Chapter 620 Passenger Overhead Loading

620.01 General

This chapter provides guidance for the design of new and retrofitted passenger overhead loading (OHL) structures. These structures provide an elevated walkway for passenger access between the terminal building and the passenger deck of the ferry vessels. OHL increases the operational efficiency of the terminal by allowing vehicle and pedestrian loading and unloading operations to occur simultaneously. It can also create a safe grade-separated ADA accessible travel path for pedestrian riders from the boat to other modes of transportation.

Edmonds OHL Structures
Exhibit 620-1

Exhibit 620-2 indicates which WSF facilities currently have OHL systems. Where OHL facilities are provided, accommodate the possibility of vehicle transfer span (VTS) pedestrian loading in the event that the OHL system is out of service.

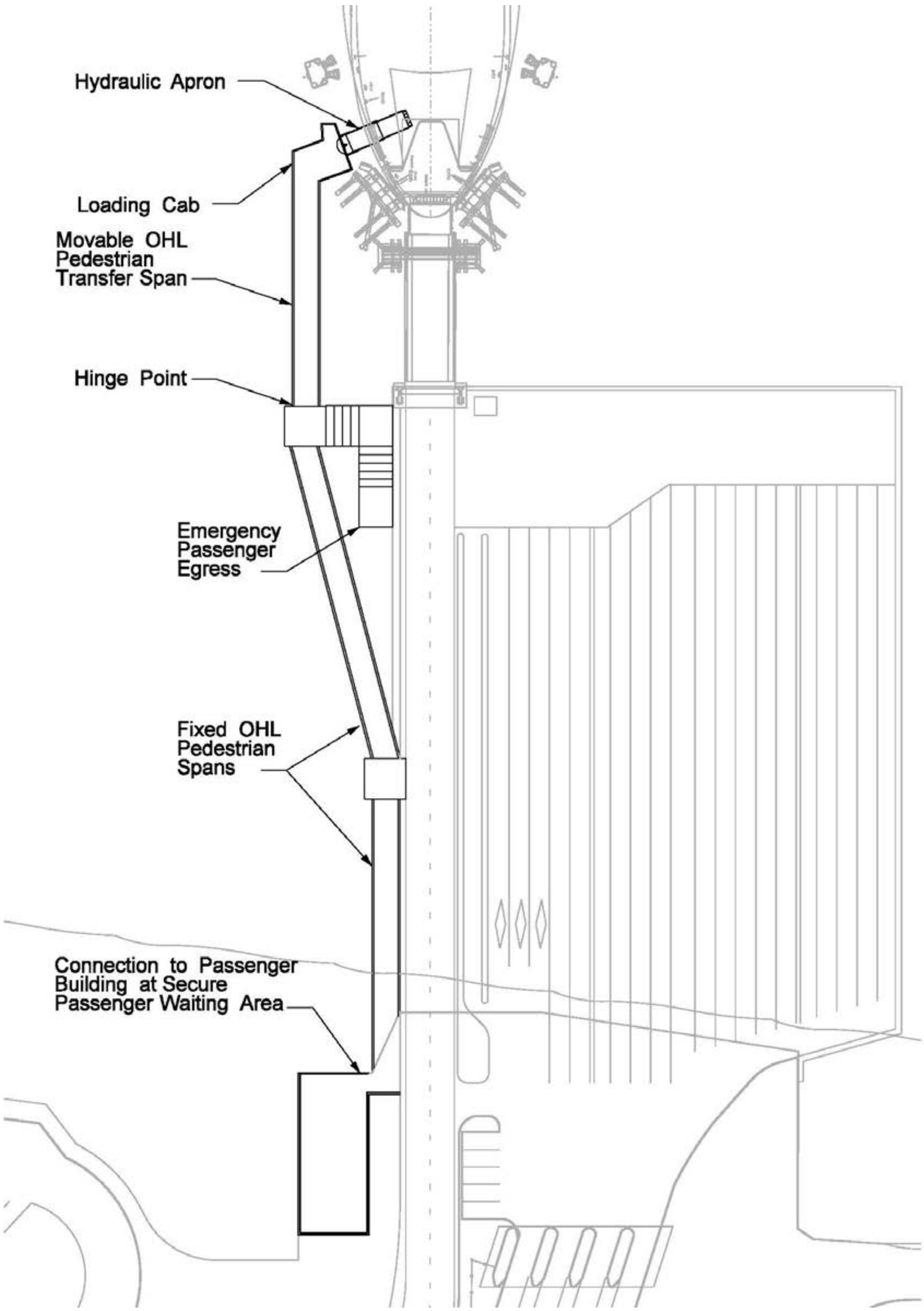
Terminal	Existing Overhead Loading Design
Anacortes	Cable Hoist
Bainbridge Island	Cable Hoist
Bremerton	Supercolumn
Edmonds	Supercolumn
Kingston	Supercolumn
Seattle Slip 1	Tension Cylinder
Seattle Slip 2	Cable Hoist
Seattle Slip 3	Cable Hoist

Overhead Loading at Existing Terminals
Exhibit 620-2

WSF currently utilizes three distinct OHL system designs – the supercolumn design, the cable hoist design, and the tension cylinder design – as shown in Exhibit 620-2. These concepts are discussed in Section 620.04. Exhibit 620-3 shows an example layout utilizing the WSF-preferred supercolumn design.

For additional information, see the following chapters:

Chapter	Subject
300	Accessibility
310	Security
320	Environmental Considerations
330	Marine
360	Electrical
600	Trestle
610	Vehicle Transfer Span



Example OHL Structures Plan
Exhibit 620-3

620.02 References

Unless otherwise noted, any code, standard, or other publication referenced herein refers to the latest edition of said document.

(1) Federal/State Laws and Codes

29 Code of Federal Regulation (CFR) Part 1918, Safety and Health Regulations for Longshoring

(2) Design Codes and Specifications

AASHTO *LRFD Bridge Design Specifications* (AASHTO *LRFD Specifications*), American Association of State Highway and Transportation Officials, Washington, DC

AASHTO *Guide Specifications for LRFD Seismic Bridge Design* (AASHTO *LRFD Guide Specifications*), American Association of State Highway and Transportation Officials, Washington, DC

AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges* (AASHTO *LRFD Pedestrian Specifications*), American Association of State Highway and Transportation Officials, Washington, DC

AASHTO *LRFD Movable Highway Bridge Design Specifications* (AASHTO *LRFD Movable Specifications*) American Association of State Highway and Transportation Officials, Washington, DC

AASHTO S*tandard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, American Association of State Highway and Transportation Officials, Washington, DC

ASCE *Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-10*, 2010, American Society of Civil Engineers, Reston, VA.

International Building Code, International Code Council, Inc.

Bridge Design Manual LRFD (BDM) M 23-50

Proposed Passenger Vessels Accessibility Guidelines. Published in the Federal Register on June 25, 2013. This document contains scoping and technical requirements for accessibility to passenger vessels by individuals with disabilities. The requirements are to be applied during the design, construction, additions to, and alteration of facilities and elements on passenger vessels to the extent required by Federal agencies under the Americans with Disabilities Act of 1990 (ADA).

2010 ADA Standards for Accessible Design, United States Department of Justice

Structural Welding Code – Steel (AWS D1.1), American Welding Society, Miami, FL

Bridge Welding Code (AASHTO/AWS D1.5M/D1.5), American Association of State and Highway Transportation Officials, Washington, DC and American Welding Society, Miami, FL

Specification for Structural Steel Buildings (ANSI/AISC 360), American Institute of Steel Construction, Chicago, IL

Design Manual M 22-01

Ferry Boarding Facilities, CAN/CSA-S826 Series-01

General Special Provisions, WSDOT

Hydraulic fluid power – General Rules and Safety Requirements for Systems and Their Components, ISO 4413, International Organization for Standardization, Geneva, Switzerland

Application guidelines for selected fluid power components – Accumulators Cylinders Hydraulic valves Pneumatic filters, regulators and lubricators Selection of position transducers, National Fluid Power Association, Milwaukee, WI

Hydraulic fluid power - Filters – Multi-pass method for evaluating filtration performance of a filter element, ISO 16889, International Organization for Standardization, Geneva, Switzerland

AASHTO *Standard Specifications for Movable Highway Bridges*, 5th Edition with 1992, 1993 and 1995 Interims, American Association of State Highway and Transportation Officials, Washington, DC

Hydraulic fluid power - Cylinders - Method for determining the buckling load, (NFPA T3.6.37) National Fluid Power Association, Milwaukee, WI

Hydraulic Flanged Tube, Pipe, and Hose Connections, 4-Screw Flange Connection Part 1: 3.5 MPa to 35 MPa (Code 61), SAE J518, SAE International, Warrendale, PA

Reference Drawings, WSF

Regional General Special Provisions, WSF

Standard Specifications for Road, Bridge, and Municipal Construction M 41-10

(3) Supporting Information

1999 Colman Dock Seattle Ferry Terminal Design Memorandum for Existing Terminal Building Design Evaluation, WSF

2006 Mukilteo Multimodal Ferry Terminal Overhead Loading Configuration/ Pedestrian Bridge Alternatives Technical Memorandum, WSF

2006 Mukilteo Multimodal Ferry Terminal Overhead Loading Mechanical Design Criteria Technical Memorandum, WSF

Life Cycle Cost Model (LCCM), WSF

620.03 Design Considerations

(1) Accessibility

Wherever pedestrian facilities are intended to be a part of a transportation facility, 28 CFR Part 35 requires that those pedestrian facilities meet ADA guidelines. Federal regulations require that all new construction, reconstruction, or alteration of existing transportation facilities be designed and constructed to be accessible and useable by those with disabilities and that existing facilities be retrofitted to be accessible.

Additionally, 49 CFR Part 39 prohibits owners and operators of passenger vessels from discriminating against passengers on the basis of disability, requires vessels and related facilities to be accessible, and requires owners and operators of vessels to take steps to accommodate passengers with disabilities. Incorporate features into the OHL facilities to allow access by persons with reduced mobility per the applicable requirements. In the absence of such features, WSF is responsible for the assisted transfer of persons with reduced mobility.

Design pedestrian facilities to accommodate all types of pedestrians, including children, adults, the elderly, and persons with mobility, sensory, or cognitive disabilities. Refer to Chapter 300 for accessibility requirements.

(2) Security

Chapter 310 includes a general discussion of the United States Coast Guard (USCG) three-tiered system of Maritime Security (MARSEC) levels, vessel security requirements, and additional information pertaining to passenger OHL design. Below are links to relevant sections by topic. Coordinate with the WSF Company Security Officer (CSO) regarding design issues pertaining to security. In addition, coordinate with the USCG and Maritime Security for all terminals, the United States Customs and Border Protection (USCBP) for international terminals, and the Transportation Security Administration (TSA) for Transportation Worker Identification Certification (TWIC) and Sensitive Security Information (SSI).

- MARSEC Levels: 310.04
- Vessel Security: 310.05
- Waterside Structures: 310.09
- Access Control/Restricted Area/TWIC: 310.10

(3) Environmental Considerations

Refer to Chapter 320 for general environmental requirements and design guidance. Refer to the project NEPA/SEPA documentation for project-specific environmental impacts and mitigation. The design should minimize the risk of hydraulic fluid spills and leaks.

(4) Marine

Refer to Chapter 330 for marine criteria pertaining to passenger overhead loading. Below are links to relevant sections by topic.

- Operations and Maintenance: 330.04(4)
- Proprietary Items: 330.04(6)
- Long Lead Time Items: 330.04(7)
- Corrosion Mitigation: 330.04(9)
- Scour and Mudline Elevations: 330.04(10)
- Geotechnical Requirements: 330.04(11)
- Materials Specification: 330.04(12)
- Miscellaneous Considerations: 330.04(13)
- Tidal Information: 330.06
- Wave, Flood, and Coastal Storm Loading: 330.09(1)

(5) Electrical

Refer to Chapter 360 for general electrical design criteria pertaining to overhead loading. Below are links to relevant sections by topic.

- Wiring and Protection: 360.04
- Wiring Methods and Materials: 360.05
- Equipment: 360.06

(6) Operations and Maintenance

- Minimize repair and maintenance required during the design life.
- Minimize potential for hydraulic fluid spills and leaks.
- Incorporate nonskid coatings appropriate to the weather exposure on surfaces intended for use by pedestrians.
- Provide on the outside of the OHL structures a means to support fall protection systems for performing periodic maintenance, cleaning, and repair of the elevated portions of the OHL structures including all mechanical and electrical components.
- Provide bird deterrent wire at all OHL structures. Provide mesh screening to prevent birds from entering the supercolumn area and the machinery compartments located under the cab floor.
- Provide unobstructed view of the holding lanes by operations personnel, where feasible.
- Provide unobstructed view of pedestrian access way from operator's cab. Locate operator control station such that there is good visibility for setting the plank on the vessel deck.
- A security gate is required before the loading cab to restrict access prior to vessel departure and until after the next arrival.
- Reader board signs, gate/door controls, and intercom/PA controls are required at the shoreward hinge point of the movable transfer span.
- Where necessary, provide an employee access door back into the terminal building adjacent to the entry into the OHL system.

(7) Design Life

Design life is based on the current *Life Cycle Cost Model* (LCCM) as required by the Washington State Office of Financial Management (OFM). Refer to Table 1 for the design life of new structures (as of 2007) and Table 2 for design life of structures prior to 2007, in the 2010 *Life Cycle Cost Model* Update (2010 LCCM) for information on when existing marine structures and their systems are due for replacement. Confirm design lives given below are consistent with the current LCCM. Replacement life may be reduced due to functional obsolescence.

- Overhead Loading Drilled Shafts: 75 years
- Overhead Loading Walkways, Transfer Span, Loading Cab and Aprons: 75 years
- Mechanical System Type 6 - Cable hoist, cable cab, manual apron and pins, counter weight: 30 years
- Mechanical System Type 7 - Cable hoist, hydraulic apron, hydraulic pins, counter weight: 30 years
- Mechanical System Type 8 - Hydraulic hoist, hydraulic apron: 40 years

(8) Vertical Clearance Requirements

When the OHL system crosses the vehicle holding and/or exit lanes, the minimum clearance under the OHL system is 16.0 feet with 16.5 feet preferred. All ferry vessels serving WSF terminals have a tunnel height of 16 feet or less. If any OHL structure is proposed to cross a state or local route, the minimum clearance must meet highway standards (WSDOT). Refer to the *Design Manual* M 22-01 for vertical clearance requirements for bridges. Contact individual railway companies for their overcrossing design standards.

(9) Operational Classification

WSF OHL systems are operationally classified per the AASHTO LRFD Specification Section 1.3.5 as typical, not critical or essential, unless noted otherwise. The performance objective for “typical” bridges is life safety. See Section 620.05(1)(c) Limit States for use of this classification.

(10) Seismic Design

Perform seismic design of OHL structures in accordance with the AASHTO *LRFD Specifications* and supplemented by the AASHTO *LRFD Guide Specifications* where appropriate. Design OHL structures for a design level earthquake (DLE) corresponding to a 7 percent probability of exceedance in 75 years (~1000 year return period) with a life safety protection/ collapse prevention performance objective. OHL structures are expected to support gravity loads after the DLE but may suffer significant damage that may disrupt service.

OHL Structures shall also be checked for an operational level earthquake event (OLE). This is an event in which no damage or only minor structural damage will occur, but a temporary interruption in service may occur.

For the fixed portions of the OHL system, the OLE event is similar to a 50 percent exceedance in 75 years (~100 year return event). Expansion joint design and locations where the relative displacement of different structures could cause damage shall be checked for this level earthquake event.

For the movable portions of the OHL system, the OLE is based on the AASHTO *LRFD Movable Specifications*. The OLE for movable bridges is defined as half of the demand values associated with the DLE. For the OLE, design and detailing are intended to allow the transfer span and apron to remain operational, i.e., movable.

Minor damage to the movable span is acceptable during the OLE event provided that it is designed to occur at a predetermined location and can be easily identified and quickly repaired.

The designer shall identify in the general structural notes of the contract drawings the anticipated structural failure locations for both the OLE and the DLE.

For seismic design of single drilled shaft foundations, plastic hinging is limited to aboveground and near-ground locations. In-ground plastic hinging is not permitted.

For geotechnical requirements, refer to Chapter 330.

(11) Accelerated Bridge Construction

Accelerated bridge construction methods such as precast concrete bridge seat caps in the design are options where the duration of slip closures must be kept to a minimum. Use of these methods minimizes interruptions during construction and can be cost effective at busy terminals.

(12) Vibration

Evaluate the vibration of OHL structures in accordance with the AASHTO *LRFD Pedestrian Specifications*. Ensure that vibration of the structures does not cause discomfort or concern to users.

(13) Fire Protection

Design provisions to safeguard the overhead loading against fire in conformance with the National Fire Protection Association as well as State and local ordinances.

Consider the following in conjunction with WSF's emergency procedures:

- The safe and efficient evacuation of passengers transiting and personnel working between shore and vessel.
- The requirements for emergency response to any fire occurring on shore, vessel, and OHL passenger spans.

(14) Signage and Wayfinding

Refer to Chapter 570 for signage requirements.

(15) Design Drawing Information

Drawing format and software used shall follow Division 8.

Include or reference the following information on design drawings:

- Principle loads used in design and number of load cycles anticipated over the life of the structure
- Statement of conformity to WSF *Terminal Design Manual* and any other applicable guidelines

- Provide the operational and extreme range of motion (highest and lowest elevations); maximum and minimum slopes of the transfer span and any other specific operating limitations
- Tide or sea level variation considered for design
- Materials specified for structure elements and load-bearing components
- Features of vessels used in design (displacement, freeboard, geometry of gate openings, etc.)
- Design life expectancy
- Description of the sequence of operations as well as any operating limitations
- Weight of major components and structural sections

(16) Proprietary Items

WSF uses competitively acquired products to fulfill the requirements of a contract wherever feasible to help achieve the lowest price, the best quality, and the most efficient use of resources. There are instances in which competitive bidding may not or cannot be provided and a specific proprietary product is allowed. Refer to Section 220.07(2) for limitations on the use of proprietary items.

620.04 OHL Components

(1) New Structures – Supercolumn Design

Design new OHL systems similar to the existing systems located at the Edmonds and Bremerton Ferry Terminals. These systems include fixed spans, pedestrian transfer span (movable bridge), loading cab, hydraulic apron, hydraulic lift cylinder, and drilled shaft foundations. Provide a supercolumn design consisting of a drilled shaft foundation that supports the loading cab at the offshore end of the pedestrian transfer span and houses a single hydraulic cylinder used to raise and lower the transfer span and loading cab. Design the OHL system with the ability to serve two vessels, one on each side of the transfer span and loading cab, where applicable. For existing OHL system drawings, refer to the WSF *Reference Drawings* or contact the WSF CADD Manager.

(a) Fixed Spans

The OHL fixed spans are fixed pedestrian bridges that provide access from the terminal building to the pedestrian transfer span for walk-on passengers. Based on ridership, design the OHL fixed spans with a 12- to 16-foot clear width between handrails. New OHL structures may require a study to determine the ideal width of the fixed and movable span. Provide a secure partial height, such as a railing, or full height division between the loading and unloading pedestrian walkways to maintain fare control, where applicable. Maintain the minimum clear width of the walkway between any doorways located along the OHL system.

In order to maintain expeditious loading, it is desirable to have a significant number of passengers as close to the vessel as possible. Therefore, passengers waiting to load queue along the fixed spans up to the pedestrian transfer span's shoreward hinge point prior to vessel arrival. Provide automatic doors at the end of the fixed span and provide a gate or door at the hinge point as well for passenger control. Provide level landings or platforms near areas used for staging to provide a level resting place for passengers with limited mobility or in wheel chairs. Passengers are not allowed past the hinge point onto the pedestrian transfer span due to building code egress requirements prohibiting "dead-end" situations.

Consider the use of fixed spans to provide passenger access to other modes of transportation in the terminal vicinity.

(b) Pedestrian Transfer Span and Hinge Point Elevation

The pedestrian transfer span is a movable bridge which connects the fixed spans to the loading cab and apron and is adjusted vertically to account for the tides. The critical elevation of the pedestrian transfer span is located at the shoreward hinge point. Locate the hinge point at the elevation which provides no more than a 1:12 slope along the pedestrian transfer span from the hinge point to the loading cab for the greatest percentage of the time.

Exhibit 620-4 lists the standard dimensions for the pedestrian transfer span. Design the pedestrian transfer span for a minimum specified, or a 12-foot clear width between handrails. Design the span to be 120 feet in length. At this length, the pedestrian transfer span (gangway) is no longer required to meet the 1:12 maximum slope at all tides. Design the pedestrian transfer span for an 8.5-foot minimum clear height. The clear height is measured from the top of walking surface to the bottom of any sign or other obstacle. Hanging or protruding objects within the walkway may present obstacles for pedestrians with visual disabilities.

Element	Measurement
Clear Width	12 feet – 16 feet
Length	120 feet
Clear Height	8.5 feet

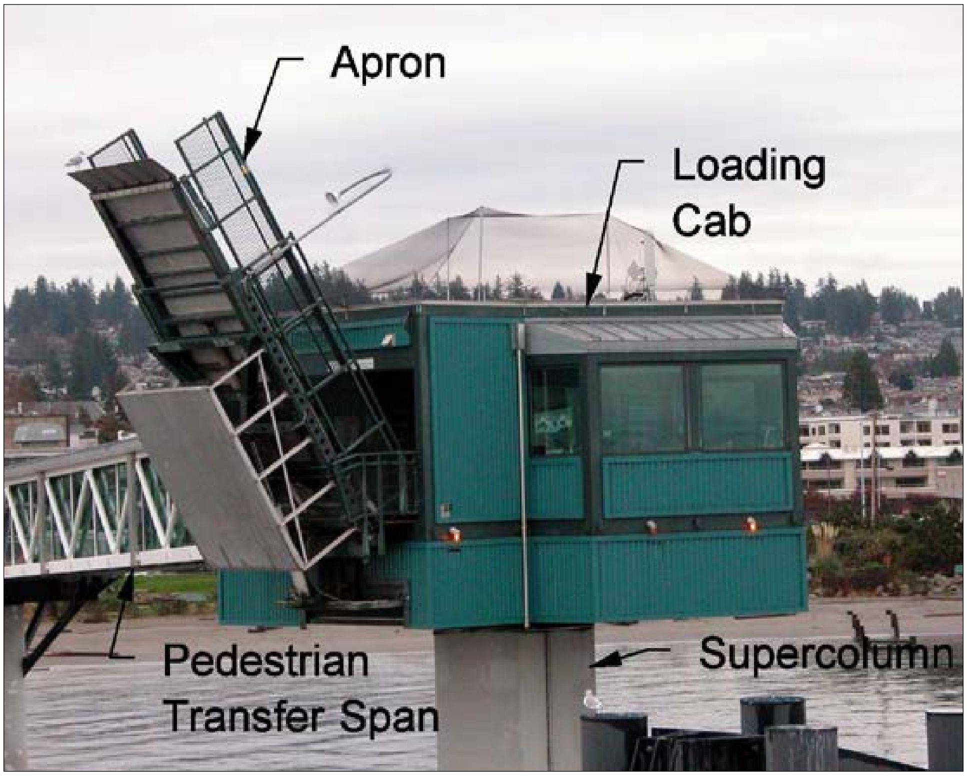
Pedestrian Transfer Span Dimensions
Exhibit 620-4

(c) Loading Cab

The loading cab system is a movable structure that serves as the last node on the passenger walkway connecting the terminal building to the ferry vessel. Exhibit 620-5 below shows the loading cab at the Edmonds Ferry Terminal. The loading cab has a movable apron which provides a ramp from the cab to the passenger deck of the ferry. The loading cab and apron are used to adjust the passenger walkway to accommodate changes in tide elevation as well as differences in ferry boat designs.

For tidal range, design vessels, and freeboards, refer to Chapter 330.

For terminals with two operating slips, consider providing a single loading cab with two hydraulically actuated aprons.



Edmonds Loading Cab and Hydraulic Apron
Exhibit 620-5

(d) Operator Station

The operator station is for the WSF attendant who operates the loading cab and hydraulic apron. Locate the operator station on the offshore side of the loading cab. Locate the controls for the loading cab, hydraulic apron, gate controls, sign controls, intercom, and PA system at the operator station. Provide the operator station with a wall heater for winter and the ability to open a couple windows for circulation during the summer. Design the operator station to be ADA accessible.

(e) Hydraulic Apron

The hydraulic apron provides a walkway for passengers traveling from the loading cab to the vessel. The hydraulic apron is lowered onto the passenger deck of the ferry vessel after the vessel is moored in the operating slip. Exhibit 620-5 shows the hydraulic apron in the raised position at the Edmonds Ferry Terminal. Include provisions to allow the apron to "float" following the movement of the vessel due to changing freeboards while loading/unloading and vessel movement due to wave action.

Element	Measurement
Apron Clear Width	9 feet – 12 feet
Length (retracted)	23 feet
Length (extended)	33 feet
Clear Height	8.5 feet

OHL Apron Dimensions
Exhibit 620-6

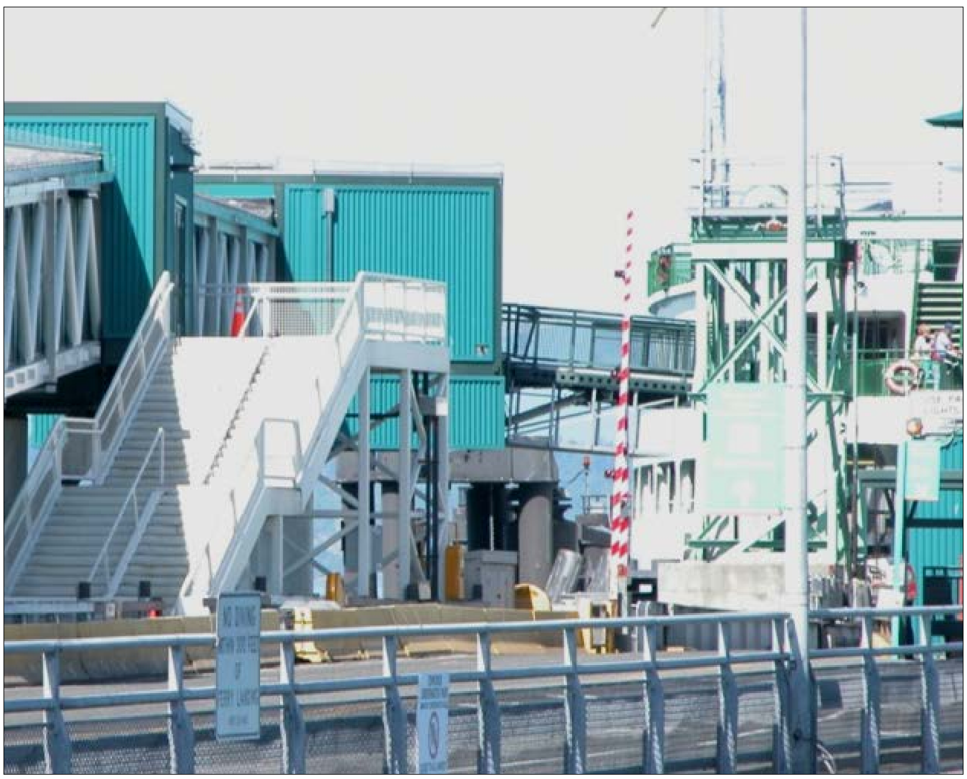
Exhibit 620-6 lists guidelines which allow for the use of standard sized apron cylinders. Verify these dimensions for each design vessel which moors at the slip and the tidal range for the terminal.

(f) Supercolumn

The supercolumn consists of a drilled shaft foundation which houses the hydraulic lift cylinder used to raise and lower the loading cab. The exact position of the supercolumn is dependent on a number of variables including the location of the trestle, vehicle transfer span system and wingwalls. The elevation of the top of the drilled shaft casing shall be a minimum of 1 foot above the maximum design tide elevation. Provide a protective dolphin for the supercolumn drilled shaft.

(g) Emergency Egress Stairs

Provide emergency egress stairs for the fixed OHL walkway in the vicinity of the shoreward end of the pedestrian transfer span. Consult with the local fire marshal for locating and sizing the stairs. Ensure that an adequate place of refuge or egress exists at the bottom of the stairs.



Edmonds OHL Emergency Egress Stairs
Exhibit 620-7

(2) Retrofitted Structures – Cable Hoist Design

<Section pending completion>

(3) Retrofitted Structures – Tension Cylinder Design

<Section pending completion>

620.05 Structural Design Criteria

(1) New Structures – Supercolumn Design

(a) Structural Design Specifications

Design OHL structures in accordance with the AASHTO *LRFD Pedestrian Specifications* and associated reference documents.

- **Steel Superstructures** – Design steel superstructures in accordance with the AASHTO *LRFD Pedestrian Specifications*. Overhead loading structures at WSF typically consist of tube steel member trusses enclosed with walls and a roof. Use prequalified welded joints to fabricate the trusses where practical. Include wind and snow loads appropriate for an enclosed structure. Design components and cladding in accordance with ASCE 7.
- **Drilled Shaft Foundations** – Design drilled shafts in accordance with the AASHTO *LRFD Specifications*, and supplemented by the AASHTO LRFD Seismic Specifications and the WSDOT BDM where appropriate. Plastic hinging in shafts or columns is limited to above-ground and near-ground locations. In-ground plastic hinging is not permitted.
- **Railings/Handrails** – Design railings and handrails in accordance with the *International Building Code*.
- **Movable Bridge/Operating Machinery** – See Mechanical Design Criteria in Section 620.07.
- **Design Deviations** – WSF is responsible for approving any deviation from these design codes not specified. Include a signed deviation in the Project File (PF)/Design Documentation Package (DDP). Refer to Section 220.05 for details on the PF/DDM.

(b) Design Life

The design life of all structural elements, including permanent steel casing, must be documented by analysis, testing, and/or research to demonstrate how the OHL structures design life identified in the LCCM will be met.

The design life for the OHL structures is based on deterioration from corrosion and/or fatigue in accordance with Section 620.03(7).

(c) Limit States

Utilize Limit States as specified in the AASHTO *LRFD Specifications*, Section 1.3, and the AASHTO *LRFD Movable Specifications*, Section 1.3.

Factor Relating to Ductility:	$\eta_D = 1.0$	For Conventional Designs and Details Complying with the AASHTO *LRFD Specifications*. Notify WSF if the Value of η_D is not 1.0.
Factor Relating to Redundancy:	η_R	Determine During Design
Factor Relating to Operational Importance:	$\eta_I = 1.0$	For Typical Bridges

(d) Design Loads

The permanent and transient loads listed below apply. Protect OHL columns from vehicle impact or include vehicle impact as a load condition.

1. Permanent Loads

DC **Dead Load of Structural Components and Nonstructural Attachments**

DW **Dead Load of Wearing Surfaces and Utilities**

2. Transient Loads

DAD **Dead Load Dynamic Load Allowance**
Include the dead load dynamic load allowance in accordance with the AASHTO *LRFD Movable Specifications*. Section 2.4.1.2.2 of the AASHTO *LRFD Movable Specifications* states, "Structural parts in which the force effect varies with the movement of the span, or in parts which move or support moving parts shall be designed for a load taken as 20 percent of the total dead load to allow for dynamic load allowance or vibratory effect."

DAM **Force Effects Due to Operation of Machinery**
Include the force effects due to operation of machinery in accordance with AASHTO *LRFD Movable Specifications*. Section 2.4.1.2.3 of the AASHTO *LRFD Movable Specifications* states, "Structural components supporting forces caused by machinery during operation of the span shall be designed for the calculated machinery forces, increased 100 percent as a dynamic load allowance."

Force effects on structural connections to hydraulic cylinders are specified in the AASHTO *LRFD Movable Specifications*, Section 2.4.1.8 "Hydraulic Cylinder Structural Connections."

EQ **Earthquake Load**
Refer to Seismic Design in Section 620.03.

LL **Vehicular Live Load**
Design OHL structures for a maintenance vehicle load in accordance with the AASHTO *LRFD Pedestrian Specifications* where vehicular access is not prevented by permanent physical methods. Locate design vehicle to produce the maximum load effects. The vehicular live load (LL) and pedestrian live load (PL) need not be considered to act simultaneously. The dynamic load allowance need not be considered for this load.

The earthquake load (EQ) and vehicular live load (LL) need not be considered to act simultaneously.

FL **Fatigue Load**
Design fatigue load in accordance with the AASHTO *LRFD Pedestrian Specifications* and the AASHTO *LRFD Movable Specifications*. The maintenance vehicle need not be considered as a fatigue design load due to infrequent loading.

PL **Pedestrian Live Load**

Design OHL structures for a pedestrian live load of 90 psf in accordance with AASHTO *LRFD Pedestrian Specifications*. Pattern the loading to produce the maximum load effects. The dynamic load allowance does not apply.

For the design level earthquake (DLE), use a pedestrian live load factor of γ_{EQ} of 0.5. The associated mass of pedestrian live load need not be included in the dynamic analysis.

S **Snow Load**

Design for snow load, S, in accordance with the appropriate local building code. Include the following load combinations for design of the superstructure:

1.25D + 1.75L + 0.5S

1.25D + 1.6S Consider snow drifting as appropriate.

WS **Wind Load on Structures**

Design the main wind force-resisting structure in accordance with the AASHTO *LRFD Pedestrian Specifications*. Structure height is measured from elevation = 0.0 feet MLLW. Design components and cladding in accordance with ASCE/SEI 7-10 Unfactored Loads.

(e) Unfactored Loads

Provide WSF-defined unfactored load combinations seen at the hinge points and cylinder connections to the mechanical designer for use in designing the mechanical system.

(2) Retrofitted Structures – Cable Hoist Design

<Section pending completion>

(3) Retrofitted Structures – Tension Cylinder Design

<Section pending completion>

620.06 OHL Utilities

(1) Locations of Utilities

(a) Under the walkway structure

Consider locating the utilities on the underside of the OHL fixed spans and transfer span. This can be achieved by hanging the utilities below the bottom chord of the support beams. Note that locating the utilities here will impact the available vertical clearance under the walkway.

(b) Above the walkway structure

Consider locating the utilities above the clear height envelope within the OHL fixed spans and transfer span.

Above the Walkway Structure - Edmonds Ferry Terminal

Below the Walkway Structure - Seattle Ferry Terminal

OHL Utility Mounts
Exhibit 620-8

(2) Types of Utilities

(a) Electrical and Communication

Refer to Section 620.08.

(b) Mechanical

Refer to Section 620.07.

(c) Drainage

Accomplish drainage of the fixed portion of the OHL walkway by means of a roof drainage collection system and floor sloped drains located at particular intervals in the walkway slab. Collect OHL drainage system into either a trestle trench drain system or the landside storm drainage system.

(d) HVAC

Consider providing radiant panel heaters. Do not provide HVAC systems for the passenger OHL.

(e) Fire Protection

Provide fire protection along the OHL system if the vehicle holding area is located underneath the spans. If the OHL system is not located over the vehicle holding area, consult with the local fire marshal to determine the fire protection requirements.

620.07 Mechanical Design Criteria

(1) Tidal Range of Motion

Design the overhead loading for a tidal range in accordance with Section 330.06.

(2) Vessel Fit Requirements

Check each installation for apron fit up for each appropriate vessel class under the following conditions using the existing vessel gate opening.

- Each appropriate vessel class in light and full load conditions
- At low tide
- At high tide
- At 0 degree span slope
- Against either side dolphin or floater as well as an alternate floater position if applicable. The alternate floater position represents floater movement due to vessel forces, wind, current, etc. and is 5 feet outboard of the nominal design position measured perpendicular to the slip centerline.
- Allow apron positioning as soon as vessel has landed and apron lines secured with no delay due to vessel maneuvering after landing lines are secured.

(3) Cab and Apron Range of Motion

The following range of motion should generally serve each terminal location, but range of motion requirements need to be checked for each installation. The correct height of the lift cylinder base is dependent on the length of the transfer span, transfer span pivot point elevation, and cylinder configuration required to accommodate the tidal range, all of which could be different at each location. Consider wave or storm surge and vessel pitch and roll in addition to tide, in setting the range of motion for the apron.

Component Movement	Range of Motion
Cab Vertical Movement	25 feet
Apron Swing	18 degrees off shore, 18 degrees in shore
Apron Raise and Lower (angle from horizontal)	65 degrees up, 14 degrees down
Apron Extend	110 inches (adjust based on slip location)

Cab and Apron Range of Motion
Exhibit 620-9

Check apron movement for interference with all surrounding structure(s). When the apron can contact any structure or object, use limit switches or position sensors to prevent all impacts. Minimize or eliminate this type of limited movement control, if possible. Design, control or limit the motion of the cab or apron so neither structure comes closer than 12 inches to any other terminal or offshore structure other than the vessel.

Design the fixed portion of the apron such that it is not capable of contacting any part of a vessel under all vessel load and tidal conditions.

(4) Apron Dimensions

The apron width shall be as specified by the Operations group, usually ten (10) to twelve (12) feet clear. The apron length shall be determined during the range of motion study to be performed at the beginning of the project by the structural/mechanical engineering team. The design shall allow for the apron to always slope down to the vessel deck. In no instance shall the apron be allowed to bear against the edge of the vessel at an upward angle to meet the design tide and freeboard conditions.

The apron length and adjustments shall be such that the apron can be positioned to rest on the deck of the vessel within the existing gate openings, has a minimum overlap with the vessel deck of two feet and a minimum clear distance between the apron edge and far pickle fork fencing of 10-12 feet with the vessel positioned at any angle within the slip.

(5) Maintenance

The mechanical system shall be designed with ease of maintenance in mind. There shall be sufficient access to remove and replace all components without having to remove or disassemble adjacent components.

Safe access to all mechanical system components shall be provided.

There shall be sufficient clearance on all fittings and fasteners that they can be tightened or loosened without requiring the use of special tools. All spot faces and countersinks shall be sized to allow for the use of standard tooling in the removal of the associated components.

Isolation valves shall be incorporated into the design to allow removal of major components without draining excessive amounts of hydraulic fluid. Lifting lugs shall be provided on the structure above all components weighing over 75 lbs.

Pad eyes shall be provided on the cab to support and raise the apron structure from the cab while replacing the apron lift cylinder or to raise the apron in emergency situations using come-alongs or similar devices.

Provisions shall be made to support the cab super column structure while replacing the cab lift cylinder. There shall be three possible support positions, low cab, mid cab and high cab heights.

(6) Factor of Safety

Design clevis pins, bearings, trunnions, clevises, and other machinery for support of hydraulic cylinders in accordance with the *Mechanical* and *Hydraulic* sections of the AASHTO *LRFD Movable Specifications* to the maximum extent practical. Design structural connections for cylinder support, including clevis brackets, weldments and high strength bolts as structural elements.

(7) Calculations

Submit calculations, including weight estimates, with each drawing submittal for the PS&E package. Provide calculations at the same or higher level of completion as the drawing submittal except at the 90 percent submittal; provide calculations ready for checking and in final form.

(8) Transfer Span to Cab Connection

The preferred method is to guide the transfer span on the cab using appropriately sized captured rollers with fixed stops and to provide the transfer span with pivot hinge pins at the bridge seat. Based on seismic analysis, the Engineer of record, with concurrence from WSF, may design the span supports at cab and bridge seat differently to suit the expected seismic movements.

(9) Speed of Operation

Component Action	Speed of Operation
Cab Raise	5 to 7 feet/minute
Apron Extend	23-23 feet/minute
Apron Lift (cylinder rod velocity)	7.5-12 feet/minute
Apron Swing (cylinder rod velocity)	3.7-5 feet/minute

Cab and Apron Speed of Operation
Exhibit 620-10

(10) Cylinder Safety

WSF requires safe and dependable operating systems, under all conditions. Terminal Engineering and Operations has decided to use a cylinder based safety design approach to ensure lift cylinder safety and reliability. Elimination of the use of the locking pins during normal operations at every cab stop is the preferred design, relying on the lift cylinder design for cab safety. Super column locks or blocks shall be provided for maintenance and inspection purposes. These locks/blocks may be manually activated and be designed to lock the cab in three general cab positions, high, medium, and low.

The designer of record, in agreement with WSF, shall have the ability to use performance-based design criteria per ASCE 7-10 Minimum Design Loads for Building and Other Structures, to demonstrate that the cab lift cylinder has an equivalent level of safety as structures designed to the code.

Cylinders shall be designed to the appropriate sections of the following prescriptive design codes:

- AASHTO Bridge Code (Structure Elements)
- ASME Boiler & Pressure Vessel Code (Fluid Retaining Elements)
- ASME A17 Elevator and Escalator Code – No cab safeties required on direct acting hydraulic elevators

By using code accepted procedures to demonstrate equivalent levels of safety to structures designed using ASCE 7-10, by documenting the procedure and by having the procedure peer reviewed, incorporation of a locking pin or similar column locking device is not mandated for the super column lift system's daily operation.

(11) Hydraulic Cylinder Design

Effort shall be made to utilize hydraulic cylinders of the same dimensions and pressure ratings as those currently in WSF inventory.

The designer shall specify cylinder bore diameter, rod diameter, stroke, retracted length, mounting pin diameter and manifold mounting configuration, including manifold orientation with respect to piston side mounting ear.

The following parameters represent cylinder sizes desired for a “supercolumn” style OHL system. If another system is chosen that uses hydraulic cylinders, the same general design principles, rod and barrel pin bearing type, pressure rating, factor of safety, design life, material, etc. apply. Adjust the size to suit the design.

(a) Seals

Specify seals that are compatible with the hydraulic oil specified and which have proven prior usage with the hydraulic oil in similar applications. Specify standard size seals with gland size compatible with at least two separate manufacturers. Custom made seals or sole source seals are undesirable.

(b) Main Lift Cylinder

- Welded construction, no tie rod cylinders
- 3000 psi working pressure
- 5000 psi non-shock design pressure
- Factor of safety for all parts – 5:1 based on material ultimate strength with 3000 psi pressure
- Buckling safety factor – 3:1 based on 3000 psi
- Buckling calculations shall be based on the AASHTO *LRFD Movable Specifications*, *NFPA (Fluid) T3.6.37*, or other method approved by the WSF Mechanical Engineer.
- Manifold Ports – to accommodate SAE code 61 4-bolt flange fittings
- Rod material – rod end stainless steel, rod chrome plated stainless steel
- Stop tubes or other design features shall be incorporated to ensure sufficient separation between the piston bearing and rod bearing at full cylinder stroke
- Bleed and gage ports shall be provided
- The design shall allow for the cylinder to be thoroughly bled in the vertical position

(c) Apron Cylinders General

- Welded construction, no tie rod cylinders
- 3000 psi working pressure
- Factor of safety for all parts – 5:1 based on material ultimate strength with 3000 psi pressure
- Buckling safety factor – 3:1 based on 3000 psi
- Buckling calculations based on the AASHTO *LRFD Movable Specifications*, *NFPA (Fluid) T3.6.37*, or other method approved by the WSF Mechanical Engineer.
- Manifold Ports - to accommodate SAE code 61 4-bolt flange fittings or SAE straight thread O-ring boss fittings.

- Rod material – chrome plated stainless steel
- Barrel end of cylinder equipped with plain bronze or Orkot sleeve bearing, grooved for grease or, if spherical bearings are used, provide spacers to prevent cylinder from twisting excessively in the clevis bracket. Spherical bearings may be made of self-lubricating material.
- Rod end of cylinder equipped with spherical self-aligning bearing, grooved for grease or constructed from self-lubricating materials.
- Spacers shall be provided to prevent the cylinder from cocking in the clevis brackets
- Air bleed and gage ports shall be provided on both ends of the cylinders. The bleed ports shall be oriented such that air can be completely bled with the cylinder in the installed position.
- Bearings shall be sized using the bearing manufacturer’s published dynamic ratings.
- Pin dimensions and hardness shall be per the bearing manufacturer’s recommendation

The dimensions listed may be adjusted if necessary to achieve the safe operational requirements of a specific terminal and slip configuration. Notify the WSF Mechanical Engineer prior to the 30 percent submittal if any such adjustments are necessary.

(d) Apron Extend Cylinder

- Rod end of the cylinder barrel supported or constrained against buckling
- Bore – 4 inches
- Stroke – 111 inches
- Rod diameter – 2.5 inches
- Pin diameter – 1.375 inches
- Pin retainers redundant and failure proof
- Stop tube

(e) Apron Swing Cylinder

- Bore – 5 inches
- Stroke – 32 inches
- Rod diameter – 3.5 inches
- Pin diameter – 1.75 inches

(f) Apron Lift Cylinder

- Bore – 7 inches
- Stroke – 52 inches
- Rod diameter – 4 inches
- Pin diameter – 2.5 inches

(12) Cylinder Testing

Each cylinder shall be shop tested with the specified hydraulic fluid and witnessed by a WSF Mechanical Engineer. Hydraulic pressure shall be recorded for no load extension and retraction. Cylinders shall demonstrate the ability to hold pressure on both sides of the piston seal. Tests shall demonstrate that no leakage occurs across piston seal, from either side and that no leakage occurs from the rod seal.

Cylinders shall be stroke tested to demonstrate that no vibration occurs during operation. Large cylinders shall be tested in the vertical position.

If manifolds are supplied with the cylinder, the manifold shall be tested for leaks, for pressure holding and valve function independent of the cylinder. The manifold shall also be attached to the cylinder and pressure tested to verify no leakage at the manifold to cylinder connection.

(13) Hydraulic System

(a) General

The following sections deal with the special consideration related to hydraulic lifting, locking and holding systems for ferry OHL facilities. In the design of hydraulic systems, consider the marine environment in which these systems must operate, as well as climatic conditions, operating temperature range and functional requirements.

Design all systems in conformance with the applicable NFPA, ANSI, SAE, and ISO Standards, and the requirements specified below.

(b) Safety

Design the mechanical and control systems to be fail safe. Perform a failure mode analysis on the design prior to the 90 percent review

to ensure that the failure of any component or subcomponent in the system will not result in harm to personnel, the travelling public, or the structure.

1. **Safety of Users** – At all times the design of the OHL facilities shall provide for the continual safety of users transiting through such facilities. The system shall be designed to allow the cab height to be safely adjusted with live load on the cab and/or transfer span
2. **Safety of Workers** – The design of the OHL shall provide for the continual safety of the operation, inspection, and maintenance personnel in the performance of their duties.

(c) Pressure

- Maximum encountered system pressure 3000 psi
- Maximum operating pressure 2500 psi
- Pumps and valves rated pressure 3000-<u>4500</u> psi
- Other component pressure ratings are listed in other areas of this criteria

(d) Controls

Control operating movement of hydraulic lifting systems electronically through solenoid-activated valves or valve stacks. Specify valves that are marine service rated if exposed to weather. Large cylinders shall be controlled through proportional directional control valves to control speed and acceleration /deceleration. The speed and acceleration/deceleration control ranges of the control units shall be sufficient to alter or limit the effects of operating vibrations and frequencies detrimental to component operation.

Include holding valves at all cylinder ports pressurized by carried loads. Provide valves which allow fluid release only for the following conditions:

1. Overpressure from impact or thermal pressure rise
2. Pilot signal descend command

   Pilot signal ratios are to be such that the valves do not open at excessive rates and do not require excessive pilot pressure.

   Require holding valves that allow free flow in reverse direction.

   Solenoid valves protected from the weather shall have lighted plugs. Solenoid valves exposed to the weather shall have conduit connections and be water proof marine grade. Plug connections shall not be allowed.

   Power supply to individual solenoid valves in each apron shall have separate circuit protection.

(e) Apron Float

Apron float is activated when a pressure switch senses a pressure drop on/in the apron lift cylinder due to the apron coming to rest on the vessel. This signal then opens several valves that allow the apron lift, swing and extend cylinders to move freely (float) with the vessel movement. This keeps the apron in contact with the vessel deck at all times. Pushing the apron lift operator closes all float valves and ports fluid to the blind end of the cylinder. Once the cylinder pressure is raised above the pressure switch set point, the apron moves only when and how commanded by the operator. Provide automatic and manual off/on controls for the float function. Prevent the apron from going into float if the apron is 7 degrees or more above horizontal.

(f) Hydraulic Fluid

Specify Mobil DTE 10 Excel 15 hydraulic fluid.

Design the span lift/apron hydraulic machinery to utilize all possible means to prevent and contain leaks of hydraulic fluid to the environment. Full containment of the fluid is mandatory where possible.

(g) Hydraulic System Schematic

Use the symbols of ANSI/Y32.10 in the schematic to indicate component and circuit functions.

Use complete symbols, not a simplified form, in the schematic diagrams for multiple flow path control valves.

Convey information on the arrangement of the schematic(s) in accordance with ISO1219 and include the following:

- Identification of all hydraulic equipment by name, catalog number, series or design number and the manufacturer's name
- Size of fluid conduits and connectors (outside diameter and wall thickness of tubing, size and schedule of pipe, inside diameter and maximum operating pressure for hose assemblies)
- Bore, rod diameter, and length of stroke of each cylinder
- The displacement per revolution and/or flow rate and output torque rating for each hydraulic motor
- The displacement per revolution and/or delivery flow rate at drive speed for each hydraulic pump
- The power rating, speed, and direction of rotation of each hydraulic pump prime mover
- Pressure and flow setting for all pressure and flow regulation devices and maximum rated operating pressure
- Design flow rate, filtration rating (acceptable minimum B_x min) and or time weighted average value of filtration ratio ($B_{x\ twa}$), for each filter
- Usable reservoir capacity and total system fluid volume
- Data, text or both depicting the operational performance including the function(s) of the related electrical and mechanical controls and actuating equipment

(h) Layout of Fluid Conduits and Connectors

Submit drawings detailing all fluid conduit and connectors. Clearly show the conduit routing, size, fittings, and supports. Drawings are to be revised to reflect "as built" conditions.

Design tubing supports following the guidelines listed below.

Tube OD	A	B	C
1/4" to 3/8"	2"	3'	4"
7/16" to 1"	4"	5'	8"
1¼" to 2"	6"	7'	12"

Dimension "A" is distance from fitting to support

Dimension "B" is distance between supports

Dimension "C" is distance from change of direction to first support

Hydraulic Tubing Support Guidelines
Exhibit 620-11

Submit pressure drop calculations using the actual routing, tubing and hose size, fittings and including all change of directions with the calculations package.

(14) Hydraulic Power Unit (HPU)

(a) General

Design and size hydraulic power unit(s) to a standard that allows safe, efficient, and reliable system performance.

(b) Redundancy

Provide an auxiliary HPU consisting of a small pump/valve unit for lifting the apron off the vessel under all failure scenarios, including but not limited to main HPU failure, electrical power failure to slip and to terminal.

The Auxiliary Pump motor starter shall be hardwired with pushbuttons to control the motor. Valves shall be manually operated. There shall be no connections in this system from the PLC.

(c) Ergonomics

Locate valves and components requiring service where accessible for adjustment, inspection, replacement, or repair. Component placement shall take into account accessibility to lifting equipment, as specified by applicable labor codes and regulations.

Arrange valve manifolds and bulkhead fittings so that all fittings (tube and hose) can be removed or tightened without removing or disturbing the fitting alongside the one being worked on. Locate all fittings, tube and hose ends such that they are clearly visible and accessible for inspection and repair.

Cartridge valves and fittings should not be countersunk into the manifold. If countersinking is required, a spotface of sufficient depth and diameter to accommodate standard tool sizes shall be provided.

(d) Hydraulic Fluid Reservoirs

Design fluid reservoirs in compliance with *ISO 4413:2010, Hydraulic fluid power – General rules and safety requirements for systems and their components* and the following additional requirements:

1. **Baffle** – Baffle the reservoir between the suction and return lines.
2. **Cleanout Access** – Reservoir is to have a cleanout access opening for cleaning and inspection purposes that allows access to both sides of the baffle(s). Locate a drain at the lowest point on the reservoir sloping bottom. Equip drain with a ball valve that is plugged. A valved port with cap shall also be provided to facilitate oil sampling for oil quality testing purposes.
3. **Material** – Specify reservoirs be fabricated from 316/316L stainless steel and welded with corresponding materials. Covers are to be fabricated with not less than 3/8 inch thickness.
4. **Capacities** – Unless heat loss calculations dictate otherwise, size reservoirs to hold the equivalent of 2 minutes of maximum combined pump capacity in addition to the combined swept volumes of all cylinders rods plus 10 percent and, if applicable, to include provisions for any local conditions such as installation at a non-horizontal angle or installation on a moving ramp that results in a fluctuating angle.

5. **Intake lines** – Design intake lines for the minimum velocity possible, less than 4 feet per minute (FPM). Ensure the intake line opening is submerged 1.75 to 2 times the intake line inside diameter. Use bell mouth openings on suction pipes to reduce intake velocity, ensure that the intake pipe is 5 to 6 times the pipe ID away from the nearest wall on at least one side and ensure that the intake pipe is no closer to the reservoir bottom than the pipe ID/2.
6. **Calculations** – Heat loss calculations are to be supplied with the calculation package.

(e) Containment

The HPU shall be built to contain all hydraulic spills whether they are from gravity drips or high pressure spray. Design net retention volume of the containment to be a minimum of 115 percent of the fluid tank's content, including allowances for containment trays subject to inclinations from horizontal. Design to ensure that no hydraulic oil from inside the HPU enters any waterway, spill on dock, transfer span or vehicle holding area. The containment is to have a plugged valve drain that allows the fluid held by the containment to be evacuated easily.

(f) Sound Level

Ensure the noise developed by the power unit during continuous operation does not exceed the sound levels that would be acceptable in a work place under applicable local or federal regulations.

When possible enclose the HPU in sound insulation to achieve the following ratings: A Sound Transmission Class (STC) rating of 50 (Field Tested) minimum is required and a STC rating of 60 shall be the target. The rating shall be achieved by an architecturally proven and calculable method.

As a minimum, apply sound damping material (Dexdamp 432) to the inside surfaces of the enclosure covering at least 80 percent of the inside area, not including vent areas and areas with brackets or components mounted to them. Apply a second sound barrier (¾ inch thick Barrier 104) on top of the Dexdamp 432 with its Mylar face exposed to the interior of the enclosure.

(g) Hydraulic Pumps

Specify axial piston type hydraulic pumps with a variable displacement configuration to accommodate various flow rate requirements of cylinders without excessive relief valve operation. Pumps are to be equipped with horsepower-limiting systems to allow pump and electric motor sizing to match normal demands and to ensure overloads are prevented at the motors during maximum operating conditions or intermittent extreme operating conditions. Gear pumps are allowed for emergency apron lift systems.

Accomplish hydraulic operation utilizing two pumps selected such that in the event that one pump fails the remaining pump can operate the span at half speed.

The pumps are to be direct coupled and supported by the electric motor. Design electric motor feet to rest on vibration absorbing mounts to reduce transmitted noise. Use flexible hose and electrical conduit to connect the pump/motor electrical and hydraulic systems.

(h) Filtration

Locate a pressure line filter directly downstream from each pump.

A properly sized return line filter is to be installed in the main system return line.

(15) Hydraulic Tubing and Fittings

Tubing shall be AL6XN per ASTM B 676.

Tube fittings for .75 inch OD and smaller tubing shall be:

For tube to tube connections - three piece bite type flareless tube fittings per SAE J514; stainless body, nuts and ferrules; minimum operating pressure rating of 3,000 psi.

- PARKER FERULOCK
- Body – ASTM A479 type 316 stainless steel
- Tube Nuts – ASTM A479 type 316 or 316L stainless steel
- Ferrule – ASTM A564 Type 630 stainless
- Ensure nut is pre-lubricated with a bonded dry film lubricant.

For tube to hose connections -three piece O-ring face seal type tube fittings per SAE J1453; stainless steel body, nuts and ferrules; minimum operating pressure rating of 3,000 psi; no flanged tubing or tubing with sleeves brazed on.

- PARKER SEAL –LOK
- Body – ASTM A479 type 316 stainless steel
- Tube Nuts – ASTM A479 type 316 or 316L stainless steel
- Flange Sleeves – ASTM A479 Type 316 stainless steel

All tube fittings are to be tightened to the manufacturer's recommended torque for the size and style of fitting used.

For 1 inch OD and larger tubing, fittings shall be SAE code 61 four bolt flange fittings welded directly to the tube ends. Body, bolts and nuts shall be 316 stainless steel. The minimum operating pressure shall be 3,000 psi.

If pipe is used, specify seamless 316 or 316L conforming to ASTM A312/A 312M with a pipe weight class of schedule 80. Pipe fittings shall be socket weld or SAE code 61 four bolt flange fittings welded directly to the tube ends. Body, bolts and nuts shall be stainless steel. Pipe assemblies shall be passivated after fabrication and welding by a WSF approved process. The minimum operating pressure shall be 3,000 psi.

No pipe threads (NPT or NPFT) are to be used on any component of the hydraulic system.

(a) Tube and Pipe Clamps

Provide heavy duty clamps to ensure that no contact occurs with structure, components, other tubes and hoses and no vibration shakes the tubing. Guide for tubing support spacing is given earlier in the criteria. Clamps are to have polypropylene clamp bodies for vibration and noise dampening of the hydraulic lines and to prevent galvanic corrosion. Do not allow pipes or tubing to come in contact with ferrous material. The clamp bodies are to have a smooth bore in contact with the hydraulic line. Specify stainless steel mounting hardware.

(16) Hydraulic Hose and Fittings

All hydraulic hose except for suction hoses shall be rated for a minimum of 3000 psi working pressure. All hoses are to be the no skive type.

All hose assemblies (hose with attached end fittings) shall be pressure tested to 1.5 times their rated working pressure before installation into the system.

Hose fittings shall have the same pressure rating as that of the hose used, as a minimum. Hose fittings shall be the o-ring face seal type or SAE Code 61 four bolt flange fittings. All hose fittings shall be plated carbon steel and crimped onto the hose.

All hose fitting or attachment bolts are to be tightened to the manufactured specified torque for the particular size and style of fitting used.

All hydraulic hose and hose fittings used in an installation are to be the same model number when possible.

Require all hydraulic hose assemblies to have metal tags attached defining pressure rating, length and installation date.

All hydraulic hose will be replaced five years after the date of installation unless inspections determine that replacement of the hose is required earlier.

Provide abrasion sleeves on all hoses connected to moving components.

All hose fittings shall be wrapped with petrolatum impregnated tape after final inspection.

(17) Hydraulic Testing

(a) General

All components and sub-assemblies shall be tested and inspected by WSF Terminal Engineering before being installed in the field. Take these testing requirements into consideration during design and include in the contract specifications.

(b) Component Testing

Key critical components or long lead items that are not easily replaced or substituted shall be tested and inspected by WSF Terminal Engineering before the component is shipped to WSF or a WSF Contractor.

(c) Shop Testing

All Contractor-manufactured hydraulic components shall be shop tested. Sub-assemblies, tanks, manifolds and valves shall be tested before final assembly in the HPU or in the OHL structure. Valve settings and flow controls shall be tested and set in the shop prior to installing in the HPU or in the OHL structure. In addition, the completed HPU shall be shop tested before being installed or sent to the terminal site.

(d) Yard Testing

The system shall be tested to the maximum extent possible in the Contractor's yard before being moved on site.

(e) Field Testing

Once the structure is installed at the terminal site, and the HPU field connections are completed, the hydraulic system shall be tested again following the requirements in the contract specifications.

(18) Alarms and Monitoring

The mechanical designer shall work with the electrical designer in identifying required indication and providing necessary hardware to achieve the required indications. Alarm Conditions shall be displayed on the message screen on the Operator Control Station. The following is a preliminary list of Alarm Conditions:

- Pressure Filter Clogged
- Return Filter Clogged
- HPU Pump Disconnect Open
- HPU Pump Overload
- HPU Pump Not In AUTO
- HPU Pump Suction Valve Closed
- Low Oil Level Warning
- Low Oil Pressure
- Cab High Limit
- Cab Low Limit

Shutdown Conditions shall stop all movement by de-energizing all equipment and valves. Shutdown Conditions shall be displayed in the message screens on the Operator Control Stations. The following is a preliminary list of Shutdown Conditions:

- High Oil Temp
- Low Oil Level
- Emergency Stop Pushbutton Pressed

In addition to displaying Alarm and Shutdown messages, the message screens will also display System Status messages. The following is a preliminary list of System Status messages:

- Apron in Float
- HPU Pump Running
- Loading Cab RAISE/LOWER Functions Disabled

620.08 Electrical Design Criteria

(1) OHL System – Super Column

(a) Power Distribution

Refer to Chapter 360 for general electrical design criteria pertaining to OHL System.

(b) Control System

Provide a Control System to control operation of the following OHL system components.

- Hydraulic power supply
- Loading cab lift cylinder and two locking pin cylinders
- Three apron control cylinders (raise, extend and swing)
- Emergency hydraulic power unit

The entire hydraulic system is controlled through an operator's console located in the loading cab. The control system uses a programmable logic controller (PLC), which is a computer, to operate all the hydraulic equipment and illuminate lights on the operator console signifying status of components and warnings of possible failure conditions. The following components are detailed:

1. **Loading Apron** – The loading apron is a ramp which extends from the loading cab to the passenger deck of the ferry. It is composed of two segments which pivot left and right and up and down from the loading cab by the action of two hydraulic cylinders. The outer of the two segments can be extended and retracted from the inner apron segment by the action of a third hydraulic cylinder.
2. **Cab Lift** – The loading cab sits on top of a square column that moves up and down with the cab. A single hydraulic cylinder is mounted under the loading cab to raise and lower the cab.
3. **Hydraulic Power Unit** – The HPU is composed of two hydraulic pumps with 30 horse power motors running from 480V, 60 Hz, 3-phase power.
4. **Emergency HPU** – The emergency HPU is mounted under the floor of the loading cab. It is to be used to raise the apron off the deck of the ferry if the main hydraulic system fails. The emergency HPU is operated from a separate control box mounted near the operators control station.
5. **Hydraulic Tank** – The hydraulic tank is used to hold hydraulic oil needed to operate all of the hydraulic systems. It is located under the floor of the loading cab. Included in the hydraulic tank is a return filter, level switches, fill port and sight level. The hydraulic tank also has breather bags connected to provide clean and dry air to the tank when oil is used to operate the system.

The primary components in the OHL control system are the programmable logic controller (PLC) cabinet and panel view screen, operator control station (one for each apron), and the auxiliary hydraulic pump system.

Control System Component	Notes
Programmable Logic Controller (PLC)	Allen Bradley Compact Logix Control System
Panel View	Allen Bradley PanelView Plus 6 1000
Operator Control Stations	There is one main control station for each apron. On each main control station there are lighted pushbuttons for: • Emergency Stop There are individual pushbuttons for: • Loading Cab Raise • Loading Cab Lower • Loading Apron Raise • Loading Apron Lower • Loading Apron Swing Left • Loading Apron Swing Right • Loading Apron Extend • Loading Apron Retract • Test Pilot Lights/Reset Alarms There are individual indicating lights for: • Maintenance Required • Shutdown Alarm There is a lighted selector switch for: • Apron Float Off-On -Auto There is a keyed selector switch for: • Control Power Off-On There are individual pushbuttons for: • Stop Auxiliary Power Unit • Start Auxiliary Power Unit • Apron Raise

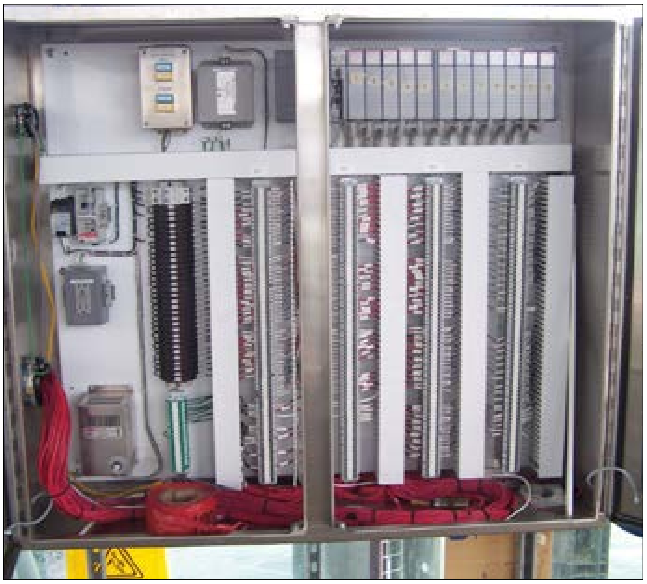
Typical OHL Control System
Exhibit 620-12

The PLC cabinet, shown in Exhibit 620-13, contains the PLC and terminals required to control the bridge and apron. The PLC also sends messages to the panel view screen, Exhibit 620-14 that are displayed in various colors for troubleshooting and to indicate the status of the OHL system. The PLC and PanelView shall communicate on the WSF Network. Provide and Ethernet Switch or Fiber Ethernet Switch in the PLC Cabinet as required to connect the Control System to the WSF Network.

The operator control station contains the required pushbuttons and indicating lights for the control of the OHL, as shown in Exhibit 620-15.

The auxiliary hydraulic pump system, shown in Exhibit 620-16, is designed to lift the apron off the boat if there is a PLC or other type failure that would prevent the main HPU from lifting the apron. The auxiliary hydraulic pump system is hardwired with pushbuttons to control the motor and valves. There are no connections in this system from the PLC.

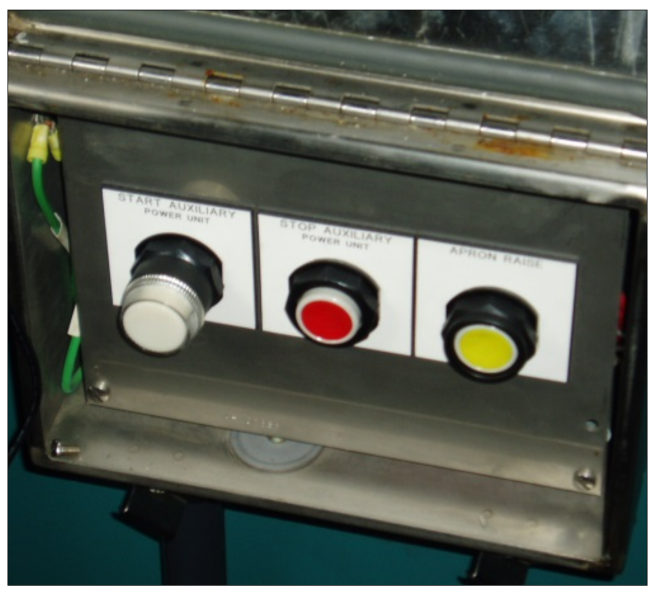
All other push buttons on the control stations, except emergency stop, are connected as inputs to the PLC. The main hydraulic power unit motor starter contactors and hydraulic system valves are controlled by outputs from the PLC. All interlocks and shutdowns, except the emergency stop pushbuttons, are programmed in the PLC's ladder logic software. The emergency stop pushbuttons are hardwired to immediately stop all motion and equipment.



PLC Cabinet
Exhibit 620-13

PLC Panel View Screen
Exhibit 620-14

Operator Control Station
Exhibit 620-15



Auxiliary Hydraulic Pump
Exhibit 620-16

A description of the control panel follows.

1. Control Power Off/On Switch
   - Keyed selector switch
   - Has two positions - OFF / ON
   - When turned “ON” connects power to the operator control station and activates the pushbuttons and selector switches on the control station to control the cab and apron.
   - When turned “OFF” disconnects power to the operator control station and deactivates the pushbuttons and selector switches. One exception is the EMERGENCY STOP pushbutton. The EMERGENCY STOP pushbutton is always active regardless of the position of the ON/OFF KEY SWITCH.
   - Remains in the “ON” position during OHL Operation.
2. Loading Cab – Raise/Lower Pushbutton
   - Square yellow pushbutton with right and left segments.
   - The right segment is for Loading Cab Raise. The left segment is for Loading Cab Lower.
   - When either segment is pressed, the Control System automatically starts the HPU pump motors. It will take approximately 6 seconds for both motors to come up to speed.
   - When either segment is pressed, the Control System will automatically raise the cab until the locking pins are centered with the pin holes and retract the pins. The cab will then move in the direction corresponding to the segment being pressed (right segment for Raise and left segment for Lower).
   - Hold the Raise or Lower pushbutton down until the cab is at the approximate desired height.
   - When released, the Control System will automatically continue moving the cab in the same direction until the pins are centered with the next pin hole. Then the Control System will stop the cab, insert the pins, and lower the cab slightly.
   - When raising or lowering the Loading Cab, it takes approximately 10 to 12 seconds between pin holes
3. Test Pilot Lights or Reset Alarms Buttons
   - Blue push button
   - Has two primary functions
     - Pressed when there are no active alarms, tests indicating light bulbs on control panel
     - Pressed when there is an alarm, if the alarm condition is no longer present, resets alarm.
     - There are no audible alarms.
     - Flashing lights are the alarms.
   - Push at the beginning of each shift to test the indicating light bulbs. If any of the lights do not turn ON, note the light and notify the Agent so that she/he can arrange to have Terminal Maintenance replace the bulb.

4. Loading Apron – Raise/Lower Pushbutton
   - Square blue pushbutton with right and left segments.
   - The right segment is for Loading Apron Raise. The left segment is for Loading Apron Lower.
   - When pressed, automatically starts one HPU pump motor
   - When pushed either to raise or lower and held, raises or lowers the apron
   - Stops when released
5. Loading Apron Swing – Left/Right Pushbutton
   - Square blue pushbutton with right and left segments.
   - The right segment is for Loading Apron Swing Right. The left segment is for Loading Apron Swing Left.
   - When pressed, automatically starts one HPU pump motor
   - Stops when released
6. The Loading Apron – Extend/Retract Pushbutton
   - Square blue pushbutton with right and left segments.
   - The right segment is for Loading Apron Retract. The left segment is for Loading Apron Extend.
   - When pressed, automatically starts one HPU pump motor
   - Stops when released
7. Loading Apron Float – Lighted Auto/Off/On Apron Float Switch
   - A three position switch: AUTO is the standard operating position
   - Green light in handle will illuminate when float is ON allowing the apron to float (ride) up and down with vessel
8. Emergency Stop Pushbutton
   - Mushroom head pushbutton, push to stop and pull to reset.
   - Hardwired to stop all cab and apron motion.
9. Panel View – Displays system status and alarms

(c) Lighting System

Illumination shall be provided in accordance with Exhibit 620-17.

Light Level Chart			
Area Description	Minimum Average Horizontal Illuminance (Footcandles)	Minimum Maintained Illuminance (Footcandles)	Distance Above Finished Floor (Inches)
Passenger Overhead Loading Access Ramps	5	1	0
Passenger Overhead Loading Apron	15		0
Passenger Overhead Loading Cab	15	5	0
Passenger Overhead Loading Transfer Span	7	3	0

OHL Illumination Requirements
Exhibit 620-17

Refer to Section 360.07 for general lighting design criteria pertaining to OHL Systems.

620.09 Architectural Design Criteria

Kingston Weather Screened OHL
Exhibit 620-18

The following architectural design criteria apply to OHL structures.

- The pedestrian transfer span and fixed bridges are weather-shielded structures providing protection from wind and rain (shown in Exhibit 620-18). Provide a glass wind screen wall system for OHL structures.
- Consider feasibility of providing weather protected holding and loading lane for bicycles and motorcycles under the OHL structure on the trestle.
- Provide emergency egress stairs for the fixed overhead walkway in the vicinity of the shore side end of the pedestrian transfer span.
- Design security gates into the passenger OHL transfer spans.
- Provide a concrete floor with a light broom finish and standing seam metal roofing.
- Provide lighting capable of maintaining current lighting code lumen level requirements. Shield to provide down lighting only.