Padmount PMH Switchgear Condition Assessment

1. Scope

This work practice details the condition assessment procedures for S&C Electric PMH, live-front padmount switchgear.

The inspection procedures contained herein can be performed while the switchgear is energized. Switchgear maintenance that requires de-energizing and grounding is outside the scope of this work practice.

2. Application

This work practice is for qualified Seattle City Light (SCL) personnel who perform inspections on padmount PMH switchgear. Section 4 defines who is qualified to perform this work.

The assessment form associated with this work practice can be obtained from Standards. See Appendix B for an example.

3. Definitions

Equipment (PS) Number - also known as the “PS” number, it is a number that follows the prefix “PS” assigned to each switch. To help explain how this number is used, a PS number could be considered the equivalent of a person’s social security number. No matter where a person lives, their social security number remains the same. PS labels are assigned, printed, and attached to the switchgear at the warehouse prior to receiving the equipment.

Switch (SW) Number – also known as the System Operations Center (SOC) Switch Number, this number follows the prefix "SOC" and indicates the switch circuit location. To help explain how this number is used, an SOC number could be considered the equivalent of a street address. No matter who lives there, the address stays the same.

Parent Facility ID No. – this is also known as the Pad (P) Number, Underground (U) Switch Number, or the Vault (V) Number.

Underground (U) Switch Number – this is a switch number specifically for underground equipment. This number follows the prefix "U."

Pad (P) Number – identifies the pad on which the switch is installed. The best practice is to affix the pad number to the pad itself. Labeling the switch enclosures with the pad number should be avoided.

Vault (V) Number – identifies the vault on which the switch is installed.

4. Safety

WARNING: Do not open or operate the switch if it emits a buzzing, hissing, or crackling sound. Such sounds may indicate presence of corona or partial discharge.

Crews shall also familiarize themselves with and follow the safety information contained in the S&C Data Bulletin 662-90 and Instruction Sheet 662-510.

Padmount switchgear shall only be inspected by qualified personnel who are knowledgeable in installation, operation, and maintenance of underground electrical power distribution equipment along with the associated hazards.

This work practice is intended only for such qualified personnel. The instructions in this work practice are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

A qualified person is one who is trained and competent in:

- Distinguishing exposed live parts from non-live parts of electrical equipment.
- Determining the proper approach distances corresponding to the voltages to which the qualified person will be exposed.
- Properly using the special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment.

No body parts shall enter the plane of the switchgear during the inspection while it is energized.

Always use an S&C Grappler attached to a suitable universal pole to insert, remove, or replace front barriers. See Figure 4. No other tools are recommended. Failure to use the proper tools can result in damage to the equipment, flashover, and injury. An S&C Grappler should be located next to the storage rack on the interior fuse compartment door of each unit.

Figure 4. S&C Grappler

Removed front barrier boards shall be placed on a clean surface. Always wipe clean the barriers before placing them back to their suspended position. Do not place the removed barrier boards on the ground because they could become contaminated and present a potential arc flash hazard.

5. Required PPE

The following PPE is required to complete padmount switchgear condition assessment procedures:

- Flame-resistant (FR) clothing that is the appropriate class
- Safety glasses
- Gloves (appropriate type)
- Hard hat
- Safety cones and yellow tape

6. Required Tools and Reference Materials

6.1 Tools

The following tools are required to complete PMH switchgear condition assessment procedures:

- Universal pole insert
- S&C Grappler (included inside each type of PMH switch)
- Flashlight
- Infrared heat sensor gun
- Digital camera
- Tripod
- Switch key/socket

6.2 Reference Materials

It is recommended that the following reference materials be on hand when conducting the condition assessment procedures:

- **SCL 1167.13**; "Padmount Switch Signs and Labels"
- S& C Instruction Sheet 662-510
- S&C Data Bulletin 662-90

7. Procedure

Follow all safety and clearance procedures before performing any work on the switch. Proper PPE is required to perform this work practice. See Section 5, "Required PPE."

Part 1: Site and Location

Assessment	Performance Expectations	Image Reference
Access to site	▪ Switch is reasonably accessible to SCL operations and maintenance personnel. ▪ Accessing the site does not require a special key, permit, or prior approval for entry, as may be required for locations inside a customer building or facility.	1a
Compartment access	▪ Compartments are accessible with adequate space to perform routine operations and maintenance: 10 ft in front of doors, 3 ft on sides.	1b, 1c

Part 2: Enclosure Exterior and Pad

Assessment	Performance Expectations	Image Reference
Signs and labels	▪ Warning, danger, and notice signs are easy to read. Switch (SOC) Number and Equipment (PS) numbers are assigned and easy to read. See SCL Work Practice 1167.13 for padmount switch signs and labels.	2a
Paint condition	▪ No graffiti, only minor rust, no moss	2b
Pad	▪ No major cracks, reasonably level	–
Seal	▪ Enclosure sealed at pad to prevent animal ingress	–
Doors, locks, and latches	▪ Easy to operate, proper alignment, all latch points engage, locks and Penta head bolts are secure.	–

Part 3: Switch Interior

Assessment	Performance Expectations	Image Reference
Water ingress	▪ No standing water	3a
Conduits	▪ Sealed	3a
Vapor barrier	▪ Installed	3a
Condensation	▪ Little or no condensation on roof or walls	3b
Contamination	▪ Little or no contamination on room or walls. ▪ No signs of animal intrusion	–

Part 4: Ground Connections

Assessment	Performance Expectations	Image Reference
Fence	▪ All fences within six feet of switch are grounded. See SCL U10-1.2, Section A-A.	4a
Enclosure	▪ Enclosure is grounded as can be practically determined by visible inspection. See SCL U10-5, Figures 1 and 3.	4b, 4c
Surge arresters and terminations	▪ Surge arresters and terminations are grounded. See U10-5, Figure 7.	4d
Electrical clearances	▪ The clearance of any energized part to the electrical ground meets the 7-1/2-in minimum air clearance requirements as described in Table 3 of S&C Data Bulletin 662-590.	4e

Part 5: Barrier Boards

Assessment	Performance Expectations	Image Reference
Installation	▪ Boards are in place and secured by appropriate 1/4 turn or thumb-screw hardware. Barrier boards are inserted in appropriate barrier guides.	5a
Physical condition	▪ No warping or delamination ▪ Only minor dirt and contamination. ▪ Boards are not wicking, coming apart, discolored, or otherwise damaged.	5b
Dielectric condition	▪ Less than 1 square inch of corona caused surface deterioration	5c
Electrical clearances	▪ The clearance of any energized part to the barrier board meets the 2-1/4-in minimum air clearance requirements as described in Table 3 of S&C Data Bulletin 662-590.	4e

Part 6: Terminations

Assessment	Performance Expectations	Image Reference
Terminations	▪ Only minor contamination, no signs of corona damage, no signs of tracking on surface	6a
Installation	▪ Terminations of the same compartment are of the same style/type. ▪ Terminations are straight and do not touch concrete knockouts. ▪ Cables are not pulling on terminations. ▪ Termination top skirt is below or at the same level as the ground studs.	6b, 6c
Electrical clearances	▪ There is at least 6-1/2-in of clearance from the grounding studs to the concentric neutral cable at the base. ▪ The clearance of the terminator skirts to the barrier board meets the 1-1/4-in minimum air clearance requirements as described in Table 3 of S&C Data Bulletin 662-590.	6d, 6e

Part 7: Fuses

Assessment	Performance Expectations	Image Reference
Fuse holders	▪ No signs of overheating ▪ No signs of tracking	7a
Fuses	▪ Little to no surface contamination ▪ No signs of physical damage ▪ No signs of tracking	–

Part 8: Surge Arresters

Assessment	Performance Expectations	Image Reference
Surge arresters	▪ Little to no surface contamination ▪ No signs of physical damage	8a
Electrical clearances	▪ Clearance from the surge arrester connecting rod to the barrier board, to termination skirts, or to the insulating surfaces between the concentric neutral's end and the conductor lug should be at least 2-1/4 inches for 25 kV as described in Table 3 of S&C Data Bulletin 662-590.	4e

Part 9: Insulators

Assessment	Performance Expectations	Image Reference
Insulator condition	▪ Little or no surface contamination ▪ No signs of physical damage	9a

Part 10: Switch

Assessment	Performance Expectations	Image Reference
Switch contacts	▪ No signs of overheating ▪ Only minor erosion	10a
Electrical clearances	▪ Clearance from the grounding studs to the barrier board should be at least 2-1/4 inches for 25 kV as described in Table 3 of S&C Data Bulletin 662-590.	4e

Notes:

In 2005 S&C Electric Company changed the design of Mini-Rupter switches used in their type of padmount PMH switchgear lineup:

- Pre-2005 Design: In this design version, the strut assembly runs the full length of the switch compartment and it is attached to the switch frame on both ends. With the exception of arc compressors, if something goes wrong with the switch, S&C will provide a new switch that would fit inside the existing switch compartment. (See Image Reference 10b)
- Post-2005 Design: In this design version, the strut assembly does not run the full length of the switch. Instead, it is attached to the switch frame on one side and supported by the lower switch insulators on the other side. The switch inter-phase and end barrier boards are also different in the post-2005 design. (See Image Reference 10c)

Part 11: Heat Sensor Readings

Assessment	Performance Expectations	Image Reference
Ambient temperature	▪ Measure ambient temperature	–
Highest bushing/elbow/fuse or switch contact temperature above ambient	▪ Less than 10 degrees centigrade above ambient	–
Comparison of values between the phases of the switch	▪ Less than 5 degrees centigrade difference between the phases	–

Part 12: Battery (Remote Supervisory PMH-5 Only)

Assessment	Performance Expectations	Image Reference
Physical condition	▪ No damage, deformities, cracks, leaks, rust, or white powder	–
Electrical condition	▪ Passes battery test/lamp test	–

Part 13: Overall Switch Condition Assessment Rating

Assessment	Performance Expectations	Image Reference
Overall rating of the switch	▪ Based on the above condition assessments and the expertise of the inspection team, what is an overall assessment of the complete switch?	–

Functional Condition Assessment Rating Guide

1 – Renewal action taken by inspector, now in acceptable condition.

2 – Unacceptable, not fit for service, immediate corrective action required. If this rating is given, contact SOC and tag appropriately.

3 – Marginal condition, schedule renewal activity in the next 6 months

4 – Deteriorated, but acceptable condition

5 - Good condition

Part 14: Scheduling Future Out-of-Service Condition Directed Renewal Tasks

Include any out-of-service renewal tasks in this section and indicated the anticipated time frame.

Part 15: Comments

Include all comments related to Parts 1-14 in this section. With each comment provided, identify which part each corresponds to.

8. References

S&C Data Bulletin 662-90, "(S&C Manual PMH Pad-Mounted Gear, Outdoor Distribution Inspection Recommendations)"

S&C Instruction Sheet 662-510, "(S&C Manual PMH Pad-Mounted Gear, Outdoor Distribution Operation)"

SCL 1167.13; "Padmount Switch Signs and Labels"

9. Sources

Shetab, Muneer; SCL Standards Engineer, subject matter expert, and originator of 1167.19 (muneer.shetab@seattle.gov)

Shipek, John; SCL Standards Supervisor and subject matter expert for 1167.19 (john.shipek@seattle.gov)

Appendix A: Procedure Images

Part 1: Site and Location

1a. Switch located inside customer's substation as shown.

1b. Brush surrounding the switch adjacent to SW648 is so dense that it is not accessible.

1c. Switch is not accessible due to excessive vegetation.

Part 2: Enclosure Exterior and Pad

2a. Switch is missing danger and warning signs. The existing caution signs are outdated and damaged.

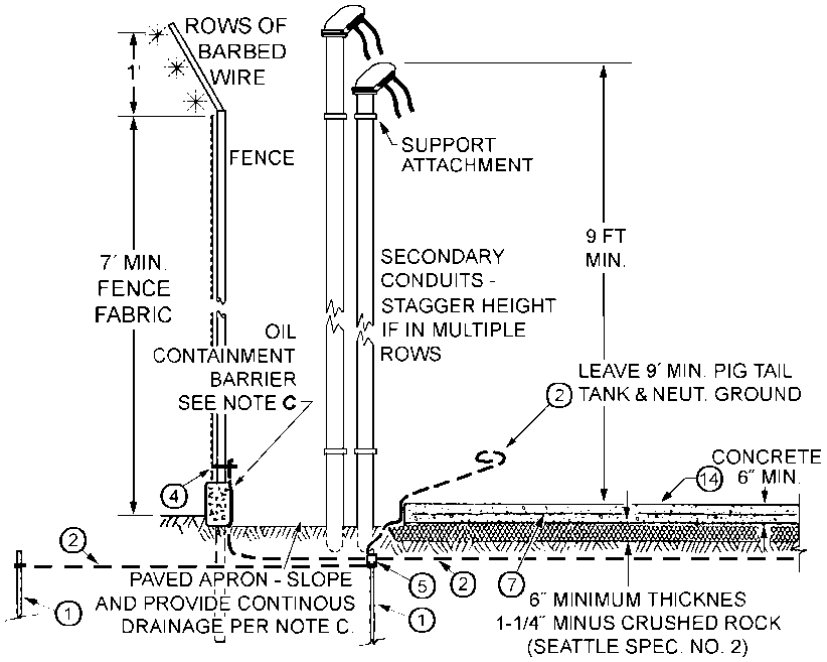
2b. Switch surface is covered with excessive moss and graffiti.

Part 3: Switch Interior

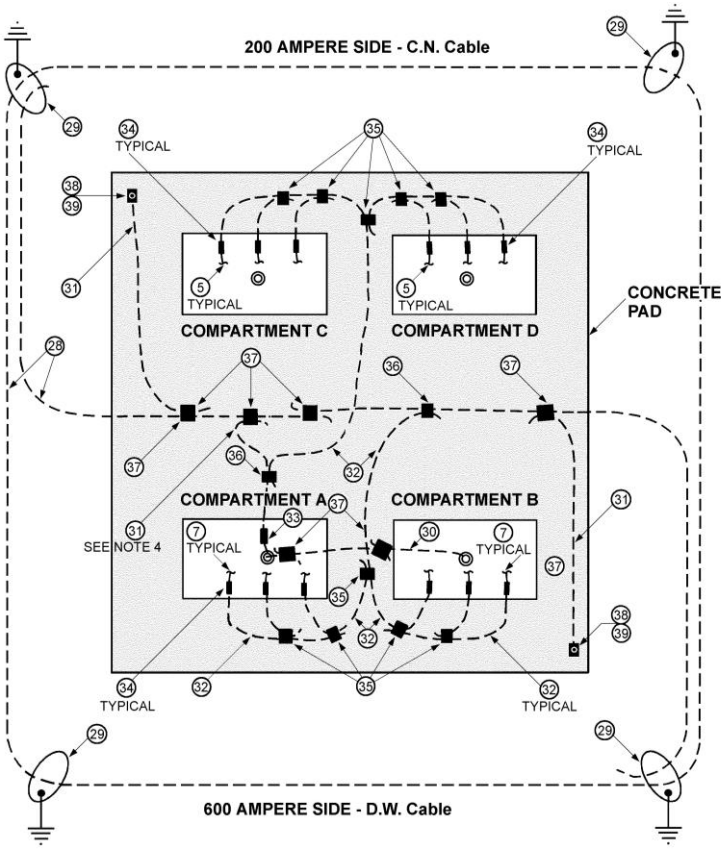
3a. Excessive condensation build up on the insulators and interior of the switch.

3b. Conduits are not sealed and a vapor barrier is not installed.

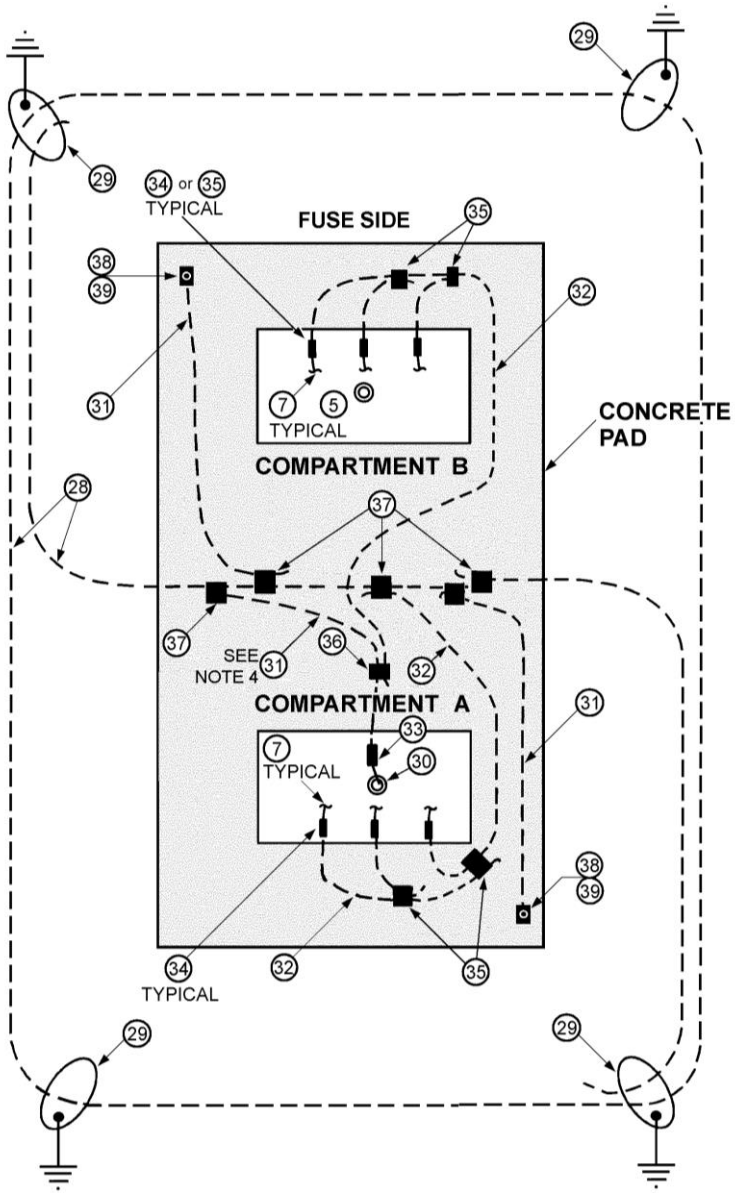
Part 4: Ground Connections



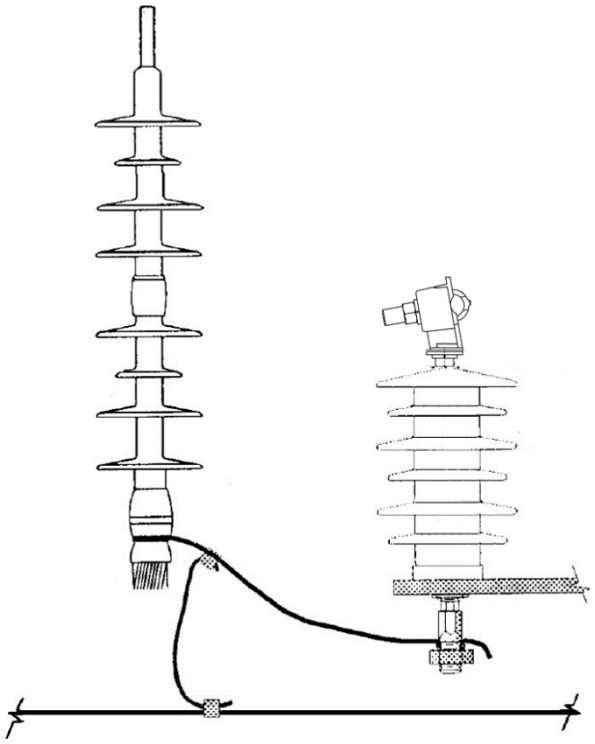
4a. Fence Grounding, Section A-A from SCL U10-1.2



4b. Grounding PMH-9, Figure 1 from SCL U10-5.



4c. Grounding, PMH-5, Figure 3 from SCL U10-5.



4d. Arrester Ground Connection Detail

Rating, kv	Minimum Air Clearances (Inches)			
	Energized Parts to Barriers	Terminator Skirts to Barriers	Energized Parts to Elec. Ground	Phase-to-Phase
14.4	1	½	6	6
25	2¼	1¼	7½	7½

4e. Minimum air clearances table from S&C Data Bulletin 662.590.

Part 5: Barrier Boards

5a. Barrier boards are contaminated and discolored. One of the barrier boards is secured with a wire tie instead of an appropriate thumb screw.

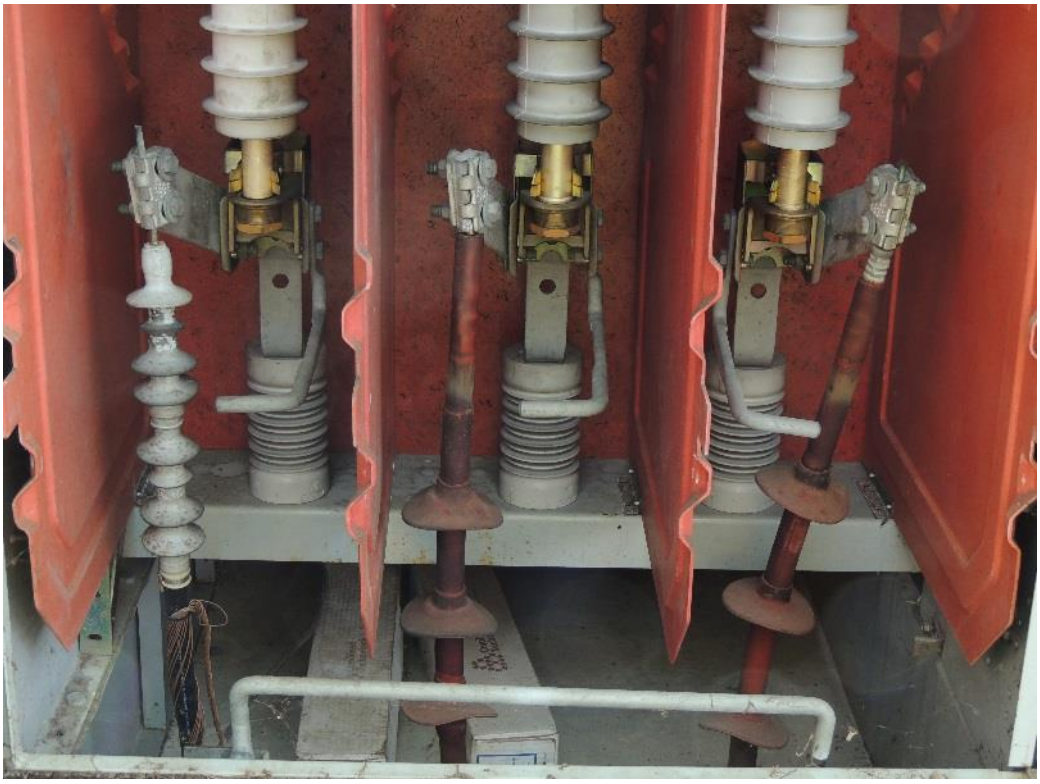
5b. Barrier boards at the center are bent.

5c. Signs of electrical activity on the barrier board.

Part 6:Terminations



6a. Terminations show signs of contamination and electrical activity.

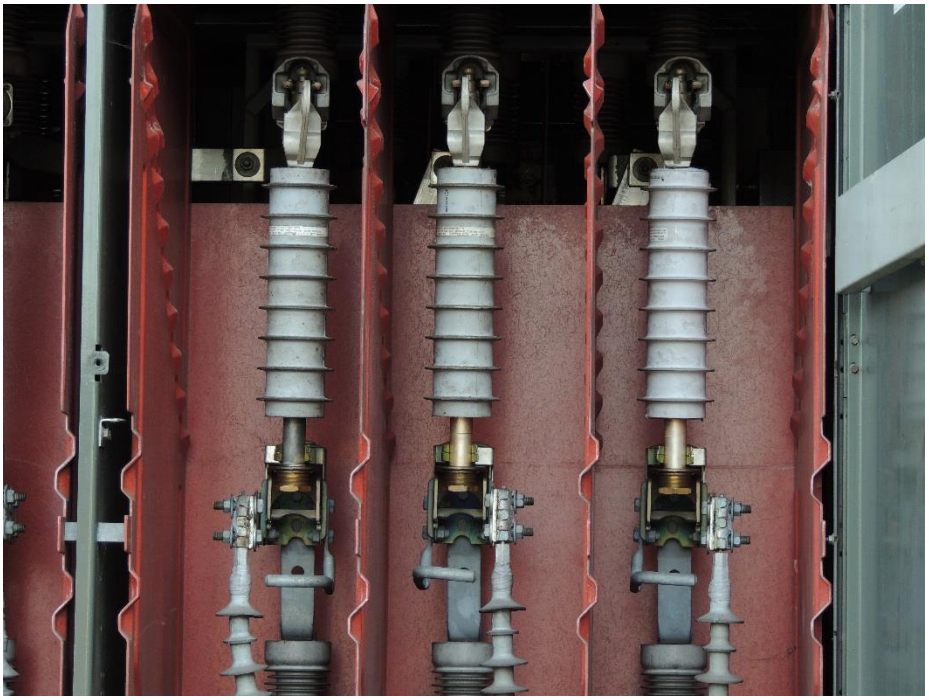


6b. Two terminations on the right side appear to be an older vintage. The termination skirts on the left termination extend far below the ground studs. The alignment of the termination skirts and the ground studs should be similar to one shown in photo 7.

6c. Two terminations on the far left are bent and are pulling on the terminal pads. The termination on the right appears to be touching the concrete pad. The terminal pads are in the Standard position.

6d. Termination is too close to the barrier board.

Part 7: Fuses

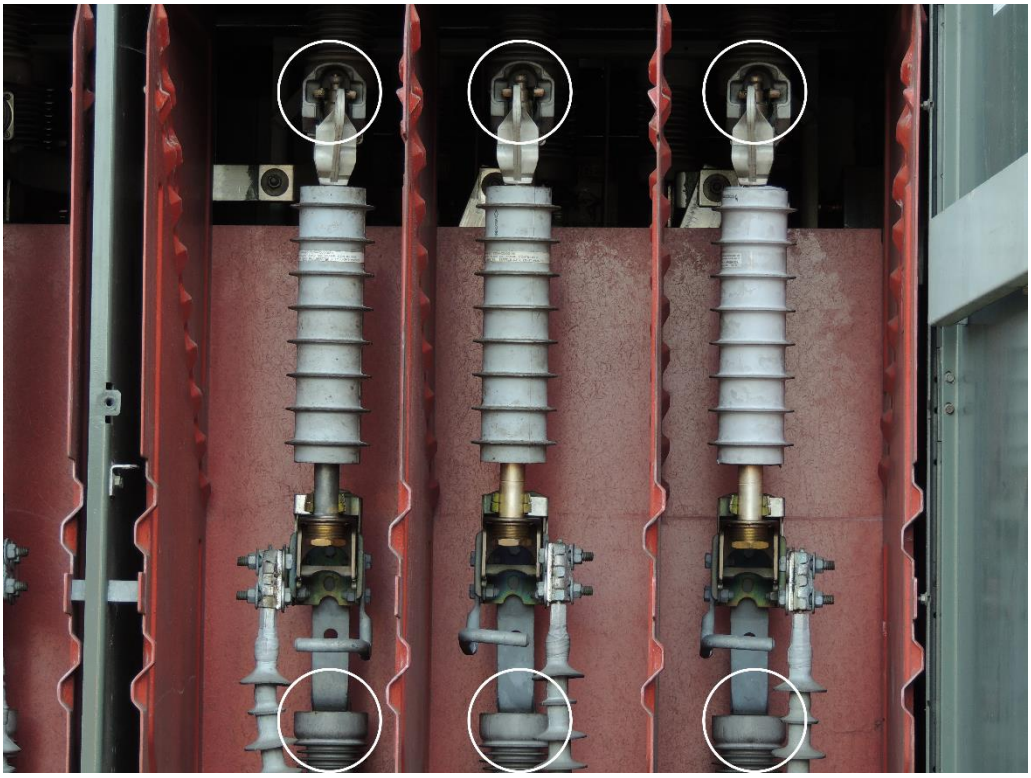


7. Excessive signs of contamination on the fuse surfaces. The fuse stud on the far left fuse appears to be discolored compared to the remaining two fuses.

Part 8: Surge Arresters

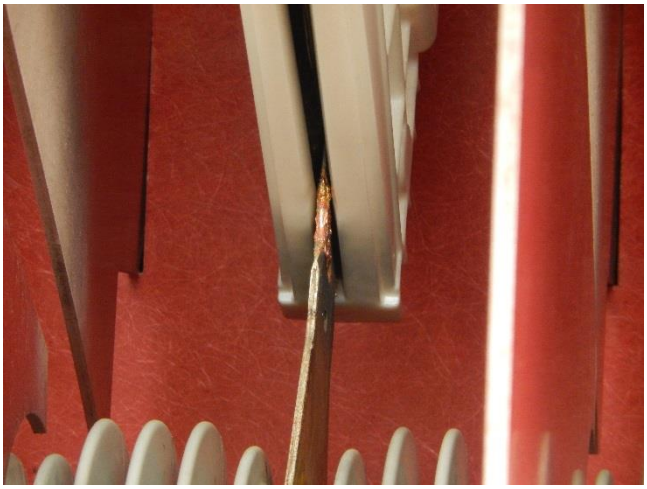
8. Surge arrester shows signs of contamination.

Part 9: Insulators



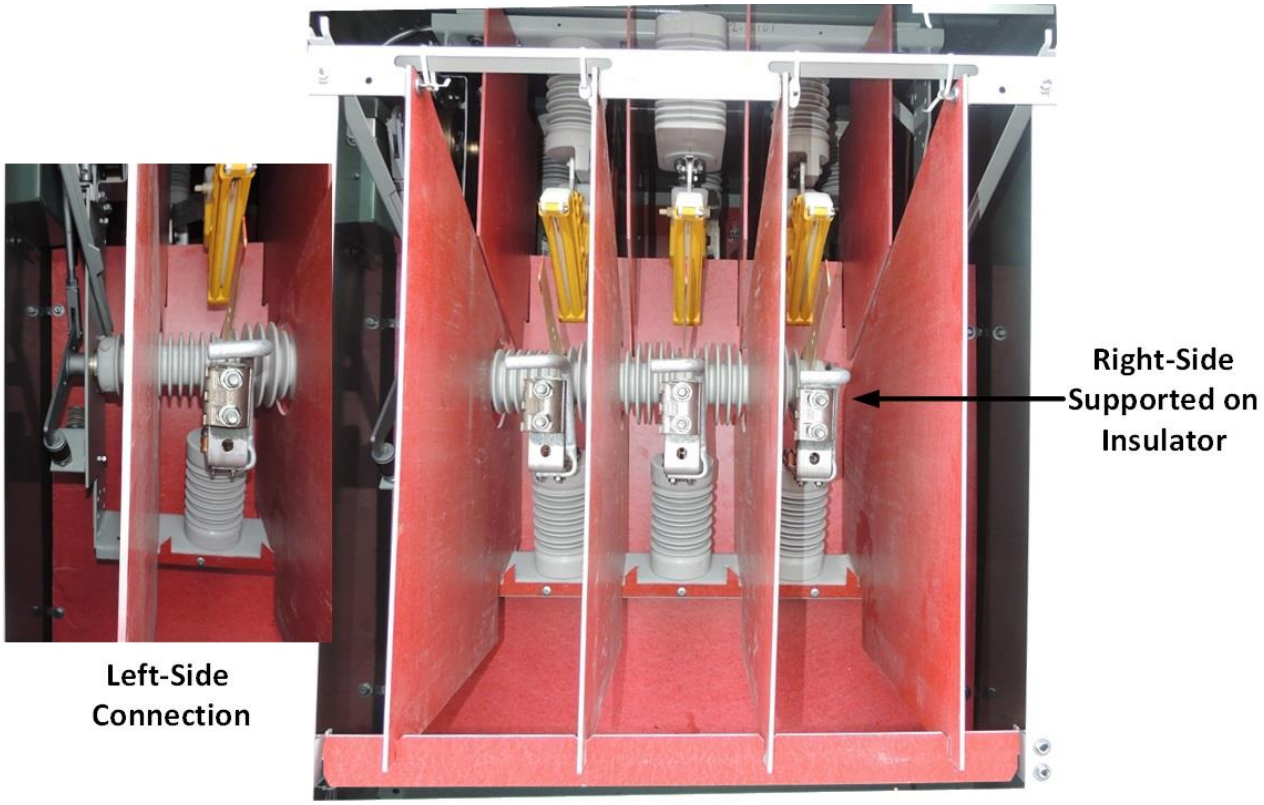
9. Upper and lower fuse insulators show signs of excessive contamination.

Part 10: Switch



10a. Signs of arcing and melting at the disconnect blade.

10b. Pre-2005 PMH Switch strut assembly. Note that the strut assembly runs the full length of the switch and is attached to the switch frame on both ends.



10c. Post-2005 PMH Switch strut assembly. Note that the strut assembly does not run the full length of the switch. It is attached to the frame on one side and supported by the insulator on the other side.

Appendix B: Example of a Padmount PMH Switchgear Condition Assessment Form

Padmount PMH Switchgear Condition Assessment
(For use with Work Practice 1167.19)

Inspected By: _____ Date: _____

Crew No: _____ Parent Facility ID No.: _____

Switch (SOC) No: _____ Equipment (PS) No.: _____

Date of Manufacture: _____ Serial No.: _____

Model No.: _____

Part 1. Site and Location		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Access to site	Switch is reasonably accessible to SCL operations and maintenance personnel. Accessing the site does not require a special key, permit or prior approval for entry, as may be required for locations inside a customer building or facility.
☐	Compartment access	Compartments are accessible with adequate space to perform routine operations and maintenance - 10 feet in front of doors, 3 feet on sides.
Part 2. Enclosure Exterior and Pad		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Signs and labels	Warning, Danger, and Notice signs are easily read. Switch (SOC) Number and Equipment (PS) Numbers are assigned and easily read. See SCL Work Practice 1167.13 for padmoutn switch signs and labels.
☐	Paint condition	No graffiti, only minor rust, no moss
☐	Pad	No major cracks, reasonably level
☐	Seal	Enclosure sealed at pad to prevent animal ingress
☐	Doors. Locks, and latches	Easy to operate, proper alignment, all latch points engage, locks and penta head bolts secure
Part 3. Switch Interior		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Water ingress	No standing water
☐	Conduits	Sealed
☐	Vapor barrier	Installed
☐	Condensation	Little to no condensation on roof or walls
☐	Contamination	Little to no dirt or moss on roof or walls. No signs of animal intrusion
Part 4. Ground Connections		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Fence	All fences within six feet of of switch is grounded. See SCL Construction Standard U10-1.2, Section A-A.
☐	Endosure	Enclosure is grounded as can be practically determined by visible inspection. See SCL U10-5, Figures 1 and 3.
☐	Surge arresters and terminations	Surge arresters and terminations are grounded. See SCL U10-5, Figure 7.
☐	Electrical clearances	The clearance of any energized part to the electrical ground meets the 7-1/2" minimum air clearance requirements as described in Table 3 of S&C Data Bulletin **662-590.**

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Functional Condition Assessment Rating Guide

5 – Good condition; **4**- Deteriorated, but acceptable condition; **3** – Marginal condition, schedule renewal activity in the next 6 months; **2**- Unacceptable, not fit for service, corrective action required. If this rating is given, contact SOC and tag appropriately; **1** – Renewal action taken by inspector, now in acceptable condition

Part 5. Barrier Boards		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Installation	Boards are in place and secured by appropriate 1/4 turn or thumb-screw hardware. Barrier boards are inserted in appropriate barrier guides.
☐	Physical condition	No warping or delamination. Only minor dirt and contamination. Boards are not wicking, coming apart, discolored, or otherwise damaged.
☐	Dielectric condition	Less than 1 square inch of corona caused surface deterioration
☐	Electrical clearances	The clearance of any energized part to the barrier board meets the 2-1/4" minimum **air clearance requirements as described in Table 3 of S&C Data Bulletin 662-590.**
Part 6. Terminations		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Terminations	Only minor contamination, no signs of corona damage; no signs of tracking on surface
☐	Installation	Terminations of the same compartment are of the same style/type. Terminations are straight and do not touch concrete knockouts Cables are not pulling on terminations. Termination top skirt is below or at the same level as the ground studs
☐	Electrical clearances	There is at least 6-1/2 inches clearance from the grounding studs to the concentric neutral cable at the base. The clearance of the terminator skirts to the barrier board meets the 1-1/4" minimum air clearance requirements as described in Table 3 of **S&C Data Bulletin 662-590.**
Part 7. Fuses		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Fuse holders	No signs of overheating No signs of tracking
☐	Fuses	Little to no surface contamination No signs of physical damage No signs of tracking
Part 8. Surge Arresters (Check box on right if no surge arrester is installed)		☐ Not installed
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Surge arresters	Little to no surface contamination No signs of physical damage
☐	Electrical clearances	Clearance from the surge arrester connecting rod to the barrier board, to termination skirts, or to the insulating surfaces between the concentric neutral's end and the conductor lug should be at least 2-1/4" for 25 kV as described in Table **3 of S&C Data Bulletin 662-590.**
Part 9. Insulators		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Insulator condition	Little to no surface contamination No signs of physical damage
Part 10. SwitchPart 3. Switch Interior (Check box on right to indicate Mini-Rupter switch style)		☐ Pre-2005 ☐ Post-2005
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Switch contacts	No signs of overheating Only minor erosion
☐	Electrical clearances	Clearance from the grounding studs to the barrier should be at least 2-1/4 in for 25 **kV as described in Table 3 of S&C Data Bulletin 662-590.**
Part 11. Heat Sensor Readings		
Condition Rating (1-5)	Assessment	Performance Expectations
☐ ____°C	Ambient temperature	Measure ambient temperature
☐ ____°C	Highest bushing/elbow/fuse or switch contact temperature above ambient	Less than 10 degrees centigrade above ambient
☐ ____°C	Comparison of values between the phases of the switch	Less than 5 degrees centigrade difference between the phases

Functional Condition Assessment Rating Guide

5 – Good condition; **4**- Deteriorated, but acceptable condition; **3** – Marginal condition, schedule renewal activity in the next 6 months; **2**- Unacceptable, not fit for service, corrective action required. If this rating is given, contact SOC and tag appropriately; **1** – Renewal action taken by inspector, now in acceptable condition

Part 12. Battery (Remote Supervisory PMH-5 Only)		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Physical condition	No damage, deformities, cracks, leaks, rust or white powder
☐	Electrical condition	Passes battery test/lamp test

Part 13. Overall Switch Condition Assessment Rating		
Condition Rating (1-5)	Assessment	Performance Expectations
☐	Overall rating of the switch	Based on the above condition assessments and the expertise of the inspection team what is an overall assessment of the complete switch?

Part 14. Scheduling Condition Directed Renewal Tasks				
Anticipated Time Frame (Months)				
0-3	3-24	24-48	Beyond 48	Renewal Task
☐	☐	☐	☐	Cleaning interior walls, roof and barrier boards
☐	☐	☐	☐	Mechanism lubrication
☐	☐	☐	☐	Contact and hinge lubrication with NYE Rheolube 368
☐	☐	☐	☐	Installation of vapor barrier on floor of switch (if switch is replaced)
☐	☐	☐	☐	Other(s)

Part 15. Comments (Include comments for Parts 1-14. With each comment provided, identify which part each corresponds to)

Functional Condition Assessment Rating Guide

5 – Good condition; **4**- Deteriorated, but acceptable condition; **3** – Marginal condition, schedule renewal activity in the next 6 months; **2**- Unacceptable, not fit for service, corrective action required. If this rating is given, contact SOC and tag appropriately; **1** – Renewal action taken by inspector, now in acceptable condition