ELLIOTT BAY
DESIGN GROUP

Memorandum

To:	Beaver Island Transit Authority (BITA)
From:	Will Nickum PE and Brian King PE
Reference:	24120-838-0-
Date:	3/13/2025
Subject:	Subchapter K Feasibility Study

3/13/2025

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EBDG designed a new vessel for BITA in 2012-13, a small RO-PAX vessel for BITA's service route between Charlevoix and Beaver Island, MI. This memo addresses the feasibility and impact to the design if increasing the passenger capacity to 296 from the original design capacity of 150.

Executive Summary

The applicable regulatory category for the original design was 46 CFR Subchapter T "Small Passenger Vessels (Under 100 GT)." Increasing the passenger count to above 150 requires that the vessel be designed to and operated in compliance with 46 CFR Subchapter K "Small Passenger Vessels Carrying More than 150 Passengers." Subchapter K regulations impose much more significant and detailed requirements suited to the increased passenger count. Fortunately, because Subchapter T lacks detail or simply doesn't address the design requirements of a passenger vessel of this size with an enclosed vehicle deck, many of the arrangements and fire protection were developed using Subchapter K for reference.

Modifying the design to suit a passenger capacity of 296 and in compliance with Subchapter K is feasible. It will not require major changes to the vessel's general arrangements, machinery or outfit. Most notably, the degree of US Coast Guard (USCG) scrutiny of the design and during construction and testing increases significantly for a Subchapter K regulated vessel. Additional documents and details will need to be developed and provided for USCG review and approval. The additional documents mostly constitute, but not exclusively: Structural fire protection plans and calculations, Emergency evacuation plans, and electrical/control details and documents. For Subchapter T passenger vessels, plans are submitted to and reviewed by the local cognizant Officer in Charge of Marine Inspection (OCMI). For Subchapter K passenger vessels, plans are submitted to the Marine Safety Center (MSC) for approval.

Principal Dimensions

• LOA	150 ft
• BOA	42 ft
• Depth	15 ft
• Full Load Draft	9.75 ft
• Passengers	150
• Gross Tons	<100 GRT
• Vehicle Lanes	380 Lin ft.
• Vehicle Capacity	Approximately 100 LT

The USCG regulations applicable to this design are contained in 46 CFR Subchapter T. The primary constraints on the vessel under Subchapter T are the passenger limit of 150, and the tonnage limit of 100 GRT

BITA has requested that EBDG investigate the feasibility of modifying the design to carry up to 296 passengers, while still admeasuring under 100 GRT. In addition to the impact on stability due to the added weight of passengers, increasing the passenger count above 150 brings into play a different regulatory pathway, namely 46 CFR Subchapter K. This regulation was created in the late 1990's to address the large "rule-beater" Subchapter T vessels that still admeasure under 100 GRT but have multiple decks and the capacity for many more passengers than envisioned when Subchapter T was originally written. Subchapter K regulations call for added fire protection measures to suit larger passenger counts and are modeled after Subchapter H regulations that are applicable to large passenger vessels over 100 GRT. These measures affect arrangements, furnishings, fire control boundaries, stairways, fire protection equipment, electrical installation, evacuation, and embarkation arrangements, among others. These items will be discussed further below.

Weight and Stability Assessment

Some stability requirements for Subchapter T vessels are contained within the T regulations, specifically those applicable to vessels less than 65 feet in length. Regulations for all passenger vessels 65 feet and longer in length are to be found within Subchapter S. As a result, for this vessel design moving from Subchapter T to K has no impact on the regulatory requirements applicable to stability or subdivision.

At the time of the original assessment (2013), the average passenger weight of passengers for use in stability calculations was 185 pounds. Regulations require periodic checks to that figure against published CDC averages for adult men and women. Current data mandate an increase of at least eight pounds per person. For the current calculations 195 pounds per person is used.

Adding another 146 persons to the vessel, with the increased weight of all passengers to 195 pounds represents an addition of 13.38 LT to the vessel's deadweight. In addition, to address potential weight changes due to regulatory requirements and Owner-desired design changes another approximately 16 LT may be added to the vessel. This added weight raises the vessel's weight and VCG enough so that it is just out of compliance with the stability limits of the hull as designed. However, if the vehicle load is adjusted to carry one less semi-truck and fill the space with cars instead, the vessel will comply. Limiting the passengers aboard to 150 when carrying two semi-trucks is suggested as a possible operational restriction.

The full extent of weight changes (and resulting stability impacts) that might result due to bringing the design into compliance with Subchapter K, as well as those desired by BITA as part of the design modification, would be addressed as part of the design modification effort.

Subchapter K Impacts to the Design

The regulatory text of Subchapter K is contained in 46 CFR Parts 114-122. These parts contain identical headings to those found in Subchapter T, and in several of the sections the language is virtually the same. Where substantive differences occur in requirements, they are noted below.

Part 114 – General Provisions

No material change.

Part 115 – Inspection & Certification

No material change.

Part 116 – Construction & Arrangement

The subparts addressed below contain most of the regulatory changes between Subchapters T and K.

Subpart D – Fire Protection

To provide for the protection of the passengers and crew in the event of fire, the Subchapter K regulations require fire control boundaries in strategic locations. These boundaries must provide well-placed pathways for people to escape from fire affected areas and provide protected areas of refuge. These refuge areas must be either located at or near an embarkation station, or else provide a protected pathway to it. There must be a stair tower that connects all decks accessible to passengers. Fire doors must be provided in all fire control boundaries. Where vehicles are carried, the decks encompassing that storage area must also meet fire control boundary requirements.

Fortunately, the configuration of the original vessel design has many of the features needed to meet Subchapter K already. A stair tower is incorporated on the starboard side, and the passenger spaces have been arranged with reasonable boundaries and escape pathways. Relocating the stair tower to the port side, or incorporating one on each side, is certainly feasible as well. There is a transverse stairway between two decks in the passenger area that will have to be enclosed at the top or the bottom, but at the design stage this is a minor issue and can be easily incorporated. As part of the design modification effort, a full fire zone plan will need to be developed to identify the level of structural fire protection needed on the decks and bulkheads throughout the vessel.

The other facets of fire protection that must be addressed to comply with Subchapter K include furniture and furnishings, ceilings, linings and interior finishes, deck coverings, and doors and window construction. These facets have little or no impact on the vessel's design configuration but will be subject to regulatory scrutiny during construction.

While the changes to the design are feasible, it is worth noting that the construction cost of the vessel will be higher under the Subchapter K regulatory pathway than under Subchapter T.

Subpart E – Escape and Embarkation Station Requirements

Means of escape from affected areas are of critical importance, irrespective of the regulatory pathway used for the design. The current arrangement of the vessel design is well-thought out and will need few alterations to ensure compliance with Subchapter K.

What Subchapter K does require that Subchapter T does not is a formalized emergency evacuation plan, and specific identification of at least two embarkation stations, one on each side of the vessel. To meet this requirement formal areas of refuge must be designated and be of sufficient size to accommodate the passenger load in an emergency.

Part 117 – Life Saving Equipment & Arrangements

No material change.

Part 118 – Fire Protection Equipment

Subchapter K requires one fire pump, though on passenger vessels of this size a second fire pump is typically installed. Locating the second fire pump in the bow thruster space and driving it from a PTO on the bow thruster engine is certainly feasible and good practice. A fire pump must be capable of remote operation.

Fire stations will need to be located throughout the vessel such that a water stream can reach any portion of the vessel from a 50' fire hose.

A fixed gas fire suppression system for the engine room is required and is also required for the compartment containing the oil fire heating boiler (if separate from the engine room) and the bow thruster engine space. A water mist system (Hi-Fog) is accepted as an alternative to fixed gas fire suppression.

In accordance with Subchapter K, an enclosed vehicle deck will require an automatic sprinkler system. Automatic sprinkler systems are pre-charged with water so the vehicle deck will require heating to protect them from freezing. A dedicated sprinkler pump and a sprinkler tank may be installed in the engine room or another location if protected from freezing.

Part 119 – Machinery Installation

Larger propulsion engines in the 1300 HP range will require considerably more engine room space as will the larger reduction gears and shafting. There appears to be enough space in the engine room as currently arranged to accommodate the higher horsepower propulsion system without the need to change the engine room boundaries.

Engines in this size range (over 800 HP) are required to be EPA Tier 4 compliant which typically requires after engine exhaust treatment. There will need to be a selective catalytic reducer (SCR) installed in the exhaust system over the engine (if there is sufficient clearance) or immediately after the engine in the exhaust uptakes. Design development will determine if there is sufficient room over the engine or in the updates for the larger exhaust piping, an SCR, an increased size silencer and larger ventilation ducts. It may be determined that the uptakes need to be enlarged in cross section. Additionally, a Diesel Exhaust Fluid (DEF) tank will need to be installed. The DEF tank may be installed in the void space either aft or forward of the engine room.

Changing to reduction gears that are close-coupled to the propulsion engines is certainly feasible and will provide more available engine room deck space. With a close coupled reduction gear there is some loss of access to the torsional coupling located between engine flywheel and the input shaft to the reduction gear. To service the coupling, bearings or seals will require dismounting and disconnecting the reduction gear. Shaft alignment will need to be restored after the reduction gear is remounted.

Part 120 – Electrical Installation

For this number of passengers, there is no material change. The primary change occurs when the passenger count exceeds 600, and the entire electrical system must comply with Subchapter H regulations.

Part 121 – Vessel Control & Miscellaneous Systems

No material change.

Part 122 – Operations

No material change.

Design Modifications

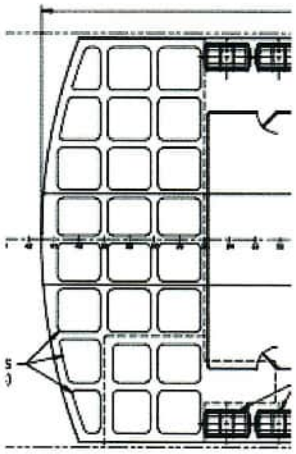
The list below has been provided by BITA/BIBCO for consideration – comments by EBDG are located below each item in blue italic type:

Requested Design Changes

- **Main Engines changed to Tier 4**
  No issue, a requirement for this horsepower. Will require SCR units and DEF tank that add weight.

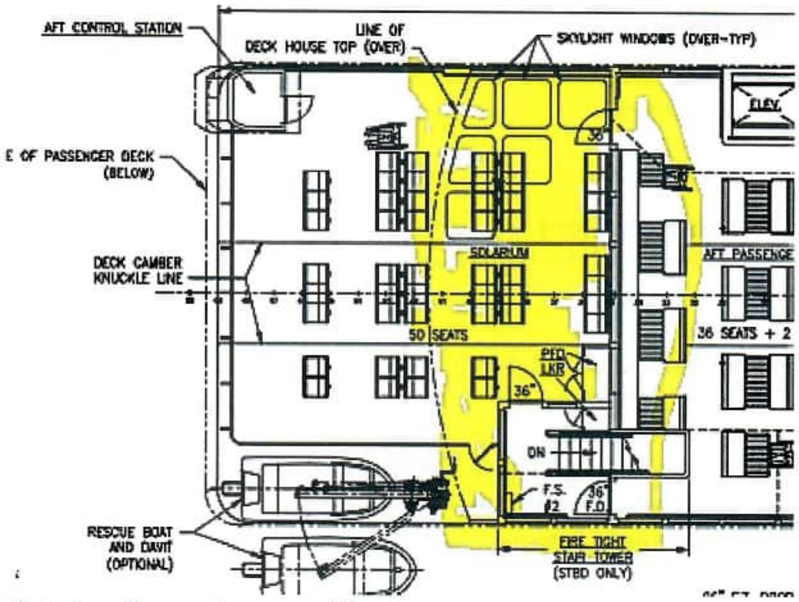
- **BIBCO recommendation: Draft Specs**
  - Minimum HP 1300/ tier 4/ V12 /A (continuous) duty cycle rating/speed range 1600-1800 minimum top speed 14 knots.
    Larger engines than originally specified, considerable size and weight increase. Speed will be no issue with the greater HP engines.
  - Service time within 3 hours
    Noted
  - Pre lube system
    Noted
  - Dual starting system for redundancy
    Noted

- **Gear Box**
  Direct couple to engine
  Noted
- **Generators**
  Same manufacturer as mains if possible
  Noted
- **Remove Skylights from Solarium**

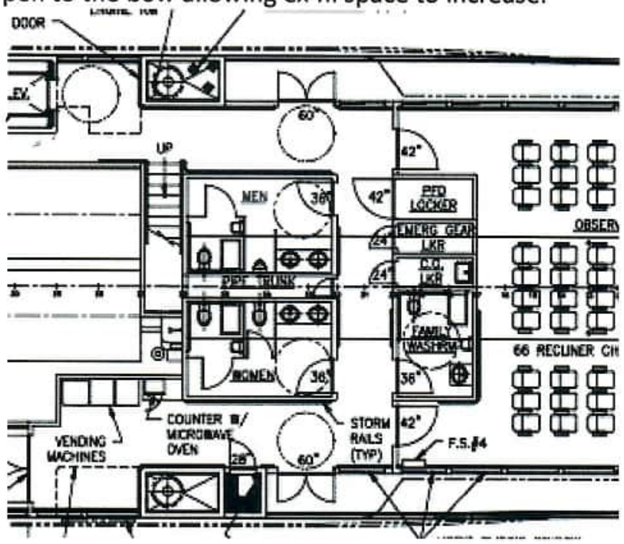


Noted

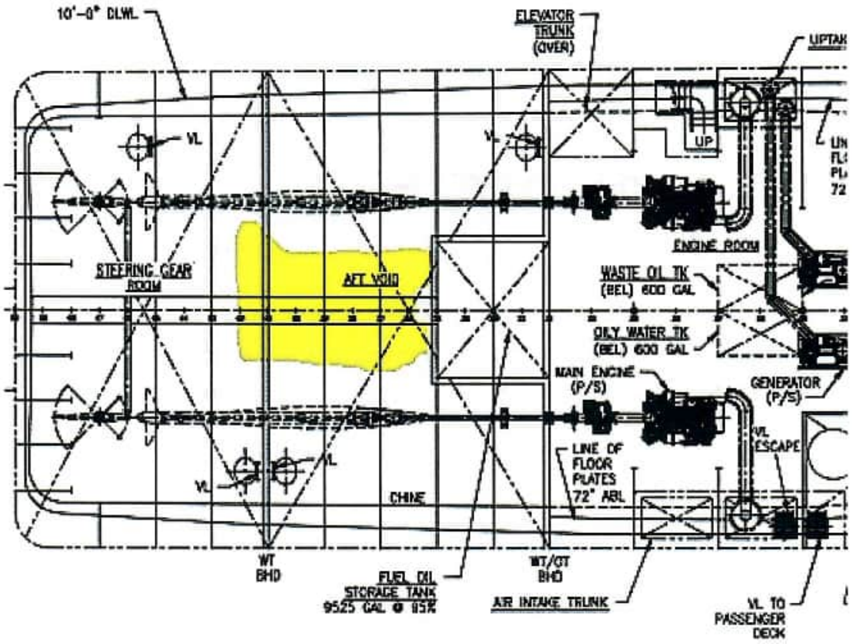
- **Increase Passenger Capacity to 296**
  Noted, addressed in earlier section, invokes Subchapter K regulations.
- **Square off solarium for dog area. Can we add a roll up enclosure perhaps and heat?**



  Noted, and yes to roll up enclosure and heat.
- **Four individual unisex bathrooms**
  - Perhaps exit to port and stbd move bathrooms forward and family washroom and lockers open to the bow allowing ex-hi space to increase.



  Noted
- **Install watertight Hatch on Car deck between Main engines. Larger the better optimal 6-foot x 10 foot.**

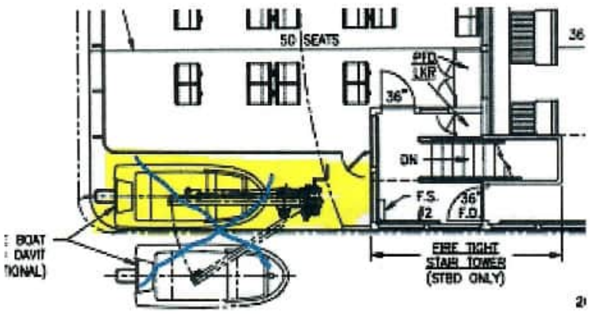


Noted. Believe a hatch approximately 10' wide by 7' long can be located between Frs. 27 and 29.

- **Pilothouse extended to outside edge of vessel.**
    - Port and stbd controls on wings
    - Sliding window on port and stbd side
    - Window heater across front windows

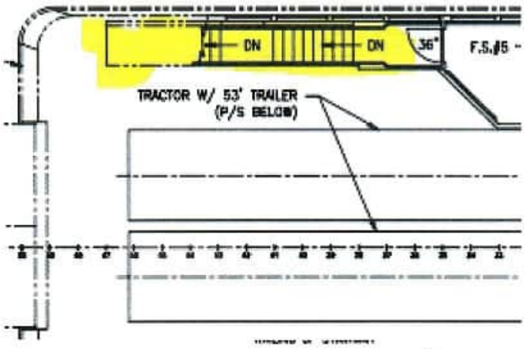
All Noted

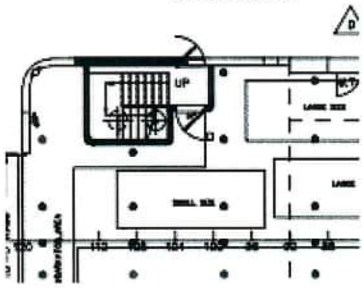
- **Increase aft vehicle ramp opening to 18 feet.**
  The current design drawing depicts an 18 ft wide opening.
- **Change all lights to LED.**
  Noted
- **Increase tank size of Lube oil tank in accordance with engine selection.**
  Noted
- **Water for toilets from sea chest not from potable water tank.**
  The current design uses sea chest provided water for flushing.
- **Remove rescue boat and relocate railing**



Noted. The rescue boat is cited as optional in the current design documents.

- **Rework port side stairwell similar to EI for emergency egress and fire safe then relocate fuel fill, oily water tank/waste oil tank and shore power station relocated to aft port side.**



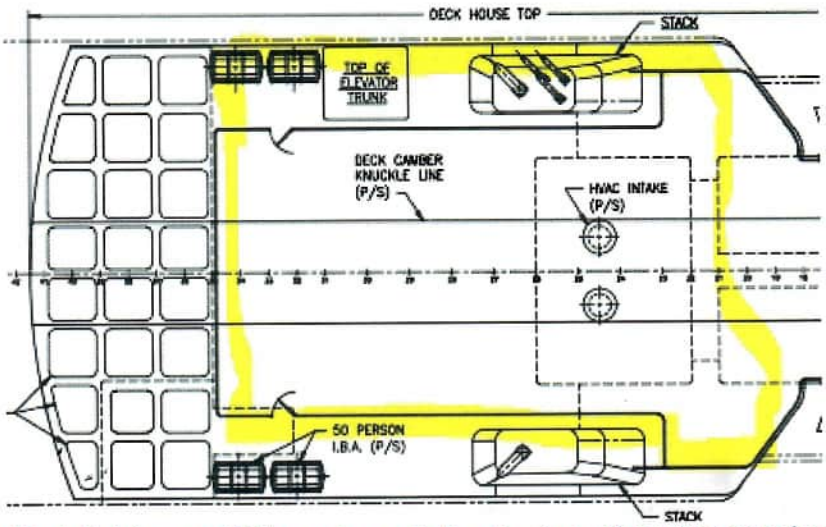


Noted

- **Access door on starboard aft side.**

  Noted

- **Add stairwell and additional seating on top of vessel.**
  - Railing needs to be adjusted for passenger use on this deck. Need stairwell access.



Noted. Be advised that to meet ADA requirements the elevator will need to extend to this level, and to meet Subchapter K requirements one stair tower will have to extend to this level as well.

- **Initial prop spin direction inward**
  Noted, inboard rotation in the ahead direction.
- **Clarify air intake volume in from one side and ducting ran to port side**
  Noted, intake air volume will need to be determined with the final machinery sizes and selections (including main engines, boilers, and generators. It may be determined that the update trunks will need to increase in size.
- **Fire pumps are both electric perhaps one driven by bow thruster**
  Noted
- **O2 built in monitoring system**
  Noted, this request will need clarification. C02 monitoring in public spaces for indoor air quality is increasingly common.
- **HIGH fog engine room fire system**
  Noted, see Part 118
- **Capstan forward port side**
  Noted

- **Ensure exhaust stacks face outward**
  Noted
- **Additional drawings needed for electronics**
  Noted
- **WI-FI**
  Noted
- **Help developing specs for radar, cctv, etc, props, shaft etc. Exterior camera FLIR for front of Vessel**
  Noted
- **USB and plugs at each table**
  Noted
- **Dripless shaft seals**
  Noted
- **Elevator goes to first floor only**
  ADA requires that the elevator serves all passenger accessible levels.
- **Rub rail and spray rail on Front of Vessel.**
  Noted

Questions and comments After Review of the Contract

The software initially used to calculate stability GHS and Computational Fluid Dynamics Resistance Analysis have been improved and due to numerous factors, these calculations may need to redone.
Noted

The cost of the redesign should include the ownership of the plans by BITA.
Noted

Lessons Learned

Lessons learned with the EMERALD ISLE that we will want to ensure we do not duplicate on the new vessel.

- Keel cooler capacity was insufficient
- Anchor not sized properly
- Channel coolers had to be expanded for bow thruster
- Bow thruster tunnel not large enough
- Shaft has too much free area not supported by a bearing
- Electrical systems not balanced
- Heating for dog area not sufficient below 50 degrees
- Added window heaters to pilothouse.
- Props and shafts cannot be removed without removing rudders
  Items listed above are noted, would be addressed in detail during a design modification/update.

Questions

Def fluid tank can be located in a void?

The def fluid must be in an independent tank, but the tank may be in an accessible void.

Channel above engine

Assume this is referring to a rail for a chain hoist?

Bow thruster size/ one or two blade

The bow thruster size and optimal configuration would be addressed in detail during a design modification/update.

Icing boiler system if we have it then keep boiler if not maybe go electric?

An HVAC heating (and cooling) loads analysis would be addressed in detail during design modification/update. Deicing heating would be included in the heating load analysis. As a point of comparison, a slightly larger closed car deck ferry of similar size designed for SE Alaska required a heating boiler of approximately 520,000 BTU/hr capacity (equivalent to about 150 kW if electrically sourced).

Deck plate account for forklift tires size

Noted

Consider some icing

Assume this pertains to hull plating and structure. Thicker hull plating and additional framing in the bow area can be designed into the hull structure to help withstand some local icebreaking in the shoulder season.

ELLIOTT BAY
DESIGN GROUP

Memorandum

To:	Beaver Island Transit Authority (BITA)
From:	Will Nickum PE and Brian King PE
Reference:	24120-043-1- Construction Cost Update
Date:	4/11/2025
Subject:	Construction Cost Estimate Update

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EBDG designed a new vessel for BITA in 2012-13, a small RO-PAX vessel for BITA's service route between Charlevoix and Beaver Island, MI. A memo was generated for BITA that addressed the feasibility and impact to the design if the passenger capacity were increased to 296 from the original design capacity of 150, see Reference [1]. This new memo provides a high-level update to the vessel's estimated construction cost, incorporating changes mandated by meeting Subchapter K regulations, the changes desired by BITA, and the increase in labor and costs from the 2012 estimated figures.

As noted in the prior memo, modifying the design to suit a passenger capacity of 296 and in compliance with Subchapter K is feasible, and the changes to the design desired by BITA can be incorporated. One of the biggest impacts to vessel cost from the changes proposed is the increase in propulsion engine power and the resulting requirement to meet Tier 4 exhaust emission requirements.

Construction Cost Discussion

The 2012 estimate generated for this design, Reference [2] was developed using the USN Ship Work Breakdown System (SWBS), a categorizing approach used throughout the marine industry. Nine separate SBWS groups were populated in the original estimate.

Each subgroup has been evaluated and adjusted as needed to reflect changes to the original design. These subgroups are discussed in more detail below.

All labor and material costs from the original estimate have been increased by 38%. This percentage is obtained from the published Producer Price Index (PPI) for the Shipbuilding and Repair Industry.[1] The increase from October 2012 (date of the original estimate) and March 2025 amounts to 37.65%.

SWBS 000 – Project Management and Administration

This portion of the estimate is adjusted to reflect an increase in construction period from 16 months to 18 months, due principally to the increased size and complexity of the propulsion system and added exhaust system components necessary to meet Tier 4. Labor rates for Project Management and Administration costs are included within this group and have been increased at the same rate as the construction labor rate.

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[1] https://fred.stlouisfed.org/

SWBS 100 – Hull and House Structure

To accommodate the changes to the vessel's structural boundaries to meet Subchapter K and the additional BITA identified changes, a ROM increase of 5% in vessel structural weight has been incorporated, with the corresponding increase in labor hours needed for fabrication.

SWBS 200 – Propulsion Machinery

This portion of the estimate is adjusted to reflect the increase in labor and material cost due to the increase in propulsion power and the need to meet Tier 4 emission requirements at the higher power. Budgetary quotes were obtained for 1340 HP Caterpillar 3512 propulsion engines and Twin Disc MGX-6690SC reversing reduction gears, appropriate for the increased power of the propulsion engine.

SWBS 300 – Electrical System

No appreciable changes in labor hours or materials are estimated for the electrical system.

SWBS 400 – Electronics and IC Systems

No appreciable changes in labor hours or materials are estimated for the electronic and IC systems.

SWBS 500 – Auxiliary Systems

Minor changes to the material and labor costs in this section are due to the removal of the rescue boat and associated equipment and the addition of more life rafts to suit the increase in passengers.

SWBS 600 – Outfitting

Changes to the labor and material costs of outfitting elements are due to the increase in the size of the wheelhouse, and the addition of passenger access to the house top.

SWBS 800 – Integration and Engineering

These costs are based in part on the vessel's overall cost plus the cost of construction related engineering subcontracts.

SWBS 900 – Shipyard Support Services

These costs are based in part on the vessel's overall cost plus the cost of construction-related subcontracts.

Conclusion

The 2012 estimated cost updated to March 2025 using the PPI and incorporating changes mandated by Subchapter K regulations and those desired by BITA, is estimated to be **$23.3 million dollars.** A summary page of the estimate is included in the Appendix for reference.

References

[1] EBDG, "Subchapter K Feasibility Study - 24120-083-0," Seattle, 2025.

[2] EBDG, "Construction Cost Estimate - 11121-043-1," Seattle, 2012.

APPENDIX

SWBS No.	Item Description	Labor Hours	Material & Services @ Cost, ($)	Subcontracts @ Cost, ($)	Labor Cost @ $96/Hr	Material & Services w/17% Mark-up, ($)	Subcontracts w/8% Mark-up, ($)	Item Total Costs	Percent of Total Cost
000	PROJECT MANAGEMENT & ADMIN	2,142	$2,081,707	$0	$205,610	$2,435,597	$0	$2,641,207	11.32%
100	HULL & HOUSE STRUCTURE	27,038	$723,220	$0	$2,595,630	$846,168	$0	$3,441,798	14.76%
200	PROPULSION MACHINERY	7,857	$587,326	$2,151,360	$754,313	$687,172	$2,323,469	$3,764,953	16.14%
300	ELECTRICAL SYSTEM	3,358	$153,384	$97,200	$322,338	$179,459	$104,976	$606,772	2.60%
400	ELECTRONICS & IC SYSTEMS	2,321	$177,768	$0	$222,808	$207,989	$0	$430,797	1.85%
500	AUXILIARY SYSTEMS	13,685	$619,445	$1,944	$1,313,743	$724,751	$2,100	$2,040,593	8.75%
600	OUTFITTING	14,364	$2,016,117	$0	$1,378,952	$2,358,856	$0	$3,737,808	16.03%
700	MISSION SPECIFIC EQUIPMENT	0	$0	$0	$0	$0	$0	$0	0.00%
800	INTEGRATION & ENGINEERING	1,686	$503,604	$529,200	$161,827	$589,217	$529,200	$1,280,244	5.49%
900	SHIPYARD SUPPORT SERVICES	9,979	$209,178	$4,433	$957,999	$244,738	$4,788	$1,207,524	5.18%
	Subtotal before Contingency, SWBS 100--600 for Materials, 300 + 600 for Subcontracts	82,429	$4,277,260	$99,144	Note that SWBS 200 Subcontract consists of the Engines & Gears only, and uses current vendor quotations.				
	2025 Inflation Increase - 38% per PPI for Shipbuilding		$1,625,359	$37,675		$1,901,670	$40,689	$1,942,359	8.33%
	Tier 4 Emission Addition	250	$50,000	$25,000	$24,000	$58,500	$27,000	$109,500	0.47%
	Contingency @ 10%							**$2,120,356**	**9.09%**
	TOTALS FOR ALL ITEMS	**82,679**	**$8,747,107**	**$2,846,812**	**$7,937,220**	**$10,234,115**	**$3,032,221**	**$23,323,912**	**100%**