEOC and will be following some RCWs for the first time. Therefore, there is not yet evidence that WSF practices comply or do not comply with these new RCWs, and they are currently deemed inconclusive. At the time of this report, WSF has published in July 2022 an RFI for the HEOC ferry program which also provides notice of the RFP which is expected to be issued in late 2022. WSF issued an RFAI in July 2022 for proposals to provide an Owner's Representative for the HEOC design-build program. Subsequently, in September 2022, WSF entered a service contract with Art Anderson Associates for IOR service for the HEOC program.[113]

2.4.2.2.1 COMPLIANT

Federal regulations, as listed in Section 2.2.3, are almost exclusively complied with by inclusion in terms and conditions which are flowed down to the builder and its subcontractors, and therefore have not been included in Table 2-7 below.

Table 2-7: Evidence of WSF Complying with Washington State Law

Legislation	Contract	Evidence
RCW 39.04.300 The purpose of apprenticeship training programs.	144, 64, HEOC 2019	In 2007, the Washington Legislature required WSDOT, including WSF, to comply with the Apprenticeship Act by placing an apprenticeship requirement in its construction contracts. WSF complied. At the time, only Todd Pacific (Vigor) Shipyards qualified based on having a state-certified apprenticeship program.
RCW 39.04.310 Definitions with respect to the		

[113] See note 97 above

Legislation	Contract	Evidence
apprenticeship training programs used in this section, RCW 39.04.300, and 39.04.320.		
RCW 39.04.320 Apprentices' utilization rates for contracts subject to this section, including monitoring and reporting requirements.		
RCW 47.60.810 (1), (3) (1) WSF may use a modified RFP when purchasing new auto ferries. Includes an exception for the HEOC 2019 program. (3) Defines phases one, two, and three.	144	WSF followed the modified RFP process for the four Olympic Class, it includes the three phases of the design-build process
RCW 47.60.810 (2) Throughout the three phases, WSF shall employ an IOR.	HEOC 2022	This section of the RCW was published in 2015, in response to the 2013 State Auditor's Office report, and did not apply to any past ferry procurement contracts. WSF has stated that they plan to hire an independent owner's representative (IOR) for the future HEOC program. The signed professional services agreement with Art Anderson Associates for IOR service for the HEOC program was provided that included a description of the final scope of work.[114]

[114] See note 97 above

Legislation	Contract	Evidence
RCW 47.60.812 WSF shall publish a notice of its intent once a week for at least two consecutive weeks in at least one trade paper and one other paper, both of general circulation in the state.	144, 64	WSF published a newspaper notice of intent to issue an RFP for the 130/144-auto ferries in 2003. The 130/144 RFP included a Newspaper Notice that contained the information required by this RCW. The notice was published once a week for at least two consecutive weeks in at least one trade paper and one other paper (both of general circulation in the state). Notices were published in the Seattle Daily Journal of Commerce[115], The Seattle Times[116], Marine Log magazine, Marine News magazine, Maritime Reporter and Engineering News magazine, and Pacific Maritime magazine.[117]On 1 August 2022, WSF published in the online industry journal WorkBoat the RFI for the 2022 HEOC procurement program, including notice of its intent to issue the RFP in October 2022.[118]
RCW 47.60.814 (1) WSF shall issue an RFP that includes these 20 items.	144	No RFP was issued for the HEOC program in 2019 because it was considered an extension of the original Olympic Class design-build contract. 144-class RFP, developed by WSF, included documents with instructions, descriptions, and requirements which comply with 47.60.814 (1) items (a) to (t). Items (i) and (s) were added in 2015, so compliance to these requirements was not required when 144 RFP documents were developed.
RCW 47.60.814 (2) WSF shall not issue an RFP for the	HEOC 2022	This section of the RCW does not apply to ferry procurement before July 6, 2015 (effective date of this section).

[115] WSF. (2 December 2003). *Letter to Seattle Daily Journal of Commerce Re RFP Advertisement* (D220815.T081017-002);

[116] WSF. (2 December 2003). Letter to Seattle Times Re RFP Advertisement (D220815.T081017-001).

[117] WSF. (18 December 2003). *List of Publications for Project Advertisement* (D220815.T081017-003).

[118] WorkBoat. (1 August 2022) *Washington State Ferries' Journey to Hybrid Electric.* https://www.workboat.com/washington-state-ferries-journey-to-hybrid-electric#:~:text=Washington%20State%20Ferries%20(WSF)%20is,gas%20emissions%2076%25%20by%202040.

Legislation	Contract	Evidence
procurement of vessels without specific authorization from the legislature. Includes an exception for the HEOC 2019 program.		WSF issued an RFI to begin the process on July 14, 2022, after the 2022 Washington Legislature provided authorization for re-bid of HEOC[119].
RCW 47.60.815 (2) When developing the engineering estimate, WSF must identify significant cost drivers.	HEOC 2019	WSF used Glosten to create the HEOC First Vessel Cost Estimate[120]. This cost estimate identified significant project cost drivers, including materials, labor, overhead, delivery, and profit, as required by this 2015 RCW.
RCW 47.60.816 (1) In phase one, WSF shall issue an RFP.	144, 64	WSF issued RFPs for Olympic Class and Kwa-di Tabil Class
RCW 47.60.816 (2) In phase one, the RFP must require that each proposer prequalify under chapter 468-310 WAC, which states in Section 050 (3) that each proposer will provide a letter of commitment.	144	WSF proposed that the contractor, in lieu of the maximum rating criteria that was required by WAC 468-310, would submit evidence of the ability to obtain Contract Security in the amount to protect 100% of WSF's exposure to loss associated with the Vessel Construction Contract. A hearing on the rule change was held on April 27, 2004, and the rule change was effective in June 2004. This rule change was allowed by a proviso in this section of RCW 47.60.816 to maximize competition among financially capable and otherwise qualified proposers. 144 RFP Addendum #6 notes that the revised WAC rules regarding Financial Prequalification Requirements will become effective on June 5, 2004, and that the revised rules are the same as presented as an attachment to CR 102, Proposed Rule Making, which WSF distributed and discussed at a public comment hearing on April 27, 2004.

[119] See note 71 above
[120] Glosten. (10 September 2021) *HEOC Construction Estimate and Risk Analysis* (17044.4).

Legislation	Contract	Evidence
		144 RFP Addendum #7 notes the due date for receipt of Letters of Commitment for Contract Security. WSF provided Shipyard Financial Prequalification Analysis for 144 Auto Ferries RFP that shows that the bidders were required to submit financial information that was used to assess their ability to obtain Contract Security in the amount to protect 100% of WSF's exposure to loss associated with the Vessel Construction Contract.[121] WSF also provided a document entitled, "Information and instructions for Prequalification of Bidders" that was revised in 2010. This document details the WSF-specific prequalification requirements including those related to WAC 468-310.[122]
RCW 47.60.816 (3) WSF may use some or all of the nonfinancial prequalification factors as part of the evaluation factors in phase one to enable the selection of best qualified proposers for phase two.	144	144 RFP package includes the documents called "008 Prequalification", "Phase I Proposal Instructions", and "Phase I Proposal Requirements" that provide information on development and submittal of Phase I proposals. WSF provided the Letter to Proposers from October 2005 that was sent to all the three pre-qualified shipyards that informed them of their status and provided instructions for the next phase of the RFP.[123] Also, WSF provided the Shipyard Financial Prequalification Analysis for 144 Auto Ferries RFP that included the financial information for each bidders that was used as part of the evaluation factors in phase one to enable the selection of best qualified proposers for phase two. [124]
RCW 47.60.816 (4) In phase one, WSF shall evaluate	144	144 RFP package includes the document called "Phase I Proposal Evaluation" that gives details about the proposal evaluation factors.

[121] WSF. (2004). WSF's Shipyard Financial Prequal Analysis For 144 Auto Ferries RFP – 2004 Draft. (D221110.T115337-001)
[122] WSF (2010) Instructions & WAC 468-310. (D221110.T115329-002 670-079)
[123] WSF. (October 2005). Letter of Proposers. (D221110.T115418)
[124] See note 121 above

Legislation	Contract	Evidence
submitted proposals in accordance with the selection criteria stated in the RFP.		WSF provided as evidence a letter, dated October 8, 2004, and sent to one of the 144 RFP bidder, Martinac Shipbuilding Corporation, requesting additional information in the form of a Cash Flow Plan. WSF requested this plan to evaluate the financial capability of the bidder and determine the bidder's final prequalification status.[125]
RCW 47.60.816 (5) In phase one, upon concluding its evaluation of proposals, selection of the best qualified proposers must be made in accordance with the selection criteria state in the RFP.	144	144 RFP package includes the document called "Phase I Proposal Evaluation" that gives details about the basis for selection. In 2005, WSF completed the prequalification process in Phase I, issuing notices of prequalification and best qualified status to the following three shipyards: J.M. Martinac Shipbuilding Corp, Nichols Brothers Boat Builders, Inc., and Todd Pacific Shipyards Corp.
RCW 47.60.818 (3) In phase two, WSF may modify the RFP by written addenda to the RFP.	144	For the 144 RFP, numerous written addendums were published to revise the RFP package. 144 RFP package included a document called "Volume II Phase II - Technical Proposal Requirements" that states that WSF reserves the right, at its sole discretion, to issue addenda which modify or amend the RFP documents, including the Technical Specifications.
RCW 47.60.820 (7) In phase three, if the proposer fails to enter into contract and furnish satisfactory contract security required by chapter	144	144 RFP package includes a document called "Volume III Phase III - Instructions to Bidders" that has the following sections: "4.2 Execution of Contract", "4.4 Failure to Execute Design-Build Contract", and "4.5 Return of Bid Security". These sections are compliant with this RCW. WSF provided for review a copy of the contract bond (No. 6517152) to cover all of the Part A, Olympic Class contract work. This contract bond was prepared and signed by representatives of Safeco Insurance Company

[125] WSF. (8 October 2004). Martinac Protest of Nichols Bros Prequalification. (D221110.T115414-012)

Legislation	Contract	Evidence
39.08 RCW, its deposit is forfeited.		of America and Todd Pacific Shipyards Corporation to fulfill the condition of the WSF contract titled, New 144 – Auto Ferries Design-Build Contract No. 00-6674, that was signed on December 12, 2007.[126]
RCW 47.60.822 (2) Aggrieved proposers may file an appeal with the superior court of Thurston County within five days of receiving notice of WSF's award decision in phase three.	144	144 RFP package includes a document called " Volume III Phase III - Instructions to Bidders" that has the following section: "Protest Regarding Acceptance or Rejection of Phase III Bid". This section describes the judicial review of WSF's award decision that is in accordance with this RCW. 144 RFP package includes the document called "Phase I Proposal Instructions" that has the following section: "Post-Selection Protests". This section describes the procedures for the appeal process that is in accordance with this RCW. WSF provided for review a legal document, titled "Declaration of Timothy P. McGuigan" that was addressed to the "Superior Court of the State of Washington In and For Thurston County" as part of the hearing in response to a protest launched by J. M. Martinac Shipbuilding Corporation.
RCW 47.60.822 (1) WSF shall immediately notify those proposers that are not selected to participate in the development of technical proposals in phase one and those proposers who submit unsuccessful bids in phase three.	144	144 RFP package includes a document called " Volume III Phase III - Instructions to Bidders" that has the following section: "Section 4 Award and Execution of Design-Build Contract". This section states that WSF will notify those proposers who submit unsuccessful bids in Phase III. 144 RFP package includes the document called "Phase I Proposal Instructions" that has the following section: "Selection for Phase II". This section states that WSF will notify those proposers that are not selected for participation in Phase II. 144 RFP includes a Notice #6, dated July 9, 2004, that states that WSF issued confirming letters to unsuccessful proposers in Phase I. Two proposers were not allowed to

[126] WSF. (13 December 2007). Contract Bond for Part A Work on 144 Auto Ferries Contract No. 00-6674. (D221110.T115339-002)

Legislation	Contract	Evidence
		continue to participate in the RFP process: Everett Shipyard, Inc and Santa Maria Steel, LLC.
RCW 47.60.824 Directions for negotiations if there is only a single best-qualified proposer participating prior to the submission of bids in phase three, or if there is only a single responsive and responsible bit submitted in phase three, or if the current best-qualified proposer elect to jointly submit a single proposal.	144	WSF used the alternative fair-value contracting approach and signed contracts for 144 with the consortium of Washington shipyards led by Todd Pacific Shipyards. WSF provided the signed copy of the Part A Technical Proposal for the Olympic Class Design-Contract No. 00-6674 from 2011 that included a section on "Primary Contract Partners". This section described the teaming agreement, dated June 13, 2007, between Todd Shipyards, J.M. Martinac Shipbuilding Corporation, and Nicholas Brothers Boat Builders whereby the parties agreed to create and submit a joint single proposal for the OC design-build contract with WSF.[127]
RCW 47.60.835 Direction to WSF about how to establish SBE goals.	HEOC 2019	Small Business Enterprise (SBE) enforceable goals program was included in the HEOC contract that was signed after this RCW was published in 2019. Olympic Class contract Part A and B included in General Conditions the Exhibit 8 about Minority and Women-Owned Business Enterprise (MWBE) Participation. This was a voluntary participation program (not mandatory like the SBE program).
WAC 468-320-010 General requirements for contract security for the construction,	144, HEOC 2019	For HEOC 2019, WSF's contractor Glosten developed: 17044.04 HEOC Cost and Risk Assessment, Rev-, 15 Dec. 2021.

[127] Vigor. (30 June 2011). New 144-Auto Ferries Design-build Contract No. 00-6674 Part A Technical Proposal Requirements Appendix C.

Legislation	Contract	Evidence
maintenance, or repair of a marine vessel.		For the Olympic Class, Elliott Bay Design Group developed: No. 06008-2-0765, New 144-Auto Ferry Project Risk Assessment, Rev-, 20 Apr. 2006.
WAC 468-320-030 Calculation of the state's exposure to loss.		

2.4.2.2.2 PARTIALLY COMPLIANT

This gap analysis was an ongoing effort that continued for the life of the project. Entries in Table 2-8 are labelled 'partially compliant' because, at the time of the review, VARD has seen evidence of some, but not all, of the requirements in the RCW. For each entry, the missing evidence was identified; these were requested via the Query Register and the gap analysis was updated as information was received and reviewed.

Table 2-8: Evidence of WSF Partially Complying with Legislation

Legislature	Contract	Evidence
RCW 47.60.812 WSF shall publish a notice of its intent once a week for at least two consecutive weeks in at least one trade paper and one other paper, both of general circulation in the state.	64	WSF published a newspaper notice of request for proposal for its 64-auto ferries in 2008 and 2009. 64-auto ferries RFPs included a Newspaper Notice that contained most of the information required by this RCW. The notices did not include this mandatory requirement: (2) A statement that a modified request for proposals design and build partnership will be used in the procurement process. The notice for the first Kwa-di Tabil class contract No. 00-7595 was published once a week for at least two consecutive weeks in the Seattle Daily Journal of Commerce in September 2008.[128] The notice for the second Kwa-di Tabil class contract No. 00-7803 was published once a week for at least two consecutive weeks in the

[128] WSF. (9 September 2008). *Ad letter - Seattle DJC 9 sep 2008* (D220815.T081011-001).

Legislature	Contract	Evidence
		Seattle Daily Journal of Commerce in August 2009.[129] However, no evidence was provided that for each contract the required notice was published in two papers, at least one trade paper and one other paper (both of general circulation in the state). Required documentation to demonstrate compliance: Dates of 64 notice publications and names of newspaper or trade papers that published the notices of intent.
RCW 47.60.820 (9) In phase three, to accommodate change orders on a fixed price contract, WSF shall request that the legislative appropriation include a contingency of 5-10% of the contract price, depending on the vessel type.	HEOC 2022	This section of the RCW was published in 2015 and did not apply to any past ferry procurement contracts. This section was added to establish a contingency fund for any auto ferry construction project that would be used to pay for change orders on a fixed price contract. This RCW did not apply to HEOC 2019 contract that was an extension of the Olympic Class program. The new WSF change order approval process has not been confirmed; however, WSF has provided possible steps based on an existing OFM approval process for the use of Emergency Capital Funding (see Section 3.10.3).
RCW 47.60.814 (1) WSF shall issue an RFP that must include these specific 20 items.	64	RFPs were issued for Kwa-di Tabil Class ferries in 2008 and 2009. The RFP instructions were modified to account for WSF's use of USCG approved Contract Drawings based on a modified existing ferry design (MV Island Home).

[129] WSF. (6 August 2009). *Ad letter - Seattle DJC 9* (D220815.T081011-001).

2.4.2.2.3 INCONCLUSIVE

This gap analysis was an ongoing effort which continued for the life of the project. Entries in Table 2-9 are labelled 'inconclusive' because, at the time of the review, VARD was missing evidence of meeting requirements in the RCW, or it is a new requirement and WSF has yet to undergo the process and demonstrate compliance. For each entry, the missing evidence was identified; where applicable, these were requested via the Query Register and the gap analysis was updated as information was received and reviewed.

The required evidence was needed to assess WSF's compliance with the RCW and/or WAC. Because it was not provided, this part of the review will remain incomplete.

Table 2-9: Inconclusive Evidence of WSF Complying with Legislation

Legislature	Contract	Evidence
RCW 47.60.815 (3) If all responses to the initial RFP are greater than 5% above the engineer's estimate, the department must reject them all and issues a new RFP.	HEOC 2022	New requirement to reject all bids that are 5% more than the engineer's estimate went into effect after July 1, 2017. Therefore, it was not applicable to Olympic Class, Kwa-di Tabil Class, or HEOC 2019. No historical documentation or WSF policy includes this requirement. An RFI was published in July 2022 which references this RCW, indicating WSF's intent to comply. However, it is too early in the process to verify whether they have complied with this in practice.
RCW 47.60.816 (3) WSF may use some or all of the nonfinancial prequalification factors as part of the evaluation factors in phase one to enable the selection of best qualified proposers for phase two.	64	64 RFP package includes the document called "Bidder Instructions" that requires all proposers to go through the prequalification process before they are given a Bid Form. Each proposer was required to submit: Standard Prequalification Questionnaire and Financial Statement. Required documentation to demonstrate compliance: Completed Standard

Legislature	Contract	Evidence
		Prequalification Questionnaires for 64 RFPs
RCW 47.60.818 (1) In phase two, proposers develop technical proposals in accordance with the RFP and must include these 4 items.	144	Technical proposals were developed for Olympic Class as per RFP instructions. 144 RFP package included a document called "Volume II Phase II - Technical Proposal Requirements" that presented the procedures and requirements for development, submittal, and review of Technical Proposals for the design of the ferries which must be followed by proposers participating in the Phase II Technical Proposal process. The Phase II package included several documents, organized as Appendices: Notice of Intent to Participate in Phase II Technical Proposal Development, Shipyard Build Strategy, Technical Proposal Form, and Honorarium Agreement Required documentation to demonstrate compliance: Proposals submitted in 144 RFP Phase II.
RCW 47.60.818 (2) In phase two, WSF shall conduct period reviews with each proposer to consider and critique their design, drawings, and specification.	144	144 RFP package included a document called "Volume II Phase II - Technical Proposal Requirements" that has the following section: “Section 3 Technical Proposal Evaluation Process”. This section gives details of the periodic review process that WSF will conduct to ensure that technical proposals meet the department’s requirements and are responsive to the critiques conducted by the department. Required documentation to demonstrate compliance: Sample of comments

Legislature	Contract	Evidence
		provided during period review process in Phase II.
RCW 47.60.818 (4) In phase two, proposers must submit final technical proposals for approval and WSF shall reject those that modify, fail to conform to, or are not fully responsive and in compliance with the RFP.	144	144 RFP package included a document called "Volume II Phase II - Technical Proposal Requirements" that has the following section: “Section 3.2 Final Approval of the Technical Proposals”. This section explains how WSF will evaluate the submitted technical proposals. Required documentation to demonstrate compliance: Evidence that WSF followed the documented approval criteria.
RCW 47.60.820 (1) In phase three, WSF shall request bids for detailed design and construction of the vessels after review of the technical proposals in phase two is complete.	144	144 RFP package includes a document called “Volume III Phase III - Instructions to Bidders” that provides the procedures and requirements for submission of fixed price bids in Phase III of the RFP process for design, construction, and delivery of the vessels. Required documentation to demonstrate compliance: Submitted bids for detailed design and construction.
RCW 47.60.820 (2) In phase three, each proposer must submit its total bid price for all vessels.	144	144 RFP package includes a document called “Volume III Phase III - Instructions to Bidders” that has the following section: “Preparation of Phase III Bids”. This section is compliant with this RCW. Required documentation to demonstrate compliance: Submitted bids for detailed design and construction.
RCW 47.60.820 (3) In phase three, a deposit in an amount specified in the RFP must be accompany each bid.	144	144 RFP package includes document called “Volume III Phase III - Instructions to Bidders” that has the following sections: “4.1 Award of Contract” and “4.3 Contract Security”. These sections state that all bids will remain in effect for ninety

Legislature	Contract	Evidence
		calendar days after the bid opening and provide details of required contract security. Required documentation to demonstrate compliance: Evidence that the required deposit accompanied each submitted bid that was considered.
RCW 47.60.820 (4) In phase three, WSF shall evaluate the bids.	144	144 RFP package includes a document called “Volume III Phase III - Instructions to Bidders” that has following section: “Section 3 Evaluation of Phase III Bids”. This section provides details about how WSF will evaluate the submitted bids. Required documentation to demonstrate compliance: Evidence of evaluation of submitted bids.
RCW 47.60.820 (5) In phase three, WSF may waive informalities in the proposal and bid process, accept a bid from the lowest responsive and responsible proposer, reject any or all bids, republish, and revise or cancel the RFP.	144	144 RFP package includes a document called “Volume III Phase III - Instructions to Bidders” that has following section: “3.4 Consideration of Bids”. This section is compliant with this RCW. Required documentation to demonstrate compliance: Evidence that WSF followed one of the options described in this section of the RCW, or instead followed the options described in section (6) of this RCW.
RCW 47.60.820 (6) In phase three, WSF may award the contract to the lowest priced responsive and responsible proposer; if that doesn’t work out, award the contract to the next lowest responsive and responsible proposer; if that doesn’t work out, repeat for	144	144 RFP package includes a document called “Volume III Phase III - Instructions to Bidders” that has following section: “4.1 Award of Contract”. This section is compliant with this RCW. Required documentation to demonstrate compliance: Evidence that WSF followed procedures described in either (a), (b) or (c) of this section of the RCW, or instead

Legislature	Contract	Evidence
each proposer until the list is exhausted.		followed the options described in section (5) of this RCW.
RCW 47.60.820 (8) WSF may provide an honorarium to each unsuccessful phase three proposer.	144	144 RFP package includes a document called "Volume II Phase II - Technical Proposal Requirements" that has the following section: “Section 4 Proposer’s Honorarium”. This section states the conditions that must be met to receive an honorarium (fixed amount of $500,000 to each proposer). Required documentation to demonstrate compliance: Evidence that the honorarium was provided to each unsuccessful Phase III proposer in the amount specified in the RFP documentation.
RCW 47.60.824 Directions for negotiations if there is only a single best-qualified proposer participating prior to the submission of bids in phase three, or if there is only a single responsive and responsible bit submitted in phase three, or if the current best-qualified proposer elect to jointly submit a single proposal.	64	WSF used the alternative fair-value contracting approach and signed contracts for 64-car ferries with the consortium of Washington shipyards led by Todd Pacific Shipyards. Required documentation to demonstrate compliance: Documentation that demonstrates that WSF complied with the process described in this RCW. Minutes of meetings, documents that show deadlines were met as required, etc.

2.4.3 RISK

2.4.3.1 WSF’S DOCUMENTED POLICIES

The WSF Vessel Engineering Manual[130] (VEM) does not include guidance for managing project risk. WSDOT has developed several guidance documents that outline tools and methods relating to identifying and managing risks and uncertainties associated with projects, including the WSDOT

[130] See note 1 above

Project Risk Management Guide, published in 2018.[131] WSF noted that the procedures of this guide were not applied to the 2019 HEOC or previous projects; however, they will be applied to the re-initialized 2022 HEOC program (see Section 1.8.2).[132]

WSDOT first introduced the Cost Estimate Validation Process (CEVP) in 2002. Since then, the cost and schedule risks have been integrated into the risk model as part of the Monte Carlo simulation[133] (see Section 3.8.2.3). In 2008, the Secretary of Transportation issued an Executive Order (SEO) E1053.00[134] that requires WSDOT employees who manage capital construction projects to actively manage project risks. The SEO 1053 was revised twice, with the latest being SEO 1053.02, published in April 2022.[135]

SEO 1053 directs WSDOT employees to apply consistency statewide in the use of project risk management and risk-based estimating for all phases of WSDOT projects. It requires that certain minimum risk management processes are used based on project size.[136] The effect of this policy is that WSDOT employees must conduct risk-based estimating workshops for all projects valued over $10 million. These workshops are meant to provide information to project managers that can help them control scope, cost, and schedule and manage risks.[137] SEO E1053 also re-affirmed the requirement that a risk management plan must be a part of the project management plan.[138]

Table 2-10 shows the different minimum risk management processes that are required based on the project size. For projects valued greater than $100 million, the required project risk management process is the CEVP. In addition, for projects that are $25 million and over, the informal self-modeling risk analysis spreadsheet, called Project Risk Analysis Model (PRAM), is to be initially used before the more formal CEVP process is completed during the design phase.[139]

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[131] WSDOT. (February 2018). Project Risk Management Guide. https://wsdot.wa.gov/publications/fulltext/CEVP/ProjectRiskManagementGuide.pdf
[132] See note 45 above
[133] See note 12 above
[134] WSDOT. (10 December 2008). *Project Risk Management and Risk Based Estimating* (SEO E 1053.00). https://www.wsdot.wa.gov/publications/fulltext/ProjectMgmt/Policy_Docs/1053.pdf
[135] WSDOT (6 April 2022). Project Risk Management and Risk Based Estimating (SEO E 1053.02). https://wsdot.wa.gov/sites/default/files/2021-10/ExecutiveOrder1053.pdf
[136] See note 135 above
[137] See note 135 above
[138] See note 135 above
[139] See note 135 above

Table 2-10: Levels of Risk-Based Estimating as per SEO 1053[140]

Project Size ($M)	Required Process*
Less than $10M	Qualitative spreadsheet in the *Project Management Online Guide*[1]
$10M to $25M	Informal workshop using the self-modeling spreadsheet[1][3]
$25M to $100M	Cost Risk Assessment (CRA) workshop[1][2]
Greater than $100M	Cost Estimate Validation Process® (CEVP®) workshop[2]

[1] In some cases, it is acceptable to combine a Value Engineering Study with a Risk-Based Estimating Workshop.

[2] Projects $25 million and over should use the self-modeling spreadsheet in the scoping phase of the risk-based estimating process, followed up by the more formal CRA or CEVP® process during the design phase.

[3] An informal workshop is composed of the project team (or key project team members); other participants may be included as the Project Manager/project team deem necessary.

*Project Managers can use a higher-level process if desired.

According to the WSDOT Project Risk Management Guide, after the CRA-CEVP workshops, the project team validates the workshop results, prepares a formal report of workshop results, and develops a risk response plan. The risk response plan explains how identified cost-risk is going to be managed and is integrated into the project risk management plan. Next, the project team is tasked with implementing the agreed-upon risk response strategies and continuing to monitor risks and response actions for effectiveness.[141]

As the design progresses, the engineer's estimate is periodically reviewed for accuracy and may be revised. It is important to closely monitor changes to the engineer's estimate as it is the base cost estimate in the process of cost and schedule risk analysis. If the project engineer determines that significant changes in project scope, cost, or schedule have occurred that affect project risk, then a cost-risk update may be appropriate, including the need for a new workshop.[142]

Traditional cost estimating approaches typically present the best-case estimates. However, CEVP results in the probable cost range for a given project that accounts for future risk and uncertainties. According to the WSDOT Project Risk Management Guide, the results of the quantitative risk analysis should be reported as a range and typically in year of expenditure

[140] See note 12 above
[141] See note 12 above
[142] WSDOT. (No date, accessed October 2022). Washington State Department of Transportation Cost Estimate Validation Process (CEVP®). https://www.wsdot.wa.gov/accountability/ssb5806/docs/6_Project_Development/PublicInvolvement/CVEP.pdf

dollars.[143] However, currently, for the purpose of establishing a statewide budget, a single number is necessary for planning, as it is difficult to gain legislature approval on a project based on a range of cost estimates.[144]

According to SEO 1053.02, the legislative budget value for WSDOT projects is to be given by the 60th percentile of the project's total cost, while the operational budget value is to be given by the 40th percentile.[145] This means that the reported legislative budget value is going to be higher than the operational budget value, and the difference in the year of expenditure is called the project risk reserve. This risk reserve is meant to address project uncertainties, and its dollar value is to be included in the legislative budget figure. It is to be used when risk mitigation efforts are insufficient to resolve the risks documented in the risk register; otherwise, the management team is responsible to manage the project within the established operational budget.[146] WSDOT and FHWA have adopted different percentiles for budgeting and risk reserve calculations; therefore, it is important to ensure that projects with FHWA requirements are consistent with the FHWA Cost Estimate Review (CER) guidance.[147]

2.4.3.2 WSF'S PRACTICES

VARD reviewed the available WSF risk documentation to assess whether WSF complied with WSDOT risk policies in the absence of WSF-specific risk policies, and whether it was required to comply with any risk-based policies. The findings are presented by procurement in the following sections.

2.4.3.2.1 OLYMPIC CLASS

WSF signed the contract for the Olympic Class ferries in December 2007 before the original SEO E1053.00 came into effect in 2008.

The Olympic Class RFP did not require any specific risk documentation from the bidder, but it required specific risk items to be addressed in the shipyard build strategy. The Olympic Class RFP, Phase II – Technical Proposal Requirements, included an Appendix B entitled "Shipyard Build Strategy" that had the following requirement:

> "In addition, shipyards must demonstrate to WSF that:
>
> (i) A thorough effort has been made to identify potential problems associated with the build strategy, the method of vessel construction and management of the project; and

[143] See note 135 above
[144] Reilly, John; McBride, Michael; Sangrey, Dwight; Macdonald, Douglas; Brown, Jennifer. (22 February 2004). The Development of CEVP – WSDOT's Cost-Risk Estimating Process. https://santafempo.org/wp-content/uploads/2010/01/WA+CEVP+Paper.pdf
[145] See note 135 above
[146] See note 135 above
[147] See note 12 above

(ii) specific, describable solutions have been found which are presented in the build strategy."[148]

In response, Vigor laid out its approach to risk management in Part A of its Technical Proposal: "risk will be assessed and mitigated throughout project development and execution utilizing the Builder's internal protocol for detecting and mitigating risk as guidance." It went on to list specific risks which had been identified and would be actively mitigated in the following areas: technical, regulatory, integration, subcontract, and towing. For example, a technical risk was the rudder trunk alignment, a regulatory risk was the Washington Department of Labor and Industries involvement regarding elevator permitting, an integration risk was security and surveillance integration and commissioning, a subcontract risk was OFE deliveries, and a towing risk was the vessel being towed from the builder's Seattle Shipyard to [superstructure outfitting vendor] SSOV's shipyard.[149]

2.4.3.2.2 2019 HEOC

The 2019 functional design of the HEOC was initiated via Change Order (CO) #71, also known as Part C of the 144-auto ferries design-build contract. Because the HEOC in 2019 was considered an extension of the original Olympic Class design-build contract, the requirements of SEO 1053[150] also did not apply. However, WSF did initiate a risk register to support oversight of the HEOC design-build contract with the initial draft based on the first site visit to Vigor at their Vancouver, WA, facility.[151]

Like the original contract for the Olympic Class, CO #71 included an Appendix A, entitled "Shipyard Build Strategy," that had the same requirement as the Olympic Class RFP's Appendix B, also entitled "Shipyard Build Strategy" (see Section 2.4.3.2.1).[152] In its build strategy, Vigor identified several risk items, including the rapid charging system (discussed further in Section 2.4.3.2.4), the vessel's weight control plan, and the safety of vessel design from a fire detection and protection perspective. [153]

Throughout the Olympic Class and 2019 HEOC contract, Vigor presented an updated risk register at every project management review (PMR) meeting with WSF. The register included the

[148] WSF, WSDOT. (July 2006). 144-Auto Ferries Design and Build No. 00-6674 RFP - Volume II Phase II Appendix B Shipyard Build Strategy.
[149] See note 127 above
[150] See note 134 above
[151] WSF. (no date, provided to VARD in June 2022). HEOC Risk Register (initial draft) [unpublished spreadsheet].; WSF. (no date, provided to VARD in June 2022). Documentation Related to Risk Summary ([unpublished spreadsheet].; Only the initial draft of the HEOC Risk Register was provided to VARD for review.
[152] WSF. (12 December 2019). Change Order Number: 71 – New Auto 144-Car Ferries Design Contract No. 00-6674, Part C (Functional Design of Hybrid Electric).
[153] Vigor. (8 July 2021). *Shipyard Build Strategy* (36241-998-0067).

following for each risk item: identification (ID) number, description, mitigation strategy, mitigation owner, and impacts. Vigor used this register to identify and manage its Part C (functional design) and Part D (detailed design and construction terms and conditions) risks.[154] This demonstrates a formal and proactive risk management process, by the shipyard and is consistent with WSF's requirements.

According to WSF, the decision not to award the vessel construction contract to Vigor was primarily because of a disagreement over risk allocation. In that single-source situation, the contractor (under new ownership of a private equity firm) declined to accept the level of risk that the state required under its application of the design-build statutes. The parties were unable to agree to terms and conditions or price.[155]

2.4.3.2.3 2022 HEOC

As the re-initiated HEOC procurement has an estimated contract value of $1.1 billion, WSF is required to comply with WSDOT's policies[156] related to project risk management and risk-based estimating, as discussed in Section 2.4.2.2. WSF intends to complete the required CEVP early in 2023 to identify budget and schedule risks.[157]

For projects valued over $100 million, an informal risk-based estimating workshop should also be conducted during the preliminary phase of the project.[158] Due to the advanced stage of the HEOC program, the preliminary stage of the project had formally passed, and WSF is preparing for the more formal CEVP workshop. It is important to note that the WSDOT Project Risk Analysis Model, expected to be used at the informal workshop, is tailored to civil and not marine projects, so there is a lot of customization required before it can be used by WSF. WSF is in the process of hiring a WSF System Electrification Program General Engineering Consultant.[159] The request for qualifications (RFQ) details Cost and Risk Assessment (CRA) and the CEVP as areas the consultant will be required to support. WSF has stated that they plan to use this consultant to complete the required risk-based estimating workshop and the CEVP for the re-initiated HEOC procurement. [160] It is evident that WSF identified the needed resources for project risk management and built them into the project development budget and schedule.

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[154] Vigor. (February 2021). Project Management Review (PMR) WSF HEOC Project. 36241-998-0094.
[155] Von Ruden, M. (14 October 2022). Task 3 Interim Report Rev 0 (444-000-06).
[156] WSDOT Ferries Division. (July 2022). Hybrid Electric Olympic Class Ferry Program Request for Information.
https://www.wsdot.com/Ferries/Business/contracts/search/browse?category=7&fiscalYear=&awarded=
[157] See note 45 above
[158] See note 12 above
[159] WSDOT. (9 August 2022). 2022 WSF System Electrification Program General Engineering Consultant. https://wsdot.wa.gov/business-wsdot/contracting-opportunties/2022-wsf-system-electrification-program-general-engineering-consultant
[160]

The CEVP workshop can be conducted once the minimum required inputs are developed, and the required resources have been secured (e.g., consultants). WSF staff will be trained on the CEVP process, so they can prepare the expected inputs for the workshop.[161] Key inputs for the CEVP include a risk register, cost estimate, and schedule: WSF developed the risk register for the re-initiated HEOC procurement[162]; WSF is in the process of updating the 2019 HEOC cost estimate[163]; and WSF intends to use the 2019 HEOC schedule from Vigor as guidance.[164]

The CEVP workshop will result in a probable cost range for the remaining stages of the HEOC program. These uncertainty values may differ from the budgets and contingencies assigned to the HEOC project. As the new contingency statutes (see Section 2.4.4.1) restrict the total amount that can be used on HEOC and future projects, WSF plans to discuss the issue with legislators.[165]

2.4.3.2.4 RAPID CHARGING SYSTEM

The HEOC rapid charging system (RCS) is a key and novel component of the hybrid-electric ferry design, initially developed under the Jumbo Mark II Class hybrid conversion contract. In April 2021, WSF contracted Siemens Energy and its subcontractor, Glosten Associates (Glosten), to evaluate the suitability of the RCS and charging arm design developed for the Jumbo Mark II Class for installation on the HEOC ferries. This work was executed under the Jumbo Mark II contract via CO #6, with an estimated value of $385,000,[166] but it is funded under the HEOC program.[167] WSF provided the completed RCS integration deliverables[168] to Vigor to be used as the basis for integration work of the RCS into the existing HEOC functional design. The RCS integration work was intended to be introduced into the HEOC contract with CO #77 and CO #78 with a total estimated value of $481,416.[169] These change orders were planned but were not executed.[170]

In July 2022, WSF utilized the existing Jumbo Mark II contract with Siemens Energy and its subcontractor Glosten Associates (Glosten) to further develop the integration of the RCS into the existing HEOC functional design. This work is executed under the Jumbo Mark II contract via CO

[161] See note 45 above
[162] WSF. (October 2022). HEOC Risk Allocation. (D221014.T152653).
[163] Von Ruden, M. (14 October 2022). JLARC Data Request Tracker Consolidated. (unpublished spreadsheet).
[164] See note 132 above
[165] See note 45 above
[166] WSF. (15 April 2021). WSF Shore Charging Arm Design Integration, Siemens - Change Order #6. (D221024.T065250)
[167] See note 45 above
[168] Glosten. (18 October 2021). Vessel Terminal Interface Report. (D221024.T065300-19063-05-000-01); Glosten. (24 September 2021). Shore Charging System Arrangement Overview. (D221024.T065249-19063.05-000-02); Glosten. (19 October 2021). HEOC Charging Arm Integration Interface Design Document. (D221024.T065235-19063-05-000-03)
[169] WSF. (21 December 2021). Hybrid Electric Olympic Spend Plan Rev 16 [unpublished spreadsheet].
[170] Von Ruden, Matt. (10 Nov 2022). [WSF comment on Rev 0 of the 444-000-7 Final Report, see *444-02 WSF Comment Register for Final Report*, Comment Nos. 52 and 53].

#19, with an estimated value of $237,000, but funded under the HEOC program. The design efforts of this change order are scheduled for delivery in November/December 2022.[171] In August 2022, WSF also contracted Siemens Energy to investigate the alternative option of locating the charging arm equipment on an over-the-water structure. This work is contracted under the Jumbo Mark II contract via CO #21, with an estimated value of $620,000.[172]

The HEOC ferry program RFI, issued in July 2022, noted that the integration of the WSF-specified RCS is not to the same level of design as the rest of the owner's model and that bidders will need to complete the integration themselves for their final technical proposal.[173] However, on October 6, 2022, WSF noted that, if time permits, a structural concept developed by Glosten will be included in the owner's model to be provided as part of the RFP package. In either way, because the bidders are undertaking the detailed integration of the WSF-specified RCS, they will need to understand and take on the associated risks. Since WSF wants standardization, the bidders will be required to use the WSF-specified RCS. According to the industry responses to the HEOC ferry RFI, most of the proposers expect that the inclusion of the charging arms onboard will make the build more difficult and riskier, and therefore prefer that the RCS is not installed onboard.[174]

WSF has managed the risk associated with the RCS by using Glosten, with expertise in risk management in the shipbuilding industry, to develop comprehensive risk documentation. Glosten's risk assessment process was thorough and included two hazard identification (HAZID) workshops and two risk assessment workshops. These workshops were performed over a total of 11 sessions with 19 experts from vessel operations, system design, and terminal operations. As a result of the risk workshops, WSF approved risk-reducing improvements to the charging arm design, such as the addition of a laser scanner to monitor the interference area while the charging arm is moving.[175]

In summary, WSF's leading solution at the time of writing is the FerryReach RCS located on the vessel.[176] However, in response to risks raised by Vigor during the 2019 HEOC procurement (see Section 2.4.3.2.2), fleet and terminal operators, and the industry responses to the 2022 HEOC RFI, WSF is actively pursuing an alternative charging approach that locates the charging equipment on a floating barge or a fixed platform offshore during the 2021-23 biennium.[177]

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[171] WSF. (21 July 2022). HEOC Charging Arm Evaluation Continuation - Change Order #19. (D221024.T065241-00-9317)
[172] WSF. (4 August 2022). Study of Shore Side Main Charging Infrastructure - Change Order #21. (D221024.T065256-00-9317)
[173] See note 71 above
[174] WSDOT. (October 2022). HEOC RFI Responses Summary/Context.
https://www.wsdot.com/Ferries/Business/contracts/search/download/10210
[175] Glosten. (11 March 2022). Charging Arm Risk Assessment Report [unpublished report].
[176] WSF. 2023-25 Budget Request Doc - Pre-design Studies (D220908.T160930-C7).
[177] See note 132 above

2.4.4 COST ESTIMATING

2.4.4.1 WSF'S DOCUMENTED POLICIES

The WSF VEM[178] has guidance for cost estimating, this is summarized in Table 2-11; however, this manual has not been updated since 2012 (see Section 2.4.2.1 for details on gaps in WSF's documented policies). Also, WSDOT M3034 Cost Estimating Manual for Projects[179] is available to WSF staff for more detailed guidance on cost estimating; however, this manual is not specific to ferries.

The contingency for future design-build contracts for ferries is constrained by RCW 47.60.820(9)(a)(ii), which was added in 2015. This section of the statute limits the contingency to 5-10% of the contract price, depending on the vessel type. WSF has not updated the VEM to include these new requirements for limiting contingency.

Table 2-11: WSF's Documented Policies related to Cost Estimating

WSF's Document	Summary
VEM Chapter 1, 1-4 Definition of Terms	Definitions for cost estimates used throughout the project lifecycle. There is the hierarchy of cost estimates for contractor costs: • Feasibility estimate (+/- 35% accuracy) • Budgetary estimate (+/- 20% accuracy) • Engineer's estimate (+/- 10% accuracy) • Interim estimate Additionally, there is the project estimate which includes costs from WSF, contractors, and consultants.
VEM Chapter 2, 2-8 Estimates for Project Budgets	Defines the responsibilities of different personnel for providing information for the cost estimates, with the chief estimator having overall responsibility. Discusses the cost estimate refinement and steps to take when estimate increases.
VEM Chapter 3, 3-3 B	The engineer's estimate is created based upon the drawings and specifications. This estimate should aim to use similar methods as contractors.

[178] See note 1 above

[179] WSDOT. (14 December 2020). Cost Estimating Manual for WSDOT Projects (M3034.04). https://wsdot.wa.gov/engineering-standards/all-manuals-and-standards/manuals/cost-estimating-manual-wsdot-projects

WSF's Document	Summary
Engineer's Estimate and Project Estimates	A project estimate should also be developed which includes the estimate for WSF and contractor costs.
VEM Chapter 4, 4-5 E Tasking of A & E Firms	Estimation work for construction firms can be completed by architecture and engineering firms with approval from the director of vessel engineering.
VEM Chapter 4, 4-6 General Information	Engineering section heads are responsible for providing estimates for their engineering work. In some cases, they may also be requested to provide estimates for the construction work.

2.4.4.2 WSF'S PRACTICES

WSF develops costs estimates for "internal" work, including predesign studies, consultants such as the independent owner's representative (IOR), etc., and for "external" work, mainly the construction contract with a shipyard. These cost estimates are needed for budget requests and for internal planning. Table 2-12 provides a sample list of the cost estimates which were provided to VARD for review.

The engineer's cost estimate is WSF's benchmark for analyzing bids and it is especially important for upcoming procurement programs because of the new "5% rule" as per RCW 47.60.815(3). In the sample list, the Olympic Class and 2019 HEOC engineer's estimates were included because they are important historical documents that were reviewed by VARD. For further discussion about these engineer's estimates, see Section 2.4.4.2.1.

WSF has developed cost estimates for "internal" work, such as for the predesign studies. In the sample list, a few cost estimates for the 124-auto predesign studies planned for the 2023-2025 biennium were included as examples. WSF plans to use on-call naval architecture firms to complete this predesign work.[180] For further discussion about these cost estimates, see Section 2.4.4.2.2.

WSF has developed initial cost estimates for vessel construction and used them for the initial budget requests. For the upcoming 124-auto ferry program, two different cost estimates were included in the sample list. Both were developed by WSF and the lower estimate of $208 million was included in the provided draft WSF Vessel Rebuild and Replacement Plan, 2023-2025 Capital

[180] WSF. (no date, received by VARD in September 2022). Predesign Studies 23-25 [unpublished spreadsheet].

Budget Request and used to develop a funding need profile.[181] For further discussion about these cost estimates, see Section 2.4.4.2.1.

Table 2-12: Sample List of Cost Estimates

Title	Author	Date	Amount	Internal or External?
124-auto Ferry Estimate[182]	WSF	May 2022	$231,150,000 (1st 124-auto ferry construction)	Internal
Vessel Rebuild Retire Replacement Plan[183]	WSF	31 August 2022	$208,000,000 (1st 124-auto ferry construction)	External (for upcoming budget request)
Predesign Studies 2023-25[184]	WSF	7 September 2022	$20,000 (124-auto ferry predesign study: Advance Technologies) $40,000 (124-auto ferry outline specification development for RFP)	External (for upcoming budget request).
HEOC First Vessel Cost Estimate[185]	Glosten	10 Sept 2021	$192,160,000 (1st HEOC ferry detailed design & construction)	External

[181] WSF. (31 August 2022). 2023-2025 Bud Doc Vessel Rebuild and Replacement Plan Draft. (D220901.T152955-C5)
[182] WSF. (May 2022). 124-Auto Ferry Estimate [unpublished spreadsheet].
[183] WSF. (no date, received by VARD in September 2022). Vessel Rebuild Retire Replacement Plan [unpublished spreadsheet].
[184] WSF. (no date, received by VARD in September 2022). Predesign Studies 23-25 [unpublished spreadsheet].
[185] Glosten. (10 September 2021). HEOC First Vessel Cost Estimate (17044.04) [unpublished report].

Title	Author	Date	Amount	Internal or External?
New 144-Auto Ferry Engineering Price Estimate[186]	Elliot Bay Design Group (EBDG)	7 March 2006	$65,198,551 (1st vessel detailed design & construction, excluding OFE)	External

2.4.4.2.1 COST ESTIMATES FOR EXTERNAL COSTS

VARD was provided with several examples of WSF's cost estimates for external costs which are primarily construction contracts, including the detailed engineer's cost estimates for the 2019 HEOC[187] and Olympic Class programs[188] which were prepared by third-party consultants. WSF has indicated that they intend to continue this practice by using a pre-existing contract with Glosten to work on the engineer's estimate for the re-initiated HEOC procurement. VARD reviewed in detail Glosten's cost estimate for the 2019 HEOC and concluded that this was exhaustive and well-researched.

Table 2-13 summarizes VARD's observations related to Glosten's cost estimate. An interview with WSF and Glosten was completed on March 3, 2022[189], and subsequent written answers to questions and requested documents were reviewed. This cost estimate identified significant project cost drivers, including materials, labor, overhead, delivery, and profit, as required by RCW 47.60.815.

Table 2-13: VARD's Observations Related to Glosten's Cost Estimate

Observation	Details
1	Glosten's cost estimate was prepared for WSF as (1) a basis for identifying project bonding requirements[190], and (2) as a reference for WSF in its negotiations with Vigor.
2	The estimate presumed the ships would be built at a generic west coast US shipyard and was not intended to model Vigor's costing specifically. It did not consider the prevailing wage rates in Washington or Washington-specific cost

[186] EBDG. (7 March 2006). New 144-Auto Ferry Engineering Price Estimate (9000-660-100-04) [unpublished report].
[187] See note 185 above
[188] Elliott Bay Design Group (20 March 2006). New 144-Auto Ferry Project Risk Assessment. (06008-2-0765).
[189] See note 132 above
[190] Glosten. (15 December 2021). HEOC Cost and Risk Assessment. (17044.4)

Observation	Details
	factors like apprenticeship costs and Small Business Enterprise (SBE) participation requirements.[191]
3	Factors used in Glosten's cost estimate for yard efficiency were based on the experience and expert knowledge of the sub-contractor NWE, LLC. This is typical industry practice. The resume and project history of the sub-constructor, David A. Nicolson (NWE, LLC) were reviewed for evidence of sufficient knowledge and experience.[192]
4	For Glosten's multi-hull cost estimate, the learning curve for the HEOC was reset to zero for the first vessel even though Vigor also built the Olympic Class vessels.[193] This is the correct approach for several reasons, such as the technical differences between the programs, change in personnel, and the time delay.
5	The propulsion system was going to be provided by ABB as a single source integrator. For the HEOC cost estimate, Glosten was provided with the cost breakdown for the system from Vigor's detailed ABB quote, via WSF. This included a breakdown of materials costs, labour, integration, and other associated costs. The availability and use of this key vendor quote should improve the overall accuracy of the cost estimate.[194]
6	Glosten's cost estimate included other major vendor equipment quotes in addition to the one for the propulsion system. These were provided by Vigor (via WSF). Glosten did not need to estimate these costs or obtain vendor quotes. VARD reviewed the list of vendors that included Bagby (elevator), Alexander Gow (fire safety equipment), and Trident (outfitting).[195] The availability and use of these vendor quotes should improve the accuracy of the cost estimate.
7	The labour rate used for the cost estimate was a composite rate developed by shipyard-experienced Glosten staff, in consultation with WSF. The labour rate was intended to be representative of a reasonable rate for the Pacific Northwest

[191] JLARC. (7 March 2022). 444 Interview Meeting 01 Agenda Glosten Responses. (D220308.T135009-VARD).
[192] David A Nicolson. Resume-2021. (D220308.T135015); NWE. (January 2022). NEW, LLC Project List - Jan 2022 - Ferry Experience. (D220308.T135009)
[193] See note 132 above
[194] Von Ruden, M. (8 March 2022). Glosten & NWE, JLARC, HEOC meeting follow-up items. (D220308.T135015)
[195] See note 77 above

Observation	Details
	and an analogue for a Washington State shipyard. It was not intended to model Vigor's labour rates.[196]
8	Glosten's cost estimate was based on the drawings and documents that were supplied by Vigor, while the functional design work was underway. Several change orders were issued after the cost estimating work was completed. The accuracy of Glosten's cost estimate was affected by the completeness and stage of development of the provided functional design package. VARD was provided for review the list of drawings used by Glosten that included revision numbers and dates.[197]
9	Glosten's first vessel cost estimate included a 25% risk contingency for the detail design estimate. The amount of risk contingency was estimated based on experience to account for Vigor's intention to pass-through liquidated damages to its subcontractors.[198]
10	Glosten's first vessel cost estimate used a 15% mark up on material and production costs.[199] This is a typical practice for shipyards to account for risk and pay for overhead costs.

For the 124-auto ferry, WSF staff developed an initial parametric cost estimate and applied a 50% contingency. The large contingency was used to account for the many unknowns at the early stage of the project. This cost estimate will be used for the initial budget request for the 124-auto ferry program. This costing approach is used for WSF terminal projects at a similar project stage.[200]

The initial 124-auto ferry estimate also accounted for annual inflation and assumed an honorarium for two proposers for the technical proposal budget.[201] This simplistic method is typically used by WSF to develop an initial cost estimate that is used for the first budget request. WSF noted that there is no funding available to develop a more detailed estimate before initial funding requests.[202] The VEM refers to a feasibility estimate being within 35% accuracy, which implies a higher level of confidence in the initial cost estimate compared to the recent WSF practice of applying a 50% margin.

[196] See note 191 above
[197] Glosten. (7 March 2022). Drawing List. (D220308.T135009)
[198] See note 191 above
[199] See note 185 above
[200] See note 132 above
[201] See note 182 above
[202] See note 45 above

2.4.4.2.2 COST ESTIMATES FOR INTERNAL COSTS

VARD was not provided with WSF's cost estimates for internal costs, such as for in-house project work, consultants to do the predesign studies, the IOR, etc. WSF claims its in-house project costs "are well known and easily estimated and pretty accurate" and it used a simple calculation of one person for one year to estimate the budget for an IOR.[203] WSF did provide a list of predesign studies for the 124-auto ferry, including a description, cost estimate, planned start date, and some internal comments.[204] To develop the cost estimates for the 124-auto predesign studies, WSF used past projects as examples.[205]

2.4.5 COST MANAGEMENT/CONTROL

2.4.5.1 WSF'S DOCUMENTED POLICIES

The WSF VEM[206] contains some guidance on how cost should be monitored over the course of a project, this is summarized in Table 2-14. However, as previously noted the VEM is not currently used by WSF for procurement programs and this should therefore be considered mainly as background information, though certain practices (such as monthly progress payments) are still in use.[207]

Table 2-14: WSF's Documented Policies related to Cost Management/Control

WSF's P&P	Summary
VEM Chapter 5, Section 5-25 Progress Estimates and Payments	Typically, contractors will receive monthly payments. Progress payment estimates contain: (i) the percentage of completion of each line item at the beginning of the billing period; (ii) the percentage change during the billing period; (iii) the total current completion percentage at the end of the billing period; and (iv) the dollar amount owed.
VEM Chapter 5, Section 5-5 Weekly Reports	The project engineer provides weekly reports to the director of vessel engineering which includes information on change orders and progress payments. A sample of a weekly project report is provided.
VEM	On projects over $5 million, it requires the project engineer to provide a monthly budget adherence

[203] See note 45 above
[204] See note 180 above
[205] See note 45 above
[206] See note 1 above
[207] See note 45 above

WSF's P&P	Summary
Chapter 5, Section 5-10 Budget Management	report detailing the planned versus actual expenditures for several areas including shipyard labor, shipyard material, WSF engineering costs, etc. Additionally, it requires the project engineer to generally monitor the budget and to promptly alert the director of vessel engineering of any 'unfavorable variances', although it does not detail what percentage variance this would be.
VEM Vessel Engineering Memorandum December 14, 2012	Defines the role of the vessel budget specialist which includes developing financial performance reports, quarterly report, project growth reports, and completing change management requests.

2.4.5.2 WSF'S PRACTICES

The use of monthly progress payments is a standard approach for WSDOT projects. For many years, WSF has also used monthly progress payments on vessel repair, preservation, and new construction projects. WSF noted that this approach has worked well in the past for the agency and for the contractor because it is administratively simple and costs less than a more detailed approach, like earned value management (EVM). However, WSF also noted that a drawback of this type of payment system is that it is not well suited in cases when WSF does not get the expected results in a design phase.[208]

According to WSF, monthly progress payments are the preferred method of payment because this approach helps the prime contractors with cashflow and with payments to small businesses employed as subcontractors and suppliers. Furthermore, WSF commented that prime contractors generally make payments to their subcontractors and suppliers after receiving the monthly progress payments. Furthermore, WSF intends to include the use of monthly progress payments in the terms and conditions of upcoming ferry projects.[209]

2.4.5.2.1 OLYMPIC CLASS

According to the Olympic Class contract Part A (for functional design), WSF used uniform monthly progress payments to pay for the functional design work when invoiced. For uniform payments, each monthly progress payment was the total contract price for Part A divided by the duration for

[208] See note 45 above
[209] See note 45 above

Part A in months until the technical proposal due date. The last payment was only to be made when WSF approved the completed technical proposal.[210]

The Olympic Class contract Part A required that the shipyard submit to WSF for review and acceptance a technical proposal schedule (TPS) within 30 days of issuance of the Part A Notice to Proceed (NTP). This schedule needed to show the proposed sequence to complete the Part A work by the due date. Furthermore, the initiation of the progress payments was conditional on submittal and acceptance of the TPS. As part of the review process, WSF reviewed the deliverables on an interim basis and made sure that they were progressing as expected.[211]

The Olympic Class contract Part B (for detailed design and construction) had a section that described WSF's process for scheduling and monitoring progress payments. WSF used periodic monthly progress payments, except as otherwise agreed. The shipyard was required to develop a master construction schedule (MCS) with the sequence proposed to complete the Part B work that included vessel delivery dates and major milestone dates. Furthermore, the shipyard was required to allocate the total contract price among the activities scheduled on the cost-loaded version of the baseline MCS. The approved baseline MCS was used for determining the progress payments and was updated every four weeks.[212] The Olympic Class process required the use of standard forms, including the progress estimate form. At least 14 days before each progress payment was due, the shipyard was required to submit to WSF a progress estimate form that showed: "(i) the percentage completion of each line item at the billing period, (ii) the change during the billing period, and (iii) the total current completion at the end of the billing period." The change orders were identified as a separate line item in the progress estimate form, but the method for making progress payments for change order work was the same as for contract work.[213]

It important to note the progress estimates are not considered rigorous assessments of contract work, since the contract stated that the "Progress Estimates are tentative and only for the purpose of determining progress payments."[214]

2.4.5.2.2 2019 HEOC

VARD received for review the 144-auto Ferries Design-Build Contract No. 00-6674, Part C, contract for the functional design of the HEOC, and draft Part D, contract for detailed design and construction of the HEOC.

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[210] WSF, WSDOT. (December 2008). 144-Auto Ferries Design and Build Contract No. 00-6674 – Part A Technical Proposal Requirements.
[211] See note 210 above
[212] WSF, WSDOT. (June 2011). 144-Auto Ferries Design and Build Contract No. 00-6674 – Part B General Conditions.
[213] See note 212 above
[214] See note 212 above

The signing of the Olympic Class contract Part A for functional design and Part C for the HEOC contract for functional design were separated by over ten years. However, both contracts have the same requirements for progress payments for functional design work.[215] The change orders payments for the HEOC functional design were in addition to the total contract price for the Olympic Class functional design (contract Part C) of $8,870,778.[216] The original 12-month duration[217] of functional design work was also significantly impacted by numerous change orders, resulting in several significant changes to the completion date of the functional design.

According to draft Part D contract, WSF was planning to use periodic monthly progress payments for the detailed design and construction program for the HEOC.[218] The same approach was used for the Olympic Class contract Part B, as discussed in Section 2.4.5.2.1.

2.4.6 CHANGE MANAGEMENT

2.4.6.1 WSF'S DOCUMENTED POLICIES

Table 2-15 summarizes policies relating to change management that are documented in the WSF VEM.[219] While the general process is well documented, the VEM allows that there may also be project specific requirements included in the contract within the "Contract Changes" article.

The contingency approval process for future design-build contracts for ferries is mandated by RCW 47.60.820(9)(b), which was added in 2015. WSF has not updated the VEM to include these new requirements for contingency spending approval. WSF commented that its initial intention was to update the VEM, but the manual needs a complete overhaul; no additional plans or dates were shared.[220]

Table 2-15: WSF's Documented Policies related to Change Management

WSF's Reference	Summary
VEM Chapter 5, 5-11 Change Orders	Change orders are written orders issued by WSF for alterations in drawings, specifications or quantities which change the contract. The sub-chapter on change orders includes the following sub-sections: A) Changes in the work B) Authorization and negotiation of change orders

[215] WSF, WSDOT. (August 2019). 144-Auto Ferries Design and Build Contract No. 00-6674 – Part C Technical Proposal Requirements.
[216] See note 215 above
[217] See note 215 above
[218] See note 102 above
[219] See note 1 above
[220] See note 45 above

WSF's Reference	Summary
	C) Concurrence of change orders by the port engineer (preservation) D) Procedures for preparation of change orders E) Contract authority for change orders F) Distribution of WSF-approved change orders.
VEM Exhibit II.06 WSF Change Order Form	Exhibit II does not include the standard change order form but says "See Vessel Construction Access Database for WSF Change Order Form."
VEM Appendix S Change Management Form	Form to be used to obtain approval for changes.
VEM Chapter 4, 4-9 D Drawing Revisions	Details on how technical changes should be managed through drawing revisions.
VEM Chapter 4, 4-9 F Engineering Change Notice (ECN)	Details on how technical changes should be managed through ECNs for minor changes.

2.4.6.2 WSF'S PRACTICES

2.4.6.2.1 USE OF CONTINGENCY

As mentioned in Section 3.10.1, change orders are ultimately limited by the amount of contingency available. The contingency for future design-build contracts for WSF ferries is constrained by RCW 47.60.820(9)(a)(ii), which was added in 2015. This did not apply to the Olympic Class contract, nor did it apply to the HEOC in 2019, since it was considered an extension of the original Olympic Class contract. The RCW limits the contingency for future vessel procurements as follows:

> "(9)(a) To accommodate change orders on a fixed price contract, the department shall request that the legislative appropriation for any auto ferry construction project include a contingency in the following amounts:

(i) For the first vessel in any class of vessels designed to be powered by liquefied natural gas, the contingency may be no more than ten percent of the contract price;

(ii) For all other vessels, the contingency may be no more than five percent of the contract price.

(b) The contingency required by this subsection (9) must be identified in the funding request to the legislature and held in reserve until the Office of Financial Management approves the expenditure."

Based on 47.60.820(9)(a)(ii), the re-initiated HEOC procurement, which is no longer considered to be an extension of the Olympic Class contract, will be limited to a contingency in the amount of 5% of the contract price.

According to the WSF VEM, in past procurements, WSF did not need to go through an external approval procedure; the WSF project engineer could approve change orders up to $50,000 and increases in contract time of one calendar day and the director of vessel engineering could approve any increase in contract time and change orders up to $1 million, for contracts valued over $4 million. [221] With the introduction of RCW 47.60.820(9), contingency for change orders is now held in reserve until the Office of Financial Management (OFM) approves the expenditure.

According to the 2013 State Auditor's Office Performance Audit, WSF, in the past procurements, used to set aside an additional 10-20% of the awarded contract as contingency funding. The higher amount was reserved for the first vessel in a new class. WSF used this contingency fund to pay for unexpected costs that were not covered in the budget.[222] Under the new RCW 47.60.820(9)(a), the percentage of the permitted contingency has been significantly reduced.

2.4.6.2.2 CHANGE MANAGEMENT PROCESS

For past procurements, WSF staff were responsible for the entire change management process in accordance with the VEM and the "Contract Changes" article for that specific contract. WSF has demonstrated a formal process for review and approval of change orders for the Kwa-di Tabil (KDT) Class, Olympic Class, and 2019 HEOC functional design contract. However, the 2013 State Auditor's Office (SAO) Report was critical of the total value of change orders over the course of the KDT Class contract and while it acknowledges that WSF used an appropriate formal change order process with the necessary review and approval oversight of a steering committee, it had one major recommendation with respect to the WSF's change management process:

[221] See note 1 above
[222] See note 65 above

> "Use an independent owner's representative. This advocate for the purchaser performs quality oversight, manages the change order process, and ensures project does not depart from the contract." [223]

RCW 47.60.810(2), passed after the publication of the SAO report, now mandates that for the re-initiated HEOC and future ferry programs, WSF must employ an IOR. The RCW states that the IOR shall "manage any change order requests"; however, this allows for interpretation. According to the signed professional services agreement with Art Anderson Associates for IOR service for the HEOC program, the work elements in Exhibit A, Section IV do not explicitly call out change management or change orders but are fairly high level and include supporting, monitoring, providing input, participating, and/or reviewing at every stage of the procurement process, in addition to any other duties they may be assigned by the WSF.[224] (The IOR was discussed in detail in Section 2.3.3.)

2.4.6.2.3 CHANGE ORDERS

The documentation for the 68 change orders executed over the course of the original Olympic Class contract was not provided for VARD's review, however, a summary list provided by WSF listing the dollar value and description of each CO indicated that change orders for the Olympic Class contract totaled $5 million. VARD did review the documentation for change orders 69 to 75 which are applicable to the 2019 HEOC contract extension; these totaled $2 million. Due to the scope and nature of this analysis, VARD did not receive for review any change order documentation for the Kwa-Di Tabil Class, however, the 2013 SAO Report stated that change orders for that contract totaled over $10 million.[225]

2.4.6.2.3.1 KWA-DI TABIL CLASS

While the 2013 SAO Report was critical of the cost of the KDT Class change orders, it did acknowledge that "WSF was under pressure to build the Chetzemoka as quickly as possible to restore ferry service to communities affected by the unplanned retirement of the four Steel Electric vessels."[226] WSF purchased the license for the existing design of the Island Home ferry, operated by The Steamship Authority in Massachusetts. This was used as the starting point for the design of the KDT Class. According to the 2013 SAO Report, WSF made 29 change orders, valued at more than $10 million for the first KDT class ferry. The total amount paid for these change orders was 16% of the $65 million that was awarded to build the first ferry. Of that, about $6.5 million was spent for additional labor and materials to maintain the project schedule.[227] For the second and third KDT class ferry, the change orders amounts were considerably less at 6% of

[223] See note 97 above
[224] See note 97 above
[225] See note 32 above
[226] See note 97 above
[227] See note 32 above

the $60 million contract award price for the second ferry and 2.7% of the $54 million contract award price for the third ferry.[228] This contract is an outlier in that it did not follow WSF's usual design-build contracting approach to get replacement vessels in operation as soon as possible. However, it does illustrate how a lack of preplanning in the predesign and RFP phases can result in expensive change orders during detailed design and construction.

2.4.6.2.3.2 OLYMPIC CLASS

The change order total value compared to the contract award price for the four-vessel Olympic Class program stands in contrast to the three-vessel KDT Class, at 1.4% compared to 8.8%. (The change orders for the Olympic Class were well below 5% of the contract price.) This demonstrates the benefit for a mature project with appropriate preplanning.

Because change orders are a normal part of the shipbuilding process, it is important to distinguish between expected change orders and unexpected change orders. For example, material price escalation, inflation, and foreign currency exchange rates are all common and expected reasons why a contract price may need adjustment, and these are often built into the contract. Unexpected changes may be necessary during the project due to outside forces such as reviews by USCG, the classification society, or other regulatory agencies, or they may be proposed by the owner or the shipyard in response to ongoing design efforts, new information, technology improvements, etc., and are desirable because they provide construction cost savings/efficiencies, future operational cost savings, improved vessel performance, etc.

For the Olympic Class, there were several costly change orders related to material price escalation, including CO #27 for $319,766 and CO #61 for $370,911. Part B of the contract, under Article 5.3, titled "Steel and Copper Material Price Escalation," permitted an adjustment to the shipyard or a credit to WSF to address fluctuation in steel and copper-based material costs that occurred over the life of the project.[229] As per the contract, the cost adjustment was based on an increase or decrease in the ratio of the US Department of Labor - Bureau of Labor Statistics (BLS) index entitled the producer price index (PPI).[230] Furthermore, the builder's material markup applied to any adjustment was limited to 5 percent. However, it is important to note that, except for Article 5.3, the Olympic Class Part B, in Article 5.2, did not allow for adjustment to the contract price solely due to "(i) inflation or escalation in the cost of labor, materials, equipment or services occurring during the performance of the Contract Work; and/or (ii) any changes in foreign currency exchange rates."[231] Any such increases were at the builder's risk.

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[228] See note 32 above
[229] See note 212 above
[230] U.S. Bureau of Labor Statistics. (accessed September 2022). Producer Price Indexes. https://www.bls.gov/ppi/home.htm
[231] See note 212 above

Table 2-16 provides a sample list of the Olympic Class change orders which include both expected and unexpected change orders. In addition to the expected material price adjustments discussed above, there are multiple change orders for art which were expected, and an unexpected change in the form of rework necessary to meet federal legislation.

Table 2-16: Examples of Expected and Unexpected Change Orders for the Olympic Class

Ferry Project Change Order #	Description Value[232]	VARD Characterization	Observation
Olympic Class CO #16	Art for Tokitae $36,754	Expected	This is a planned expenditure as WSF expected to spend a certain amount on art via change orders. This amount was not included in the fixed price contract; therefore, it is considered “an extra” item.
Olympic Class CO #27	Material Price Escalation $319,766	Uncertain	This is not a design change order. The material price escalation clause in the contract is included to handle material price fluctuation during a project via change orders.
Olympic Class CO #41	Add Americans with Disabilities Act (ADA) Head to Vehicle Deck $253,704	Unexpected	This late design change was costly because it impacted many deliverables. If the need for this change was identified earlier in the design process, this additional cost to modify the design would have been avoided.
Olympic Class CO #57	Art for Suquamish $45,211	Expected	This is a planned expenditure as WSF expected to spend a certain amount on art via change orders. This amount was not included in the fixed price contract; therefore, it is considered “an extra” item.
Olympic Class CO #61	Material Price Escalation	Uncertain	This is not a design change order. The material price escalation clause in the contract is included to handle

[232] WSF. (no date). List of Change Orders [unpublished spreadsheet].

Ferry Project Change Order #	Description Value[232]	VARD Characterization	Observation
	$370,911		material price fluctuation during a project via change orders.

2.4.6.2.3.3 2019 HEOC

In 2019, several predesign studies related to the HEOC were undertaken by Vigor, one of which was the cost savings report directly presented to the Joint Transportation Committee.[233] Following that report, multiple change orders were issued under the Olympic Class contract for the functional design phase of the HEOC. These change orders included an impact to the schedule for the completion of the design stage of the project and had significant impact on costs. The 2019 HEOC functional design contract was essentially a sole-source contract that combined the functions of predesign studies and RCW RFP phase two design development under a contract (Olympic Class contract no. 00-6674) that was not designed for these purposes.

Because construction of the HEOC ferries has not begun, the change management efforts that were reviewed by VARD are related to the cost increases of the functional design only. The change management of the functional design as it applied to the 2019 HEOC procurement is described in Part C of the Olympic Class contract.

- Under Part C, the functional design scope of work included the WSF-specified modifications to the Olympic Class design listed in Exhibit 4 to CO #71 (see Table 2-17). The contractor was required to incorporate each of the listed modifications.
- The shipyard was also expected to evaluate a list of additional WSF-specified candidate design modifications listed in Exhibit 5 (see Table 2-18).[234] The contractor was required to deliver the results of its evaluation for each candidate change to WSF. WSF then determined whether to request a change order. Absent a change order, the contractor was not required to incorporate these changes. Some were later added to the functional design by change order (e.g., the anchor windlass room modification included in CO #73).

[233] Mackie, J. (11 September 2019). [Letter from Senior Vice President, Public Affairs, Vigor Industries to Chairs Hobbs and Fey of the Washington State Joint Transportation Committee and Director Schumacher of the Office of Financial Management].
[234] WSF. (12 December 2019). New Auto 144-Car Ferries Design Contract, Part C, Change Order 71, Functional Design of Hybrid Electric.

Table 2-17: Sample List of WSF-Specified Design Modifications[235]

Number	Stakeholder	WSF Response
2	*Redesign rescue boat pockets to provide more space.*	*Moving life jacket locker and make minor change (cut back) to curtain plate.*
18	*Install different hot water heater for HVAC system.*	*Current sectional boiler is a maintenance problem on all classes of vessels. Current heating and ventilation system will require reconfiguration with the loss of waste hear source from the main engines.*
21	*Change material of fire main system back to Cu-Ni from steel.*	*Material was changed to steel as a cost savings. This has not materialized and resulted in requirement to* line *the piping system with epoxy. Returning to Cu-Ni material will reduce long term maintenance and extend the life expectancy.*
27	*Rework joiner partitions to provide window openings from galley to seating area. Eliminate the half wall enlarging galley seating area to provide a larger area for alcohol consumption.*	*This will allow for line of sight for galley personnel serving alcohol and enlarging the seating to allow for selling additional alcohol. All of the bulkheads are non-fire boundaries and can be modified.*
55	*Relocate flood light above car deck to aim straight down.*	*Outfitting issue should be no cost.*

[235] WSF. (12 December 2019). Change Order Number: 71 – New Auto 144-Car Ferries Design Contract No. 00-6674, Part C (Functional Design of Hybrid Electric); italicized text indicates a direct quote from the cited source

Table 2-18: Sample List of WSF-Specified Candidate Design Modifications[236]

Number	Stakeholder	WSF Response
1	*Enlarge anchor windlass room.*	*Examine options for enlarging anchor windlass room. Pocket can be enlarged by shifting adjacent bulkhead to restroom.*
38	*Consider Z drives.*	*Examine the feasibility of azimuth thrusters. Vigor is accepting proposals for ither Z drives or azipods. The primary constraint is not to have to redesign the hull form.*
43	*Reduce walkway in front of pilothouse to improve visibility.*	*Examine methods to improve line-of-sight. Reducing size will improve visibility for people who do meet the design height of eye.*
68	*Wireless antenna, modify lowering method.*	*WSF will define requirements via owner furnished information (OFI). Improve safety, spec change.*
72	*Isolation valves in various piping systems were reduced in number as cost savings.*	*WSF will provide information on which systems and quantities via owner furnished information (OFI). Valves were reduced as cost savings. Can be added back in with input from SCE on what systems and were the valves need to be.*

The change order documentation as applicable to the 2019 HEOC and as provided to VARD for review is organized and detailed, and includes approved WSF change order forms, Vigor configuration change request forms, Vigor contract report forms with a summary of cost and schedule impacts, and EBDG request for change forms (Vigor's subcontractor for the Part C functional design work). The EBDG supporting documentation included the basis of estimate templates provided by EBDG to Vigor management. Overall, changes to the 2019 HEOC functional design were well-tracked and went through a standard approval process. This process included the use of standard approval forms, as specified by the VEM, that clearly communicated the

[236] See note 235 above

impacts on cost and schedule to WSF. However, while the HEOC extension to the Olympic Class contract was intended to result in minimal changes to the design, the reality of the design modifications was more complex and resulted in significant change orders, see Table 2-19.

Table 2-19: Review of HEOC 2019 Change Order History[237]

Ferry Project Change Order #	Description Value	Observation
HEOC 2019 CO #69	Functional Design $750,000	On 19th September 2019, WSF issued CO 69 to Vigor. This incorporated a proposal from Vigor dated 20th August 2019 for the Functional Design phase of the HEOC. CO #69 set a completion date of September 2020 for the completion of the Functional Design and submission of a final proposal for the build of the first (5th) ferry.
HEOC 2019 CO #70	Functional Design Azimuth Thruster Study $375,065	Change order included the following tasks: 1) Azimuth Thruster Feasibility Study ($125,065.00) 2) Functional design update work at a not to exceed value of $250,000.00.
HEOC 2019 CO #71	Functional Design $7,870,778	CO #71 was issued on 12th December 2019 and represented the final version of Part C contract for functional design. This change order resulted in the most substantial increase to the funding for functional design.
HEOC 2019 CO #72	Vessel Weight Reduction Modifications $290,253	As per Part C, Design-Build Contract No. 00-6674, Exhibit 1, Section 3.2, Vessel Weight, refers to a weight study to maintain a reasonable service life margin. Vigor insisted that it performed and delivered the required weight reduction study, and that Exhibit 1 requirements do not indicate that subsequent

[237] WSF, Vigor, Glosten. Part C, Change Order(s) 69-75, Combined Files. (D220110.T135507-D211029.T111801-00-6674)

Ferry Project Change Order #	Description Value	Observation
		implementation of these weights reductions measures in the functional design as being within the scope of Part C. WSF agreed that this work represents a change that requires an adjustment to the Part C Contract for increased scope, cost, and schedule. The design work covered by this change order could have been included in CO #71 for HEOC functional design without cost or schedule impacts.
HEOC 2019 CO #73	Power Study & Anchor Windlass Room Modifications $227,027	Change Order included the following tasks: 1) Sea trial data and Computational Fluid Dynamics (CFD) analysis at design draft ($139,573.14) 2) Enlarge the anchor windlass room and reduce the Americans with Disabilities Act (ADA) restroom ($71,064.31) This change order is for implementing the candidate design modification that was evaluated by Vigor as part of work completed under CO #71. This design change moved a bulkhead that increased working space in the anchor windlass room and still allowed for an ADA-compliant restroom. However, a total of 15 deliverables not yet submitted were impacted by this design change and a total of 4 submitted deliverables also needed to be revised.[238] 3) Addition of isolation valves in various systems ($10,944.63). This relatively small change order is for implementing the candidate design modification that was evaluated by Vigor as part of work completed under CO #71.

[238] Vigor Fab, LLC. (6 September 2020). Change Order Proposal. Change Control Request (CCR) 1004.

Ferry Project Change Order #	Description Value	Observation
HEOC 2019 CO #74	Modification for Fleet Input $199,098	Change order included the following tasks: 1) Rescue boat space modifications ($93,470.31). Rescue boat and pocket modifications were required to accommodate a new, larger rescue boat. This change order had an impact on schedule for completion date of functional design (moved from January 6 to February 17, 2021). This costly late design change could have been avoidable if the need for the larger rescue boat was identified earlier in the design process. 2) Miscellaneous Electrical System modifications ($87,314.42)
HEOC 2019 CO #75	Additional Modification to Support HEOC Design and Project Delays/ Schedule Compression $656,906	Change order included the following tasks: 1) Project schedule extension and schedule delay claim ($375,000). This cost should be avoided as part of good management practices, and it is a direct consequence of multiple changes orders that significantly impacted the operations of the contractor/ sub-contractor. The lengthening of the project schedule corresponded to an approximately 20% increase in original functional design agent scope by dollars for configuration change orders that posed a significant impact on the HEOC ferry functional design. 2) Modification to fuel fill level and tank configuration ($162,846.97). This costly design change was critical for the overall life cycle and maintenance of the future vessels, but it could have been avoided if the need for this modification was identified at the preliminary design stage. This design change facilitated a future fuel related weight reduction and added volume for cableways.

Ferry Project Change Order #	Description Value	Observation
		3) Bolted access hatch for battery installation/replacement ($87,393.63). This change order implemented important modifications to the functional design for bolted equipment removal plates (BERPs) that are required for HEOC battery installation/ replacement. This modification was needed to facilitate battery room technological upgrades in the future. This design change also could have been avoided as it should have been a key consideration at the early stages of HEOC design.
HEOC 2019 CO #76	Additional Modification to Support HEOC Design $303,859[239]	Change order included the following tasks: 1) Upgrade passenger elevator design ($99,669.20) This costly design change should have been avoided. The passenger elevator model should be selected and integrated into the HEOC functional design at an earlier stage when this change would not impact many submitted and/or approved deliverables. 2) Functional Design Review compared to RevA Technical Specification ($87,751.41) 3) Increase use of non-metallic piping ($44,136.12) This design change was implemented to try to further reduce the vessel weight by replacing heavier metallic piping with lighter non-metallic piping where appropriate. This design change was one way to reduce the vessel weight in addition to the vessel weight reduction modifications completed under CO #72.

[239] WSF. (21 December 2021). Hybrid Electric Olympic Spend Plan Rev 16. [unpublished spreadsheet].

In addition to the change orders that were prepared, discussed, and executed there were other change orders which were prepared but not implemented. For example, design work for the electrical charging system was not progressed under the HEOC contract but was subsequently explored under a separate contract (see Section 3.4.2.4).

2.4.7 THROUGH LIFE COST OPTIMIZATION

2.4.7.1 WSF'S DOCUMENTED POLICIES

2.4.7.1.1 PREDESIGN STUDIES

The WSF VEM[240] does not explicitly detail how construction cost reduction, lifecycle costs, or efficiencies are considered for a new construction project. There is reference in the VEM Chapter 2, Section 2-9 E to the project engineer being responsible for considering lessons learned from previous projects when developing the work scope. This may lead to some consideration of lifecycle costs by leveraging lessons from previous vessels.

WSF does not have documented policies as guidance to follow with respect to the content of the required predesign studies for newbuild ferries. The OFM predesign manual includes guidance on analysis of alternatives, use of life cycle cost models, a predesign checklist, and other useful information; however, it is not tailored to ferry procurement projects and cannot be followed as written by WSF, as many items and much guidance is tailored to civil engineering projects, while no items are specific to shipbuilding challenges or processes.[241] The legislature provided some minimum requirements in the body of RCW 47.60.385; however, these predesign study requirements are written for the different types of projects, including terminal improvement and vessel improvement, and are not all relevant to new construction.

2.4.7.1.2 NEW CONSTRUCTION

WSF currently does not have standard specifications for newbuilds. A detailed technical specification was developed for the Olympic Class RFP.[242] WSF later revised these specifications, as needed, based on a "living" document approach. WSF also explained that, in the past, new vessel construction projects occurred one after the other and had unique requirements; also, there was a lack of available personnel; as a result, standard specifications were not developed.[243]

For the 2019 HEOC procurement, WSF developed the HEOC Technical Specification that was initially released in April 2020 and has since been revised several times, with the latest available

[240] See note 1 above
[241] OFM, Capital Budget Division. (June 2022). 2023-25 Budget Instructions, Part 2, Chapter 8: Predesign Manual. https://ofm.wa.gov/sites/default/files/public/budget/instructions/capital/2023-25/Chapter8Predesign.pdf
[242] WSF. (July 2006). 144-Auto Ferries Design and Build Contract No. 00-6674. Volume IV. Technical Specification.
[243] See note 45 above

version updated in July 2021.[244] According to WSF, one of the planned activities is to develop a WSF Vessel Design Standards Manual from the existing HEOC Technical Specification.[245] As further discussed in Section 3.4.2.1, WSF plans to include this updated set of design standards as part of future RFPs.

2.4.7.1.3 PRESERVATION AND MAINTENANCE

WSF noted that currently there are standard specifications that are used for preservation, and maintenance projects, included in the VEM.[246] Appendix L of the WSF VEM has the list of WSF standard specifications (all of which were last updated in September 2000) which are used to create drawings and write specifications for preservation, and maintenance work and include the following topics:

- Deck coverings
- Electrical systems
- Insulation, lagging, and linings
- Marine coating and color scheme (paint)
- Piping systems
- Structural installations and repairs.

These standards in turn reference CFR chapters, NVICs, standards from other governmental bodies such as the United States Public Health Service (USPHS), standards from national associations such as the National Fire Protection Association (NPFA), standards from international associations such as the World Health Organization (WHO), standards from industry bodies such as the Institute of Electrical and Electronic Engineering (IEEE), Society for Protective Coatings (SSPC), and American Society for Testing and Materials (ASTM) International, and rules and guides from classification societies such as ABS. [247]

2.4.7.2 WSF'S PRACTICES

WSF has provided for VARD's review many examples of predesign studies that were completed as part of previous ferry procurement efforts (see Sections 2.4.7.2.1.1 and 2.4.7.2.1.2). Also, WSF has provided the details for the planned predesign studies for the 124-auto ferry program.[248] The number and content of the predesign studies differ for each ferry program. These decisions are made by WSF project staff in the early preliminary engineering phase and are based on various factors, not limited by RCW and OFM specific requirements. In the past, WSF hired outside consultants to complete the predesign studies, including Glosten, Jensen Maritime Consultants, and EBDG.

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[244] WSF. (2020). HEOC Ferry Technical Specification (36241-012-0001-A).
[245] See note 45 above
[246] See note 45 above
[247] See note 1 above
[248] See note 180 above

The 2022 HEOC RFI included the following statement in relation to making changes to the owner's model: "Changes may also be made to increase competitiveness (e.g., by reducing lifecycle cost and/or improving performance). All deviations from the owner's model should be explained and justified in the Technical Report."[249] This statement demonstrates that WSF is keeping in mind the potential future operational efficiencies of the HEOC design and is open to considering input from bidders even though the owner's model is based on a USCG-approved functional design. However, as WSF is required to accept the lowest bid as the basis for contract award (RCW 47.60.820), it is not clear what incentive bidders have to propose measures that will reduce lifecycle cost (or improve performance) if this comes at an increase in detailed design and construction cost. Section 3.6 lists some areas in which procurement cost and through life cost may involve trade-offs. Section 4.3.2.5 suggests an alternative to the low bid requirement.

For the electrification of future vessels, the WSF System Electrification Plan recommends investigations into technologies to increase automation and allow for efficient power and battery management and automatic connection and disconnection from the RCS. For the new 124-auto class, the plan recommends considering the use of auto-crossing, auto-docking, and restraint systems to improve the safety and efficiency of the future ferries.[250] While this would add additional capital cost in the form of design complexity and equipment, it would result in improved future efficiencies by reducing crew size and reducing fuel/energy requirements.

The use of the life cycle cost model as required by RCW 47.60.345 (see Section 2.3.6.1) has informed some future vessel requirements by highlighting high-cost drivers, reliability, and commonality.[251]

2.4.7.2.1 PREDESIGN STUDIES

2.4.7.2.1.1 OLYMPIC CLASS

As detailed in Section 1.4.2, WSF undertook considerable effort to develop the Olympic Class requirements. Table 2-20 provides a sample list of predesign studies that were incorporated into the development of the outline specification and owner's model that was provided to bidders as part of the Olympic Class RFP package (see Section 1.4).

[249] See note 156 above
[250] WSF. (December 2020). Washington State Ferries System Electrification Plan Appendix B: Task 4: — Vessel Functional Requirements. https://wsdot.wa.gov/sites/default/files/2021-11/WSF-System-Electrification-Plan-Appendices.pdf
[251] See note 45 above.

Table 2-20: Sample List of Completed Olympic Class Predesign Studies[252]

Title	Author	Date
Results of calm water model tests for WSF double ended ferry	Glosten Associates	31 January 2005
Propulsion Study for a New 130 Car Ferry	Jensen Maritime Consultants	29 December 2003
Results of CFD computation of wake wash from WSF double ended ferry, 2nd hull version	Glosten Associates	4 January 2005
Model resistance propulsion, Streamline, wake and wash wave tests in calm deep water	Glosten Associates	27 March 2006
Increased Capacity Feasibility Study	Glosten Associates	unknown
Cost Benefit Analysis for Aluminum Superstructure	Glosten Associates	unknown

2.4.7.2.1.2 HEOC

Table 2-21 provides a sample list of predesign studies completed for the HEOC program. The initial Hybrid Feasibility Study, completed by EBDG at a high level, provided a list of changes needed to convert the Olympic Class design to use a hybrid-electric propulsion system. This and other studies explored the battery capacity and size of the propulsion systems required by different route profiles. Other predesign studies investigated propulsion system modifications. These and other studies completed by both Vigor and WSF, see Table 2-21, demonstrate that while the HEOC was, on the surface, simply a change in propulsion system for an existing class, there were still predesign efforts undertaken to optimize the conversion to hybrid-electric and to explore other design changes which could improve future operational efficiencies.

As an example of the use of option analyses, these studies explored trade-offs for battery bank design. One decision has been to standardize all vessels for the longest route to provide operational flexibility, at the cost of requiring a larger battery capacity for every vessel. Another approach is to accept a short initial battery life to allow the battery bank size to be reduced (saving on weight, space, and up-front costs), with the expectation based on the rate of improvement in battery technology that replacement batteries will offer better performance by the time that the

[252] These have not been reviewed by VARD, but these were part of a WSF provided list of hard copies of archived material from phase one of the new 144-auto ferry construction.; WSF. (26 August 2022). WSFs Hard Copy Document Inventory Vessel New Construction Program 26 Aug 22 [unpublished spreadsheet].

initial set have to be replaced. Standardization for interoperability is often a feature of ferry procurements, for example, in Norway and British Columbia. Battery life/size decisions have been part of various hybrid designs undertaken by VARD.

As noted in Section 2.3.6.3, predesign studies should evaluate long-term costs including fuel efficiency, preservation, and staffing. Previous WSF predesign studies for either the HEOC or Olympic Class have not evaluated long-term staffing costs or the possibility of crew reductions through more automation onboard its vessels. The crew will require more specialized training to operate hybrid technology, and WSF includes that as a requirement in the design-build contract for HEOC. With increasing turnover rates of crew members, it is possible that an increased training budget will be required in future years to train new hires or crew members who are not familiar with hybrid technology.

Table 2-21: List of Completed HEOC Predesign Studies

Title	Ref. No.	Author	Date
Hybrid Feasibility Study[253]	18091-001-070-1	EBDG	28 February 2019
Hybrid Life Cycle Cost Analysis: Seattle-Bremerton Route[254]	18091-003-070-3	EBDG	28 February 2019
Hybrid Life Cycle Cost Analysis: Mukilteo-Clinton Route[255]	18091-003-070-2A	EBDG	28 February 2019
Hybrid Dwell Time vs. Transit Speed Analysis: Seattle-Bremerton Route [256]	18091-003-070-4	EBDG	31 May 2019
Azimuth Thruster Feasibility Study[257]	36241-245-0005	EBDG	11 December 2019

2.4.7.2.1.3 124-AUTO FERRY PROGRAM

Table 2-22 provides a sample list of WSF's planned predesign study topics for the upcoming 124-auto ferry program; WSF has requested funding for these in the 2023-25 biennium. The study of applicable advance technologies will look at future operational efficiencies such as machine learning that can improve safety and minimize fuel/energy consumption. The pilothouse study will investigate the benefits and impacts on operations of only having a single pilothouse on a

[253] EBDG. (28 February 2019). Hybrid Feasibility Study (18091-001-070-1).
[254] EBDG. (28 February 2019). Hybrid Life Cycle Cost Analysis: Seattle-Bremerton Route (18091-003-070-3).
[255] EBDG. (28 February 2019). Hybrid Life Cycle Cost Analysis: Mukilteo-Clinton Route (18091-003-070-2A).
[256] EBDG. (31 May 2019). Hybrid Dwell Time vs. Transit Speed Analysis: Seattle-Bremerton Route (18091-003-070-4).
[257] EBDG. (11 December 2019). Azimuth Thruster Feasibility Study (36241-245-0005).

double ended ferry (the current WSF fleet has dual pilot houses) which could reduce construction costs. As discussed in Section 1.3.3.1, a concept design will help WSF define requirements, develop a preliminary cost estimate, and illustrate WSF's intent to potential bidders during the industry engagement and RFP phases. A concept design may also highlight additional areas for WSF to explore trade-offs and investigate potential improvements.

Table 2-22: List of Planned 124-auto Ferry Predesign Studies[258]

Topic
Advance technologies (machine learning, automation, hazard detection, etc.)
Vessel energy storage and terminal electrification requirements for Vashon Triangle route
Single pilothouse versus dual pilothouse
Concept design (see definition in Section 1.2)

3 VOLUME 3: BEST PRACTICES

Key points:

- WSF follows typical industry practices in its approach to estimating the costs of new ferries and is increasingly using WSDOT practices for some aspect and stages of the work. However, for estimation of overall project costs there is very little formal documentation of practices and a heavy reliance on the expertise and experience of key personnel. Several legislative requirements apply very stringent requirements to overall cost estimates and to assigning contingencies to budgets. These may lead to severe impacts on future programs.
- Ferries can be quite complex vessels and their procurement incurs technical, cost, and schedule risk. WSF should identify and manage risks throughout projects. At present, it has a limited set of policies and practices for this. The WSF contracting approach aims to transfer almost all risk to the shipbuilder, but this may lead to higher costs and to substantial risk of overall project failure.
- Cost management for a project starts at the earliest stage by setting technical and contractual requirements with an awareness of which factors drive cost and where cost-benefit trade-offs can be made. WSF has addressed technical factors on past and current projects and understands contractual factors but has few documented processes for this. Following contract award, cost control is exercised largely through change management.
- Introducing change becomes increasingly expensive as a project progresses, and particularly after the start of construction. However, changes should be encouraged at

[258] See note 180 above

earlier stages where they offer the potential for through life cost reduction or cost-effective performance enhancement. WSF has a robust change management approach, but legislative requirements constrain its flexibility.

- Most of the cost of a ferry relates to its operations over the course of its life, for crewing, fuel, and maintenance. Decisions, at the design stage, will "bake in" most of this cost, and through life cost reduction will sometimes conflict with procurement cost reduction. WSF faces conflicting requirements in estimating and controlling through life cost.
- Legislation requires that WSF engages an Independent Owner's Representative (IOR) to undertake key project management functions for ferry procurement. While WSF typically utilizes contracted support to assist with projects, the IOR's mandate is unusual and is not well-aligned with normal public sector accountability principles.

3.1 INTRODUCTION

This volume addresses some specific procurement features and best practices related to the legislative requirements for WSF ferry procurement in order to answer the study questions detailed in Section 1.1.2. To fully answer the study questions related to best practices, VARD has first used the general design-build process described in detail under the Section 1.3 to highlight a set of best practices that in VARD's experience are most critical to the overall success of a ferry procurement project; with the overall objective of delivering vessels which:

- Meet the service needs of the operator's clients
- Have construction costs aligned with appropriate budgeting expectations
- Are delivered on a timeline that addresses fleet renewal and upgrade requirements
- Support other public policy objectives established by the State of Washington.

The first three overall objectives are common to any ferry/vessel owner/operator. The last is a requirement for many public sector operators, though specific policy objectives will vary between jurisdictions.

For each topic, VARD has structured this volume by first discussing the industry best practices and then explaining how they align with WSF's practices. VARD decided on which best practices to recommend by a combination of VARD's experience, and relevant literature review.

VARD tailored the best practices described in this volume to the design-build approach currently mandated under RCWs. However, as discussed in Section 1.5, this is not the only potential procurement model for ferries, and in fact has not been used in a "pure" form on any WSF project to date. VARD has also provided details on how and where an alternative approach could influence a best practice.

3.2 PUBLIC POLICY

WSF Public policy objectives are discussed first due to their importance in setting the overall procurement approach They are desired outcomes that policymakers want to achieve and can vary greatly depending on the area of the world and economic conditions. WSF procurement is

governed by many Washington State policies, but for the purpose of this review the most important are:

- Environmental policy
- Build In Washington
- Bidder apprenticeship program
- Small Business Enterprise participation.

Environmental policy is a type of technical constraint that is commonly applied by both public and private sector clients. VARD frequently encounters similar requirements in projects ranging from ferries to wind farm support vessels. Washington State-specific environmental policies have led to the selection of a hybrid-electric drive for the HEOCs, and (presumably) for most or all future ferry classes. This type of policy influences some elements of best practice in contractor selection and in cost estimation.

Build in Washington may not apply in all cases, but the current exception to this is not formulated clearly. As noted in Section 2.3.2, if the low bid is more than 5% above the engineer's estimate, then the procurement must be re-started on a US-wide basis. This is a very arbitrary basis for a decision that will delay the project significantly, cost a significant amount, and incur many other challenges, such as how the apprenticeship and SBE requirements could or should be applied to such a re-initiated procurement. Even the best engineer's estimate has difficulty being within 5% of any bid price, as a bidder not only calculates its direct costs using proprietary and sensitive information, but also applies its estimates of risk and considerations such as financing and cash flow, which are very difficult for an outside organization to assess accurately. Level playing field bids such as the Staten Island Ferries referenced in Section 1.6.1.2 can differ by 30% or more. Shipyards rarely submit price-based proposals if they do not consider that they could be the low bidder. Cost estimation is discussed again at Section 3.8.

Currently, the initial RFP for a WSF procurement is restricted to in-state bidders. If their bids do not meet the 5% rule, a subsequent RFP can be opened to all US shipyards. Bids in this second round may or may not be lower than those in the first round, but the sole criterion for award will remain lowest technically compliant offer. Therefore, the procurement will go from full preference for in-state bids to zero preference.

As noted in Section 2.3.4.1, as the apprenticeship and SBE programs are tied to specifically Washington state legislation, they are incompatible with anything other than a Build in Washington project approach. If building in state is made mandatory, the requirements for the apprenticeship and SBE programs can be retained as-is. Because there is an exception to the Build In Washington law, how provisions for these types of programs can be included in the contract when there is no requirement to build in-state should be given further attention.

Other aspects of the procurement approach that may require review for a second RFP are the prequalification/down select approach and the level of bid detail/honorarium. It may be

considered desirable to ensure that at least one in-state bidder is included in the full process. It may also be considered undesirable to provide one or more large honorarium payments to out-of-state bidders. These are both potential issues of the current process.

3.3 INTERNATIONAL V. DOMESTIC CONSIDERATIONS

Overall, it is evident that the design-build approach for procuring ferries is more common outside of the United States, while there are only a few recent examples of domestic programs that used this approach, aside from its use by WSF (namely, AMHS).

There are no fundamental differences in best practices between domestic and international ferry procurement programs. However, legislative requirements constrain individual owners to a greater or lesser extent depending on where in the world they operate. In the US, the Jones Act limits both public and private sector owners to using only US shipyards. In other countries, public sector organizations may have similar requirements for domestic preference, and private operators may be faced with tariffs or encouraged by incentives to use local suppliers. Sanctions may also limit the ability to use certain sources of supply. The US is an outlier in terms of the level of restrictions, but its approach is not unique.

Similarly, public sector procurement in most countries is generally subject to more constraints than is its private sector equivalent. These range from how funding can be raised to policies such as set asides for various business types.

3.4 SERVICE NEEDS

3.4.1 INTRODUCTION

While there are more steps listed in the overall general design-build contract process (detailed in Section 1.3), the most critical elements for which best practices should be established include:

- Forecasting and planning (see Sections 1.3.1, 1.3.2, and 1.3.3)
- Assembling the owner project team (see Section 1.3.4.2)
- Developing project technical requirements (see Sections 1.3.2 and 1.3.3)
- Integrating ship- and shore-side solutions (see Sections 1.3.2 and 1.3.3)
- Contractor selection (see Section 1.3.4)

3.4.2 INDUSTRY BEST PRACTICES

3.4.2.1 FORECASTING AND PLANNING

WSF has a reasonably robust system for developing and updating its Long Range Plan.[259] The publication of this plan was preceded by extensive public engagement,[260] and included generating inputs from executive, policy, and technical advisory groups with a range of representation, covering four close-set pages in the plan's Appendix M. The resulting plan itself is a detailed document covering themes including:

- Providing reliable service
- Enhancing customer experience
- Managing growth
- Ensuring sustainability and resilience.

The WSF approach is industry-leading, based on comparisons with other ferry operators as listed in Section 1.6. For example, BC Ferries has not recently published an overall strategic plan of similar scope, though its annual reports cover the same themes in rather less depth. AMHS do not appear to have any similar recent documentation.

Since the publication of the most recent version of the WSF Long Range Plan, there have been extreme shocks to the social and economic context, including the COVID-19 pandemic and its impacts on supply chains, staffing, inflation, etc. WSF is working on an update to the overall plan, and it is in the final stages of development. This updated plan will be published earlier than the normal 10-year cycle to adjust certain elements.

The WSF System Electrification Plan (SEP), published in 2020, builds upon the 2040 Long Range Plan. The SEP determined high-level feasibility and identified guiding requirements for vessel and terminal improvements.[261]

3.4.2.2 ASSEMBLING THE OWNER PROJECT TEAM

Failure to adequately resource a project team is a well-documented cause of failure in ship (and other) procurement programs. The team needs to have appropriate expertise and an adequate level of available effort. This needs to be tailored to the procurement approach, whether design-

[259] WSDOT. (January 2019). *Washington State Ferries 2040 Long Range Plan*. https://wsdot.wa.gov/sites/default/files/2021-10/WSF-LongRangePlan-2040Plan.pdf

[260] WSDOT. (August 2022). *Washington State Ferries Long Range Plan public involvement*. https://wsdot.wa.gov/travel/washington-state-ferries/about-us/washington-state-ferries-planning/washington-state-ferries-long-range-plan/washington-state-ferries-long-range-plan-public-involvement accessed August 2022

[261] WSDOT. (December 2020). *System Electrification Plan*. https://wsdot.wa.gov/sites/default/files/2021-11/WSF-SystemElectrificationPlan-December2020.pdf

build, design-bid-build, or other[262] and also to the specific challenges and risks of the project. Defining resource requirements is an important early-stage project challenge.

WSF retains a level of project management and engineering expertise in-house and has traditionally supplemented its in-house capabilities by making use of support contracts of different types. It has standing offer supply contracts for small/medium levels of effort with consultants of various types, and issues targeted RFPs for larger packages of work such as the pending engineering support for the next ferry class. WSF can also draw on the resources of WSDOT for assistance with certain aspects of project management support in areas such as legal advice and contract formulation. In general, this approach appears to have worked satisfactorily in some recent projects. However, the current system appears to rely heavily on the experience and expertise of a few key individuals. Documents reviewed by VARD do not contain sufficient detail about succession planning including recruitment and training. These are potential challenges for the future. A less-experienced in-house team may also have greater difficulty in defining its support needs.

The IOR approach, which is currently mandated by RCW, has been discussed at Section 2.3.3. VARD does not consider assigning that degree of authority to an IOR to be a best practice and it is not followed in any of the other ferry procurement projects that have been reviewed. An alternative approach would be to allow WSF to define the role of the IOR based on its own resource needs.

In 2020, Vigor had selected ABB to provide the hybrid-electric propulsion and energy storage systems for the HEOC ferry program.[263] ABB, a global technology leader in providing hybrid-electric propulsion solutions, added the essential new technology expertise to the Vigor team. ABB, acting as the single system integrator (SSI), selected Spear's Trident batteries, as the preferred technical solution for the HEOC ferries.[264]

Siemens Energy was repeatedly hired by WSF due their expertise in marine electrical systems. In 2021, WSF contracted Siemens Energy and its subcontractor, Glosten Associates (Glosten), to evaluate the suitability of the rapid charging system (RCS) developed for the Jumbo Mark II Class for installation on the HEOC ferries.[265] WSF contracted Siemens Energy for this work because the

[262] Design-Build Institute of America. (February 2014). *Design-Build Done Right – Universally Applicable Best Design-Build Practices*. https://dbia.org/wp-content/uploads/2018/04/Best-Practices-Universally-Applicable.pdf

[263] Ship-Technology. (5 June 2020). *ABB to Provide Hybrid-Electric Propulsion to Vigor.* https://www.ship-technology.com/news/abb-hybrid-electric-propulsion-vigor/

[264] Spear Power Systems. (October 2020*). Spear and ABB Marine & Ports Collaborate with Vigor on Electrifying Washington State Ferries' Fleet*. https://www.spearpowersystems.com/wp-content/uploads/2020/10/Spear-WSF-PR-approved-ABB-r0.pdf

[265] See note 166 above

company initially developed the RCS under the Jumbo Mark II Class hybrid conversion contract. For further discussion, see Section 2.4.3.2.4.

WSF identified the need to supplement its project management and engineering staff with a general engineering consultant. In 2022, WSF is preparing an RFP for general engineering support for the WSF Electrification Program, consisting of both vessel and terminal projects, with an agreement amount of approximately $15 million.[266] The use of a general engineering consultant is a practice used on past projects. According to the published request for qualifications (RFQ), WSF is planning to use a general engineering consultant team to support WSF engineering staff in many areas, including but not limited to: general contract administration, project controls and scheduling, Cost and Risk Assessment (CRA), Cost Estimate Validation Process (CEVP), Value Engineering (VE), naval architecture, marine engineering, terminal and vessel integration, feasibility studies, and predesign studies.[267]

3.4.2.3 DEVELOPING PROJECT TECHNICAL REQUIREMENTS

An owner must be able to convey its requirements to the shipbuilder in a manner that defines the required characteristics of the delivered vessel(s). This can be done in many ways and in different levels of detail. At the top level, it will always be necessary to cover aspects such as speed and cargo capacity and constraints such as draft and length, if applicable. At a more detailed level, if there is a need for (say) a 60-year life expectancy, then typical shipbuilding standards may need to be supplemented by requirements for material selection, structural fatigue analysis, etc. As noted in the Section 1.3.3, all requirements cost money and so it is important that only requirements that are truly necessary are prescribed. “Nice to have” aspects can be identified but are unlikely to be offered where low bid is the only basis for selection. Requirements should be SMART – Specific, Measurable, Appropriate/Achievable, Realistic and Timely/Traceable.

In a design-bid-build project, the owner will work with a designer to develop a package of drawings and specifications that encompass the technical requirements. This can and should be accomplished as a team effort. For any operation, including a ferry service, the owner has unique insights that are important to design development. In design-build, the engagement with bidders during the equivalent design phase can be more challenging, as it is necessary:

- to avoid providing direction that can confuse the issue of design responsibility
- to maintain a level playing field, that gives the same key information to all participating bidders.

For these reasons, it is particularly important to have a reasonably full and mature set of requirements before initiating a design-build contract, as there is less flexibility to introduce

[266] See note 159 above
[267] WSDOT. (31 August 2022). WSDOT Notice to Consultants: WSF System Electrification Program General Engineering Consultant. https://wsdot.wa.gov/sites/default/files/2022-08/2022-WSF-System-Electrification-Program-RFQ.pdf

change during the process. With a design-build approach, the bidders are provided with functional requirements, in the form of an outline specification, generated from predesign studies. During the design development phase, the bidders have flexibility in defining how the provided set of requirements will be met in their technical proposals while complying with a set of design standards.

There is no universal "best practice" that can be applied to every element of requirements formulation and verification. For example, speed may be expressed as a set of performance requirements, such as normal (cruise) speed of X knots and maximum speed at 100% power of Y knots. Potentially, a bidder can demonstrate compliance by analysis or by model testing. The latter is considered more accurate but is more expensive and time consuming. Deciding whether to require bidders to present model test results for their designs is a judgement call.

However, it is necessary to set some form of measurement/verification check for every requirement, and to decide at what stage in the procurement this verification has to be provided. The current HEOC procurement, while nominally a design-build approach, has quite a mature design (functional design level of detail) provided as an owner's model. Bidders will be able to adopt this design; and presumably, if they wish to change any aspects of this design, they will be required to demonstrate a similar level of compliance. Based on the budgets allocated for the 124-auto ferry[268], it appears that for the next ferry design project it is envisaged that bidders will be required to develop a similar functional design level of detail. This is at the high end of practices in other design-build projects, where owners require packages at a preliminary to a basic design level. From the bidder's perspective, this can be sufficient to develop a fixed price bid with limited contingencies. From the owner's perspective, this should also be adequate to allow for verification of compliance with key requirements. Limiting the scope of the competitive phase of design development can reduce overall project schedule and cost and also reduce the burden on the owner's team resources who have to review each technical proposal. WSF should consider such scope reductions in developing its future RFPs.

3.4.2.4 INTEGRATION OF SHIP AND SHORE FACILITIES

The efficient operation of many ship types, with ferries being a prime example, requires the integration of ship- and shore-side elements of the system. Ferries must be able to dock and undock safely and rapidly. Ramps and gangways must allow for rapid transfer of passengers and vehicles. Supplies of fuel (energy) and other consumables must be sent on-board, and wastes removed. Roads, parking lots, and waiting areas at the terminals need the capacity to handle those waiting to board, and to clear those disembarking. Arrangements may be needed to transfer passengers to and from other forms of mass transit or ride sharing.

For WSF, much of this is considered in general terms under the Long Range Plan but changes to technologies and practices may occur more rapidly than anticipated and in unforeseen ways. As

[268] See note 108 above

an example, for the electrification of the ferry fleet, the move from diesel fuel to electric energy requires WSF to verify the adequacy of electric feed systems in terms of capacity and reliability. The WSF System Electrification Plan noted that Energy Storage Systems (ESS) are anticipated at four WSF terminals (Clinton, Kingston, Bremerton, and Seattle) based on best available estimates of local grid capacity.[269]

The transition to a hybrid-electric fleet also requires the installation of rapid charging infrastructure at the terminals and compatible equipment on the ships. Work is in progress related to the rapid charging system and is discussed separately in Section 2.4.3.2.4.

Best practices in this area also include not being too close to the leading edge of technology insertion, often referred to as the "bleeding edge". As ferries represent an essential public service, the possibilities of delays or interruptions due to immature or unproven technology should be avoided. If this philosophy clashes with other public sector priorities it may be necessary to add redundancy features to the design or, to the service as a whole, by providing back-up.

3.4.2.5 CONTRACTOR SELECTION

The selection of the contractor(s) who will deliver a project is one of the most critical elements in the overall process. There is a surprising dearth of literature on best practices associated with this topic and so the discussion below draws heavily on VARD's experience participating in many contractor selections, with external citations where available and appropriate.

With almost any ferry procurement, there will be a selection of a designer and a builder. In design-build, they will be selected simultaneously, while in design-bid-build, selections will be separate processes. Some organizations include both design and build capability but for ferries some or most elements of design work are typically undertaken by specialized designers.

The basic design will drive much of the cost of the build and also the majority of the through life cost of the ship (or class of ships). However, the work itself may represent only 5% of the cost of the first ship built. Therefore, the selection of a designer will normally focus on factors such as experience, expertise, and the ability to offer innovative solutions rather than on low bid, though price will normally either be an evaluation criterion or a declared budget for the work.

The build phase represents the majority of total project cost, and so the bid price is likely to be a much larger factor in contractor selection. Other factors, such as compliance with schedule, quality, contract terms, and other items can be made mandatory pass/fail criteria or can be considered but given lower weighting importance than price. In VARD's judgment, best practice is to give some importance to issues that are considered risk factors for cost, schedule, or quality, as even if the builder takes most or all of the direct risk, the owner will still incur the consequential impacts of a failed procurement, which may include cost, schedule, quality, and reputation.

[269] See note 261 above

In design-build, and particularly in progressive design-build as practiced by WSF, the challenge is to combine both aspects of selection in a manner that does not compromise the ability to end up with a good design and a competitive price. The initial down-select to a short-listed set of bidders needs to elicit information that can be useful for both aspects. BC Ferries' requirement for a concept design at the short-listing stage helps to provide this – the design can be assessed as an initial indicator of the quality of design work and for probable cost relative to other solutions.

Builder selection factors which have been identified in other work are shown in Figure 3-1. This is a long list, and the process of developing specific criteria for many items can be challenging, as can the assignment of relative importance. However, it is considered a best practice to allow for ranked consideration of items other than solely low bid. The process used can also help with determining appropriate levels of contingency to include in project budgets.

Under the current WSF default contracting approach, which assumes very limited competition under a set of Build in Washington constraints, the shipyard options are very small in number. However, if competition is opened up to US shipyards, the contractor selection process will become much more important.

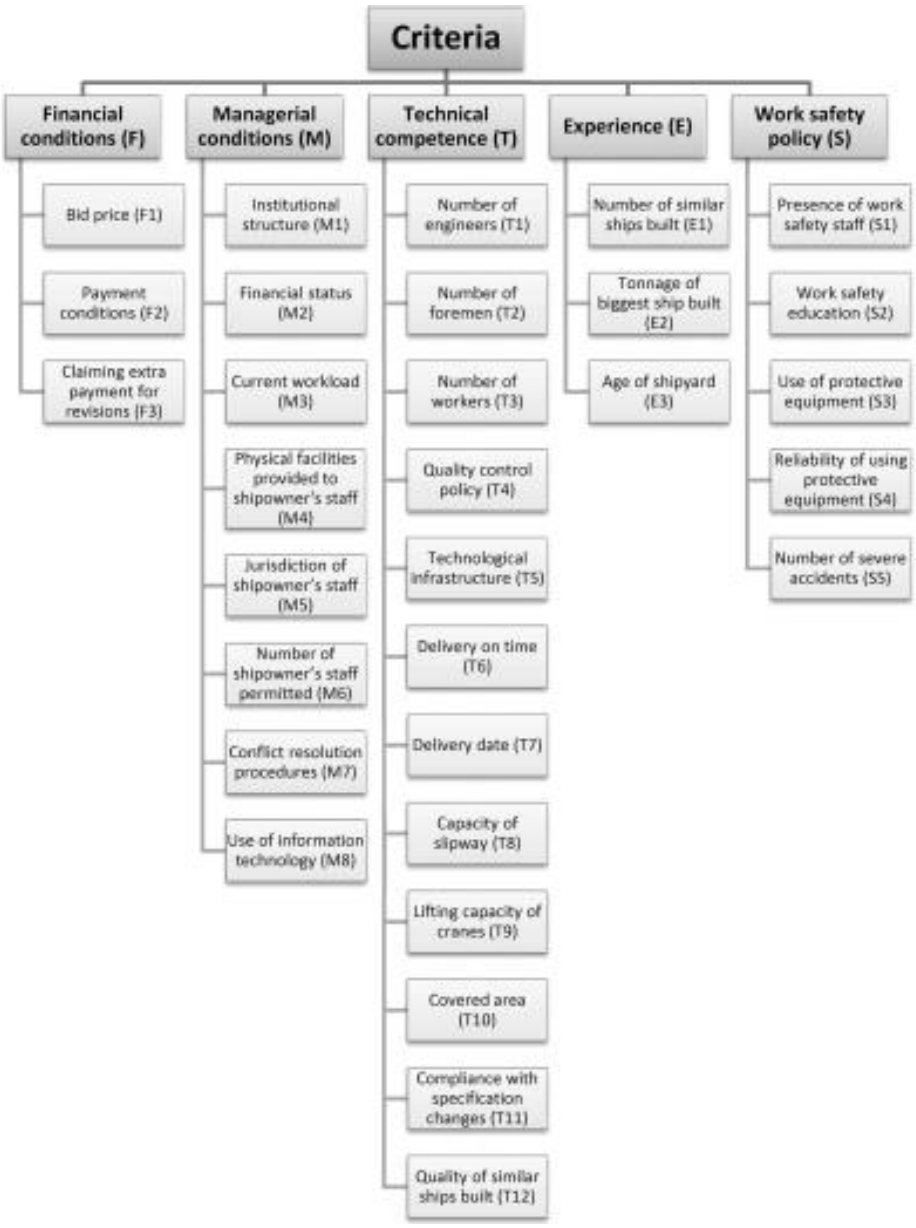

Figure 3-1: Shipyard Selection Criteria[270]

[270] Kafalı, M. & Özkök, M. (2015) Evaluation of shipyard selection criteria for shipowners using a fuzzy technique. *Journal of Marine Engineering & Technology,* 14(3), 146-158. https://doi.org/10.1080/20464177.2015.1118787

3.4.3 WSF'S ALIGNMENT WITH BEST PRACTICES

3.4.3.1 FORECASTING AND PLANNING

WSF's approach to forecasting and planning is considered to be aligned well with best practices. WSF developed and updated several forecasting and planning documents that follow industry-leading practices, including the WSF Long Range Plan. WSF is currently developing an update to the Long Range Plan that will account for recent shocks to the social and economic context.

3.4.3.2 ASSEMBLING THE OWNER PROJECT TEAM

In general, WSF's approach to staffing its projects is reasonably well aligned with best practices, namely the practice of supplementing its in-house capabilities by making use of support contracts of different types, including with industry technology experts like Siemens. However, to avoid potential challenges in the future, WSF should address the issue of succession planning for its in-house personnel with key project management and engineering expertise. Also, as required by the RCW, WSF has hired an external consultant as an IOR for the re-initiated HEOC program. And while the contract's SOW does not use the same language as the RCW, in VARD's professional opinion, WSF's SOW is in line with best practices, where their role is to support the owner and supplement in-house resources.

3.4.3.3 DEVELOPING PROJECT TECHNICAL REQUIREMENTS

WSF's approach to project technical requirements is reasonably well aligned with best practices. WSF generally follows the best practice of developing a full and mature set of requirements before initiating a design-build contract. While an owner's model was developed and provided in the past to potential bidders, WSF communicated its intention not to develop one for future design-build procurements. However, WSF should consider limiting the scope of the competitive phase of design development, which may reduce overall project schedule and cost, as well as reduce the burden on the owner's in-house resources who must review each technical proposal.

3.4.3.4 INTEGRATION OF SHIP AND SHORE FACILITIES

WSF's approach to integration of ship and shore facilities is reasonably well aligned with best practices. WSF is planning and executing the electrification of its terminals in parallel to its conversion work to hybridize existing vessels and to its procurement of new vessels (for further discussion about ship and shore facilities, and best practices, see Section 3.11.1).

3.4.3.5 CONTRACTOR SELECTION

WSF's approach to contractor selection is not well aligned with best practices, and this process will become more important if competition is opened up to out-of-state shipyards, resulting in more bidders. Currently, RCW 47.60.820 requires that WSF award the contract to the responsive and responsible proposer that has submitted the lowest total fixed price bid. WSF has additional options under this RCW including the option to award the contract to the second lowest responsive and responsible proposer if a contract cannot be signed with the successful proposer offering the lowest total fixed price bid; or reject any or all bids and republish or cancel the RFP if its in the best interests of the department. However, VARD does not consider that selection of

the lowest bid is always the most appropriate for contractor selection, particularly where projects are complex and involve multiple risk factors.

The best value approach can be defined as a competitive bid process that awards contracts to those shipbuilders who offer the best combination of cost and other factors important to the owner instead of just awarding to the lowest bid. The use of a best value approach incorporating life cycle and risk considerations can add flexibility and allow for the monetization of other considerations which do have economic importance for the client.[271] This approach is often used by government organizations such as the USN, USCG, Royal Canadian Navy, etc., but it is also used by private owners. For example, while BC Ferries normally accepts the lowest compliant bid, it evaluates bidders at the pre-qualification stage and then later the bids themselves for a variety of criteria, see Section 1.6.2.1.3.1. This allows BC Ferries to filter builders and designs for characteristics that are important to them (e.g., experience novel technologies, etc.). Where such an approach is intended to be used, this must be clearly set out in the RFP and more care is needed to ensure that evaluations are as far as possible based on objective metrics.

3.5 PLANNING AND SCHEDULING

3.5.1 INDUSTRY BEST PRACTICES

Many of the cost control measures discussed at Section 3.9 are also directly relevant to schedule control. In some areas, similar measures can be adopted to assist in maintaining schedule requirements and reducing the potential for schedule disputes. EVM, for example, is a valuable schedule control resource.

It is important at the earliest stage in a project to develop realistic schedules for both the internal and external elements of the work, which should include consideration of the timelines required for items such as budget ratification, contract approvals, and other client-side items that may have schedule impacts. Industry engagement should explicitly include consideration of implementation timelines and expectations should be updated throughout the pre-contract stages of the process. The overall duration of a full design-build process is such that changes in market conditions, shipyard workloads, and other factors may have significant schedule impacts during this period.

In a multi-factor evaluation of proposals, scheduled delivery can be included as a factor. The contract may include a required date, which can be set to encourage multiple bidders. If a shipyard can do better than this, it may offer additional value to the client, who can retire an existing vessel earlier and avoid its maintenance costs, and who will also benefit directly by reducing the level of effort for their own project team.

[271] NAVSEA. (23 March 2022). Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP) Operations Manual (SOM) (S0300-B2-MAN-010). https://www.navsea.navy.mil/Portals/103/Documents/SUPSHIP/SOM/SOM2008-23Mar2022.pdf

Another factor to be considered in schedules and project plans is whether the builder intends, or is required, to complete all aspects of the design before starting construction. RCW 47.60.814 requires that "...all vessel design specifications and drawings must be complete and, when applicable, meet United States Coast Guard standards before vessel construction begins...", but this may be subject to some interpretation regarding the level of detail implied. Some highly experienced builders are capable of "concurrent engineering", in which some detailed and production engineering may still be under way for parts of the ship while construction of other parts has already begun. However, while this approach can reduce schedule, it also adds project risk, and has been warned against by the 2013 SAO report on best practices (see Section 3.12). Whether this approach should be considered permissible should be evaluated during the RFP phases, based on the capabilities and proven performance of the short-listed shipyards.

3.5.2 WSF'S ALIGNMENT WITH BEST PRACTICE

WSF's approach to planning and scheduling is aligned reasonably well with best practices. WSF has demonstrated good practices related to industry engagement by issuing an RFI, collecting industry responses, and hosting an industry day for the re-initiated HEOC ahead of issuing the RFP. As part of the RFI, WSF collected responses to a range of topics, including feasibility of desired delivery schedule and time allotted for development of technical proposals.[272] Based on these RFI responses, WSF should be able to make adjustments to develop a realistic schedule.

As noted in Section 3.9, WSF has a good range of effective practices in place to control cost, and many of the same measures are also directly relevant to schedule control. However, WSF currently does not use EVM, which can be a valuable schedule control resource.

3.6 THROUGH LIFE COST OPTIMIZATION

3.6.1 INTRODUCTION

This section of the report addresses two linked issues included in the SOW:

1. Measures that can be taken to decrease vessel construction costs
2. Measures that can lead to future operational efficiencies.

Most measures are common to both issues, but there are some aspects in which the two may be in conflict.

WSF, like most ferry operators, will normally look at new building projects with the experience of vessels already in operation as a starting point, supplemented by forecasts of trends in traffic, service delivery standards, direction from senior management (or, in the case of a public sector state agency, the state executive and legislature), and knowledge of technology trends. All of these may tie into identification of opportunities to realize future operational efficiencies. Work in this area needs to be undertaken early in a project, when the ability to influence both

[272] See note 174 above

construction and through life cost is at its maximum, see Figure 3-2[273] (which has been adapted to show approximate alignment with WSF procurement phases). The approach involves the use of predesign studies or concept exploration work and the scope can be tailored to whether the procurement is expected to introduce incremental change or more dramatic adjustment to previous operational practice.

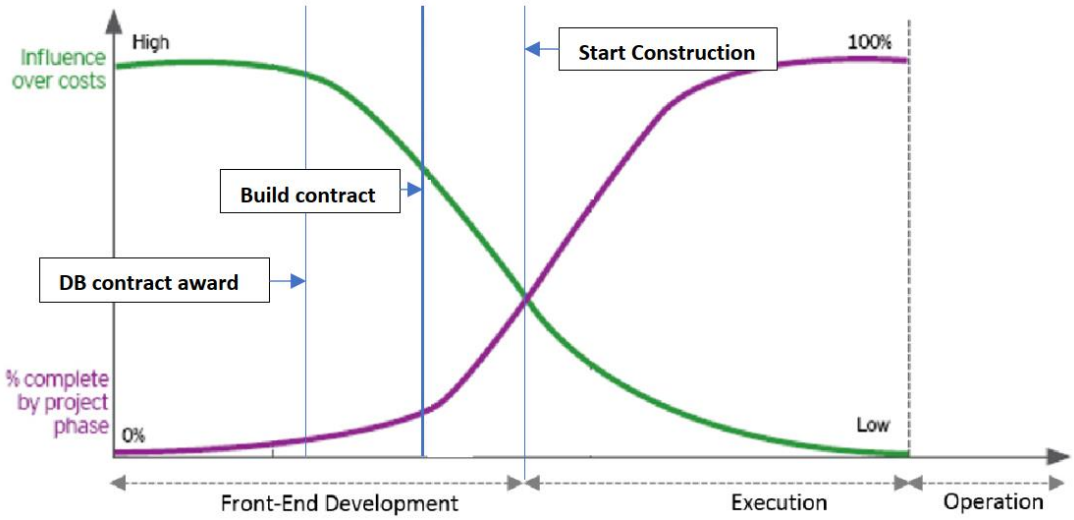

Figure 3-2: Influence over Costs versus Project Phase[274]

For a ferry, "operational efficiency" is essentially the cost per unit of transportation, which can be expressed as passenger miles or vehicle miles. Voyage time can also be factored into the definition of efficiency, as this is a key consideration for the end users. If service frequency is low, or transit time high, then a user may decide to use another mode of transport or to forego travel altogether. Transit time is also a key consideration in construction cost, as it determines ship speed and then in turn installed power and fuel (or energy) consumption. Simulating operations can be undertaken at various levels of sophistication and is presumed to be part of WSF's overall planning activities. VARD does not explore this in detail in the current project, which is focused more directly on ship procurement activities.

Once the overall plan is set, at the ship level, the opportunities for operational efficiencies can be categorized into several areas representing the major through life cost categories:

- Crewing

[273] De Stoppelaar, A. (2017). *Towards Agile Contracting: Enabling agile project management through contracting in the construction industry* [Masters thesis, TU Delft Civil Engineering and Geosciences]. http://resolver.tudelft.nl/uuid:b11ec804-6729-41c0-b44f-05762f9fdd0c

[274] See note 273 above

- Fuel
- Maintenance
- Capital cost amortization.

Their relative importance depends on the nature of the operation and the desired life expectancy of the vessel; for example, maintenance cost will increase in importance compared with the initial capital cost if the vessel life expectancy is relatively long. Meanwhile, construction cost can also be expected to increase for a vessel with long life expectancy, as structure, piping systems etc., will need to have a longer resistance to corrosion, fatigue, and other degraders. Crew size has complex influences on through life cost – in general, larger numbers increase costs substantially, but there can be upkeep and maintenance savings if the crew has the capacity to undertake some of these duties during regular operations. Meanwhile, there can be opportunities to reduce crew by increasing automation, which will increase acquisition cost. Crew numbers in some categories may be set by emergency response requirements, in which case automation benefits can be minor.

Once the required characteristics of the ship have been set, additional factors that influence construction cost are the other technical requirements/specifications and the nature of the procurement contract. As discussed in Section 3.3 and again in Section 3.4.2.3, all requirements cost money. The owner needs to decide whether a requirement is necessary, nice to have, or does not add value at all. The same applies to contract terms and conditions.

It is often claimed by shipbuilders that the use of design-build contracts allows the bidding shipyards to reduce construction cost by optimizing design for production in the yard's facilities. For a ferry, constraints on size and shape imposed by terminal interfaces and other fleet commonality considerations limit this scope considerably. Design for production will still be part of the functional design and the build strategy, but this will also be the case under design-bid-build and other contracting approaches (as defined in Section 1.5).

3.6.2 PREDESIGN PROCESS

According to RCW 47.60.385, a new vessel acquisition project funding request must be submitted to the OFM with a predesign study. According to the OFM predesign manual, a predesign study should explore alternatives for a potential capital project and include cost estimates and details for the selected alternatives. This study will be reviewed by the OFM and used to determine whether the project should be given funding to proceed.[275]

[275] OFM, Budget Division. (June 2020). Predesign Manual for Capital Projects Funded in the 2021-23 Biennium. https://ofm.wa.gov/sites/default/files/public/budget/instructions/capital/2021-23/2021-23Predesign.pdf

The current OFM predesign manual states that the predesign studies are required for all capital construction projects that are valued over $5 million,[276] which means WSF will need to prepare predesign studies for all new ferry procurement projects.

The June 2022 revision of the OFM predesign manual, that will form the 2023-25 budget instructions, states that predesign studies will be required for all construction projects valued over $10 million or for projects selected by the legislature or OFM. In addition, this revised version has a new section that states that "OFM has authority to make exception to some of the predesign requirements but must report any exceptions to the fiscal committees of the legislature with a justification." [277] The OFM predesign manual is not ferry specific and some of its requirements are not applicable to WSF newbuild or preservation projects. In the past, before this new section about granting of an exception, the OFM accepted WSF predesign studies that did not fully meet the stated requirements but provided the main elements that were deemed sufficient to proceed. Furthermore, for preservation projects valued over $10 million, OFM has given WSF an exception for projects, where the work is simply necessary maintenance and therefore does not actually need a predesign study to justify it.[278] The predesign studies should be an important element of WSF's approach to through life cost estimation, and so their scope should be expected to address through life costs.

3.6.3 INDUSTRY BEST PRACTICES

3.6.3.1 REQUIREMENT FORMULATION

As noted in Section 3.6.1 and in Section 1.3.3, the early stage of requirement formulation will establish most of the cost of the ship, both for construction and operation. Best practice is to identify those aspects of the new vessel which are most likely to drive both elements of cost early in the project, and to use concept exploration (predesign studies in WSF terminology) to support trade-offs in aspects of the requirements. This approach has been used extensively by the BC Ferries, for example, in determining approaches to future fuels, vessel sizing, and vessel performance, as outlined in Section 1.6.2.1. For several projects vessel speed was identified as a major cost driver, leading to investigation of how changes to speed profile, terminal interface design and other aspects could allow for lower maximum speed.

As noted in Section 1.3.3 and again in Section 3.3, it is important that the key elements of requirements which will drive up-front and through life cost are established before a project moves into the type of RFP approach used by WSF. For all ferry designs, capacity and speed will be amongst these factors, but other elements may be project- or service-specific. In all design-build RFPs, it is important that the requirements provide a level playing field for bidders. This is particularly the case if low bid is the basis for contract award.

[276] See note 275 above
[277] See note 241 above
[278] See note 45 above

3.6.3.2 INDUSTRY STUDIES

An alternative approach to internal predesign studies is to utilize competitive industry studies to explore the same issues. The US Federal Government is using this approach for many of its major shipbuilding programs. Prequalified builders (or teams) are funded to undertake concept exploration of the key aspects of a future vessel, which may generate more and better ideas than a single owner-consultant team will come up with. This work also prepares potential bidders for the project and shortens and simplifies the construction contract RFP process. However, depending on the number of bidders and the extent of the studies is it likely to incur more up-front cost.

Recent United States Navy (USN) and USCG projects such as the Large Unmanned Surface Vehicle (LUSV) and Polar Security Cutter (PSC) have used industry studies of aspects ranging from construction materials and hull form to propulsion plant configuration and reliability. The results of the work have been used to set the requirements for final design-build RFPs, and to refine project budgets. Because the industry study phases are constructed as stand-alone contracts, they do not incur the "level playing field" concerns of embedding similar studies within a progressive design-build contract.

3.6.4 WSF'S ALIGNMENT WITH BEST PRACTICES

In general, WSF's approach to construction and through life efficiency is considered to be aligned reasonably well with best practices. For the Olympic Class design and construction, its use of consultants to complete predesign studies and develop a concept design to inform the outline specification and an owner's model resulted in a relatively uncomplicated detailed design and construction project and the delivery of vessels which appear to provide a balance of construction and through life cost attributes.

The HEOC project has taken a non-standard procurement approach, but the selection and scope of predesign studies has explored many of the most significant cost drivers – given the decision to adapt the Olympic Class rather than taking a clean sheet approach. For the subsequent 124-auto class the types of studies listed in Table 2-22 provide a good starting point for design decisions and trade-offs. However, it would be advisable to revisit this scope to incorporate any additional lessons learned from HEOC and from other relevant projects outside Washington State. The rate of change in hybrid-electric propulsion systems and in other aspects of marine technology is currently high, and so any new project should consider the current state-of-the-art and state of the practice.

The amounts of funding preliminarily assigned to the competitive phases for the 124-auto ferry should be sufficient for reasonably in-depth studies of factors that will determine through life cost; however, as discussed elsewhere the use of low-bid as the only determinant of builder selection will tend to focus efforts on construction cost alone. Restructuring the approach either to increase the level of internal effort for predesign studies or to fund external industry studies as

outlined in Section 3.6.3.2 could improve the approach, as could a change to contractor selection criteria.

3.7 RISK

3.7.1 INTRODUCTION

Risk is present in any type of activity. For engineering projects, risk in the acquisition process is often subdivided into cost, schedule, and technical risk. Technical risk includes potential shortfalls in performance, reliability and other factors which may carry through into the in-service phase of the asset, and lead to an inability to meet service needs. Cost and schedule risk are self-explanatory – the project may be over budget and delivered late.

Risk management aims to prevent or mitigate negative outcomes and to realize opportunities for positive outcomes, such as early delivery, reduced cost, and enhanced performance. Risk management should be an ongoing activity throughout a project, as both internal and external factors can change dramatically. Internal factors as considered here are those directly relating to the conduct of the project, and which are controlled by the actions of one or more of its stakeholders. External factors affect the context within which the project is taking place. As a recent example, the COVID-19 pandemic is an external factor which has led directly to schedule delays and indirectly to supply chain impacts that have fed into higher inflation. The failure to reach agreement on contract terms for the HEOC project as originally envisioned is an internal factor which has led to the need for a new and quite different procurement approach.

This section of the report reviews the WSF approach to risk management, identifying specific requirements imposed by state legislation and policies, WSF's own internal policies and practices, and the types of best practice applied by other organizations for similar projects.

Important context for this review is that WSF aims (and is currently required) to handle ferry procurements as design-build contracts, in which most of the risk for the direct procurement project is transferred to the builder. However, as noted in Section 1.3.4.4 and Section 3.4.2.5, there is still a substantial level of risk held by the client in the event of non-performance. As examples, in the worst case of a complete failure to deliver, WSF would need to initiate a new procurement with an alternative shipyard, with potentially significant schedule impacts for delivery and large financial impact beyond the scope of performance bonding. Risk mitigation for this can include due diligence in pre-qualification, and a readiness to reject proposals that do not give adequate confidence in the shipbuilder's capabilities. Technical risks may not manifest themselves until after delivery, examples being rapid wear of equipment which lasts until after warranties expire but then requires extensive maintenance, repair, or replacement. These risks can be mitigated by incorporating appropriate requirements in the technical specifications and by an adequate program of construction supervision and inspection,

There are also other technical, cost, and schedule risks which cannot be transferred, such as the danger of specifying inappropriate performance requirements, or the risk that the "5% rule" for

engineer's estimates will lead to a need to restart the project after an initial RFP (as discussed in Section 2.3.2).

3.7.2 INDUSTRY BEST PRACTICES

3.7.2.1 GENERAL RISK MANAGEMENT

Risk management on a project should be proactive rather than reactive, allowing for risks to be addressed or exploited before they occur. It focuses on the project objectives (e.g., cost, schedule, quality) and what could occur to impact these objectives being achieved. Tools and processes to undertake risk management are relatively generic and can be applied in similar manners across many industries.

The Project Management Body of Knowledge[279] (PMBOK), published by the Project Management Institute (PMI), defines standard terminology, best practices, and process guidelines for project management. In relation to risk management, Figure 3-3 demonstrates the recommended seven-step process; the WSDOT Project Risk Management Guide is based on this same seven-step risk management process.

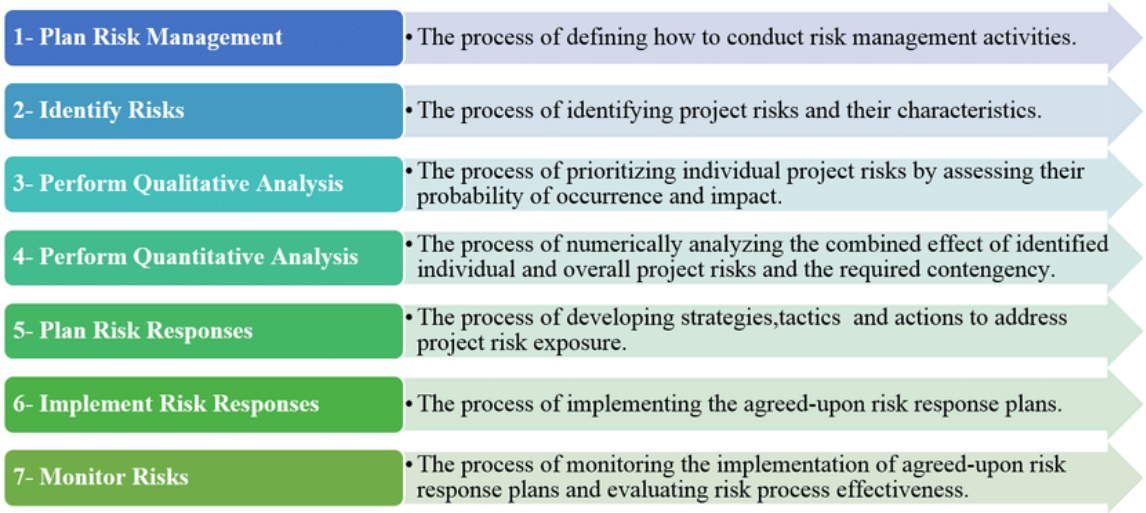

Figure 3-3: PMBOK Risk Management Process[280]

While qualitative risk analysis is commonplace as it can be completed quickly, to increase accuracy as the project progresses, quantitative risk analysis may be beneficial. This is commonly

[279] Project Management Institute. (2021). A Guide to the Project Management Body of Knowledge (PMBOK® Guide). https://www.pmi.org/pmbok-guide-standards/foundational/PMBOK

[280] Othman, A. (2019). The Impact of Risk Factor on The Value Engineering Proposal for Architectural Projects. https://www.researchgate.net/figure/Figure-1-Risk-Management-Processes-Source-PMBOK-2017_fig1_333644435.

completed for risks with cost and/or schedule impacts where a more accurate estimate of the quantitative impact can be established. The assessment produces a probabilistic distribution of the projected cost and schedule. As this assessment is more complex, it is typically conducted using software.

Another widely recognized standard produced by the International Organization for Standardization is ISO 31000:2018 – Risk Management which provides guidelines, principles, and a process for managing risk, this can be applied to any organization. The process has six steps as shown in Figure 3-4.[281] The core risk assessment step includes risk identification, risk analysis and risk evaluation. The standard is supported by International Electrotechnical Commission (IEC) 31010 – Risk Management – Risk Assessment Techniques, which provides further detail on techniques which could be used at each stage in the process.

Both PMBOK and ISO 31000:2018 provide organizations with a beneficial framework to assist in developing their own internal structured risk management processes. While the PMBOK is focused on the project level, ISO 31000:2018 aims to be more flexible to be applied to operations, strategy, processes, products, governance, as well as projects.[282]

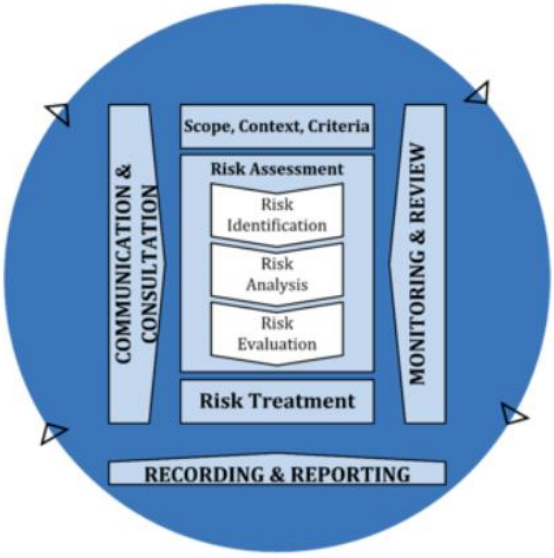

Figure 3-4: ISO 31000:2018 Risk Management Process[283]

[281] International Organization for Standardization. (2018). *Risk Management – Guidelines*. https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-2:v1:en.
[282] Vargas, D.B. and de Souza Campos, L.M. (2022). *Risk Management: A Parallel Between ISO 31000 (2018) and the PMBOK Guide (2017).* https://ieomsociety.org/proceedings/2022istanbul/285.pdf
[283] See note 281 above

3.7.2.2 FERRY PROCUREMENT

As mentioned in Section 3.7.2, risk management tools are generic and can be applied across all industries. Therefore, VARD's literature research of papers and articles related to risk management practices in vessel procurement and construction did not identify any industry specific risk management models. Rather, to identify industry specific best practices, the approach taken was to review other ferry projects and identify lessons learned. It should be noted that as risk management usually happens behind the scenes, the practices become visible most often when it fails, or is not applied. Similarly, analyses of the issues will normally focus on those aspects which have led to the problems, which will not always provide a holistic review of best practices as successes may not be identified.

A project in Whatcom County for the replacement of a small ferry servicing Lummi Island is underway. While the project is in early stages, community engagement identified several risks which were documented in a risk register and the county aims to mitigate these prior to proceeding with the preliminary design. Whatcom County Public Works notes it is experienced in the delivery of large projects within budget and on schedule, which is believed to be linked to early identification and minimization of risks.[284]

An independent audit review conducted of the Newfoundland and Labrador Department of Transportation's (Canada) purchase of the MV Veteran and MV Legionnaire identified several best practices related to risk management in ferry procurement. These vessels were referenced in Section 1.6.2.2. The review recommended that organizations should establish a risk profile which evaluates their readiness to accept risk over the course of a project. There should be a clear risk management plan which details how during risk assessment, the risks will be assessed and addressed. A risk assessment should be completed prior to executing a contract, to allow contract clauses to be adjusted so risks are within the acceptable range of the organization's risk profile.[285] This context of risk profile is more aligned with the term risk appetite which ISO defined as "amount and type of risk that an organization is prepared to seek, accept or tolerate,"[286] this is

[284] Whatcom County. (April 2022). 2022 RAISE Discretionary Grants Program Application for Lummi Island Ferry Replacement and System Modernization Project. https://www.whatcomcounty.us/DocumentCenter/View/57482/2022-RAISE-Grant---FINAL?bidId=

[285] Office of the Auditor General, Newfoundland and Labrador. (2021). *MV Veteran* and *MV Legionnaire* Department of Transportation and Infrastructure Independent Auditor's Report. https://assembly.nl.ca/business/electronicdocuments/ReportOfTheAuditorGeneralOnMVVeteranAndMVLegionnaire-August4-2021.pdf

[286] Hillson, D (2012). How much risk is too much risk? Understanding risk appetite. https://www.pmi.org/learning/library/much-risk-understanding-risk-appetite-6076

closely related to risk tolerance which usually provides a quantitative acceptable range of acceptable risk.[287]

Audit Scotland conducted a review of the project to deliver Vessels 801 and 802, being built by Ferguson Marine Engineering Limited (FMEL) for Caledonian Maritime Assets Limited (CMAL) in Scotland. The project is over four years late with the cost estimated to be over double the contract price.[288] An industry standard shipbuilding contract was used (BIMCO New Build Contract); this places the shipyard with sole responsibility and risk for the design and build of the vessels. This type of contract only works effectively when a full refund guarantee is in place, which was not the case for this contract. Risks were found to be discussed within meetings, but these were not documented and monitored using risk registers. This issue was common with the shipyard, owner, and relevant government departments. Clear governance arrangements such a progress reports need to be in place, ensuring that stakeholders are updated on expenditure and risk.[289]

The Auditor General of Quebec carried out an audit of the design and construction of the Félix-Adrien Gauthier ferry built for the Société des Traversiers du Québec (STQ). The audit identified that although risks were documented, there were instances where risks were recorded as being controlled or closed when mitigation actions had not been taken. Similarly, when overseeing the build, technical risks were realized, and defect notices were raised and subsequently closed with inadequate documentation of successful corrective actions being taken. This led to the client ultimately accepting a ship of lower quality as defects were not actioned in a timely manner. STQ management had little shipbuilding expertise, resultantly decisions were made without an understanding of the risks they presented. The audit recommended that a qualified committee of experts would have been beneficial to consult to contribute to risk assessments of key decisions.[290]

In summary the lessons which can be learned from these other ferry construction projects and applied as best practices are:

- Begin risk assessment at the outset of a project, prior to developing design solutions

[287] Deloitte. (2019). Turn your risk profile into an action plan using risk appetite. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/public-sector/us-ps-risk-profile-action-plan.pdf

[288] Audit Scotland. (23 March 2022). Multiple failings have led to delays and cost overruns which continue to obstruct delivery of island ferries. https://www.audit-scotland.gov.uk/news/multiple-failings-have-led-to-delays-and-cost-overruns-which-continue-to-obstruct-delivery-of

[289] Audit Scotland. (March 2022). New vessels for the Clyde and Hebrides, arrangements to deliver vessels 801 and 802. https://www.audit-scotland.gov.uk/uploads/docs/report/2022/nr_220323_vessels.pdf

[290] The Auditor General of Quebec. (October 2022). MV F.-A.-Gauthier: Design and Construction Special Audit. https://www.vgq.qc.ca/Fichiers/Publications/rapport-annuel/166/vgq_stq-automne2020_web.pdf (Report only available in French)

- Establish an organizational risk profile/appetite/tolerance to establish what risks the owner will be willing to accept
- Ensure contract and any supporting requirements are clear and in place to protect the owner if risks are realized over the course of the project
- Continually discuss risks internally and with the builder and ensure that these are recorded
- Have a clear risk management process in place
- Involve qualified individuals in the risk assessment process to ensure it is carried out comprehensively
- Ensure a clear technical risk/defect management process is in place, with clear terms on responsibility for correction.

3.7.2.3 RISK MANAGEMENT PLAN

As discussed in Section 2.3.3.4, it is essential that the shipyard demonstrate a feasible project plan and it should include a risk management plan that details a robust process to manage issues and risks in accordance with industry best practices. Including a risk management plan as part of the RFP would allow the owner to review the plan and potentially disqualify the bidder if it was deemed insufficient, preventing them from having to accept a bid from a high-risk bidder, even if they have the lowest price. Without an explicit requirement for a risk management plan, or other risk management documentation as part of the bid, WSF would have to accept the lowest bid, irrespective of the quality of the risk analysis behind the fixed price.

However, ensuring the shipyard has a risk management system does not eliminate the need for WSF to have its own risk register and risk management system, since the shipyard and WSF may have different risks.

3.7.3 WSF'S ALIGNMENT WITH BEST PRACTICES

The WSDOT Project Risk Management Guide is in alignment with the seven-step PMI risk management process as presented in Figure 3-3 and discussed in Section 3.7.2. As this guide has a civil engineering focus, it would be beneficial for WSF to develop a tailored risk management process to document risk management for ferry projects.

There is evidence from the 2019 HEOC procurement effort that when new risks arose and there was not sufficient internal knowledge to determine the path forward, that WSF sought external expertise. There are also plans to use specialist consultants to assist with risk management on the re-initiated HEOC procurement currently underway (see Section 2.4.3.2.4). This is in alignment with the best practice to ensure the risk assessments are carried out by qualified individuals.

WSF developed the risk register for the 2022 HEOC procurement prior to issuing the RFP. To align with best practice, the preliminary risk register should be started in the predesign stage when the project is being defined in terms of scope, schedule, and costs. WSF needs to consistently identify and document risks in a risk register on an on-going basis through the project life stages. Without

this key tool, WSF cannot effectively assess, mitigate, and monitor risks. Furthermore, the risk register is an important input into the required CEVP.

The review of WSF's P&P does not provide a clear indication whether all best practices identified in Section 3.7.2 are being undertaken or not. If they are not, WSF should consider establishing their organizational risk profile to help inform the level of risk they are willing to accept. They should consider establishing the process for risk assessments to be conducted with their builder for cost, schedule, and technical risks. It should be ensured that the contract clearly reflects the desired requirements for the builder's responsibilities for risk management.

3.8 COST ESTIMATING

3.8.1 INTRODUCTION

It is critical to the success of any ferry procurement (and almost all other projects) that accurate estimates of the expected cost are generated in advance, and that the estimates have sufficient fidelity to allow for the exploration of alternative approaches. This should cover not only the immediate cost of procurement, but also the through life cost of the asset.

Cost estimates should include provisions for uncertainties and contingencies. Uncertainties arise partly because the client never has perfect visibility into potential builder's costs either for labor or for equipment, or into their business strategy – e.g., is this contract essential to survival, or a distraction from other work in hand or in prospect? Contingencies, on the other hand, are needed to account for risk factors such as increases in material costs or other inflationary factors. Bidders may build their own contingencies into price proposals; in which case they will become part of the contract value. The size of owner contingencies should reflect the extent to which risk is transferred to the builder or retained by the owner. At an early stage in the procurement process, uncertainty and contingency are often combined in top-down estimates, but at later stages, such as the preparation of the engineer's estimate, they should be clearly separated. Price uncertainty largely disappears when bids are opened, but contingency needs to be carried forward.

It is also useful in most cases to have a sufficiently granular understanding of expected cost to allow for negotiation of price, both prior to contract award and to assess any change orders that arise as the project progresses. If costs are presented showing equipment items, materials costs, labor hours and rates, etc., then it is easier to see where estimates differ, and if there are incompatible assumptions involved. VARD has noted in Section 1.3.5.2 and Section 3.10 the importance of change control, particularly at later stages in the contract.

3.8.2 COST ESTIMATION METHODS

Cost estimates for the ship and for the overall program should be updated in parallel with design development work. Data collection is a prerequisite for this in both top-down and bottom-up estimation, as discussed further below. Both collection and analysis can be undertaken in-house

or contracted to another organization, such as SPAR Associates[291] (US) or Royal Haskoning[292] (international). For US ferry builds, there are only relatively few comparable projects, and this will limit the confidence in any cost estimate.

Many cost estimation approaches and methods exist. Different methods are used at different stages of the design. They vary from simple to complex estimations and may be time consuming or not. The two main different cost estimation approaches are top-down and bottom-up. Estimators often use a combination of these approaches based on the level of detail of the available information on different aspects of the program.

For a ship procurement, from the owner's perspective there are two main categories of cost – shipyard cost and program cost. The shipyard cost will be the value of the main contract. Program cost includes all the items borne directly by the owner, including its own staff and consultant support, costs associated with travel and on-site work, etc. If some items are provided as OFE these will also need to be accounted for. Life cycle costing, which should always be a factor in setting requirements and may also be an element of bidder selection, is discussed separately in Section 3.8.3.

3.8.2.1 TOP-DOWN COST ESTIMATION

Top-down estimates are generated early in a project to assist in establishing budgets and sometimes to assist in guiding requirements definition and concept exploration, where budget limits are likely to apply.

Top-down methods are also called analogous or extrapolation models. They are based on the comparison and extrapolation of known data from vessels with some similarities to the intended ship. The owner's own historical data can provide a basis, as can recent contract data for other owners' recent builds.

As other vessels are almost never identical to the intended new vessel, some form of scaling will generally need to be applied, and escalation factors are needed to relate older contracts to current market conditions. Parametric cost estimating methods are an approach to top-down estimation which use inputs such as a newbuild design's estimated lightship weight, steel weight, habitable volume, and habitable area. These values are multiplied against coefficients for categories of material and labor costs which are derived from historical empirical data, refined, and vetted over many design efforts, and validated against reported contract costs. The resulting material costs and labor hours estimates are summed with estimates for design effort, as well as any equipment particular to the design to give a rough order of magnitude (ROM) estimate for

[291] SPAR Associates. (August 2022). *Welcome to SPAR Associates.* http://www.sparusa.com/

[292] Royal HaskoningDHV. (August 2022). *Cost estimating and cost structure analysis*. https://global.royalhaskoningdhv.com/about-us/our-companies/fmi/our-services/cost-estimating-and-cost-structure-analysis

the procurement cost of the ship.[293] At the very early stages in a project, WSF has recently applied a 50% margin to estimates based on a small number of parameters[294], while the older VEM refers to feasibility estimates being within 35%. Somewhat tighter tolerances may be applied as the level of definition increases.

As noted in Section 1.3.1.1, some level of design information is needed to apply even top-down estimating methods. For parametric estimation, this will normally be a concept design. At the most basic level, knowing a ferry's required vehicle and passenger capacity, operating speed and route characteristics may be sufficient for a comparison to other recent projects, but will have a higher level of uncertainty.

3.8.2.2 BOTTOM-UP COST ESTIMATION

The more detailed methods of estimating construction costs are bottom-up methods. They are sometimes referred to as grass root or engineering build up estimating. Only after the design has reached at least a basic design level of technical maturity are bottom-up methods meaningful, though in some cases a mix of bottom-up and top-down methods can be used when some aspects of the design are relatively mature and others still conceptual. Bottom-up cost estimation sums individual line items of cost to create an estimate of the total cost of the new vessel. Bottom-up estimations can be based on bills of materials, drawings, existing quotes, and historical vendor costs.[295]

Best practices for owners will normally include obtaining their own independent supplier quotations for major equipment items and, in the case of operators such as WSF who conduct a considerable volume of maintenance and overhaul work, can use in-house data for smaller components and materials. These types of information can be used in-house or provided to third party cost estimators to assist in their work. The builder will normally have more information than the owner to support their cost estimate, particularly for projected labor cost.

This type of detailed cost estimates will be generated by the builder to set their build price and independent versions can be used by the owner to:

- Finalize project budgets
- Support price negotiations with shipyards
- Inform the development of design changes.

In the WSF legislated approach, the detailed estimate also acts as a trigger for procurement decisions, as discussed in Section 2.3.2.

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[293] Shetelig, H. (June 2013). *Shipbuilding Cost Estimation – Parametric Approach* [M.Sc. thesis, The Norwegian University of Science and Technology]. https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/238624/649603_FULLTEXT01.pdf?sequence=1&isAllowed=y

[294] See note 108 above

[295] See note 293 above

3.8.2.3 PROBABILISTIC APPROACH

Traditionally, most cost estimates have been presented as single point values for the overall ship and project cost. Increasingly, best practice is to work with probabilistic methods that represent uncertainty in a more realistic manner. Probabilistic methods can be applied to top-down and bottom-up estimates. They are most commonly used by owners to assist with their own project budgeting and planning, but some builders now use the approach in assessing price risk.

Probabilistic models use cost items associated with building the ship, as available at the relevant stage in the procurement, including material, labor, design, finance, project teams and resources, etc. Each cost item is given a “most likely” cost. The provenance of each item should be recorded, and a level of confidence assigned to each item based on its provenance. The sources of cost data can include quotes, information from suppliers, other projects, comparable costs, and subject matter expert (SME) estimates.

This data is used to create a triangular distribution of possible costs for each item in the model, appropriate to the level of fidelity for the item. For example, an original equipment manufacturer (OEM) quote will have a narrow distribution of possible costs, while a parametric estimate will have a wide spread of possible costs to account for its uncertainty. The entire set of cost items can then be iterated through a Monte Carlo simulation to produce a set of results for the cost of the ship. The procurement cost of the ship is then presented as a curve instead of a single value. This allows the owner to select the estimated build cost for a percentile result which best suits their risk tolerance.

The process is illustrated in Figure 3-5. Anticipated cost is now a statistical distribution rather than a single point value, which in the traditional approach would be expected to represent approximately the mean value of the distribution. The shape and range of the distribution can be used in setting project contingencies as discussed in Section 3.8.2.4.

If a level of confidence is selected, such as 80%, that would mean there is an 80% probability that one or more bids will be at or below this single value that can be extracted from the statistical distribution of probable cost/price outcomes (see Figure 3-5 that shows vertical lines representing different confidence levels and different single figures). If only a 50% confidence level is selected, this figure is going to be larger compared to the figure at an 80% confidence level. The reason for this is that, at early stages of a project, there is a lower confidence level, for example, of 50%, in the base cost estimate and a higher contingency allowance is included resulting in a higher overall cost estimate. However, at advance stages of the project, when the design has progressed, there is a higher confidence level, for example, of 80%, in the base cost estimate and a lower contingency allowance is included resulting in a lower overall cost estimate (typically, the base cost estimate increases while the contingency allowance decreases).

In accordance with WSDOT Secretary's Executive Order (SEO) E 1053.02[296], WSF is required to use WSDOT provided tools and methods for project risk management and risk-based cost estimating. This is meant to identify risks and uncertainties for projects and to provide cost and schedule estimates as a range, rather than as a single point, using Monte Carlo simulations as described above. In accordance with SEO E 1053.02, due to the project size (greater than $100M), WSF intends to conduct a Cost Estimation Validation Process (CEVP)[297] for the reinitiated HEOC. However, while this method takes into account risk, it does not take into account the amount of uncertainty which applies to each element of the cost estimate, and it still results in a base cost estimate which is a single point value.

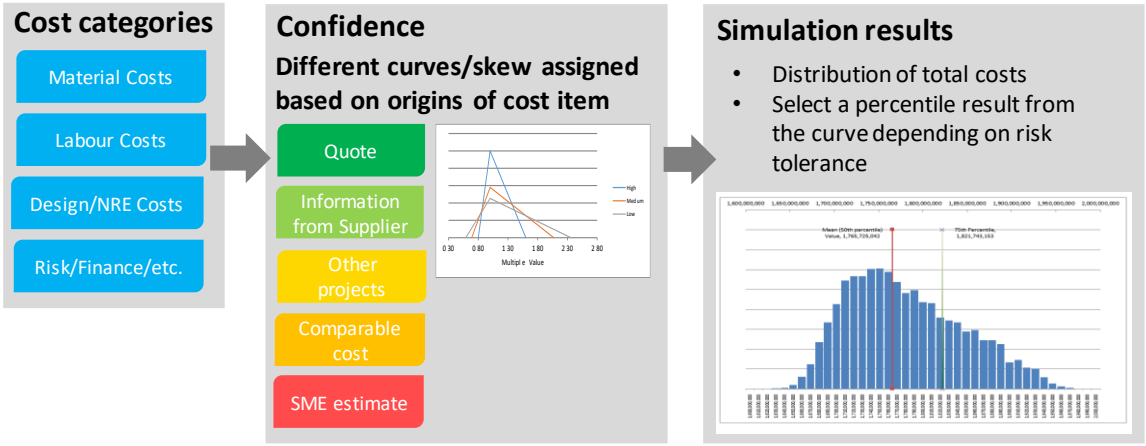

Figure 3-5: Probabilistic Cost Estimation[298]

3.8.2.4 ESTIMATING CONTINGENCY

All cost estimates should include some contingency amount to reflect the level of uncertainties involved in the estimation process. These uncertainties will normally reduce somewhat as the project progresses and the characteristics of the ship are better defined[299]. However, even at the final bid stage, shipyard prices will often differ by 40-50% (see example at Section 2.3.1.2), and this should be appreciated by those setting and reviewing budgets. Often, manuals (such as the WSF VEM) will provide guidance on what contingency should be applied to ROM, budgetary, and detailed engineer's estimates, but these should not be considered as absolutes.

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[296] WSDOT. (6 April 2022). *Project Risk Management and Risk Based Estimating* (SEO E 1053.02).
[297] WSDOT. (February 2018). *WSDOT Project Risk Management Guide.*
[298] Produced by VARD Costing User Group for use in presentations and reports.
[299] British Columbia Ministry of Transportation and Infatuation. (December 2020). *Project Cost Estimating Guidelines.*https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/planning/guidelines/cost_estimating_guidance.pdf

With probabilistic approaches, a confidence level can be used rather than a contingency and this can be useful in conveying a more sophisticated appreciation of cost risk. If, for example, the budget is set at the 80% confidence level, then there is an 80% probability that one or more bids will be at or below this value, and a 20% probability that the project will need to request additional funding (or reduce the performance requirements for the ship).

An estimating contingency is separate from a budget contingency reserve (see Section 3.9).

3.8.3 LIFE CYCLE COSTING

Normally, the initial purchase cost of any ship is a smaller part of the total cost of ownership than the combined costs of crewing, fuel, maintenance, and other costs incurred while in service. Decisions at the design stage can have a significant influence on life cycle cost, and it is best practice to undertake cost estimation for the full life cycle in order to make trade-off decisions on ship characteristics. As future costs can be quite uncertain – for example energy costs, or wage inflation – in some cases multiple scenarios may be modelled. In other cases, time horizons may deliberately be kept quite short. Many commercial operators require trade-offs to show a payback period of five years or less, to give confidence that changes in economic outlook will not invalidate design decisions.

WSF does make some use of life cycle cost models for aspects of future ship design, examples being in the areas of the hybrid-electric propulsion system performance requirements. It does not, however, have the ability to factor life cycle cost into shipyard selection, which limits the ability of bidders to propose overall cost saving measures in their proposed solutions. As noted at Section 1.3.4.10 and elsewhere, the use of “best value” contractor selection offers other clients more flexibility in this regard.

3.8.4 MARKET CONDITIONS

The task of developing accurate cost estimates has become more challenging since the COVID pandemic due to market fluctuations and inflation. In particular, quotes from original equipment manufacturers (OEMs) are only valid for a few months, and sometimes even weeks because OEMs are not willing to take on the risk of future price fluctuations. This means that the cost estimates based on these quotes are only accurate for a short time as well, which can negatively impact project budgeting (see Section 3.9.3 for additional discussion).

With this situation of no long-term pricing guarantees, shipyards would prefer to order equipment for multiple ships, instead of risking the costs later increasing. By purchasing for multiple ships, the shipyard can use economies of scale to reduce costs and improve its profit margin. However, the shipyard will not buy the equipment for multiple ships if it does not have a signed contract for all ships.

Due to the market conditions in 2022, the more time which passes between the cost estimate and contract signing, the more likely it is that prices will have increased. For example, due to the two-

year delay, Glosten's first vessel cost estimate for the HEOC, that was issued in 2021, is likely going to be significantly lower than any price proposal that WSF will receive in 2023.

3.8.5 MATERIAL PRICE ESCALATION

Material price escalation describes the tendencies of prices for major materials like steel and copper to rise over the course of a contract. When a shipyard provides a fixed price bid, it must predict how the price of materials will trend over the life of the contract. When prices are fluctuating unpredictably, this adds a large element of risk for the shipyard and how this is managed can have a significant effect on final cost estimates. It can be mitigated by the shipyard by adding a large contingency on the price of materials and driving up the final purchase price. This may result in a large range of bid prices, with no insight into the level of risk assumed. Or it can be mitigated by the owner using clauses in the contract that allow for contract price adjustments due to material price escalation using an agreed upon method of calculation. This allows for more confidence in cost estimates for the contract, but results in the risk of spending a considerable amount of the contract's contingency on material price escalation.

For past procurements, WSF dealt with material price escalation by taking on the risk themselves and including a clause in the contract that allowed adjustment to the shipyard or a credit to WSF to address fluctuation in steel and copper-based material costs that occurred over the life of the project. This material price escalation clause was used most recently during the construction of the Olympic Class ferries and was executed via change orders on a per vessel basis. In general, for international shipbuilding contracts, it is unusual for price escalation clauses to be written into a contract, because for fixed price contracts, it is the builder's risk to deal with rising material costs[300]. However, government procurements such as for US Navy vessels may protect their shipbuilders from external price escalation risks and use 'compensation adjustment clauses' or 'escalation provisions' in contracts to account for rising or falling labor and material costs.[301]

As noted in Section 2.4.3.2, for the Olympic Class, WSF was not required to follow RCW 47.60.820(9) which limited the allowable contingency on fixed-price contracts. However, future ferry procurements may need to develop a new policy to deal with the issue of material cost escalation and contingency funding for changes in scope on multi-vessel programs to allow sufficient contingency for expected changes such as this but also for unexpected design changes that are necessary or desirable (discussed in further detail in Section 3.10). For example, between January 2020 and January 2022 US steel prices more than doubled.[302]

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[300] Steenderen. A. and Steenderen. C. (2021). Shipbuilding 2021. https://www.haynesboone.com/-/media/project/haynesboone/haynesboone/pdfs/alert-pdfs/2021/2021_shipbuilding_england--wales-final.pdf?rev=700f56943010471d8998434511e244d7&hash=659BAA589338205EFB51875EC99BCACF

[301] Keating. E. et al. (2008). Using the Steel-Vessel Material-Cost Index to Mitigate Shipbuilder Risk. https://www.jstor.org/stable/10.7249/tr520navy.8?seq=1#metadata_info_tab_contents

[302] Global Data. (2022). US steel prices eased in March 2022, although remain elevated. https://www.designbuild-network.com/comment/us-steel-prices-eased-march-2022/.

WSF requested industry feedback in its July 2022 re-initiated HEOC RFI on the issue of feasibility to provide fixed prices for five vessels with appropriate escalation factors.

3.8.6 INDUSTRY BEST PRACTICES

It is often challenging for organizations with relatively infrequent procurements to assess the level of internal effort (including external support in the form of consultants) that will be needed to develop project documentation and to manage the ensuing construction contract. Often, using data from previous projects is of limited use due to changes in practices, staff, and requirements. Best practice is often to initially use scoping studies on the procurement strategy conducted by experienced consultants, at a relatively low initial level of effort, to better define the overall needs of the project, considering project phases, schedules, and levels of effort. This can provide the basis for resource planning for internal staff and for one or more contracts to perform cost estimation and management support for the main project.

As discussed in Section 3.8.1, for procurements with similar approaches and constraints to WSF, cost estimation best practice is to move from top-down rough order of magnitude (ROM) and budgetary estimates in the earlier stages of a project to more detailed bottom-up estimates as the project progresses towards selection of a builder. Section 3.8.2.3 discussed the use of probabilistic cost estimation as the current state-of-the-art in handling cost uncertainty and notes the importance of gathering as much high-quality pricing data as possible at every stage of the process.

The selection of an appropriate owner's contingency for a project is highly dependent on how cost risk is allocated under the construction contract. As discussed in Sections 3.8.4 and 3.8.5, items such as material cost escalation, exchange rate risk for overseas components, and labor rate inflation can be assigned to the builder or taken/shared by the owner. In best risk management practice, risk should be assigned wherever it is most cost-effective. In public sector procurement, the owner is often better insulated from the consequences of inflation than the builder, and so it may be more cost-effective to add contingency rather than to force the builder to include this in a fixed price.

3.8.7 WSF'S ALIGNMENT WITH BEST PRACTICES

As discussed in Section 4.2.3.4, WSF's approach to cost estimation is reasonably well aligned with industry best practices, namely at early-stage estimates, all high-level elements of project cost are considered, and an appropriate level of contingency is included. However, WSF uses single point cost estimates. As proposed in Section 3.8.2.3, best practice would be to use a probabilistic approach to account for the appropriate level of uncertainty applied to each line item in the cost estimate at each stage of the project. A probabilistic approach is now mandated through the use of the CEVP, but this is accounting for risk rather than uncertainty, and these are not the same concepts.

WSF's estimation process for internal costs is not well documented, see Section 2.4.4.2.2. It is unclear whether the amounts that are included in budgets for the HEOC and early estimates for

the next project will be sufficient, either for in-house resources or for external consulting support, including the mandated IOR. WSF should consider formalizing this process, with a defined standard set of items to be costed. The Section 4.2.3.10 makes some recommendations in this regard.

The contingency amounts to be available for construction contracts are set by RCW at 5% of contract value, which is not considered to be appropriate. Contingency should reflect risk, and for a multi-ship program should be front-end loaded in the expectation that the lead ship will have most potential for changes. It should also be clarified what items form part of any defined contingency amount and which are better handled using other approaches, for example, price escalation. It is recognized that legislative budgetary constraints may affect what is possible in this regard.

Table 3-1 illustrates how the different cost estimating methods relate to the design stages according to best practices. For example, top-down cost estimates are used early in a project, normally at a concept and preliminary design stages. Bottom-up cost estimates start to be generated after the design has reached at least a preliminary design level of technical maturity. There is a transitional phase in which bottom-up and top-down methods may be used for different elements of the design, when some aspects are relatively mature, while others are still more conceptual. The engineer's estimate, included as a predictor of bid price in the WSF process, needs to be based on the bottom-up and more detailed methods of estimating construction costs. Probabilistic costing approach, shown as the recommended best practice for all stages, is a valuable tool to convey the levels of uncertainty involved.

Table 3-1: Cost Estimating Methods and Design Stages

WSF Stages	Design Stage	Type of Estimate	Methodology
Planning	Concept	Feasibility estimate	Top-down cost estimate: historical projects, rough-order-of-magnitude (ROM), parametric Probabilistic
	Preliminary	Budgetary estimate Preliminary estimate	Top-down/bottom-up cost estimate Probabilistic Cost Estimate Validation Process (CEVP) (initiated)
RFP	Basic	Engineer' estimate (prior to bid)	Bottom-up cost estimate: vendor quotes, bills of materials, drawings, specifications Probabilistic

WSF Stages	Design Stage	Type of Estimate	Methodology
	Functional	Engineer's estimate (prior to bid)	Bottom-up cost estimate: vendor quotes, bills of materials, drawings, specifications Probabilistic

3.9 COST MANAGEMENT/CONTROL

3.9.1 INTRODUCTION

Controlling costs under the actual construction contract is an essential element of ship procurement. Many of the best practices identified in the 2013 SAO report of WSF vessel construction costs[303], summarized in Section 3.12, relate to cost control.

Management of costs during a project may not require a great deal of complexity, depending on how progress payments are scheduled and monitored, and how project financing is organized. Cost monitoring may still be useful as part of the general review of progress and project health, which can help to manage risk.

3.9.2 COST CONTROL METHODS

3.9.2.1 PROJECT PLAN

The bidder's project plan is a crucial document for both cost and schedule control and should be required to be developed in accordance with best practices for project management. Such plans are almost always required as part of a bid package, to allow clients to verify that offerings are credible. As with the ship design, the level of detail specified in such plans should be tailored to the size and complexity of the project.

3.9.2.2 EARNED VALUE MANAGEMENT

Shipbuilding projects are good candidates for the use of earned value management (EVM), which can provide early indications of shortfalls in progress in both financial and schedule terms. This project management and reporting methodology has its origins in United States government agencies during the 1960s and started as a way to ensure accountability among contractors involved in complex, long-term projects.[304] EVM is more difficult to apply to the design stage of projects if this is used for significant exploratory work, but in a design-build contract it can offer

[303] See note 95 above

[304] Defense Web. (5 April 2012). Shipyard finds Earned Value Management compliance an ongoing process. https://www.defenceweb.co.za/sea/sea-sea/shipyard-finds-earned-value-management-compliance-an-ongoing-process/

significant insights. Some contractors resist requirements for EVM implementation and reporting, but where effective recording and reporting systems are in place, they represent minor overhead burdens. Where such systems are not in place, this itself is a major risk indicator.

The key EVM terms are illustrated in Figure 3-6. WSDOT website has a resource page, called Project Management Guide, under Engineering & Standards, that includes links to tools and forms related to cost control, estimates and earned value.[305] WSDOT Earned Value Management Guidelines document (issued in 2008, no revisions found) includes guidance and recommendations for the application of EVM on WSDOT capital projects, and includes this Project Management Institute (PMI) definition of EVM:

> "A management methodology for integrating scope, schedule and resources, and for objectively measuring project performance and progress. Performance is measured by determining the budgeted cost of work performed (i.e., earned value) and comparing it to the actual cost of work performed (i.e., actual cost). Progress is measured by comparing the earned value to the planned valued."[306]

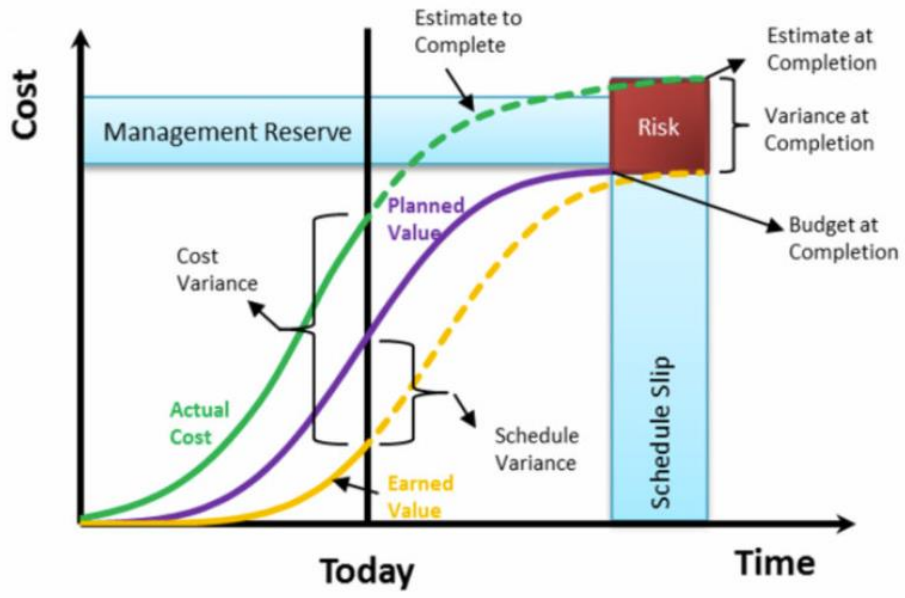

Figure 3-6: Earned Value Management Terminology[307]

[305] WSDOT. (Accessed December 2022). Project management Guide. https://wsdot.wa.gov/engineering-standards/project-management-training/project-management/project-management-guide
[306] WSDOT. (21 April 2009). Earned Value Management Guidelines. https://wsdot.wa.gov/sites/default/files/2021-10/EarnedValueGuidelines.pdf
[307] Martins, Philippe. (2 October 2019). Earned Value Management. https://martinsitconsulting.com/cost-earned-value-management/

EVM started to become a standard required practice for federal government contractors in the early 1990s. As an example Todd Pacific Shipyards (acquired by Vigor Industrial LLC in 2011) received a letter of approval from the US Navy for its EVM system in 2003.[308] In its general requirements to all suppliers for the 2019 HEOC procurement, Vigor included the standards document, "Contractor Scheduling and EVM Standard," that details the requirements for development of contractor-provided schedules, reporting by the contractor and progressing based on earned value. This document emphasized that the contractor will be allowed to report and invoice only for physical progress on deliverables as measured on the execution schedule.[309] Note that this flow-down does not match the monthly progress payment approach used by WSF, as described at Section 2.4.5.2.

3.9.3 PROJECT FINANCING

WSF has a biennial budgeting cycle, and the Washington Legislature operates on a biennial budget. WSF capital project funds are approved based on this two-year cycle. The fact that WSF's project funding is tied to biennial state budgets can make it difficult for WSF to make long-range plans, as budgets can change.[310] WSF has plans for multi-vessel programs that require multi-year commitments; and, as required by RCW 47.05.030, WSF submits a 10-year investment plan in support of its budget requests with documentation that explains project overruns or underruns.[311]

For past procurements, this project financing system created challenges. The Kwa-di Tabil Class was constructed across the 2009-11 and 2011-13 biennia. Because the shipyard accelerated its construction schedule and consequently spending for the second ferry, the shipyard requested progress payments that exceeded the amount that was authorized in the 2009-11 biennium. This situation, coupled with delayed budget approval, resulted in a cash flow problem for WSF. To avoid this situation in the future, WSF added a clause to the Olympic Class contract that limited the amount that the shipyard can invoice WSF during a biennium.[312] For example, CO #28 for the third Olympic Class ferry included the statement "due to the rate at which funding will become available for this Project; payments to the Contractor shall not exceed $50,000,000 total prior to June 30, 2015, for Contract Work on Vessel #3."[313]

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[308] See note 304 above
[309] Vigor Industrial, LLC. (6 March 2020). Contractor Scheduling and EVM Standard. (Doc. No. 36241-998-0052) https://vigor.net/assets/docs/36241-998-0052-B-Contractor-Scheduling-EVM-Reporting-Standard.pdf
[310] WSF. (29 June 2012). Lessons Learned: 64-Auto Ferry New Construction.
[311] OFM. (June 2022). 2023-2025 Budget Instructions, Part 1. Chapter 14: Transportation. https://ofm.wa.gov/sites/default/files/public/budget/instructions/operating/2023-25/Chapter14Transportation.pdf#page=3
[312] See note 310 above
[313] WSF. (11 June 2014). Change Order #28. Contract No. 00-6674.

During the Olympic Class construction phase, for every additional ferry, WSF exercised an option using a change order that authorized the new ferry. This option was at WSF's sole discretion and was based on the option price and construction duration submitted by the shipyard. The negotiated composite hourly rates in place at the time of the execution of the change order applied to the construction of the new ferry. Furthermore, CO #5 for the second Olympic Class ferry included the following statement: "In light of the current budget, WSF is only constructing two Vessels at this time. However, WSF continues to reserve options to add two additional Vessels to the Contract Work at later dates depending on budget appropriations."[314] CO #28 for the third Olympic Class ferry included a similar statement.[315]

WSF is treating the HEOC program as a five-ship program and has provided a budgetary estimate for five ferries.[316] VARD understands that authorizations have been provided under the next three biennium legislative budgets for part of the program. However, these amounts will not be enough to allow for a five-ship program to be handled as a fixed price contract. It is therefore expected that, as in previous projects, the contract will be handled as an initial fixed price for one (or more) vessels with options for follow-ons. Under current market conditions, as discussed in Section 3.8.4, the option pricing may be quite difficult to structure. Equipment suppliers are not prepared to guarantee pricing for even one year into the future, and material and labor costs are also highly uncertain. This is already an issue for other owners with similar preferred procurement strategies, such as British Columbia Ferry Services (BC Ferries), who noted their expectation that options will either need to be exercised rapidly or be subject to renegotiation in future.

As WSF are required to award contracts to the lowest compliant bidder, the nature of option pricing will be particularly challenging. Bidders may or may not be prepared to provide fixed prices for follow-on ships and may include differing assumptions even in indicative pricing for options, resulting in widely varying numbers. This will need to be considered when defining contract terms and conditions and in planning for future negotiations, which may come to resemble sole source proposals.

A partial mitigation for this set of challenges could be to order multiple shipsets of major equipment as part of the initial contract, "freezing" price and delivery schedules for these key – and expensive – items. In the event of a change in builder for later ships, this equipment could be transferred to the new yard at limited risk. Note that this is not the same as providing these items initially as owner-furnished equipment, as that incurs other risks and retains responsibility on the part of the owner. For example, the owner must ensure that all technical information is correct and is provided in a timely manner and will be responsible for the performance of the equipment in service.

[314] WSF. (11 April 2012). Change Order #5. Contract No. 00-6674.
[315] See note 313 above
[316] See note 45 above

3.9.4 INDUSTRY BEST PRACTICES

The use of monthly progress payments is somewhat unusual for shipbuilding contracts, which more typically define milestone payments that represent verifiable stages in construction. B.C. Ferries generally uses milestones payment, although in an RFP process for LNG ferries which involved five shipyards, the ferries were built in Poland with 80% of the payment made upon vessel completion.[317] For the ferry procurement examples discussed in Section 3.7.2.2, all used milestone payments. CMAL (Scotland) would normally pay for a ferry in five (5) milestone payments but for the 801 and 802 ferries they agreed to 15 milestone payments to smooth cash flow for the builder.[318] Similarly, the MV Veteran and MV Legionnaire ferries purchased by the Newfoundland and Labrador Department of Transportation were paid in six (6) milestone payments.[319] Standard shipbuilding contract terms are built on this approach.[320]

As discussed in Section 3.9.2.2, the use of earned value management (EVM) methods of project cost and schedule control can be a superior alternative to the use of monthly progress payments but may incur additional effort in reporting and monitoring.

Shipbuilding milestone payments are typically linked to major events such as:

- Final design review
- Steel cutting
- Launch/float-up
- Completion of dock trials.

The nature and value of milestone payments can be negotiated based on builder construction planning, though this can make price comparisons between bidders problematic if the time value of money needs to be factored in. This can result in more or fewer payments compared to monthly payment, though typically for international projects there are fewer, which increases the financing burden on the builder. Many international shipyards are accustomed to meeting this type of challenge. It is not uncommon for ships to be paid for in full, on delivery – a single

[317] BC Ferry Services Inc. (2014). BC Ferries awards $165 million in contracts for three new Liquefied Natural Gas fueled intermediate class ferries. https://www.newswire.ca/news-releases/bc-ferries-awards-165-million-in-contracts-for-three-new-liquefied-natural-gas-fuelled-intermediate-class-ferries-514605551.html

[318] The Scottish Parliament. (2021). Construction and procurement of ferry vessels in Scotland. https://sp-bpr-en-prod-cdnep.azureedge.net/published/REC/2020/12/9/5517356c-7b44-11ea-af53-000d3a23af40-1/RECSO52020R12.pdf

[319] See note 285 above

[320] Ship Building Contract (Contract Number: 06CA44S1981021) for Construction of one 2500 TEU container vessel (Hull No. YZJ2006-721C) between Seaspan Corporation as Buy and Jiangsu Yangzijiang Shipbuilding Co., Ltd., and Guangdong Machinery Imp. & Exp. Co., Ltd. collectively as Seller. (Accessed September 2022). https://www.sec.gov/Archives/edgar/data/1332639/000119312507055526/dex424.htm

milestone. However, this is more common for “standard” ship types such as tankers rather than more specialized ships such as ferries.

Under EVM, a more complex set of metrics may be used to define progress. During the design phase, this may relate to the status of drawings and their review/approval by organizations such as USCG and/or the classification society. During construction, progress can be linked to the build strategy, through indicators such as the percentage of steel fabrication, the number of outfitted blocks that have been assembled, etc., weighted in accordance with their labor and materials content. This requires that the owner has good visibility into the builder’s plans and schedules, and a level of confidence in these. The owner’s team also needs to have the expertise to evaluate and monitor the information (either internally, through contracts, or through the IOR).

Establishing appropriate metrics for any payment approach will always present some challenges and tensions between owner and shipyard, with the owner aiming to reduce risk exposure and the shipyard aiming to optimize cash flow by reducing the gap between incurring cost and being reimbursed – this can also reduce cost to the owner, assuming that the owner’s cost of money is less than that of the shipyard (normally the case for a public sector owner).

3.9.5 WSF’S ALIGNMENT WITH BEST PRACTICES

As discussed in Section 4.2.3.5, WSF has a good range of effective practices in place to control cost. The reporting undertaken for the functional design work for the 2019 HEOC procurement incorporated many elements of EVM, for example with metrics for drawing stages of completion. However, actual progress payments were generally not tied to these, most being equal lump sums based on total (original) contract value. In a full EVM system, the shipyard will report on all labor and materials costs, but will only be paid based on the aggregate progress, i.e., if 60% of budget has been expended but only 50% of progress achieved, then the total payments will not exceed 50% (less any retainage specified in the contract).

WSF’s contracting process for follow-on ships in a class has used the exercising of options rather than simultaneous award of multiple ships. This can be problematic, particularly in times of rapid economic change. Suppliers may not provide competitive pricing for additional sets of equipment for follow-on ships, and builders may be challenged in quoting future labor and material costs. State budgetary procedures may limit the options available to address this issue, but an approach that can be useful is to front-end load the ordering of major equipment, so that the price and delivery schedule is fixed as part of the initial contract, as discussed in Section 3.9.3.

3.10 CHANGE MANAGEMENT

3.10.1 INTRODUCTION

Change management is a broad term that describes the process of implementing adjustments to an active contract. These adjustments give the owner and the shipyard the opportunity to renegotiate specific elements of the project. Depending on the contract itself and the timing with

which changes are made, they can have zero cost or schedule impact, but still need to be formally agreed. Some examples of many possible types of changes include:

- Adjustments to overall schedule or milestone dates
- Owner requests for technical changes to improve performance
- Contractor requests for technical changes to simplify construction or replace specified equipment items
- Changes to key project personnel, on owner or contractor side
- Adjustments to contractual terms and conditions.

Changes will happen in a standard shipbuilding contract, so they need to be managed appropriately and tracked from the time they are raised, through the approval process, and to their resolution.

Typically, where the builder is responsible for proposing the change, they will provide a description of and rationale for the change itself, the resources required to make the change, any technical, cost, and schedule impacts, and any supporting information considered appropriate. The owner will review this information and approve or reject the change. Where a change proposal comes from the owner, the builder is usually requested to evaluate the impacts and present the same information back to the owner. The builder may be compensated for the work required in developing this evaluation. Contracts typically include timelines for the process and provide for dispute resolution processes to prevent a disagreement over a change from holding up the whole build.

Change management always includes cost management, as limits imposed by budgets for contingency may constrain the type and degree of changes. This can add a degree of discipline to the change order process by ensuring a rigorous cost-benefit analysis is conducted for every change order. However, it can also be detrimental if changing circumstances justify substantial changes, but the contingency budget does not allow it.

3.10.2 INDUSTRY BEST PRACTICES

During predesign, the owner needs to conduct sufficient design development and trade-off and feasibility studies to explore the design space and define its needs and wants and ensure that they are implemented into the requirements right from the start, reducing the chances of unexpected, expensive change orders later in the process. In an ideal world, most of the significant design changes would happen during this preplanning phase and not after a contract has been signed based on a fixed price. This was discussed in more detail in Section 3.6.

However, some change orders are unavoidable. In general, the cost of making design changes, using change orders, is substantially smaller before construction starts, though this may result in big schedule impacts if significant design re-work is required. Furthermore, making changes to the design of the vessel becomes more costly, and time consuming, as the design progresses from

concept to functional to detailed design because, in the later stages, substantial changes will impact many deliverables that are either completed or partially completed.

It is important that the contingency amount is set realistically, and that its use is properly managed. The existence of contingency should not be used to justify the introduction of design changes, which should be made only when truly required, due to their disruptive impacts on the project. The original WSF Olympic Class contract provides good evidence of contingency management.

On the owner side, it is always best practice to include in the overall project budget a contingency for unexpected changes to the design, and for other changes to pricing that may be allowed for under the contract (such as materials escalation or exchange rate fluctuations). With probabilistic approaches, a cost estimate with a corresponding confidence level can be used for budgeting instead of developing a separate contingency that would be in addition to the base cost estimate (see Section 3.8.2.3).

3.10.3 WSF'S ALIGNMENT WITH BEST PRACTICES

Overall, WSF's documented policies indicate a robust and well-organized change management system that is in accordance with best practices, however, it should be reviewed and updated to align with legislated requirements.

The new WSF change order approval process has not been confirmed; however, WSF has provided possible steps based on an existing OFM approval process for the use of Emergency Capital Funding. To begin that process, a request memo is prepared by WSF that includes justification for the use of the contingency fund for the change order. This memo is reviewed first by WSDOT's Central Budget Office, and afterwards it is submitted to the OFM for approval. The Director of OFM reviews the request and has the authority to approve it. WSF also noted that OFM approvals could be done separately for each change order or periodically/quarterly as part of batch. [321] It is important to note that this is just speculation and the new process has not been used for a previous WSF ferry procurement, which means that challenges may arise as to its implementation in practice. This process should be defined before it is needed.

While the RCW 47.60.820(9)(b) requirement for the OFM to approve contingency spending provides independent, objective oversight to the change order approval process, there are several potential issues with this approach. OFM staff are not expected to have the necessary vessel construction knowledge and experience to make sufficiently informed final approval decisions about change orders. This means that the OFM staff should employ an external consultant to

[321] Singer, R. (13 September 2022). [email from Rick Singer of WSF to Matt Von Ruden, Thomas Timmerman, Brain Kopka, Mark Steele, Tim McGuigan, and John Bernhard of WSF regarding the OFM approval process for the use of emergency capital funding and its potential applicability to future vessel procurement contingency approval process].

understand the purpose and significance of the planned change orders. This process may result in unnecessary delays in the approval process that can impact the project schedule.

3.11 HYBRID-ELECTRIC SPECIFIC CONSIDERATIONS

3.11.1 INDUSTRY BEST PRACTICES

As noted in Section 1.7.1, Norway is a world leader in the electrification of ferries, with many counties in the country taking steps to electrify their ferry fleets.[322] Most of these ferries are equipped with hybrid-electric systems supplied by Norwegian Electric Systems (NES), who have acted as the system integrator for both the onboard propulsion systems and dockside charging systems, covering both aspects allows them to optimize the power system and reduce risk.[323] An example from one county in Norway explains the infrastructure strategy for the ferry procurement as:

> "The bidders were required to acquire and own the vessels and to construct the charging infrastructure and then sell it to the county council at cost. The purpose of the latter requirement was to let the bidders match the infrastructure to their own propulsion technology choices."[324]

In summary, the best practice related to dockside charging systems is to handle the vessel procurement and terminal electrification as a single project/ program. The vessel procurement and terminal work may be handled under different contracts, but they should be part of the same project/ program to ensure that all the requirements are considered. With this approach, the successful bidder should be able to optimize the required power systems to deliver a better overall solution and to reduce the risk.

A key aspect of successful implementation is consideration of the dock-side infrastructure required, which can be expensive and complex, particularly for more rural locations which are further from gridlines.[325] Additionally, if the grid can currently support the demands, the general trend to electrical transportation (trucks, cars, etc.) could soon overload the grid, so increased future demand needs to be considered. In some areas land may need to be acquired for onshore

[322] See note 56 above.
[323] Fjord1 converts ferries to run on battery power. (8 July 2021). *Vessel Performance Optimisation Global.* https://vpoglobal.com/2021/07/08/fjord1-converts-ferries-to-run-on-battery-power/; Fjord1 chooses NES as the system integrator for three ferries. (22 January 2020). *Norwegian Electric Systems.* https://www.norwegianelectric.com/news/2020/fjord1-chooses-nes-as-the-system-integrator-for-three-ferries/
[324] Bugge, M., Finne., H., Hansen, T., Jolly, S., Steen, M., & Suvinen, N. (22 June 2021). *Regional policies for green growth: Nordic experiences* (2021:00682-unrestricted). https://www.sintef.no/globalassets/project/gonst/sintef_2021-00682.pdf
[325] See note 56 above

battery systems, or when land is unavailable floating charging docks may need to be acquired.[326] These more complex solutions to providing infrastructure can be costly and time intensive to implement. Generally, the options for charging infrastructure are direct charging from the grid (low, medium, or high voltage), Energy Storage Systems, renewable sources, or a combination of the aforementioned, each with varying implementation costs.[327]

With various Norwegian counties each taking different approaches to the procurement, other lessons have also been learned. For example, specifications should be written with technology advancement in mind as battery technology is evolving so rapidly that previous solutions can become obsolete over the contract period. Technical studies should be conducted to determine ways to maximize the life of the batteries that are to be installed. In addition, the specifications should also include the requirement for battery removal routes to allow for battery replacement in the future with advanced batteries or other new technologies.

One contract included a "climate bonus" which encouraged the supplier to continually include new technology to reduce emissions over the contract period,[328] Additionally, "technology-neutral tendering models" have been used which provide freedom for the bidders to propose technologies, rather than it being prescribed in a specification[329]. It is important that environmental requirements are weighted highly in the proposal evaluations to ensure bidders place high importance on low emissions; for example, Norway has required that public procurements should weight environmental factors to at least 30%.[330]

More generally, the introduction of any new technology into a vessel, or fleet of vessels, should involve several modifications to standard procurement practices. These should include some or all of the following:

- Considering requirements for supporting infrastructure – in this case the need for rapid charging systems and ensuring that electricity supply to charging stations has adequate capacity and acceptable reliability

[326] Leigh, G. (3 July 2021). Travel Norway's Fjords on a Quiet Electric Ferry. *BNN Bloomberg.* https://www.bnnbloomberg.ca/travel-norway-s-fjords-on-a-quiet-electric-ferry-1.1624752

[327] Ćelić, J., Cuculić., A., Panić, I., & Škrobonja, A. (2013). Implementation of Charging Stations for Hybrid and Electrical Ferries in Croatian Ports. https://hrcak.srce.hr/file/403524

[328] Bertsen, A., Biresselioglu, M. E., Demir, M. H., Røyrvik, J., & Sæther, S. (29 June 2021). The Significance of Enabling Human Consideration in Policymaking: How to Get the E-Ferry That You Want. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2021.635722

[329] Wold, M. C. (5 April 2018). Dawn of a new era. https://www.dnv.com/expert-story/maritime-impact/Dawn-of-a-new-era.html

[330] Bjerkan, K. Y., Damman, S., Karlsson, H., Meland, S., & Sondell, R. S. (6 November 2019). Governance in Maritime Passenger Transport: Green Public Procurement of Ferry Services. *World Electric Vehicle Journal* 10(4), 74. https://doi.org/10.3390/wevj10040074

- Ensuring that potential builders have the required expertise with the new technology – this may involve teaming and technology transfer agreements with suppliers, and evaluation of track record as part of the bidding process
- Ensuring that any potential regulatory challenges are identified early in the project, and that approaches to these are incorporated in project plans
- Providing for training of ship crews on new systems and equipment as part of the scope of supply
- Giving special consideration to maintenance and support arrangements once the ship(s) are in service; standard warranty provisions are not necessarily sufficient, and owners should explore requirements for availability and reliability.

3.11.2 WSF'S ALIGNMENT WITH BEST PRACTICES

WSF's overall infrastructure strategy for ferry procurement aligns with the best practice of handling the vessel and terminal electrification under the same project/ program, as discussed in Section 3.11.1. WSF uses separate contracts to deal with the terminal electrification projects and projects related to new vessel procurement and hybridization of existing vessels, because WSF has two separate departments, one is dedicated to terminal engineering, while the other deals with vessel engineering and preservation. However, to help deal with the complexity of electrification of both vessels and terminals, WSF has implemented a centralized project management strategy with an overall Electrification Program Manager who is supported by vessel and terminal engineering program managers and is accountable to executive management.[331]

WSF's approach to developing the RCS, detailed in Section 2.4.3.2.4, resulted in some push back from Vigor during the functional design phase of 2019 HEOC procurement process.[332] Also, according to the summary of HEOC RFI responses collected for the re-initiated HEOC procurement process, most would prefer that the WSF-specified RCS is located on the terminal side instead of on the vessel.[333]

The WSF System Electrification Plan (SEP), published in 2020, and mentioned in Section 3.4.2.4, is a good example of industry best practices. The SEP determined high-level feasibility and identified guiding requirements for vessel and terminal improvements. In particular, the SEP identified the importance of appropriate ship crew training on new battery systems and important safety systems, like the fire suppression systems. In addition, the SEP addressed the need for specific changes to the WSF vessel maintenance program, including an increase in mechanical and electrical workforce and the need for hybrid systems training for troubleshooting and

[331] See note 261 above
[332] See note 45 above
[333] See note 174 above

maintenance, and medium/high-voltage safety.[334] These are all important aspects for introducing a new technology into a fleet.

In support of both the Jumbo Mark II Class conversion and the HEOC procurement, WSF is already working with utility companies to electrify the necessary terminals, see Figure 3-7. As of October 2022, WSF's intention is to sign a memorandum of understanding (MOU) with power companies to provide dedicated power reserves and battery storage at Pier 48 and a dedicated underwater power line to Pier 52 in Seattle. WSF expects similar agreements will be made for other terminals as necessary. The WSF SEP was the planning document that calculated the energy needed for each route and the grid capability. As new terminals are designed, electrification will be built in.[335]

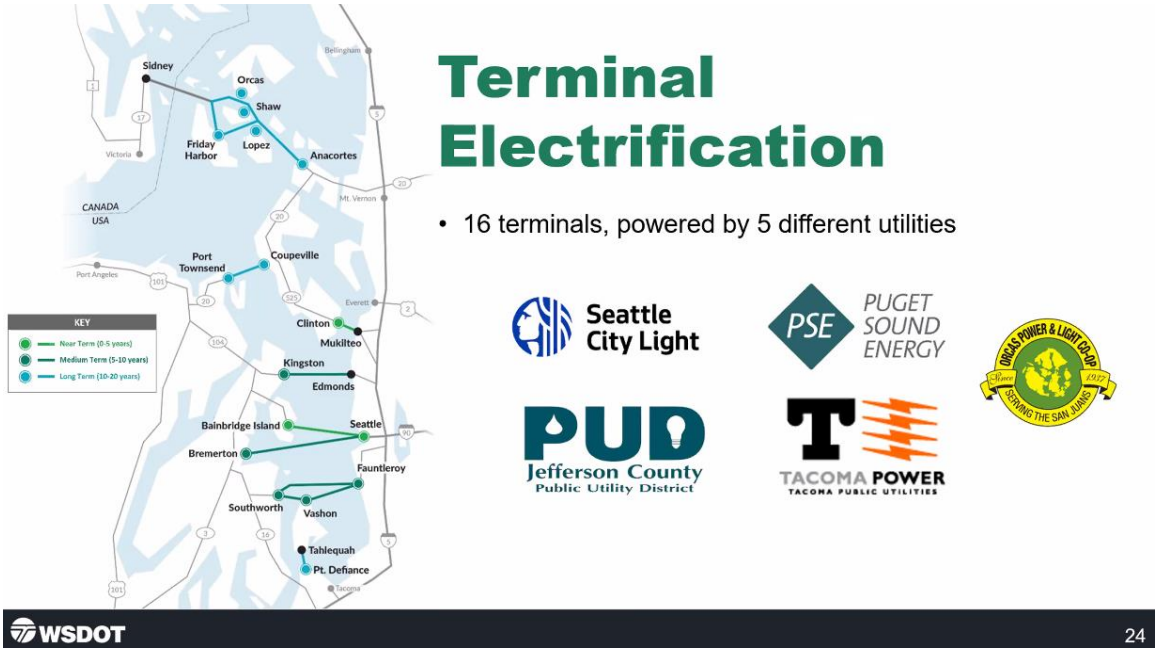

Figure 3-7: WSF October 2022 Industry Day Slide regarding Terminal Electrification[336]

WSF has considered the issue of available dock-side land for supporting infrastructure during the design phase of the required RCS. WSF's leading concept at the date of publishing is the onboard charging arm solution, which is based on the consideration that WSF vessels are typically moored end-to-end and there is a lack of available real estate for land-based charging arm structures. This

[334] See note 261 above
[335] See note 45 above
[336] WSDOT. (10 October 2022). WSF Industry Day Hybrid Electric Olympic Class Ferry Program [unpublished slideshow].

approach is also meant to achieve interoperability and cost avoidance at terminals.[337] As per best practices, WSF is also investigating an alternative solution using a floating or fixed over-the-water structure (see Section 2.4.3.2.4). However, WSF's intention to continue with the RFP and procurement while there is still considerable uncertainty regarding the RCS is not in accordance with best practice for risk management.

As detailed in Section 3.4.2.3, hybrid technology experts, like ABB and Siemens Energy, were contracted by both Vigor and WSF to assist with past and ongoing work related to hybrid-electric ferries. For future bidding processes, WSF should ensure that potential shipyards have internal or external resources with the necessary expertise in any applicable new technology.

WSF has not included in its past specifications a requirement to review technology advancements during the project. As detailed in Section 2.4.7.2.1.2, for the 2019 HEOC, several battery-related studies were completed that explored trade-offs for battery bank design. These studies impacted the design decisions related to the 2019 HEOC, including the size and life of batteries to be installed. Also, as discussed in Section 2.4.6.2.3.3, bolted access hatches for battery removal and replacement were added to the 2019 HEOC design at a late design stage, via a change order, but this important modification was needed to facilitate battery room technological upgrades in the future. WSF updated the Propulsion Batteries and Drives section of the HEOC Technical Specification in May 2021 to include a requirement for battery room equipment removal hatches.[338]

Hybrid-electric specific regulatory challenges were identified at an early stage by Vigor for the 2019 HEOC design. As part of its risk identification requirement in the build strategy, Vigor identified as a risk item the safety of vessel design from a fire detection and protection perspective due to the installation of large batteries onboard, and the new RCS robotic arm design that did not have regulatory approval (see further RCS details in Section 2.4.3.2.2). In addition, as detailed in Section 2.4.3.2.4, WSF contracted Glosten to complete risk assessments related to the RCS design that included potential safety concerns, so that they could be addressed with design updates. The intent of this assessment was also to be used as a tool to communicate project risk management to the regulatory bodies.[339] According to WSF, as of 6 October 2022, the USCG has seen preliminary drawings of the RCS but there is no formal approval. To make sure that the best practice of early identification of potential regulatory challenges is consistently used in future procurements, WSF should make it an explicit contractual requirement, especially considering the evolving nature of new technology such as batteries.

Consistent with best practices, WSF has made plans to provide the necessary training to ship crews on the new hybrid systems. Under the Jumbo Mark II Class ferries hybridization contract, staff of MV Wenatchee, the first vessel to be converted to hybrid-electric power, will be first to

[337] See note 175 above
[338] See note 244 above
[339] See note 175 above

receive training on the new technology. The requirements for training on new systems and equipment were included in the technical specification that was part of the Jumbo Mark II RFP. The required training plan included both classroom training and in-service training.[340] In the HEOC technical specification developed for the 2019 procurement process, WSF included in the general requirements details for the contractor provided training of WSF personnel. This training also included both classroom training and in-service training for switchboards, propulsion controls, and propulsion equipment including energy storage.[341] There is no minimum required number of in-class or in-service hours that can be referenced as a benchmark for this kind of training; however, it is key to include the training as part of the scope of supply to ensure proper training is provided by the designers of the new technology in a timely manner to avoid any delays.

WSF has included Olympic Class Part B warranty provisions in the HEOC Part D draft contract, under the heading "Warranty Deficiencies and Remedies".[342] This standard set of warranty terms are not specific to hybrid-electric technology. However, WSF did include hybrid-electric specific provisions in Exhibit 13 on liquidated damages, which is part of the HEOC Part D contract. This exhibit provided details about liquidated damages due to additional energy consumed and reduced battery life, as well as the minimum projected battery life required for WSF to accept delivery of the vessel.[343] While this is generally consistent with best practice, in VARD's judgment, if the shipyard and its propulsion supplier have a history of delivering newbuild ferries with hybrid-electric propulsion, then the typical warranty provisions may be considered sufficient (as per HEOC Part D draft contract). However, given that this is not the case for most US shipyards, it is important to consider the associated risks and to consider extended warranty provisions to minimize the risks to the owner after the standard warranty period ends.

3.12 STATE AUDITOR'S OFFICE 2013 AUDIT AND RECOMMENDATIONS

The 2013 SAO report of WSF construction costs[344] identified a set of best practices related to reducing and controlling these costs, which cover parts of the process presented in Section 1.3. Some of these practices have since been incorporated into legislation, as reviewed in Section 2.2. Table 3-2 repeats the 2013 summary of recommendations, updated to current status. As noted in the table, VARD has explored a number of these specific points in depth as part of this report, and its own findings and assessments are cross-referenced as applicable.

The 2013 SAO report offered a set of best practices that related to the mandate of that particular review, which focused on construction cost control. That report also reflects the context of the procurement processes in place then, which have changed substantially since 2013.

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[340] WSF. (31 August 2018). Jumbo Mark II Class Ferries Propulsion Control System and Hybrid Upgrade Design Contract No. 00-9317. Technical Specifications.
[341] See note 244 above
[342] See note 102 above
[343] See note 102 above
[344] See note 95 above

As can be seen in Table 3-2, VARD concurs with the majority of the 2013 recommendations as applicable to WSF's current context. Where VARD disagrees, the reasons are discussed elsewhere in this report. In cases where a recommended and agreed best practice has not yet been effectively implemented, VARD's suggestions for future improvements are included in Volume 4.

Table 3-2: Reproduction of SAO 2013 Review of Best Practices Table[345] with VARD's Assessment of Current Status and Questions Arising

Description of Leading Practice		What its Effective Implementation Looks Like	Is this Practice Used Effectively at WSF [in 2013]?			Vard Status Assessment and Questions Arising
			Used Effectively	Could Strengthen	Not used	
1	Use a formal change order process that includes approval criteria.	Change orders reviewed and approved by appropriate level of staff, shared with management as needed, ensures only appropriate changes are approved to the contract.	✓			Change order (CO) process appears robust. No change to assessment of status; See Section 3.4.2.3. WSF should review its practices for development of project technical requirements to limit excessive change orders on future projects.
2	Require the shipyard to provide operational training, standard operating procedures, and spare parts.	Saves purchaser time and expense to develop materials and reduces maintenance costs.	✓			Part of contract scope for recent projects; no reason to expect change.
3	Secure the right to own the final as-built design for future reuse.	Owning the design avoids paying reuse or royalty fees if a follow-on vessel is ordered.	✓			Part of contract scope for recent projects; no reason to expect change.

[345] See note 65 above

	Description of Leading Practice	What its Effective Implementation Looks Like	Is this Practice Used Effectively at WSF [in 2013]?			Vard Status Assessment and Questions Arising
			Used Effectively	Could Strengthen	Not used	
4	Owner describes in detail specific needs and preferences.	Ensures clarity within contractor's and owner's organizations regarding the design, construction, and outfitting of the desired finished vessel.	✓			Detailed specifications part of recent contracts; no reason to expect change. For further discussion about WSF standard specifications, see Section 2.4.6.2 and Section 4.2.3.2.
5	Project partners agree to a Project Charter outlining the purpose, goals, and expected outcomes of the project.	Ensures all parties are 'on the same page' and promotes better working relationships.	✓			Not clear that this was part of Vigor HEOC process or intended approach for re-initiated project. VARD does not consider this a priority item. The Project Charter was re-signed as part of the 2019 HEOC procurement process; however, WSF noted that it has not been effective.[346]

[346] Von Ruden, Matt. (10 Nov 2022). [WSF comment on Rev 0 of the 444-000-7 Final Report, see *444-02 WSF Comment Register for Final Report*, Comment No. 84].

	Description of Leading Practice	What its Effective Implementation Looks Like	Is this Practice Used Effectively at WSF [in 2013]?			Vard Status Assessment and Questions Arising
			Used Effectively	Could Strengthen	Not used	
6	Project Plan fully developed, outlining timelines, personnel/vendor roles and responsibilities, expected duration of the project. Plan is updated throughout project.	Ensures that purchaser and shipyard understand roles and tasks, project goals, and what expectations they must meet.	✓			Part of contract scope for recent projects; no reason to expect change. Discussed further in Section 3.9.
7	Define responsibility and establish processes to resolve issues in timely manner.	Having a resolution process in place helps reduce the risk of disputes jeopardizing the production schedule	✓			Part of contract scope for recent projects; no reason to expect change.
8	Use a steering committee to review and approve changes.	Ensures appropriate stakeholders are involved in reviewing and approving changes.	✓			Not clear that this was part of Vigor HEOC process or intended approach for re-initiated project. As noted above, CO process is robust.

Description of Leading Practice		What its Effective Implementation Looks Like	Is this Practice Used Effectively at WSF [in 2013]?			Vard Status Assessment and Questions Arising
			Used Effectively	Could Strengthen	Not used	
Leading Practices that WSF uses but could strengthen						
9	Use a formal process to ensure 'lessons learned' activities are completed in a timely way and effectively used on subsequent projects.	To improve its use of this leading practice, WSF should establish and use performance metrics to monitor progress based on independent collection of data from all stakeholders.		✓		Interviews with WSF indicate this process remains informal and not always done in timely manner.[347] See Section 4.2.3.6.
10	Develop project budgets based on appropriately estimated project costs; do not depend on large contingency amounts.	To improve its use of this leading practice, WSF should limit its contingency budgets to no more than 5% of the total. Large contingency amounts undermine the integrity of fixed-price contracts.		✓		Work to date has clarified how cost estimates are generated. Olympic contract showed good cost control, so no evidence that contingencies were inappropriate. Discussed further in Section 3.5.

[347] See note 45 above

	Description of Leading Practice	What its Effective Implementation Looks Like	Is this Practice Used Effectively at WSF [in 2013]?			Vard Status Assessment and Questions Arising
			Used Effectively	Could Strengthen	Not used	
11	Use chosen contracting method effectively.	To improve its use of this leading practice, WSF should not employ multiple design firms and should consider using one contract to cover vessel design and construction		✓		This refers to use of design-build contracting, which is mandated by new RCWs.
Four Key Leading Practices that, if implemented together, offer the best opportunities to reduce costs						
12	Use a fixed price contract.	Fixed-price contracts require the contractor to deliver the project for a set price.		✓		Part of contract scope for recent projects; no reason to expect change.
13	Design is complete and reviewed before construction begins.	Helps prevent cost overruns on fixed-price contracts by purchaser not being responsible for changes to an approved design.			✓	Discussed further in Section 3.5.

Description of Leading Practice		What its Effective Implementation Looks Like	Is this Practice Used Effectively at WSF [in 2013]?			Vard Status Assessment and Questions Arising
			Used Effectively	Could Strengthen	Not used	
14	Use an independent owner's representative.	This advocate for the purchaser performs quality oversight, manages the change order process, and ensures project does not depart from the contract.			✓	IOR is mandated by new RCWs. Variants of approach discussed in Section 2.3.3; VARD does not agree with the IOR concept promoted by SAO.
15	Owner places all responsibility on contractor to deliver project quality.	Allows the owner to hold the shipyard accountable for errors and omissions		✓		Attribute of design-build contracting approach, incorporated in contract terms and conditions.

4 VOLUME 4: PROPOSED CHANGES TO WSF'S P&P AND LESGISLATION

4.1 INTRODUCTION

The suggestions included in this volume are those derived from the assessments documented throughout this report that, in VARD's judgment, will have the greatest impact on future ferry procurements. There are many smaller opportunities for improvement in WSF policies and practices, as in most organizations. At this detailed level, it is normally more effective for the organization itself to establish an overall continuous improvement process and to use this to develop changes that are aligned with available resources and other factors.

VARD's suggestions are divided into potential changes to the legislative framework within which WSF functions and those which are under its internal control.

4.2 PROPOSED CHANGES TO WSF'S P&P

4.2.1 INTRODUCTION

After reviewing WSF's documented P&P, interviewing WSF staff to understand the procurement process as it is in practice, and reviewing the historical evidence surrounding the Olympic and Hybrid-Electric Olympic Class ferries and comparing them to current state and federal legislation, VARD has compiled in Section 4.2.2 a list of proposed changes to WSF's P&P in order to bring them into full compliance with state and federal statutes or regulations. In Section 4.2.3, VARD has also compiled a list of proposed changes to WSF's P&P to align with best practices as detailed in Volume 3.

4.2.2 CHANGES TO ALIGN WITH LEGISLATION

Table 4-1 provides a matrix of the results of the two gap analyses presented in Sections 2.4.2.1 and 2.4.2.2 where WSF's documented P&P does not demonstrate full compliance with the legislation. It is an overview of the RCW and WAC which are not fully addressed in WSF's documented policies (per Section 2.4.2.1) but are, in many cases, still complied with as evidenced by recent procurement practices (per Section 2.4.2.2). This table is intended to illustrate that WSF has complied with legislative direction even if it does not have those policies and practices documented. It could also be used to prioritize changes to P&P to reduce the instances of partial compliance going forward.

Table 4-1: WSF's Documented Policies and Historical Practices compared to Legislation

	RCWs which are not documented in WSF policy	RCWs which are inconsistent with documented WSF policy
WSF practices were Compliant with these RCWs	RCW 47.60.810 (3), (4) RCW 47.60.814 (1), (2) RCW 47.60.816 (1) RCW 47.60.820 (5) RCW 47.60.822 (1) WAC 468-320-010 WAC 468-320-030	
WSF practices were Partially Compliant with these RCWs	RCW 47.60.810 (2)	RCW 47.60.812
Whether or not WSF practices complied with these RCWs is Inconclusive	RCW 47.60.820 (1), (2), (3), (4), (8), (9) RCW 47.60.816 (3), (4), (5) RCW 47.60.818 (1), (2), (4) RCW 47.60.822 (2) RCW 47.60.824	RCW 47.6.815 (3)

Table 4-2 uses the list from Table 4-1 to summarize the nature of the additional documentation that should be developed to provide guidance for future projects. This involves filling gaps that have been identified in previous sections and in the supporting materials. Additional process-related documentation is important to fill the gaps in the existing policy documents in order to improve efficiency and effectiveness of WSF's future ferry procurement programs. In some cases, the documented P&P are not consistent with the latest legislation and may result in confusion or mistakes (for example, the VEM discusses a 10% variable for the engineer's estimate, instead of 5%, and does not mention that bids outside that range will trigger a nation-wide recompete, see Table 2-6). In other cases, there are gaps in the documentation for processes and the legislation is silent on the required approach. Individual recommendations could be addressed by stand-alone policies or, in some cases, as part of a more comprehensive document, such as an updated version of the VEM.

Table 4-2: Recommended Changes to WSF's Documented Policies to align with Legislation

RCW/WAC Area	Documented?	Recommendation	See Section
RCW 47.60.810 (2), (3), (4) Definition of independent owner's representative and how it should be used throughout the three phases.	Not documented	The processes for selecting a suitable IOR and for defining the scope of work and reporting responsibilities should be documented and reviewed to ensure that these are consistent with legislation and applied in a consistent manner across future projects.	2.4.2.1.4, 2.4.2.2.1
RCW 47.60.812 Notice of RFPs.	Inconsistent	WSF policies should be updated to align with the RCW requirements of intent to issue RFP notices being published once a week for at least two consecutive weeks in at least one trade paper and one other paper (both of general circulation in the state) and include detail of what the notice should include.	2.4.2.1.3, 2.4.2.2.1, 2.4.2.2.2
RCW 47.60.814 (1), (2) Issuance of RFPs.	Not documented	WSF should document the required elements of the RFP package in alignment with the RCW requirements and also require that legislative appropriation and authorization are needed before issue.	2.4.2.1.4, 2.4.2.2.1, 2.4.2.2.2
RCW 47.60.815 (3) Description of the engineer's estimate and how it is used.	Inconsistent	WSF policy includes requirements for bid estimates to be within 10% of the engineer's estimate, this should be updated to 5% and the process of reissuing RFPs	2.4.2.2.3

RCW/WAC Area	Documented?	Recommendation	See Section
		not subject to in-state build requirements should also be documented.	
RCW 47.60.816 (1), (3), (4), (5) Description of activities undertaken in phase one: evaluation and selection of proposers to participate in development of technical proposals in phase two.	Not documented	WSF should update its policies to include the process by which prospective proposers can note their interest and receive the RFP package. The P&P should also include details of evaluation factors needed to select proposers and details of what selection criteria should be used to assess proposals.	2.4.2.1.4, 2.4.2.2.1, 2.4.2.2.3
RCW 47.60.818 (1), (2), (4) Description of activities undertaken in phase two: preparation of technical proposals by the selected proposers in consultation with WSF.	Not documented	WSF policies are not written for design-build contracts, they should be updated to include the requirements of each phase in the RCW design-build process, in specifically the technical proposal phase.	2.4.2.1.4, 2.4.2.2.3
RCW 47.60.820 (1), (2), (3), (4), (5) (8), (9) Description of activities undertaken in phase three: submittal and evaluation of bids, the award of the contract to the successful proposer, and the design and construction of the ferries.	Not documented	WSF policies do not include design-build contracts, they should be updated to include the requirements of each phase in the RCW design-build process, specifically the detail design and construction phase.	2.4.2.1.4, 2.4.2.2.2, 2.4.2.2.3
RCW 47.60.822 (1), (2) Appeal process.	Not documented	A WSF policy should be written which includes details on notifying unsuccessful	2.4.2.1.4, 2.4.2.2.1

RCW/WAC Area	Documented?	Recommendation	See Section
		proposers and the appeal process that they can take.	
RCW 47.60.824 Negotiations when there is only a single proposer.	Not documented	WSF policies should be updated to include details on the process to be taken if there is only one best-qualified proposer or joint proposer and the fair-value contract negotiations to be undertaken. It should also include details on honorarium payments for unsuccessful proposers.	2.4.2.1.4, 2.4.2.2.1, 2.4.2.2.3
WAC 468-320-010 Contract security for marine vessel contracts.	Not documented	WSF policies do not include details of Contract Security requirements, these should be added to the P&P in alignment with these WAC.	2.4.2.1.4, 2.4.2.2.1
WAC 468-320-030 Calculation of the state's exposure to loss.	Not documented		2.4.2.1.4, 2.4.2.2.1

4.2.3 CHANGES TO ALIGN WITH BEST PRACTICES

Table 4-3 provides a summary of the proposed changes to WSF's policies and practices which are expanded on in the following subsections.

Table 4-3: Summary of Proposed Changes to WSF's P&P to align with Best Practices

Category	Proposed Change	See Section
Risk Management	Develop a robust system for internal project resource planning.	4.2.3.1
General Contracting Approach	Update internal documentation to include reference to applicable classification society notations and standards organization materials (e.g., ASTM International, the Institute of Electrical and Electronics Engineers [IEEE]) which typically apply to projects.	4.2.3.2

Category	Proposed Change	See Section
General Contracting Approach	Develop a structured contractor selection approach and define the criteria which they should be evaluated against.	4.2.3.3
Cost Estimation	Adopt a probabilistic costing approach for estimates at all stages of design.	4.2.3.4
Cost Management/ Control	Ensure builder is undertaking effective schedule and cost control using tools such as EVM, to provide WSF accurate visibility into project performance.	4.2.3.5
General Contracting Approach	Introduce a structured project close-out review to identify lessons learned and improvement opportunities to be applied for future projects.	4.2.3.6
Risk Management	Develop a policy for a ferry specific risk management process.	4.2.3.7
Risk Management	Ensure that a risk assessment is completed, and a risk register is initiated at the very beginning of the procurement process.	4.2.3.7
Risk Management	Establish WSF's organizational risk profile.	4.2.3.8
Risk Management	Establish the process for risk assessments to be conducted with the shipyard.	4.2.3.7
Risk Management	Define standard terms and conditions that include the shipyard's responsibility for risk management.	4.2.3.9
Cost Estimation	Define the cost estimation process for internal costs for procurements.	4.2.3.10
Cost Estimation	Define what items are intended to be covered by the contingency amounts and define standard terms and conditions which will address expected price fluctuations (e.g., material escalation) in the contract.	4.2.3.9
Cost Management/ Control	Define standard terms and conditions that align payments with milestones or EVM metrics.	4.2.3.9

Category	Proposed Change	See Section
Cost Management/ Control	Define standard terms and conditions that address how funding will be managed for the full class of ship (e.g., follow-on ships, major equipment, etc.).	4.2.3.9
Change Management	Define the change order approval process.	4.2.3.11
Change Management	Update the documented change management process.	4.2.3.11
Through Life Cost Optimization	Expand predesign efforts in order to improve WSF through life costs, either by decreasing construction costs at the outset or by reducing life cycle costs through future operational efficiencies.	4.2.3.12

4.2.3.1 INTERNAL PROJECT RESOURCE PLANNING

WSF makes use of staff resources and external contractors to undertake various aspects of ferry procurements. It is suggested that a more robust system of planning for the number and scheduling of these resources would be beneficial in managing this process and ensuring that shortfalls do not impact schedule or quality. For any given project, this should be tailored to the detailed project approach and informed by lessons learned from past projects. (See Section 3.4.2.1.)

As one example, the historical approach to supporting on-site inspections using WSF staff may be less sustainable in the future, given the pressures on operational staffing levels in the fleet. Similarly, where there is turnover in office staff and a loss of experience and expertise, the needs of future projects should be factored into recruitment and professional development.

4.2.3.2 TECHNICAL REQUIREMENTS

The WSF VEM[348] incorporates a small set of standard specification sections for use on maintenance and repair projects, and limited guidance on the use of third-party requirements documentation. WSF should develop internal documentation including incorporation by reference the use of classification society notations and standards organization materials (e.g., ASTM International, the Institute of Electrical and Electronics Engineers [IEEE]). This should consider the needs of the running fleet and the same information can be used in maintenance and updates. (See Section 3.4.2.3.)

[348] See note 1 above

When specifying any requirement, WSF should also consider how compliance will be monitored and verified. Compliance with a class notation can be ensured by having the classification society review drawings and supporting documentation. Materials certificates can be provided, as can standards organization compliance for a piece of equipment. At a systems level, the issue is more complex and may require training for the staff who will be involved. This issue is particularly challenging for any items involving software, where additional specialized support may need to be used.

4.2.3.3 CONTRACTOR SELECTION

As discussed in Section 3.4.2.5, contractor selection for the design phase of a design-build project needs to be included and weighted appropriately in the down-select to shortlisted recipients of the full RFP. Builder selection attributes also need to be addressed for both the initial down-select and for a final contract award, whether these are treated as binary yes/no or as items to be included in a best value decision. When following a Build in Washington approach, this can all be done quite simply, due to the dearth of potential bidders. If this pool is expanded, the process becomes more challenging, and needs to consider the much greater potential for protection if the criteria can be claimed to be inappropriate or mis-applied.

It is suggested that WSF develops a documented set of policies that can be applied to design-build contracts in particular, and that these are provided at least in outline to prospective bidders during the early industry engagement activities. If there is no feedback/pushback, this can be helpful in heading off complaints later in the process.

WSF should also consider the number and detail level of deliverables required for bid evaluation (and cost/price estimation). The re-initiated HEOC is a special case, given that the owner's model represents the outcome of an in-depth redesign effort. For future projects, it should be possible to cut back on this to save on both cost and schedule (see Section 1.4.3).

4.2.3.4 COST ESTIMATION

The current WSF approach to costing includes early-stage parametric estimates leading to bottom-up estimates of the final bid design(s). Currently, both of these are developed as single-point values. Best practice would involve a move to a more probabilistic approach, in which the range of uncertainty in every element of the estimates is used to create a statistical distribution of probable cost/price outcomes. This can provide a more realistic picture of the level of confidence that be assigned to the project cost and the level of contingency that should be assigned to the overall budget. As noted in Section 3.8.2.4, this is not the same as the contingency that should be authorized for the project once a bid is accepted – for a fixed price contract that can and should be a much smaller number.

4.2.3.5 COST AND SCHEDULE CONTROL

WSF already has a wide range of effective practices in place to control and manage cost and schedule slippage. Procurement contracts include liquidated damages for both aspects, and recent contracts show effective use of change order processes. Most direct risk is transferred to

the shipbuilder. However, there is potential benefit in ensuring that the builder's own cost and schedule control and reporting system applies best practices, such as EVM, to give WSF good visibility into the project and early warning of any problems, to allow mitigation measures to be identified and applied.

4.2.3.6 LESSONS LEARNED

The use of lessons learned reviews on project completion is a best practice under all quality assurance systems such as ISO 9001 (2015)[349]. It is a step included in VARD's procurement process map (Figure 1-1) and a recommendation from the 2013 SAO report (see Section 3.12). WSF's practices in this area are not currently either consistent or timely and are likely to fail to ensure that lessons learned in recent projects are used as opportunities for improvement in the future. VARD suggests that project close-out procedures require that reviews be undertaken within a specified period, and that their structure encourages honest appraisal of the strengths and weaknesses of all aspects of the project. It should then be demonstrated that prior lessons learned have been considered in subsequent procurements.

4.2.3.7 FERRY SPECIFIC RISK MANAGEMENT PROCESS

The WSDOT Project Risk Management Guide is in alignment with the seven-step PMI risk management process (as presented in Figure 3-3 and discussed in Section 3.7.2) but this a civil engineering focus. It would be beneficial for WSF to develop a tailored risk management process to document risk management for ferry projects.

As part of the process, WSF needs to consistently identify and document risks in a risk register on an on-going basis through the project life stages, including planning, scoping, design, and construction. Without this key tool, WSF cannot effectively assess, mitigate, and monitor risks. This can then provide input to the CEVP when it is completed.

As part of the overall risk management process, WSF should consider establishing the process for risk assessments to be conducted with their builder for cost, schedule, and technical risks during the RFP phase and following contract award.

4.2.3.8 WSF'S ORGANIZATIONAL RISK PROFILE

Every project carries a degree of risk for the owner. Every risk has a degree of probability and consequence. These can be reduced through mitigation efforts such as: transferring it completely to someone else (e.g., the builder), sharing the risk with someone else (e.g., the builder), warranties, or specific actions such as adding details to the requirements. Or the risk can be accepted. An owner should understand its operating environment and its ability and capacity to deal with significant high-level risks. An organizational risk profile allows senior management to analyze risks and set priorities and allocate resources accordingly. WSF should consider

[349] International Organization of Standards. (2015). *ISO 9001:2015 Quality Management Systems – Requirements.* https://www.iso.org/standard/62085.html

establishing their organizational risk profile to help inform the level of risk they are willing to accept.

4.2.3.9 STANDARD TERMS AND CONDITIONS

WSF should define standard terms and conditions that include the shipyard's responsibility for risk management. These would ensure that the contract clearly reflects the desired requirements for the builder's responsibilities for risk management.

WSF should define what items are intended to be covered by the contingency amounts and define standard terms and conditions which will address expected price fluctuations (e.g., material escalation) in the contract. Contingency should reflect risk, and for a multi-ship program should be front-end loaded in the expectation that the lead ship will have most potential for changes. Defining what and where potential changes in cost will be handled post contract award will give greater confidence in the contingency cost estimate for the entire program.

The use of monthly progress payments is somewhat unusual for shipbuilding contracts, which more typically define milestone payments that represent verifiable stages in construction. Alternatively, in a full EVM system, the shipyard will report on all labor and materials costs, but will only be paid based on the aggregate progress. WSF should define standard terms and conditions that align payments with milestones or EVM metrics.

WSF's contracting process for follow-on ships in a class has commonly used the exercising of options rather than simultaneous award of multiple ships. Under current market conditions, as discussed in Section 3.8.4, the option pricing may be quite difficult to structure. Bidders may or may not be prepared to provide fixed prices for follow-on ships and may include differing assumptions even in indicative pricing for options, resulting in widely varying numbers. State budgetary procedures may limit the options available to address this issue, but an approach that can be useful is to front-end load the ordering of major equipment, so that the price and delivery schedule is fixed as part of the initial contract. This will need to be considered when defining contract terms and conditions and in planning for future negotiations, which may come to resemble sole source proposals.

4.2.3.10 IN-HOUSE COST ESTIMATION

WSF's budget requests for procurements include internal costs such as in-house resources and external contracts (e.g., an IOR, external consultants to complete predesign studies, etc.). WSF's estimation process for internal costs is not well documented. WSF claims that in-house project costs "are well known and easily estimate and pretty accurate". It uses past projects to estimate predesign studies for future projects. It used a simple calculation of one person for one year to estimate the budget for an IOR. It is unclear whether the amounts that are included in budgets for the HEOC and early estimates for the next project will be sufficient, either for in-house resources or for external consulting support, including the mandated IOR.

Currently, WSF does not have a formal policy for how its in-house cost estimates are supposed to be calculated. WSF should develop standard calculation templates for its frequently used in-

house cost estimates, so that they could be consistently used across newbuild projects. A standard calculation template, with instructions for new users, would include a standard set of line items that need to be included in each cost estimate. A reference to this formal process of cost estimating should be included in the updated VEM or other internal documentation. See Section 2.4.4.2.2 and Section 3.8.7.

4.2.3.11 CHANGE MANAGEMENT

The RCW 47.60.820(9)(b) requirement for the OFM to approve contingency spending has not been used before, therefore there is a need to define the approval process to ensure it is efficient and does not add unnecessary delays to the overall change management process that may impact the project schedule.

Overall, WSF has a robust and well-organized change management system that is in accordance with best practices, however, with the introduction of the IOR and the OFM into the process, the system should be reviewed and roles and responsibilities and the approval process updated to align with legislated requirements (if these are not adjusted as recommended in Sections 4.3.2.8 and 4.3.2.9).

4.2.3.12 PREDESIGN EFFORTS

The use of lowest bid as the only determinant of builder selection as required by RCW 47.60.820(4) will tend to focus bidders' design efforts on reducing construction cost alone. Restructuring the approach either to increase the level of internal effort for predesign studies or to fund external industry studies as outlined in Section 3.6.3.2 could improve the approach, as could a change to contractor selection criteria (as proposed in Section 4.3.2.5).

4.3 PROPOSED CHANGES TO LEGISLATION

4.3.1 INTRODUCTION

The suggestions for potential changes to the legislative framework within which WSF functions included in this section are those derived from the assessments documented throughout this report that, in VARD's judgment, will have the greatest impact on future ferry procurements.

4.3.2 CHANGES TO ALIGN WITH BEST PRACTICES

Table 4-4 provides a summary of the legislation for which VARD has proposed changes and which are expanded on in the following subsections.

Table 4-4: Summary of Proposed Changes to Legislation to align with Best Practices

Category	RCW	Proposed Changes	See Section
Risk Management	RCW 47.60.814(1)(r) – Build in Washington requirement	Consider alternative mechanisms that would support Washington shipbuilding and also increase	4.3.2.1

Category	RCW	Proposed Changes	See Section
		the number of bids, to encourage competition, and to ultimately procure ferries at a lower cost.	
Cost Estimation / Risk Management	RCW 47.60.815(3) – If all responses to the initial RFP are greater than 5% above the engineer's estimate, the department must reject them all and issues a new RFP.	The current requirement to cancel RFP process should be changed. Procurement decisions should be based on the best and most objective cost estimates available but should still be considered uncertain until actual price proposals are received.	4.3.2.2
Independent Owner's Representative	RCW 47.60.810(2) – Throughout the three phases, WSF shall employ an IOR.	Allow WSF determine the nature and scope of contractor support services required for all project phases.	4.3.2.3
General Contracting Approach	RCW 47.60.810(3) – Defines phases one, two, and three of the design-build procurement process.	Allow WSF the flexibility to adopt one of several models for future procurements, subject to using an appropriate selection methodology that reflects the procurement's characteristics.	4.3.2.4
General Contracting Approach / Risk Management / Through Life Cost Optimization	RCW 47.60.820(4) – Lowest total fixed price bid	Allow WSF to use a "best value" approach and accept design-build proposals which may offer a lower through life cost, or which have a better risk profile.	4.3.2.5
Risk Management	47.60.385(1)(g) – Details that a project funding request should	Require the use of probabilistic cost estimation in SEO 1053 and require that vessel acquisition project funding	4.3.2.6

Category	RCW	Proposed Changes	See Section
	identify all contingency amounts.	requests detail the probability distribution of the cost estimate and the difference between the most likely and the worst case (and define what percentiles those are).	
Risk Management / Change Management	47.60.820(9)(a) – To accommodate change orders on a fixed price contract, contingency shall be requested as no more than 5% of contract price.	Remove the 5% limit. Improve predesign requirements to ensure a design is mature prior to contract award.	4.3.2.7
Change Management	47.60.820(9)(b) – Use of contingency needs to be approved by financial management.	Reserve OFM approval for changes which have a significant impact on cost or schedule. Apply a reasonable limit on change orders which can be approved by WSF.	4.3.2.8
Change Management	47.60.810 – Change order requests shall be managed by the independent owner's representative.	Allow WSF to define the role and responsibilities of support contracts based on the needs of the specific project.	4.3.2.9

4.3.2.1 BUILD IN WASHINGTON

RCW 47.60.814(1)(r) says that RFPs for the procurement of vessels must include "a requirement that vessels be constructed within the boundaries of the state of Washington…" This statute is often referred to as the Build in Washington law.

RCW 47.60.815(3) says that "…if all responses to the initial request for proposals under RCW 47.60.814 are greater than five percent above the department's engineer's estimate for the project, the department must reject all proposals and issue a subsequent request for proposals that is not subject to RCW 47.60.814(1)(r)."

It is very important that the legislature clarifies its position with regards to Build in Washington (RCW 47.60.814). The current requirement is that in-state options be considered first, but that a procurement can subsequently be opened US-wide if bids exceed the somewhat uncertain engineer's estimate (RCW 47.60.815(3)). This possibly leads to higher cost, certainly cuts off the federal funding source, and certainly increases risks to project schedule.

An alternative approach would be to open the RFP to all US bidders to increase the number of bids, to encourage competition, and to ultimately procure ferries at a lower cost. If the legislature's aim is to benefit the local economy, keep local jobs, and maintain a local shipbuilding capacity while still receiving competitive bids, it may want to consider alternative approaches such as opening the process to all US bidders but offering an in-state bidder's preference or setting evaluation criteria which awards extra points for in-state bidders, use of Washington State accredited SBEs, etc. (see Section 2.3.2.2). In-state preferences which still allow for competition from outside the state is used across the US in some form and for many different industries[350]. Alaska, in particular, has applied its in-state preferences to recent ferry procurements, as discussed in Section 1.6.1.1, and BC Ferries has benefited from opening its RFPs to a wider pool of bidders, as discussed in Section 1.6.2.1 (though the Canadian context is quite different). VARD makes no specific recommendation for what approach to take – this is a public policy issue, though one that should be informed by an understanding of budget implications.

Depending on the overall disposition of this item, related polices for SBE and apprenticeships may need to be addressed as well.

4.3.2.2 ENGINEER'S ESTIMATE

RCW 47.60.815(3) says that "…if all responses to the initial request for proposals under RCW 47.60.814 are greater than five percent above the department's engineer's estimate for the project, the department must reject all proposals and issue a subsequent request for proposals that is not subject to RCW 47.60.814(1)(r)."

The current requirement to cancel an RFP if bids are more than 5% above the engineer's estimate is a major source of project uncertainty and should be revisited, regardless of whatever decisions are taken with respect to Build in Washington. As discussed in Section 2.3.2 and Section 3.8, estimating the cost of a new ferry is problematic, and is a challenge for all operators. Best practice says procurement decisions should be based on the best and most objective cost estimates available but should still be considered uncertain until actual price proposals are received. If the legislature's aim is to encourage competitive bids, it may want to consider alternative approaches as discussed in Section 4.3.2.1 above.

[350] See note 93 above

4.3.2.3 INDEPENDENT OWNER'S REPRESENTATIVE

RCW 47.60.810(2) says that "…the department shall employ an independent owner's representative to serve as a third-party intermediary between the department and the proposers, and subsequently the successful proposer" and then goes on to list the responsibilities of the IOR.

This highly prescriptive requirement for an IOR does not represent best practices for ferry procurement and is not well-aligned with general public sector procurement practices for delegation of authority and responsibility, as discussed in Section 2.3.3. The use of external resources to assist in complex projects is normally a part of project planning, and WSF does this in various ways. While its policies and practices in this area could be updated and enhanced, VARD does not consider that an IOR as defined should be mandated. If the legislature's aim is to ensure efficient communication and a successful relationship between WSF and the builder, an alternative approach would be to allow WSF the freedom to choose the nature and scope of contractor support services. This approach allows WSF to choose the options that best complements its in-house expertise and available resources.

4.3.2.4 DESIGN-BUILD MODEL

RCW 47.60.810(3) says that:

> "(a) "Phase one" means the evaluation and selection of proposers to participate in development of technical proposals in phase two.
>
> (b) "Phase two" means the preparation of technical proposals by the selected proposers in consultation with the department.
>
> (c) "Phase three" means the submittal and evaluation of bids, the award of the contract to the successful proposer, and the design and construction of the auto ferries."

This definition of phases and the follow-on RCWs outline the general process for a design-build procurement approach, as detailed in Section 1.3. Therefore, currently, only the design-build model can be used for WSF procurements. Best practice would be to give WSF the flexibility to adopt one of several models for future procurements, subject to using an appropriate selection methodology that reflects the procurement's characteristics. If the legislature's aim is to transfer the maximum possible amount of risk to the shipbuilder, and to provide builders with flexibility in their design and build approach, it may want to consider that the differences in risk transfer between this and other approaches can be rendered minimal by sound contract planning, and other approaches can in some cases offer benefits for cost reduction and for design quality. BC Ferries has used both design-bid-build and design-build procurement approaches in recent years which has allowed it to find an approach which works to its best advantage and to tailor its RFP to procure the best value for money (see Section 1.6.2.1).

4.3.2.5 LOW BID

RCW 47.60.820(4) says that "…the department may select the responsive and responsible proposer that offers the lowest total fixed price bid for all vessels."

By law, WSF can only accept the lowest bid for contract award. Best practice would allow WSF to use a "best value" approach and accept design-build proposals which may offer a lower through life cost, or which have a better risk profile. In some respects, the low bid approach is better suited to design-bid-build, which should lead to more similar through life cost profiles. If the legislature's aim is to reduce the costs of the ferry system as a whole, it may consider alternative approaches which take into account the full life cycle cost of the ship (see Section 3.8.3) and not just the upfront purchase price by using a carefully selected evaluation criteria which gives equal weight to estimated maintenance and preservation costs as to bid price. BC Ferries, for example, uses purchase price as the main criterion in bidder selection but retains other evaluation criteria to avoid being forced to accept an offer which has other concerns (see Volume Section 3.8.6).

4.3.2.6 VESSEL ACQUISITION PROJECT FUNDING REQUESTS

RCW 47.60.385(1)(g) says that "vessel acquisition project funding requests must adhere to the capital plan, include route-based planning, and be submitted with a predesign study that," amongst other things, "identifies all contingency amounts."

As discussed in Section 3.8.2.4, an appropriate contingency is highly dependent on many factors, not least how cost risk is allocated, market conditions, and the level of uncertainty involved in the cost estimation process. At the time of funding request and prior to industry engagement, any contingency stated in the predesign study will be subject to change, potentially significantly.

Best practice says that instead of using a contingency, a cost estimate with a corresponding confidence level should be used to convey a more sophisticated appreciation of cost risk. To complicate matters, RCW 47.60.820(9)(a)(ii) limits contingency to 5% of the contract price, regardless.

If the legislature's aim is to gain awareness of potentially budget increases, an alternative approach would be to include probabilistic cost estimating as a new RCW requirement. This would still provide the legislature with the necessary information for budget purposes and, also, allow for greater visibility of the overall risk of funding increases.

4.3.2.7 5% CONTINGENCY

RCW 47.60.820(9)(a)(ii) says that "to accommodate change orders on a fixed price contract … the contingency may be no more than five percent of the contract price."

As discussed in Section 3.8.2.4, an appropriate contingency is highly dependent on many factors, not least how cost risk is allocated, market conditions, and the level of uncertainty involved in the cost estimation process. While 5% is a reasonable amount of contingency for many projects, this is dependent upon successful preplanning efforts, mutually acceptable terms and conditions, a stable financial environment, etc. Limiting the contingency in such a strict manner does not allow for unexpected changes which may be required through no fault of WSF or the shipyard. As examples, the direct and indirect impacts of the COVID pandemic on worksites and supply chains, the recent rapid rise in inflation, and the major shift in exchange rates (with their effects on non-

US components and materials) all generate cost and schedule risks that could not have been foreseen at the outset of the HEOC program.

As discussed in Section 4.3.2.6, best practice says that instead of using a contingency, a cost estimate with a corresponding confidence level should be used to convey a more sophisticated appreciation of cost risk.

If the legislature's aim is to limit cost overruns, rather than restricting contingency value, better practice is to ensure that the ship design is mature prior to contract award, and that no significant technical risk factors are still present.

4.3.2.8 OFM APPROVAL OF CONTINGENCY SPENDING

RCW 47.60.820(9)(b) says that "The contingency required by this subsection (9) must be … held in reserve until the Office of Financial Management approves the expenditure."

As discussed in Section 2.4.6.2.1 and Section 3.10.3, the addition of the OFM to the change management process has some potential issues. First, OFM staff are not expected to have the necessary vessel construction knowledge and experience to make informed final approval decisions about change orders. And secondly, this process has never been used and is not well defined, so it may result in unnecessary delays in the approval process that can impact the project schedule.

Best practice is to reduce the need for change orders in the first place, as discussed in Section 3.10.2. However, recognizing that change orders may be unavoidable, best practice is to have a robust change management process that uses a formal process that ensure appropriate and knowledgeable stakeholders are involved and includes approval criteria.

If the legislature's aim is to ensure the project does not depart from the contract, an alternative approach would be to limit which changes require OFM approval. This would allow WSF to use its internal change order review and approval process to approve expected change orders (such as material price adjustments, as discussed in Section 3.8.5) and those change orders which fall below a certain dollar amount / schedule change and do not result in a significant impact to the project. This would help ensure the change order process does not delay the project except in exceptional cases. It would also reduce the burden on the OFM, which would potentially need to hire an external consultant with the necessary expertise to help them understand the purpose and significance of every change order.

4.3.2.9 CHANGE MANAGEMENT

RCW 47.60.810(2)(c) says that "the department shall employ an independent owner's representative" and that "the independent owner's representative shall," amongst other things, "manage any change order requests."

The addition of the OFM into the approval process (as discussed in Section 2.4.6.2.1) and also the IOR into the change management system (as discussed in Section 2.4.6.2.2) adds multiple additional layers, potentially introducing conflict surrounding the roles and responsibilities of

WSF, OFM, and the IOR. This could result in delayed change order approval decisions and could impact the project schedule.

As discussed in Section 3.10.3, WSF already has a change management system that aligned with best practice prior to the addition of the OFM and IOR. As discussed in Section 2.3.3.2, employing an external consultant(s) is best practice, however, their role is to support the owner and supplement in-house resources. As discussed in Section 2.4.6.2.2, WSF has entered into contract with Art Anderson Associates for IOR service for the HEOC program; the scope of work spelled out in that contract is in line with best practices for the use of an IOR (i.e., Art Anderson Associates will be supporting, monitoring, providing input, participating, and/or reviewing at every stage of the procurement process but is not given any authority).[351]

If the legislature's aim is to ensure the project does not depart from the contract, an alternative approach would be to add the OFM into the change management system as discussed in Section 4.3.2.8 and allow WSF to define the role of the IOR based on its own resource needs.

[351] See note 224 above

APPENDIX A: VARD PERSONNEL

The following is a list of VARD personnel who have worked on this project and a brief description of their experience:

Alex Bond – Ship cost estimating and economics expert. Alex is an Engineering Technologist with over four years of experience in the marine industry. He has provided his cost estimating expertise to many large government vessel new build projects and provided life cycle cost modelling to focus on the OPEX side of vessel cost. He has provided expertise for the Canadian Coast Guard on their Polar Class Icebreaker Project, as well as other programs for the Chilean Navy, and international clients.

Andrew Kendrick – Principal consultant. Andrew is a Principal Naval Architect with over 45 years of experience in marine consultancy and ship design. He has provided input to government ship acquisition programs in the US, Canada, UK, and other jurisdictions, including advising on contracting approaches, generating cost estimation models and cost estimates, supporting project offices during project implementation, etc. He has also worked on numerous ferry projects in roles including client support, design, shipyard support, and on-site supervision. He has provided risk management services for a variety of marine projects, including the implementation of new technologies such as dual-fuel and hybrid propulsion. He now works part time with VARD, while filling the office of President of the Society of Naval Architects and Marine Engineers, based in Alexandria, VA.

Angelique Davis – Project Manager (from contract amendment onwards). Angelique is a Senior Naval Architect, Project Manager, and a licensed Professional Engineer with over 13 years experience in the ship design and shipbuilding industry. She holds a bachelor's degree in ocean and naval architectural engineering and is licensed to practice engineering by Professional Engineers Ontario. Angelique has managed a range of ship design projects and a variety of research and feasibility studies. Her technical experience includes structural design and analysis, control systems review, validation, and integration, feasibility studies, requirements development and validation, amongst others. Angelique is also the Quality Assurance coordinator for the VARD Ottawa office.

Artur Polec – Shipbuilding project management expert. Artur has 10 years experience managing newbuilding projects and an additional 10 years experience working as a project manager on the technical side. He has experience in systems and process engineering, alternative propulsion and power/hybrid power systems, naval architecture, automated control and monitoring systems, building technology and process, and building cost evaluations/budgeting/follow up. Artur has extensive experience designing and building ro-pax ferries in European shipyards.

Darren Truelock – Executive Sponsor and Project Director. Darren is the Vice President of Vard Marine Inc. (Houston Office). He has over 15 years of experience in the marine industry providing oversight of design and engineering packages for both newbuild ships and refit projects, as well

as class society regulatory rule development and engineering management. Darren understands project leadership skills and has extensive experience with delivering on engineering, design, and support to construction of real ships now in service.

Evgueni Sapojnikov – Mechanical systems expert. Evgueni is Marine Engineering Systems Technologist with over five years of experience in the ship design and shipbuilding industry. He holds a bachelor's degree in finance and economics, and a master's degree in marine transport management, and a diploma of technology in marine engineering systems design. He has provided his financial analysis capability to new build projects, including the CCG Program Icebreaker. He contributed to numerous studies and research initiatives that included the implementation of new technology and risk management. He has new construction shipyard experience and worked with the purchasing department to reduce procurement costs on fixed-price contracts.

Joanne Bell – Depute project manager and engineering program management expert. Joanne is an engineer with a background in program management, most recently for a high-value sector of the aerospace industry. She has extensive experience with engineering program management, including best practices for change, risk, communication, and requirements management.

Mark Munzel – Ship design/build program manager. Mark is both a Senior Naval Architect and a Senior Project Manager at VARD with over 20 years of experience. He has managed a number of key design and build contracts including the US Coast Guard Offshore Patrol Cutter (OPC) design contract with Eastern Shipyard, and the US Coast Guard Heavy Polar Icebreaker (HPIB) design and build contract. Mark has extensive understanding of ship design and construction contract risk, analysis, and management best practices.

Matthyw Thomas – Project Manager (From contract award to contract amendment) and ship cost estimating expert. Matthyw is a Professional Engineer with over 18 years of experience in the marine industry and extensive experience in large vessel CAPEX and OPEX cost estimation. He has provided project management and cost estimating expertise to many large government vessel design and procurement programs including the Canadian Navy Arctic Offshore Patrol Vessel (AOPS), the Canadian Navy Join Support Ship (JSS), the Canadian Submarine Fleet, BC Ferries (multiple ferry classes), the Canadian Polar Icebreaker, and other programs for the US Navy, US Coast Guard, and international clients.

Ron Ogoniek – Projects and Programs Department Lead (formerly Ottawa Office Engineering Manager). Ron is a Mechanical Engineer and licenced as a Professional Engineer in Ontario. With 30 years experience in product design, engineering consultancy and ship design and build. His current role is the Projects & Programs Department Manager. Ron has extensive experience in project and program management: 11 years with a large tier one automotive supplier in various technical and leadership roles; 4 years specializing in industrial/manufacturing automation; and 15 years in naval in-service support, supporting various new ship construction projects, ship ref-fits and marine consultancy contracts. Ron's experience includes managing large complex

technical projects as Project and Technical Manager and also in commercial aspects as a discipline lead in negotiating large international joint ventures.

Sarah Thomson – Technical Lead, ship cost estimating expert, quality management, and business management systems expert. Sarah is an Engineer and Quality Manager with a masters in product design engineering, with 5 years of experience in the marine sector. She has managed several high value investments to improve manufacturing capabilities in a UK shipyard. On the technical side, her experience at VARD has included producing cost estimates for US Navy studies, liaising with vendors to identify candidate equipment to advance design maturity, and completed trade off analyses and research studies. From a management perspective she is a Project Manager, Costing User Group Lead, and Quality Manager, responsible for maintaining ISO 9001:2015 certification and leading valuable process improvements.