TABLE OF CONTENTS

CHAPTER 1 – PURPOSE AND SCOPE OF MAINTENANCE MANUAL

1.1 PURPOSE OF MANUAL ........................................................................................................1-1
1.2 INTRODUCTION TO MAINTENANCE MANUAL ..........................................................1-1
1.3 LOCKOUT AND TAGOUT PROCEDURES ........................................................................1-1
1.4 MAINTENANCE ACCESS ..............................................................................................1-1
1.5 MAINTENANCE OPENINGS ...........................................................................................1-1
1.6 MAINTENANCE TECHNICIAN TRAINING ....................................................................1-1
1.7 MAINTENANCE AND BRIDGE OPERATORS DURING OPENING .........................1-2

CHAPTER 2 – STRUCTURAL MAINTENANCE

2.1 STRUCTURAL CONCRETE .................................................................................................2-1
2.2 STRUCTURAL STEEL .......................................................................................................2-1
2.3 FENDER SYSTEM ...........................................................................................................2-2
2.4 FIRE PROTECTION PIPING ..........................................................................................2-2

CHAPTER 3 – ELECTRICAL AND MECHANICAL MAINTENANCE

3.1 LEAF SUPPORT AND COUNTERWEIGHTS ..................................................................3-1
3.2 SPAN DRIVE MACHINERY ............................................................................................3-3
3.3 SPAN LOCK MACHINERY ............................................................................................3-8
3.4 TAIL LOCK MACHINERY ..............................................................................................3-11
3.5 TRAFFIC GATES ............................................................................................................3-14
3.6 ELECTRICAL POWER SYSTEMS .................................................................................3-17
3.7 LIGHTING SYSTEMS ....................................................................................................3-29
3.8 ELECTRIC MOTORS ......................................................................................................3-32
3.9 CONTROL SYSTEM .......................................................................................................3-37
3.10 MISCELLANEOUS ELECTRICAL SYSTEMS ...............................................................3-43

CHAPTER 4 – PHOTOS

4.1 TRAFFIC CONTROL DEVICES AND NAVIGATION LIGHTS ......................................4-4
4.2 LEAF OPERATING MACHINERY ..................................................................................4-12
4.3 LOCK MACHINERY .......................................................................................................4-17
4.4 POWER DISTRIBUTION EQUIPMENT .........................................................................4-22
4.5 CONTROL EQUIPMENT ...............................................................................................4-26
CHAPTER 5 – SUPPLEMENTAL INFORMATION
5.1 BASCULE SPAN MACHINERY LUBRICATION CHARTS AND SCHEDULE..............5-1
5.2 BARRIER GATE LUBRICATION SCHEDULE .................................................................5-5
5.3 COUPLING FASTENER TIGHTEN TORQUE VALUES .................................................5-7
5.4 SWITCHGEAR TEST PLAN..........................................................................................5-9

CHAPTER 6 – MAINTENANCE FORMS
6.1 MECHANICAL MAINTENANCE FORMS......................................................................6-2
6.2 ELECTRICAL MAINTENANCE FORMS.......................................................................6-8

CHAPTER 7 – CONTACTS, TELEPHONE NUMBERS AND EMERGENCY CALL OUTS
7.1 CONTACTS AND TELEPHONE NUMBERS.................................................................7-1
7.2 EMERGENCY CALL OUTS ...............................................................................................7-1
CHAPTER 1

PURPOSE AND SCOPE OF MAINTENANCE MANUAL

1.1 PURPOSE OF MAINTENANCE MANUAL

Schedules and procedures are established for the inspection, replacement, cleaning, adjustment, and general maintenance of the mechanical and electrical equipment used to operate the bridge. A separate section is also provided for general structural maintenance. The frequency of maintenance is based on recommendations by the manufacturers and guidelines established by AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual. All maintenance forms and activities are to be recorded and maintained by the Asset Management Team Manager/Supervisor.

1.2 INTRODUCTION TO MAINTENANCE MANUAL

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. Chapter 6 Maintenance Forms are identified for the specific equipment.

1.3 LOCKOUT/TAGOUT PROCEDURE

No electrical apparatus or electrically driven apparatus should be worked on while energized. The appropriate circuit breakers (for both A & B systems) 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.

1.4 MAINTENANCE ACCESS

For maintenance access see Volume III – Chapter 3 Inspection Access Features.

1.5 MAINTENANCE OPENINGS

For the requirements on maintenance openings see Volume I – Chapter 1.

1.6 MAINTENANCE TECHNICIAN TRAINING

Trained maintenance technicians must be familiar with the layout of the bridge and all associated electrical and mechanical equipment and is trained in the following areas. Training shall be scheduled and conducted by Maryland State Highway Administration (MDSHA).

1.6.1 BRIDGE LAYOUT

Each maintenance technician must be able to locate any piece of equipment of the bridge by name and designation (i.e. IVN span lock motor). He or she must have an in-depth understanding of the electrical and mechanical systems and understand the functions of these systems. Required training shall include at least 4 hours of training on the bridge layout.

1.6.2 BRIDGE OPERATION

Maintenance technicians must be able operate the bridge and all ancillary devices in a safe manner as described herein. Each maintenance technician must be trained on all modes of operation and have a basic understanding of operation of the bridge. Training shall include 8 hours of classroom training.

1.6.3 TROUBLESHOOTING AND EMERGENCY SITUATIONS

Maintenance personnel must be trained in emergency situations and be capable to perform troubleshooting as described in this manual. At least 40 hours of training is required for each maintenance technician.

In the event of an emergency the operator must have knowledge of proper procedures describes herein. Each operator must receive at least 8 hours of training in emergency situations.
1.6.4 BRIDGE MAINTENANCE

Maintenance technicians must be trained in bridge maintenance activities as specified herein. At least 40 hours of training is required for each maintenance technician.

1.6.5 MAINTENANCE OF SWITCHGEAR

Each substation switchgear must follow an annual maintenance program offered by one of the following:

- Eaton - (800) 498-2678
- Potomac Testing – (301) 352-1930
- Reuter Hanney – (703) 263-7163

Maintenance technicians as specified above are not permitted to directly perform maintenance or manual operation on this equipment.

1.6.6 MAINTENANCE OF GENERATOR

Each generator must follow a yearly maintenance program offered by one of the following:

- Alban Caterpillar – (866) 993-6446
- Fidelity Power Systems – (800) 787-6000
- Cummins Power Systems – (800) 783-7061

Maintenance technicians as specified above are not permitted to directly perform maintenance on this equipment.

1.7 MAINTENANCE AND BRIDGE OPERATORS DURING OPENINGS

During each opening for maintenance or for marine vessel passage the bridge must be staffed with the following personnel unless otherwise noted:

(2) Trained Bridge Operators
(2) Maintenance Technicians

The bridge operators shall be stationed in the control room level of the operator house (Level 6). During emergency situations where the bridge and/or ancillary devices malfunction, one of the trained operators shall be capable of relocating to one of the Virginia electrical rooms or one of the Virginia machinery rooms as required.

The maintenance technicians shall be stationed in the vicinity of the Maryland and Virginia pedestrian gates and capable of relocating to the machinery and/or the electrical rooms during openings as directed by the operator.
CHAPTER 2

STRUCTURAL MAINTENANCE

Portions of this section are taken from the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual which contains a detailed description of the general maintenance requirements. Routine preventive maintenance should focus on the main structural elements with particular focus on corrosive action and dirt and debris buildup. Portions of the structure that are vulnerable include catwalks and railings, bearings, regions around the expansion joints, drainage systems, the pedestrian walkway and railings, noise wall at the north side of Virginia approach, operator’s house exterior concrete walls, and the fender rings. An important aspect of the maintenance procedure includes identifying the cause of problems which are detected and the elimination of these causes. All detected problems should be recorded and maintained on file.

2.1 STRUCTURAL CONCRETE

2.1.1 DESCRIPTION

Regular high pressure waterblasting of concrete is recommended for regions that are subject to debris buildup, deicing agents and dirt. This typically occurs under the finger joints. Concrete surfaces can also be coated with waterproofing sealants to reduce the likelihood of moisture and deicing chloride infiltration. Spalls in concrete should be patched or repaired depending on the depth of the unsound concrete. Cracked and spalled concrete in the bridge bearings should be repaired with a quick setting, nonshrink, cementitious mortar while cracks should be injected with a bonding material. If any exposed reinforcing is found, it should be cleaned and painted prior to any patching. Larger spalls (greater than 6" x 6") should be repaired using specific details developed by the Engineer.

2.1.2 NUMBER OF ITEMS AND LOCATION

These regions include the concrete below the six expansion joints (VA Abutment, V5E, V1W, M1E, M6W, and MD Abutment), the shear keys at the same locations, as well as floors of both bascule piers and the pedestrian walkway.

2.1.3 ANNUAL MAINTENANCE AND SCHEDULE

- High pressure waterblasting of structural concrete.
- Crack and spall repairs.
- Repair barriers and curbs as required.

2.2 STRUCTURAL STEEL

2.2.1 DESCRIPTION

Periodic cleaning of structural steel with waterblast is required in areas that accumulate dirt, debris and deicing agents. Areas of structural steel that exhibit rust staining, rust flakes, cracked or flaking paint should be sandblasted in accordance with SSPC requirements and repainted with the bridge’s paint system. Loose, broken or missing fasteners should be recorded, installed new and painted. Fasteners with greater than 20% section loss should also be replaced. Any suspected cracks or defects in structural steel should be penetrant dye tested to verify presence of crack. Crack repairs should be developed by the Engineer.

2.2.2 NUMBER OF ITEMS AND LOCATION

Regions include the six expansion joints (VA Abutment, V5E, V1W, M1E, M6W, and MD Abutment), the shear keys at the same locations, structural steel support frames on the bascule piers, and other regions which are found to accumulate dirt and debris. These may include the base of the overhead sign structures and gates, the railings of the pedestrian walkway and the various inspection walkways, operator’s house painted structural steel screenwall supports, including railings and fall protection, stainless steel screen wall panels. Maintenance should include cleaning and maintaining loose or missing fasteners, rusting etc.
2.2.3 MAINTENANCE AND SCHEDULE

ANNUALLY
- Clean and repaint structural steel as required.
- Retighten and replace fasteners as required.

SIX MONTHS
- Clean the expansion joint troughs of dirt and debris.
- Clean all inspection walkways and access ways.
- Remove all sand and debris from roadway surface (recommended spring and fall).
- Clean the gutter/trough adjacent to the trunnion towers below the roadway deck joint.

2.3 FENDER SYSTEM

2.3.1 DESCRIPTION
The two fender systems around piers M1 and V1 are comprised of structural concrete rings, composite marine timber attached with stainless steel fasteners and galvanized walkways and railings, fire protection piping.

2.3.2 NUMBER OF ITEMS AND LOCATION
Fender systems are located at the water level at M1 and V1.

2.3.3 MAINTENANCE AND SCHEDULE

ANNUALLY
- Replace damaged timber components and fasteners as needed.
- Clean debris and dirt.
- Inspect any regions subject to impact damage.
- Clean debris from walkways.

2.4 FIRE PROTECTION PIPING

2.4.1 DESCRIPTION
Fire protection atop the bridge is provided from below via manifold attached to the Virginia abutment.

2.4.2 LOCATION
Manifold is located in locked box in front of the Virginia Abutment. The Alexandria Fire Department maintains and controls the keys to the box.

2.4.3 MAINTENANCE AND SCHEDULE

ANNUALLY
- Several check valves in the standpipe system are located in the manifold at South Royal Street and on top of the ring wall. Open and clean out these valves of any debris, leaves, branches.
- Flush clean the drip valves in the drain system.
- Gate valves generally do not require maintenance, but after a fire event during which river water is used for the system, some debris could lodge in the seat of a gate valve and would have to be removed.
CHAPTER 3
ELECTRICAL AND MECHANICAL MAINTENANCE

3.1 LEAF SUPPORT SYSTEM AND COUNTERWEIGHTS

The leaf balance system consists of trunnion bearings, live load bearings and counterweights. The following outlines the basic maintenance of these items.

3.1.1 TRUNNION BEARINGS

3.1.1.1 DESCRIPTION

The trunnion bearings are split sleeve type journal bearings with split pillow blocks. The bearing base is cast steel and the bearing cap and lower bushing is a bronze alloy. Each trunnion bearing has seven grease fittings, three in each cap and four in each base. Each bearing assembly supports the bascule leaves and provides the rotational axes. Springs are located under the castle nut and washer securing the trunnion bearing cap to the base.

Refer to Photo numbered 4.2E.

3.1.1.2 NUMBER OF ITEMS AND LOCATION

There are 32 trunnion bearings. Four are used to support each bascule leaf. The trunnion assemblies are located in the bascule piers just forward of the leaf counterweights.

3.1.1.3 MAINTENANCE AND SCHEDULE

THREE MONTHS (Use Form 6-3)

- Remove purge-plugs and purge old grease by pumping new lubricant into the grease fittings. There are seven grease fittings per trunnion bearing. The lubricant should be Mobil Mobilux EP-2 grease or equal. Remove excess grease from the inboard and outboard sides of the main trunnion bearings, and reinstall purge-plugs.

ANNUALLY (Use Form 6-3)

- Check housing and supporting frame for signs of corrosion. Clean and spot paint, as necessary.
- Check housing cap bolts and base bolts. Torque as necessary. Springs at cap nuts should be compressed to 5.0”.

3.1.2 LIVE LOAD BEARINGS

3.1.2.1 DESCRIPTION

A live load bearing consists of a live load shoe mounted under the bascule girder and a strike plate mounted to the pier.

The live load bearings react against the live load from traffic and relieve some of the load on the trunnions when the span is closed. The live load shoes make contact with strike plates mounted on pedestals located in each corner of the pier on the channel side. Shims underneath the strike plates provide adjustment of the vertical position of the closed span.

Refer to Photo numbered 4.2F.

3.1.2.2 NUMBER OF ITEMS AND LOCATION

There are sixteen live load bearings, one located at each bascule girder lower flange forward of the trunnion. The live load bearings are accessible outside of the span drive machinery rooms.
3.1.2.3 MAINTENANCE AND SCHEDULE

THREE MONTHS (Use Form 6-3)

- Check that all live load bearings are in contact with their strike plates when the span is closed and the center and tail locks are driven. There should be no movement of the live load shoes when heavy traffic loads cross the span.

- Clean debris from all supporting members and plates.

ANNUALLY (Use Form 6-3)

- Check that all fasteners are tight and corrosion free.

- Visually examine the live load strike plate pedestals for cracking and corrosion.

- Check the contacting surfaces between the shoe and plate for deformations and wear. There should be no corrosion on the contact areas of the shoe and plate. If corrosion is present, clean the bearing surfaces.

- If necessary, use shims to adjust the position of the live load strike plates. The shims must be adjusted so that each shoe makes full contact with its strike plate when the center locks are driven and the brakes are set.

3.1.3 REAR LIVE LOAD BEARINGS

3.1.3.1 DESCRIPTION

Rear live load bearings consist of a steel masonry plate mounted to the piers and steel bearing strike plates mounted to the tail of the bascule girders. The rear live load bearings limit uplift on the trunnion bearings accompanied by heavy live loads at the toe of the leaf. When there are no traffic loads on the bascule span the masonry plates should not be in contact with strike plates. The clearance should be approximately ¼ inch. Shims at the strike plate adjust the clearance between the masonry plate and strike plate.

Refer to Photo numbered 4.2G.

3.1.3.2 NUMBER OF ITEMS AND LOCATION

There are sixteen rear live load bearings, one located at the rear of each bascule girder.

3.1.3.3 MAINTENANCE AND SCHEDULE

THREE MONTHS (Use Form 6-3)

- Check that the masonry plates have approximately ¼ inch clearance with their strike plates when the span is closed and the center and tail locks are driven.

ANNUALLY (Use Form 6-3)

- Check that all fasteners are tight and corrosion free.

- Check the contacting surfaces between the masonry plates and strike plates for deformations and wear. Clean the bearing surfaces.

- If necessary, use shims to adjust the position of the strike plate. The shims must be adjusted so that each masonry plate has approximately ¼ inch clearance with its strike plate.

3.1.4 COUNTERWEIGHTS

3.1.4.1 DESCRIPTION

The counterweights are concrete masses that balance the weight of the bascule leaves forward of the trunnion center lines.
3.1.4.2 NUMBER OF ITEMS AND LOCATION

There are a total of 8 counterweights, one on each bascule leaf.

3.1.4.3 MAINTENANCE AND SCHEDULE

ANNUALLY (Use Form 6-3)

- Check counterweight balance block pockets for proper drainage and clean out debris.
- Check for concrete spalling, cracks, and signs of structural distress.
- Check for shifting of balance blocks during leaf operation.

3.2 SPAN DRIVE MACHINERY

The Span Drive Machinery for each leaf is located in the machinery room on the bascule piers, directly below the Trunnions. Span Drive Machinery for each leaf consists of two 150 HP electric motors, four brakes, three gear reducers, pinions, racks, pinion bearings, couplings and shafts. Each of the two AC squirrel cage motors has a full load torque of 441 lb-ft at a speed of 1785 RPM, full load current is 163 Amperes. The motors have a 60 minute duty cycle and only one motor operates during an opening. The motors are connected to opposite ends of the continuous input shaft of the primary differential reducer through grid couplings. The differential of the primary reducer is located on the low speed shaft and divides the torque evenly between the two output shafts. Each output shaft connects to separate secondary reducers through floating shafts and gear couplings. Each secondary reducer drives a pinion which meshes with a rack fastened to the bottom flange of a bascule girder. The secondary reducer output shafts also turn right angle bevel gear reducers which are connected to rotary cam limit switches and a rotary position resolver. There are Motor Brakes (a total of two per machinery room) located on opposite ends of the primary reducer input shaft between the motor coupling and the reducer housing. There are also Machinery Brakes (a total of two per machinery room) located at the non-driven ends of the input shafts of the Secondary Reducers. All motor and machinery brakes are spring set and electro-hydraulically released, as commanded by the Bridge Control System.

American Bridge has provided Operation and Maintenance manuals for the Woodrow Wilson Bridge Span Drive Machinery. These manuals are thorough and describe the required maintenance for all Span Drive Machinery. The manuals contain as built drawings of all components, certified prints of purchased components and contains copies of the respective manufacturer's original documentation including copies of manufacturer's maintenance manuals. Lubrication charts from the manual have been copied, for reference, to Appendix A of this manual.

3.2.1 MOTOR AND MACHINERY BRAKES

3.2.1.1 DESCRIPTION

The Motor and Machinery Brakes were manufactured by Bubenzer Bremsen. The brakes are used for holding the span in any position and for emergency stops. They should experience limited wear. Although it is unlikely, the brakes may require adjustment over time due to brake shoe wear.

Refer to Photos numbered 4.2I and 4.2J.

3.2.1.2 NUMBER OF ITEMS AND LOCATION

Each leaf is equipped with a total of 4 brakes, two motor brakes and two machinery brakes.

The two Motor Brakes are located on opposite ends of the continuous input shaft of the primary reducer between the motor coupling and the reducer housing.

The Machinery Brakes are located on the non driven end of the input shaft on the secondary reducers.
3.2.1.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

GENERAL
Brakes should experience limited wear. In the event that brakes require the following items, refer to the Manufacturer’s Operation and Maintenance Manuals for detailed instructions.

- Maintenance of the Automatic Wear Control (AWC)
- Setting Equal Air Gap between the brake shoes and the brake drum
- Adjusting the Thrustor Reserve Stroke
- Brake Shoe Replacement
- Replacing the Thrustor
  - Replacing the Spring unit
  - Replacing limit switches
  - Adjusting the time delay
  - Checking and Changing Thrustor Oil

Brake Thrustor maintenance, if necessary, should be performed by a Bubenzer Bremsen authorized specialist.

ANNUALLY (Use Form 6-4)

- Check fluid level in hydraulic reservoir, check for leakage of fluid and clean as necessary. If fluid is added, check level again after the thrustor pump mechanism has been operated a few times, and if necessary, add fluid to the proper level. The plug for checking the hydraulic brake fluid is located on the top of the thrustor. Do not overfill.
- Inspect brake shoes and drums for wear, dust, dirt, grease and proper adjustment. Inspect chrome plated brake wheel for damage. 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 hand released.
- Inspect mechanical linkage for wear, broken parts and tightness of nuts and bolts. Lightly lubricate bearing pins, check for freedom of moving parts (no binding or sticking).
- Check for excessive heating of parts, evident by discoloration of metal parts, odor, evidence of water dripping on brake, corrosion, smooth operation and excessive vibration.
- Check adjustment of limit switches and hand release devices.
- Check for possible wear of the automatic wear compensator (AWC).
- Check thrustor reverse stroke and brake spring tension.
3.2.2 COUPLINGS

3.2.2.1 DESCRIPTION

Falk couplings are used throughout the span drive machinery for transmitting leaf driving torque. Couplings should require little maintenance as long as they are well lubricated.

Refer to Photo numbered 4.2B.

NUMBER OF ITEMS AND LOCATION

The span drive machinery for each leaf has 2 grid couplings and 6 gear couplings. Grid couplings connect the motors to the primary reducer. Single engagement Gear couplings and floating shafts connect the primary reducer to the secondary reducers. Double engagement gear couplings connect the secondary reducers to the pinion shafts.

3.2.2.2 MAINTENANCE AND SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

MONTHLY (Use Form 6-4)

- Inspect key and keyways at all couplings for leaks, tightness and cracking. Check coupling flange bolts for corrosion and tightness.
- Inspect for leaks at seals and gaskets.

SIX MONTHS (Use Form 6-4)

- Purge lubricant and replace with new. Remove pipe plugs and install a grease fitting into the upper most port. Place a collection bucket underneath the lower most port. Connect grease gun and pump the appropriate amount of grease into the coupling to completely replace the existing grease. See lubrication schedule in Appendix A for details.

TWO YEARS (Use Form 6-4)

- Check tightening torque of flange fasteners (see table in Appendix C)
- Inspect seal ring and replace if damaged
- Sample lubricant from couplings with least favorable alignment. Lubricant can be analyzed for excessive quantities of metal particles. Iron content should not exceed 150 parts per million. Should Iron content exceed 150 parts per million, the coupling may require disassembly and internal inspection.

Refer to the lubrication charts located in Appendix A for lubrication frequency, quantities, and other details.

3.2.3 PRIMARY AND SECONDARY REDUCERS

3.2.3.1 DESCRIPTION

The primary differential reducers are an Earle Gear Design and were manufactured by the Steward Machine Co. The secondary reducers were manufactured by Foote Jones. The primary and secondary are parallel shaft reducers and have gear ratios of 32.6:1 and 32.9:1, respectively. Name plates for each reducer have serial numbers specific to each particular unit that should be referenced if inquiries to the manufacturers are ever required. For more information, refer to the manuals provided by their manufacturers' and to the AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual Section 4.3.7.
Refer to Photos numbered 4.2B and 4.2C.

3.2.3.2 NUMBER OF ITEMS AND LOCATION

There is one primary differential reducer and two secondary reducers on each leaf. All eight primary reducers on the bridge are identical to each other. All secondary reducers are nearly identical in construction, except for left and right hand versions which are symmetrical about a vertical plane passing through the centerline of the primary reducer.

3.2.3.3 MAINTENANCE SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/ Tagout Procedure.

MONTHLY (Use Form 6-4)

- Listen for unusual noises during operation of the machinery.
- Visually inspect the oil level in the sight gauge before operating the leaf, in order to obtain an accurate observation. Add make up oil as necessary
- Inspect hygroscopic breather for discolored beads. Generally, blue is acceptable and pink warrants replacement.

ANNUALLY (Use Form 6-4)

- Check for leaks at seals.
- A test sample of the oil should be taken from each primary and secondary reducer. Oil should be sampled from the sampling port, preferably immediately after an operation of the leaf. Oil should analyzed to check for metal particles, water, sludge and correct viscosity. The oil shall be deemed in need of replacement or filtering if any of the following limits is exceeded:
  
  Water content in excess of 500 parts per million (.05%)
  Iron content in excess of 150 parts per million
  Silicon (dust/dirt) content in excess of 25 parts per million
  Viscosity changes more than +/- 15%
  ISO 4406 cleanliness guidelines 25/22/18 exceeded

Additionally, the presence of any additives should be recorded. Test reports should be provided in a quantitative as well as qualitative format.

It is acceptable to filter contaminants and water from a lot of oil and return it to service, as long as the viscosity has not changed in excess of 15%.

3.2.4 PILLOW BLOCKS

3.2.4.1 DESCRIPTION

Spherical Roller bearings support the pinion shaft. The bearings are adapter mounted, the inboard bearings are fixed and the outboard bearings float.

3.2.4.2 NUMBER OF ITEMS AND LOCATION

Pillow blocks are located on the pinion shaft, each shaft is supported by two bearings.
### 3.2.4.3 MAINTENANCE AND SCHEDULE

**THREE MONTHS**

Fill with new grease, as required to completely purge the bearing. Use Mobilux EP-2, refer to the lubrication schedule.

**TWO YEARS**

Remove the bearing cap and clean old lubricant from the bearing. Inspect for any signs of degradation.

### 3.2.5 RACK AND PINIONS

#### 3.2.5.1 DESCRIPTION

Two open Rack and Pinion gear sets provide the final reduction from the span drive machinery to the bascule leaf. The rack is a 45 tooth, 60.7º sector gear with a 21 inch face width. The pinion is a 21 tooth straight spur gear integral with the pinion shaft, with a 23 inch face width.

Refer to Photo numbered 4.2D.

##### 3.2.5.2 NUMBER OF ITEMS AND LOCATION

Each leaf has two rack and pinion sets. The pinions are supported in spherical bearing pillow blocks and coupled to the secondary reducer output shafts. The racks are fastened to the bottom flange of the bascule girder.

#### 3.2.5.3 MAINTENANCE SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**THREE MONTHS (Use Form 6-4)**

- Remove any debris from the area
- Remove any lubricant that has been displaced to non-contact surfaces

**TWO YEARS (Use Form 6-4)**

Observe displacement patterns in open gear lubricant for evidence of misalignment. Clean all old lubricant from all shaft, rim and gear tooth surfaces, including the top and bottom land, using solvent, a brush and a scraper. Use SwanTek Quickclean Solvent Cleaner Spray or similar. Use a pan or tray to catch the solvent and lubricant and avoid polluting the river. When the gear teeth have been cleaned, inspect for any signs of abnormal wear or misalignment. Add new lubricant to contact surfaces where lubricant has been displaced.

### 3.2.6 BEVEL GEAR REDUCER

#### 3.2.6.1 DESCRIPTION

Bevel gear reducers are used to connect rotary position measurement equipment to the secondary reducers. These reducers transmit very little torque and should require minimal maintenance.

Refer to Photo numbered 4.2C.

#### 3.2.6.2 NUMBER OF ITEMS AND LOCATION

The Bevel gear reducers are located on the non-drive end of the secondary reducer output shaft extensions. The span drive machinery of each leaf has a total of two bevel gear reducers.
3.2.6.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from
all pertinent electrical equipment, which includes multiple power sources, before
beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

MONTHLY (Use Form 6-4)

- Listen for unusual noises during operation of the machinery
- Visually inspect the oil level by removing the plug in the side. Add make up oil as necessary
- Inspect shaft seals for evidence of leakage

TWO YEARS (Use Form 6-4)

- Sample oil and analyze according to the same criteria used for the primary and secondary reducers. Add makeup oil since a typical sample is 1/8 of this reducer's capacity. If viscosity has changed in excess of 15%, replace the oil.

3.3 SPAN LOCK MACHINERY

The span lock machinery consists of an electric motor, brake, motor coupling, speed reducer, instrumentation coupling, floating shaft couplings, floating shaft, crank shaft, crank shaft bearings, connecting rod, lock bars, lock bar guides and receivers. Span lock bars provide a locking mechanism and transfer live load (traffic loads) between the near and far leaves of the bridge's bascule span.

Refer to Photo numbered 4.3A for span lock machinery access identification.

3.3.1 SPEED REDUCERS, COUPLINGS AND FLOATING SHAFTS

3.3.1.1 DESCRIPTION

The prime mover of the span lock speed reducers is an electric motor located at each span lock. An electric brake engages the extended output shaft of the electric motor. The motor is coupled to an enclosed speed reducer with a controlled torque coupling. There are two output shafts for the enclosed speed reducer. One output shaft is coupled to the rotary cam limit switch while the other output shaft is coupled to the floating shaft which transmits torque to operate the lock bar.

Refer to Photo numbered 4.3B.

3.3.1.2 NUMBER OF ITEMS AND LOCATION

There are sixteen controlled torque couplings, enclosed speed reducers, instrumentation couplings and floating shafts with two located on each leaf. There are 32 floating shaft couplings with four located on each leaf.

The speed reducers, couplings and floating shafts are located at the toe on both the East and West leaves on the North and South sides.

3.3.1.3 MAINTENANCE SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from
all pertinent electrical equipment, which includes multiple power sources, before
beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.
MONTHLY (Use Form 6-5)

- Listen for unusual noises during operation of the equipment. Only one lock bar shall be operated per bridge with traffic on the span.
- Inspect keys and keyways at all couplings for tightness and cracking. Check coupling flange bolts for corrosion and tightness.
- Visually inspect oil level from the site gauge located on the enclosed speed reducer. Add oil as necessary to maintain proper levels. Use MobilGear 600XP 150.
- Visually inspect the hydroscopic breather. When the beads change to pink, replace the breather.

THREE MONTHS (Use Form 6-5)

- Purge old grease from the controlled torque coupling and apply new grease. Use Mobil Mobilux EP-111 grease. Wipe off excess grease to prevent contamination of the clutch friction surfaces.

SIX MONTHS (Use Form 6-5)

- Purge old grease from the floating shaft couplings and apply new grease. Use Mobil Mobilith SHC 1000 Special grease. Wipe off excess grease.

ANNUALLY (Use Form 6-5)

- Obtain a sample of each reducer lubricant through the sampling port, have it analyzed by a qualified testing lab for the presence of contaminants, water, metal particles, sludge and correct viscosity. Depending on the lab results, oil should be drained, properly discarded, and new oil added to replace the old. Use MobilGear 600XP 150. If lab results indicate a high percentage of contamination, further examination should take place by the reducer manufacturer to assess the problem. Collection of the sample should follow operation of the lock bar.
- Check the external housing and structural support to which the reducer is mounted for any loose or cracked paint. The housing, including all bolts, mounting feet and flanges, and structural support should be free of rust. Corner areas that collect dirt and debris should be cleaned. Rusted housing and structural support areas should be cleaned and spot painted with a rust inhibitor.
- Inspect floating shaft for signs of cracks paying particular attention to areas of high stress such as keyways.
- Check torque setting for the controlled torque coupling. Torque setting shall be 46 ft-lbs. Adjust setting as required.

3.3.2 CRANK SHAFT AND CONNECTING ROD

3.3.2.1 DESCRIPTION

The crank shaft is coupled to the floating shaft couplings and is supported by sleeve bearings. The crank shaft attaches to the connecting rod which provides the linear motion of the lock bar.

Refer to Photos numbered 4.3C and 4.3D.

3.3.2.2 NUMBER OF ITEMS AND LOCATION

There are sixteen crank shafts and connecting rods. Two crank shafts and connecting rods are located on each leaf. There are 32 crank shaft sleeve bearings with four bearings located on each leaf.

The crank shaft and connecting rod are located at the toe on both the East and West leaves on the North and South sides.
3.3.2.3 MAINTENANCE AND SCHEDULE

**WARNING**
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

THREE MONTHS (Use Form 6-5)

- Purge old grease from the crank shaft bearings and apply new grease. Use Mobil Mobilux EP-2 grease. Wipe off excess grease. There is one fitting located in the bearing cap.

- Purge old grease from the crank shaft-connecting rod connection and apply new grease. Use Mobil Mobilux EP-2 grease. Wipe off excess grease. There is one grease fitting located on the connecting rod.

- Purge old grease from the connecting rod-lock bar connection and apply new grease. Use Mobil Mobilux EP-2 grease. Wipe off excess grease. There are two grease fittings located on the lock bar.

ANNUALLY (Use Form 6-5)

- Visually examine the crank shaft and connecting rod for signs of stress by checking for paint cracking.

- Check the external sleeve bearing housings and structural supports for the bearings for loose or cracked paint. The housing, including all bolts, mounting feet and flanges, and structural supports should be free of rust. Rusted housing and structural support areas should be cleaned and spot painted with a rust inhibitor.

3.3.3 LOCK BAR, GUIDES AND RECEIVERS

3.3.3.1 DESCRIPTION

The lock bar is driven in and out of receiving socket with the guides supporting the lock bar. The lock bar function is to provide a locking mechanism between the East and West leaves. In addition, when the span is closed and all the lock bars are engaged (driven into the receivers) live load shear and moment at the tips of the leaves is transferred to the structure. On the top and bottom of each lock bar, a wear plate is mounted to engage with the receiving socket shoes.

There are two permissive limit switches connected to the lock bar. The limit switch arm is connected to rod ends with an adjustable threaded rod. The rod end is secured to the adapter mounted to the lock bar.

Refer to Photos numbered 4.3D, 4.3E and 4.3F.

3.3.3.2 NUMBER OF ITEMS AND LOCATION

There are sixteen lock bars with one receiving socket, front guide and rear guide per lock bar. There are two lock bars, receiving sockets, front guides and rear guides per leaf.

There are 64 rod ends with eight rod ends per leaf. The rod ends are located between the rear guide and front guide at the toe of each leaf.

3.3.3.3 MAINTENANCE SCHEDULE

**WARNING**
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before
beginning maintenance. Refer to Section 1.3, Lockout/ Tagout Procedure.

THREE MONTHS (Use Form 6-5)

- Visually inspect guides and sockets, receiving socket shoes, lock bar, wear plates, fasteners and shims for excessive wear, fit or damage.

- Apply grease to the grease fitting for all rear and front guides. There are two fittings at each guide for a total of 64 grease ports. Use Mobil Mobilux EP-2 grease. Wipe off excess grease.

- Pull the lock bar to obtain access for grease removal from the top and bottom of the receiving socket shoes and the top and bottom of the lock bar. Brush or swab the receiving socket shoes and top and bottom of the lock bar with Mobil Mobilux EP-2 grease as required. Only one lock bar shall be pulled at a time per bridge with traffic on the span.

- Purge old grease from the limit switch rod ends and apply new grease. Use Mobil Mobilux EP-2 grease. There is one fitting per rod end for a total of 64 grease ports. Wipe off excess grease.

- In the vicinity of the front and rear guide, remove the existing grease from the lock bar and brush or swab the lock bar with Mobil Mobilux EP-2 grease as required.

ANNUALLY (Use Form 6-5)

- Visually inspect all lock bar guides and receiver castings at flange radii and mounting connectings. Castings should be checked for cracks, rust and section loss. Mounting connections should be checked for corrosion and tightness. All components should have flaking paint brushed clean and spot painted as necessary.

- Check for tightness of limit switch rod ends with limit switch arm and adapter. Tighten as required.

3.4 TAIL LOCK MACHINERY

The tail lock machinery consists of an electric motor, brake, motor coupling, speed reducer, instrumentation coupling, output shaft coupling, crank shaft, crank shaft bearings, connecting rod with turnbuckle, lock bars, lock bar guides and receivers. Tail locks provide a locking mechanism and transfer live load (traffic loads) between the approach span and the rear of the leaf.

3.4.1 SPEED REDUCERS, COUPLINGS AND FLOATING SHAFTS

3.4.1.1 DESCRIPTION

The prime mover of the tail lock speed reducers is an electric motor located at each span lock. An electric brake engages the extended output shaft of the electric motor. The motor is coupled to an enclosed speed reducer with a controlled torque coupling. There are two output shafts for the enclosed speed reducer. One output shaft is coupled to the rotary cam limit switch while the other output shaft is coupled to the crank shaft with a double engagement gear coupling.

Refer to Photos numbered 4.3G and 4.3H.

3.4.1.2 NUMBER OF ITEMS AND LOCATION

There are sixteen controlled torque couplings, enclosed speed reducers, instrumentation couplings and gear couplings with two located on each leaf.

The speed reducers, couplings and floating shafts are located at the rear of each leaf on the North and South sides.
3.4.1.3 MAINTENANCE SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

MONTHLY (Use Form 6-6)

- Listen for unusual noises during operation of the equipment. Only one lock bar shall be operated per bridge with traffic on the span.
- Inspect keys and keyways at all couplings for tightness and cracking. Check coupling flange bolts for corrosion and tightness.
- Visually inspect oil level from the site gauge located on the enclosed speed reducer. Add oil as necessary to maintain proper levels. Use Mobil MobilGear 600 XP 150.
- Visually inspect the hydroscopic breather. When the beads change to pink, replace the breather.

THREE MONTHS (Use Form 6-6)

- Purge old grease from the controlled torque coupling and apply new grease. Use Mobil Mobilux EP 111 grease. Wipe off excess grease to prevent contamination of the clutch friction surfaces.

SIX MONTHS (Use Form 6-6)

- Purge old grease from the double engagement gear coupling and apply new grease. Use Mobil Mobilith SHC 1000 grease. Wipe off excess grease.

ANNUALLY (Use Form 6-6)

- Obtain a sample of each reducer lubricant through the sampling port, have it analyzed by a qualified testing lab for the presence of contaminants, water, metal particles, sludge and correct viscosity. Depending on the lab results, oil should be drained, properly discarded, and new oil added to replace the old. Use Mobil MobilGear 600 XP 150. If lab results indicate a high percentage of contamination, further examination should take place by the reducer manufacturer to assess the problem. Collection of the sample should follow operation of the lock bar.
- Check the external housing and structural support to which the reducer is mounted for any loose or cracked paint. The housing, including all bolts, mounting feet and flanges, and structural support should be free of rust. Corner areas that collect dirt and debris should be cleaned. Rusted housing and structural support areas should be cleaned and spot painted with a rust inhibitor.
- Check torque setting for the controlled torque coupling. Torque setting shall be 46 ft-lbs. Adjust setting as required.
3.4.2 CRANK SHAFT, CONNECTING ROD AND TURNBUCKLE

3.4.2.1 DESCRIPTION
The crank shaft is coupled to the output shaft of the enclosed reducer and is supported by sleeve bearings. The crank shaft attaches to the connecting rod and turnbuckle assembly which provides the linear motion of the lock bar.

Refer to Photos numbered 4.3I and 4.3J.

3.4.2.2 NUMBER OF ITEMS AND LOCATION
There are sixteen crank shafts and connecting rods. Two crank shafts and connecting rods are located on each leaf. There are 32 crank shaft sleeve bearings with four bearings located on each leaf.

The crank shaft and connecting rod are located at the rear of each leaf on the North and South sides.

3.4.2.3 MAINTENANCE SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

THREE MONTHS (Use Form 6-6)

- Purge old grease from the crank shaft bearings and apply new grease. Use Mobil Mobilux EP-2 grease. Wipe off excess grease. There is one fitting located in the bearing cap.

- Purge old grease from the crank shaft-connecting rod connection and apply new grease. Use Mobil Mobilux EP-2 grease. Wipe off excess grease. There is one grease fitting located on the connecting rod.

- Purge old grease from the connecting rod-lock bar connection and apply new grease. Use Mobil Mobilux EP-2 grease. Wipe off excess grease. There are two grease fittings located on the lock bar.

- Check turnbuckle for tightness. Tighten turnbuckle nuts as necessary.

ANNUALLY (Use Form 6-6)

- Visually examine the crank shaft and connecting rod for signs of stress by checking for paint cracking.

- Check the external sleeve bearing housings and structural supports for the bearings for loose or cracked paint. The housing, including all bolts, mounting feet and flanges, and structural supports should be free of rust. Rusted housing and structural support areas should be cleaned and spot painted with a rust inhibitor.

3.4.3 LOCK BAR, GUIDES AND RECEIVERS

3.4.3.1 DESCRIPTION
The lock bar is driven in and out of receiving socket with the guides supporting the lock bar. The lock bar function is to provide a locking mechanism between the approach span and the rear of bascule leaf.

There are two interlock limit switches connected to the lock bar. The limit switch arm is connected to rod ends with an adjustable threaded rod. The rod end is secured to the adapter mounted to the lock bar.
Refer to Photos numbered 4.3H and 4.3I.

3.4.3.2 NUMBER OF ITEMS AND LOCATION
There are sixteen lock bars with one receiving socket, front guide and rear guide per lock bar. There are two lock bars, receiving sockets, front guides and rear guides per leaf.

There are 64 rod ends with eight rod ends per leaf. The rod ends are located between the rear guide and front guide at the rear of each leaf.

3.4.3.3 MAINTENANCE SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

THREE MONTHS (Use Form 6-6)

- Visually inspect guides, receiving socket, receiving socket shoe, lock bar, fasteners and shims for excessive wear, fit or damage.
- Apply grease to the grease fitting for all rear and front guides. There are two fittings at each guide for a total of 64 grease ports. Use Mobil Mobilux EP-2 grease. Wipe off excess grease.
- Remove existing grease from the receiving socket and lock bar and brush or swab lock bar and receiving socket shoe with Mobil Mobilux EP-2 grease when the lock bar is in the retracted position. This should be performed with one tail lock bar retracted at a time and traffic on the bridge.
- Purge old grease from the limit switch rod ends and apply new grease. Use Mobil Mobilux EP-2 grease. There is one fitting per rod end for a total of 64 grease ports. Wipe off excess grease.

ANNUALLY (Use Form 6-6)

- Visually inspect all lock bar guides and receiver castings at flange radii and mounting connections. Castings should be checked for cracks, rust and section loss. Mounting connections should be checked for corrosion and tightness. All components should have flaking paint brushed clean and spot painted as necessary.
- Check for tightness of limit switch rod ends with limit switch arm and adapter. Tighten as required.

3.5 TRAFFIC GATES
3.5.1 PEDESTRIAN GATES
3.5.1.1 DESCRIPTION
Pedestrian gates are horizontal swing gates that swing open and block the walkway to prevent pedestrians from walking onto the bascule span during a bridge opening.

Refer to Photos numbered 4.1C, 4.1D, and 4.1E.

3.5.1.2 NUMBER OF ITEMS AND LOCATION
There are a total of four pedestrian gates, two to the East of the Bascule Spans and two to the West of the Bascule Spans. The gates are arranged in series. The pedestrian walkway is slightly wider at the locations of
the gates to allow a space for the machinery enclosures and space for the gate arms without imposing on the width of the walkway.

3.5.1.3 MAINTENANCE SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

SIX MONTHS (Use Form 6-7)

- Check the Transmission oil level, if oil is low check seals for evidence of leaks and refill. If oil is cloudy or dirty, purge from the drain port, flush with a light flushing oil and refill. Use Mobil SHC-629.
- Lubricate all bearings and rod ends. Use Texaco Marfak 2.
- Lubricate limit switch roller chain. Check chain tension. Use CRC Chain and Wire Rope Lubricant #03050.

Refer to the maintenance manuals prepared by B&B Roadway for more information and for non-routine maintenance.

3.5.2 WARNING GATES

3.5.2.1 DESCRIPTION

Warning gates signal on and off going traffic to stop for a bridge opening. The gate support stand is mounted adjacent to the roadway. A machinery enclosure is on top of the support stand and a rotating trunnion attaches to the gate’s counterweight arm.

Refer to Photos numbered 4.1F, 4.1G and 4.1H.

3.5.2.2 NUMBER OF ITEMS AND LOCATION

There are eight warning gates on the bridge, located on both the Virginia and Maryland sides of the bascule span. Six of the eight warning gates are equal in gate arm size; the two northernmost gates (inner loop) have a longer support arm than the others in order to span the pedestrian walkway. The warning gate machinery platforms are located outboard of the roadway barrier on a cantilevered platform.

MAINTENANCE SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

GENERAL

The warning gates are outfitted with a shear pin that is intended to fail if the gate is impacted by a vehicle. Spare pins were supplied and should be available in the event of a failure. If additional pins are required, they can be obtained from the gate manufacturer. Replacement of a failed shear pin requires tightening a nut onto the shear pin. Use a nylon insert lock nut. Hand-tighten the nut with a small wrench; the nut should not be heavily tightened. The shear pin should be able to rotate when turned by hand or with a
small wrench after tightening. The gate should not be operated with a failed pin, if not otherwise restrained.

Adjustment of the open and closed position limits is achieved through adjustment of the rotary cam limit switches. When the gate is in its fully stowed position, the gate arm should rest within the saddle.

Refer to the maintenance manual provided by B & B roadway for non-routine maintenance.

**SIX MONTHS (Use Form 6-7)**

- Check the Transmission oil level, if oil is low check seals for evidence of leaks and refill. If oil is cloudy or dirty, purge from the drain port, flush with a light flushing oil and refill. Use Mobil SHC-634.
- Check right angle reducer oil level. If oil is low, check seals for evidence of leaks and refill. If oil is cloudy or dirty, purge, flush and refill. Use Mobil SHC-629.
- Purge and lubricate trunnion bearings until clean grease flows from the bearing purge ports. Use Shell Alvania EP-2.
- Purge and Lubricate transmission shaft coupling. Remove one set screw and replace the other set screw with a grease fitting. Apply grease until new grease flows from removed set screw hole.

### 3.5.3 BARRIER GATES

#### 3.5.3.1 DESCRIPTION

Each Barrier Gate is made up of a large round tube structure, supported on either side of the roadway. Reel boxes rise and lower within the structure and wire rope net spans from one box to the other, across the roadway. Should a vehicle not stop at the warning gate, the wire net of the barrier gate should prevent it from passing onto the bascule span.

Refer to Photos numbered 4.1I, 4.1J, and 4.1K.

#### 3.5.3.2 NUMBER OF ITEMS AND LOCATION

Barrier gates are located on all approach roadways; there are a total of 2 assemblies, each with two drop down barriers.

#### 3.5.3.3 MAINTENANCE SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**THREE MONTHS (Use Form 6-7)**

- Remove water and debris from inside of vertical posts.

**ANNUALLY (Use Form 6-7)**

- Refer to Appendix B which contains a lubrication table for the Lokran Barrier Gates.

#### 3.5.3.4 GENERAL

Refer to the inspection and maintenance manual submitted by Lokran Industries for all maintenance concerns. Note that most of the mechanical components requiring maintenance are high above the roadway and access will require a lift and a lane closure.
In the event of an errant vehicle striking the arresting net, the net will have to be carefully retracted and inspected for damage. In the event that the net becomes skewed, it can be adjusted. When properly adjusted, either end of the net should be approximately the same distance above the roadway.

3.5.4 MOBILE Median BARRIER

3.5.4.1 DESCRIPTION

The movable median barriers allow emergency vehicles to cross between express and local lanes. Two movable barriers open in opposing directions allowing emergency vehicles to pass. The Movable Barriers must be inspected and maintained to ensure proper operation. The Movable Barrier machinery consists of a motor, a reducer, a sheave, a pulley, cables, tracks, rollers and springs. The barriers can be controlled either from the movable barrier control panel or the Operator's House portable control station. Operation from both locations must be verified. Operation from the Operator's House is limited to opening the barrier only.

Refer to Photos numbered 4.1L.

3.5.4.2 NUMBER OF ITEMS AND LOCATION

Movable Median Barriers are located on the Maryland approach spans between station 1476+74 and 1477+94.

3.5.4.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/ Tagout Procedure.

**SIX MONTHS (Use Form 6-7)**

- Clean debris from the area and from within the moving barrier enclosure
- Lubricate bulkhead assembly grease fittings, use Shell AeroShell Grease 7
- Lubricate capstan drive grease fittings, use Shell AeroShell Grease 7
- Spray light oil on capstan drive release knob pivot point, use Shell AeroShell Grease 7
- Operate the movable barrier after lubrication, listen for unusual noises.

**ANNUALLY (Use Form 6-7)**

- Replace or repair any damages panels, wire ropes, etc.
- Paint any scratched surfaces
- Inspect for and adjust excessive capstan drive slack
- Tighten loose nuts and bolts

3.6 ELECTRICAL POWER SYSTEMS

3.6.1 MOTOR CONTROL CENTERS

3.6.1.1 DESCRIPTION

Motor Control Centers (MCC) are assemblies of enclosed cubicles or buckets 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 Photos numbered 4.5A, 4.5B and 4.5C.

### 3.6.1.2 NUMBER OF ITEMS AND DESCRIPTION

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Location</th>
<th>Equipment Name</th>
</tr>
</thead>
</table>
| 2        | Inner Loop Virginia South Electrical Room | IVL MCC-A  
|          |                           | IVL MCC-B |
| 2        | Inner Loop Maryland South Electrical Room | IML MCC-A  
|          |                           | IML MCC-B |
| 2        | Outer Loop Virginia North Electrical Room | OVL MCC-A  
|          |                           | OVL MCC-B |
| 2        | Outer Loop Maryland North Electrical Room | OML MCC-A  
|          |                           | OML MCC-B |

### 3.6.1.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

MONTHLY (Use Form 6-10)

- Open and clean with a vacuum cleaner.
- Remove accumulation of dirt, grease, and gum with contact cleaner. Lightly lubricate contacts with silicone grease.
- Wipe off all main bus insulators and vertical bus barriers
- Remove draw-out units and check stabs and unit wiring.
- Check for corrosion and moisture.
- Examine bus bar connections for poor or loose connections and evidence of overheating.
- Lubricate door hinges and latches.
- Push each indicating light in and verify each lamp turn on. Replace bulbs as required
- Check unit door interlocks and circuit breaker disconnects for proper operation.
- Inspect terminal block screws and tighten all connections.
- Inspect wiring from unit terminal blocks for deterioration of insulation
- Inspect all circuit breakers. Verify with meter that continuity is broken on trip or switch off conditions.
- Check all starter contacts. Replaced when nearly all the silver tip is gone and the contact tip support is exposed. Do not file the contacts. Filing or otherwise dressing the contacts only results in lost tip material and reduces starter life.
- Inspect all fuses with meter and verify continuity. If fuse replacement is necessary, always install the same type and rating fuses furnished with the motor control center. Evolution in
fuse design has produced fuses that are mechanically equivalent but not electrically equivalent. They may not have the same short-circuit withstand ability and current limiting ability.

- Inspect fuse clips for dirt and verify that the clips provide a tight fit.
- For maintenance of Warning Gate drive, follow instructions under Section 3.2.6 Drive Cabinets.

**ANNUALLY (Use Form 6-12)**

- Check for discolored connections on terminals, contact supports, bus bars, or connectors. Discoloration usually indicates 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.
- Operate the motor controller/contactor without load (turn circuit breakers off) 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/contactor 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.
- Measure and record current draw on load side of contactor. Elevated reading may indicate poor connection.

**SIX YEARS (Use Form 6-13)**

- Insulation test MCC incoming service feeder conductors. Isolate conductors from all other equipment before testing. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform tests on each phase to ground and phase to phase.

### 3.6.2 DRIVE CABINETS

#### 3.6.2.1 DESCRIPTION

Drive Cabinets are free standing enclosures which house the leaf motor drive, control relays, contactors, circuit breakers, fuses, and terminal blocks.

Refer to Photos numbered 4.5D and 4.5E.

#### 3.6.2.2 NUMBER OF ITEMS AND LOCATION

Each MCC electrical room contains four drives (2 for A system and 2 for B system). Only 2 of the four drives are energized and running for any given opening.

Under normal no load condition all drives should be turned on with their fans running. Do not turn off drives unless deemed necessary for service, maintenance or inspection.

#### 3.6.2.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**NOTE:** After turning off power, the smoothing capacitors in the DC section of the main circuit take time to discharge (approx. 10 minutes). To prevent electric shock, confirm with a multi-meter that the voltage has dropped below the safety value (25VDC or below) after the charge lamp goes off.
MONTHLY (Use Form 6-10)

- Open and clean with a vacuum cleaner.
- Remove accumulation of dirt, grease, and gum with contact cleaner. Lightly lubricate contacts with silicone grease.
- Check for corrosion and moisture.
- Lubricate door hinges and latches
- Inspect terminal block screws and tighten all connections.
- Inspect wiring from unit terminal blocks for deterioration of insulation
- Inspect all circuit breakers. Verify with meter that continuity is broken on trip or switch off conditions.
- Inspect all fuses with meter and verify continuity. If fuse replacement is necessary, always install the same type and rating fuses furnished with the motor control center. Evolution in fuse design has produced fuses that are mechanically equivalent but not electrically equivalent. They may not have the same short-circuit withstand ability and current limiting ability.
- Inspect all relays and tighten connections as necessary.
- Verify enclosure heaters are functioning.
- Verify enclosure lights turn on when doors are open. Replace bulbs as required.

ANNUALLY (Use Form 6-12)

- Clean out filters with vacuum or replace if necessary
- Verify enclosure fan is functioning.
- Check for discolored connections on terminals, contact supports, bus bars, or connectors. Discoloration usually indicates 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.
- Operate the motor controller/contactor without load (turn circuit breakers off) 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/contactor normally (under load) from the control desk during a vessel or maintenance opening 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.
- Measure and record current draw on load side of contactor. Elevated reading may indicate poor connection.
- Perform drive maintenance as recommended by the drive manufacturer (See drive instruction manual page 8-3). Note: Only experienced personnel should perform maintenance of this device.
3.6.3 PANELBOARDS

3.6.3.1 DESCRIPTION

Lighting panels, also known as panel boards, 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 4.4G.

3.6.3.2 NUMBER OF ITEMS AND LOCATION

Panels are located in Electrical Rooms on Virginia and Maryland sides and in the Operator’s House.

3.6.3.3 MAINTENANCE AND SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

ANNUALLY (Use Form 6-12)

- 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.

SIX YEARS (Use Form 6-13)

- Perform megohm meter (Megger) testing of each bus section phase to phase and phase to ground.

3.6.4 TRANSFORMERS

3.6.4.1 DESCRIPTION

Transformers are electrical devices that change the electrical power source by either changing the voltage or improving the power distribution. All other maintenance should be performed by qualified personnel as listed in Chapter 1.

Refer to Photo numbered 4.4B.

3.6.4.2 NUMBER OF ITEMS AND LOCATION

There are 2 transformers in each substation located in the Medium voltage switchgear, one on each end. Testing and torque values for connections can be found in the Cutler-Hammer Medium voltage O&M Manual.
3.6.4.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**ANNUALLY** (Use Form 6-12)

- Open and clean with vacuum cleaner.
- Check for corrosion and moisture.
- Check the torque of the bus bolts and transformer taps per manufacturer’s recommendations.
- Test each Cimco Model A21 Winding Temperature indicator and Controller per manufacturer’s recommendations.

3.6.5 SWITCHGEAR

3.6.5.1 DESCRIPTION

The switchgear is comprised of Medium and Low Voltage equipment rated 34.5kV and 480v respectively and a step-down transformer. The medium voltage equipment is comprised of a main 34.5kV circuit breaker which is then connected to a step-down transformer and then to 480V breakers. All other maintenance should be performed by qualified personnel as listed in Chapter 1.

Refer to Photos numbered 4.4A, 4.4B and 4.4C.

3.6.5.2 NUMBER OF ITEMS AND LOCATION

The Virginia switchgear is located in the Outer Loop Virginia North electrical room and the Maryland switchgear is located in the Outer Loop Maryland South electrical room adjacent to the bridge control equipment (MCCs control cabinets, drives, etc.). All preventative maintenance shall be performed per Cutler-Hammer O&M Manuals.

3.6.5.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

The warning above gives precaution to remove power. Therefore, the following testing will be performed without power and no consequences will occur as a result of functionally operating control switches when power is removed.

**ANNUALLY** (Use Form 6-12)

Medium Voltage Switchgear

- Remove each FP5000 multifunction relay in the MV Equipment, check calibration and bench test.
- Remove each breaker and inspect and test.
• Operate each control switch for functionality.
• Operate each indicating light for functionality.
• Test all transducers, potential transformers and current transformers.
• Oil door hinges.
• Check and retorque all bus bolts.
• Inspect all terminal block connections.
• Inspect conductors for corrosion.

Low Voltage Switchgear

• Inspect, calibrate and test each Digitrip 1150 multifunction relay in the LV Equipment.
• Remove each breaker and inspect and test.
• Operate each control switch for functionality.
• Operate each indicating light for functionality.
• Test all transducers, potential transformers and current transformers.
• Check and retorque all bus bolts.
• Oil door hinges.
• Inspect all terminal block connections.
• Inspect conductors for corrosion.

Overall Substation

• Perform Sequence of Operation Test found in Appendix D as well as the front of the Medium Voltage Switchgear O&M Manual Vol 1 of 2.

3.6.6 STANDBY EMERGENCY GENERATOR

3.6.6.1 DESCRIPTION

Each Outer Loop south electrical room is equipped with a stand-by emergency generator to power the bridge if both utility sources are lost. The multiple utility sources and the generator are routed to the switchgear located in the Outer Loop electrical rooms. In the event both utility sources are lost, the switchgear will automatically start the generators and transfer the electrical system from normal to stand-by power. The generators will supply power until either one or both of the Utility return to service. The generators will then shut down after the cool down timer times out. A detailed preventative maintenance schedule can be found in the Emergency Standby Diesel Generator O&M Manual. Standby generators should be run weekly to ensure proper operation. Only weekly mechanical maintenance should be performed by the owner. All other maintenance should be performed by qualified personnel as listed in Chapter 1.

Refer to Photos numbered 4.4D, 4.4E, and 4.4F.

3.6.6.2 NUMBER OF ITEMS AND LOCATION

The Virginia generator is located in the Outer Loop Virginia North electrical room adjacent to the bridge control equipment (MCCs control cabinets, drives, etc.) and the Maryland generator is located in the Outer Loop Virginia North electrical room adjacent to the bridge control equipment (MCCs control cabinets, drives, etc.).
3.6.6.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**WEEKLY (Use Form 6-9)**

- Verify indicator on the annicator panel are normal.
- Perform all pre-start-up inspections and maintenance.
- Start and run generators for 15 minutes with no load.
- Perform all post run inspections and maintenance.
- Inspect batteries.
- Check Fuel level.

**ANNUALLY (Use Form 6-12)**

- Start and run generators under load for one complete opening.
- Test generator controller.
- Test Fuel System Controller.
- Check for corrosion and moisture on generator and fuel tank.
- Check all bolted connections for proper torque.
- Inspect all terminal block connections for corrosion.
- Inspect and test battery charger.
- Check battery voltage is adequate.
- Check fan belts

3.6.7 SAFETY AND DISCONNECT SWITCHES

3.6.7.1 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 and motor disconnect switches.

Refer to Photos numbered 4.5F, 4.5G, and 4.5H.

3.6.7.2 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.

3.6.7.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before
beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

ANNUALLY (Use Form 6-12)

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. Lightly lubricate contacts with silicone grease.
- 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.
- 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).

3.6.8 ELECTRICAL CONDUCTORS

3.6.8.1 DESCRIPTION

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

3.6.8.2 NUMBER OF ITEMS AND LOCATION

Numerous electrical conductors are located throughout the bridge.

3.6.8.3 MAINTENANCE AND SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

ANNUALLY (Use Forms 6-12 and 6-14)

- Insulation test conductors from the motor disconnects to the motors. Isolate conductors from all other equipment before testing, especially motor drives. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform tests on each phase to ground. The insulation test between each motor and the disconnect switch can be performed without opening the motor terminations.
• 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 fittings for signs of distress.

SIX YEARS (Use Forms 6-13, 6-14 and 6-15)

• Insulation test MCC incoming service feeder conductors. Isolate conductors from all other equipment before testing. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform tests on each phase to ground and phase to phase.

• Insulation test conductors from all other equipment, excluding incoming service conductors. Isolate conductors from all other equipment before testing. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform test on each phase to ground and phase to phase. Wiring between local circuit breakers and MCC circuit breakers can be isolated by opening the circuit breakers. Other wires will have to be disconnected from their terminals to take the reading, so take care to verify all wiring is properly labeled before disconnecting the wiring in order to reconnect it accurately.

• Insulation test conductors from motor control centers and drive cabinet load contactors to motor disconnects (Note: If load contact is closed while performing tests damage to drive may occur). Isolate conductors from all other equipment before testing. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform tests on each phase to ground and phase to phase. The wiring between the motors and the MCC can be isolated by taking the readings from the open side of the motor contactor to the opened disconnect switch. Wiring between local circuit breakers and MCC circuit breakers can be isolated by opening the circuit breakers. Take care to verify all wiring is properly labeled before disconnecting the wiring in order to reconnect it accurately.

• Using an infrared thermometer and/or camera measure and record temperatures of the terminations during maintenance and/or vessel openings. Elevated reading may indicate poor connection.

3.6.9 DROOP CABLES

3.6.9.1 DESCRIPTION

Droop cables are flexible electrical conductors that are routed from the fixed portion of the bascule pier through to the movable bascule span equipment.

These cables carry power and control conductors to equipment located on the span (navigation lights, aviation lighting, service lighting, and span lock equipment).

Refer to Photos numbered 4.5I and 4.5J.

3.6.9.2 NUMBER OF ITEMS AND LOCATION

Seven (7) Droop Cables and associated termination cabinets located on each leaf along the tail lock access platform (56 cables total).

3.6.9.3 MAINTENANCE AND SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.
ANNUALLY (Use Form 6-12)

- 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 fittings for signs of distress.
- Tighten loose connections.
- Check cables for any wear or abrasions on the outer jacket.

SIX YEARS (Use Forms 6-13 and 6-15)

- Insulation test droop cable conductors. Isolate conductors from all other equipment before testing. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform tests on each phase to ground and phase to phase. Wires will have to be disconnected from their terminals on both ends to take the reading, so take care to properly label all wiring to reconnect it accurately.
- Using an infrared thermomter and/or camera measure and record temperatures of the terminations during maintenance and/or vessel openings. Elevated reading may indicate poor connection.

3.6.10 SUBMARINE CABLES

3.6.10.1 DESCRIPTION

Submarine cables are electrical conductors routed from the Virginia electrical rooms and operator's house underneath the Potomac River to the Maryland electrical rooms to distribute power and control to the various electrical/mechanical equipment (including CCTV equipment). The submarine cable system consists of conduit and wire (single conductor wire and shielded signal cables) and multiple termination points located in the electrical rooms and the Inner Loop Virginia South and Outer Loop Virginia North Machinery Rooms. Refer to Photos numbered 4.5K, 4.5L and 4.5M.

3.6.10.2 NUMBER OF ITEMS AND LOCATION

Submarine Cables and associated termination cabinets on the bridge are located as follows:

Submarine Cables

- Bridge Control Submarine Cables (18)
- Medium Voltage Submarine Cables (1)
- Power Submarine Cables (10)
- Fiber Optic Submarine Cables (2)
- Control Submarine Cable (1)
- Termination Boxes/Cabinets
- Bridge Control Submarine Terminal Cabainets (8)
- Power Submarine Terminal Cabinets (2)
- Locations are identified in the submarine Cable Location Plans
警告

使用极大的小心，并在所有相关的电气设备前，包括多个电源，总是移除电力。参见第1.3节，锁定/标记程序。

每年（使用6-12表）

- 观察连接和接头的裂缝、退化、腐蚀、变色或其他异常。
- 检查每个导体接头在每个终端盒的紧固度。
- 检查拉力释放套管是否有损坏迹象。
- 紧固松动的连接。

**维护电缆位置图**

### 3.10.3维护和计划

**警告**

使用极端的小心，并总是移除电力从所有的相关电气设备，包括多个电源，开始维护。参见第1.3节，锁定/标记程序。

**每年（使用6-12表）**

- 环视连接和接头的裂缝、退化、腐蚀、变色或其他异常。
- 检查每个导体接头在每个终端盒的紧固度。
- 检查拉力释放套管是否有损坏迹象。
- 紧固松动的连接。

**BC - 桥梁控制**

**FO - 光纤**

**HV - 高电压功率（35kV）**

**SC - 遗留电缆**

**P - 480伏特功率**

**SP - 剩余导管通过基座**

**C - 控制**

**POTOMAC RIVER**

**SUBMARINE CABLE LOCATION PLAN**

**3.10.3 MAINTENANCE AND SCHEDULE**

**警告**

使用极大的小心，并总是移除电力从所有的相关电气设备，包括多个电源，开始维护。参见第1.3节，锁定/标记程序。

**每年（使用6-12表）**

- 环视连接和接头的裂缝、退化、腐蚀、变色或其他异常。
- 检查每个导体接头在每个终端盒的紧固度。
- 检查拉力释放套管是否有损坏迹象。
- 紧固松动的连接。
• Visually inspect the submarine cable through the arch ribs. Watch for signs of cracks, deterioration and discoloration of the cable jacket.

**SIX YEARS (Use Forms 6-13 and 6-15)**

• Insulation test submarine cable conductors. Isolate conductors from all other equipment before testing. Perform 500 volts DC insulation resistance megohm meter (Megger) testing. Perform tests on each phase to ground and phase to phase. Wires will have to be disconnected from their terminals on both ends to take the reading, so take care to properly label all wiring to reconnect it accurately.

• Using an infrared thermometer and/or camera measure and record temperatures of the terminations during maintenance and/or vessel openings. Elevated reading may indicate poor connection.

### 3.7 LIGHTING SYSTEMS

#### 3.7.1 NAVIGATION LIGHTS

##### 3.7.1.1 DESCRIPTION

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

The red/green bascule span pendulum navigation lights are divided fixtures, with portions that are red and portions that are green. When all eight leafs are fully open, the four (4) outboard lights located at the toes of each leaf turn from red to green and the twelve (12) inboard lights also located at the toes of each leaf turn from red to off. When any one leaf is not fully open, all pendulum lights are red.

The twelve (12) red bascule span pendulum navigation lights have two red sections. When any one leaf is not fully open, either of these lights located at the toes of the each leaf are red. When all eight leafs are fully open, these lights located at the toes of the each leaf will turn off.

Refer to Photos numbered 4.1M, 4.1N and 4.1O.

##### 3.7.1.2 NUMBER OF ITEMS AND LOCATION

Four red fender lights are located on each fender ring. There are sixteen (16) bascule span pendulum navigation lights. Each outboard leaf has a red/green span navigation lights as well as the inboard side of the outer loop (6 total). The green lens located on the Outer Loop inboard red/green navigation light is not connected and therefore should operate in the same as the other inboard lights. Each Inner Loop inboard side has a double unit red span navigation light (6 total).

##### 3.7.1.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**WEEKLY (Use Form 6-9)**

• Check navigation lights for proper operation.

• Replace lamps or fixtures as required.

**ANNUALLY (Use Form 6-12)**

• Check gaskets
• Tighten loose connections
• Inspection for corrosion of metal parts
• Replace worn or broken mechanical parts
• Replace lamps

3.7.2 AVIATION/OBSTRUCTION LIGHTS

3.7.2.1 DESCRIPTION

Aviation lights are red lighting fixtures. Their function is to mark tall structures on the bridge which may be a potential hazard to aviation traffic.

Refer to Photos numbered 4.1P, 4.1Q and 4.1R.

3.7.2.2 NUMBER OF ITEMS AND LOCATION

Two double unit aviation lights are located on the operator's house. Each leaf has a double unit aviation lights installed at its highest point at the fully open position (these lights only come on when the static permissive relays energize indicating all gates are down and all locks are pulled). Each (4 total) roadway light pole adjacent to the bascule span has a double unit aviation light. The controller is mounted at the base of the light pole.

3.7.2.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**WEEKLY** (Use Form 6-9)

• Check aviation lights for proper operation.
• Replace lamps or fixtures as required.

**ANNUALLY** (Use Form 6-12)

• Perform test on Aviation light system controller.
• Check gaskets.
• Tighten loose connections.
• Inspection for corrosion of metal parts.
• Replace worn or broken mechanical parts.
• Replace lamps.

3.7.3 INTERIOR/EXTERIOR LIGHTS

3.7.3.1 DESCRIPTION

Incandescent and fluorescent fixtures are mounted throughout the bridge. Lighting panels are located in the Electrical Rooms to feed the lights.
3.7.3.2 NUMBER OF ITEMS AND LOCATION

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

3.7.3.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

WEEKLY (Use Form 6-9)

- Check for burned-out lamps. Replace lamps as needed.

ANNUALLY (Use Form 6-12)

- 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.

3.7.4 TRAFFIC AND WARNING SIGNALS

3.7.4.1 DESCRIPTION

Traffic signals, warning signals and pedestrian gate Walk/Don’t Walk signals caution roadway and pedestrian traffic before and during periods of span operation.

Refer to Photos numbered 4.1A, 4.1B and 4.1D.

3.7.4.2 NUMBER OF ITEMS AND LOCATION

There are eight (8) warning signals on each on-coming approach mounted to a sign structure (4 warning signal per structure) that alternately flash upon operation. The signal heads are equipped with a flashing white strobe light. The purpose of these lights is to warn vehicular traffic to prepare to stop.

There are six red/yellow/green traffic signals on each on-coming approach mounted to a sign structure (3 warning signal per structure) ahead of the warning gates. The lights turn from green to red, after signaling yellow for approximately 10 seconds. The red signal head is equipped with a flashing white strobe light.

There are two Walk/Don’t Walk pedestrian warning traffic signals located ahead of each set of pedestrian gates. The Walk light is normally on unless an opening is occurring or about to occur. Before any of pedestrian gates are about to close to pedestrian traffic, the Walk signal will flash for approximately 10 seconds, at which point the Don’t Walk signal will come on for the duration of the opening.

3.7.4.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.
MONTHLY (Use Form 6-10)

• Verify that the traffic and warning signals directly align with the lane of traffic it controls
• Check for lights proper illumination and replace bulbs if necessary.
• Verify proper operation during marine and maintenance openings.

ANNUALLY (Use Form 6-12)

• Clean all reflectors, lenses and spot paint heads.

3.7.5 GATE ARM LIGHTS

3.7.5.1 DESCRIPTION
Gate arm lights caution roadway traffic before and during periods of span operation.
Refer to Photos numbered 4.1C and 4.1F.

3.7.5.2 NUMBER OF ITEMS AND LOCATION
There are red flashing gate arm lights mounted on the four pedestrian gate arms, eight warning gate arms and four barrier gate nets.

3.7.5.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

WEEKLY (Use Form 6-9)

• Check gate arm lights for proper operation. Replace burned out bulbs as needed.

SIX MONTHS (Use Form 6-11)

• Replace gate arm light lamps and check wiring.

3.8 ELECTRIC MOTORS

3.8.1 LOCK MOTORS

3.8.1.1 DESCRIPTION
The Electric lock motors transform electric power to mechanical power to drive and pull the lock bars.
Refer to Photos numbered 4.3F, 4.3G, 4.3H and 4.3K.

3.8.1.2 NUMBER OF ITEMS AND LOCATION
Each leaf contains two (2) - 5HP Span Locks motors and two (2) – 5HP Tail Lock Motors. Span Lock Motors are located at the toe of each span lock platform. Tail Lock Motors are located in back of the counterweight on the tail lock platforms.

3.8.1.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before
beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

DO NOT USE WATER TO HOSE DOWN THE MOTOR HOUSING

SIX MONTHS (Use Form 6-11)

- Verify Vibration Measurements for the Tail Lock Motors and Span Lock Motors are within the acceptable displacement of between 0.0025-0.005 in

ANNUALLY (Use Form 6-12 and 6-14)

Motors

- 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, using ball bearing grease manufactureres listed in the following schedule:

<table>
<thead>
<tr>
<th>VENDOR</th>
<th>REULAND</th>
<th>MOBILE OIL</th>
<th>SHELL OIL</th>
<th>CHEVERON OIL</th>
<th>TEXACO OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRAND</td>
<td>Shell Alvania #2</td>
<td>Mobilith AVQ</td>
<td>Shell Alvania #2</td>
<td>Cheveron SRI-2</td>
<td>Regal AFB2</td>
</tr>
<tr>
<td>TEMP. RANGE</td>
<td>-30°F to +230°F</td>
<td>-20°F to +350°F</td>
<td>-30°F to +230°F</td>
<td>-20°F to +350°F</td>
<td>-30°F to +230°F</td>
</tr>
</tbody>
</table>

- 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 measured, open the motor terminations and take readings directly at the motor to confirm the results. Record results of megohm meter tests on Form 6-14.
• Check the phase currents flowing in motors under loaded conditions with a clamp-on ammeter for all motors. Utilize a true RMS ammeter. Compare the measured current with the nameplate data. Record values on Form 6-14.

Solenoid Brakes
• Perform a general visual inspection while stationary and during lock 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.

SIX YEARS (Use Form 6-13)
• Repaint motors. Do not paint nameplates.

3.8.2 LEAF (SPAN) MOTORS
3.8.2.1 DESCRIPTION
The Electric leaf motors transform electric power to mechanical power to raise and lower each leaf. Refer to Photos numbered 4.2B and 4.2H.

3.8.2.2 NUMBER OF ITEMS AND LOCATION
Leaf motors on the bridge are located as follows:
Each leaf contains two (2) 150HP span motors with encoders which are located in the machinery room.
During leaf operation, only one motor is energized per leaf.

3.8.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

DO NOT USE WATER TO HOSE DOWN THE MOTOR HOUSING

SIX MONTHS (Use Form 6-11)
• Verify Vibration Measurements for the Leaf Motors are within the acceptable displacement of between .0015-.002 in

ANNUALLY (Use Forms 6-12 and 6-14)
• 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 using ball bearing grease manufactureres listed in the following schedule:

<table>
<thead>
<tr>
<th>VENDOR</th>
<th>REGLAND</th>
<th>MOBILE OIL</th>
<th>SHELL OIL</th>
<th>CHEVRON OIL</th>
<th>TEXACO OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRAND</td>
<td>Shell Alvania #2</td>
<td>Mobilith AW2</td>
<td>Shell Alvania #2</td>
<td>Chevron SR1-2</td>
<td>Regal AFB2</td>
</tr>
<tr>
<td>TEMP RANGE</td>
<td>-30°F to +230°F</td>
<td>-20°F to +350°F</td>
<td>-30°F to +230°F</td>
<td>-20°F to +350°F</td>
<td>-30°F to +230°F</td>
</tr>
</tbody>
</table>

• 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 measured, open the motor terminations and take readings directly at the motor to confirm the results. Record results of megohm meter tests on Form 6-14.

• Check the phase currents flowing in motors under loaded conditions with a clamp-on ammeter for all motors. Utilize a true RMS ammeter. Compare the measured current with the nameplate data. Record values on Form 6-14.

SIX YEARS (Use Form 6-13)

• Repaint motors. Do not paint nameplates.

3.8.4 TRAFFIC GATE MOTORS

3.8.4.1 DESCRIPTION

The Electric motors for the Barrier Gates, Warning Gates and Pedestrian Gates transform electric power to mechanical power to operate each traffic gate. Each gate motor is provided with a solenoid brake to provide holding torque on the specific device.

Refer to Photos numbered 4.1E, 4.1G and 4.1K.

3.8.4.2 NUMBER OF ITEMS AND LOCATION

Traffic gates and their locations are as follows:

• ½ HP Pedestrian Gate Motors (4) – Located on the Inner Loop North Pedestrian Walkway
• 7 ½ HP Warning Gates Motors (2) – Located on IMN and IVN approaches

• 5 HP Warning Gate Motors (6) – Located on the IMS, IVS, OMS, OMN, OVS, OVN approaches.

• 3HP Barrier Gate Motors (8) – Located on IMN, IMS, OVN and OVS approaches. (2-3HP motors per Barrier Gate).

• Movable Barrier (4) – Located on the Inner Maryland and Outer Maryland approaches. Each barrier has two motors (one to open and close the gate panels and the other latches the panel in place).

MAINTENANCE AND SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

DO NOT USE WATER TO HOSE DOWN THE MOTOR HOUSING

ANNUALLY (Use Forms 6-12 and 6-14)

Motors

• 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.

• 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 measured, open the motor terminations and take readings directly at the motor to confirm the results. Record results of megohm meter tests on Form 6-14.
• Check the phase currents flowing in motors under loaded conditions with a clamp-on ammeter for all motors. Utilize a true RMS ammeter. Compare the measured current with the nameplate data. Record values on Form 6-14.

Solenoid Brakes

• Perform a general visual inspection while stationary and during gate 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.

3.9 CONTROL SYSTEM

3.9.1 RELAY CONTROL CABINETS

3.9.1.1 DESCRIPTION

Relay Cabinets are free standing cabinets which house motor control relays, contactors, circuit breakers, fuses, power supplies and terminal blocks.

Refer to Photos numbered 4.5N, 4.5O and 4.5P.

3.9.1.2 NUMBER OF ITEMS AND LOCATION

Each MCC electrical room contains three (3) relay control cabinets (one for A system, one for system B and one for C).

3.9.1.3 MAINTENANCE AND SCHEDULE

WARNING

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

MONTHLY (Use Form 6-10)

• Open and clean with a vacuum cleaner.
• Remove accumulation of dirt, grease, and gum with contact cleaner. Lightly lubricate contacts with silicone grease.
• Check for corrosion and moisture.
• Lubricate door hinges and latches.
• Inspect terminal block screws and tighten all connections.
• Inspect wiring from unit terminal blocks for deterioration of insulation.
• Inspect all circuit breakers. Verify with meter that continuity is broken on trip or switch off conditions.
• Inspect all fuses with meter and verify continuity. If fuse replacement is necessary, always install the same type and rating fuses furnished with the relay control cabinet. Evolution in fuse design has produced fuses that are mechanically equivalent but not electrically equivalent. They may not have the same short-circuit withstand ability and current limiting ability.

• Inspect all relays and tighten connections as necessary.

• During operation verify each relay lamp turn on. Replace bulbs as required.

• Verify enclosure heaters are functioning.

• Verify enclosure lights turn on when doors are open. Replace bulbs as required.

**ANNUALLY (Use Form 6-12)**

• Clean out filters with vacuum or replace if necessary.

• Check for discolored connections on terminals, contact supports, bus bars, or connectors. Discoloation usually indicates 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.

• Manually operate each relay and contactor with associated circuit breakers off and observe contact operation to be sure it opens and closes cleanly and that the contacts are fully sealed in the closed position.

• Monitor relay and contactor operation during normal operation 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.

**SIX YEARS (Use Form 6-13)**

• Using an infrared thermometer and/or camera measure and record temperatures of all terminations. Elevated reading may indicate poor connection.

### 3.9.2 CONTROL CONSOLE

#### 3.9.2.1 DESCRIPTION

The Control Console is fabricated from 11 individual free standing cabinets which house indicating lights, selector switches, pushbuttons, meters, control relays, contactors, circuit breakers, fuses, and terminal blocks.

Refer to Photos numbered 4.5Q, 4.5R and 4.5S.

#### 3.9.2.2 NUMBER OF ITEMS AND LOCATION

Operators House Level 6 contains 11 separate control desk sections combined together to form one common control console. For information regarding the location of each specific desk within level 6 of the Operators House refer to Volume I – Operation Manual section 1.10.2.

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.
MONTHLY (Use Form 6-10)

- Open and clean with a vacuum cleaner.
- Remove accumulation of dirt, grease, and gum with contact cleaner. Lightly lubricate contacts with silicone grease.
- Check for corrosion and moisture.
- Lubricate door hinges and latches.
- Inspect terminal block screws and tighten all connections.
- Inspect wiring from unit terminal blocks for deterioration of insulation
- Inspect all circuit breakers. Verify with meter that continuity is broken on trip or switch off conditions.
- Inspect all fuses with meter and verify continuity. If fuse replacement is necessary, always install the same type and rating fuses furnished with the control console. Evolution in fuse design has produced fuses that are mechanically equivalent but not electrically equivalent. They may not have the same short-circuit withstand ability and current limiting ability.
- Inspect all relays and tighten connections as necessary.
- Check all pushbuttons, selector switches and meters and replace as necessary.
- Check all indicating lights by turning the pilot light test selector switch located behind the cabinet door and verify each lamp illuminates. Replace bulbs as required
- Verify enclosure lights turn on when doors are open. Replace bulbs as required.

ANNUALLY (Use Form 6-12)

- Check for discolored connections on terminals, contact supports, bus bars, or connectors. Discoloration usually indicates 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.
- Manually operate each relay and contactor with associated circuit breakers off and observe contact operation to be sure it opens and closes cleanly and that the contacts are fully sealed in the closed position.
- Monitor relay and contactor operation during normal operation 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.

SIX YEARS (Use Form 6-13)

- Using an infrared thermometer and/or camera measure and record temperatures of all terminations. Elevated reading may indicate poor connection.

3.9.3 LIMIT SWITCHES & RESOLVERS

3.9.3.1 DESCRIPTION

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

Refer to Photos numbered 4.1E, 4.1H, 4.1K, 4.2C, 4.2I, 4.2J, 4.3F, 4.3G, 4.3H, 4.3K, 4.5T, and 4.5U.

3.9.3.2 NUMBER OF ITEMS AND LOCATION

Limit Switches and resolvers on the bridge are located as follows:
Span Control

- 18 Circuit Span Position Rotary Cam Limit Switches (16) – Two limit switches located in each machinery room.
- Over Travel Limit Switch (16) – One located on each side of the trunnion towers
- Brake Limit Switches (128) – Four located on each brake frame
- Position Resolver (16) – Two located in each machinery room.

Lock Control:

- 12 Circuit Tail Lock Rotary Cam Limit Switch (16) – One located off of each Tail Lock reducer.
- 12 Circuit Span Lock Rotary Cam Limit Switch (16) – One located off of each Span Lock reducer.
- Tail Lock Interlocking Limit Switch (32) – Two located on each Tail Lock Bar.
- Span Lock Interlocking Limit Switch (32) – Two located on each Span Lock Bar.
- Tail Lock Manual Operation Limit Switches – Two located on each Tail Lock Motor adjacent to the covered extended shaft.
- Span Lock Manual Operation Limit Switches (32) – Two located on each Span Lock Motor adjacent to the covered extended shaft.
- Fully Seated Plunger Limit Switch (16) – Two located adjacent to each Tail Lock.

Traffic Control

- 18 Circuit Pedestrian Gate Rotary Cam Limit Switch (4) – One located in each Pedestrian Gate Housing.
- Pedestrian Gate Manual Operation Limit Switch (4) - One located in each Pedestrian Gate Housing.
- Pedestrian Gate Door Switches (12) – Three located in each Pedestrian Gate
- 18 Circuit Gate Rotary Cam Limit Switch (4) – One located in each Warning Gate Housing.
- Warning Gate Manual Operation Limit Switch (8) - One located in each Warning Gate Housing.
- Warning Gate Door Switches (24) – Three located in each Warning Gate Housing.
- 18 Circuit Barrier Gate Rotary Cam Limit Switch (8) – One located in each Barrier Gate Tower.
- Barrier Gate Manual Operation Limit Switch (8) - One located in each Barrier Gate Tower.
- Barrier Gate Door Switches (8) – One located inside each Barrier Gate Equipment Enclosure Door.
- Median Barrier (4) – Two located in each movable barrier.
3.9.3.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**ANNUALLY (Use Form 6-12)**

For all limit switches and resolvers:

- Remove accumulated dust, dirt, and moisture on housing. Use brush, soft cloth, or vacuum cleaner.
- Remove accumulated dust, dirt, and moisture from overspeed switch shafts, keeping it clean and free of galling. The bearings are sealed, lifetime bearings.
- Inspect latches, mounting hardware and seals to ensure proper seal of housing.
- Inspect all screws and tighten connections as necessary.
- If accessible, remove the cover and visually inspect condition of all internal parts.

For Rotary Cam Limit Switches:

- Inspect the switches for wear. The longevity of the switches is based on the number of cycles, and typically these do not need to be replaced for several hundred thousand cycles. Based on the number of cycles per year of this bridge, these switches should never have to be replaced.
- Inspect the rollers for wear. The longevity of the rollers is based on the number of cycles, and typically these do not need to be replaced for several hundred thousand cycles. Based on the number of cycles per year of this bridge, the rollers should never have to be replaced.
- Inspect the cams for wear. The cams are made of a harder material than the rollers, thus should last even longer. The longevity of the cams is based on the number of cycles, and typically these do not need to be replaced for several hundred thousand cycles. Based on the number of cycles per year of this bridge, the cams should never have to be replaced.

For Tail and Span Lock Interlocking and Indication (U5/7K):

- Remove the cover and visually inspect condition of all internal controller parts.
- Inspect and lubricate camshaft bearings with an all-pressure, lithium-based grease, such as GRS 91A0006.
- Inspect and lubricate contact assembly rollers, pins, and bearings with GRS 91A0007 semaphore oil (2A oil). Wipe off any excess oil.
- Inspect and lubricate 2 surfaces of rocker arm with grease. See the manufacturers literature for lubrication, maintenance, and servicing suggestions.

For Over Travel Limit Switches:

- Inspect snap action contact blocks and all internal component connections. Tighten if necessary.
- Inspect all wiring from snap action contact blocks for deterioration.
• Cycle lever arm several times.

For Fully Seated Plunger Limit Switches:
• Inspect snap action contact blocks and all internal component connections. Tighten if necessary.
• Inspect all wiring from snap action contact blocks for deterioration.
• Inspect and lubricate spring loaded trip plate with lithium-based grease, such as GRS 91A0006. Use this grease on all moving parts.

For Position resolver:
• Remove accumulated dust, dirt, and moisture from digisolver shaft, keeping it clean and free of galling.

3.9.4 OVER SPEED SWITCHES
3.9.4.1 DESCRIPTION
Centrifugal speed switches (high, medium and low) are installed on an output shaft to each motor to check operating speeds of each motor. In the event the correct speed is not reached during deceleration or the running speeds exceeds 1850 RPM the speed switches will direct the system to perform an emergency stop.
Refer to Photo numbered 4.2H.

3.9.4.2 NUMBER OF ITEMS AND LOCATION
Two high speed switch and two medium/low speed switches are located in each machinery room (32 total switches).

3.9.4.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/ Tagout Procedure.

MONTHLY (Use Form 6-10)
• Lubricate flyweight assembly with light weight non-guming oil.

ANNUALLY (Use Form 6-12)
• Remove accumulated dust, dirt, and moisture on housing. Use brush, soft cloth, or vacuum cleaner.
• Remove accumulated dust, dirt, and moisture from overspeed switch shafts, keeping it clean and free of galling where sleeve bearings slide. All bearings are sealed and are permanently lubricated.
• Inspect latches to ensure proper seal of housing.
• Inspect all screws and tighten connections as necessary. Heavy vibration of the structure causes screws to tend to loosen at a rapid rate.
3.10 MISCELLANEOUS ELECTRICAL SYSTEMS

3.10.1 VENTILATION FANS AND EXHAUST LOUVERS

3.10.1.1 DESCRIPTION
Exhaust fans are present in the block walls surrounding the Electrical Rooms.

3.10.1.2 NUMBER OF ITEMS AND LOCATION
The fans (4 each on Inner Loop and 3 each on Outer Loop) are present at both the Maryland and Virginia sides of the bridge.

3.10.1.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

WEEKLY (Use Form 6-9)
- Test fans in conjunction with the generators

3.10.2 CLOSED CIRCUIT TELEVISION SYSTEM

3.10.2.1 DESCRIPTION
A closed circuit television (CCTV) system provides operators with a view of the oncoming gates. The CCTV camera signal is transmitted to the Bridge Control House CCTV Headend equipment via fiber optic cabling. The video signals from the cameras are routed to the video multiplexers, located in the Operator's House, which provide output signals to the monitors for local operator viewing.

3.10.2.2 NUMBER OF ITEMS AND LOCATION

3.10.2.3 MAINTENANCE AND SCHEDULE

WARNING
Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

SIX MONTHS (Use Form 6-11)
- Check camera and monitor mounting bolts and tighten as necessary.
- Inspect interior of the enclosures for moisture and loose screws.
- Clean camera lenses and faceplates.
- Check electrical connectors on camera and monitor and tighten as necessary.

3.10.3 SECURITY AND FIRE ALARM SYSTEMS

3.10.3.1 DESCRIPTION
A security and fire alarm system is provided to protect the operators and the bridge.

3.10.3.2 NUMBER OF ITEMS AND LOCATION
Security and Fire Alarm are located in the Operator's House.
3.10.3.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**ANNUALLY (Use Form 6-12)**

- Inspect various detectors for proper operation by actuating their test buttons.
- Perform a general visual inspection of the equipment.
- Electrical Components: Check electrical connections and tighten if 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.

3.10.4 AIR HORN AND AIR COMPRESSORS

3.10.4.1 DESCRIPTION

The air horn provides an audible signal to vessels for an upcoming operation. The air horn is activated manually by a pushbutton on the group control desk. The air horn is connected to an air compressor that provides sufficient compressed air to sound the air horn.

3.10.4.2 NUMBER OF ITEMS AND LOCATION

Two double unit air horns are located on the roof of the Operator’s House and the air compressors are located above the control console on the top floor.

3.10.4.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

**WEEKLY (Use Form 6-9)**

- Perform a general visual inspection of the equipment and check for proper operation of the system and correct as necessary.

**ANNUALLY (Use Form 6-12)**

- Electrical Components: Check electrical connections and tighten as necessary.
- Operate the compressor under load and 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 the air horn trumpets for debris inside the trumpets.
- Inspect connecting piping, tubing or hoses for cracking or leaks.
- Check the condition of the air filter. Clean or replace as required.
3.10.5 HEATING AND AIR CONDITIONING SYSTEMS

3.10.5.1 DESCRIPTION

HVAC systems provide service for the Operator's House. Heaters and exhaust fans serve the electrical rooms at the bridge.

3.10.5.2 NUMBER OF ITEMS AND LOCATION

One air cooled evaporator unit is located at the ceiling on Level 6 of the Operator's House, the second air cooled evaporator unit is located at mechanical/electrical room floor on Level 1 of the Operator's House. Two air cooled condensing units are located at the access walkway floor on Level 3 of the Operator's House. One exhaust fan is located at rest room ceiling on Level 2 of the Operator's House.

3.10.5.3 MAINTENANCE AND SCHEDULE

**WARNING**

Use EXTREME CARE and ALWAYS REMOVE POWER from all pertinent electrical equipment, which includes multiple power sources, before beginning maintenance. Refer to Section 1.3, Lockout/Tagout Procedure.

MONTHLY (Use Form 6-10)

- Check all air filters and clean or replace as necessary.
- Check all cooling coils seals, fittings, ducting connections and pipelines for leaks and rectify as necessary.
- Purge air and non-condensable gases from all cooling coils by adhering to manufacturer's instructions.
- Check all fan bearings for excessive noise, wear and temperature and lubricate with oil or grease as necessary.
- Inspect belts and pulleys for wear and check tension of belting as necessary.
- Clean all the condensate pans, trays and drains and also operation of drain pipes especially the traps. Rectify any leakage or corrosion as necessary.
- Clean cooling coils to remove accumulated dirt and other foreign matter by washing with caustic soda solution and clean thoroughly with clean water.
- Check surfaces of casing for signs of corrosion and retreat or repaint as necessary.
- Check insulation and vapor barrier on casing and repair or replace as necessary.
- Record running hours.
- Clear, adjust and lubricate all bearings pivots and other moving parts as necessary.
- Clean or renew electric contactors as necessary.
- Renew electric fuses as necessary.
- Check all motor bearings and lubricate with oil or grease as necessary.
- Clean dust and dirt from all current carrying parts and from insulation.
- Check all safety devices, such as over-current protection devices, clean, adjust and lubricate as necessary.
- Check HVAC equipment and performance related to temperature and humidity.
CONDITION-BASED MAINTENANCE (Use Form 6-12)

- Equipment failure such as:
  - Voltage or current output of an impressed current rectifier goes to zero;
  - Galvanic action anode voltage goes to zero;
  - Current in stray current drain goes to zero, goes very high or reverses direction.
- Other conditions such as changes in anode voltage or current by more than 20% since previous readings.
- Any other abnormal condition found.

3.10.6 STRAY CURRENT

3.10.6.1 DESCRIPTION

Stray current systems entails 4/0 cable routed along the bridge girder to the stray current test box and a 250 MCM cable between the bridges.

3.10.6.2 NUMBER OF ITEMS AND LOCATION

The sole stray current test box is mounted above the bridge seat on the Virginia abutment between girders G13 and G14. From there, 4/0 cables are routed along girder G14 to Pier V7 ground grid and a 250 MCM cable connects the test box to the Inner Loop bridge at girder G8.

3.10.6.3 MAINTENANCE AND SCHEDULE

MONTHLY (Use Form 6-12)

- Verify cleanliness of the stray current/corrosion control equipment and the surrounding area. Clean dirty equipment and surrounding area.
- Check for the presence of oil, dust or other material on the equipment. Clean dirty equipment and if oil is present, locate and correct the cause.
- Check for the presence of water or other material leaking onto the equipment. If water is present, locate and correct the cause.
- Check for the presence of any "burning" smell, fumes, scorch marks or other material that could be a sign of future breakdown. Service the equipment immediately.
- Verify operation of all lamps and replace as necessary.
- Verify operation of all alarms and repair as necessary.
- Verify proper operation of any anti-condensation heaters and ensure that equipment vents are not blocked. Remove blockage and perform any repairs as needed.
- Measure and record voltage/current readings. Verify that voltage/current meters give expected readings. Investigate any unexpected readings.

3.10.7 UNINTERRUPTIBLE POWER SUPPLY (UPS)

3.10.7.1 DESCRIPTION

An Uninterruptible power supply (UPS), also known as a battery back-up, provides emergency power and line regulation as well to connected equipment by supplying power from a separate source when utility power is not available.

3.10.7.2 NUMBER OF ITEMS AND LOCATION

One UPS is located in the Operator's House.
3.10.7.3 MAINTENANCE AND SCHEDULE

SEMIANNUALLY (Use Form 6-12)

- Visually check for liquid contaminated from batteries and capacitors. Replace any contaminated liquids.
- Clean and vacuum UPS equipment enclosures.

ANNUALLY

- Conduct thermal scans on electrical connections to ensure all are tight and not generating heat, which is the first and sometimes only indication of a problem. A non-evasive diagnostic tool helps technicians identify hot spots invisible to the human eye. Technicians should re-torque if thermal scan provides evidence of a loose connection.
- Provide a complete operational test of the system, including a monitored battery-rundown test to determine if any battery strings or cells are near the end of their useful lives.
4.2 LEAF OPERATING MACHINERY
General View of Operating Machinery
Operating Machinery
Typical Trunnion Bearing, and Front and Rear Live Load bearings
Typical Span Motor and Brakes
4.3 LOCK MACHINERY
Maryland Span Lock Machinery

Access to Virginia Span Locks

Maryland Span Lock No. 1 Machinery

Maryland Span Lock No. 2 Machinery

Span Lock Access Platform

Typical Span Lock Rotary Cam Limit Switch

Typical Span Lock Speed Reducer

Typical Span Lock Connecting Rod

Typical Span Lock Crank Shaft

Typical Span Lock Bearing

Typical Span Lock Floating Shaft Coupling

Typical Span Lock Floating Shaft

Oil Sampling Port

Photo 4.3A

Photo 4.3B

General View of Maryland Span Lock Machinery

(Virginia Span Locks Similar, Except Support Structure is Below Machinery)
Typical Span Lock
Connecting Rod

Typical Span Lock
Rear Guide

Typical Span Lock
Rear Guide

Typical Span Lock
Floating Shaft and Coupling

Typical Span Lock
Crank Shaft

Typical Span Lock
Crank Shaft

Typical Span Lock
Connecting Rod

Typical Lock Bar

Controlled Torque
Coupling (Under Cover)

Typical Span Lock Rotary
Cam Limit Switch

Typical Span Lock Manual Operation
Cover, Hand Crank and Limit Switch

Typical Span Lock
Connecting Rod

Typical Lock Bar

Typical Span Lock
Reducers

Typical Span Lock
Reducer Breather

Typical Span Lock
Limit Switch Linkage Assembly

Typical Span Lock
Front Guide

Typical Span Lock
Motor and Brake

General View of Virginia Span Lock Machinery Details
Chapter 4

General View of Tail Lock Machinery

Tail Lock Machinery Supports
Tail Lock No. 1 Motor Disconnect Switch
Tail Lock No. 1 Interlocking Limit Switches
Tail Lock No. 1 Motor
Tail Lock No. 1 Rotary Cam Limit Switch

Tail Lock No. 2 Interlocking Limit Switches
South Fully Seated Limit Switch (North Not Shown)
Tail Lock No. 2 Motor Disconnect Switch
Tail Lock No. 2 Motor
Tail Lock No. 2 Rotary Cam Limit Switch
Tail Lock Reducers

Typical Tail Lock Disconnect Switch
Typical Tail Lock Rotary Cam Limit Switch
Typical Tail Lock Speed Reducer
Typical Tail Lock Motor and Brake

Typical Tail Lock Manual Operation Cover, Hand Crank and Limit Switch
Controlled Torque Coupling (Under Cover)
U5 Type Limit Switch
Typical Tail Lock Limit Switch Linkage Assembly
Typical Tail Lock Rear Guide
Typical Tail Lock Bar Front Guide (Behind Support)
Typical Tail Lock Bar
Typical Tail Lock Connecting Rod
Typical Tail Lock Crank Shaft
Tail Lock Machinery Details
4.4 POWER DISTRIBUTION EQUIPMENT
Chapter 4

35KV and 480V Switchgear

Photo 4.4A

Typical Low Voltage Power Circuit Breakers

Manual Controls

Battery Charger

Battery Rack

Photo 4.4B

1500KVA Transformer Section

Photo 4.4C

35KV Main Circuit Breaker Section
Typical Stand-By Diesel Generator

Photo 4.4D

Photo 4.4E

Photo 4.4F
Typical Distribution Panelboards

Photo 4.4G
4.5 CONTROL EQUIPMENT
Motor Control Center

Typical MCC Bucket
Circuit Breaker and Local Controls

Motor Circuit Breaker and Disconnect Handle

Local Controls and Indicators

Motor Circuit Breaker

Full Voltage Reversing Starter

Motor Overloads

Fuse

Photo 4.5A

Full Voltage Non-Reversing Starter (Behind Panel)

Photo 4.5B

Photo 4.5C

Motor Control Center

Chapter 4

Volume II – Maintenance Manual

August 2009

Maryland State Highway Administration

Woodrow Wilson Memorial Bridge
Drive Cabinet

- Drive Kilowatt and Speed Displays
- Drive Keypad
- Drive Circuit Breaker Disconnect Switch
- Cabinet Louvers
- Drive Circuit Breaker
- Disconnect
- Variable Frequency Drive
- Line and Load Reactors
- Fuses
- Load Contactor
- Industrial Control Relays
- Line Regen DC Drive

Photo 4.5D

Photo 4.5E
Safety Disconnect Switches for Span Motors, Machinery Brakes, Motor Brakes, Tail Locks and Span Locks
Droop Cables and Termination Boxes

- Fixed Droop Cable Termination Box
- Movable Droop Cable Termination Box
- Strain Relief Fittings
- Droop Cables

Photo 4.5I: View of Droop Cables

Photo 4.5J: Close-up of Strain Relief Fittings and Termination Boxes
Submarine Cables and Termination Cabinets

Typical Electrical Room Submarine Cable Terminal Cabinet

Conduit End Bell

Submarine Cables

Photo 4.5K

Photo 4.5L

Photo 4.5M
Control Cabinets

Typical Control Cabinet

Enclosure Light

Industrial Control Relays

Wire Terminations

Photo 4.5N

Photo 4.5O

Photo 4.5P

[Image of control cabinets with labeled parts]

Chapter 4

Volume II – Maintenance Manual

August 2009

Maryland State Highway Administration

Woodrow Wilson Memorial Bridge
Control Console

Homeland Security Phone
Marine Radios
Control Desk Pilot Devices
Typical Control Desk Section
Outlet
Movable Barrier
Portable Control Station
Door (Access to Wiring and Terminations)

Landline Phone
Movable Barrier Control Station Receptacle
Typical Control Desk Section

Photo 4.5Q
Photo 4.5R
Photo 4.5S
Over Travel and Fully Seated Limit Switch
CHAPTER 5 – SUPPLEMENTAL INFORMATION

5.1 BASCULE SPAN MACHINERY LUBRICATION CHARTS AND SCHEDULE
## LUBRICATION TABLE

Note: Each component to be visually inspected when lubricated.

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<th>TAG #</th>
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*August 2009*  
*Maryland State Highway Administration*  
*Woodrow Wilson Memorial Bridge*
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<td>D</td>
<td>MOBILUX EP-2</td>
<td>REMOVE CAP, CLEAN BEARINGS, FILL WITH NEW GREASE</td>
</tr>
<tr>
<td>96</td>
<td>RACK AND PINION</td>
<td>24</td>
<td>C</td>
<td>MOBILUX MARC</td>
<td>CLEAN OUT ALL LUBRICANT AND RELUBRICATE</td>
</tr>
<tr>
<td>97</td>
<td>RACK AND PINION</td>
<td>24</td>
<td>C</td>
<td>MOBILUX MARC</td>
<td>CLEAN OUT ALL LUBRICANT AND RELUBRICATE</td>
</tr>
</tbody>
</table>
5.2 BARRIER GATE LUBRICATION SCHEDULE
# Lokran Energy Absorbing Barrier Gates Maintenance Chart

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Frequency</th>
<th>Lubricant</th>
<th>Method of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance of the Lokran Barrier Gate Safety Net</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Roller at Column Base</td>
<td>Lubricate the grease fitting and assure the roller rotates.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td><strong>Maintenance of the Lokran Barrier Gate Reel Box Assembly</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting Sheave Bushing</td>
<td>Grease front and back cartridge bearings.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td>Thrust Bearing</td>
<td>Grease thrust bearing located between plates supporting the lifting bearing.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td>Brake Arm Bearing</td>
<td>Grease fittings located between the brake springs. A rigid grease hose extension aids access.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td>Brake Disk Keys</td>
<td>Exposed keys at sides of plates. Be careful to not contaminate disk brakes.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td>Motor Spring Chain Drive</td>
<td>Lubricate the exposed three row roller chain with &quot;Marine Moly Lubricant&quot; after removing any debris.</td>
<td>Annual</td>
<td>&quot;Marine Moly Lubricant&quot; from McMaster-Carr Supply (Catalog # 10625K15)</td>
<td>Grease Gun</td>
</tr>
<tr>
<td><strong>Maintenance of Lokran Barrier Gate Counterweights and Lifting System Assemblies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting Sheave Bearing - On Tops of Counterweights</td>
<td>Lubricate front and back bearings with grease. Back bearing plumbed for easy access.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td>Lifting Sheave Bearings - On Drive and Idler Plates</td>
<td>Lubricate front and back bearings with grease. Back bearing plumbed for easy access.</td>
<td>Annual</td>
<td>NLGI Grade No. 2 Lithium 12 - Hydroxystearate</td>
<td>Grease Gun</td>
</tr>
<tr>
<td>Motor Drive</td>
<td>Lubrication port on motor frame</td>
<td>Annual</td>
<td>Polyrex EM</td>
<td>Lubrication Port</td>
</tr>
<tr>
<td>Gear Box</td>
<td>Inspection and fill port located on top of gear box. Access port in roof for filling gearbox.</td>
<td>Annual</td>
<td>Mobile SHC-634 Oil</td>
<td>Grease Gun</td>
</tr>
</tbody>
</table>
5.3 COUPLING FASTENER TIGHTENING TORQUE VALUES
### Coupling Fastener Tightening Torque Values

<table>
<thead>
<tr>
<th>Description</th>
<th>Make and Model</th>
<th>Tightening Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span Drive Motor Coupling</td>
<td>FALK 1090T10</td>
<td>200 lb-in</td>
</tr>
<tr>
<td>Span Drive Intermediate Shaft Couplings</td>
<td>FALK 1045G52</td>
<td>3,000 lb-ft</td>
</tr>
<tr>
<td>Span Drive Pinion Shaft Coupling</td>
<td>FALK 1120G20</td>
<td>Center Flange: 1,840 lb-ft, End Plate: 260 lb-ft</td>
</tr>
<tr>
<td>Tail Lock Motor Coupling</td>
<td>FALK 1030T41</td>
<td>100 lb-in</td>
</tr>
<tr>
<td>Tail Lock Crank Shaft Coupling</td>
<td>FALK 1040G10</td>
<td>1,800 lb-ft</td>
</tr>
<tr>
<td>Span Lock Motor Coupling</td>
<td>FALK 1030T41</td>
<td>100 lb-in</td>
</tr>
<tr>
<td>Span Lock Floating Shaft Coupling</td>
<td>FALK 1040G51</td>
<td>1,800 lb-ft</td>
</tr>
</tbody>
</table>
5.4 SWITCHGEAR TEST PLAN

(FROM EATON OPERATION AND MAINTENANCE MANUAL VOLUME 1 OF 2)
GENERAL LAYOUT OF MARYLAND SWITCHGEAR
WOODROW WILSON MEMORIAL BRIDGE

GENERAL ORDER NUMBER MPG00667

SEQUENCE OF OPERATION

ENGINEERING SERVICE TEST PLAN

This test procedure is used to test and demonstrate proper operation of the low voltage switchgear transfer control for the Woodrow Wilson Memorial Bridge.

Electrical outages will occur as a result of these testing procedures.

Preparations for emergency lighting may be necessary. All safety precautions should be observed to insure emergency power and normal power are NEVER connected in parallel.

NOTE: Prior to testing the transfer scheme, the 34.5 kV Virginia and the Maryland side sources should be phase checked to verify proper phasing and rotation.

This procedure will address the following operations:

- Normal Conditions (State of Main and Tie Breakers during continued operations)
- Initial Start Up
- Manual Operations
- Automatic Operations
- Failure of Automatic Operations

The following references are included in this procedure and are described as follows in the order they are used:

43-11 (VA) "AUTOMATIC / MANUAL" Selector Switch in the Virginia 34.5 kV switchgear.
43-12 (MD) "AUTOMATIC / MANJAL" Selector Switch in the Maryland 34.5 kV switchgear
43-21 (EDP1) "AUTOMATIC / MANJAL" Selector Switch in the Virginia LV switchgear.
43-22 (EDP2) "AUTOMATIC / MANJAL" Selector Switch in the Maryland LV switchgear.

VM Virginia side low voltage switchgear 3200 amp main breaker
IM Maryland side low voltage switchgear 3200 amp main breaker
VT Virginia side low voltage switchgear 3200 amp tie breaker to Maryland switchgear.
MT Maryland side low voltage switchgear 3200 amp tie breaker to Virginia switchgear.
69 VA Virginia side 34.5 kV "TRANSFER TEST" selector switch.
69 MD Maryland side 34.5 kV "TRANSFER TEST" selector switch.
VA Virginia side 34.5 kV medium voltage main breaker.
MD Maryland side 34.5 kV medium voltage main breaker.
M1 Virginia side low voltage EDP1 switchgear 2000 amp main breaker
M2 Maryland side low voltage EDP2 switchgear 2000 amp main breaker
T1 Virginia side EDP1 switchgear 2000 amp tie Bkr. to Maryland EDP2 switchgear.
T2 Maryland side EDP2 switchgear 2000 amp tie Bkr. to Virginia EDP1 switchgear.
G1 Virginia side Emergency Generator and Generator breaker.
G2 Maryland side Emergency Generator and Generator breaker.
NORMAL CONDITIONS

1. Main 3200 amp breakers “VM” and “MM” are closed.
2. Main 2000 amp breakers “M1” and “M2” are closed.
3. Tie breakers “VT” and “MT” are open.
4. Tie breakers “T1” and “T2” are open.
5. Generator breakers “G1” and “G2” are open.
6. All 4 Device 43 selector switches are in the “AUTOMATIC” mode.

INITIAL START UP

1. Verify all 4 selector switches (43) are in the “MANUAL” position.
2. Verify all transfer related circuit breaker are in the fully connected position in their cells.
3. Open and close breakers (using the breaker control switch) to obtain correct breaker status as described in “NORMAL CONDITIONS” above.
4. Place all 4 selector switches (43) in the “AUTOMATIC” position.

MANUAL OPERATIONS

The tests below begin with Main & Tie breakers in the normal position, and 43-11 (VA), 43-12 (MD), 43-21 (EDP1), and 43-22 (EDP2) selector switches in the “MANUAL” position.

NOTE: For an actual visual verification that the source to be tested is lost, the secondary Potential Transformer Fuses on the 34.5 kV PT’s can be pulled to substitute the 69 VA or 69 MD selector switch operation in the procedures below.

1. No automatic operations are enabled.
   A. Test Manual Loss of Virginia Side 34.5 kV voltage.
      a) Select “TEST” on the 69 VA Transfer Test Switch on 34.5 kV main breaker VA.
      b) (No transfers at any level should occur).
   B. Test Manual Loss of Maryland Side 34.5 kV
      a) Select “TEST” on the 69 MD Transfer Test Switch on 34.5 kV main breaker MD.
      b) (No transfers at any level should occur).

2. Main breakers, Tie breakers and Generator breaker are controlled only by their respective control switches.
   A. Test the Virginia Side Manual Breaker Control Switches
      a) Open main breaker VM via the control switch.
      b) Close tie breaker VT via the control switch.
      c) Open tie breaker VT via the control switch.
      d) Close main breaker VM via the control switch.
      e) Open main breaker M1 via the control switch.
      f) Close generator breaker G1 via the control switch.
      g) Open generator breaker G1 via the control switch.

A. Test the Virginia Side Manual Breaker Control Switches (Con’t)
h) Close tie breaker T1 via the control switch.
i) Open tie breaker T1 via the control switch.
j) Close main breaker M1 via the control switch.

B. Test the Maryland Side Manual Breaker Control Switches

a) Open main breaker MM via the control switch.
b) Close tie breaker MT via the control switch.
c) Open tie breaker MT via the control switch.
d) Close main breaker MM via the control switch.
e) Open main breaker M2 via the control switch.
f) Close generator breaker G2 via the control switch.
g) Open generator breaker G2 via the control switch.
h) Close tie breaker T2 via the control switch.
i) Open tie breaker T2 via the control switch.
j) Close main breaker M2 via the control switch.

3. All interlocking to prevent paralleling remains enabled.

A. Test the Virginia Side Manual Main Breaker Interlocks.

a) The main breaker (VM) should not be able to be closed if main breaker (MM) is closed, and both tie breakers (VT & MT) are closed.
b) Open main breaker VM via the control switch.
c) Open 34.5 kV main breaker VA. (Prevent source paralleling if interlocks fail).
d) Close tie breaker MT via the control switch.
e) Close tie breaker VT via the control switch.
f) Attempt to close main breaker VM via the control switch (it should not close).
g) Open tie breaker MT via the control switch.
h) Open tie breaker VT via the control switch.
i) Close 34.5 kV main breaker VA.
j) Leave main breaker VM open (Prevent source paralleling if interlocks fail).

k) The main breaker (M1) should not be able to be closed if main breaker (M2) is closed, and both tie breakers (T1 & T2) are closed.
l) The main breaker (M1) should not be able to be closed if generator breaker (G1) is closed, regardless of the position of the main breaker (M2), and tie breakers (T1 & T2).
m) Open Main Breaker M1 via the control switch.
n) Close tie breaker T1 via the control switch.
o) Close tie breaker T2 via the control switch.
p) Attempt to close main breaker M1 via the control switch (it should not close).
q) Open tie breaker T1 via the control switch.
r) Open tie breaker T2 via the control switch.
s) Close generator breaker G1 via the control switch.
t) Attempt to close main breaker M1 via the control switch (it should not close).
u) Open generator breaker G1 via the control switch.
v) Close main breaker VM via the control switch.
w) Close main breaker M1 via the control switch.

a) The tie breaker (VT) should not be able to be closed if both main breakers (VM & MM) are closed.
b) Verify that tie breaker (MT) is open. (Prevent source paralleling if interlocks fail).
c) Attempt to close tie breaker VT via the control switch (it should not close).
d) The tie breaker (T1) should not be able to be closed if both main breakers (M1 & M2) are closed, or if either generator breaker (G1 or G2) is closed.
e) Verify that tie breaker (T2) is open. (Prevent source paralleling if interlocks fail).
f) Verify both main breakers (M1 & M2) are closed.
g) Attempt to close tie breaker T1 via the control switch (it should not close).
h) Open main breakers (M1 & M2) via their control switches.
i) Close generator breaker (G1) via the control switch.
j) Attempt to close tie breaker T1 via the control switch (it should not close).
k) Open generator breaker (G1) via the control switch.
l) Close generator breaker (G2) via the control switch.
m) Attempt to close tie breaker T1 via the control switch (it should not close).
n) Close generator breaker (G1) via the control switch.
o) Verify both generator breakers (G1 & G2) are closed.
p) Attempt to close tie breaker T1 via the control switch (it should not close). This verifies that the interlocking to prevent paralleling generators is present.
q) Open generator breakers (G1 & G2) via their control switches.
r) Close main breakers (M1 & M2) via their control switches

C. Test the Maryland Side Manual Main Breaker Interlocks.

a) The main breaker (MM) should not be able to be closed if main breaker (VM) is closed, and both tie breakers (VT & MT) are closed.
b) Open main breaker MM via the control switch.
c) Open 34.5 kV main breaker MD. (Prevent source paralleling if interlocks fail).
d) Close tie breaker MT via the control switch.
e) Close tie breaker VT via the control switch.
f) Attempt to close main breaker MM via the control switch (it should not close).
g) Open tie breaker MT via the control switch.
h) Open tie breaker VT via the control switch.
i) Close 34.5 kV main breaker MD.
j) Leave main breaker MM open (Prevent source paralleling if interlocks fail).
k) The main breaker (M2) should not be able to be closed if main breaker (M1) is closed, and both tie breakers (T1 & T2) are closed.
l) The main breaker (M2) should not be able to be closed if generator breaker (G2) is closed, regardless of the position of the main breaker (M1), and tie breakers (T1 & T2).
m) Open Main Breaker M2 via the control switch.
n) Close tie breaker T1 via the control switch.
o) Close tie breaker T2 via the control switch.
p) Attempt to close main breaker M2 via the control switch (it should not close).
q) Open tie breaker T1 via the control switch.
r) Open tie breaker T2 via the control switch.
s) Close generator breaker G2 via the control switch.
t) Attempt to close main breaker M2 via the control switch (it should not close).

C. Test the Maryland Side Manual Main Breaker Interlocks. (Con't)

u) Open generator breaker G2 via the control switch.
v) Close main breaker MM via the control switch.
w) Close main breaker M2 via the control switch.

D. **Test the Maryland Side Manual Tie Breaker Interlocks.**

a) The tie breaker (MT) should not be able to be closed if both main breakers (VM & MM) are closed.
b) Verify that tie breaker (VT) is open. (Prevent source paralleling if interlocks fail).
c) Attempt to close tie breaker MT via the control switch (it should not close).
d) The tie breaker (T2) should not be able to be closed if both main breakers (M1 & M2) are closed, or if either generator breaker (G1 or G2) are closed.
e) Verify that tie breaker (T1) is open. (Prevent source paralleling if interlocks fail).
f) Verify both main breakers (M1 & M2) are closed.
g) Attempt to close tie breaker T2 via the control switch (it should not close).
h) Open main breakers (M1 & M2) via their control switches.
i) Close generator breaker (G2) via the control switch.
j) Attempt to close tie breaker T2 via the control switch (it should not close).
k) Open generator breaker (G2) via the control switch.
l) Close generator breaker (G1) via the control switch.
m) Attempt to close tie breaker T2 via the control switch (it should not close).
n) Close generator breaker (G2) via the control switch.
o) Verify both generator breakers (G1 & G2) are closed.
p) Attempt to close tie breaker T2 via the control switch (it should not close). This verifies that the interlocking to prevent paralleling generators is present.
q) Open generator breakers (G1 & G2) via their control switches.
r) Close main breakers (M1 & M2) via their control switches.
AUTOMATIC OPERATIONS

The switchgear operations consist of 2 levels of automatic power transfer.

Level one transfer scheme consists of monitoring the available utility 34.5 kV power from both the Virginia and Maryland sides of the bridge.

Upon the loss of either source, and after a 5 second time delay, the main breaker on the affected source will open and both tie breakers ("VT" & "MT") will close, feeding both sides from the unaffected source.

In the event of the loss of both 34.5 kV utility sources, both main breakers ("VM" & "MM") and the tie breakers ("VT" & "MT") will open. The breakers will remain open until one of the 2 utility sources return.

Level two transfer scheme monitors the main 480 V power from both the Virginia and Maryland sides of the bridge.

Upon the loss of either source, and after a 10 second time delay, the main breaker on the affected source will open and both tie breakers ("T1" & "T2") will close feeding both sides from the unaffected source.

The 10 second delay is longer than the 5 second delay on the Level 1 transfer scheme in order to allow for the upstream power to transfer first, avoiding a "race" condition.

For testing purposes, the timers (delay time) can be adjusted to better view / understand the transfer scheme operations.

There is an emergency generator on each side of the bridge. In the event of the loss of both 480 V sources, both main breakers ("M1" & "M2") and the tie breakers ("T1" & "T2") will open, the emergency generators will start and Generator breaker ("G1" & "G2") will close providing power the emergency loads on their respective sides of the bridge.

LEVEL 1 AUTOMATIC OPERATIONS

The tests below begin with Main & Tie breakers in the normal position, and the 43-11 (VA), 43-12 (MD), 43-21 (EDP1), and 43-22 (EDP2) selector switches are in the "AUTOMATIC" position.

NOTE: For an actual visual verification that the source to be tested is lost, the secondary Potential Transformer Fuses on the 34.5 kV PT's can be pulled to substitute the 69 VA or 69 MD selector switch operation in the procedures below.

1. Loss of Normal 34.5 kV Utility Source on the Virginia Side.

   A. Test Automatic Loss of Virginia Side 34.5 kV voltage,

   a) Select "TEST" on the 69 VA Transfer Test Switch on 34.5 kV main breaker.
   b) 34.5 kV VA Utility breaker opens after UV time delay in the FP-5000 relay.
   c) Level 1 Timer 62-11 (Adjustable) delays for 5 seconds.
   d) Main breaker "VM" opens.
   e) Tie breakers ("VT" and "MT") close.
   f) No second level transfer operations should occur.
   g) The Virginia side switchgear is powered from Maryland side.
B. Test Automatic Return of Virginia Side 34.5 kV voltage.

   a) Select “NORMAL” on the 69 VA Transfer Test Switch on 34.5 kV main breaker.
   b) 34.5 kV VA Utility breaker closes. (Only if VA is in "Auto")
   c) Level 1 Timer 2-11 (Adjustable) delays for 20 seconds.
   d) Tie breakers ("VT" and "MT") Open.
   e) Main breaker "VM" Closes.
   f) No second level transfer operations should occur.
   g) The Virginia side switchgear is returned to normal.

2. Loss of Normal 34.5 kV Utility Source on the Maryland Side.

   A. Test Automatic Loss of Maryland Side 34.5 kV voltage.

      a) Select “TEST” on the 69 MD Transfer Test Switch on 34.5 kV main breaker.
      b) 34.5 kV MD Utility breaker opens after UV time delay in the FP-5000 relay.
      c) Level 1 Timer 62-12 (Adjustable) delays for 5 seconds.
      d) Main breaker "MM" opens.
      e) Tie breakers ("VT" and "MT") close.
      f) No second level transfer operations should occur.
      g) The Maryland side switchgear is powered from Virginia side.

   B. Test Automatic Return of Maryland Side 34.5 kV voltage.

      a) Select “NORMAL” on the 69 MD Transfer Test Switch on 34.5 kV main breaker.
      b) 34.5 kV MD Utility breaker closes. (Only if MD is in "Auto")
      c) Level 1 Timer 2-12 (Adjustable) delays for 20 seconds.
      d) Tie breakers ("VT" and "MT") Open.
      e) Main breaker "MM" Closes.
      f) No second level transfer operations should occur.
      g) The Virginia side switchgear is returned to normal.

LEVEL 2 AUTOMATIC OPERATIONS

The tests below begin with Main Tie & Generator breakers in the normal position, and the 43-11 (VA) and 43-12 (MD) selector switches in the “MANUAL”, and the 43-21 (EDP1), and 43-22 (EDP2) selector switches in the “AUTOMATIC” position.


   A. Test Automatic Loss of Virginia Side 480 voltage.

      a) Open main breaker "VM" to simulate loss of 480 V.
      b) Level 2 Timer 62-21 (Adjustable) delays for 10 seconds.
      c) Main breaker "M1" opens.
      d) Tie breakers ("T1" and "T2") close.
      e) The Virginia EDP1 switchgear is powered from Maryland EDP2 switchgear.

   B. Test Automatic Return of Virginia Side 480 voltage.
a) Close main breaker “VM” to simulate return of 480 V.
b) Level 2 Timer 2-21 (Adjustable) delays for 20 seconds.
c) Tie breakers (“T1” and “T2”) open.
d) Main breaker “M1” closes.
e) The Virginia EDP1 switchgear is returned to normal.

4. Loss of Normal 480 V Source on the Maryland Side.

A. Test Automatic Loss of Maryland Side 480 voltage.
   a) Open main breaker “MM” to simulate loss of 480 V.
b) Level 2 Timer 62-22 (Adjustable) delays for 10 seconds.
c) Main breaker “M2” opens.
d) Tie breakers (“T1” and “T2”) close.
e) The Maryland EDP2 switchgear is powered from Virginia EDP1 switchgear.

B. Test Automatic Return of Maryland Side 480 voltage.
   a) Close main breaker “MM” to simulate return of 480 V.
b) Level 2 Timer 2-22 (Adjustable) delays for 20 seconds.
c) Tie breakers (“T1” and “T2”) open.
d) Main breaker “M2” closes.
e) The Maryland EDP2 switchgear is returned to normal.

LEVELS 1 AND 2 LOSS OF BOTH SOURCES (GENERATOR OPERATION)

The tests below begin with Main & Tie breakers in the normal position, and the 43-11 (VA), 43-12 (MD),
43-21 (EDP1), and 43-22 (EDP2) selector switches in the “AUTOMATIC” position.

5. Loss of Both Normal 34.5 kV Utility Sources.

A. Test Automatic Loss of both 34.5 kV sources.
   a) Select “TEST” on the 69 VA, and 69 MD Transfer Test Switches on 34.5 kV main
      breakers.
b) 34.5 kV VA & MD Utility breakers open after UV time delay in the FP-5000 relay.
c) Level 1 Timers 62-11 (Adjustable) and 62-12 (Adjustable) delay for 5 seconds.
d) Main breakers (“VM” and “MM”) open.
e) Tie breakers (“VT” and “MT”) remain open.
f) Level 2 Timers 62-21 (Adjustable) and 62-22 (Adjustable) delay for 10 seconds.
g) Main breakers (“M1” and “M2”) open.
h) Tie breakers (“T1” and “T2”) remain open.
i) Level 2 Timers 62-23 (Adjustable) and 62-24 (Adjustable) delay for 20 seconds.
j) Emergency Generators (“G1” and “G2”) start.
k) Generator breakers (“G1” and “G2”) close.
l) Switchgear EDP1 is powered by Emergency Generator “G1”.
m) Switchgear EDP2 is powered by Emergency Generator “G2”.

B. Test Automatic Return of Virginia Side 34.5 kV voltage.
a) Select “NORMAL” on the 69 VA Transfer Test Switch on 34.5 kV main breaker.
b) 34.5 kV VA Utility breaker closes. (Only if VA is in ‘Auto’)
c) Level 1 Timer 2-11 (Adjustable) delays for 20 seconds.
d) Main breaker “VM” Closes.
e) Tie breakers (“VT” and “MT”) close.
f) The Maryland side switchgear is powered from Virginia side.

g) Level 2 Timers 2-21 (Adjustable) and 2-22 (Adjustable) delay for 20 seconds.
h) Generator breakers (“G1” and “G2”) open.
i) Main breakers (“M1” and “M2”) close.
j) Tie breakers (“T1” and “T2”) remain open.
k) Generators (“G1” and “G2”) cool down and stop.
l) The Virginia EDP1 switchgear and Maryland EDP2 switchgear are returned to normal.
m) Return the system back to Generator operation by selecting “TEST” on the 69 VA Transfer Test Switch on 34.5 kV main breaker. (This step needs to be done before additional testing below can be completed.)

C. Test Automatic Return of Maryland Side 34.5 kV voltage.

a) Select “NORMAL” on the 69 MD Transfer Test Switch on 34.5 kV main breaker.
b) 34.5 kV MD Utility breaker closes. (Only if MD is in ‘Auto’)
c) Level 1 Timer 2-12 (Adjustable) delays for 20 seconds.
d) Main breaker “MM” Closes.
e) Tie breakers (“VT” and “MT”) close.
f) The Virginia side switchgear is powered from Maryland side.

g) Level 2 Timers 2-21 (Adjustable) and 2-22 (Adjustable) delay for 20 seconds.
h) Generator breakers (“G1” and “G2”) open.
i) Main breakers (“M1” and “M2”) close.
j) Tie breakers (“T1” and “T2”) remain open.
k) Generators (“G1” and “G2”) cool down and stop.
l) The Virginia EDP1 switchgear and Maryland EDP2 switchgear are returned to normal.
m) Return the system back to Generator operation by selecting “TEST” on the 69 MD Transfer Test Switch on 34.5 kV main breaker. (This step needs to be done before additional testing below can be completed.)

D. Test Automatic Return of both 34.5 kV sources.

a) Select “NORMAL” on the 69 VA, and 69 MD Transfer Test Switches on 34.5 kV main breakers.
b) The 34.5 kV VA and MD Utility breakers close. (Only if VA and MD are in ‘Auto’)
c) Level 1 Timers 2-11 (Adjustable) and 2-12 (Adjustable) delays for 20 seconds.
d) Main breakers (“VM” and “MM”) Close.
e) The Virginia side and Maryland side switchgear is returned to normal.

f) Level 2 Timers 2-21 (Adjustable) and 2-22 (Adjustable) delay for 20 seconds.
g) Generator breakers (“G1” and “G2”) open.
h) Main breakers (“M1” and “M2”) close.

D. Test Automatic Return of both 34.5 kV sources. (Cont)

i) Tie breakers (“T1” and “T2”) remain open.
j) Generators (“G1” and “G2”) cool down and stop.
k) The Virginia EDP1 switchgear and Maryland EDP2 switchgear are returned to normal.

**FAILURE OF THE AUTOMATIC OPERATION**

The tests below begin with Main & Tie breakers in the normal position, and the 43-11 (VA), 43-12 (MD), 43-21 (EDP1), and 43-22 (EDP2) selector switches in the “AUTOMATIC” position.

The term transfer breaker refers to the following circuit breakers:

VM, VT, MM, MT, M1, T1, M2, T2, G1, and G2.

6. **Failure for a transfer breaker to close or open with 2 seconds will force an “AUTO-FAILURE”.**

   A. **Test Timer to Initiate Lock Out (Transfer Breaker Failure to Respond).**

      a) This test requires a breaker to malfunction and not open or close when required in the “AUTOMATIC” mode. This cannot be tested without re-wiring a breaker cell to cause a malfunction. This is not recommended.

      b) **OPTIONAL TEST**: Placing a jumper across terminals 1 and 3 of the “TIMER TO INITIATE LOCK OUT” timers will simulate a breaker failure and cause an “AUTO-FAILURE”. These timers are located in Structure 3 of the Virginia side switchgear and Structure 7 of the Maryland side switchgear. This test should only be performed by qualified electrical personnel who are familiar with ANSI power switchgear applications.

7. **Removing a transfer breaker from its connected position will cause “AUTO-FAILURE”.**

   A. **Test Breaker Disconnect**

      a) Before performing this test, insure the transfer breaker to be tested is open.

      b) Rack out the transfer breaker.

      c) Once the breaker is disconnected, it will cause an “AUTO-FAILURE”.

8. **An overcurrent trip or remote trip via the 86 lock-out devices will cause “AUTO-FAILURE”.**

   A. **Test Breaker OTS contact / 86 Lock Out Device**

      a) Before performing this test, insure the transfer breaker to be tested is open. If not, the test will trip the breaker.

      b) Use the Digitrip 1150 solid-state trip unit to perform a self-test.

      c) When the breaker trips, it will pick up the appropriate 86 lock-out device which will cause an “AUTO-FAILURE”.

To reset an “AUTO-FAILURE”, clear the problem causing the failure, place the mode selector switch (43) in “MANUAL”. This will reset the “AUTO-FAILURE” relay. The system can now be placed back in “AUTOMATIC”. 

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*Eaton Electrical: Page 36 of 858*
6.1 MECHANICAL MAINTENANCE FORMS
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**Notes:**

*Types

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Immediate Replacement = IR
Schedule Replacement = SR
Immediate Repair = IRP
Schedule Repair = SRP
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Notes:

- None = N
- Immediate Replacement = IR
- Schedule Replacement = SR
- Immediate Repair = IRP
- Schedule Repair = SRP
## Bridge Name: Woodrow Wilson Bridge

## Bridge Number: 1617305/1617306

### Inner Loop / Outer Loop

### Form 6-5

**MECHANICAL MAINTENANCE**

**SPAN LOCK MACHINERY**

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**Notes:**

- **None = N**
- **Immediate Replacement = IR**
- **Schedule Replacement = SR**
- **Immediate Repair = IRP**
- **Schedule Repair = SRP**
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Notes:

*Types

None = N
Immediate Replacement = IR
Schedule Replacement = SR
Immediate Repair = IRP
Schedule Repair = SRP
## Bridge Name: Woodrow Wilson Bridge

### Bridge Number: 1617305/1617306

#### Inner Loop / Outer Loop

---

**Inspector Names:**

---

**Date:**

---

### Table: Traffic Gate Machinery

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*Types:
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- Immediate Replacement = IR
- Schedule Replacement = SR
- Immediate Repair = IRP
- Schedule Repair = SRP
6.2 ELECTRICAL MAINTENANCE FORMS
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Notes:

*Types

None = N
Immediate Replacement = IR
Schedule Replacement = SR
Immediate Repair = IRP
Schedule Repair = SRP
## Monthly Frequency

**Inspector Names:**

**Bridge Name:** Woodrow Wilson Bridge  
**Bridge Number:** 1617305/1617306  
**Inner Loop / Outer Loop**

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**Notes:**

*Types*

- None = N
- Immediate Replacement = IR
- Schedule Replacement = SR
- Immediate Repair = IRP
- Schedule Repair = SRP

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**FORM 6-10**  
**MAINTENANCE MANUAL**
## Electrical Maintenance

**Bridge Name:** Woodrow Wilson Bridge  
**Bridge Number:** 1617305/1617306  
**Inner Loop / Outer Loop**

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**Notes:**

- None = N
- Immediate Replacement = IR
- Schedule Replacement = SR
- Immediate Repair = IRP
- Schedule Repair = SRP

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**FORM 6-11**  
**MAINTENANCE MANUAL**
### ANNUAL FREQUENCY

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**Bridge Number:** 1617305/1617306  
**Inner Loop / Outer Loop**

**Inspector Names:**

**Date:**

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**Notes:**

*Types

None = N  
Immediate Replacement = IR  
Schedule Replacement = SR  
Immediate Repair = IRP  
Schedule Repair = SRP
**Bridge Name:** Woodrow Wilson Bridge  
**Bridge Number:** 1617305/1617306  
**Inner Loop / Outer Loop**

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**Notes:**

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*Types

- None = N
- Immediate Replacement = IR
- Schedule Replacement = SR
- Immediate Repair = IRP
- Schedule Repair = SRP

**FORM 6-12**  
**Part 2 of 3**
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Notes:

*Types

None = N
Immediate Replacement = IR
Schedule Replacement = SR
Immediate Repair = IRP
Schedule Repair = SRP
### ELECTRICAL MAINTENANCE

#### Bridge Name: Woodrow Wilson Bridge
- **Bridge Number:** 1617305/1617306
- **Inner Loop / Outer Loop**

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**Notes:**

- *Types*
  - None = N
  - Immediate Replacement = IR
  - Schedule Replacement = SR
  - Immediate Repair = IRP
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**FORM 6-13**

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Ammeter used:  
Megger used:  
Portable tachometer used:  
Ambient temperature:  
Vibration meter used:  
Notes:  
Weather conditions:  

FORM 6-14
Part 1 of 4
## INNER LOOP MOTOR TESTING

**Bridge Name:** Woodrow Wilson Bridge  
**Bridge Number:** 1617305

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### Electrical Maintenance

- **Bridge Number:** 1617305  
- **Bridge Name:** Woodrow Wilson Bridge

**Volmeter used:**  
**Ammeter used:**  
**Megger used:**  
**Weather conditions:**  
**Ambient temperature:**  
**Notes:**
### OUTER LOOP MOTOR TESTING

Bridge Name: Woodrow Wilson Bridge
Bridge Number: 1617306

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Voltsmeter used: 
Ammeter used: 
Megger used: 
Portable tachometer used: 
Ambient temperature: 
Vibration meter used: 
Notes: 
Weather conditions: 

FORM 6-14 MAINTENANCE MANUAL 
Part 3 of 4
## MOTOR DESCRIPTION

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Megger used: Weather conditions:

Ambient temperature:

Notes:
**Bridge Name:** Woodrow Wilson Bridge  
**Bridge Number:** 1617305/1617306  
**Inner Loop / Outer Loop**

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**Megger used:**  
**Weather conditions:**

**Ambient temperature:**

**Notes:**
CHAPTER 7 - CONTACTS, TELEPHONE NUMBERS AND EMERGENCY CALL OUTS

7.1 CONTACTS AND TELEPHONE NUMBERS

- Maryland State Police 301.568.8101
- Virginia State Police 703.323.4500
- City of Alexandria Police Department 703.838.4444
- Metropolitan Police Department 202.698.1500
- United States Coast Guard 757.398.6390
- Maryland State Highway Administration 888.375.1084
- Virginia Department of Transportation 703.383.8368
- District Department of Transportation 202.673.6813
- Woodrow Wilson Memorial Bridge 703.836.2396

7.2 EMERGENCY CALL OUT PROCEDURES

During emergency situations the following procedures and protocols should be followed.

7.2.1 MALFUNCTION (FAILURE TO OPEN OR CLOSE)

During maintenance, inspection or marine vessel openings if the bridge cannot be opened or closed contact order should be as follows:

1. AMT Manager/Supervisor
2. Bridge Maintenance

7.2.2 DAMAGE TO BRIDGE FROM VESSEL OR VEHICLE

When damage to the bridge is observed or detected contact order should be as follows:

7.2.2.1 FOR MINOR DAMAGE:

When damage will not hamper normal bridge operation perform the following:

1. Log in log book
2. Notify Maintenance at earliest convenience.

7.2.2.2 FOR MAJOR DAMAGE

When damage may hamper normal bridge operation perform the following:

1. Notify Maintenance immediately.
2. Log in log book
7.2.3 FOR VEHICLE ACCIDENT OR DISABLED VEHICLE ON BRIDGE:

When an accident occurs on the bridge or a disabled vehicle is observed perform the following:

Contact SHA/CHART 410-582-5650
Contact VDOT at 703-383-2600
Contact WTOP News at 866-304-9867

1. If accident, check about possible injuries, notify Police agencies listed under Section 6.1.
2. **DO NOT** operate the bridge if accident or disabled vehicle is within the operational area of the bridge.
3. If it is an injury accident before or after operational area of the bridge contact emergency services (911) at the scene before proceeding with an opening.
4. If unable to open the bridge due to an accident or disabled vehicle notify any waiting vessels and the Coast Guard.

7.2.4 FOR MARINE RELATED EMERGENCIES:

For a marine related accident or emergency contact the following:

Coast Guard 757.398.6390