Rejuvenation Instructions

#611 –Large Diameter Cables – UPR

This NRI covers the following:

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

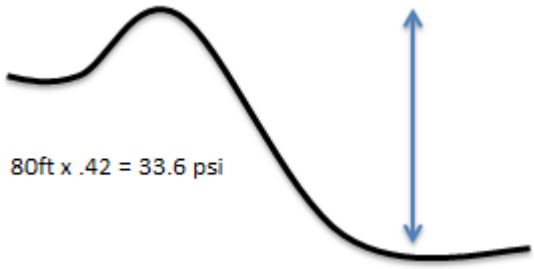

Figure 1: Check elevation during pre-job walk-through to determine if special steps need to be addressed with Engineering to accommodate the pressure.

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.

e. Perform the pre-injection PD test (if specified by the customer contract) to confirm that the cable is a good candidate for injection by following the procedures in **NRI 290**.

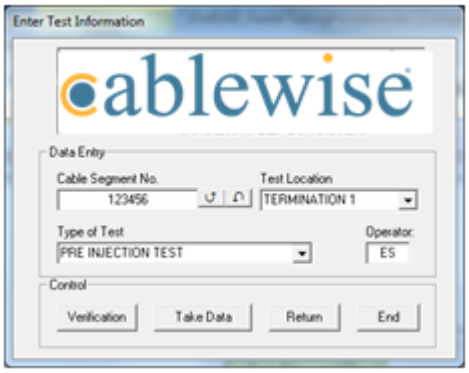

Figure 2: Perform pre-injection test if requested in customer contract.

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. Use the high-impedance device (HIDD) first to ground the cable "softly" so that the capacitive charge is slowly bled off and does not "pop".

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

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

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

Figure 3: Use the HIDD to ground the cable softly to bleed off the capacitive charge before installing the safety ground.

3. Test and measure the cable.

a. Connect the TDR to the cable through an ITD streamliner and examine the cable following the procedures in **NRI 230**.

Figure 4: Use an ITD to streamline the TDR signal as it transitions into the cable.

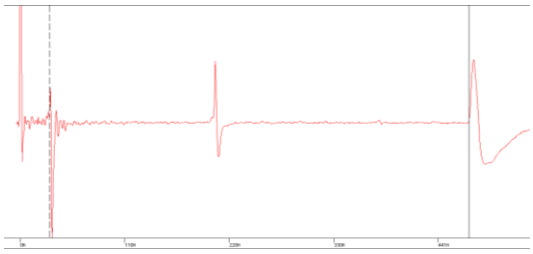

Figure 5: Perform a TDR test to identify splices and neutral corrosion, and to measure the cable's length.

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.

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 to identify 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. Use the splice locating procedures from **NRI 270** to pin-point the location of all splices identified by the TDR.

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

Figure 6: Use an RF locator to pin-point the location of all splices on the circuit.

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.

b. Install the injection terminations.

- For 600A deadbreak terminations, follow the procedures in **NRI 551**.
- For live-front terminations, follow the procedures in **NRI 561**.

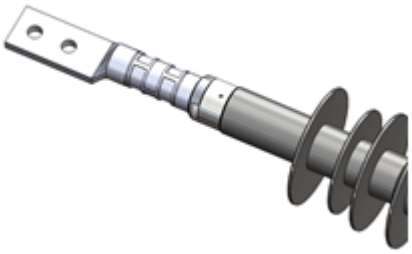

Figure 7: Install injection terminations and perform termination test to identify leaks and blockages.

c. After installing each injection termination, it is advisable to perform a termination test following the procedures in **NRI 280**.

d. Use the termination test for the early detection of leaks and blockages while the termination is easily available for repair.

e. If a leak is detected, repair the injection adapter and repeat the test before continuing.

2. Splices.

a. Excavate and replace all splices on the large-diameter cable with a threaded seal kit and compatible cold-shrink splice housing as detailed in **NRI 571**.

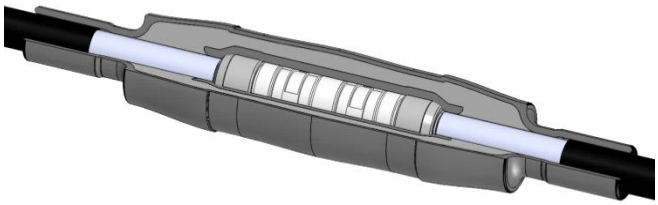

Figure 8: Install flow-through threaded seal kit and cold-shrink splice housings.

b. With the original splice removed, it is recommended that a TDR test be performed in both directions to verify the location of the adjacent splice or termination and to confirm that no previously unknown splices exist on the circuit.

c. For long circuits over 1,500ft, it may be advantageous to install an injectable splice so that the injection can take place through two short sub-segments rather than one continuous run. See injectable splices in **NRI 571**.

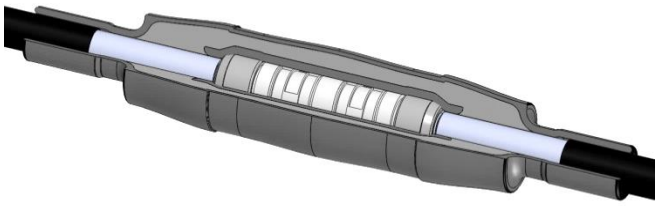

Figure 9: Use 1-way and 2-way injectable splices to break long segments into shorter sub-segments to reduce injection time.

d. It is also recommended that the crew progress through the cable systematically from the first termination so that flow and pressure tests discussed in steps 3 and 4 can be done in process to confirm that all craftwork has been done correctly.

3. Flow test.

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

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.

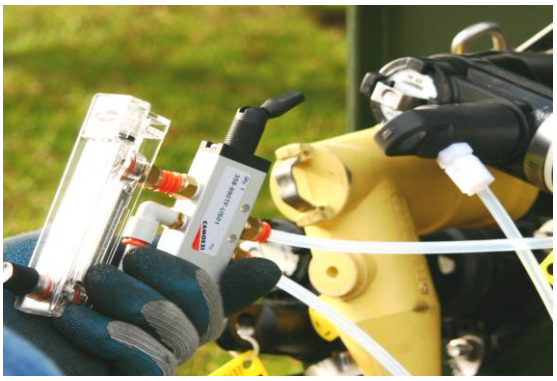

Figure 10: Perform flow test to verify that adequate flow exists through the cable system before injection.

- 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, the leak must be identified and repaired prior to continuing with the injection.

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

Figure 11: Perform a pressure test to test the cable system for leaks prior to injection.

Treating the Cable

1. Evacuate the cable.

a. Prepare the vacuum tank 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).

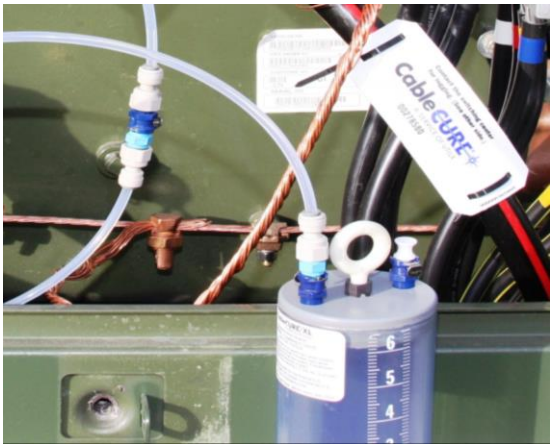

Figure 12: Install vacuum tank and check to ensure an adequate vacuum within the cable.

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.

g. If the vacuum tank is going to be left unattended, disconnect the QD leading to the vacuum pump and secure the equipment in the enclosure or on the pole.

2. Inject fluid.

a. Determine the pressure to perform the injection at as outlined in **NRI 351**.

b. Set up the Cablecure pump and the fluid reservoir as specified in **NRI 411**.

- The pump should be located lower than the reservoir and gravity fed.

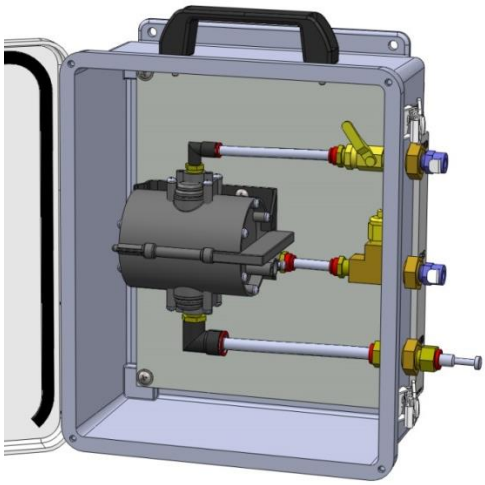

Figure 13: Set up the Cablecure pump and fluid reservoir so that the reservoir is above the pump and rests on a flat surface for the scale to operate.

c. Position the fluid reservoir on a flat surface where it can rest evenly on the digital scale.

d. Cycle the pump until the fluid flows steadily through the outlet tube into a catch bucket.

e. Take an initial reading of the fluid's weight and record it in Knomentous and connect the pump to the cable through the injection adapter as outlined in **NRI 451**.

- Never leave the pump unattended.

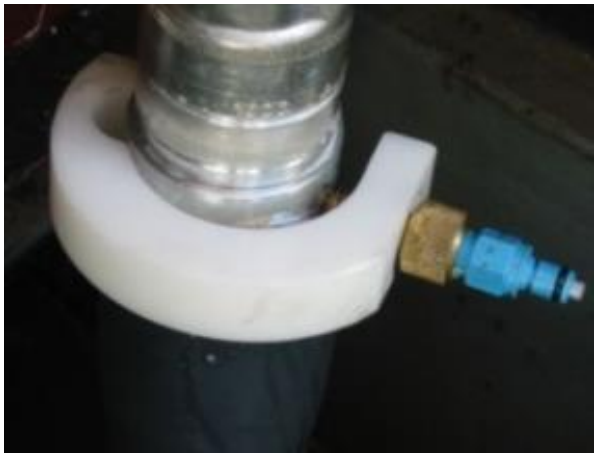

Figure 14: Connect the pump to the cable by using the injection adapter and connecting the QDs.

f. The injection is complete when enough discard fluid has been collected in the vacuum tank.

g. Remove the vacuum tank from the cable by separating the QDs at the injection adapter.

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

i. Record the final fluid level and injection pressure in Knomentous.

3. Post-injection.

a. Re-energize the circuit following the procedures outlined in the Novinium FOSH and by local standards.

b. Follow the procedures in **NRI 290** to perform the post-injection PD test (if specified by the customer contract) to verify that all craftwork has been done correctly.

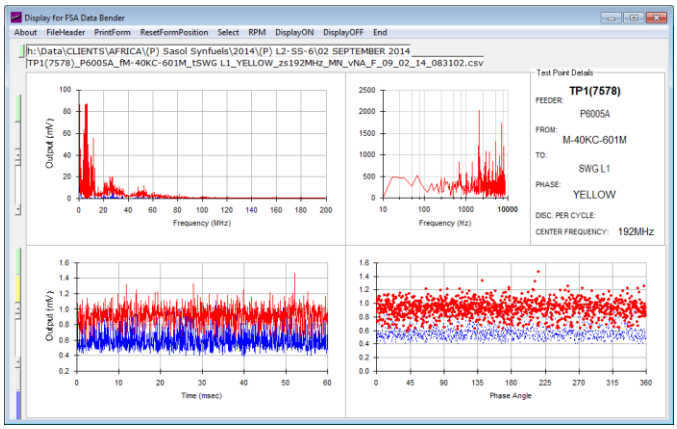

Figure 15: Use the post-injection PD test to verify that all craftwork was done properly and there is no partial discharge operating within the circuit.