Vard Marine Inc.

FINAL REPORT EXECUTIVE SUMMARY

Joint Legislative Audit and Review Committee (JLARC)

106 11th Ave SW

PO Box 40910

Olympia, WA 98504-0910

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VARD Contact:	Angelique Davis, P.Eng.

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)

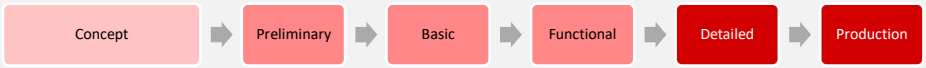
ES-6. Risk Management

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)

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.