Rejuvenation Instructions

#601 –Small Diameter Cables – UPR

This NRI covers the following:

- How to test and confirm that a small diameter cable is a good injection candidate.
- How to perform the craftwork and necessary testing to make a small cable ready for injection.
- How to use the injection and vacuum systems to inject and soak small diameter cables.

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WARNING: It is dangerous working around energized high-voltage systems, pressurized systems, and chemicals. Always work in accordance to the Novinium Field Operations Safety Handbook (FOSH) or other local governing safety standards.

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Revised: September 28, 2015

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Getting Started

1. Pre-job.

a. Perform a pre-job walk-through when possible to survey the system and confirm that the cable is a good candidate for injection prior to taking the outage.

b. The walk-through should provide information on the cable size, the type and length that is possible to forecast the required materials, and the necessary equipment to complete the job.

c. The walk-through should also provide information on elevation changes (see **NRI 281**) and whether special procedures need to be discussed with Engineering (Figure 1).

d. Select whether the feed tank and discard control system will be used for injection or whether the charge tank will be used with a vacuum tank.

- The equipment choice will affect the specific procedures used for testing and injecting.

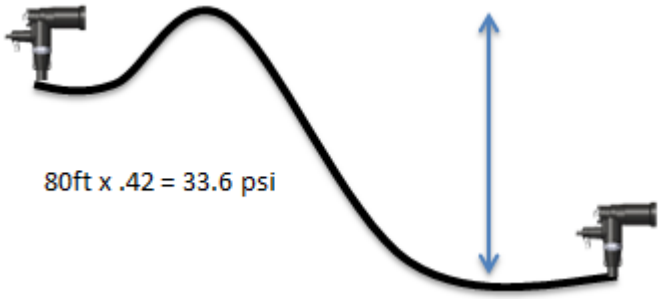

Figure 1: Check elevation during the pre-job walk-through to determine if special steps need to be addressed with Engineering to accommodate the pressure.

2. Make the cable safe to work.

a. De-energize and ground the cable following Novinium and customer standard procedures. See the FOSH for details.

b. Remove the existing terminations using care to preserve the length and condition of the cable.

c. Inspect the cable with the terminations removed to confirm the cable size and its compatibility with injection.

Figure 2: Ground the cable and make safe to work.

d. Create a Knomentous record and enter details on the customer, circuit location, termination IDs, and cable type, etc.

3. Test and measure the cable.

a. Connect the TDR to the cable through an ITD streamliner (Figures 3 and 4) and examine the cable following the procedures outlined in **NRI 230**.

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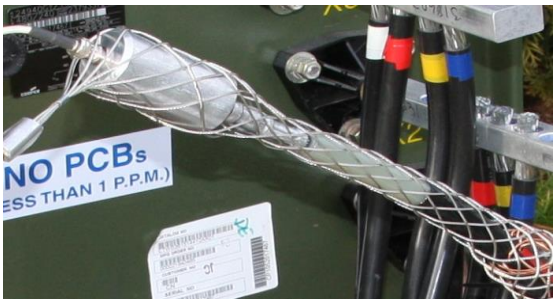

Figure 3: Use an ITD to streamline the TDR signal as it transitions into the cable.

Figure 4: Perform TDR test to identify splices and neutral corrosion and to measure the cable's length.

b. Store the waveform into the TDR's memory for later upload to Knomentous.

c. Record the memory position in your notes along with the segment number and the terminal number where the recording was made.

d. Analyze the stored waveform on the TDR to measure the cable length, location, and number of splices; and to survey for neutral damage.

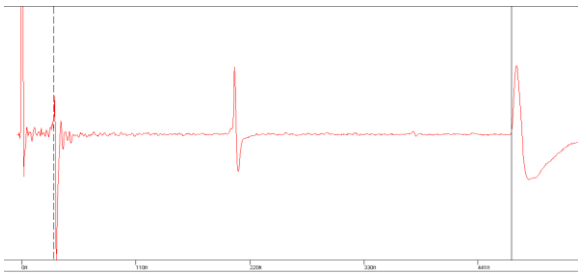

Figure 5: Analyze the wavetrace to measure the cable length, identify splices, and assess the level of neutral corrosion.

e. For challenging waveforms, it may be helpful to use RiserBond's Waveview software on the laptop to view multiple waveforms recorded on the cable at different pulse widths or from different ends of the cable.

f. Perform a walk-over locate over the cable path through the procedures outlined in **NRI 270**.

g. Use the cable path to measure the cable length and to set the VOP for the TDR measurements.

h. Record the VOP, neutral condition, splice number, and location in Knomentous.

Electrical Craftwork and Testing for Injection

1. Install injection terminations.

a. Measure the cable's insulation diameter, conductor diameter, and strand diameter and enter the cable data into Knomentous.

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b. Install the injection terminations.
   - For 200A injection elbows, follow the procedures found in **NRI 521**.
   - For live-front terminations, follow the procedures in **NRI 541**.

Figure 6: Install injection terminations and perform termination test to identify leaks and blockages.

c. After installing each injection termination, it is advisable to perform a termination test following the procedures outlined in **NRI 280**.
   - The termination test is used for the early detection of leaks and blockages while the termination is easily available for repair.
   - If a leak is detected, repair the injection adapter and repeat the test prior to continuing.

2. Splices.

a. Reinforce all accessible pre-molded splices following the procedures outlined in **NRI 531**.

Figure 7: Reinforce all accessible pre-molded splices.

b. All accessible tape or cold-shrink splices should be replaced with pre-molded splice as these will not be compatible with injection.

c. At this point, the cable may be re-energized in accordance with the FOSH and local standards.

d. Pending the results from the flow and pressure tests that are performed in step 3, it may be necessary to address other splices on the circuit.

e. If it is necessary to dig and replace the splices, de-energize the circuit and follow the procedures found in **NRI 531**.

3. Flow test.

a. Determine the flow test pressure for the circuit as outlined in **NRI 351**.

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b. Perform a flow test following the procedures in **NRI 281** to evaluate the cable's internal flow resistance.
   - If the cable passes the flow test, record the test data in Knomentous and proceed to the pressure test.
   - If the cable fails the flow test or if resistance is greater than 1.0, follow the procedures found in **NRI 281** to improve the flow rate.

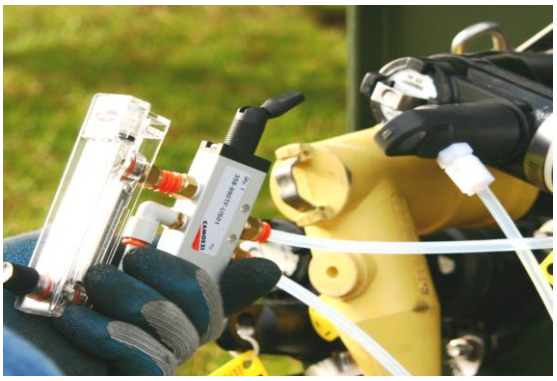

Figure 8: Perform flow test to verify adequate flow exists through the cable system prior to injection.

   - If a splice is found to be a source of a restriction, the splice must be excavated and replaced with a pre-molded flow through splice as detailed in **NRI 531** prior to continuing.

c. Record the flow direction, the inlet flow pressure, and the outlet flow rate in Knomentous.

4. Pressure test.

a. Determine the pressure to perform the pressure on the circuit as outlined in **NRI 351**.

b. Perform a pressure test following the procedures in **NRI 281** to confirm that the cable system is free of leaks.
   - If the cable passes the pressure test, vent the gas to atmospheric pressure and proceed to the injection phase.
   - If the cable does not pass the pressure test, identify and repair the leak prior to continuing with the injection.

c. Record the pressure that the test was performed at in Knomentous.

Figure 9: Perform pressure test to test the cable system for leaks prior to injection.

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Injecting and Soaking

1. Evacuate the cable.

a. Prepare the vacuum tank or discard control system in accordance with the procedures in **NRI 411** and connect it to the injection adapter at the receiving end of the cable.

b. Connect the vacuum pump to the vacuum tank.

c. Temporarily install a pressure gauge assembly (11021-1 or -2) between the vacuum tank and the vacuum pump and evacuate the cable to at least 25inHg.

d. Disconnect the vacuum pump and pressure gauge assembly from the tank by separating the quick disconnects (QDs).

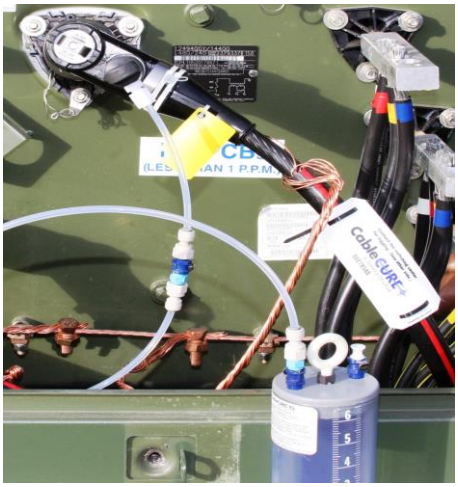

Figure 10: Install the discard control system and regularly check to ensure an adequate vacuum.

e. Monitor the pressure inside the vacuum tank or discard control system by periodically connecting the pressure gauge assembly and connect the vacuum pump as necessary to maintain adequate vacuum within the cable.

f. Record the vacuum tank size in Knomentous.

2. Inject Cablecure fluid.

a. Fill the feed tank or charge tank with Cablecure fluid and pressurize to injection pressure in accordance with **NRI 411**.

b. When possible, the total amount of fluid as calculated through the procedures in **NRI 351** should be added to the feed tank.

- At a minimum, the feed tank should contain enough fluid to cover the interstitial volume, the discard volume, and a little extra to cover field variances and to begin the soak period.

c. Record the beginning fluid level, the feed tank pressure and feed tank size in Knomentous.

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d. Connect the feed tank to the injection adapter using the QD.

e. Secure all injection equipment in the enclosure, vault, or pole.

- If left unattended, the equipment should never be left within the reach of the public.

Figure 11: Connect the feed tank to the cable by connecting the QDs and secure within the enclosure.

f. Install Cablecure warning tags (819781) at each termination to provide disconnect and handling instructions should a customer crew need to work on the system.

Figure 12: Install warning tags at each enclosure to alert trouble crews to the presence of injection equipment inside.

3. Remove vacuum system.

a. The injection is complete when the discard control valve has closed or when enough discard fluid has been collected in the vacuum tank.

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b. Remove the vacuum system from the enclosure by separating the QDs at the injection adapter.
   - For an injection elbow, relieve the pressure in the tubing and replace the injection cap with the shielded permanent cap.

c. Record the amount of discard fluid in the Knomentous database, specifically noting the amount of water if any was collected.

d. Record the final fluid level and pressure of the feed tank in Knomentous.

Figure 13: Install the permanent cap at the receiving end of the cable.

e. Inspect and clean the injection cap and tubing thoroughly as described in **NRI 521**.
   - If they appear contaminated, non-functional, or damaged, they must be discarded.

4. Install the soak tank.

a. Cables with splices and flow resistance greater than 1.0 should be soaked from both sides and the fluid level split evenly between the two feed tanks.

b. Add any additional Cablecure fluid to the feed tanks so that the cable receives the full soak volume as calculated through the process in **NRI 341**.

c. Pressurize the feed tank to match the pressures prescribed for soak as discussed in **NRI 351**.
   - If a tank is connected to both ends of the cable, the pressure should be equal and deviate only if dictated by a change in elevation.

d. If the headspace inside the feed tank(s) is less than half, a second tank or a miniature helium cylinder (11744-1) may be used to maintain adequate soak pressure.

e. Record the beginning volume and pressure for the feed tank(s) in the Knomentous database.

f. Connect the feed tank(s) to the injection adapter(s) using QD(s).

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g. Secure all injection equipment in the enclosure, vault, or pole.

Figure 14: Re-install the feed tank for the 60-120 days soak period.

5. Remove the soak tank.

a. Remove the feed tank(s) from the system when all the soak fluid has been absorbed by the cable or after the duration of the prescribed soak period.

b. For an injection elbow, relieve the pressure in the tubing and replace the injection cap with the shielded permanent cap.

c. Record the ending volume(s) and pressure(s) in the Knomentous database.

Figure 15: Remove feed tank from enclosure and install permanent cap.

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