**Directors**

This training guide is to be used by a Subject matter expert (SME) authorized Evaluator/Trainer and Trainee during on-the-job training (OJT) or prior to an evaluation as a resource.

**(S)** Indicates a demonstration or skill task  
**(K)** indicates a knowledge task.

**OJT Reminder:** OJT is an active hands-on process. Practice should be as similar to the actual job task as possible. However, if the training is being provided on actual job site while a covered task is actually being simulated, the Evaluator either needs to be qualified on that covered task or be assisted by someone that is qualified on the covered task. The Evaluator should closely monitor the Trainee's practices to ensure safe and correct task performance. At no time should a non-qualified individual perform, or train for, a covered task unless directed and observed by a qualified individual. However, if the “span of control” for that particular covered task is “NA” (requiring only qualified individuals to perform the covered task), the training must be simulated. Training is simulated by “walking through” the task and simulating all actual manipulations (valves, switches, tools, etc.) an individual would use during the performance of a covered task. Simulating includes the use of safety and administrative requirements as if the task was being performed live. Refer to the Veriforce Evaluator Training Program for more on how to conduct formal OJT.

**Disclaimer:** This training resource is offered in good faith. Anyone choosing to utilize this document is doing so at their own discretion and choice.

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misuse of this document. All critical information should be independently verified. The subject matter included in this training guide has been compiled from a variety of sources, and is subject to change without notice.

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### Recommended Student Training or Resources

- DOT 49 CFR 192.465(b)
- DOT 49 CFR 195.416(c)

### Definitions

| **Foreign structure** | A foreign structure is a metallic structure that is:
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<td>• Owned / operated by another company, or</td>
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<td></td>
<td>• A pipeline or structure owned by the Company but is electrically isolated, and cathodically protected by a totally separate cathodic protection system(s).</td>
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| **Interference Bond** | An interference bond is a cable installed between the company pipeline and the foreign pipeline, in an effort to alleviate the damaging effects of stray DC currents between the two structures. |

| **Shunt** | A metallic wire or strip with a known resistance. A shunt is used to measure current flow in a circuit. Direction of current can also be determined by observing the polarity of the voltage drop across the shunt; as displayed on a voltmeter connected in parallel with the shunt. |

| **High input Impedance Multimeter** | A combination voltmeter/ammeter with a high input impedance voltmeter circuitry (normally more than 10 Mega ohms). |

| **Clamp-on Ammeter** | An instrument used to measure current flow and direction in a cable. |
### Visual Inspection of Bond

Always be aware of your surroundings, and always be aware of the safety hazards for each task. For this task, we have identified the following typical safety hazards:

- Check for nesting insects such as wasps, hornets, bees, spiders, snakes, etc. when opening a junction box, test station lid, or any other enclosure.
- Inspect for any shock hazard when making the electrical connections needed to obtain a measurement.

**WARNING:** Warning if sparks are visible, the current in the circuit is high and can be very dangerous.

- If the interference bond is burnt out, notify your supervisor and System Corrosion Leader or Corrosion Technician as applicable.
- Check if the shunt is melted, notify your supervisor and System Corrosion Leader or Corrosion Technician as applicable.

**CAUTION:** Do not replace with the same rated shunt.

- Check if the bond is hot to the touch, or you can feel heat when you open the test station or box, notify your supervisor and System Corrosion Leader or Corrosion Technician as applicable.

### Conditions to Watch Out For

The following conditions can be encountered when inspecting a bond, and must be immediately communicated to your supervisor as well the System Corrosion Leader.

- Broken or missing interference bond (measure pipe-to-soil on both company pipeline and foreign pipeline. The System Corrosion Leader or Corrosion Technician as applicable will determine if any rectifiers must be turned off to avoid stray current damage to the pipeline.
- Melted or hot shunt or cable.
- Current measured is significantly higher or lower than previous inspection (+/- 20% or more).
- Current direction is opposite than previous month’s measurement. Normally, bond currents are not dynamic, meaning they tend to remain constant in magnitude and direction. Therefore, it is not normal to have a non-critical bond change to a critical bond in a month. If the current direction changes, further investigation must be conducted as follows:
Inspecting Interference Bonds

- Make sure the meter is connected properly and the polarity of the measurement is recorded.
- Make sure that the Company or the foreign operator had not recently installed any new cathodic protection systems or adjusted their existing cathodic protection systems.
- Finally, any reversal in current direction must be immediately communicated to the System Corrosion Leader or Corrosion Technician as applicable.

Documentation

Proper documentation in the Maximo/BASS databases is very important to comply with applicable Regulations. The documentation of each interference bond must include the following:

- Time and Date measurement is taken
- Identify the foreign structure (Owner, diameter if known, any relevant CP information)
- Document the location of the bond (station, MP, road name, GPS, etc.)
- Measure and document the current flow in the bond per this procedure.
- Define if the bond is a critical bond.
- Note any changes in current direction from last month’s measurement; and if so, what measures or tests were conducted to verify the reversal and reasons for the reversal.
- Document all the information in the proper Maximo/Bass database.
- For critical bonds, set inspection frequency to bi-monthly.
- For non-critical bonds, set inspection frequency to yearly.
- If errors are found in the database, provide proper documentation to the System Corrosion Leader who will seek to correct the errors through the proper process.
Inspect Interference Bond

K: Describe the need for bonds.

The most common form of pipeline interference is experienced with stray currents from a rectifier on one pipeline affecting another company’s pipeline. Sources of stray current include cathodic protection systems, direct current power trains, mining areas, and electrical grounding systems.

To cause corrosion, stray currents must flow onto the pipeline in one area, travel along the pipeline to some other area where they then leave the pipe (with resulting corrosion) to reenter the earth and complete the circuit by returning to its source. The amount of metal lost from corrosion is directly proportional to the amount of current discharged from the affected pipeline.
This type of corrosion is often seen as very localized, deep pits in the metal surface. Typically, connecting a resistance bond between the two pipelines is installed to provide a metallic path back to the current source. If the current travels through this bond instead of the electrolyte (soil) no corrosion will occur. The bond has to be of lower resistance than the electrolyte. This bond is adjusted to drain just enough current from the affected line to eliminate the damaging condition.

**K: Describe how often bond inspections are required by the Department of Transportation.**

Annual inspections are required after the bond is installed to check for proper performance unless it is a “critical bond”. Critical bonds are those that if not attached, would allow corrosion to occur and jeopardize the safe operation of one of the pipelines in question. Since they ensure the pipe’s integrity, critical bonds must be inspected six times a year. DOT 49 CFR 192.465(c) Each reverse current switch, each diode, and each interference bond whose failure would jeopardize structure protection must be electrically checked for proper performance six times each calendar year, but with intervals not exceeding 2-1/2 months. Each other interference bond must be checked at least once each calendar year, but with intervals not exceeding 15 months.

**K: Describe the test station usually designed for checking bonds.**

Foreign line crossing test stations are installed to serve as pipe to soil potential measurement points for both the company and foreign pipeline. These test stations usually consists of two lengths of wire, one pair on the company’s pipeline and the other pair on a foreign operator’s line. Both sets of wire are clearly labeled and color-coded. Shunts and blocking diodes can be installed inside of the test box also.
K: Identify the equipment necessary for the proper inspection of a bond.

Bond inspection requires the use of:
- Calibrated resistor (shunt)
- Calibrated meter capable of measuring millivolts
- Calibrated electrode (copper copper sulfate)

S: Demonstrate how to check condition and operation of bonds, diodes and reverse switches.

Structure-to-electrolyte Potential
Potential pipe-to-soil measurements should be taken for the company pipeline and the foreign pipeline. The reference electrode should be placed directly over the point of crossing (or at the point of maximum exposure).

Company Pipeline
Pipe-to-soil “on” measurement

Foreign Pipeline
Pipe-to-soil “on” measurement

The readings should be documented and compared to previous readings. If significant changes are recorded, contact your Pipeline Operator representative.

S: Calculate current flow across calibrated shunt (if table not provided).

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.

- The multimeter reading across the shunt is 30 mV.
- The shunt size is 50 mV – 25 A.
- Using the scale, find the correct shunt size and multiplication factor to calculate the correct amperage output:

<table>
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<th>Shunt Size</th>
<th>Multiplication Factor</th>
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<tr>
<td>50 mV – 100 A</td>
<td>MV reading x 2.0 = Amps</td>
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<tr>
<td>50 mV – 80 A</td>
<td>MV reading x 1.6 = Amps</td>
</tr>
<tr>
<td>50 MV – 75 A</td>
<td>MV reading x 1.5 = Amps</td>
</tr>
<tr>
<td>50 MV – 50 A</td>
<td>MV reading x 1.0 = Amps</td>
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</tbody>
</table>
Inspecting Interference Bonds

50 MV – 45 A MV reading x 0.9 = Amps
50 MV – 30 A MV reading x 0.6 = Amps
50 MV – 25 A MV reading x 0.5 = Amps
50 MV – 15 A MV reading x 0.3 = Amps
50 MV – 10 A MV reading x 0.2 = Amps
50 MV – 5 A MV reading x 0.1 = Amps

- The multiplication factor for a 50 MV – 25 A shunt is 0.5
- Therefore, if you multiply the reading of 30 mV x 0.5 the result is 15 A, which is the correct reading of amperage.

The readings should be documented and compared to previous readings. If significant changes are recorded, contact your Pipeline Operator representative.

Abnormal Operating Conditions

K: Describe the proper actions to take in case of pipeline leak, unauthorized release, vapors, or hazardous atmosphere.

Response: Protect the public, property, and the environment. Follow appropriate procedures for notification, documentation, and remedial action.

K: Describe the proper actions to take in case of material defects, anomalies, or physical damage of pipe or a component that has impaired or is likely to impair the serviceability of a pipeline.

Response: Follow appropriate procedures for notification, documentation, and remedial action.

K: Describe the proper actions to take in case of an unintended fire and/or explosion near the pipeline.

Response: Leave the area immediately. Protect the public, property, and the environment. Follow appropriate procedures for notification, documentation, and remedial action.

K: Describe the proper actions to take in case of a failure or malfunction of pipeline component(s).

Response: Protect the public, property, and the environment. Follow appropriate procedures for notification, documentation, and remedial action.