Covered Task

Inspect Rectifiers and Obtain Readings

Answers to Procedural Questions

	Questions	Answers
1a	***Explain what the bi-monthly inspection requires.***	The bi-monthly inspection requires obtaining and recording **volt** and **amp** measurements and an **"on" and "off" pipe-to-soil potential** unless remote monitoring systems are available, then only the volt and amp measurements are required. Perform the pipe-to-soil potential in accordance with the Operators Procedures and pay close attention to the polarity on the instrument to ensure the pipe is connected to the **negative** side of the rectifier and current is flowing toward the pipe. If remote monitoring systems are being used, access the remote monitor's company web site at least **6 times** a year with intervals not exceeding 2½ months and document the rectifier's output (DC volts and DC Amps). Copy that information into Maximo.
1b	***Explain how to perform the annual inspection as required in this procedure.***	Do the inspection as you would during a bi-monthly inspection BUT perform these tasks in addition. 1) Visual Inspection of/for these problem areas: • Insect problems, • Exposure of components to the weather, • Bird, rat and ant nests, • Potential short in connecting wires, • Connections (to ensure tightness), • Burn spots or other defects on the rectification element or stack (either multiple plates of selenium or four diodes of silicon) in order to prevent premature failure/fire.

		2) Inside rectifier box: • Interference caused by the cathodic protection current, • Electrical shorts in the rectifier are causing the ground system and all other metallic structures to it becoming a ground bed, accelerating the destruction. *3)* Test the ground annually. *Procedures and Remedial Measures are listed below in the supplement tables.* *4)* Perform rectifier readings in accordance with the information provided in Procedures. *5)*
1c	***Describe how the data is recorded and documented.***	Recording procedures are listed throughout. Document **ALL** your inspection data in Maintenance Management System (**MMS)** and always contact appropriate personnel immediately if problems arise.

Supplement Table 1: Procedures for Testing the Rectifier Ground

Test Procedure (Grounding)	*Method of Testing*
Interference	The ground wire potential should be measured to a copper **sulfate** electrode with the rectifier current interrupted. This potential should not be depressed more than **10 mV** before remedial steps are taken.
Electrical Short	A **0.01-ohm** shunt should be installed in each ground wire connection to a rectifier. This will permit the measurement of current flow from the rectifier to the ground system. Under normal operating conditions, this should be zero (0) current flow.

Supplement: Remedial Measures if Problem is Found

Potential Problem Area	Remedial Measure to be Taken
Interference	The interference current must return to its source by a metallic path. This requires a bond from the ground wire to the negative terminal of the rectifier. Resistance may be added to control the amount of current needed to solve the interference and restore the potential of the ground system. A shunt can also be installed in the circuit to permit measuring the current being drained.
Electrical Short	When current is found to be flowing in the shunt during the test, the rectifier should be turned "OFF" and remain out of service until the short is corrected. The repair is accomplished by replacing the rectification element or stack.
	Notify the* Pipeline Specialist *when any problem occurs with the rectifier.

Supplement: Rectifier Readings to be Performed During Inspection

Required Data Reading

- **Power meter readings are obtained from the dials or digital readout on the face of the power meter.**
- **The Kh factor can be found on the face of the power meter.**
- **Direct Current (DC) Volts - Position the multi-meter to the highest DC Volt range. Connect the positive lead to the positive cable (the groundbed cable). Connect the negative lead to the negative cable (the cable leading to the structure being protected).**
- **DC Amps - Position the setting of the multimeter to the highest DC Millivolt range. Connect the instrument test leads to each side of the shunt. Calculate the amperage output by determining the size of shunt and using the multiplication factor as demonstrated in the following example:**

Example:

The reading on the instrument across the shunt is 30 mV. The shunt size is 50 mV - 25 A. Using the scale that follows, find the correct shunt size and multiplication factor to calculate the correct amperage output.

Shunt Size	Multiplication Factor
50mV – 100A	mV Reading X 2.0 = Amps
50mV – 80A	mV Reading X 1.6 = Amps
50mV – 75A	mV Reading X 1.5 = Amps
50mV – 50A	mV Reading X 1.0 = Amps
50mV – 45A	mV Reading X .9 = Amps
50mV – 30A	mV Reading X .6 = Amps
50mV –10A	mV Reading X .5 = Amps
50mV – 15A	mV Reading X .3 = Amps
50mV – 10A	mV Reading X .2 = Amps
50mV – 5A	mV Reading X .1 = Amps

The multiplication factor for a 50 mV - 25A shunt is 0.5 as shown in the previous listing. Therefore, if you multiply the reading of 30 mV x .5, the result is 15A, which is the correct reading of amperage.

Measure (in seconds) the time it takes for the dial on the electric meter to make one revolution. Divide the number of seconds into 60. The resultant number is RPM.

Example:

If you timed the meter and it took 120 seconds for the meter to make one revolution, divide 60 by 120. The result would be 0.5 RPM.

Calculated Efficiency:

$$W1: (\text{Input wattage}) = Kh \times RPM \times 60$$

$$W2: (\text{Output wattage}) = \text{Volts} \times \text{Amps}$$

$$\% \text{ Efficiency} = \frac{W2}{W1} = \frac{\text{Volts} \times \text{Amps}}{K_h \times RPM \times 60}$$

Example:

Volts = 10V Current = 15 Amps
K_h = 7.2 RPM = .5
W2 is equal to (10 Volts x 15 Amps) = 150 Watts
W1 is equal to (7.2 x .5 x 60) = 216 Watts
W2 divided by W1 150 ÷ 216 = .69
Efficiency .69 x 100 = 69%

- **The tap setting is obtained by documenting the location of the link bars or wire connections in the terminal block of both fine and course taps of the transformer. The tap set location should be documented during the annual inspection or when changes are made from the original setting.**
- **Ground Shunt Reading — In the previous listing of shunts, the equivalent size for a .01 ohm wire shunt, which is to be installed on the ground lug of the rectifier cabinet, is a 50 mV - 5 A shunt. When calculating the correct reading, the multiplication factor is 0.1, which is demonstrated, in the following example:**

Example:

- Position the setting of the multimeter to the highest DC millivolt range. Connect the instrument test leads to each side of the shunt. The millivolt reading is 1.5 millivolts. Calculate the amperage output by multiplying the millivolt reading by 0.1. In this example, the reading would be:

- 1.5 x .1 = .15 amp current flow across the shunt