REQUEST FOR INFORMATION – VESSEL ELECTRICAL SYSTEM

GUEMES ISLAND FERRY REPLACEMENT

000 GENERAL REQUIREMENTS

000.1 Objective

This Request for Information describes the requirements for the electrical system of the Guemes Island Ferry Replacement (GIFR) vessel, a 160-ft. battery electric passenger and vehicle ferry, at the ferry terminal in Anacortes, Washington. Skagit County owns and operates the Guemes Island ferry and ferry terminal. Glosten has been selected by Skagit County to design the replacement vessel and the associated charging system. We are requesting detailed technical information including a basic one-line diagram, equipment drawings, specifications, and rough order of magnitude (ROM) pricing for this equipment to progress the design of the vessel.

The GIFR vessel is expected to be the first purpose-built electric vehicle ferry in the United States. The battery electric system for this project could serve as a model for similar future ferry projects in Washington State and the surrounding region.

The information provided in response to this RFI will not be used as a basis for selection of vendor or equipment.

Responses are requested by 30 June. Please note all information does not need to be provided at one time and early information submittal is encouraged.

000.2 Reference Documents

The following are document is referenced within this RFI:

1. *GIFR Transportation System Assessment (PDF)*. Glosten, Inc., Document No. 17097-000-02, Rev. -, 14 December 2018.

The above document is for informational purposes only and should not be used for design and engineering beyond the purposes of this inquiry.

To request these documents, please email Jeff Rider at jmrider@glosten.com.

000.3 Acronyms

Acronyms used throughout this document are as follows:

ASCS	Automatic Shore Connection System
CFR	Code of Federal Regulations
GIFR	Guemes Island Ferry Replacement
HMI	Human Machine Interface
LMFB	Last make/First break
NEC	National Electrical Code, NFPA 70
PCS	Propulsion Control Systems
PMS	Power Management System
RFI	Request for Information
ROM	Rough Order of Magnitude
SES	Shoreside Electrical System
SOC	State of Charge

VES	Vessel Electrical System
WAC	Washington Administrative Code

000.4 Requested Data

The following drawings and data are requested:

- Dimensional drawings of all components.
  - Switchboards.
  - Propulsion battery banks.
  - Power conversion equipment.
- Weight estimate of all components.
- Electrical equipment description and ratings.
- One-line electrical diagram indicating scope of supply and significant features.
- Auxiliary system requirements (cooling, ventilation, etc.).
- Technical description of equipment and its operation. The description shall list all components that are in the scope of supply and proposed step by step instructions for system operation. If drawings of minor components cannot be provided at this time, a clear description with overall dimensions and weights should be provided.
- Overall electrical efficiency of all major distribution and conversion components.
- ROM cost estimate for equipment, with itemized commissioning services. Cost estimates should not include costs for shipping equipment.
- Information outlining vendor support and warrantee of equipment throughout vessel's operational life.

All documents do not need to be delivered at one time.

000.5 Project Information

The GIFR project electrical system (see Figure 1 for overview) has been broken into three portions: the Shoreside Electrical System (SES), the Automatic Shore Connection System (ASCS), and Vessel Electrical System (VES). Figure 1 is an outline of how the systems are expected to interface with each other; details of system architecture within each system may vary by vendor and technical solution.

As indicated in Figure 1, the standby generator is not within the scope of supply of the vessel electrical system vendor. Details of the AC ship service distribution panelboard are under development, Figure 1 represents preliminary design which may evolve throughout the development of the vessel.

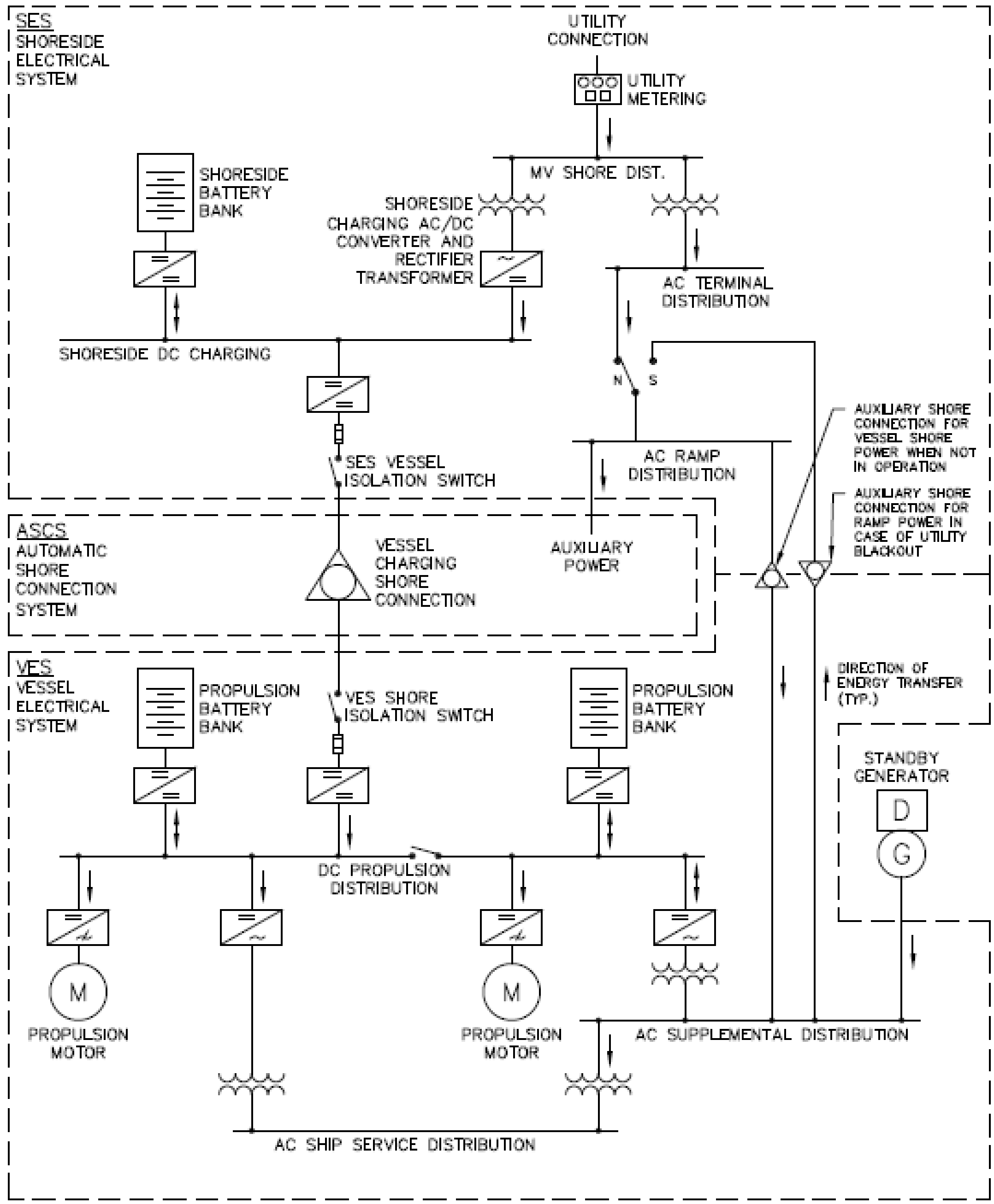


Figure 1 GIFR project electrical overview

000.5.1 Procurement and Support

Table 1 Estimated project timeline

Preliminary design complete	September 2020
Contract design complete	March 2021
Shipyard period	November 2021 to July 2023
Terminal modification period	November 2022 to April 2023
Vessel in service	September 2023

Table 1 provides an estimated timeline for major milestones for the GIFR project. Preliminary VES information from vendors is expected ahead of the completion of the preliminary design.

000.5.2 Multiple GIFR RFIs

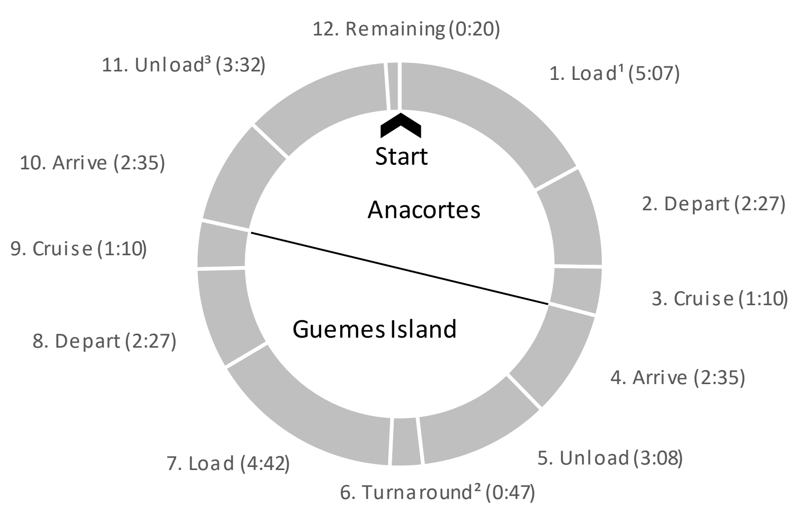
Glosten will issue separate RFIs for the automatic shore connection system (ASCS), shoreside electrical system (SES), and propulsor units. Vendors may elect to respond to any of the RFIs on an individual basis. In cases where a cost savings may be obtained by selection of a single vendor for multiple scope items, this should be explicitly stated and costs savings broken out.

000.5.3 Vessel

Table 2 Vessel Particulars

Length, Overall	160'-0"
Beam	53'-0"
Draft	7'-6"
Car Capacity	28
Full Load Displacement	530 LT
Propulsors	(2) 700 kW L-Drive Azimuthing Propulsors
Speed, Cruise	11.5 kts

It is estimated that the vessel will operate 365 days per year, with an average of 24 round-trip crossing per operating day. Figure 2 depicts the timeline of a typical round-trip crossing, which takes 30 minutes. Note the battery sizing calculations assume some maintenance downtime resulting in 8400 round trips per year.



1. Loading in Anacortes includes the time required for the first embarking vehicle or walk-on passenger to transit the transfer span (move from the waiting area to the ferry).

2. Turnaround time on Guemes Island is the time between the last Guemes-bound vehicle or walk-on passenger to step off the ferry, and the first Anacortes-bound vehicle or walk-on passenger to step onto the ferry.

3. Unloading in Anacortes includes the the time required for the last disembarking vehicle or walk-on passenger to clear the transfer span.

Figure 2 Typical round-trip transit

000.5.4 Terminal

The SES will be installed at the Anacortes terminal to provide high-power charging capability for the ferry. The SES will include a set of shore batteries to allow relatively constant power draw from the medium voltage utility system, with cyclic higher power discharge to the ferry.

The ASCS will be installed at the Anacortes terminal docking facility to serve the vessel. The ASCS will transfer the required electrical energy from the SES to the VES to charge the propulsion batteries and power the vessel during connection. No shore charging connection is required on the Guemes Island side.

The SES and ASCS outlined above are outside the scope of this RFI, see Section 000.5.2.

000.5.5 Regulatory

The vessel will be required to satisfy the rules for a USCG Inspected Small Passenger Vessel under US CFR Title 46, Subchapter T. This includes all aspects of the vessel electrical system which are installed on the vessel, and may also include review of the shoreside system for information. Per Title 46, the electric propulsion system is required to meet the applicable portions of Section 4-8-5/5 of the ABS Steel Vessel Rules.

The USCG has limited experience reviewing and inspecting this type of all electric vessel and the rules and requirements pertaining to a large battery installation of this type are not well defined. The integration of an ASCS of this nature on the vessel is unique in the United States and we expect both the USCG and the Washington State electrical inspectors to review this aspect of the project. Glosten is working with the regulatory bodies to define particular requirements and will provide details to vendors when available.

001 VESSEL ELECTRICAL SYSTEM (VES)

The VES shall be an all-electric system which allows the vessel to transit back and forth between the Anacortes and Guemes terminals using energy stored in propulsion batteries. The batteries will be charged during the regular loading/unloading period at the Anacortes terminal via the ASCS.

The VES must be equipped with two (2) independent propulsion battery banks. The propulsion battery banks shall serve as the two independent power sources required by the USCG, and all ship service and propulsion loads must be able to be powered from either battery bank. The main propulsion bus shall be capable of being split so that a fault on one portion of the bus does not disable ship service power and one of the two propulsion motors.

The VES must accommodate the interface to a standby generator to supplement the battery capacity in severe weather conditions and other abnormal operations (e.g. emergency evacuation or utility blackout). The standby generator is anticipated to operate less than 5% of the time the vessel is operating, but may run for extended periods of time during some runs.

Table 3 provides a summary of the major electrical power sources and loads on the vessel.

This RFI is written with the assumption that a DC propulsion bus configured in a manner similar to that shown in Figure 1 will be best suited for this project. Figure 1 is primarily intended as an outline of the scope of each electrical system; the details of the configuration may be modified to fit the capabilities of the systems offered by vendors. Vendors may propose alternate configurations. If proposing an alternate configuration, vendors should interpret the requirements of this RFI accordingly, and are encouraged to provide support in the proposal to justify the deviation from the DC bus configuration.

Table 3 Summary of major electrical power sources and loads

Equipment	Qty.	Rating (each)	Notes
DC Propulsion Dist. and ASCS Interface	1	2.0 MW 1000V DC (nom.)	See Section 001.1.3
Propulsion Battery Banks	2	800 ekW (charge) 600 ekW (discharge)	Energy storage capacity to be based on operating profile, see Section 001.1.2
Propulsion Motors/Drives	2	~750 ekW Variable speed drive	See Section 001.1.1
Ship Service Distribution	1	40 ekW 208Y/120V, 3Ø, 4W, 60 Hz	Redundant feed from propulsion battery banks See Section 001.3.1
Standby Generator	1	550 ekW 480V, 3Ø, 3W, 60 Hz	See Section 001.2.1
Ship Service Shore Connection	1	60 Amps 480V, 3Ø, 3W, 60 Hz	For use when moored and not in operation, see Section 001.2.2
Ramp Standby Connections	2	50 Amps 480V, 3Ø, 3W, 60 Hz	For ramp power in case of blackout (one each end), see Section 001.3.2

001.1 Electric Propulsion

001.1.1 Propulsion Motors and Drives

Two (2) 750 ekW variable speed motors powered by variable speed inverters will provide power for the azimuthing L-drive propulsors. The following are general motor characteristics which should be used for the purposes of this proposal:

a. Water-jacket cooled.

b. PM synchronous type.

c. V1 flange mount (vertical, shaft facing down, to interface with propulsor).

d. Continuous duty.

e. Embedded winding and temperature sensors.

f. DE & NDE bearing temperature sensors.

g. 0-100% speed control.

h. 6500 Nm torque.

i. 1100 rpm maximum (both directions).

The above characteristics are preliminary and will be confirmed as the design progresses. The motor is expected to need to be as short as possible to clear the deck above. A compact purpose-built motor for marine L-drive applications is expected to be most suitable. Geometric requirements of the motor are discussed in the propulsor RFI, see Section 000.5.2.

The propulsion drives must interface with the power management system and power limiting functions (see Sections 001.1.4 and 001.4.3).

001.1.2 Propulsion Batteries

Two sets of propulsion battery banks must be configured to serve as the two electrical power sources required by USCG. The batteries should be sized to provide a 10 year operational life based on the probabilistic load profiles listed in Table 4 and 8400 round trips per year (24 runs per day, 350 operating days per year). The load profiles listed in Table 4 reflect the battery power required for each propulsion battery bank.

The standby generator is assumed to be operating in the “With Generator” and “Schedule Slip” load profiles shown in Table 4.

Each battery bank is to have the following features/capabilities:

a. Independent battery management system.

    1. Charging control.

    2. High temperature alarm and high-high temperature shutdown functions.

    3. High voltage and abnormal voltage deviation alarm and shutdown functions.

b. Battery modules equipped for isolation and mitigation of thermal runaway.

c. Meet the requirements of ASTM F3353-19, *Shipboard Use of Lithium-Ion Batteries*.

d. UL 1642 or IEC 62619 certified.

e. Temperature monitoring for each battery cell. A single sensor located between two cells may be used, but a single sensor may not monitor more than two cells.

Table 4 Cumulative probability load profiles for propulsion batteries based on weather and tidal predictions

Route	Operation	50% Probability[1]		80% Probability[1]		95% Probability[1]				99.7% Probability[1]	
		Average Run		*Above Average*		Without Generator		With Generator		Schedule Slip	
		Time [minute]	Power[2] [kW]	Time [minute]	Power[2] [kW]	Time [minute]	Power[2] [kW]	Time [minute]	Power[2] [kW]	Time [minute]	Power[2] [kW]
Anacortes to Guemes Isl.	*Maneuver*	0.87	566.0	0.90	629.1	0.90	681.7	0.90	194.1	0.87	566.0
	Ramp Up	0.78	816.4	0.78	923.7	0.78	999.4	0.78	511.8	0.78	816.4
	Cruise	1.17	687.0	1.17	776.4	1.18	839.5	1.18	351.9	1.17	687.0
	Ramp Down	0.78	492.9	0.78	555.5	0.78	599.6	0.78	112.1	0.78	492.9
	Maneuver	1.03	566.0	1.03	629.1	1.20	681.7	1.20	194.1	1.03	566.0
	Unload/Load	9.02	134.7	9.67	229.4	10.23	408.2	10.23	-79.4	9.02	134.7
Guemes Isl. to Anacortes	*Maneuver*	0.87	566.0	0.90	629.1	0.90	681.7	0.90	194.1	0.87	566.0
	Ramp Up	0.78	816.4	0.78	923.7	0.78	999.4	0.78	511.8	0.78	816.4
	Cruise	1.17	687.0	1.17	776.4	1.18	839.5	1.18	351.9	1.17	687.0
	Ramp Down	0.78	492.9	0.78	555.5	0.78	599.6	0.78	112.1	0.78	492.9
	Maneuver	1.03	566.0	1.03	629.1	1.20	681.7	1.20	194.1	1.03	566.0
	Unload/Load	1.00	134.7	1.00	229.4	1.00	408.2	1.00	-79.4	1.00	134.7
	Unload/Load (charging)[3]	10.72	-702.7	10.00	-948.2	9.07	-1386.3	9.07	-206.5	10.72	-702.7

1. Probabilities listed indicate the annual cumulative probability that the required load profile power will not be exceeded.
2. Required power discharge from batteries reflects the quantity that would be measured at connection to DC propulsion switchboard; negative values indicate battery charge. Conversion and battery losses are not reflected in these values.
3. Charging from the ASCS during unload/load at Anacortes estimated assuming a constant charge/discharge cycle efficiency of 95%. These values should be adjusted based on specific system capabilities.

001.1.3 Shore Charging

The electric propulsion and battery systems must be capable of being powered through the ASCS while simultaneously providing power to ship service and propulsion motor loads, charging both propulsion battery banks, and in some cases also consuming power generated by the standby generator.

001.1.4 Power Management System (PMS)

The PMS will provide control and monitoring of the battery electric system through HMIs and other operator interfaces at the main switchboard and the two (2) pilothouse control stations (one facing each direction). The PMS should include the following features:

a. Automatic loadshed of non-vital ship service loads and power-limit control of propulsion motors as required to avoid prolonged overload and blackouts. Additional capability for manual control to loadshed of non-vital loads in case of lower than desired battery SOC.

b. Control, monitoring, and safety protection function interfaces with the ASCS and SES to enable automated charging and safety disconnections. See Section 001.4 for interface details.

c. Controls to remotely bring the standby generator on and off-line and set the power generation level. Operation of the standby generator will be manual only, with no automatic functions except for safety related shutdowns. See Section 001.4.4 for interface details.

d. Alarm, monitoring, and control of equipment within the scope of the electric propulsion system, similar to that required for an unattended machinery space; including equipment faults, propulsion battery health and status, breaker status, voltage, frequency, current, etc.

e. Monitoring of power consumption and battery SOC with options for real time comparison to a range of previous trip profiles, averages, and targets.

f. Monitoring and alarm of the battery SOC which provides indication of various SOC thresholds and a range of alarms activated by SOC levels outside of the nominal range.

The PMS shall include or interface with a method of logging parameters of the electric propulsion system such as propulsion power, ship service power, and SOC, along with other outside parameters which affect energy use like currents, wind, and vessel loading. Vendors are encouraged to propose logging, tracking, and analytic tools that will help reduce operation costs and energy consumption.

001.2 Supplemental Power Sources

001.2.1 Standby Generator

A 550 ekW standby diesel generator will serve as a standby power source in addition to the main battery electric system. The standby generator is expected to operate in the following instances:

a. Utility blackout at the Anacortes terminal which prevents charging of the propulsion batteries through the ASCS.
b. High propulsion loads due to severe weather, requiring supplemental power generation to maintain schedule or avoid undesirably high discharges of the propulsion batteries.
c. Transit off-site or emergency operations outside of typical operating profile.

The standby generator is planned to be a standardized skid mounted 480V, 3-phase, 3-wire, 60Hz synchronous marine genset. Figure 1 shows an acceptable configuration for integrating the standby genset in to the VES, however the vendor may propose alternate ratings and methods of interconnection which meet the project design intent (see exception below).

The vendor should provide for interfaces with the standby generator as described in Section 001.4.4.

Other than the exception described below, supply of the standby genset skid should not be included in the scope of the VES proposal; the standby genset skid is intended to be provided by the shipyard.

Exception: Vendors may propose an alternative to the 480VAC rating for the standby generator, but must include the proposed genset skid (engine, generator, etc.) in the technical proposal and as a line item in the commercial proposal. Vendors considering this alternative are encouraged to discuss further with Glosten.

001.2.2 Auxiliary Shore Power

A ship service shore power receptacle rated for 480V, 3-phase will provide power for the ship service system while the vessel is moored at the Anacortes terminal and unattended (ASCS not intended to operate while vessel is not crewed). The rating of the circuit will be 60 amps or less, to be finalized later in the design process. The receptacle will be located on the Anacortes end of the vessel and will be used for manual connection to the shore power cable.

001.3 AC Distribution

001.3.1 Ship Service Distribution

The main ship service system should distribute 208Y/120Y, 3-phase, 4-wire, 60Hz power and must have the following characteristics:

a. Separate power feed from each of the two propulsion batteries (similar to Figure 1), with interlocked breakers or power transfer switches for isolation to ensure the panel can only be energized from one source at a time. The separate power feeds shall include independent inverters and transformers to provide fully redundant means of power supply to the ship service bus.

b. Rated, at minimum, for 40kW continuous load.

001.3.2 Ramp Standby Power Receptacles

Two (2) ramp standby power receptacles, each rated for a maximum of 60 amps, 480V, 3-phase, will provide a second source of power for equipment which actuates the ramp and ASCS in case of utility blackout. Receptacles will be located on each end of the vessel and will be used for manual connection to cable plugs at each terminal.

Unlike the main ship service distribution, the ramp standby power receptacles are not vital loads and do not require redundant power sources. The system must be able to provide 60 amps continuously at one of the standby power receptacles, and have sufficient short-time overload capacity for starting a 15kW 3-phase squirrel cage motor.

001.4 Systems Interface

The VES should provide a high level of automation and integration to allow the two-person crew on the ferry to focus attention on maneuvering and vessel operation.

001.4.1 Automatic Shore Connection System (ASCS)

The following outlines the interfaces and connections expected to be required between the VES and ASCS:

a. Wireless communication between ASCS and VES to allow the vessel operator to remotely monitor the ASCS and control the ASCS connection.

b. Ground bond to hull for ASCS ground conductor(s) and ground continuity relay pilot conductor. VES to facilitate installation of ground continuity relay end device, but the ground continuity check system to be provided as part of SES.

c. The following hard-wired control circuits are envisioned but may be modified as the design progresses:

    1. The primary control and data transfer interface between the SES and VES (see below).

    2. ASCS emergency disconnect circuit. The circuit will be energized by the ASCS control power, and the ASCS will immediately disconnect if the circuit is opened. The ASCS vendor shall provide emergency pushbuttons to open the circuit at the pilothouse control stations and adjacent to the ASCS socket.

    3. SES pilot circuit, circuit made by LMFB contacts in ASCS. The circuit will be energized by the SES control power, and the SES isolation switch will not be able to close unless the circuit is closed and will open if the circuit is broken. The VES shall provide a contact in series with the circuit to coordinate operation of the isolation switches.

    4. VES pilot circuit, circuit made by LMFB contacts in the ASCS. The circuit shall be energized by the VES, and the VES shore isolation switch shall not be able to close unless the circuit is closed, and shall open if the circuit is broken. The SES and ASCS will provide contacts in series with the circuit to coordinate operation of the isolation switches.

Items (b) and (c) above are based on what is expected to be required for a galvanically connected ASCS. Induction or other galvanically isolated types of connection systems will have different interfaces, but the functions for item (c) will still be required in some manner.

001.4.2 Shoreside Electrical System (SES)

Electrical Power

The SES will provide electrical power on demand to the VES through the ASCS to charge the vessel propulsion batteries and power vessel loads while the ASCS is connected. The SES will regulate the source voltage to maintain the nominal voltage at the vessel.

The VES must coordinate fluctuations in vessel loads with charging the vessel batteries to maintain a relatively constant power transfer from the SES over a given charging cycle, and to ramp up and ramp down power transfer on either end of the charge cycle.

Control and Data Transfer

The SES and VES must have a set of control and data transfer interfaces which allow communication between the two systems. These interfaces are expected to be driven primarily by the requirements of the SES, but will include:

a. Basic connection and monitoring feedback to the SES to coordinate operation of isolation switches and charging.
b. Basic energy required and charging duration feedback in real-time to the SES during the vessel charging cycle. This is intended to allow the SES to coordinate the power flow from the shoreside batteries and the utility in an effort to allow the SES to optimize utility power demand (i.e. reduce monthly peak power demand) and the shoreside battery cycle.
c. Additional feedback to the SES including required energy and duration predictions for upcoming charge cycles, time remaining before next charge cycle, and other relevant data. This is intended to inform the shoreside battery charging rates while the ASCS is not connected as a means to further optimize each SES cycle.
d. Basic monitoring information from the SES to alert vessel operators of utility blackouts and other shoreside electrical conditions which will impact vessel operations.

The primary interface between the two systems will be over a wired or fiber-optic connection provided through the ASCS, intended to facilitate items (a) and (b) above. The details of the signal protocol used for (b) will be developed. Either analog current/voltage signals or an industrial ethernet communication over fiber-optic is expected to be used. Note that if the ASCS is of the non-conductive type (e.g. inductive charging) the primary interface will need to be over a robust and secure wireless connection.

A secondary interface between the two systems should be able to facilitate basic data transfer between the VES and SES when the ASCS is not connected (i.e. wireless) to facilitate items (c) and (d) above. The secondary interface is not intended to be used for primary control of charging equipment.

001.4.3 Propulsion Control Systems (PCS)

A basic PCS will allow for thrust and azimuth control of the two L-drives from the two pilothouse control stations. The propulsion drives shall interface with the PCS to provide the required control and feedback, and the PMS shall interface with the PCS for power limit control functions. The secondary interface is not intended to be used for primary control of charging equipment.

001.4.4 Standby Generator

The VES shall include all required interfaces to connect, control, and provide electrical protection of the standby generator, including the following:

a. Base load operation in parallel with ship service inverter capabilities. Baseload setpoint as percent power to be manually adjustable through the PMS interfaces.

b. Manual start/stop and connection capability through PMS.

c. Standard generator protection features including overcurrent, short-circuit, reverse power as well as automatic stop of generator upon high voltage or 100% battery SOC.

The standby generator skid is planned to include a local operator panel to handle the basic standard alarm and protection functions such as over-speed, high-temperature, low-pressure. These functions are expected to be outside the scope of the VES.