

OPERATION AND MAINTENANCE MANUAL

HYLEBOS BRIDGE

MAY 2012 **with 2020 revisions**



Prepared By: Hardesty & Hanover, LLP

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1.1 PURPOSE OF MANUAL

This manual provides procedures for operation of the Hylebos Bridge, and for maintenance of the bridge's electrical and mechanical equipment.

1.2 SCOPE OF MANUAL

This manual is divided into 4 primary sections, and one sub-section (Troubleshooting). In brief, each section provides the following information:

Section 1	Responsibilities for personnel involved in the bridge. A brief overview of the operation and maintenance manual. Figures showing the location of equipment.
Section 2	Step-by-step procedures describing how to open and close the bridge, acknowledge a vessel's request to open the bridge, when it is acceptable to open the bridge, and what to do in the event that there are problems in the electrical or mechanical equipment during an opening or closing operation.
Section 3	Step-by-step procedures for the maintenance of the bridge's mechanical and electrical equipment. Included are the location of the equipment and number of units, as well preventative maintenance procedures and frequencies.
Section 4	Photos of the mechanical and electrical equipment identified in Section 3.

1.3 OPERATIONAL RESPONSIBILITIES

Operational responsibilities are assigned by the City of Tacoma Department of Public Works. Operation of the bridge shall be in accordance with the requirements of the US Coast Guard.

1.4 MAINTENANCE RESPONSIBILITIES

The maintenance responsibilities are assigned by the City of Tacoma Department of Public Works.

1.5 SAFETY PROCEDURES

Maintenance personnel shall follow all safety procedures as required by the City of Tacoma.

1.6 REVISIONS TO MANUAL

If at any time there is a request for revisions to this manual, complete the form (page 1-4) titled "Revisions to the Operation and Maintenance Manual for the Hylebos Bridge." Send the completed form to the City of Tacoma Public Works Department Engineering Division at the mailing address shown on the form. The Department of Public Works is responsible for reviewing and implementing requested changes.

Name: _____
Date: _____

REVISIONS TO THE O&M MANUAL FOR THE HYLEBOS BRIDGE

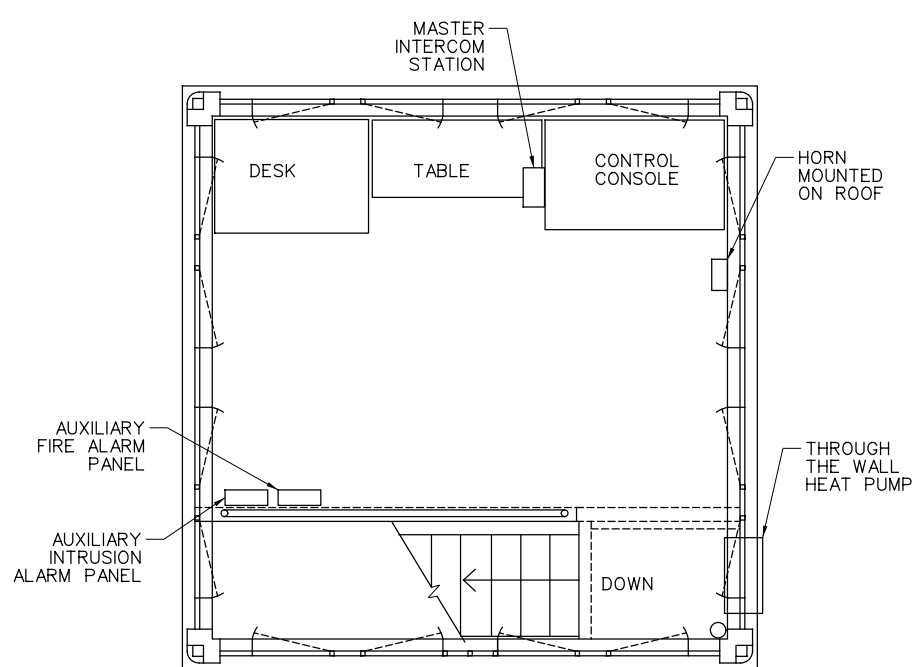
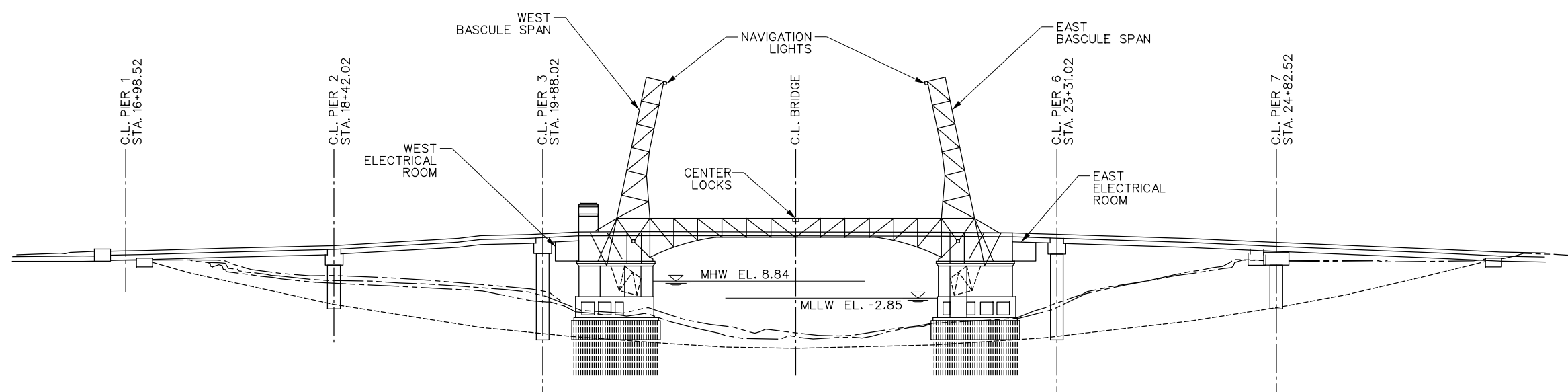
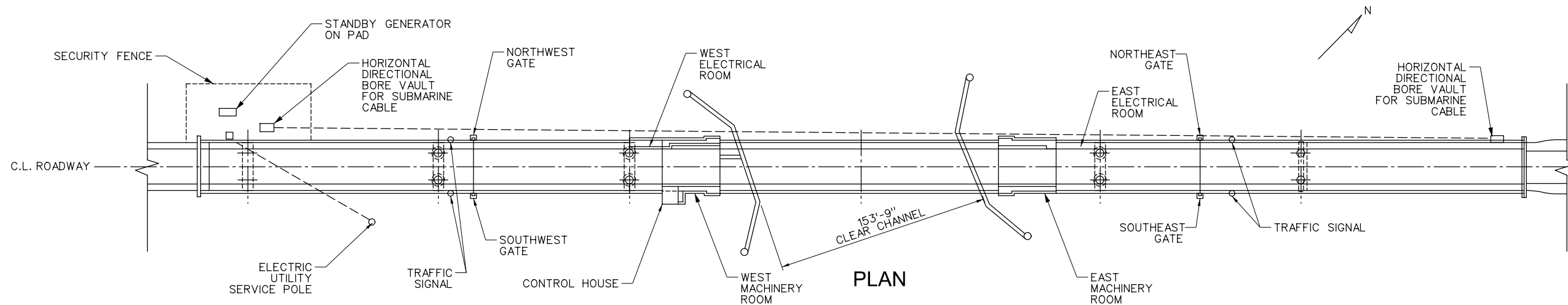
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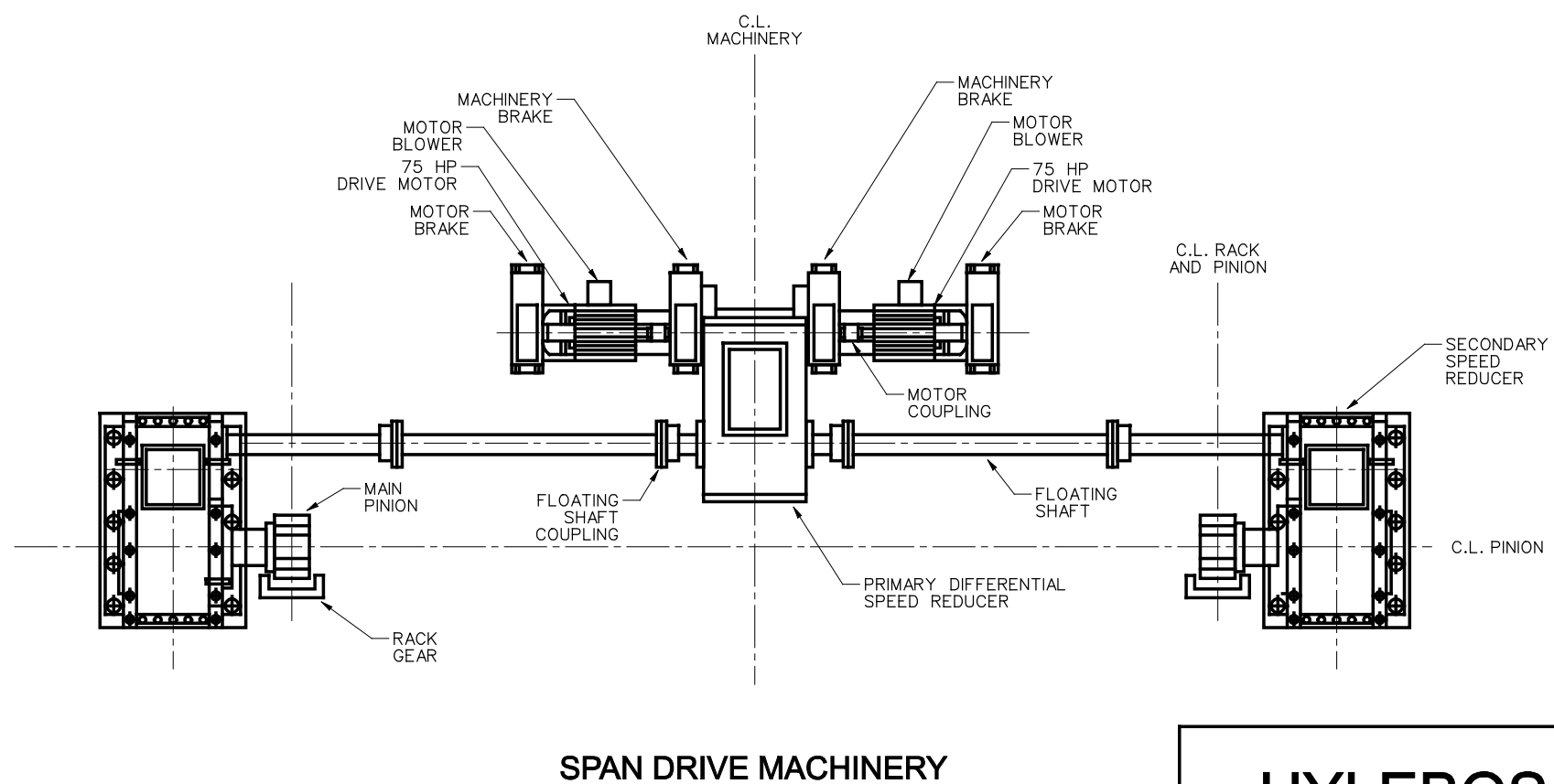
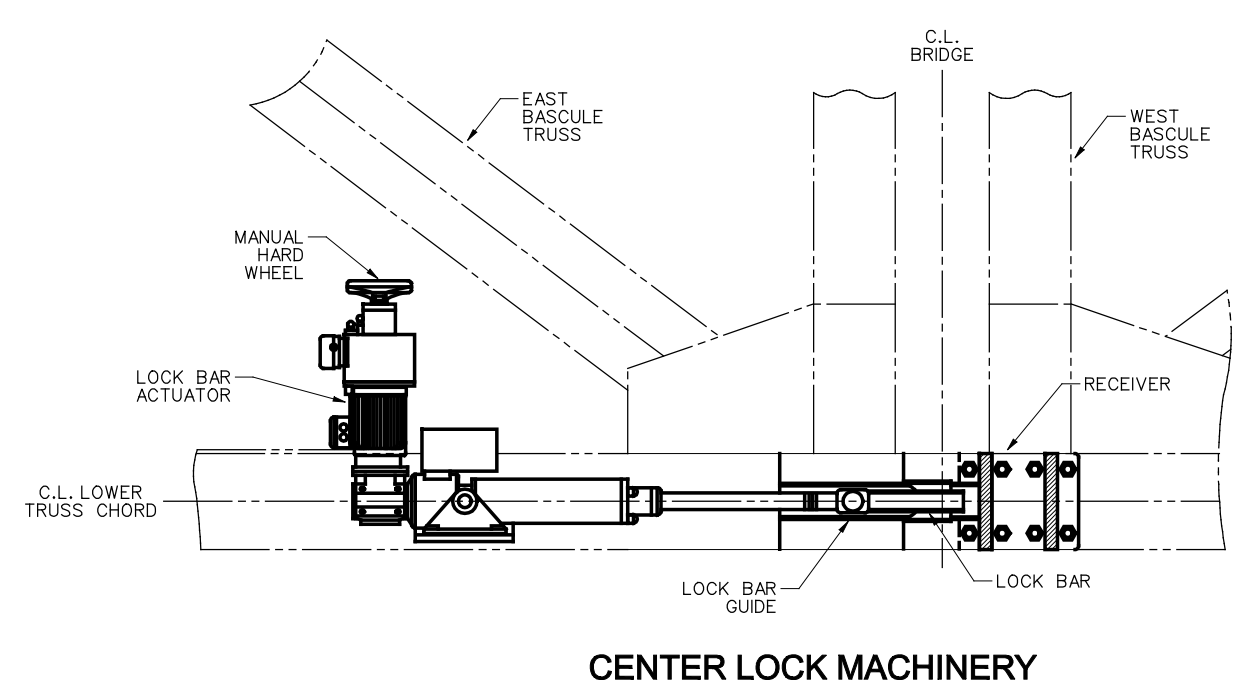
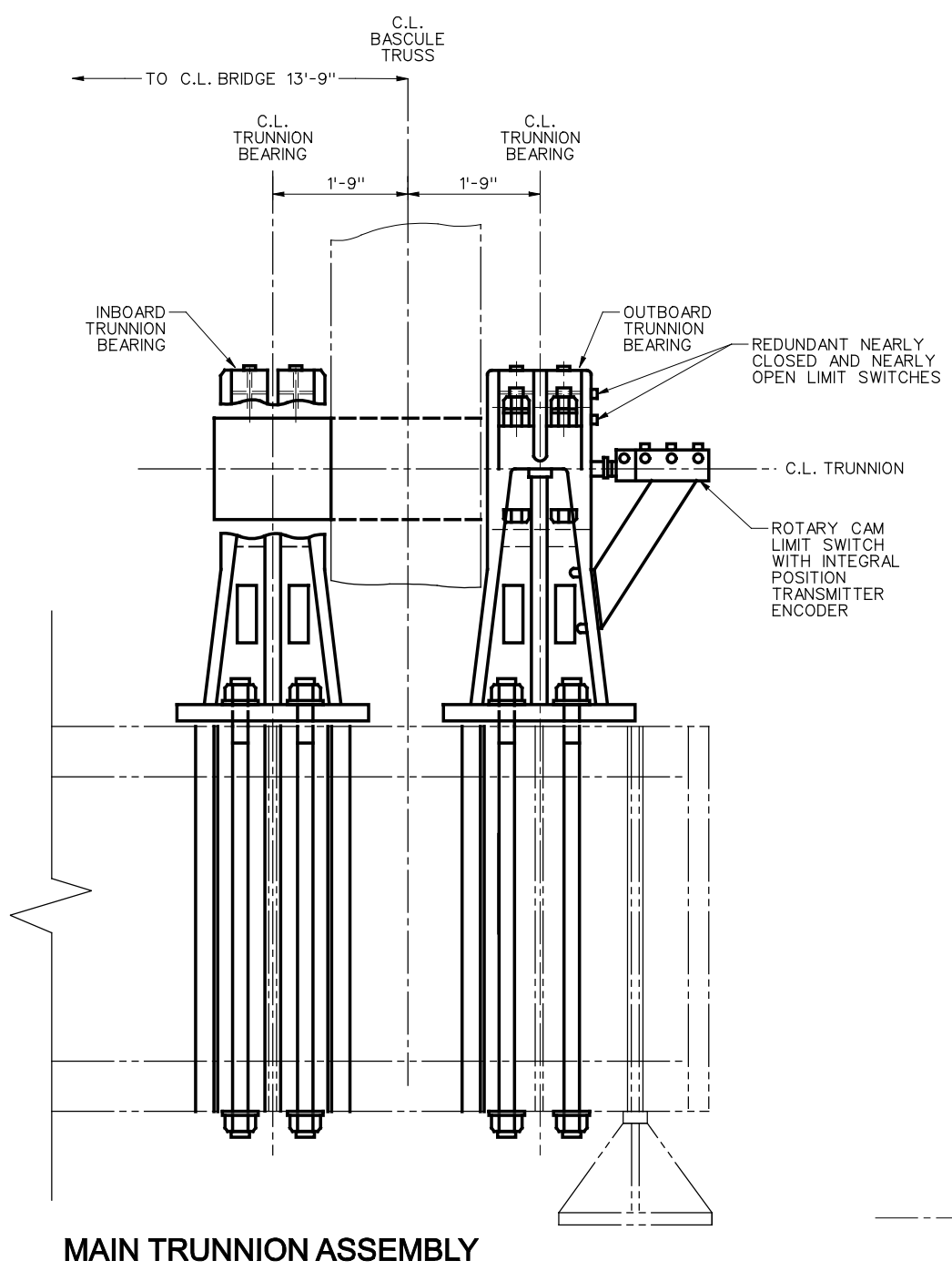


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O & M MANUAL

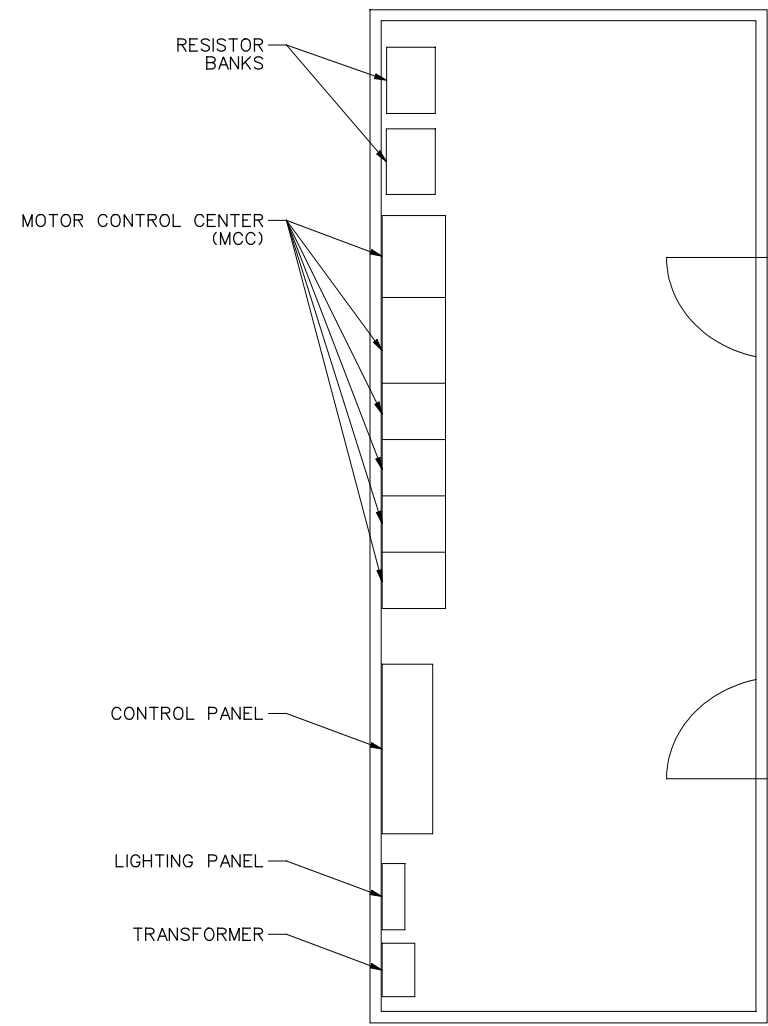
FIGURE 1.1
PLAN AND ELEVATION

PAGE 1-4

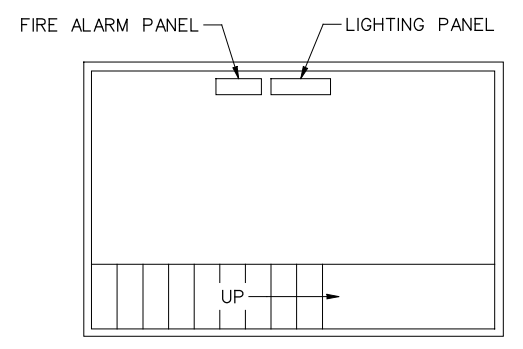
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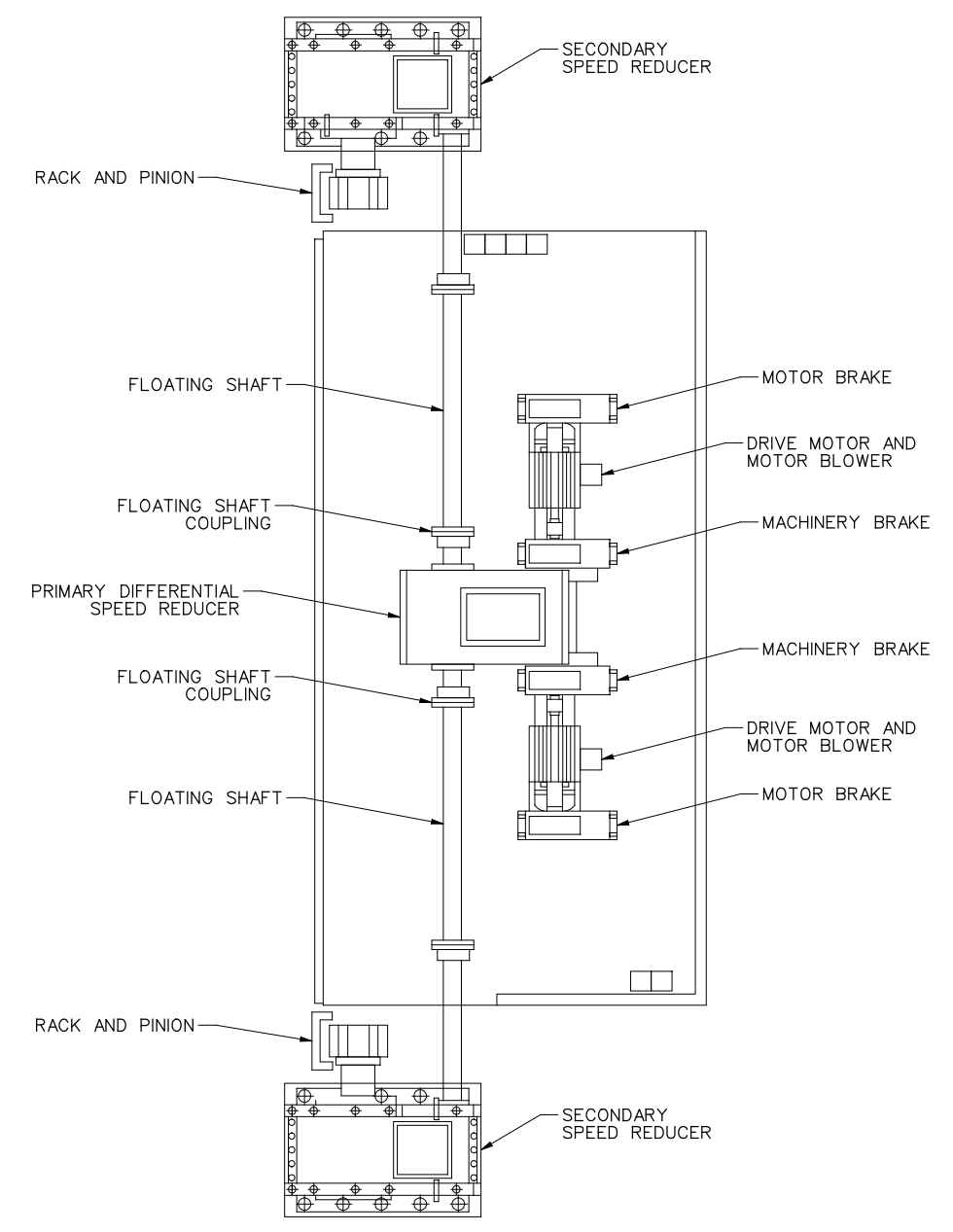
HYLEBOS BRIDGE
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FIGURE 1.2
BRIDGE MACHINERY
PAGE 1-5



**ELECTRICAL ROOM LAYOUT
(TYPICAL)**



**CONTROL HOUSE
FIRST FLOOR PLAN**



**MECHANICAL ROOM LAYOUT
(TYPICAL)**

**HYLEBOS BRIDGE
O & M MANUAL**

**FIGURE 1.3
ELECTRICAL AND MECHANICAL ROOMS**

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2.1 INTRODUCTION

This section describes rules and procedures required to operate the bridge.

Information provided in this section includes:

- Scheduling bridge openings
- The correct status of the electrical equipment prior to beginning bridge operations - identified as the Pre-Operation Status
- The appropriate procedures to acknowledge a request to open the bridge
- Normal bridge operation procedure.

Also included in this section is information on Troubleshooting (red tabbed section) in the event that a prescribed operational event, following a required action, does not occur.

2.2 MARINE VESSEL OPENINGS

For each opening it is **required** to complete the Bridge Opening Log. It is **required** to send the Bridge Opening Log to the City of Tacoma at the end of each month.

The Code of Federal Regulations for Navigational Waters provides the legal basis governing the opening and closing of the Hylebos River Bridge for marine traffic. Therefore, all personnel involved in the operations of the bridge are required to be a trained bridge operator, to abide by and be fully familiar with these regulations summarized below:

1. A trained bridge operator must be in the Bridge Control Tower for the purpose of operating the bridge.
2. The bridge shall be opened on request from a vessel's captain when notified by means of whistle blasts, radio, telephone or other suitable methods.
3. When the bridge operator is not present a vessel's captain desiring passage through the opened end is required to give 1 hours notice requesting a bridge opening. The vessel's Captain can use the telephone number posted or radio to request an opening.

(For exact wording of regulations see Title 33, Chapter 1, Part 117)

As a rule, the Bridge Operator is **required** to open the bridge when requested by the operator of a marine vessel requesting clear passage.

The Hylebos River Bridge may also be opened by City of Tacoma for the purpose of repairs, emergencies, and public safety.

2.3 MAINTENANCE OPENINGS

It is **required** to open the bridge at least once a month as a test of the bridge's full operational capability. The opening will serve as a test of all elements of the bridge machinery, including gates and signals.

MAIN BREAKER ON OFF

GENERATORS NORMAL TROUBLE

TRANSFER SWITCH RUNNING

GENERATOR ON OFF

CONTROL POWER ON OFF

WEST LEAF EAST LEAF

SPAN POSITION

90°

KILOWATTS 0.00

FULL OPEN NEAR OPEN NEAR CLOSED FULL CLOSED

MTR 1 RUNNING MTR 2

NW GATE NE GATE

OFF LOWER RAISE

SW GATE SE GATE

OFF LOWER RAISE

OFF LOWER RAISE

OFF LOWER RAISE

STOP HS-002

OPEN

STOP

STOP

CLOSE

TRAFFIC SIGNALS GO STOP

HORN

BL

ALARM SUMMARY

ALARM TIME ACKNOWLEDGE TIME MESSAGE

ACK ALARM SHUT DOWN

ALARM HISTORY

PLC TROUBLE/RESET

LAMP TEST

BL

ALARM ACKNOWLEDGE

BL

MASTER BYPASS

OFF ON

BL

NAVIGATION LIGHTS

W

AUTO OFF ON

FLOOD LIGHT OFF ON

OFF LOCK UNLOCK

OFF ON

OFF LOWER RAISE

OFF LOWER RAISE

LEGEND:

	ENERGIZED	ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGIZED DUE TO CURRENT ACTION
GREEN LIGHT	G	G	G	G	G
AMBER LIGHT	A	A	A	A	A
RED LIGHT	R	R	R	R	R
WHITE LIGHT	W	W	W	W	W

HYLEBOS BRIDGE CONTROL DESK

PRE OPERATION STATUS

2.4 PRE-OPERATION STATUS

On the facing page is a schematic of the Control Desk identifying each push button, indicating light, switch and key on the Desk for the pre-operational status. The schematic also shows which of the indicating lights are energized (illuminated) and/or de-energized (turned off), and the position of each switch and push button. The pre-operational status is as follows:

- All Circuit Breakers at the Motor Control Centers - located in the Electrical Rooms - are closed (on).
- The Incoming Main Circuit Breaker - located along the southeast (far downstream) side of the bridge - is closed (on).
- The Manual Transfer Switch - located along the southeast (far downstream) side of the bridge - is switched to Utility Power.
- Tower lights are on.
- Gates are raised.
- The bridge is seated and locked.
- All **Red** Channel Lights and Pier Lights are on
- “CONTROL POWER” key operated switch on Control Desk is switched to **OFF**. “DRIVE LOCKOUT” key operated switches on Control Desk are switched to **OFF**. “MASTER BYPASS” key operated switch on Control Desk is switched to **OFF**.
- The Emergency Stop button on the Control Desk is pulled out
- Span positions are at “0” degrees.
- The “NW GATE” switch is switched to **OFF**. The “SW GATE” switch is switched to **OFF**. The “NE GATE” switch is switched to **OFF**. The “SE GATE” switch is switched to **OFF**. The “CENTER LOCK” switch is switched to **OFF**. The “NAVIGATION LIGHTS” switch is switched to **AUTO**. The “FLOOD LIGHT” switch is switched to **OFF**.
- The following **White**, **Red**, and **Green** Control Desk indicating lights are energized (on).
 1. **White** NAVIGATION LIGHTS
 2. **Green** “MAIN BREAKER” ON
- The PLC Alarm Screen is energized.
- The door to the Bridge Control Tower is always locked.

2.5 VESSEL ACKNOWLEDGEMENT

Acknowledgment of the request by the Bridge Operator is mandatory.

Acknowledgement is the verbal or other communicative responses from a Bridge Operator to the responsible person or Captain of any marine vessel who has communicated a “bridge open” request to the Bridge Operator. The marine vessel will usually communicate a “bridge open” request by horn or by calling the operator on the marine radio VHF Channel 13 or 16. The horn “bridge open” request is one prolonged blast (4 to 6 seconds) followed by one short blast (1 second).

The Bridge Operator is **required** to acknowledge the “bridge open” request within 10 seconds of receiving it and also relay information as to how long before the operation will begin if it will not be within the next 10 minutes.

There are two methods of acknowledging a vessel’s “bridge open” request and to indicate that an opening will occur immediately. The principle method of acknowledgement (the first method to be tried) is calling the vessel on the marine radio VHF Channel 13 or 16 and informing the vessel Captain that his request is acknowledged and the Bridge Operator understands his request. Channel 13 is the bridge-to-bridge, and the vessel-to-vessel hailing channel. (*Note: Channel 16 is the Coast Guard emergency/work channel*).

If the VHF is not working, the “back-up method” of acknowledgement is using the boat signal horn, by using the pushbutton marked “HORN” on the Hylebos Bridge control desk. Acknowledgement of the vessel Captain’s request using the horn is achieved as follows:

- **One prolonged blast followed by one short blast.** The short blast is sounded not more than three seconds following the prolonged blast.

When the bridge cannot be opened immediately, the vessel’s opening request must still be acknowledged by either the VHF system or the horn. Again, **VHF is the primary method** of acknowledgement and the horn is the back-up method of acknowledgement. If the horn is used to acknowledge that the bridge cannot be opened, this is achieved as follows:

- **Five short blasts.** Each short blast must be shorter than 1 second and be sounded in rapid succession not more than 30 seconds after the vessel’s opening signal. The five rapid blast signals shall be repeated until acknowledged in some manner by the requesting vessel.

If the VHF and the horn are inoperative, and the bridge cannot be opened; the bridge operator may use flags or other viable methods of communication to inform the vessel captain that the requested opening must be delayed.

2.6 NORMAL BRIDGE OPERATION

On the following pages are the normal procedures described as “Operator Action” which are used to operate the bridge. The Operator Actions are presented in numerical sequence. Each Operator Action is listed with a “Result” column that explains what should happen if the operation is successful and a “Troubleshooting” column that explains how to proceed if the operation is not successful. The “Troubleshooting” column will reference Section 2.8 “Troubleshooting and Corrective Action” which provides procedures to follow in the event that a malfunction occurs during a bridge operation.

On the page facing the numerical sequence is a schematic of the Control Desk identifying each push button, indicating light, switch and key on the Desk. The schematic also shows the sequence in which the desk buttons are to be pushed – and consequently, the order in which the indicating lights are energized (illuminated) and/or de-energized (turned off).

Bridge operation begins and ends in the Pre-Operation Status as described in Section 2.5.

An indicating light test should be performed before each operation of the bridge to verify all indicating lights will energize properly. The test should be performed before control power is activated on the control desk. In order to perform an indicating light test, manually depress each indicating light and verify it is energized (illuminated), then release the light and verify it de-energizes (turns off) properly. All the lamps on the control desk should energize only while depressed. If a lamp does not energize, replace the bulb when convenient.

2.6.1 Opening the Bridge

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
	<p>Verify PRE-OPERATION STATUS as described in Section 2.5.</p> <p>Note: The City of Tacoma is abbreviated as 'CoT.' The current telephone numbers to call City of Tacoma are located in Section 7 "Contacts and Telephone Numbers"</p>	<p>Bridge systems have power available for operation and the control desk switches are in the correct position.</p>	<p>If circuit breakers are turned off consult Section 4.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES to verify it is safe to energize the equipment. If so, manually turn circuit breaker handles to match the pre-operation status.</p> <p>Manually turn the switches to match the pre-operation status.</p> <p>If the White CONTROL ON indicating light is not energized: <i>-Notify CoT.</i> <i>-See section 2.8.1 "Power Outage"</i></p>
	<p>Perform an indicating light test by manually depressing the LAMP TEST pushbutton to verify all lamps energize (illuminate), then release the LAMP TEST pushbutton to verify all lamps de-energize (turns off) properly.</p>	<p>All indicating lights energize and de-energize properly.</p>	<p>Replace lamps that do not energize properly.</p>
	<p>Use VHF 13 or VHF 16 to acknowledge vessel's request for an opening. Or use the boat signal horn by pressing the Black "HORN" pushbutton (located on the Hylebos Bridge Control Desk) two short blasts followed by one prolonged blast to acknowledge the vessel.</p>	<p>Vessel knows that the bridge operator is aware of the vessel's request.</p>	<p>VHF fails to function: <i>-Use boat signal horn.</i></p> <p>Both VHF and boat signal horn fail: <i>-Use flags.</i> <i>-Notify CoT.</i></p>

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
<p>1</p>	<p>Turn “CONTROL POWER” key switch to ON and release the switch, allowing it to stay in the ON position.</p>	<p>White “CONTROL POWER” ON indicating light is energized.</p> <p>Green “TRANSFER SWITCH” NORMAL indicating light is energized.</p> <p>Green TRAFFIC SIGNALS indicating light is energized.</p> <p>Green NW GATE, SW GATE, NE GATE, SE GATE indicating lights are energized.</p> <p>Green “WEST LEAF” BRAKES SET indicating light is energized.</p> <p>Green “WEST LEAF” FULL CLOSED indicating light is energized.</p> <p>Green “EAST LEAF” BRAKES SET indicating light is energized.</p> <p>Green “EAST LEAF” FULL CLOSED indicating light is energized.</p> <p>Green CENTER LOCK indicating light is energized.</p>	<p>If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and does not energize:</p> <p><i>-BACK OUT of the operation. (Go to ACTION 12.)</i></p> <p><i>-Call CoT and notify the vessel of the delay.</i></p>
	<p>Visually verify that the sidewalks are clear of pedestrians and bicycles.</p>	<p>OK to proceed to ACTION 2 when sidewalks are clear.</p>	<p>If sidewalks are not clear:</p> <p><i>-Delay the opening until clear.</i></p>

MAIN BREAKER ON OFF

GENERATORS NORMAL TROUBLE

TRANSFER SWITCH RUNNING

GENERATOR ON OFF

CONTROL POWER ON OFF

WEST LEAF EAST LEAF

SPAN POSITION

90°

KILOWATTS

±0 TO 100 (MID) (SET) (RET)

FULL OPEN NEAR OPEN NEAR CLOSED FULL CLOSED

NW GATE MTR 1 RUNNING MTR 2 NE GATE

OFF LOWER RAISE

SW GATE SE GATE

OFF LOWER RAISE

OFF LOWER RAISE

OFF LOWER RAISE

TRAFIC SIGNALS

GO STOP

HORN

BL

RE

OFF UNLOCK

LOCK UNLOCK

CENTER LOCK

NAVIGATION LIGHTS

W

R

OFF ON

OFF ON

FLOOD LIGHT

OFF ON

OFF ON

ALARM BYPASS

OFF ON

ALARM ACKNOWLEDGE

OFF ON

BL

BL

PLC TROUBLE/RESET

LAMP TEST

BL

ALARM SUMMARY

ALARM TIME ACKNOWLEDGE TIME MESSAGE

ACK ALARM SHUT DOWN

ACK ALARM HISTORY

LEGEND:

	ENERGIZED	ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGIZED DUE TO CURRENT ACTION
GREEN LIGHT	G	G	G	G	G
AMBER LIGHT	A	A	A	A	A
RED LIGHT	R	R	R	R	R
WHITE LIGHT	W	W	W	W	W

HYLEBOS BRIDGE CONTROL DESK

ACTION 2 STOP TRAFFIC

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
2	Press and release the “TRAFFIC SIGNALS” Red Stop push button.	<p>Green “TRAFFIC SIGNALS” indicating light is de-energized.</p> <p>Amber “TRAFFIC SIGNALS” indicating light is energized.</p> <p>Red “TRAFFIC SIGNALS” indicating light flashes.</p> <p>Amber “TRAFFIC SIGNALS” indicating light de-energizes.</p> <p>Red “TRAFFIC SIGNALS” indicating light is energized.</p> <p>Gate arm yellow lights start flashing.</p> <p>Traffic signals on the bridge approach energize changing from green to yellow to red.</p>	<p>If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT:</p> <p><i>-BACK OUT of the operation. (Go to ACTION 15.)</i></p> <p><i>-Call CoT and notify the vessel of the delay.</i></p>
	Visually verify that oncoming traffic has stopped. Verify that oncoming gate areas are clear of people, bicycles, and vehicles.	OK to proceed to ACTION 3 when traffic has stopped and oncoming gate areas are clear.	<p>If oncoming gate areas are not clear:</p> <p><i>-Delay the opening until clear.</i></p>

MAIN BREAKER: ON (G), OFF (R)

GENERATORS: NORMAL (G), TROUBLE (R)

TRANSFER SWITCH: RUNNING (A), ON (W), OFF (W)

CONTROL POWER: ON (W), OFF (W)

WEST LEAF: FULL OPEN (W), NEAR OPEN (W), NEAR CLOSED (W), FULL CLOSED (G)

EAST LEAF: FULL OPEN (W), NEAR OPEN (W), NEAR CLOSED (W), FULL CLOSED (G)

SPAN POSITION: 90°

KILOWATTS: ±0 TO 100 (RET)

MTR 1 RUNNING MTR 2: (A), (A), (R), (G), (R), (R), (R), (R)

BRK TRBL/BRKES SET: (R), (G), (R), (R)

BRK LOCKOUT/BRKES RELEASE: (R), (R), (R), (R)

BRK LOCKOUT: OFF (R), ON (BL)

TRAFIC SIGNALS: GO (G), STOP (RE)

HORN: (BL)

NE GATE: (R), (G), (R), (G)

SE GATE: (R), (G), (R), (G)

SW GATE: (R), (G), (R), (G)

NW GATE: (R), (G), (R), (G)

OFF LOWER RAISE: (R), (G), (R), (G)

OFF LOWER RAISE: (R), (G), (R), (G)

OFF LOWER RAISE: (R), (G), (R), (G)

OFF LOWER RAISE: (R), (G), (R), (G)

ALARM SUMMARY: ALARM TIME, MESSAGE, ACK ALARM, SHUT DOWN, ACK ALARM, HISTORY

PLC TROUBLE/RESET: (R)

LAMP TEST: (BL)

ALARM: ACKNOWLEDGE (BL), MASTER BYPASS (BL)

CENTER LOCK: (G), (R)

LOCK UNLOCK: (R)

NAVIGATION LIGHTS: (W), AUTO OFF (W), ON (W)

FLOOD LIGHT: OFF (W), ON (W)

LEGEND:

	ENERGIZED	DE-ENERGIZED DUE TO CURRENT ACTION	ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED DUE TO CURRENT ACTION	ENERGIZED THEN DE-ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGIZED DUE TO CURRENT ACTION
GREEN LIGHT	(G)	(G)	(G)	(G)	(G)	(G)
AMBER LIGHT	(A)	(A)	(A)	(A)	(A)	(A)
RED LIGHT	(R)	(R)	(R)	(R)	(R)	(R)
WHITE LIGHT	(W)	(W)	(W)	(W)	(W)	(W)

HYLEBOS BRIDGE CONTROL DESK

ACTIONS 3 & 4 LOWER GATES

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
3	Turn and hold the oncoming gate “NE GATE” and the oncoming gate “SW GATE” switches to the LOWER position. Release the switches when the oncoming gates are fully lowered.	Gongs begin sounding. Red “NE GATE” indicating light is energized. Red “SW GATE” indicating light is energized. Green “NE GATE” indicating light is de-energized. Green “SW GATE” indicating light is de-energized. Oncoming gate arms lower. Gongs stop sounding when fully lowered.	If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT: <i>-Note inoperable indicating light and proceed to visual verification.</i>
	Visually verify that oncoming gates are fully lowered. Visually verify that there are no people, bicycles or vehicles on the bridge. Visually verify that off going gate areas are clear of people, bicycles, and vehicles.	OK to proceed to ACTION 4 when oncoming gates are fully lowered, and the bridge and off going gate areas are clear.	If either oncoming gate is not fully lowered: <i>-Call the CoT and notify the vessel of the delay</i> <i>-Manually lower the oncoming gate. See Section 2.8.1 “Procedure to Manually Operate the Gates.”</i> If off going gate areas are not clear: <i>-Delay opening until clear</i>
4	Turn and hold the off going gate “NW GATE” and the off going gate “SE GATE” switches to the LOWER position. Release the switches when the gates are fully lowered.	Red “NW GATE” indicating light is energized. Red “SE GATE” indicating light is energized. Green “NW GATE” indicating light is de-energized. Green “SE GATE” indicating light is de-energized. Off going gate arms lower.	If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT: <i>-Note inoperable indicating light and proceed to visual verification.</i>

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
	<p>Perform final check to confirm no people, bicycles, or vehicles are on the bridge.</p> <p>Visually verify that all gates are lowered.</p>	<p>OK to proceed to ACTION 5 if bridge is clear and all gates are fully lowered.</p>	<p>If a gate is not fully lowered:</p> <p><i>-Call the CoT and notify the vessel of the delay.</i></p> <p><i>-Manually lower the Gate. See Section 2.8.1 "Procedure to Manually Operate the Gates."</i></p> <p>If bridge is not clear:</p> <p><i>-Delay opening until clear.</i></p>
<p>5</p>	<p>Turn and release the "CENTER LOCK" switch to the UNLOCK position.</p>	<p>Red "CENTER LOCK" indicating light is energized.</p> <p>Green "CENTER LOCK" indicating light is de-energized.</p>	<p>If indicating lights do not energize per RESULT and if the lamp test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT:</p> <p><i>-Call the CoT and notify the vessel of the delay.</i></p> <p><i>-Manually operate the Center Lock. See Section 2.8.2 "Procedure to Manually Operate the Center Lock."</i></p>

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
<p>6</p>	<p>Place your foot in the floor mounted Foot Switch and depress the pedal with your foot.</p> <p>Depress and release the Green OPEN push button.</p> <p>When both the east leaf and west leaf are in the FULL OPEN position, release the Foot Switch pedal.</p>	<p>When the ‘Deadman Switch’ pedal is depressed the Red “WEST LEAF” BRAKES RELEASED and Red “EAST LEAF” BRAKES RELEASED indicating lights are energized; and Green “WEST LEAF” BRAKES SET and Green “EAST LEAF” BRAKES SET indicating lights are de-energized.</p> <p>When the Green OPEN push button is depressed and released:</p> <p>Amber “WEST LEAF” MTR 1 RUNNING (or MTR2) is energized. Amber “EAST LEAF” MTR 1 RUNNING (or MTR2) is energized. The PLC controller will alternate which motor operates between each operation.</p> <p>The east leaf and west leaf will start to raise:</p> <p>Green “WEST LEAF” and “EAST LEAF” FULL CLOSED indicating lights are de-energized.</p> <p>“WEST LEAF” and “EAST LEAF” SPAN POSITION indicator <i>position arrow</i> follows the angle of the raising bridge leaf relative to its fully lowered position.</p> <p>“WEST LEAF” and “EAST LEAF” KILOWATTS meters fluctuate between 0kW to approximately 200kW.</p> <p>The east leaf and west leaf will raise to 6°: White “WEST LEAF” and “EAST LEAF” NEARLY CLOSED indicating light is energized then de-energizes as the east leaf and west leaf continue raising.</p> <p>The east leaf and west leaf will raise to 65°: White “WEST LEAF” and “EAST LEAF” NEARLY OPEN indicating light is energized and then de-energized as the east leaf and west leaf continue raising.</p> <p>The east leaf and west leaf will raise to 70°: White “WEST LEAF” and “EAST LEAF” FULL OPEN indicating lights are energized.</p> <p>The east leaf and west leaf stop moving.</p> <p>Amber “WEST LEAF” MTR 1 RUNNING (or MTR2) is de-energized. Amber “EAST LEAF” MTR 1 RUNNING (or MTR2) is de-energized.</p> <p>When the Foot Switch pedal is released the Red “WEST LEAF” BRAKES RELEASED and Red “EAST LEAF” BRAKES RELEASED indicating lights are de-energized; and Green “WEST LEAF” BRAKES SET and Green “EAST LEAF” BRAKES SET indicating lights are energized.</p>	<p>If indicating lights do not energize per RESULT and if the lamp test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT:</p> <p><i>-BACK OUT of the operation. (Go to ACTION 7.)</i></p> <p><i>-Call CoT and notify the vessel of the delay.</i></p> <p>If the bridge leaf will not raise or stops raising once started (before the Full Open position):</p> <p><i>-BACK OUT of the operation. (Go to ACTION 7.)</i></p> <p><i>-Call CoT and notify the vessel of the delay.</i></p>

THE END OF OPENING OPERATIONS

MAIN BREAKER: ON (G), OFF (R)

GENERATORS: NORMAL (G), TROUBLE (A)

TRANSFER SWITCH: RUNNING (G)

GENERATOR: ON (A), OFF (W)

CONTROL POWER: ON (W), OFF (W)

WEST LEAF: FULL OPEN (W), NEAR OPEN (W), NEAR CLOSED (W), FULL CLOSED (W)

EAST LEAF: FULL OPEN (W), NEAR OPEN (W), NEAR CLOSED (W), FULL CLOSED (W)

SPAN POSITION: 90°

KILOWATTS: ±0 TO 100 (RET)

MTR 1 RUNNING MTR 2: (A), (A), (A), (A)

BRAKE TROUBLE: (R), (R)

BRAKE LOCKOUT: (R), (R)

BRAKES SET: (G), (G)

BRAKES RELEASED: (R), (R)

OFF LOWER RAISE: (W)

SW GATE: (R), (G)

OFF LOWER RAISE: (W)

STOP: (RE)

CLOSE: (GN)

NE GATE: (R), (G)

OFF LOWER RAISE: (W)

SE GATE: (R), (G)

OFF LOWER RAISE: (W)

STOP HS-002 (E-Stop)

OPEN: (GN)

STOP: (RE)

CLOSE: (GN)

ALARM SUMMARY

ALARM TIME: MESSAGE

ACK ALARM, SHUT DOWN, ACK ALARM, ALARM HISTORY

CENTER LOCK: (G), (R)

LOCK UNLOCK: (W)

NAVIGATION LIGHTS: (W)

AUTO OFF, ON: (W)

FLOOD LIGHT: OFF, ON: (W)

PLC TROUBLE/RESET: (R)

LAMP TEST: (BL)

ALARM: (BL)

MASTER BYPASS: (BL)

LEGEND:

	ENERGIZED	ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGI ZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGI ZED DUE TO CURRENT ACTION
GREEN LIGHT	(G)	(G)	(G)	(G)	(G)
AMBER LIGHT	(A)	(A)	(A)	(A)	(A)
RED LIGHT	(R)	(R)	(R)	(R)	(R)
WHITE LIGHT	(W)	(W)	(W)	(W)	(W)

HYLEBOS BRIDGE CONTROL DESK

PRIOR TO CLOSING

2.6.2 Closing the Bridge

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
		<p>Prior to Closing the Bridge, the control desk will have the following indicating lights illuminated:</p> <ol style="list-style-type: none"> 1. White NAVIGATION LIGHTS 2. Red CENTER LOCK 3. Red NW GATE 4. Red SW GATE 5. Green "WEST LEAF" BRAKES SET 6. White "WEST LEAF" FULL OPEN 7. Green "EAST LEAF" BRAKES SET 8. White "EAST LEAF" FULL OPEN 9. Red NE GATE 10. Red SE GATE 11. Red TRAFFIC SIGNALS 12. Green "MAIN BREAKER" ON 13. Green "TRANSFER SWITCH" NORMAL 14. White "CONTROL POWER" ON 	
	Visually verify that all marine vessels are clear of the bridge area.	OK to proceed if clear.	<p>If bridge waterway area is not clear: <i>-Delay closing until clear.</i></p>

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
7	<p>Place your foot in the floor mounted Foot Switch and depress the pedal with your foot.</p> <p>Depress and release the Green CLOSE push button.</p> <p>When both the east leaf and west leaf are in the FULLY CLOSED position, release the Foot Switch pedal.</p>	<p>When the Foot Switch pedal is depressed the Red “WEST LEAF” BRAKES RELEASED and Red “EAST LEAF” BRAKES RELEASED indicating lights are energized; and Green “WEST LEAF” BRAKES SET and Green “EAST LEAF” BRAKES SET indicating lights are de-energized.</p> <p>When the Green CLOSE push button is depressed and released:</p> <p>Amber “WEST LEAF” MTR 1 RUNNING (or MTR2) is energized. Amber “EAST LEAF” MTR 1 RUNNING (or MTR2) is energized. The PLC controller will alternate which motor operates between each operation.</p> <p>The east leaf and west leaf will start to lower:</p> <p>Green “WEST LEAF” and “EAST LEAF” FULL OPEN indicating lights are de-energized.</p> <p>“WEST LEAF” and “EAST LEAF” SPAN POSITION indicator <i>position arrow</i> follows the angle of the closing bridge leaf relative to its fully lowered position.</p> <p>“WEST LEAF” and “EAST LEAF” KILOWATTS meters fluctuate between 0kW to approximately 200kW.</p> <p>The east leaf and west leaf will lower to 65°: White “WEST LEAF” and “EAST LEAF” NEARLY OPEN indicating light is energized then de-energizes as the east leaf and west leaf continue lowering.</p> <p>The east leaf and west leaf will lower to 6°: White “WEST LEAF” and “EAST LEAF” NEARLY CLOSED indicating light is energized and then de-energized as the east leaf and west leaf continue lowering.</p> <p>The east leaf and west leaf will lower to 0°: White “WEST LEAF” and “EAST LEAF” FULLY CLOSED indicating lights are energized.</p> <p>The east leaf and west leaf stops moving.</p> <p>Amber “WEST LEAF” MTR 1 RUNNING (or MTR2) is de-energized. Amber “EAST LEAF” MTR 1 RUNNING (or MTR2) is de-energized.</p> <p>When the Foot Switch pedal is released the Red “WEST LEAF” BRAKES RELEASED and Red “EAST LEAF” BRAKES RELEASED indicating lights are de-energized; and Green “WEST LEAF” BRAKES SET and Green “EAST LEAF” BRAKES SET indicating lights are energized.</p>	<p>If indicating lights do not energize per RESULT and if the lamp test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT:</p> <p>-Call CoT and notify the vessel of the delay.</p> <p>If the bridge leaf will not lower or stops lowering once started (before the Fully Closed position):</p> <p>-Call CoT and notify the vessel of the delay.</p>

MAIN BREAKER: ON (G), OFF (R)

GENERATORS: NORMAL (G), TROUBLE (R)

TRANSFER SWITCH: RUNNING (A), ON (W), OFF (W)

CONTROL POWER: ON (W), OFF (W)

WEST LEAF: FULL OPEN (W), NEAR OPEN (W), NEAR CLOSED (W), FULL CLOSED (G)

SPAN POSITION: 90°

KILOWATTS: ±0 TO 100 (RET)

MTR 1 RUNNING MTR 2: (A), (A)

BRAKE TROUBLE/ BRAKES SET (R), (G)

BRAKE LOCKOUT/ BRAKES RELEASED (R), (R)

BRAKE LOCKOUT (OFF) ON (W)

EAST LEAF: FULL OPEN (W), NEAR OPEN (W), NEAR CLOSED (W), FULL CLOSED (G)

SPAN POSITION: 90°

KILOWATTS: ±0 TO 100 (RET)

MTR 1 RUNNING MTR 2: (A), (A)

BRAKE TROUBLE/ BRAKES SET (R), (G)

BRAKE LOCKOUT/ BRAKES RELEASED (R), (R)

BRAKE LOCKOUT (OFF) ON (W)

ALARM SUMMARY

ALARM TIME: MESSAGE

ACK ALARM, SHUT DOWN, ACK ALARM, ALARM HISTORY

TRAFFIC SIGNALS: GO (G), STOP (R), STOP (RE)

HORN: (BL)

NW GATE: OFF LOWER RAISE (R), SW GATE (G), OFF LOWER RAISE (W)

NE GATE: (G)

SE GATE: (R), (G), OFF LOWER RAISE (W)

LOCK UNLOCK: OFF (G), ON (R)

CENTER LOCK: (G), (R)

NAVIGATION LIGHTS: (W), AUTO OFF (W), FLOOD LIGHT OFF (W), ON (W)

PLC TROUBLE/ RESET (R), LAMP TEST (BL)

ALARM: (BL), MASTER BYPASS OFF (W), ON (W)

LEGEND:

	ENERGIZED	DE-ENERGIZED DUE TO CURRENT ACTION	ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED DUE TO CURRENT ACTION	ENERGIZED THEN DE-ENERGIZED DUE TO CURRENT ACTION	DE-ENERGIZED THEN ENERGIZED DUE TO CURRENT ACTION
GREEN LIGHT	(G)	(G)	(G)	(G)	(G)	(G)
AMBER LIGHT	(A)	(A)	(A)	(A)	(A)	(A)
RED LIGHT	(R)	(R)	(R)	(R)	(R)	(R)
WHITE LIGHT	(W)	(W)	(W)	(W)	(W)	(W)

HYLEBOS BRIDGE CONTROL DESK

**ACTIONS 8 & 9
CENTER LOCK AND
OFF GOING GATES**

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
	Visually verify that the bridge is full closed.	Immediately proceed to Action 8 if the bridge is fully closed.	If bridge is not fully closed: <i>-Repeat Action 7.</i>
8	Turn and release the “CENTER LOCK” switch to the LOCK position.	Green “CENTER LOCK” indicating light is energized. Red “CENTER LOCK” indicating light is de-energized.	If indicating lights do not energize per RESULT and if the lamp test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT: <i>-Call CoT.</i> <i>-See Section 2.7.2 “Procedure to Manually Operate the Center Locks”</i>
	Visually verify that off going gate areas are clear of people and bicycles.	OK to proceed to ACTION 9 if off going gate areas are clear.	If off going gate areas are not clear: <i>-Delay until clear.</i>
9	Turn and release the off going gate “NW GATE” and the off going gate “SE GATE” switches to the RAISE position.	Green “NW GATE” indicating light is energized. Green “SE GATE” indicating light is energized. Red “NW GATE” indicating light is de-energized. Red “SE GATE” indicating light is de-energized. off going gate arms raise.	If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT: <i>-Note inoperable indicating light and proceed to visual verification.</i>
	Visually verify that the off going gates are fully raised. Check that oncoming gate areas are clear of people and bicycles.	OK to proceed to ACTION 10 if oncoming gate areas are clear and off going gates are fully raised.	If off going gates are not fully raised: <i>-Call the CoT and notify the vessel of the delay.</i> <i>-Manually raise the Gate. See Section 2.8.1 “Procedure to Manually Operate the Gate.”</i> If areas are not clear: <i>-Delay until clear.</i>

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
10	Turn and release the oncoming gate “NE GATE” and the oncoming gate “SW GATE” switches to the RAISE position.	<p>Gongs start sounding.</p> <p>Green “NE GATE” indicating light is energized.</p> <p>Green “SW GATE” indicating light is energized.</p> <p>Red “NE GATE” indicating light is de-energized.</p> <p>Red “SW GATE” indicating light is de-energized.</p> <p>Oncoming gate arms raise.</p> <p>Gongs stop sounding when fully raised.</p>	<p>If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT:</p> <p><i>-Note inoperable indicating light and proceed to visual verification.</i></p>
	Visually verify that oncoming gates are fully raised.	OK to proceed to ACTION 11 when oncoming gates are fully raised.	<p>If either oncoming gate is not fully raised:</p> <p><i>-Call the CoT.</i></p> <p><i>-Manually raise the oncoming gate. See Section 2.8.1 “Procedure to Manually Operate the Gates.”</i></p>
11	Press and release the “TRAFFIC SIGNALS” Green GO push button.	<p>Green “TRAFFIC SIGNALS” indicating light is energized.</p> <p>Red “TRAFFIC SIGNALS” indicating light de-energizes.</p> <p>Traffic signals on the bridge approach energize changing from red to green.</p>	<p>If indicating lights do not energize per RESULT and if the indicating light test determines the light is operable and it does not energize, or if a light does not de-energize per RESULT:</p> <p><i>-Call CoT.</i></p>

ACTION	OPERATOR ACTION	RESULT	TROUBLESHOOTING
12	Turn "CONTROL POWER" key switch to OFF and release the switch, allowing it to stay in the OFF position.	<p>White "CONTROL POWER" ON indicating light is de-energized.</p> <p>Green "TRANSFER SWITCH" NORMAL indicating light is de-energized.</p> <p>Green TRAFFIC SIGNALS indicating light is de-energized.</p> <p>Green NW GATE, SW GATE, NE GATE, SE GATE indicating lights are de-energized.</p> <p>Green "WEST LEAF" BRAKES SET indicating light is de-energized.</p> <p>Green "WEST LEAF" FULL CLOSED indicating light is de-energized.</p> <p>Green "EAST LEAF" BRAKES SET indicating light is de-energized.</p> <p>Green "EAST LEAF" FULL CLOSED indicating light is de-energized.</p> <p>Green CENTER LOCK indicating light is de-energized.</p>	<p>If indicating lights do not turn off:</p> <p><i>-Notify CoT.</i></p>

THE END OF CLOSING OPERATIONS

Control Desk Returns to Pre-Operation Status

2.7 TROUBLESHOOTING AND CORRECTIVE ACTION

This section provides corrective action procedures for a power outage, provides information on bypass operation, provides troubleshooting and corrective action procedures for gate failure, center lock failure, and leaf operation failure

2.7.1 Procedure to Manually Operate the Gates

This troubleshooting section explains how to manually operate the gates.

The bridge control system will not allow the off going gates to raise until the center lock is in the LOCK position. Do not manually raise the off going gate unless the center lock is in the LOCK position.

The bridge control system will not allow the oncoming gates to raise until the off going gates are FULLY RAISED. Do not manually raise the oncoming gates unless the off going gates are FULLY RAISED.

Perform the following steps to manually raise or lower the gate:

1. Contact CoT to let them know that there is a gate failure. The personnel at the CoT will notify the appropriate CoT maintenance crew of the failure.
2. The gate housing is locked. The **Operator's key** will open a lock box mounted to the housing. The key to open the housing is located in the **lock box**.
3. Go to the gate and open the housing on the sidewalk side.
4. Disconnect power in the housing by flipping the disconnect switch to OFF.

CAUTION

Failure to switch off the disconnect could result in serious injury as the motor may start automatically.

5. Release the motor brake by rotating the knob on top of the brake cover.
6. Take the hand crank from the inside of the housing where it is mounted.
7. Place hand crank on the motor shaft extension. In order to raise the arm, turn the hand crank to raise the arm. **DO NOT OPEN PAST 90 DEGREES**. In order to lower the arm, turn the hand crank to lower the arm. The direction of rotation is labeled on the motor shaft.
8. Reset the motor brake by rotating the knob on top of the brake cover back to its original position.
9. Return the hand crank to its mount on the inside of the housing.
10. Reconnect power in the housing by flipping the disconnect switch to ON.
11. Close the housing and lock the access door.
12. Return to the Bridge Control Tower and complete the bridge operation.

2.7.2 Procedure to Manually Operate the End Lock

This troubleshooting section explains how to manually operate the center lock.

The bridge control system will not allow the center lock to LOCK until the bridge leaf is in the full closed position. Do not attempt to lock the center lock unless the bridge leaf is in the full closed position.

The bridge control system will not allow the center lock to UNLOCK until all the gates are lowered and traffic is stopped. Do not unlock the center lock unless all the gates are down or traffic is fully stopped by a flagger and barricade at each inoperable gate.

1. Contact CoT to let them know that there is a lock failure. The personnel at the CoT will notify the appropriate CoT maintenance crew of the failure.
2. Go to the sidewalk directly above the center lock motor. Use the **Operator's key** to unlock the hatch. The key to open the housing is located in the **lock box**. Open the hatch and secure it open.
3. Go to the center lock platform located below the west bridge leaf toe, and proceed to the center lock that is not operating properly. Each center lock is operated independently.
4. Turn the center lock motor disconnect switch to the OFF position.

CAUTION

Failure to switch off the disconnect could result in serious injury as the motor may start automatically.

5. The procedure to manually operate the center lock is posted on the center lock unit.
6. Release the brake by pulling the motor brake release arm.
7. Unlock the brake wheel engagement lever and push the brake wheel down until it locks into the gearing.
8. Turn hand wheel to crank the shaft to lock or unlock the center lock.
9. Visually verify that the center lock is fully locked or fully unlocked.
10. Pull the hand wheel to disengage the wheel from the gearing and lock the wheel engagement lever.
11. Set the brake by pushing the motor brake release arm.
12. Close and lock the hatch.
13. Return to the Bridge Control Tower and complete the bridge operation.
14. Contact CoT to verify that power should be returned to the center locks. With CoT approval, go to the center lock platform located below the bridge leaf toe, and turn the center lock motor disconnect switch to the ON position.

2.7.3 Bypass Operation

CAUTION

Bypass switches are for emergency situations only. If bypass switch operation is required, do not continue with bridge opening without contacting the City of Tacoma.

The control desk is equipped with one bypass key operate switch located on the control desk at the lower right side. The use of the bypass switches allows for certain operations that an interlock would normally prevent.

The following is a list of alarms that indicate a bypass can be activated:

Alarm	Acknowledge Alarm	Bypass Alarm
<i>CENTER LOCK UNLOCK</i>		
Center Lock CL-2 Unlock Trouble	Center Lock CL-2 Unlock Trouble Ack	Center Lock CL-2 Unlock Bypass On
Center Lock CL-1 Unlock Trouble	Center Lock CL-1 Unlock Trouble Ack	Center Lock CL-1 Unlock Bypass On
<i>CENTER LOCK LOCK</i>		
Center Lock CL-1 Lock Trouble	Center Lock CL-1 Lock Trouble Ack	Center Lock CL-1 Lock Bypass On
Center Lock CL-2 Lock Trouble	Center Lock CL-2 Lock Trouble Ack	Center Lock CL-2 Lock Bypass On
<i>GATE RAISE</i>		
Traffic Gate TG-E1 Raise Trouble	Traffic Gate TG-E1 Raise Trouble Ack	Traffic Gate TG-E1 Raise Bypass On
Traffic Gate TG-E2 Raise Trouble	Traffic Gate TG-E2 Raise Trouble Ack	Traffic Gate TG-E2 Raise Bypass On
Traffic Gate TG-W1 Raise Trouble	Traffic Gate TG-W1 Raise Trouble Ack	Traffic Gate TG-W1 Raise Bypass On
Traffic Gate TG-W2 Raise Trouble	Traffic Gate TG-W2 Raise Trouble Ack	Traffic Gate TG-W2 Raise Bypass On
<i>GATE LOWER</i>		
Traffic Gate TG-E1 Lower Trouble	Traffic Gate TG-E1 Lower Trouble Ack	Traffic Gate TG-E1 Lower Bypass On
Traffic Gate TG-E2 Lower Trouble	Traffic Gate TG-E2 Lower Trouble Ack	Traffic Gate TG-E2 Lower Bypass On
Traffic Gate TG-W1 Lower Trouble	Traffic Gate TG-W1 Lower Trouble Ack	Traffic Gate TG-W1 Lower Bypass On
Traffic Gate TG-W2 Lower Trouble	Traffic Gate TG-W2 Lower Trouble Ack	Traffic Gate TG-W2 Lower Bypass On
<i>LEAF SEATING</i>		
East Leaf Seating Trouble	East Leaf Seating Trouble Ack	East Leaf Seating Bypass On
West Leaf Seating Trouble	West Leaf Seating Trouble Ack	West Leaf Seating Bypass On

In order to use a bypass switch:

1. Only use a bypass switch as directed below. Verify that all conditions in the instructions are met.
2. Note what step in the operation requires a bypass.
3. If a bypass is required, the PLC Allen Bradley HMI display screen will provide an alarm after attempting an operation. The alarms that can be bypassed are listed above in the table heading 'Alarm.'
4. Read the PLC Allen Bradley HMI display screen to verify the action that requires a bypass.
5. Visually verify the state of equipment allows it to be bypass.
6. Manually press and release the 'ALARM ACKNOWLEDGE' **Black** pushbutton. The PLC Allen Bradley HMI display screen will provide an alarm after pushing the pushbutton. The acknowledge

alarms are listed above in the table heading ‘Acknowledge Alarm.’

7. Turn and release the key operated bypass switch.
8. The PLC Allen Bradley HMI display screen will provide an alarm after turning the key switch. The bypass alarms are listed above in the table heading ‘Bypass Alarm.’
9. After the Bypass Alarm message has been displayed on the PLC Allen Bradley HMI display screen, proceed with the next step in the operation.

Bridge Operator bypasses are as follows:

Bypass: CENTER LOCK UNLOCK

WARNING

Visually verify that both center locks are in the UNLOCK position before operating the CENTER LOCK CL-1 UNLOCK TROUBLE or CENTER LOCK CL-2 UNLOCK TROUBLE bypass.

If either of the center lock unlocked limit switches fails, this will provide an interlock to prevent the continued operation of the bridge by preventing the leaf drives from operating. Verify that the both center locks are in the UNLOCK position. When this bypass is used, the bridge operator can operate the leaf drives despite the failure.

Bypass: CENTER LOCK LOCK

WARNING

Visually verify that both center locks are in the LOCK position before operating the CENTER LOCK CL-1 LOCK TROUBLE or CENTER LOCK CL-2 LOCK TROUBLE bypass.

If the center lock locked limit switch fails, this will provide an interlock to prevent the continued operation of the bridge by preventing the gates from operating. Verify that the center lock is in the LOCK position. When this bypass is used, the bridge operator can raise the gates despite the failed limit switch.

Bypass: GATES RAISE

WARNING

Visually verify that all gate arms are clear of traffic before operating the TRAFFIC GATE TG-E1 RAISE TROUBLE, TRAFFIC GATE TG-E2 RAISE TROUBLE, TRAFFIC GATE TG-W1 RAISE TROUBLE, or TRAFFIC GATE TG-W2 RAISE TROUBLE bypass. If any gate arm is not clear of traffic proceed to Section 2.7.1 “Procedure to Manually Operate the Gate.”

When any gate rotary limit switch has a failure, this will provide an interlock to prevent the traffic warning signals from turning off. Verify that the gate arms are raised and clear of traffic. When this bypass is used, the bridge operator can turn off the warning signals and release vehicular traffic, despite the limit switch failure.

Bypass: GATES LOWER**WARNING**

Visually verify that all gates are down before operating the TRAFFIC GATE TG-E1 LOWER TROUBLE, TRAFFIC GATE TG-E2 LOWER TROUBLE, TRAFFIC GATE TG-W1 LOWER TROUBLE, or TRAFFIC GATE TG-W2 LOWER TROUBLE bypass. If a gate is not down provide a flagger and a barricade to stop traffic at that location.

When any the gates rotary limit switch has a failure, this will provide an interlock to prevent the continued operation of the bridge by preventing the center lock from operating. Verify that the gate arms are lowered and traffic is safely stopped. When this bypass switch is used, the bridge operator can unlock the center lock and open the bridge, despite the limit switch failure.

Bypass: LEAF SEATING**WARNING**

Visually verify the bridge leaf is fully seated before operating the EAST LEAF SEATING TROUBLE or WEST LEAF SEATING TROUBLE bypass.

If the leaf full closed limit switch fails, this will provide an interlock to prevent the center lock from operating. Verify that the each bridge leaf is full closed. When this bypass switch is used, the bridge operator can lock the center locks despite the failed limit switch.

2.7.4 Power Outage and Manual Transfer Switch Operation

A power outage may occur at any time. The bridge is equipped with a diesel generator rated to power the equipment, such as lights and radios in the control tower, and rated to fully operate the Hylebos Bridge. If a power outage occurs:

1. Notify the Power Company of the power outage. Inquire about the anticipated time period that the outage will be in effect.
2. Notify CoT immediately and give a status report.
3. If the bridge will not be available for opening or becomes disabled during a scheduled opening time, notify the vessel, the Coast Guard and City of Tacoma immediately.

Operation during a power outage:

1. When a power outage occurs the bridge will lose power momentarily. If the power outage occurs during an operation, stop the operation you are attempting.
2. The control system will automatically attempt to start the generator. The “GENERATOR” RUNNING Amber indicating light on the control desk will illuminate when the generator is running.
3. Once the generator is running, the automatic transfer switch will switch to generator. The “TRANSFER SWITCH” NORMAL Green indicating light will de-energize and the “TRANSFER SWITCH” GENERATOR Amber indicating light will illuminate.

4. If you were in the middle of an action when power was lost, resume the last action you were taking to complete the bridge operation.

2.7.5 Single Leaf Operation

There may be time when it is required to operate a single leaf of the bridge.

1. Determine which leaf is not to be operated.
2. Turn the key operated DRIVE LOCKOUT switch for that leaf from OFF position to the ON position. The DRIVE LOCKOUT **Red** indicating light for that leaf will flash.
3. That leaf is now locked out of operation, and the operator can operate the leaf that is not locked out. Follow the steps in the Normal Bridge Operation to completely raise and lower the leaf.
4. Once the leaf operation is complete, turn the key operated DRIVE LOCKOUT switch for the locked out leaf from ON position to the OFF position. The DRIVE LOCKOUT **Red** indicating light for that leaf will de-energize.

2.7.6 PLC Allen Bradley HMI Display Screen Alarm List

The alarms in this section cannot be bypassed and may prevent operation. If the alarms appear on the PLC Allen Bradley HMI display screen do not continue with bridge opening without contacting the City of Tacoma.

The following is a list of alarms that the PLC Allen Bradley HMI display screen may display:

- CENTER LOCK CL-1 NOT READY
- CENTER LOCK CL-1 STARTER TROUBLE
- CENTER LOCK CL-2 NOT READY
- CENTER LOCK CL-2 STARTER TROUBLE
- DRIVE E1 NOT READY
- DRIVE E1 TROUBLE
- DRIVE E2 NOT READY
- DRIVE E2 TROUBLE
- DRIVE W1 NOT READY
- DRIVE W1 TROUBLE
- DRIVE W2 NOT READY
- DRIVE W2 TROUBLE
- EAST FULL OPEN LIMIT SWITCH TROUBLE

- EAST NEARLY CLSD LIMIT SWITCH TROUBLE
- EAST NEARLY OPEN LIMIT SWITCH TROUBLE
- EAST POSITION SENSOR TROUBLE
- GENERATOR TROUBLE
- MACH BRAKE MAB-E1 DID NOT RELEASE
- MACH BRAKE MAB-E1 DID NOT SET
- MACH BRAKE MAB-E1 MAN. RELEASED
- MACH BRAKE MAB-E1 NOT READY
- MACH BRAKE MAB-E1 TROUBLE
- MACH BRAKE MAB-E2 DID NOT RELEASE
- MACH BRAKE MAB-E2 DID NOT SET
- MACH BRAKE MAB-E2 MAN. RELEASED
- MACH BRAKE MAB-E2 NOT READY
- MACH BRAKE MAB-E2 TROUBLE
- MACH BRAKE MAB-W1 DID NOT RELEASE
- MACH BRAKE MAB-W1 DID NOT SET
- MACH BRAKE MAB-W1 MAN. RELEASED
- MACH BRAKE MAB-W1 NOT READY
- MACH BRAKE MAB-W1 TROUBLE
- MACH BRAKE MAB-W2 DID NOT RELEASE
- MACH BRAKE MAB-W2 DID NOT SET
- MACH BRAKE MAB-W2 MAN. RELEASED
- MACH BRAKE MAB-W2 NOT READY
- MACH BRAKE MAB-W2 TROUBLE
- MAIN BREAKER OPEN
- MOTOR BRAKE MOB-E1 DID NOT RELEASE
- MOTOR BRAKE MOB-E1 DID NOT SET

- MOTOR BRAKE MOB-E1 MAN. RELEASED
- MOTOR BRAKE MOB-E1 NOT READY
- MOTOR BRAKE MOB-E1 TROUBLE
- MOTOR BRAKE MOB-E2 DID NOT RELEASE
- MOTOR BRAKE MOB-E2 DID NOT SET
- MOTOR BRAKE MOB-E2 MAN. RELEASED
- MOTOR BRAKE MOB-E2 NOT READY
- MOTOR BRAKE MOB-E2 TROUBLE
- MOTOR BRAKE MOB-W1 DID NOT RELEASE
- MOTOR BRAKE MOB-W1 DID NOT SET
- MOTOR BRAKE MOB-W1 MAN. RELEASED
- MOTOR BRAKE MOB-W1 NOT READY
- MOTOR BRAKE MOB-W1 TROUBLE
- MOTOR BRAKE MOB-W2 DID NOT RELEASE
- MOTOR BRAKE MOB-W2 DID NOT SET
- MOTOR BRAKE MOB-W2 MAN. RELEASED
- MOTOR BRAKE MOB-W2 NOT READY
- MOTOR BRAKE MOB-W2 TROUBLE
- WEST FULL OPEN LIMIT SWITCH TROUBLE
- WEST NEARLY CLSD LIMIT SWITCH TROUBLE
- WEST NEARLY OPEN LIMIT SWITCH TROUBLE
- WEST POSITION SENSOR TROUBLE

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3.1 PURPOSE

Guidelines are set up for periodic cleaning, adjustment, or servicing of specific items. For each item, the frequency of maintenance is based on recommendations by the manufacturer's guidelines and generally established good practice.

3.2 LOCKOUT/TAGOUT PROCEDURE

The lockout/tagout procedure is that no electrical apparatus or electrically driven apparatus should be worked on while energized. The appropriate circuit breakers or disconnect handles for the equipment being worked on shall be locked in the open (off) position and tagged. The appropriate, immediate upstream circuit breaker or protective device should always be used to electrically isolate the equipment. A sign should be posted on the control desk to identify that the devices are tagged out of service. A contact person shall be identified on the tag.

3.3 HOW THIS SECTION IS STRUCTURED

The maintenance section is divided into subsections that group equipment by type. Each subsection describes an equipment item, the number of such items, location, the maintenance frequency, and describes maintenance procedures. Photo references are included where applicable.

3.4 TRUNNION BEARING AND SPAN SUPPORT SYSTEM

Each bascule span is supported by two simply supported trunnion shafts. Each trunnion shaft is supported by two bronze bushing bearing assemblies. The two trunnion shafts on the same bascule span are collinear and each bascule span rotates around the axis formed by its two trunnion shafts. The centerline to centerline horizontal distance between the two bascule spans is 216'-10".

There are two live load support bearings on each bascule span attached to the lower chord of each bascule truss approximately 12 feet forward of the trunnion centerline. In the down position, the live load bearings contact strike plates mounted to the front faces of the bascule pier walls. The function of the live load bearing system is to transfer a portion of live load on the on the bascule span to the forward sections of the bascule piers.

Each bascule span is balanced by a large mass counterweight located rearward of the trunnion assemblies.

There are two air buffer cylinders mounted to the bascule pier walls behind the each bascule span counterweight. The air buffers contact the counterweights near the span fully closed position and aid in smooth seating of the bascule spans.

3.4.1 Main Trunnion Assemblies

Description

Each main trunnion assembly consists of two main trunnion bearings and one main trunnion shaft. The main trunnion bearings are split sleeve type journal bearings. The bearing caps and bases are cast steel with bronze split bushings. Lubrication fittings in the bearing caps and trunnion shaft ends provide grease to the trunnion shaft/bushing bearing surface.

The trunnion bearings on the West bascule span are original. The trunnion bearings on the East bascule span were replaced in 2011 and have additional lubrication fittings.

Refer to photo numbered 4-3 and 4-4.

Number of Items & Location

There are four main trunnion assemblies, one located at each bascule span truss.

Maintenance Schedule and Procedures

3 Months

- When possible, lubricate the trunnion shafts while rotating the bascule spans. Pump in Chevron Moly EP2 grease or equal into each grease fitting in the trunnion shafts until old grease is purged from the trunnion shaft journal/bushing interface. Wipe away purged grease.
- When possible, lubricate the trunnion shafts while rotating the bascule spans. Pump in Chevron Moly EP2 grease or equal into each trunnion bearing cap grease fittings until old grease is purged from the trunnion shaft journal/bushing interface. Wipe away purged grease.

Annually

- Check housing and supporting frame for signs of corrosion. Thoroughly clean grease and debris from the exterior of the trunnion assemblies and spot paint, as necessary.
- Check housing cap bolts and base bolts. Torque as necessary.
- Perform a visual and auditory examination of the bearings during operation. Check for unusual movements, binding and abnormal sounds.

3.4.2 Live Load Bearings

Description

Each live load bearing consists of a live load shoe mounted to the bascule truss and a strike plate assembly mounted to the bascule pier.

Each strike plate is bolted to a cast steel base with shims for fine adjustment of the movable span in the closed position.

Refer to photo numbered 4-4.

Number of Items & Location

There are four live load bearings, one located below each lower bascule truss chord, each pair being approximately 12 feet forward of the trunnion centerline for their respective bascule spans.

Maintenance Schedule and Procedures

2 Months

- Check that the strike plates are in hard contact with their live load shoes when the span is closed and when there is no traffic on the bridge. There should be no vertical movement at the live load bearings when traffic crosses the span. If clearance or movement is present, add shims as necessary.

Annually

- Check that all fasteners are tight and corrosion free. Visually inspect the live load shoes for cracks, corrosion and deteriorated grout.
- Check the contacting surfaces between the strike plates and live load shoes for deformations and wear. There should be no rust on the contact areas.
- Clean dirt and debris from the bearing assembly contact surfaces.
- If necessary, shim the strike plates to provide full contact with the live load shoes and to adjust the bascule span tip elevation. The bascule leaf should be slightly span heavy when seated to maintain positive contact at the ~~{sentence not completed}.~~

3.4.3 Air Buffer Assemblies**Description**

Each bascule span is equipped with two air buffer assemblies. The air buffers function is to provide cushioning while seating the bascule spans at normal speed and also provide buffering if the bascule spans are traveling too fast when nearing the fully closed position.

Each air buffer cylinder is hung from a pin connection to the bascule pier behind the counterweight. Each air buffer assembly consists of the air buffer, mounts, air piping and associated valves and fittings.

As the bascule span nears the air buffers, the buffer rods make contact with strike plates mounted at the extreme rear of the counterweights.

Refer to photo numbered 4-5.

Number of Items & Location

There are a total of four air buffers, two on the east and two on the west bascule piers. They are accessible from the doors to the east and west electrical equipment rooms.

Maintenance Schedule and Procedures**3 Months**

- Pump in Chevron Moly EP2 grease or approved equal into each grease fitting on the air buffer rod bearings until old grease is purged from the sleeves. Wipe away purged grease.
- Remove the pipe plugs and pump Chevron Moly EP2 grease or approved equal into each grease fitting on the air buffer upper pin connect until old grease is purged from the bearing assembly. Wipe away purged grease.
- Inspect the automatic oil lubricators and add XYZ Oil ~~{is this the actual name of the oil?}~~ as necessary.

Annually

- Perform a complete visual and auditory examination of the air buffers during full bascule span operations to check for unusual movement, rod binding and sounds.
- Observe the air buffer cylinder in operation and confirm that adequate air pressure is being produced while the bascule spans are being seated. Adjust needle valve as necessary.
- Perform a complete visual inspection of the air buffer piping system.

live load bearings
assemblies

SAE 40W motor
oil

- Replace batteries in automatic lubricators.

3.5 SPAN DRIVE MACHINERY

The span drive machinery is the system of mechanical equipment used to raise and lower the bascule spans. The majority of the bridge machinery is located within the east and west side machinery rooms below the roadway level.

The span drive machinery consists of drive motors, motor and machinery brakes, primary differential speed reducers, secondary speed reducers, shafts, bearings, main drive pinions and operating racks – See Figures 1.2 and 1.3. See Section 3.10 for maintenance of electric drive motors.

Refer to photo numbered 4-6.

3.5.1 Motor and Machinery Brakes

Description

The motor and machinery brakes are thruster type brakes that are hydraulically released and spring set with an adjustable brake set delay and a hand release mechanism. Each brake assembly consists of a motor, a hydraulic actuator, a torque spring, a drum, brake shoes, mechanical linkages and limit switches. When the bascule spans are seated the all motor and machinery brakes are in the set position.

Refer to photos numbered 4-6, 4-7 and 4-8.

Number of Items & Location

There are two motor brakes located in both the east and west machinery rooms located at the rear of each span drive motor. There are two machinery brakes in both the east and west machinery rooms located on the input shaft of the primary differential speed reducer.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Check level of fluid in hydraulic reservoir, check for leakage of oil. Clean and repair as necessary. If oil is added, recheck level after the thruster pump mechanism has been operated under power at least twice, and if necessary, add additional oil to achieve the recommended level.
- Check hydraulic actuator height per the manufacturer's recommendations and adjust as required.
- Inspect all brake shoes and drums for damage, wear, dust, dirt, grease and proper adjustment. Brake shoes should be replaced when lining thickness at the center of the shoe decreases to 1/8 inch in thickness. Maintain 3/64 inch clearance between brake shoe and brake wheel when the brake is released.

- Inspect all mechanical linkage for wear, broken parts, tightness of bolts and nuts. Check for freedom of moving parts (no binding or sticking).
- Check torque with calibrated torque wrench. Set the motor brakes to 140 ft-lb. and the machinery brakes to 175 ft-lb. Follow manufacturer's specification for adjusting brakes.
- Check for excessive heating of parts, evident by discoloration of metal parts, odor, corrosion, smooth operation and excessive vibration.

Five years

- Change fluid in the thrusters using Chevron Turbine ISO 32 or approved equal.

3.5.2 Motor Couplings

Description

The motor couplings are flexible grid type couplings. A flexible grid connects the two coupling halves and provides protection against shock loads and vibration.

Refer to photo numbered 4-9.

Number of Items & Location

There are four motor couplings, two located in both the east and west machinery rooms. The motor couplings connect the 75 HP electric drive motors to the primary differential speed reducer.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Observe for smooth operation. Check for vibration and unusual noises during operation.
- Remove the two plugs in the coupling housing and install a grease fitting. Pump in Chevron Moly EP2 grease or approved equal into each motor coupling until old grease is purged from the coupling housing. Wipe away purged grease, remove grease fitting and re-install the grease plugs.
- If grease leaks from the coupling housing, replace the seals or cover gaskets as required.

3.5.3 Floating Shaft Couplings and Floating Shafts

Description

The output shafts of the primary differential speed reducers transmit torque to the secondary speed reducers via steel floating shafts and floating shaft couplings. The floating shaft couplings are gear type couplings. A splined internal hub engages the coupling housing providing misalignment capabilities and torque transmission.

The floating shafts are hollow welded steel shafts spanning between the output couplings of the primary differential reducers to the input shaft of the secondary reducers. Since they are supported only at the ends by the coupling connections they are designated as “floating shafts.”

Refer to photo numbered 4-10.

Number of Items & Location

There are eight float shaft couplings, four located in both the east and west machinery rooms. There are four floating shafts, two located in both the east and west machinery rooms.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to **Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.**

Annually

- Observe all float shaft couplings and floating shafts for smooth operation. Check for vibration and unusual noises during operation. Check tightness of coupling connection bolts and tighten as necessary.
- Pump in Chevron Moly EP2 grease or approved equal into each floating shaft coupling as required until each coupling is full. Wipe away purged grease.
- Clean exterior surfaces of float shaft couplings and floating shafts of grease and debris and spot paint as required.

3.5.4 Primary and Secondary Speed Reducers

Description

The primary differential speed reducer receives the input power main drive motor to operate the bascule span. An internal differential gearing assembly equalizes the output torque transmitted to the secondary speed reducers, and therefore equalizes the torque transmitted to the bascule spans for smooth and even force transmission while operating the bascule spans. Motor torque is also increased and the shaft speed is decreased by the primary differential reducer.

The secondary speed reducer further increases the machinery system torque and decreases the shaft speed. Each secondary speed reducer has a single cantilevered output shaft. The main drive pinions are keyed to the output shafts of the secondary reducers.

All speed reducers are oil filled and they have automatic splash internal lubrication. The shaft bearings also require grease lubrication.

Refer to photos numbered 4-6, 4-10, 4-11 and 4-12.

Number of Items & Location

There are two differential primary speed reducers, one in both the east and west machinery rooms. There are four secondary speed reducers, two located outside the north and south walls of the east and west machinery rooms.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

3 Months

- Inspect housing of primary and secondary speed reducers for leaks and other abnormalities.
- Check tightness of all reducer mounting bolts. Torque as necessary.
- Check color and condition of dessicant breathers on the primary and secondary speed reducers. Replace breather cartridges as necessary.
- Using the drip sticks, check the oil level in the primary differential reducers. If low, correct oil level by adding AGMA 6FP ISO Grade 320 gear oil or approved equal as necessary.
- Using the drip sticks, check the oil level in the secondary reducers. If low, correct oil level by adding AGMA 8FP ISO Grade 680 gear oil or approved equal as necessary.
- Remove the plugs in the reducer shaft bearing housings and pump in Chevron Moly EP2 grease or approved equal into each shaft bearing cavity until the old grease is purged from each bearing housing. Wipe away purged grease and re-install the grease plugs.

Annually

- Remove all reducer inspection covers and visually inspect the condition of the internal gearing for abnormal gear tooth wear patterns, chips or cracks. Visually inspect shafts, shaft bearings and internal areas cracks, corrosion and wear.
- With span in motion, check for excessive vibration and unusual noises.

Five years

- Change the lubricating oil in the primary differential reducers using AGMA EP6 ISO 320 gear oil or approved equal.
- Change the lubricating oil in the secondary reducers using AGMA EP8 ISO 680 gear oil or approved equal.

3.5.5 Main Pinions and Rack Gears

Description

The main pinions are keyed to the output shafts of the secondary reducers. These pinions engage inside cut rack gear segments that are bolted to the trusses for the bascule spans. The rack pitch diameters coincide with the trunnion shaft centlines. Rotation of the main pinions and rack segments causes rotation of each bascule span about its trunnion axis.

Refer to photos numbered 4-6, 4-10, 4-11, 4-12 and 4-13.

Number of Items & Location

There are four main pinion and rack sets, two that drive both the east and west bascule spans.

Maintenance Schedule and Procedures

3 Months

- Lubricate all main pinion teeth and rack teeth with Mobiltac 375 Open Gear Grease or approved equal. Remove excess build up of old grease.

Annually

- Visually inspect all gear teeth for rust, cracking, excessive tooth wear and proper gear tooth alignment.
- Visually inspect rack to truss mounting bolts. Tighten loose bolts as required.
- Visually inspect the condition of the main pinion to shaft key and key seat. Inspect for cracks near the key seats and tightness of keys.
- With the bascule spans in motion check for excessive vibrations, binding and unusual noises through the complete range of span motion.

3.6 CENTER LOCK MACHINERY

The center lock machinery is a system of mechanical equipment used to transfer the shear load from passing vehicles from one bascule span to the other. The center locks also function to maintain a constant level joint between the bascule spans so that vehicles passage is smooth across the joint. There are two sets of center locks located at the bascule tips at the lower chords of the bascule trusses below the roadway deck.

Each center lock machinery assembly consists of a lock bar actuator, lock bar guide blocks, a lock bar and a lock bar receiver assembly – See Figure 1.2. There is also a manual hand crank handle at the rear of the lock bar actuator that can be utilized to operate each center lock in the event of a power outage or drive motor failure.

3.6.1 Lock Bar Actuator

Description

The lock bar actuator is a screw type linear actuator that retracts and extends each lock bar. Each lock bar actuator is trunnion base mounted to the lower bascule truss chords of the west bascule and each actuating rod is pin connected to the lock bars. Each lock bar actuator is manufactured complete with integral drive motor, enclosed gearing, a brake, screw actuator and internal limit switches.

Refer to photos numbered 4-14 and 4-15.

Number of Items and Location

There are two lock bar actuators, one for each center lock assembly. They are located at the bascule span tip of the west bascule and mounted to the lower truss chords of the bascule trusses.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

3 Months

- Visually inspect the lock bar actuators for proper alignment and smooth operation.
- Check tightness of all lock bar actuator mounting bolts. Torque as necessary.
- Pump in Chevron Moly EP2 grease or approved equal into each trunnion mount of the lock bar actuators. Wipe away purged greases.

Annually

- Observe for smooth operation. Check for vibration and unusual noises during operation.
- Verify that the manual handwheel system is functional by manually cycling each lock bar actuator through one complete retract/extend cycle.
- Grease the thrust unit with Chevron Moly EP2 grease or equal. Wipe away purged grease.
- If grease leaks from the actuator housing, replace the seal where leakage is occurring.

3.6.2 Lock Bar Guide Blocks, Lock Bars and Receivers

Description

Each lock bar on the west bascule is supported by two lock bar guide blocks. The guide blocks are bolted to the interior of the lower bascule truss chords. Each guide block has top and bottom bronze wear plates that serves as the sliding surfaces between the lock bars and the guide blocks. These guide block wear plates are adjustable via steel shim packs. When clearance due to wear becomes excessive, the guide block wear plate shims can be adjusted for a tighter fit between the wear plates and the lock bars.

When the lock bar actuator extends the lock bar from the west bascule, the lock bar engages a receiver assembly bolted to the interior of the lower bascule truss chord on the east bascule. The lock bar receivers also have top and bottom bronze wear plates that serves as the sliding surface between the lock bars and the receivers. When clearance due to wear becomes excessive, the receiver wear plate shims can be adjusted for a tighter fit between the wear plates and the lock bars.

Refer to photos numbered 4-15 and 4-16.

Number of Items and Location

There is one pair of lock bar guide blocks per center lock on the west bascule span (total of four). There is one lock bar receiver assembly per center lock on the east bascule span (total of two).

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Monthly

- Grease the lock bars, lock bar guide blocks and receiver socket sliding surfaces with Chevron Moly EP2 grease or approved equal. Wipe away debris, old grease and excess grease.
- Visually inspect condition of lock bars, lock bar guide blocks and receiver sockets for excessive wear and loose bolts. Tighten loose bolts as required.

Annually

- Using feeler gauge, take clearance measurements between the lock bars and the guide blocks/receiver wear plates. If the total clearance exceeds .025 inches, adjust the appropriate wear plate shims to restore the design clearance of between .006 and .013 inches.
- If the bronze wear plates are severely worn, replace them with the spare wear plates.

3.7 GATES

The gates block vehicular and pedestrian traffic from crossing the bridge during raising and lowering of the bascule span. The bridge west leaf and east leaf physically block the bridge to prevent vehicles from approaching the channel when the bascule span is in the open position.

3.7.1 Gates

Description

The gates provide notice to vehicular traffic that the bridge is operating and provide a convenient location for the traffic to remain stopped throughout the bridge operation. The gates have aluminum/fiberglass arms which are in the vertical position when the bridge is open to traffic. When the bridge roadway is to be closed to traffic each gate arm lowers into a horizontal position across the adjacent lanes of traffic.

Inside each gate housing there is a 1 HP motor and motor brake to control the oncoming gate arm's movement. There is a shaft extension for a hand crank to operate the arm manually. Gate motion is started by a combination of interlocks and switch on the control console. While raising or lowering the gates, the motor is stopped by end of travel rotary limit switch contacts in the control wiring.

Each gate arm is supplied with red lights mounted on the oncoming gate arm that are controlled by a flasher located in the gate housing.

Refer to photos numbered 4-17 and 4-18.

Number of Items & Location

There are four gates. Two are located on the east approach and two are located on the west approach.

Maintenance Schedule and Procedures

Motors and brakes shall be maintained under Section 3.10. Limit switches shall be maintained under Section 3.12.4 and 3.12.5.

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

6 Months

- Check oil level in gear reducers. Maintain oil level with Mobil HSC-629 ISO VG 150 or equal, as necessary.
- Grease all shaft and crank arm bearings with Chevron Moly EP2 grease and wipe off excess grease.
- Check bolts holding the oncoming gate arm for any sign of looseness. Check the oncoming gate arms for any play or movement. Tighten the bolts as required to securely hold the oncoming gate arms.
- Inspect the oncoming gate housing for any external damage. Check the housing doors or hatches for proper closure. Inspect interior for any water accumulation, and determine the cause of the leakage, if any is found. Seal any holes in the housing and replace door gaskets as required.

5 Years

- Replace oil in the gear reducer with Mobil HSC-629 ISO VG 150 or equal.

3.8 ELECTRICAL POWER SYSTEMS

The electrical power systems consist of motor control centers (MCC), lighting panelboards, motor controllers and contactors, switches and disconnects, fuses, lighting contactors and relays, electrical cables, electronic motor drives, and transformers.

3.8.1 Lighting Panel (LP) and Motor Control Center (MCC)

Description

Lighting panels, also known as panelboards, are assemblies of bus bars and main/branch circuit breakers. The circuit breakers provide over-current protection as well as a means of turning on and off electrical distribution circuits.

Refer to photo numbered 4-19.

Motor Control Centers (MCC) are assemblies of enclosed cubicles that house motor controllers, over-current protection, and metering equipment. There is a single incoming main circuit breaker and a common system that feeds all of the cubicles.

Refer to photo numbered 4-20.

Number of Items and Location

There are two MCCs, one on the west side (WEST MCC) located in the Electrical Room West and one on the east side (EAST MCC) located in the Electrical Room East.

There are three lighting panelboards. Two are located on the west side, panel LP-W1 is located in the Electrical Room West and panel LP-W2 is located in the Control Tower. Panel LP-E1 is located in the Electrical Room East.

Maintenance Schedule and Procedures

Component parts of the lighting panels, and MCC shall be maintained under Sections 3.8.2 through 3.8.9. Lighting panels and MCC shall be maintained as follows:

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Open and clean with a vacuum cleaner.
- Remove accumulation of dirt, grease, and gum with contact cleaner.
- Check for corrosion and moisture.
- Examine bus bar connections for poor or loose connections and evidence of overheating.
- Lubricate door hinges and latches.
- Operate each circuit breaker to check proper operation.
- Measure resistance to ground at each panelboard using a ground test kit. Verify resistance is 25 ohms or less.

3.8.2 Motor Controllers and Contactors

Description

Motor controllers (starters) and contactors are devices used to start and stop a motor at full voltage through a contact opening or closure. The motor controllers are combination circuit breaker and contactor assemblies with overload current relays. Motor controllers are located in the Motor Control Center and the drive cabinets. The motor controller doors are equipped with indicating lights and pushbuttons. See Section 3.8.9 Motor Drives for a description of the motor drive cabinets.

Number of Items and Location

Description	Location	Equipment
Feeder Circuit Breaker	West MCC	Main Incoming Circuit Breaker 400AT

Description	Location	Equipment
Feeder Circuit Breaker	West MCC	Lighting Panel 75AT
Feeder Circuit Breaker	West MCC	East MCC 250AT
Feeder Circuit Breaker	East MCC	Main Incoming Circuit Breaker 225AT
Feeder Circuit Breaker	East MCC	Lighting Panel LP-E 50AT
Full Voltage Reversing (FVR) Comb. Starter	West MCC	Oncoming Gate (TG-W1) 1HP
Full Voltage Reversing (FVR) Comb. Starter	West MCC	Off Going Gate (TG-W2) 1HP
Full Voltage Reversing (FVR) Comb. Starter	East MCC	Oncoming Gate (TG-E1) 1HP
Full Voltage Reversing (FVR) Comb. Starter	East MCC	Oncoming Gate (TG-E2) 1HP
Full Voltage Reversing (FVR) Comb. Starter	West MCC	Center Lock (CL-1)
Full Voltage Reversing (FVR) Comb. Starter	West MCC	Center Lock (CL-2)
Full Voltage Non-Reversing (FVNR) Starter	West MCC	Sump Pump (SP-W) 5 HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Sump Pump (SP-E) 5 HP
Full Voltage Non-Reversing (FVNR) Starter	West MCC	Machinery Brake (MAB-W1) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	West MCC	Machinery Brake (MAB-W2) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	West MCC	Motor Brake (MOB-W1) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	West MCC	Motor Brake (MOB-W2) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	West	Motor Blower (MBLR-W1) 1 HP

Description	Location	Equipment
	MCC	
Full Voltage Non-Reversing (FVNR) Starter	West MCC	Motor Blower (MBLR-W2) 1 HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Motor Blower (MBLR-E1) 1 HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Motor Blower (MBLR-E2) 1 HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Machinery Brake (MAB-E1) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Machinery Brake (MAB-E2) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Motor Brake (MOB-E1) ½ HP
Full Voltage Non-Reversing (FVNR) Starter	East MCC	Motor Brake (MOB-E2) ½ HP

Maintenance Schedule and Procedures

Component parts of the motor controllers and contactors shall be maintained as specified under this Section through Section 3.8.6. Motor controllers and contactors shall be maintained as follows:

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Open enclosure and clean with a vacuum cleaner.
- Remove accumulation of dirt, grease, and gum with contact cleaner.
- Check for corrosion and moisture.
- Lubricate door hinges and latches.
- Check for worn or broken mechanical parts.
- Check Contacts:
 - Replace pitted or worn contacts. Install and adjust per manufacturer's specifications, otherwise replace entire relay.

- When replacing contacts or other current-carrying parts, clean surfaces that are to be bolted together.
- Discolored connections on terminals, contact supports, bus bars, or connectors usually indicate that overheating has occurred, probably because of loose connections. Clean connection points that are discolored. Tighten all hardware. Replace or repair heat-damaged wires and connectors as necessary.
- Insulating Parts:
 - Remove dust and dirt from insulating parts.
 - Insulators should be replaced if they are found to have carbonized tracks, or are either cracked or broken.
 - Before a repaired part is put into service, subject repaired part to a megger test.
- Electrical Operation:
 - Operate the motor controller/contacter without load and observe contact operation to be sure it opens and closes cleanly and that the contacts are fully sealed in the closed position.
 - Operate the motor controller/contacter under load and check for loud noise and arcing, both on opening and on closing. A loud noise and arcing on closing is usually due to contact bounce.

3.8.3 Safety Switches, Disconnects, and Enclosed Circuit Breakers

Description

Switches are devices for making, breaking, or changing connections in an electric circuit under the conditions of the load for which it is rated. There are various types of switches; some of the more common are main circuit breakers, safety switches and motor disconnect switches.

Refer to photo numbered 4-21.

Number of Items and Location

Numerous switches are located throughout the bridge and are individually mounted as main circuit breakers, disconnect switches, and motor disconnect switches.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

When replacing contacts or other current-carrying parts, clean surfaces that are to be bolted together.

- Remove accumulation of dirt, grease, and gum with contact cleaner.
- Check for corrosion and moisture.

- Examine for excessive heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Check for freedom of moving parts.
- Check for worn or broken mechanical parts.
- Tighten loose mountings and connections.
- Contacts:
- Replace pitted or worn contacts if practical. Install and adjust per manufacturers' specifications, otherwise replace entire item.
- When replacing contacts or other current-carrying parts, clean surfaces that are to be bolted together.
 - Check for excessive arcing.
 - Check condition of gaskets (for dust-tight or watertight units).

3.8.4 Fuses

Description

A fuse is an overcurrent protective device. Fuses protect the electrical equipment only one time, and then must be replaced with a new fuse. Fuses are cylindrical in shape and are fastened in place at the ends by fuse clips or ferrules.

Refer to photo numbered 4-22.

Number of Items and Location

There are numerous fuses in control wiring for multiple pieces of equipment located in the motor control centers (MCCs), control desk, control panels, gate housings, and drive panels.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

As Needed

Replace all defective fuses.

Annually

When replacing contacts or other current-carrying parts, clean surfaces that are to be bolted together.

- Inspect fuses for evidence of overheating and corrosion.
- Inspect fuse clips for dirt and verify that the clips provide a tight fit.

- Replace fuses as necessary with a fuse of the same model or an approved replacement model, and the same rating as the damaged fuse. Check the fuse ratings as referenced in the maintenance manual diagrams.

3.8.5 Lighting Contactors and Relays

Description

Lighting contactors and power relays are devices which are used to open or close the electrical power circuits to lighting loads such as the traffic signal lights and navigation lights.

Location

Lighting contactors and relays for the traffic signals and the navigation lights are located in the control desk and control panels.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to **Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES**.

Annually

When replacing contacts or other current-carrying parts, clean surfaces that are to be bolted together.

- Remove accumulation of dirt, grease, and gum with contact cleaner.
- Check for corrosion and moisture.
- Check for worn or broken mechanical parts.
- Check Contacts:
 - Replace pitted or worn contacts if practical. Install and adjust per manufacturer's specifications, otherwise replace entire relay.
 - Discolored connections on terminals, contact supports, bus bars, or connectors usually indicate that overheating has occurred, probably because of loose connections. Clean connection points that are discolored. Tighten all hardware. Replace or repair heat damaged wire and connectors.
- Insulating Parts:
 - Remove dust and dirt from insulating parts.
 - If carbonized tracks or cracked or broken insulators are found, replace the defective parts.
 - Before a repaired part is put into service, subject repaired part to an over-voltage test.
- Electrical Operation:
 - Operate the contactor without load and observe contact operation to be sure it opens and closes cleanly and that the contacts are fully sealed in the closed position. Contacts may

not be visible. A humming sound emanating from the coil may indicate loose laminations or mounting.

- Operate the contactor under load and check for abnormal noise and arcing, both on opening and on closing. A loud noise and arcing on closing is usually due to contact bounce.

3.8.6 Electrical Conductors

Description

Conductors may be stranded single-conductor or multiple-conductor cable.

Number of Items and Location

Numerous electrical conductors are located throughout the bridge.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Visually inspect terminations and splices for cracks, deterioration, corrosion, discoloring, or any other abnormalities.
- Check tightness of each conductor termination at each terminal box.
- Check the strain relief fitting for signs of distress.

3.8.7 Submarine Cable System

Description

Submarine cables are electrical conductors routed underneath the Hylebos Waterway from the west submarine terminal box to the east submarine terminal box. A direct bore was installed under the waterway with an HDPE pipe that connects the east shore to the west shore. The submarine cable is pulled through this pipe. The submarine cable system consists of conduit and wire (multi-conductor cables with communication cables) routed between terminal boxes.

Number of Items & Location

There are two terminal boxes, one located on the west approach adjacent to the bridge and one located on the east approach adjacent to the bridge. There are two submarine cables that contain power and control wiring.

Refer to photos numbered 4-25.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Visually inspect terminations and splices for cracks, deterioration, corrosion, discoloring, or any other abnormalities.
- Check tightness of each conductor termination at each terminal box.
- Check the strain relief fitting for signs of distress.
- Tighten loose connections.

3.8.8 Resistor Banks

Description

Resistor banks are housed in ventilated enclosures, made from ventilated panels. Inside the resistor banks are individual grid resistors made of a steel alloy. The individual resistors are arranged in a grid pattern with open ventilated construction between grids. Resistors are used to limit the current to a motor and allow better motor control.

Number of Items & Location

There are four resistor banks located in the Electrical Rooms. Two resistor banks are located in the Electrical Room West and two resistor banks are located in the Electrical Room East.

Refer to photo numbered 4-23.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Check for excessive heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Check for corrosion of metal parts.
- Tighten any loose connections.

3.8.9 Motor Drives

Description

The main bascule leaf drive motors are controlled by electronic motor “drives.” These controllers are solid state devices that control voltage to the motor, electronically, according to preset control parameters. Each drive is an alternating current (AC) silicon controlled rectifier (SCR) vector drive. Refer to vendor data for more details including troubleshooting. Each drive is rated to control both motors, and only one drive operates at a time during a bridge opening.

Refer to photo numbered 4-22.

Number of Items and Location

The motor drives for the bridge are located in cabinets in the motor control centers (MCCs) in both the Electrical Room West and Electrical Room East. Each drive is connected to a resistor bank (see Section 3.8.8).

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to **Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES**.

6 Months

- Check plug-in relays to make sure they are fully seated.

Annually

- Open enclosure and clean with a vacuum cleaner.
- Check for corrosion and moisture.
- Lubricate door hinges and latches.
- Check for worn or broken mechanical parts.
- Check contacts.
 - Replace pitted or worn contacts.
 - Install and adjust per manufacturer’s specifications, otherwise replace entire relay.
- Discolored connections on terminals, contact supports, bus bars, or connectors usually indicate that overheating has occurred, probably because of loose connections. Clean connection points that are discolored. Tighten all hardware. Replace or repair heat-damaged wires and connectors as necessary.
- Insulating Parts:
 - Remove dust and dirt from insulating parts.
 - Insulators should be replaced if they are found to have carbonized tracks.
- Electrical Operation:

- Measure current draw on load side of contactor. Elevated reading may indicate poor lubrication or binding in the drive machinery.
- Electronic Sections:
 - Avoid disturbing potentiometer settings.
 - Inspect printed circuit boards for discoloration. Replace damaged boards as necessary.
 - Inspect wire terminations to assure tightness.
- Encoder
 - Open enclosure and check for moisture and corrosion.
 - Check electrical connections and mounting bolts for tightness; tighten as necessary.

3.8.10 Transformers

Description

Transformers are electrical devices that change the electrical power source by either changing the voltage or improving the power distribution.

Refer to photo numbered 4-24.

Number of Items & Location

There are transformers are follow:

Description	Location
Lighting Panel Transformer TF-W	Electric Room West
Lighting Panel Transformer TF-E	Electric Room East

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Open and clean with vacuum cleaner.
- Check for corrosion and moisture.
- Check for unusual humming or other noises while operating. This may indicate loose bus bar connections.
- Check for evidence of overheating.

3.8.11 Incoming Service, Automatic Transfer Switch Panel, and Generator

Description

Utility incoming service is routed from a utility pole adjacent to the northwest approach. The utility metering equipment is mounted along the northwest side of the bridge. The incoming service is then routed by conduit to an automatic transfer switch panel. The service is then routed to the west motor control system.

The diesel generator wiring is also routed to the automatic transfer switch.

When Utility service is lost, the automatic transfer switch senses the loss of utility power it will start the generator. The generator provides emergency power to operate the bridge. When utility power returns the automatic transfer switch will sense the return of utility power and transfer the service back to the utility, turning off the generator automatically.

Location

The equipment is located in a fenced off area adjacent to the northwest approach to the bridge. There is one main service circuit breaker panel, automatic transfer switch, and one generator.

Refer to photo numbered 4-26, 4-27, and 4-28.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Maintain the circuit breaker and the switches as described in section 3.8.3.

Semi-Annually

- Test the automatic transfer switch with the generator. Verify that the automatic transfer switch and generator operate properly.

Annually (Use Form 6-9)

- Remove accumulation of dirt, grease, and gum with contact cleaner from the automatic transfer switch.
- Check for corrosion and moisture on the automatic transfer switch.
- Check for worn or broken mechanical parts on the automatic transfer switch.
- Discolored connections on terminals, contact supports, bus bars, or connectors usually indicate that overheating has occurred, probably because of loose connections. Clean connection points that are discolored. Tighten all hardware. Replace or repair heat damaged wire and connectors from the automatic transfer switch and power receptacle.

3.9 LIGHTING SYSTEMS

The lighting systems consist of navigation lights, traffic signals, gates lights, interior and exterior lights.

3.9.1 Navigation Lights

Description

Pier lights are red fixtures. Their function is to enhance visibility of the piers and locate the channel for marine vessels.

Channel lights are red and green fixtures. When the bascule leaves are fully open, the channel lights located at the toes of the bascule leaves change from red to green.

There is a sign light mounted over the sign that notifies river traffic that one hour notice is required to open the bridge. There is a floodlight used to illuminate the sign.

Refer to photo numbered 4-16.

Number of Items and Location

Quantity	Type	Location
2	Red Pier Lights	East Pier
2	Red Pier Lights	West Pier
2	Red/Green Channel Lights	Toe of the West Bascule Leaf
2	Red/Green Channel Lights	Toe of the East Bascule Leaf
1	Flood Light	Sign illumination in channel

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Weekly

- Check pier and channel lights to confirm proper operation.
- Replace lamps or fixtures, as needed.

Annually

- Clean globes, interior surface, and weep holes.
- Check gaskets.
- Tighten loose connections.
- Inspect for corrosion of metal parts.
- Replace worn or broken mechanical parts.

- Replace lamps.

3.9.2 Traffic Signals

Description

Traffic signals caution roadway traffic before and during periods of span operation.

Approaching the bridge, on both sides of the roadway on the approaches are traffic signal lights.

Locations and Number of Items

The bridge traffic signals and warning signals are located as follows:

Location	Color	Fixtures	Lamps per Fixture
Oncoming Lane, West Approach	Red-Yellow-Green	3	1
Off Going Lane, West Approach	Red-Yellow-Green	3	1
Oncoming Lane, West Approach	Red-Yellow-Green	3	1
Off Going Lane, East Approach	Red-Yellow-Green	2	1

Refer to photo numbered 4-17.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 **LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES**.

Weekly

- Check lights for proper operation. Replace lamps as needed.

Annually

- Replace all lamps. Verify lamp filament is properly aligned with respect to the lens to maximize lens refraction.
- Clean all reflectors and lenses, and spot paint heads.

3.9.3 Gate Lights

Description

Gate lights caution roadway traffic before and during periods of span operation.

Refer to photo numbered 4-17.

Locations and Number of Items

There are red flashing lights on the gate arms mounted to each gates.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Weekly

- Inspect flashing lights and verify that they work properly. Replace light bulbs as required. Check that the lights are firmly attached to the arm and tighten as required.

6 Months

- Inspect flashing lights and verify that they work properly. Replace light bulbs as required. Check that the lights are firmly attached to the arm and tighten as required.
- Check wiring for evidence of excessive overheating. Determine cause and repair as necessary.

3.9.4 Interior and Exterior Lights

Description

Incandescent, emergency battery, and florescent fixtures are mounted throughout the bridge. A lighting panel is located in the Control Tower, Electrical Room West, and Electric Room East to feed the lights.

Number of Items and Location

There are numerous lights located throughout the bridge in the enclosed rooms, platforms, ladders, and catwalks.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Weekly

- Check for burned-out lamps. Replace lamps as needed.
- Test emergency lights for proper operation, repair/replace as needed.

Annually

- Clean luminaire lenses, interior surfaces, and weep holes (where applicable).

- Check gaskets and replace as needed.
- Tighten loose connections.
- Inspect for corrosion of metal parts. Spot paint as necessary.
- Replace worn or broken parts.

3.10 ELECTRIC MOTORS, THRUSTOR BRAKE MOTORS, AND SOLENOID BRAKES

3.10.1.1 Electric Motors

Description

Electric motors transform electric power to mechanical power.

Refer to photos numbered 4-6, 4-9, 4-14, and 4-18.

Number of Items and Location

Motors on the bridges are located as follows:

Quantity	Location	Equipment Name	Horsepower
1	Oncoming West Approach Lane	Southeast Oncoming Gate Motor (TG-W1)	1
1	Off Going West Approach Lane	Southwest Off Going Gate Motor (TG-W2)	1
1	Oncoming East Approach Lane	Southeast Oncoming Gate Motor (TG-E1)	1
1	Off Going East Approach Lane	Southwest Off Going Gate Motor (TG-E2)	1
1	Machinery Room West	Sump Pump (SP-W)	5
1	Machinery Room West	Motor Blower W1 (MBLR-W1)	1
1	Machinery Room West	Motor Blower W2 (MBLR-W2)	1
1	West Bascule Leaf	Center Lock (CL-1)	2.1
1	West Bascule Leaf	Center Lock (CL-2)	2.1
1	Machinery Room East	Sump Pump (SP-E)	5

Quantity	Location	Equipment Name	Horsepower
1	Machinery Room East	Motor Blower E1 (MBLR-E1)	1
1	Machinery Room East	Motor Blower E2 (MBLR-E2)	1
1	Machinery Room West	Drive Motor (M-W1)	75
1	Machinery Room West	Drive Motor (M-W2)	75
1	Machinery Room East	Drive Motor (M-E1)	75
1	Machinery Room East	Drive Motor (M-E2)	75

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Verify that shaft is free of oil and grease from bearings.
- Check for leakage around bearings. Clean off excess grease and dirt.
- Verify that shaft end-play is normal.
- Inspect and tighten electrical connections on motor.
- See that all keys, bolts, and pins are in their proper position. Check all bolts for tightness. If loose, tighten.
- Check operation of space heaters where applicable. This can be accomplished by touching the motor to see if it is warm before operation.
- During operation, examine motor for smooth running and absence of vibration.
- During operation, check motor and bearing for overheating.
- Lubricate motor bearings equipped with grease fittings or oil spout filler, using Chevron GST-68 oil or Molub Alloy 777 NGLI No. 2 grease. Where grease tubes have threaded plugs, remove plugs on both sides. Install grease fitting on one side and lubricate bearings with grease gun. Grease must be allowed to vent through the open plug or the seal will be damaged and grease will enter the motor windings. Remove the grease fitting and install the plugs.
- Check painted surfaces for signs of corrosion. Spot paint as necessary. Do not paint nameplates.
- Perform Dielectric Tests: Perform megohm meter tests to check insulation resistance values on all three-phase motors. Make megohm measurements from each phase to ground, and measurements should be identical for all phases. (Perform a phase to phase reading, which should be zero, to verify

the motor leads are properly selected.) Readings should be taken using a 500 volt DC hand cranked or battery operated Megger. Readings can be made from the opened insight disconnecting equipment. The readings will include the short run of feeder wire. Overhaul shall be scheduled for motors when megohm measurements from phase to ground are projected to reach 2.0 megohms or less. If the megohm value reaches 1.0 megohm, overhaul is mandatory. When low readings are taken, open the motor terminations and take readings directly at the motor to confirm the results.

- Check the phase currents flowing in motors under loaded conditions with a clamp-on ammeter for motors 1 horsepower or larger. Utilize a true RMS ammeter. Compare the measured current with the nameplate data.

Eight Years

- Repaint motors. Do not paint nameplates.

3.10.2 Thrustor Brake Motors

Description

Thrustor brakes are used on the span drive machinery to provide braking and holding torque on the bascule leaf machinery. The electrical components on the thrustor brakes include the thrustor pump motors and three lever operated limits switches that sense brake "released" and "manually released".

Refer to photos numbered 4-6, 4-7, 4-8, 4-9, and 4-11.

Number of Items and Location

Quantity	Location	Equipment Name	Horsepower
1	Machinery Room West	Machinery Brake (MAB-W1)	½
1	Machinery Room West	Machinery Brake (MAB-W2)	½
1	Machinery Room West	Motor Brake (MOB-W1)	½
1	Machinery Room West	Motor Brake (MOB-W2)	½
1	Machinery Room East	Machinery Brake (MAB-E1)	½
1	Machinery Room East	Machinery Brake (MAB-E2)	½
1	Machinery Room East	Motor Brake (MOB-E1)	½
1	Machinery Room East	Motor Brake (MOB-E2)	½

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 **LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES**.

Annually

- Perform a general visual inspection while stationary and during bascule leaf operation.
- Electrical Components: Check electrical connections and tighten as necessary.
- Check for excessive heating of parts evidenced by discoloration of metal parts, charred insulation, or odor. Check for collections of dirt or gum, evidence of water dripping, or corrosion. Clean as necessary.
- Check for excessive vibration or noise during operation.
- Check limit switch operation. Check lever arm to shaft connection for tightness and corrosion. Tighten and clean as needed. Check lever arm rollers for free rotation, roundness and cracks or breakage.
- Perform Dielectric Tests: Perform megohm meter tests to check insulation resistance values on all three-phase motors. Take megohm measurements from each phase to ground; measurements should be identical for all phases. Readings should be taken using a 500 volt DC hand cranked or battery operated Megger. Overhaul shall be scheduled for motors when megohm measurements from phase to ground are projected to reach 2.0 megohms or less. If the megohm value reaches 1.0 megohm, overhaul is mandatory.

3.10.3 Solenoid Brakes

Description

Solenoid brakes serve to provide braking and holding torque on various motors and associated machinery where the machinery is required to be held in a fixed position.

Refer to photos numbered 4-14 and 4-18.

Number of Items and Location

Quantity	Location	Equipment Name	Type
1	Oncoming West Approach Lane	Southeast Oncoming Gate Motor (TG-W1)	Disc
1	Off Going West Approach Lane	Southwest Off Going Gate Motor (TG-W2)	Disc
1	Oncoming East Approach Lane	Southeast Oncoming Gate Motor (TG-E1)	Disc
1	Off Going East Approach Lane	Southwest Off Going Gate Motor (TG-E2)	Disc
1	West Bascule Leaf	Center Lock (CL-1)	Disc
1	West Bascule Leaf	Center Lock (CL-2)	Disc

Maintenance Schedule and Procedures**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Perform a general visual inspection while stationary and during bascule leaf operation.
- Electrical Components: check electrical connections and tighten as necessary.
- Mechanical Components: inspect for wear, broken parts, and bolt and nut tightness. Check for freedom of moving parts (no binding or sticking).
- Check for excessive heating of parts evidenced by discoloration of metal parts, charred insulation, or odor. Check for collections of dirt or gum, evidence of water dripping, or corrosion. Clean as necessary.
- Check for excessive vibration or noise during operation.

3.11 MISCELLANEOUS ELECTRICAL SYSTEMS

3.11.1 Traffic Gongs

Description

The traffic gongs provide an audible warning of an upcoming bascule leaf operation. The gongs are automatically turned on when the gates are lowered. They automatically turn off when all gates are fully raised.

Number of Items and Location

There are two traffic gongs, one on each of the oncoming gates.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Weekly

- Check gongs for proper operation.

6 Months

- Check for proper operation of the system. Correct as necessary.
- Tighten assembly bolts.
- Lubricate hammer mechanism with light machine oil.

3.11.2 PA Speaker Intercom

Description

There is a Public Announcement (PA) Intercom system on the bridge. The system allows the operator to use the PA Intercom to address waterway traffic and roadway traffic.

Number of Items and Location

There is one operator handset located adjacent to the control desk in the Control Tower. There is one speaker on the west approach off going traffic lane traffic signal and the east approach oncoming traffic signal. There is one speaker on the west side of the channel to address the waterway traffic.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

6 Months

- Check for proper operation of the system. Correct as necessary.
- Check for corrosion and moisture.
- Check for excess heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Tighten loose connections.

3.11.3 Fire Alarm System

Description

There is a fire alarm system provided on the bridge. The system consists of smoke detectors, manual pull stations, and strobe/horn alarm units.

Refer to photo numbered 4-19.

Number of Items and Location

There is a fire alarm panel, a manual pull station, and a strobe/horn alarm unit, in the lower level of the Control Tower. There is a manual pull station, smoke detector, and a strobe/horn alarm unit in the upper level of the Control Tower.

There is a manual pull station, two smoke detectors, and a strobe/horn alarm unit in each Electrical Room and each Machinery Room.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

6 Months

- Check for proper operation of the system. Correct as necessary.
- Check for corrosion and moisture.
- Check for excess heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.

- Tighten loose connections.

3.11.4 Intrusion Alarm System

Description

There is an intrusion alarm system provided on the bridge. This consists of door sensors, a keypad controller, and alarm panel.

Number of Items and Location

There is one Alarm Panel and key pad located in the lower level of the Control Tower. There is one door sensor on the door to Control Tower and each door to the Electrical and Machinery Rooms.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 **LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES**.

6 Months

- Check for proper operation of the system. Correct as necessary.
- Check for corrosion and moisture.
- Check for excess heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Tighten loose connections.

3.11.5 Heating

Description

A heating unit is provided to heat the Control Tower, Electrical Rooms, and Machinery Rooms.

Number of Items and Location

There is one heating unit located in each Machinery Room and each Electrical Room. There is a heater in the lower level and a heat pump in the upper level of the Control Tower.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Check for proper operation.
- Check for excessive heating of parts evidenced by discoloration of metal parts, charred insulation, or odor. Check for collections of dirt or gum, evidence of water dripping, or corrosion. Clean as necessary.
- Check for excessive vibration or noise during operation.

3.12 CONTROL SYSTEMS

The control systems consist of the control desk, meters and instruments, limit switches, and position indication system.

3.12.1 Control Desk

Description

The control desk is a metal floor-mounted cabinet that contains such items as pilot lights, pushbuttons, switches, and position indicators. The devices are actuated by the operator as defined in Section 2 to open and close the bascule leaf while the pilot lights provide status indication for equipment position and operational status. The control desk contain a programmable logic control (PLC) input/output (I/O) drop in the desk to control the bridge operation.

There is an uninterruptible power supply in the control desk to provide emergency power.

Refer to photo numbered 4-29.

Number of Items and Location

There is one control desk located in the upper level of the Control Tower.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Switches, relays, meters, etc. should be maintained as discussed under the appropriate section covering that equipment.

All instruments should be visually inspected and the necessary performance characteristics noted.

Annually

- Open enclosure and clean with a vacuum cleaner. Remove accumulation of dirt, grease, and gum with contact cleaner.
- Check for corrosion and moisture.
- Check for excess heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Tighten loose connections.
- Check for worn or broken mechanical parts.
- Lubricate door hinges and latches.
- Check strip heaters for operation.
- Check UPS for alarms and replace batteries as necessary.
- Check PLC I/O drop for alarms or indications. Replace PLC I/O cards as required.

Six Years

- Measure resistance to ground for the control desk using a ground test kit. Verify resistance is 25 ohms or less.

3.12.2 Control Panels

Description

The control panels control all of the sequence interlocks and control indications for the bridge. Each panel contains terminal blocks, circuit breakers and both plug-in and machine tool relays. Each panel has a uninterruptible power supply (UPS) to provide emergency power. The control panels contain a programmable logic controller (PLC) and PLC input/output (I/O) drops in the panel to control the bridge operation.

Refer to photo numbered 4-30.

Number of Items and Location

There is a main control panel CP-2 located in the Electrical Room West. There is a control panel CP-3 located in the Electrical Room East.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

When replacing contacts or other current-carrying parts, clean surfaces that are to be bolted together.

- Remove accumulation of dirt, grease, and gum with contact cleaner.
- Check for corrosion and moisture.
- Check for worn or broken mechanical parts.
- Check UPS for alarms and replace batteries as necessary.
- Check PLC racks for alarms and indicator lights. Replace PLC cards as required.
- Check Contacts:
 - Replace entire relay if in poor condition.
 - When replacing contacts or other current carrying parts, clean surfaces that are to be bolted together.
- Discolored connections on terminals, contact supports, bus bars, or connectors usually indicate that overheating has occurred, probably because of loose connections. Clean connection points that are discolored. Tighten all hardware. Replace or repair heat damaged wire and connectors.
- Insulating Parts:
 - Remove dust and dirt from insulating parts.
 - If carbonized tracks or cracked or broken insulators are found, replace the defective parts.
 - Before a repaired part is put into service, subject repaired part to an over-voltage test.

3.12.3 Meters and Instruments

Description

Various ammeters, kilowatt meters, indicating lights, and instrumentation are used to monitor electrical apparatus. Most of these instruments receive power by shunts from the main line they are metering.

Number of Items and Location

Numerous instruments and meters are located in the control desk and motor control centers.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 **LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES**.

Annually

- Tighten loose connections.
- Check for corrosion and moisture
- Inspect for cracks and broken cases or cover glass. Replace as necessary.
- Remove accumulation of dirt, grease, and gum with contact cleaner.

3.12.4 Rotary Limit Switches

Description

A limit switch is a switch/device that provides feedback in an electrical circuit. When actuated this device will restrict or initiate an operation.

Each bascule leaf and gate is equipped with rotary limit switches that control drive system and provide position status indication. Rotary limit switch components include adjustable cam operators and sealed contact lever operated snap switches.

The bascule leaf rotary limit switch is driven by an open gear section. The bascule leaf rotary limit switch is used for control and interlocking of the leaves and associated devices. Cover plates protect the rotary cam limit switch drive mechanisms from debris.

Refer to photo numbered 4-3.

Number of Items and Location

The bascule leaf is equipped with a rotary limit switch located on the trunnion adjacent to the Machinery Room.

There are four gate rotary limit switches. A rotary limit switch is attached to the extended shaft of the reducer by a sprocket and chain inside each of their respective housings.

Maintenance Schedule and Procedures

WARNING

Use **EXTREME CARE** and **ALWAYS REMOVE POWER** from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

6 Months

- Remove accumulation of dirt, grease, and gum.
- Check for excessive heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Check for freedom of moving parts (no binding or sticking).
- Check for corrosion and moisture.
- Tighten loose mountings and connections.
- Check for worn or broken mechanical parts.
- Check condition of gaskets, if present.

3.12.5 Lever Operated Limit Switches

A limit switch is a switch/device that provides feedback in an electrical circuit. When actuated this device will restrict or initiate an operation.

Refer to photos numbered 4-3, 4-7, 4-8, 4-15, 4-18 and 4-31.

Number of Items and Locations

Quantity	Limit Switch Function	Location
1	Brake Released	Motor Brake (MOB-W1)
1	Brake Manually Released	Motor Brake (MOB-W1)
1	Brake Set	Motor Brake (MOB-W1)
1	Brake Released	Motor Brake (MOB-W2)
1	Brake Manually Released	Motor Brake (MOB-W2)
1	Brake Set	Motor Brake (MOB-W2)
1	Brake Released	Machinery Brake (MAB-W1)
1	Brake Manually Released	Machinery Brake (MAB-W1)
1	Brake Set	Machinery Brake (MAB-W1)

Quantity	Limit Switch Function	Location
1	Brake Released	Machinery Brake (MAB-W2)
1	Brake Manually Released	Machinery Brake (MAB-W2)
1	Brake Set	Machinery Brake (MAB-W2)
1	Brake Released	Motor Brake (MOB-E1)
1	Brake Manually Released	Motor Brake (MOB-E1)
1	Brake Set	Motor Brake (MOB-E1)
1	Brake Released	Motor Brake (MOB-E2)
1	Brake Manually Released	Motor Brake (MOB-E2)
1	Brake Set	Motor Brake (MOB-E2)
1	Brake Released	Machinery Brake (MAB-E1)
1	Brake Manually Released	Machinery Brake (MAB-E1)
1	Brake Set	Machinery Brake (MAB-E1)
1	Brake Released	Machinery Brake (MAB-E2)
1	Brake Manually Released	Machinery Brake (MAB-E2)
1	Brake Set	Machinery Brake (MAB-E2)
1	Nearly Closed Limit Switch (ZS-114)	West Bascule Leaf Trunnion
1	Nearly Open Limit Switch (ZS-115)	West Bascule Leaf Trunnion
1	Sump Pump (SP-W) Level Switch	West Bascule Leaf Counterweight Pit
1	Sump Pump (SP-E) Level Switch	East Bascule Leaf Counterweight Pit
1	Center Lock Lock Bar Unlock (ZS-008)	Center Lock (CL-1)
1	Center Lock Lock Bar Lock (ZS-007)	Center Lock (CL-1)
1	Center Lock Actuator (ZS-005)	Center Lock (CL-1)
1	Center Lock Hand Crank Switch	Center Lock (CL-1)
1	Center Lock Lock Bar Unlock (ZS-010)	Center Lock (CL-2)
1	Center Lock Lock Bar Lock (ZS-009)	Center Lock (CL-2)

Quantity	Limit Switch Function	Location
1	Center Lock Actuator (ZS-006)	Center Lock (CL-2)
1	Center Lock Hand Crank Switch	Center Lock (CL-2)
1	Full Closed Limit Switch (ZS-112)	West Counterweight Pit
1	Full Closed Limit Switch (ZS-212)	East Counterweight Pit
1	Redundant Nearly Closed Limit Switch (ZS-214)	East Bascule Leaf Trunnion
1	Redundant Nearly Open Limit Switch (ZS-215)	East Bascule Leaf Trunnion
1	Buffer Extended Limit Switch (ZS-120)	West Pier
1	Buffer Extended Limit Switch (ZS-121)	West Pier
1	Buffer Extended Limit Switch (ZS-220)	East Pier
1	Buffer Extended Limit Switch (ZS-221)	East Pier
2	Traffic Gate Enclosure Door Safety Switch	Traffic Gate (TG-W1)
2	Traffic Gate Enclosure Door Safety Switch	Traffic Gate (TG-W2)
2	Traffic Gate Enclosure Door Safety Switch	Traffic Gate (TG-E1)
2	Traffic Gate Enclosure Door Safety Switch	Traffic Gate (TG-E2)

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

6 Months

- Check mounting bolts and tighten as needed.
- Remove accumulation of dirt, grease, and gum.
- Check for excessive heating of parts, discoloration of metal parts, charred insulation, odor, or blistering.
- Check for freedom of moving parts (no binding or sticking).
- Check for corrosion and moisture.
- Tighten loose mountings and connections.

- Check for worn or broken mechanical parts.
- Check condition of gaskets, if present.
- Check lever arm for tightness, deformation, and damage to wheel.
- Check for proper actuation of the limit switch arm.

3.12.6 Position Transmitters

Description

Each bascule leaf position transmitter encoder is installed in the same enclosure as the bascule leaf rotary limit switch. Cover plates protect the rotary cam limit switch and position transmitter drive mechanisms from debris.

The position transmitter is an analog device that provides a current signal that is proportioned to the rotation of the input shaft. The position indicator shows the position of the bascule leaf.

Number of Items and Location

The bascule leaf is equipped with a position transmitter in the same enclosure as the rotary limit switch, located on the trunnion adjacent to the Machinery Room.

Refer to photo numbered 4-3.

Maintenance Schedule and Procedures

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment before beginning maintenance. Refer to Section 3.2 LOCKOUT/TAGOUT AND OTHER SAFETY PROCEDURES.

Annually

- Check electrical termination and tighten as necessary.
- Inspect interior of enclosure for moisture and corrosion.
- Inspect coupling and shaft for wear.

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**INCOMING SERVICE, INCOMING SERVICE CIRCUIT BREAKER DISCONNECT, AND
AUTOMATIC TRANSFER SWITCH 4-26**

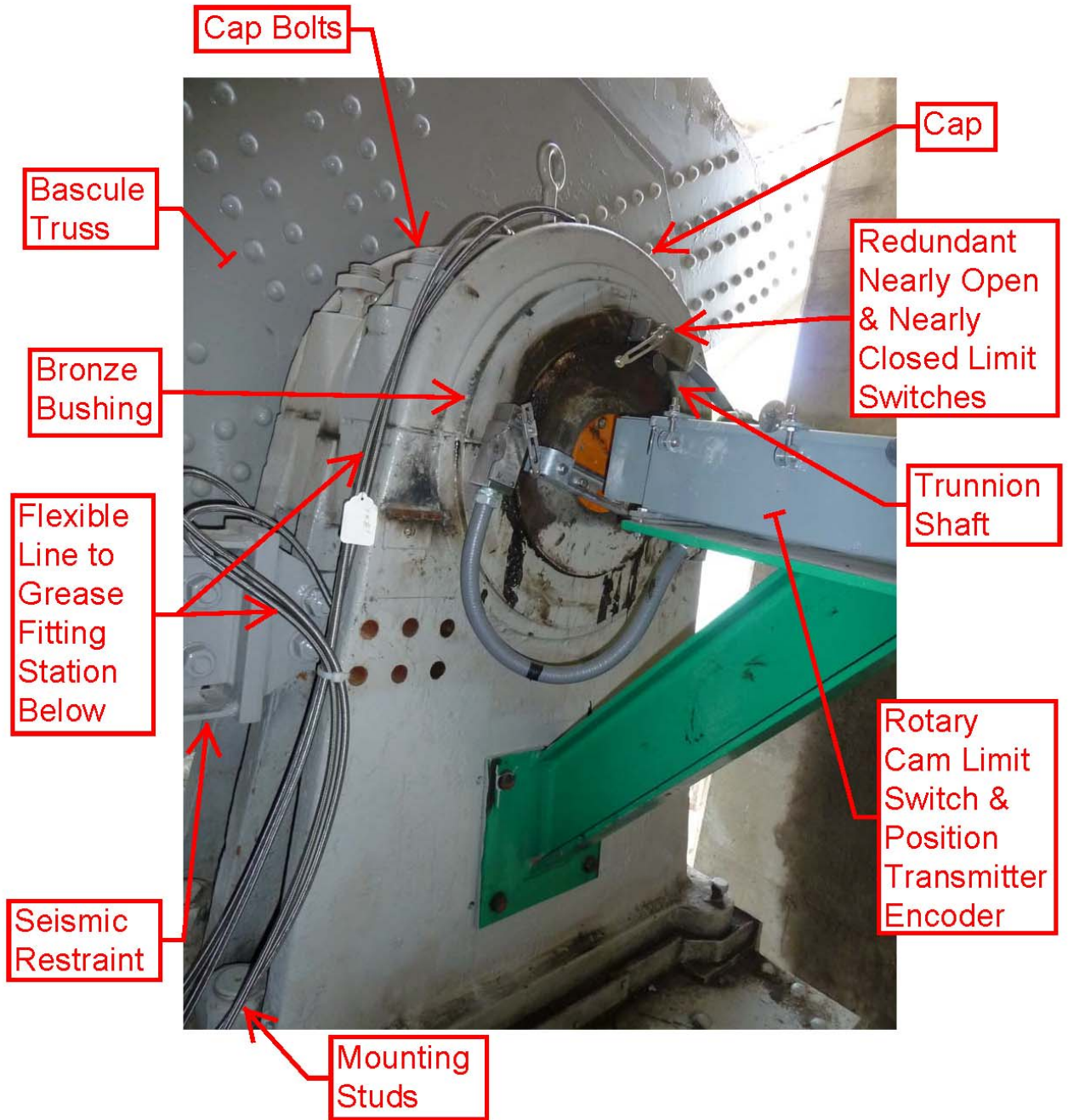
**INCOMING SERVICE, INCOMING SERVICE CIRCUIT BREAKER DISCONNECT, AND
AUTOMATIC TRANSFER SWITCH WITH PANEL OPEN 4-27**

DIESEL GENERATOR 4-28

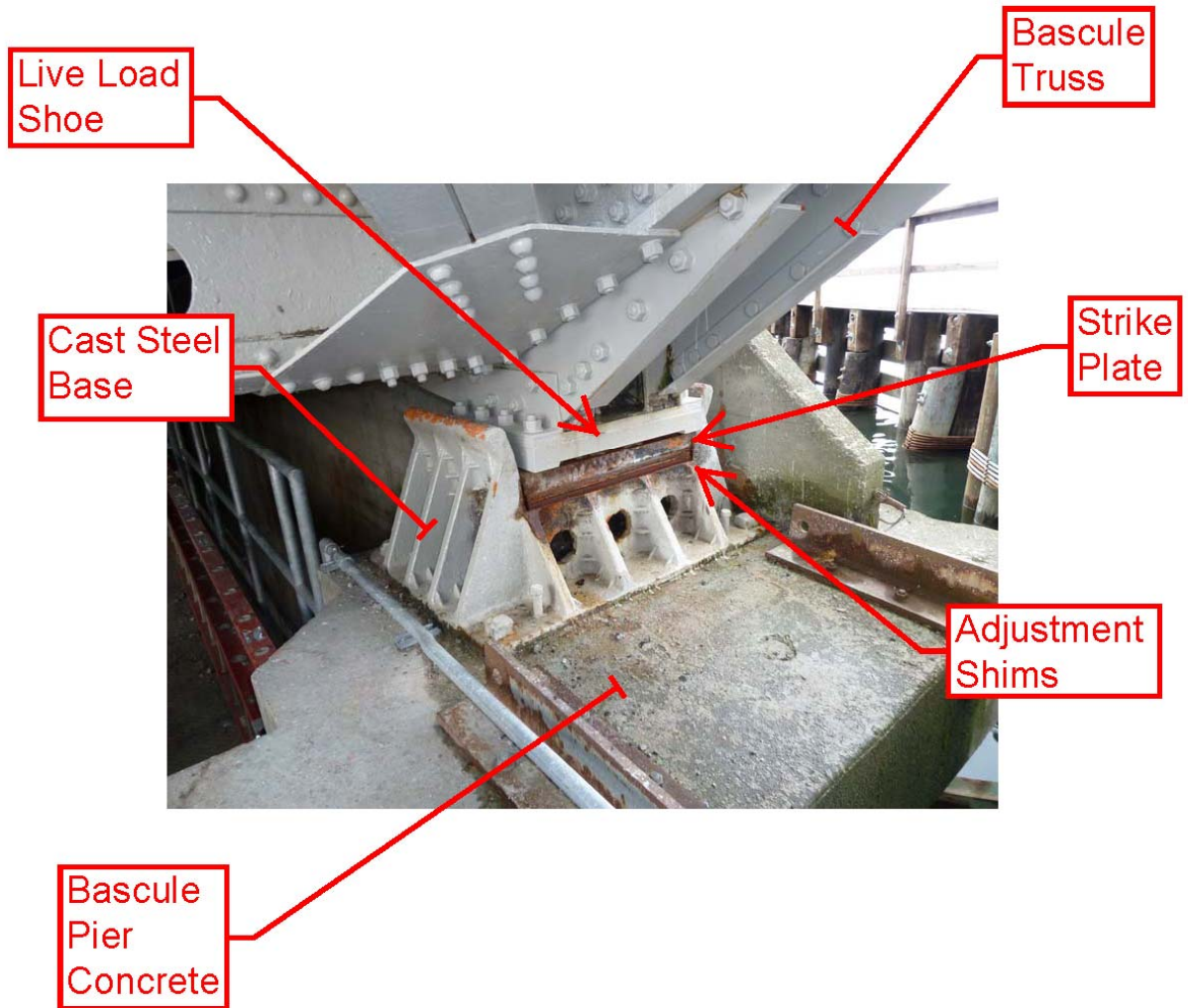
CONTROL DESK 4-29

CONTROL PANEL CP-2 4-30

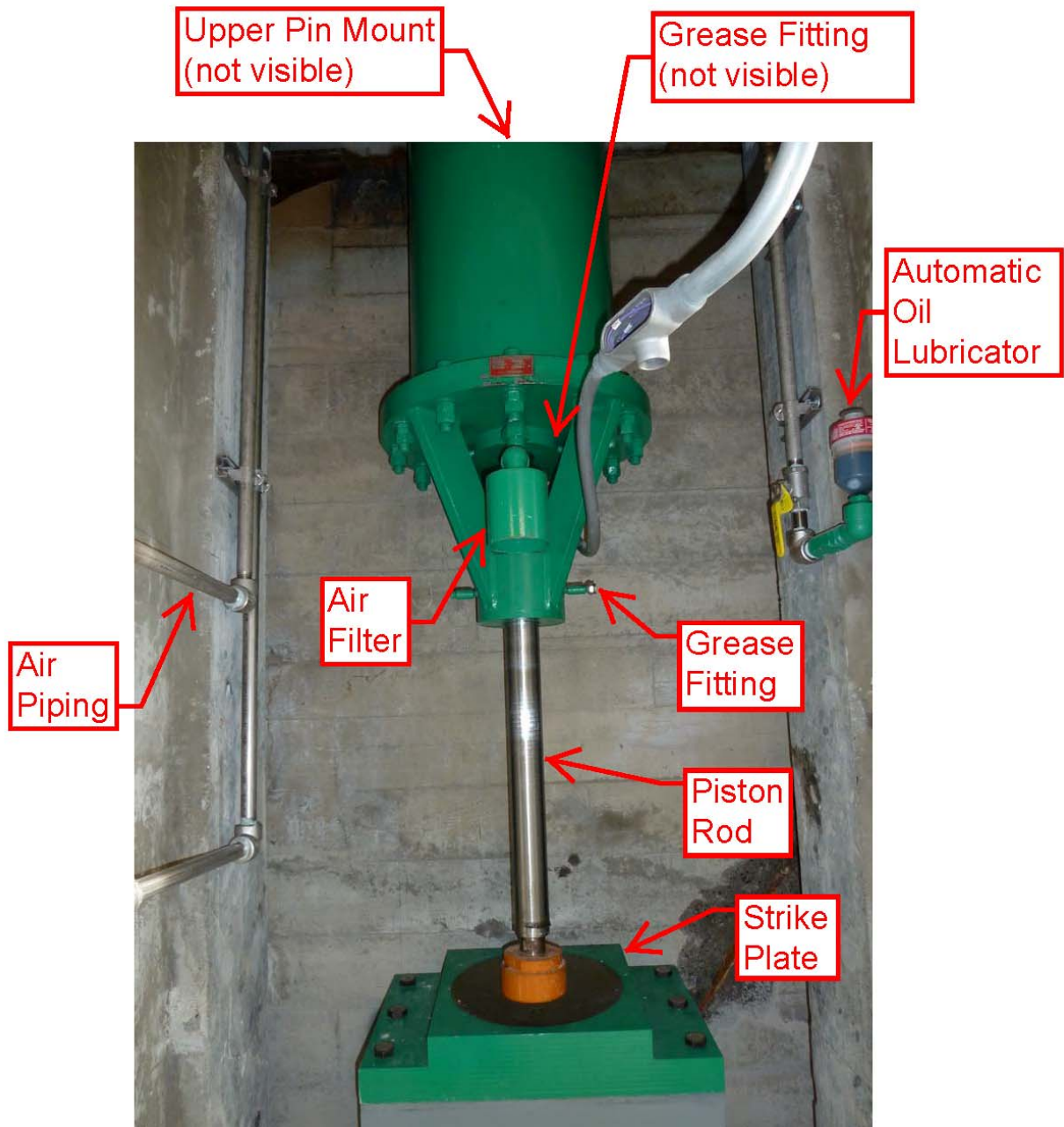
FULLY SEATED LIMIT SWITCH 4-31



TRUNNION BEARING ASSEMBLY

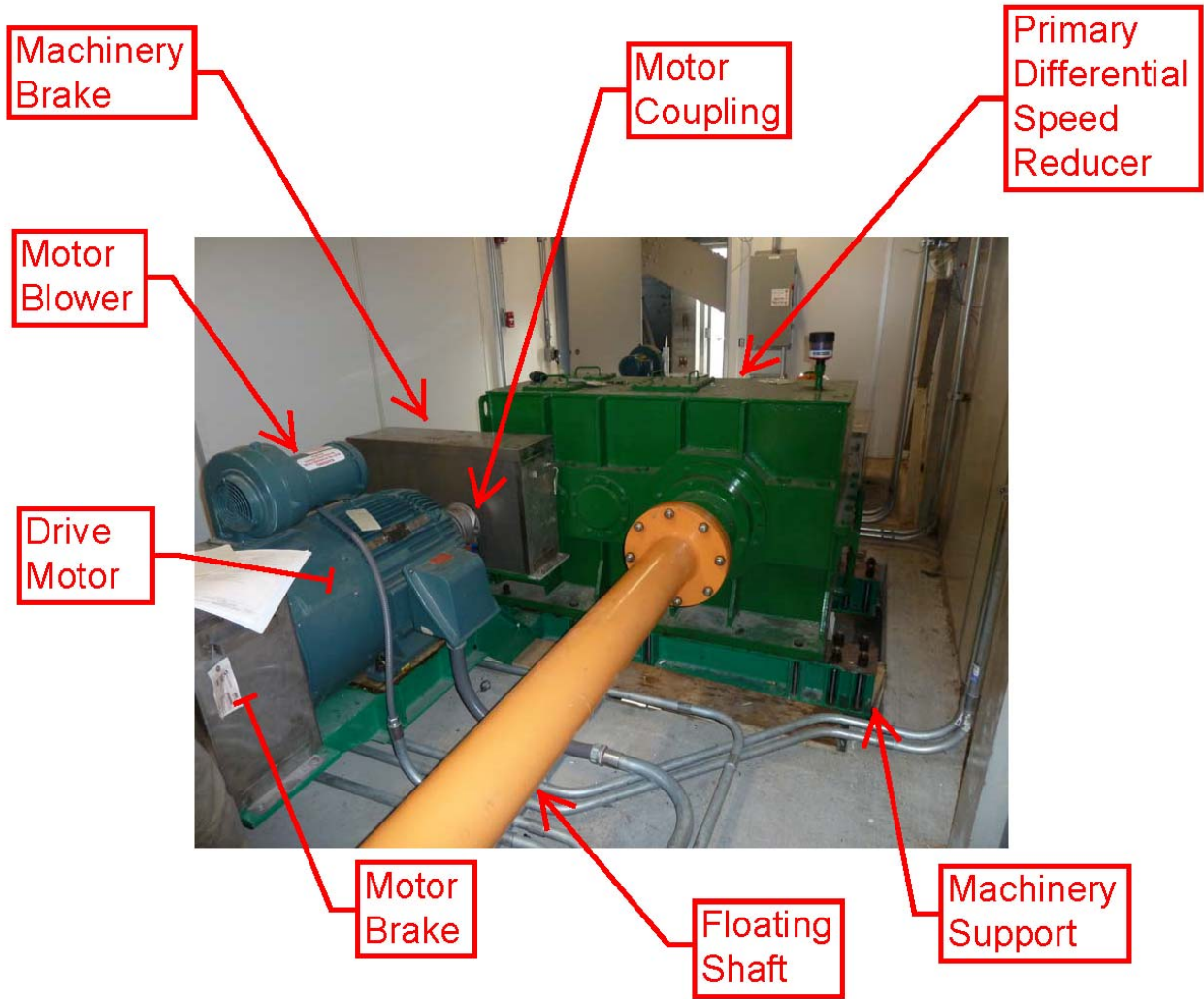


LIVE LOAD BEARING ASSEMBLY

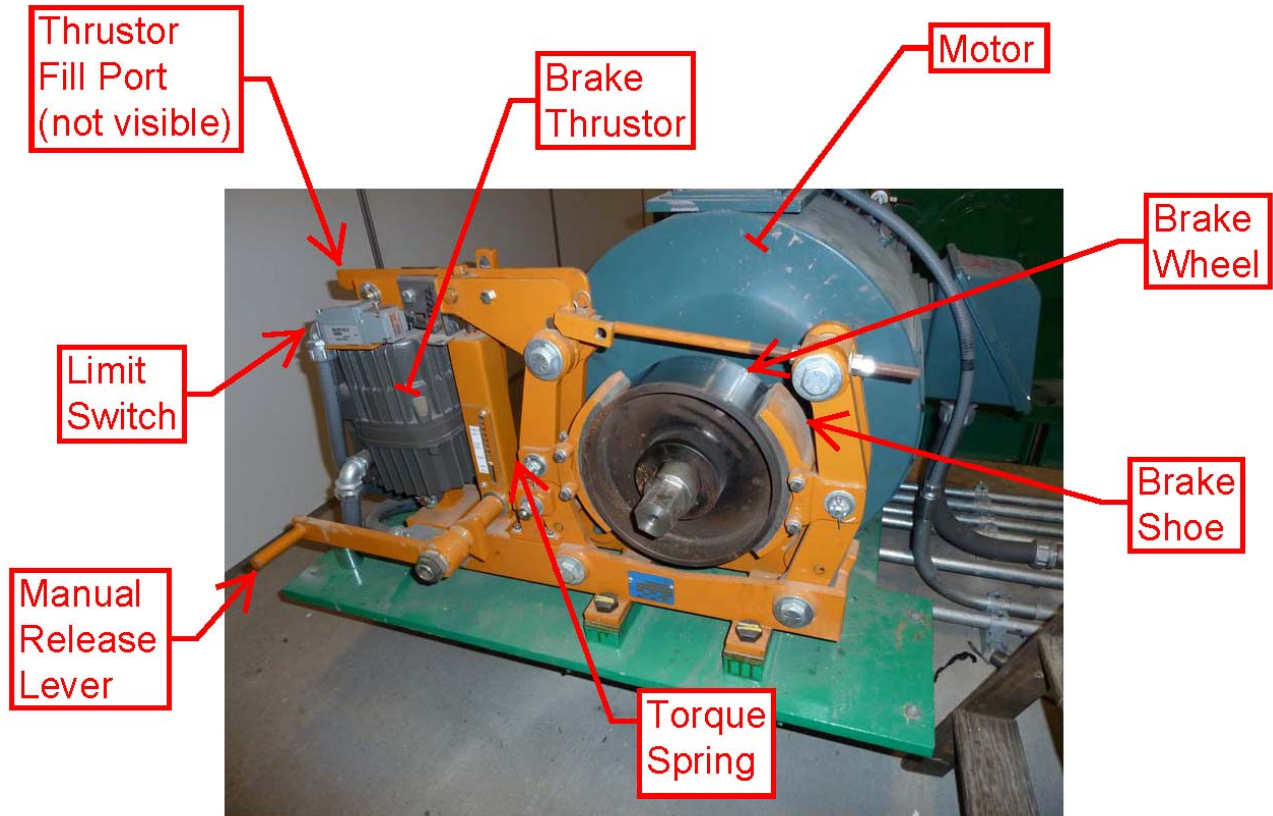


AIR BUFFER ASSEMBLY

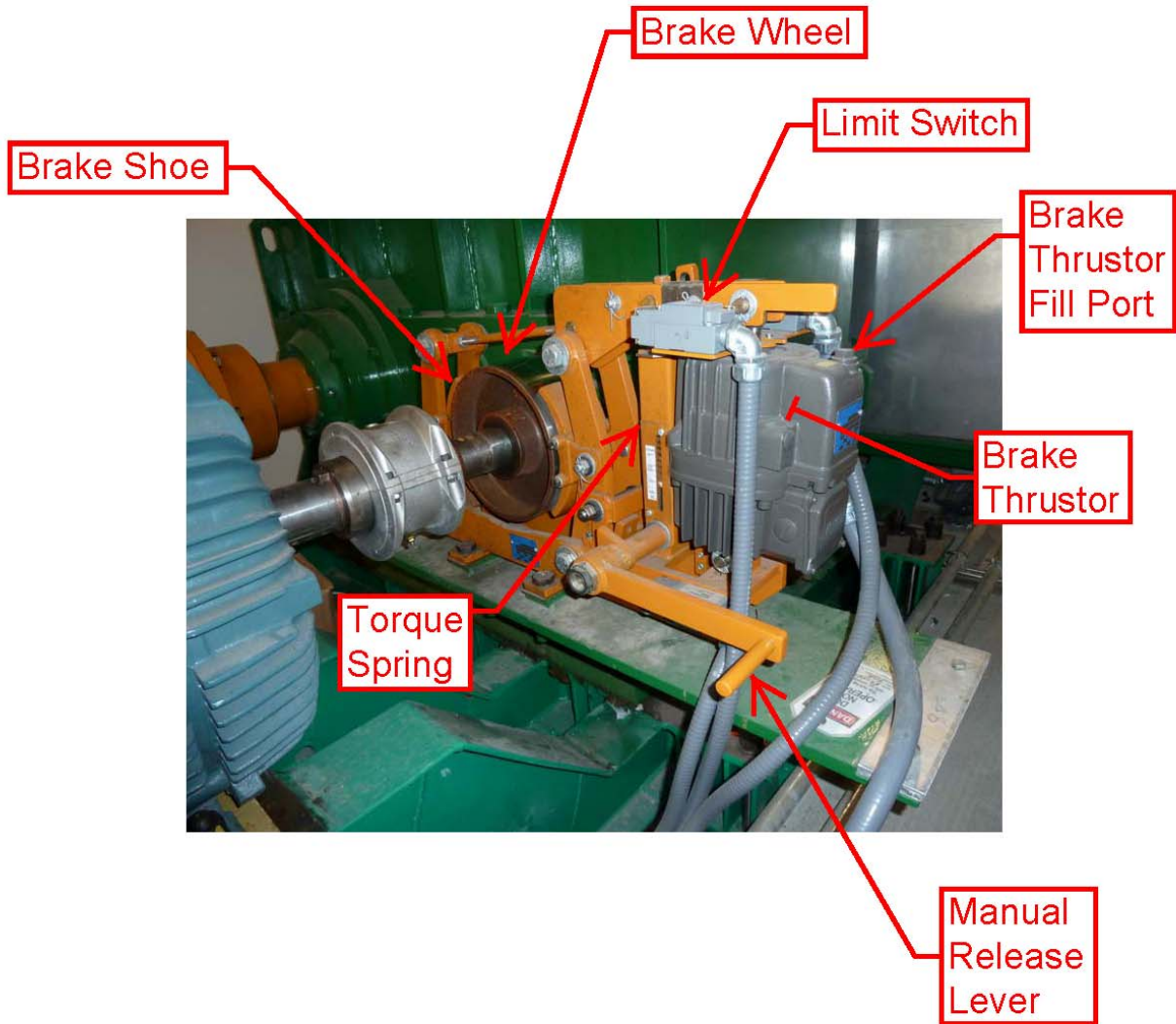
Shown in Extended Position



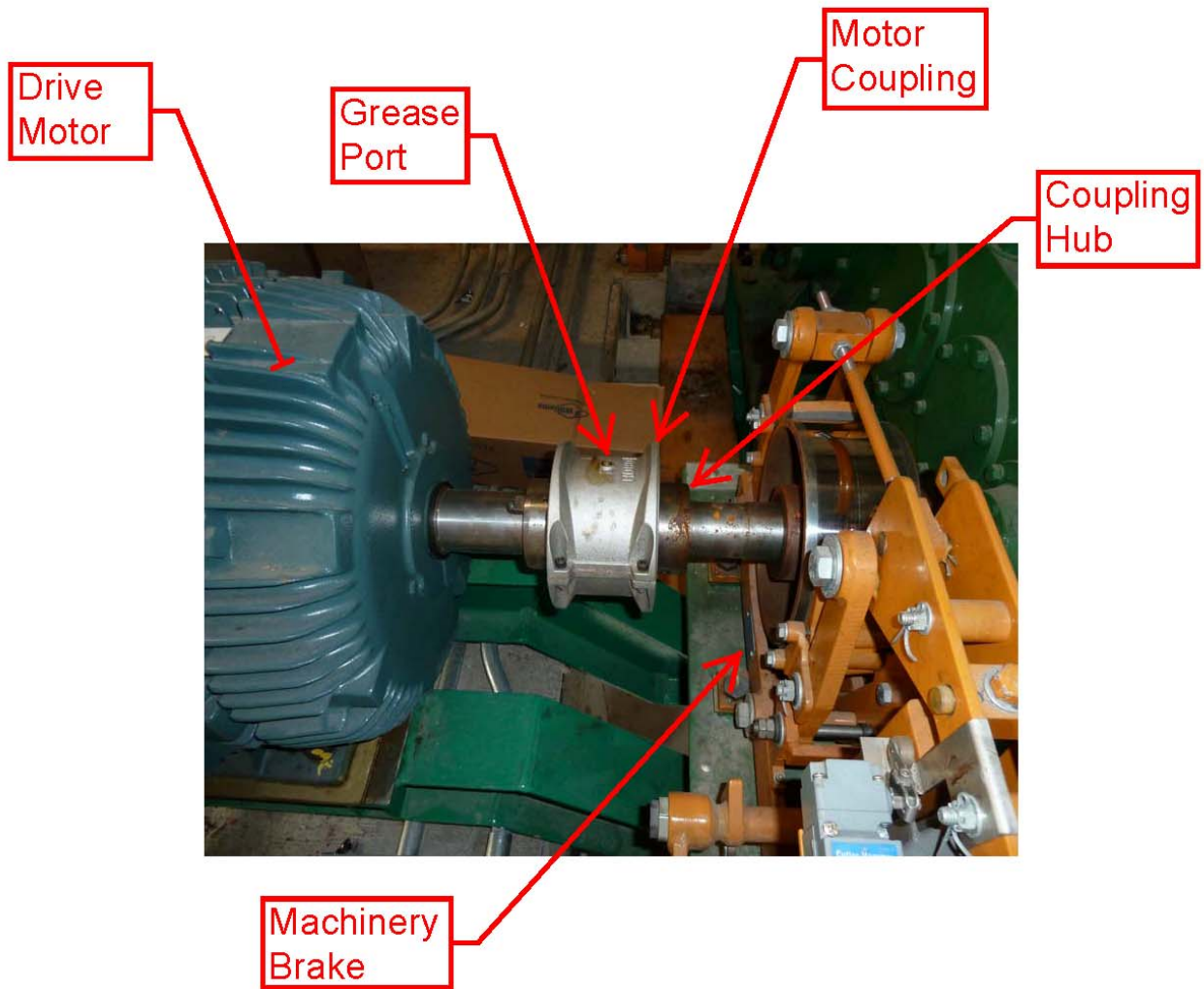
SPAN DRIVE MACHINERY



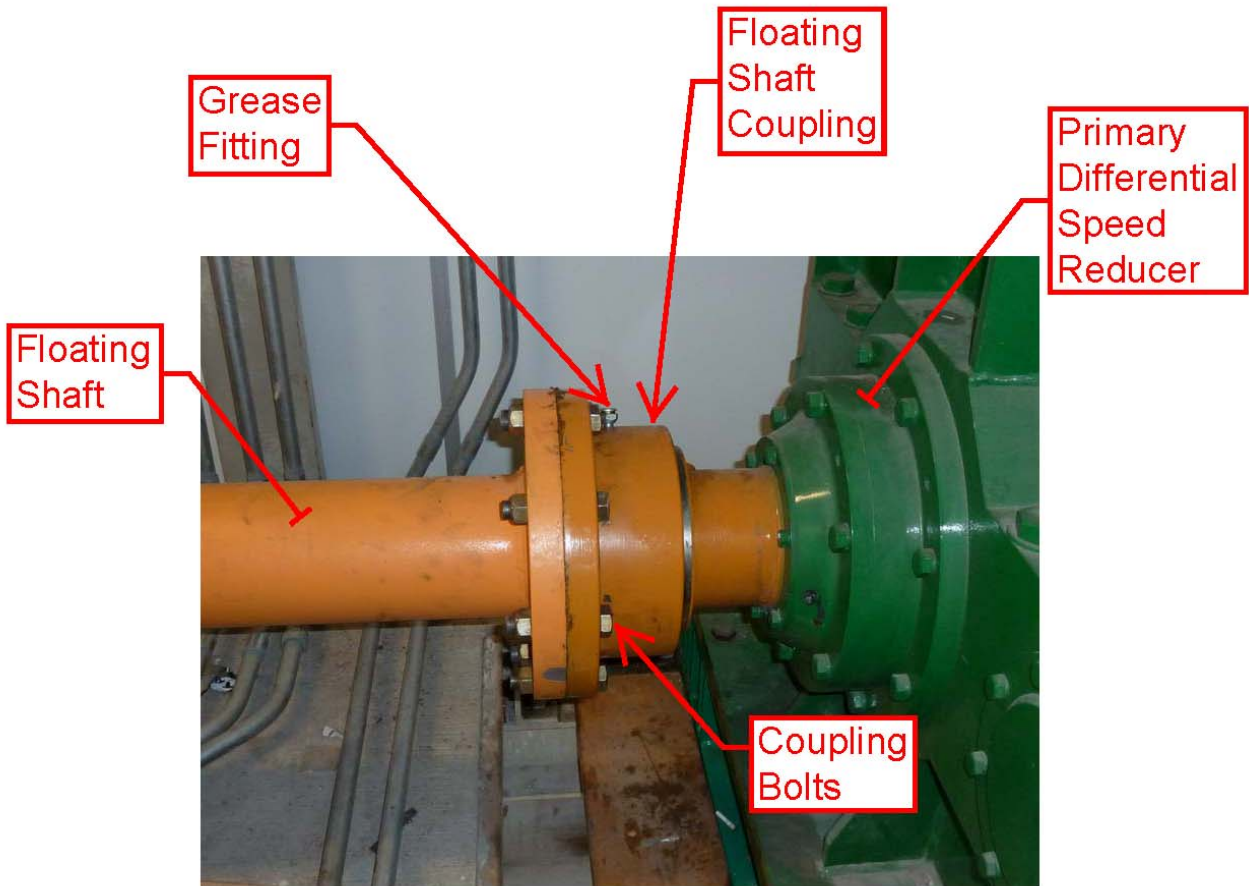
MOTOR BRAKE



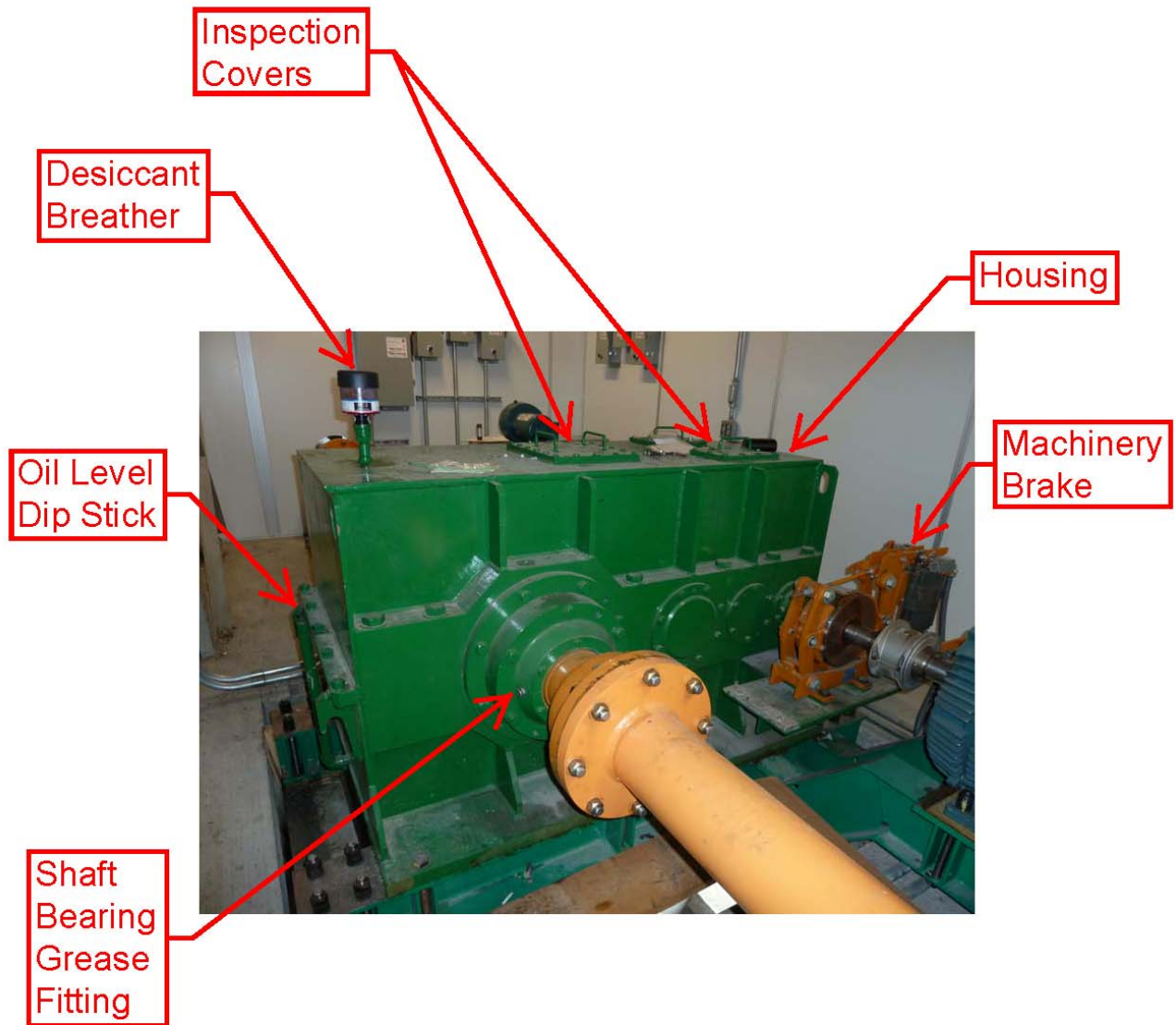
MACHINERY BRAKE



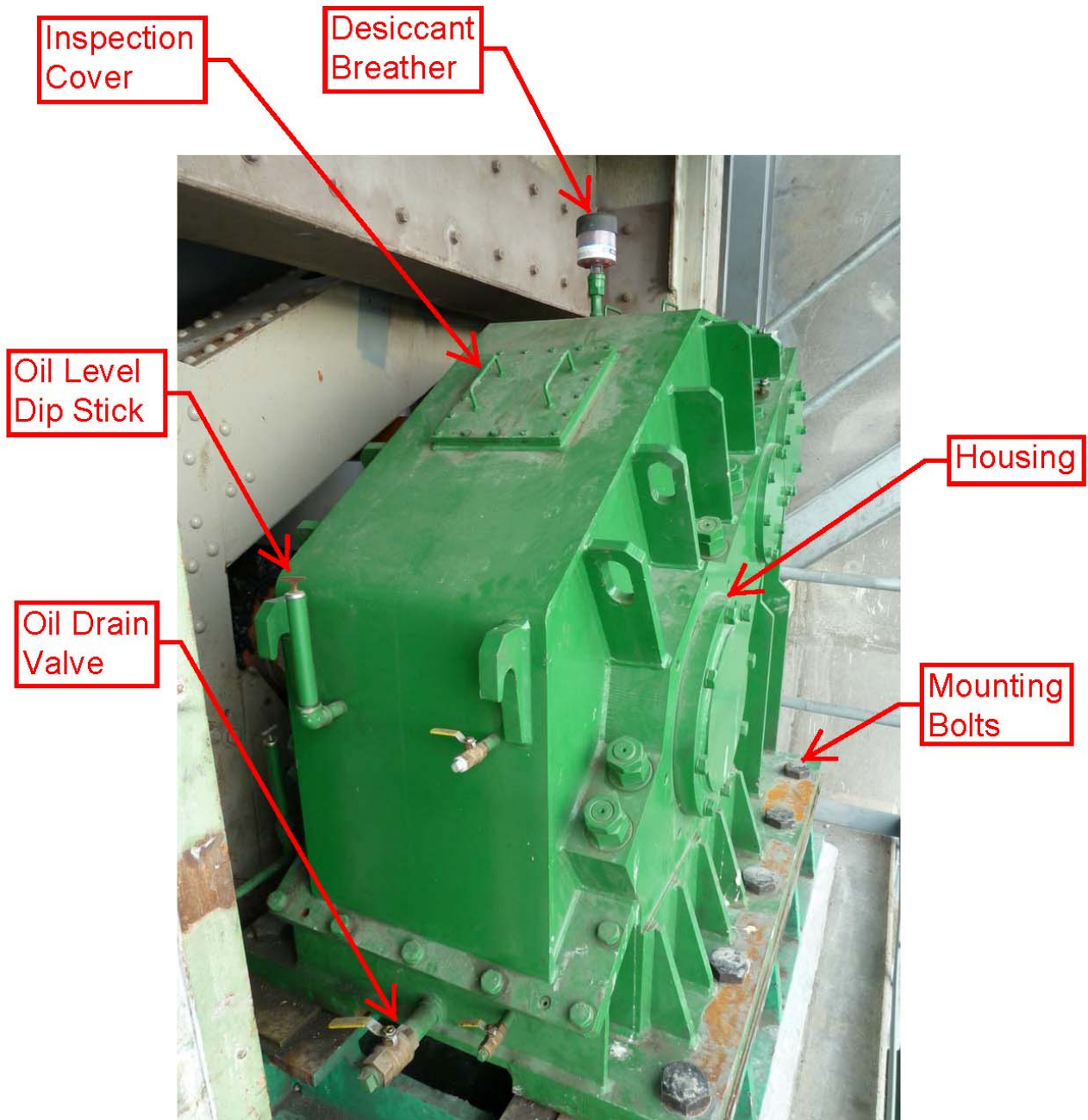
MOTOR COUPLING



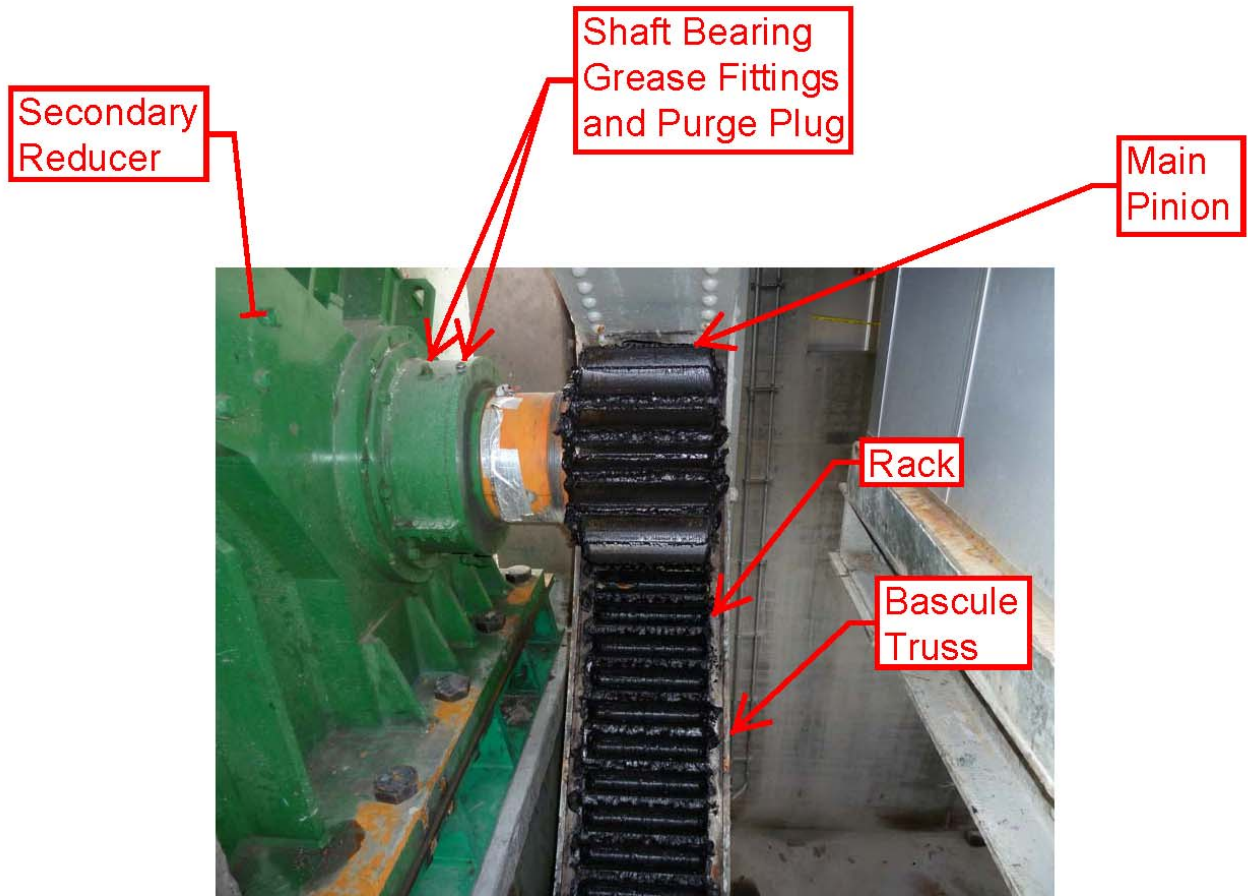
FLOATING SHAFT AND FLOATING SHAFT COUPLING



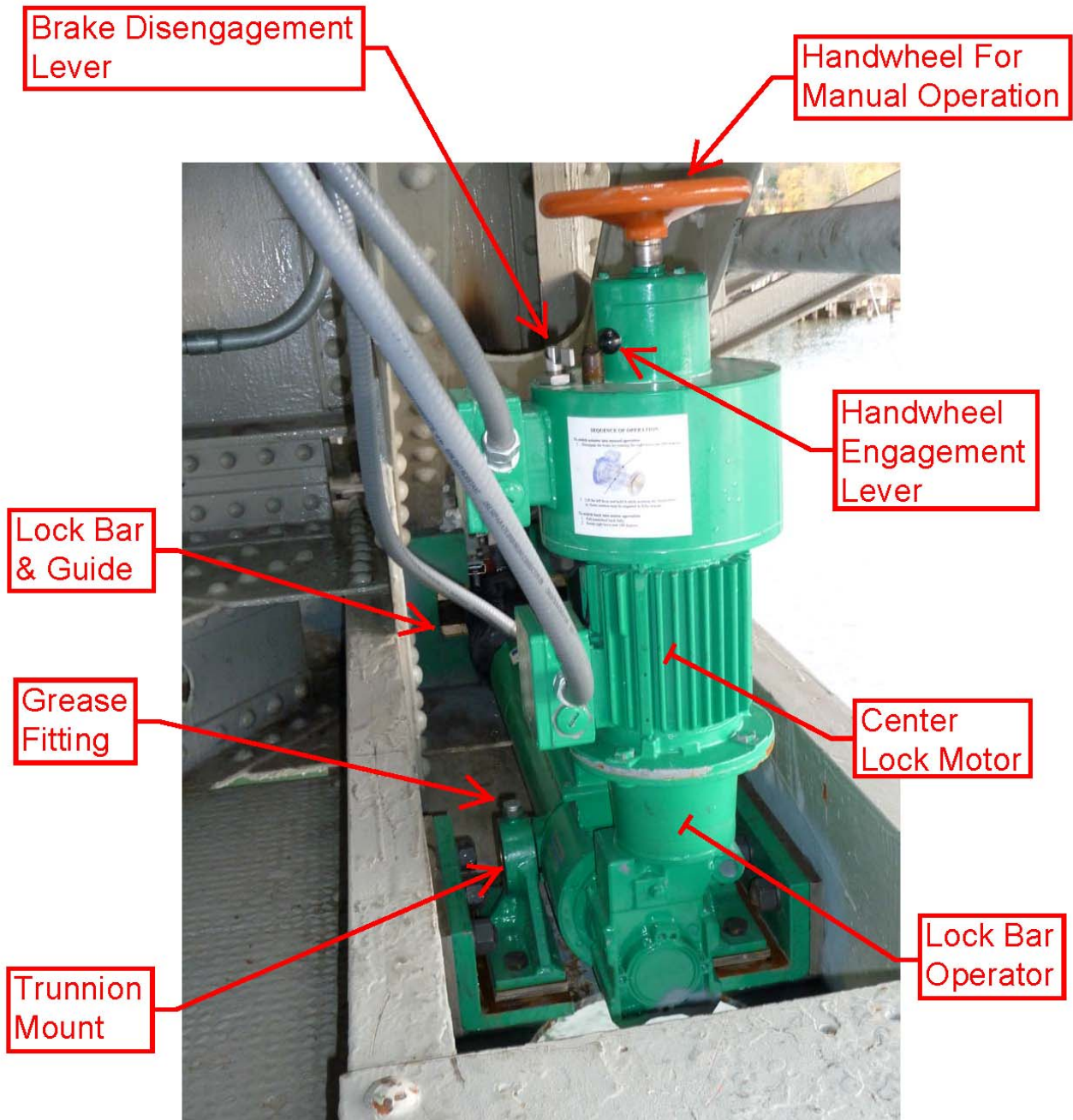
PRIMARY SPEED REDUCER



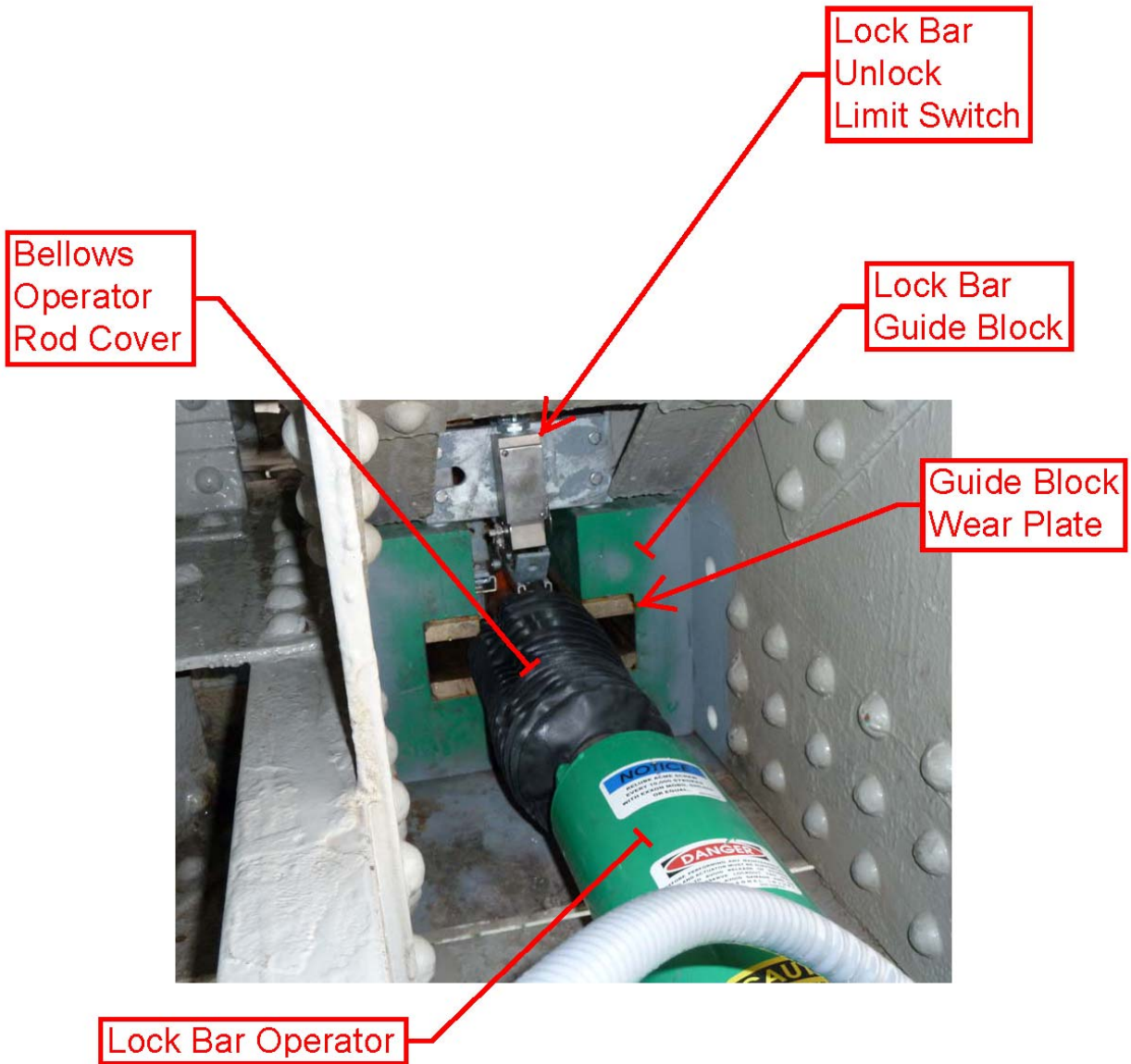
SECONDARY DIFFERENTIAL SPEED REDUCER



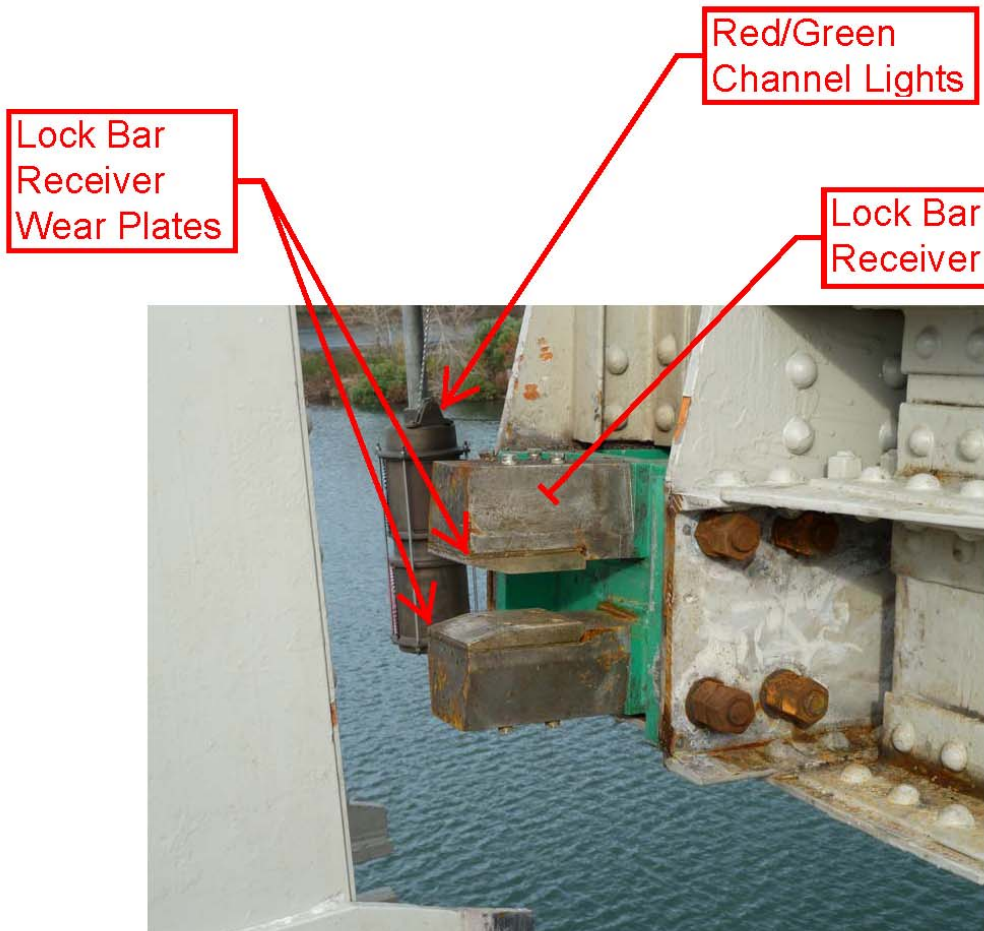
MAIN PINION AND RACK



CENTER LOCK MACHINERY



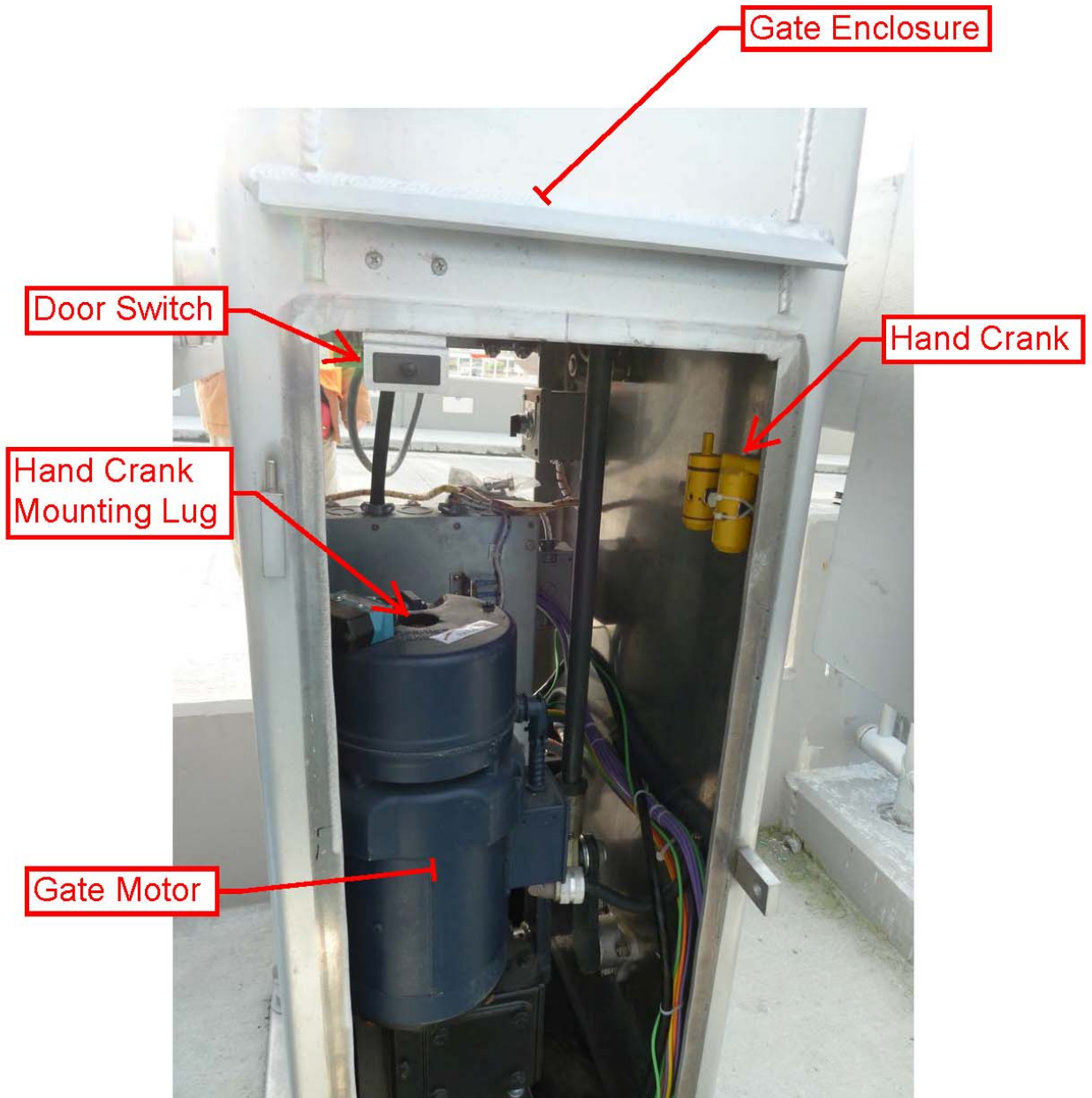
CENTER LOCK BAR AND LOCK BAR GUIDE



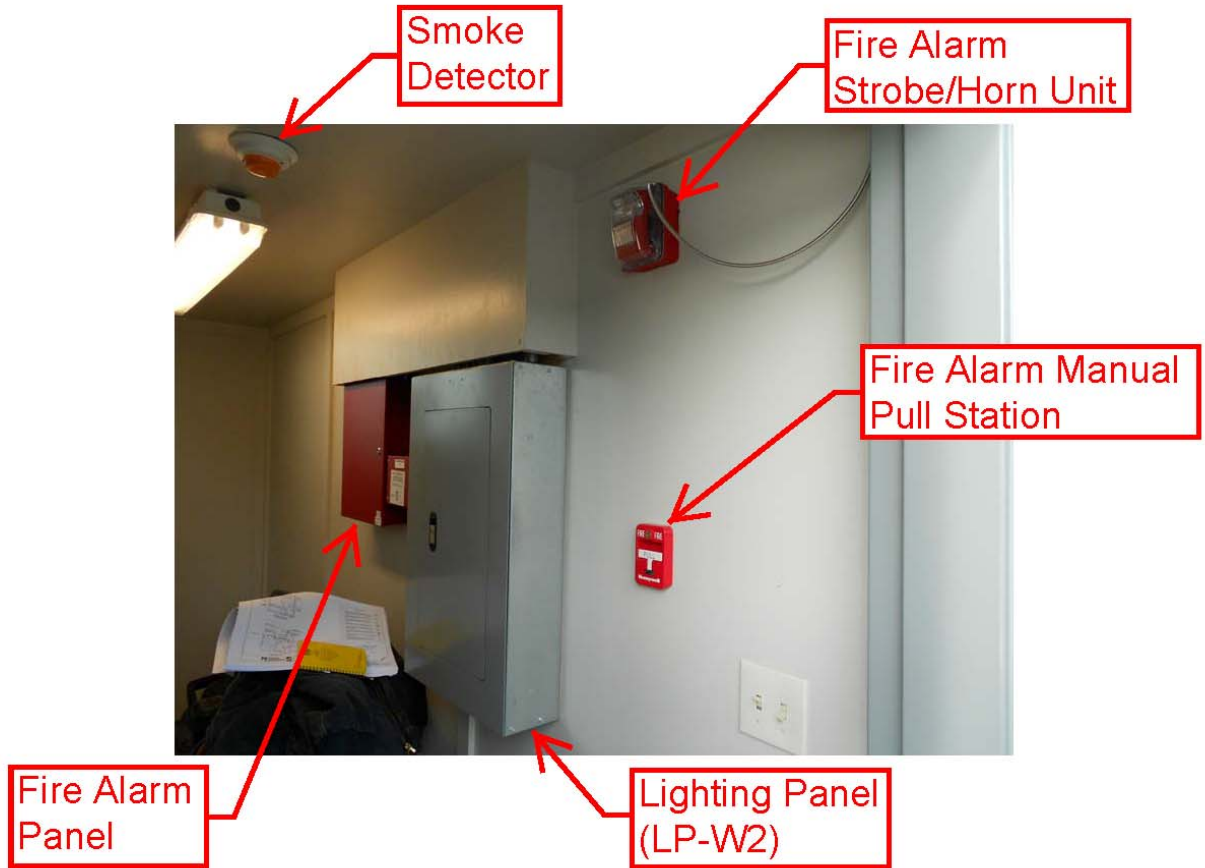
CENTER LOCK RECEIVER ASSEMBLY



NORTHWEST GATE AND TRAFFIC SIGNAL



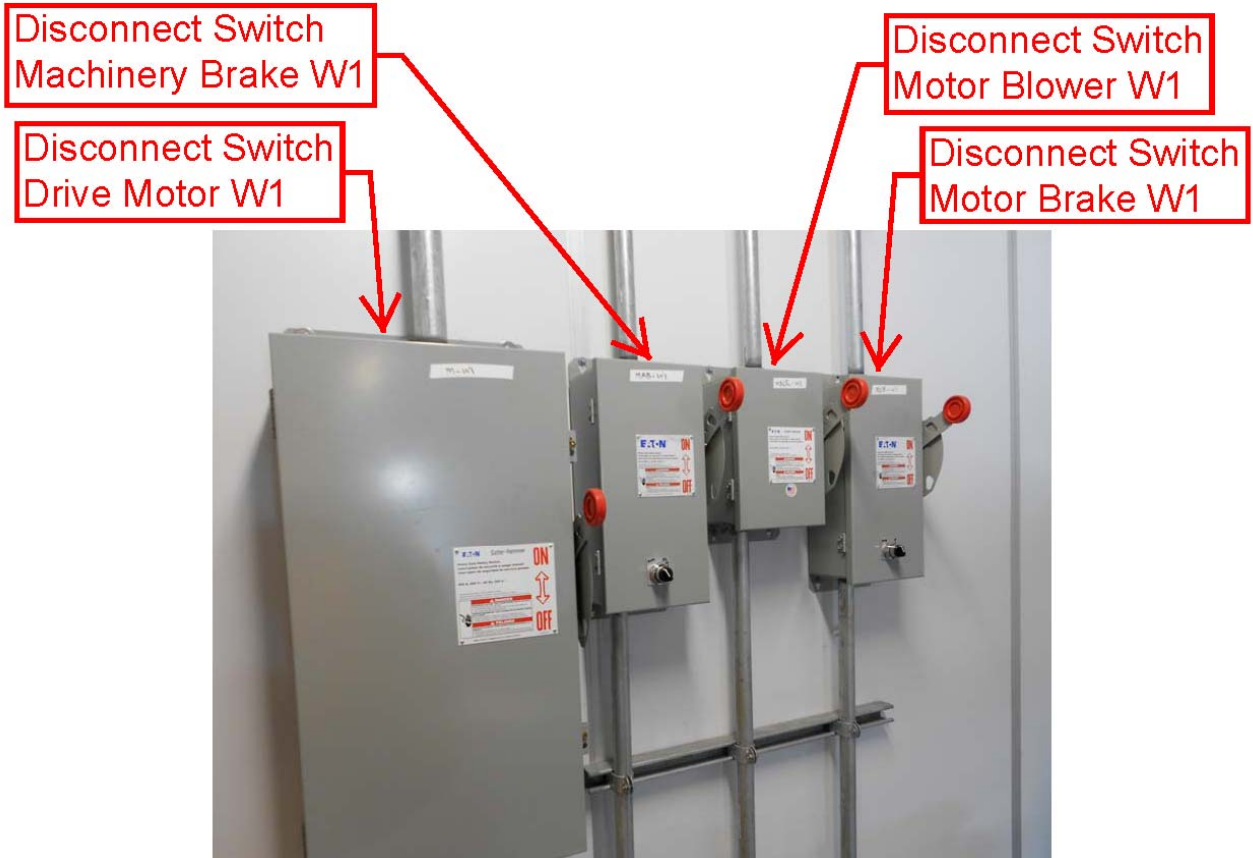
NORTHWEST GATE INTERIOR



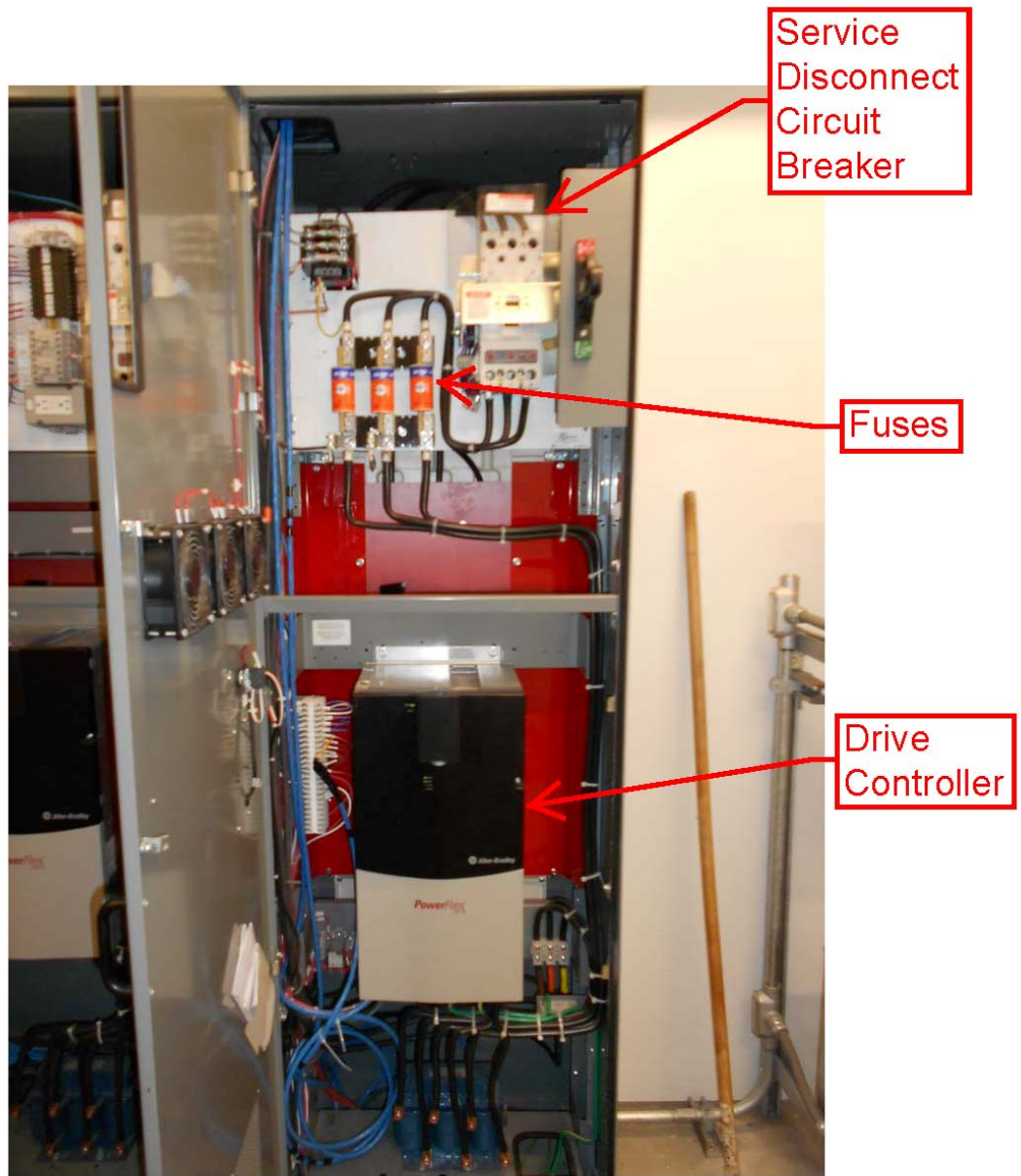
LIGHTING PANEL (LP-W2) – CONTROL TOWER



WEST MOTOR CONTROL CENTER



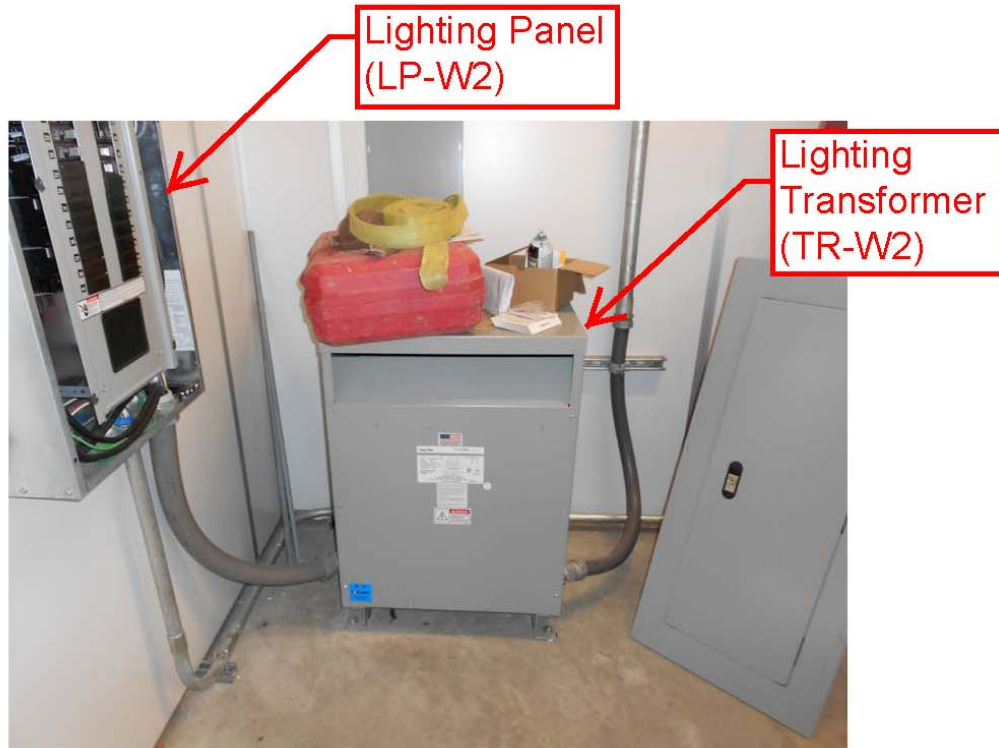
DISCONNECT SWITCHES



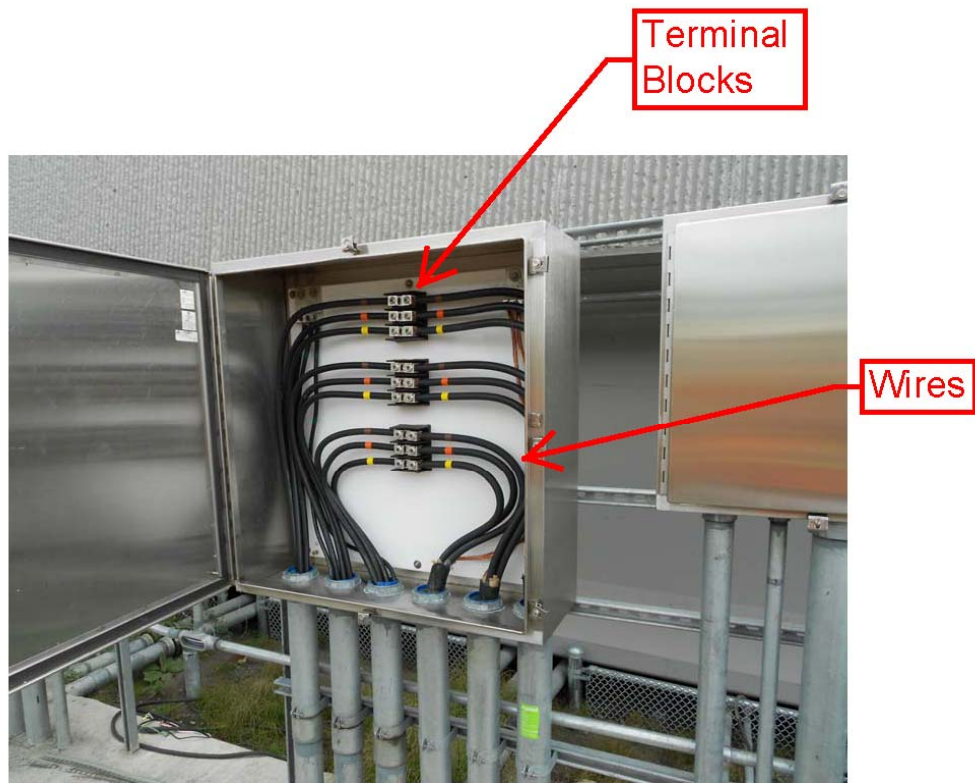
MOTOR DRIVE



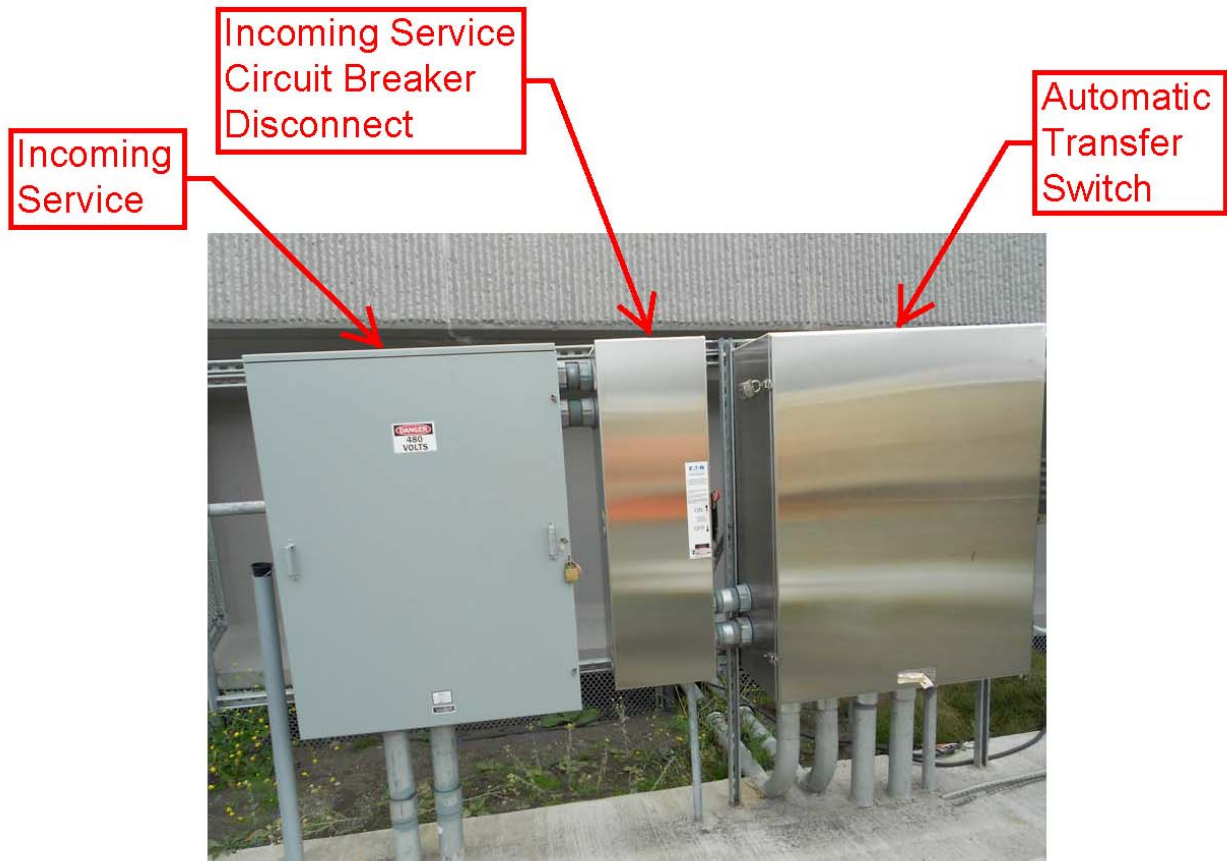
RESISTOR BANKS



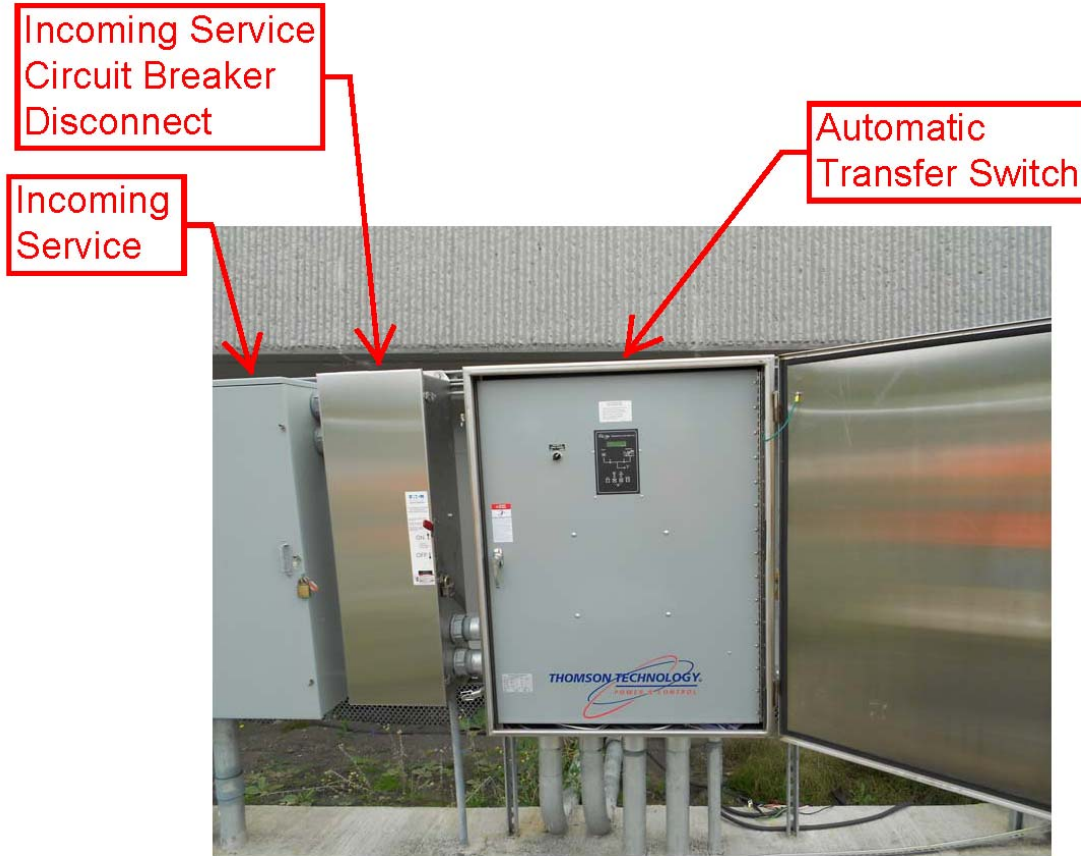
LIGHTING PANEL TRANSFORMER



SUBMARINE CABLE TERMINAL CABINET



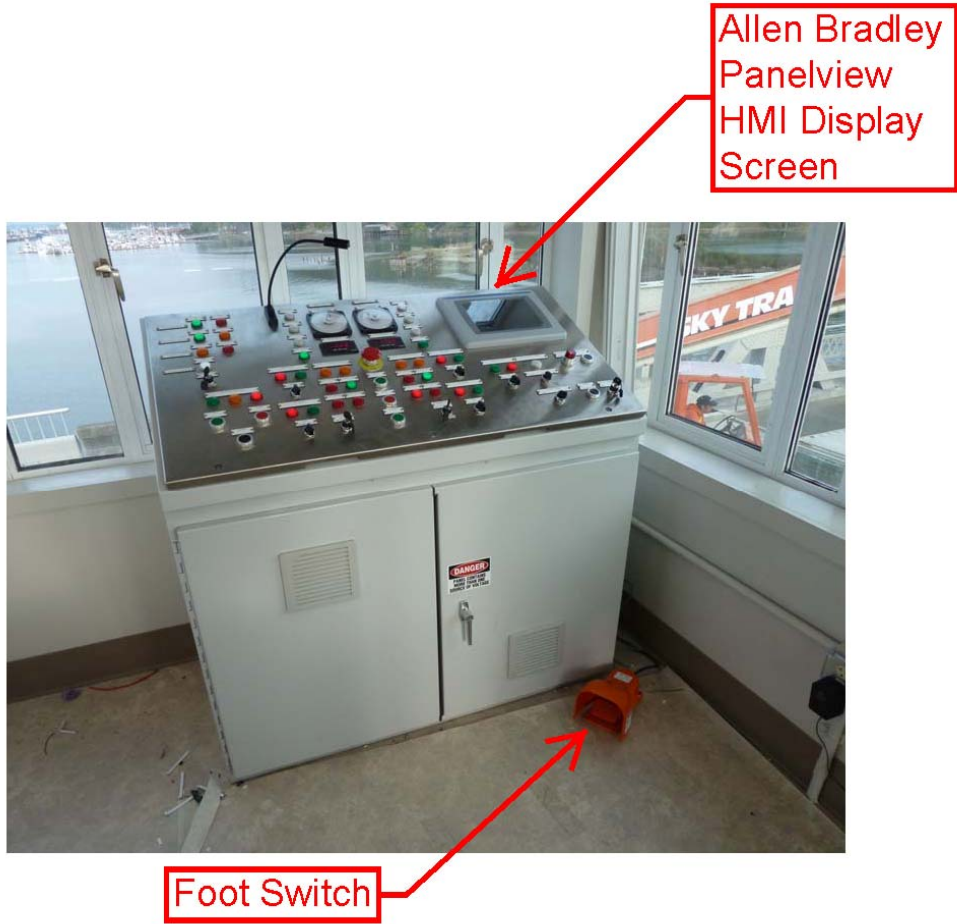
INCOMING SERVICE, INCOMING SERVICE CIRCUIT BREAKER DISCONNECT, AND AUTOMATIC TRANSFER SWITCH



INCOMING SERVICE, INCOMING SERVICE CIRCUIT BREAKER DISCONNECT, AND AUTOMATIC TRANSFER SWITCH WITH PANEL OPEN



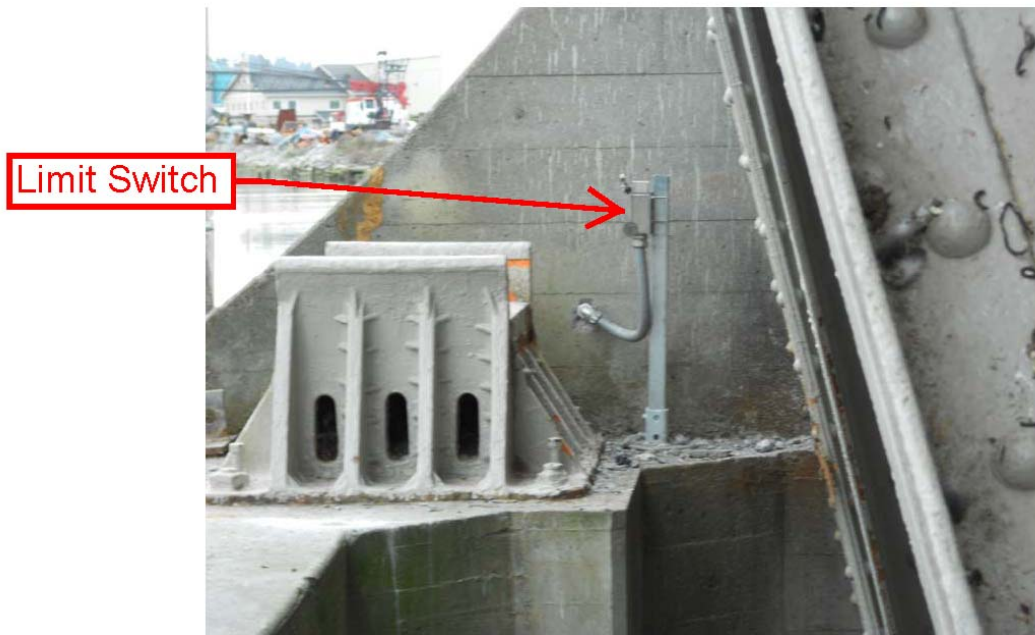
DIESEL GENERATOR



CONTROL DESK



CONTROL PANEL CP-2



FULLY SEATED LIMIT SWITCH