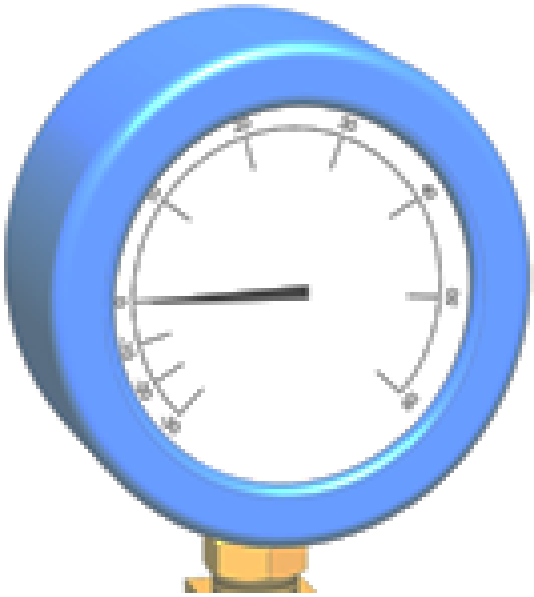
# Rejuvenation Instructions

## #351 – Injection Pressure Selection – UPR



**This NRI covers the following:**

- How to find the pressure ratings of the individual components in the cable system.
- How to determine effects of elevation changes on the cable system.
- How to select the test, injection, and soak pressures to use for the UPR injection.

**Trademarks:** http://www.novinium.com/trademarks/

**Patents:** http://www.novinium.com/patents/

**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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# The Cable System

The cable system consists of the cable, injection terminations, splices, and injection equipment used to treat the cable. The pressure rating of the cable system is only as high as the lowest rated component.

## 1. System components.

a. Determine the pressure rating of the cable.

- For energized cables insulated with PE, HDPE, XLPE, or TR-XLPE, apply the ratings listed in Table 1.

| Cable Size | Pressure Rating (psi) |
|---|---|
| #2-3/0 | 200 |
| 4/0-500kcmil | 100 |
| 750-1000kcmil | 30 |

**Table 1:** Pressure rating for energized PE, HDPE, XLPE, and T-XLPE cables.

- For de-energized cables insulated with PE, HDPE, XLPE, or TR-XLPE, apply the ratings listed in Table 2.

| Cable Size | Pressure Rating (psi) |
|---|---|
| #2-3/0 | 400 |
| 4/0-500kcmil | 200 |
| 750-1000kcmil | 100 |

**Table 2:** Pressure rating for de-energized PE, HDPE, XLPE, and TR-XLPE cables.

- For EPR cables, always contact Engineering for the maximum operating pressure.

b. Determine the pressure rating for the injection terminations referencing their respective NRIs.

c. Determine the pressure rating for the splices referencing **NRI 521** or **NRI 571**.

d. Determine the pressure rating for the fluid systems and vacuum systems used for injection referencing **NRI 411** and **NRI 421** respectively.

## 2. The cable system.

a. Reference the TDR wave trace and sketch the cable system.

- Note the position of the terminations and splices in relation to elevation changes such as power poles, hills, dips, valleys, elevated structures, etc., and pay close attention to the location.

b. For cable systems involving complex terrain and significant elevation changes or where there is not a direct line of site between the terminations, it may be necessary to employ one of the following:

- An altimeter.
- A range finder with a built-in compass to measure inclines.
- A GPS mapping system such as Garmin or Google Earth.

c. Calculate the pressure required to push fluid from the injection end to the highest point of the cable (h) using the following equations for XL and DMDB fluids (Figure 1):

- **XL(psi) = h x .42**
- **DMDB(psi) = h x .36**

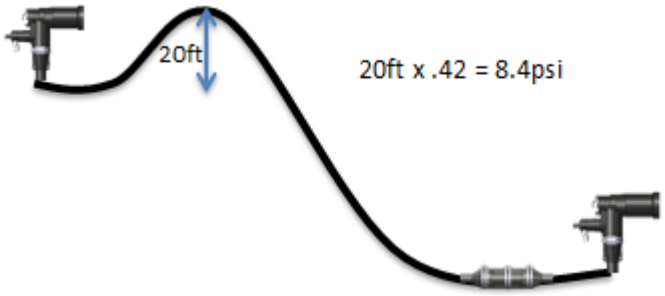


**Figure 1:** Calculate the pressure required to push fluid to the highest point of the cable.

d. Calculate the pressure that the fluid at the highest point has on the lower points in the cable, such as terminations and splices, using the same equations above for XL and DMDB fluids (Figure 2).

e. Verify that the calculated pressure does not exceed the maximum pressure rating for the individual component.

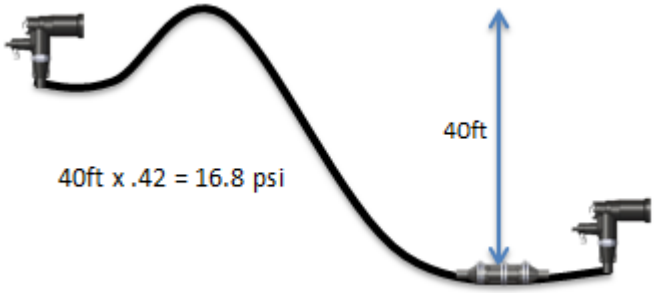


**Figure 2:** Calculate the pressure that the fluid at the highest point has on the lower points in the cable.

f. If the calculated pressures for the elevation changes exceed the pressure rating of the component, the cable cannot be injected. Contact Engineering to see if an alternate injection strategy can be applied.

# Small Diameter Cables (Used with Feed Tanks)

## 1. Pressure test.

a. Use the pressure test to prove that the cable system is leak-free before you begin injecting with the feed tank (Figure 3).

b. Perform the pressure test near the maximum allowable pressure based on the components in the cable system as determined above.

- **Pressure test = maximum of cable system**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 20psi
- Without splices = 25psi

**Figure 3:** Determine pressures for testing, injecting, and soaking small diameter cables when using feed tanks.

## 2. Flow test.

a. Use the flow test to prove that an adequate flow path exists within the cable system at the lowest pressure that will be encountered during the injection and soak period.

b. If the injection will take place using a non-regulated pressure such as a feed tank or charge tank, the flow test should be performed according to the equation below:

- **Flow Test (psi) = .5 x Pressure Test (psi)**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 10psi
- Without splices = 12.5psi

d. If the injection will take place using a regulated pressure such as with a pump or a miniature regulator connected to the feed tank, the flow test should be performed according to the equation below:

- **Flow Test (psi) = Pressure Test (psi)**

e. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With spices = 20psi
- Without splices = 25psi

## 3. Injection.

a. Use a 10% margin of safety to determine the injection pressure relative to the pressure test.

b. For all injections, select the injection pressure according to the equation below:

- **Injection (psi) = .9 x Pressure Test (psi)**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 18psi
- Without splices = 22.5psi

## 4. Soak.

a. Use the same pressure that was used for injection to soak.

- **Injection (psi) = Soak (psi)**

b. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 18psi
- Without splices = 22.5psi

c. If soaking a cable from both ends, elevation changes must be considered when setting the soak pressure in each feed tank.

# Small Diameter Cables (Used with Charge Tanks)

## 1. Pressure test.

a. Use the pressure test to prove that the cable system is leak-free before you begin injecting with the charge tank (Figure 4).

b. Perform the pressure test near the maximum allowable pressure based on the components in the cable system as determined above.

- **Pressure test = maximum of cable system**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 20psi
- Without splices = 25psi

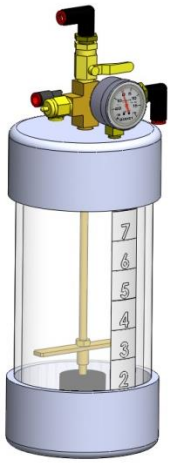

**Figure 4:** Determine pressures for testing, injecting, and soaking small diameter cables when using charge tanks.

## 2. Flow test.

a. Use the flow test to prove that an adequate flow path exists within the cable system.

- **Flow Test (psi) = Pressure Test (psi)**

b. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 20psi
- Without splices = 25psi

## 3. Injection.

a. Use a 10% margin of safety to determine the injection pressure relative to the pressure test.

b. For all injections, select the injection pressure according to the equation below:

- **Injection (psi) = .9 x Pressure Test (psi)**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:

- With splices = 18psi
- Without splices = 22.5psi

## 4. Soak.

a. Determine the pressure required to push fluid to the highest point of the cable.

b. As fluid exits the charge tank, accommodate for the drop in pressure by doubling the pressure requirement from above. Add 2psi for a factor of safety.

- **Soak (psi) = 2 x elevation change (ft) x 0.4 + 2psi**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:
   - With splices = 12psi
   - Without splices = 12psi

d. If soaking a cable from both ends, elevation changes must be considered when setting the soak pressure in each charge tank.

# Large Diameter Cables

## 1. Pressure test.

a. Use the pressure test to prove that the cable system is leak-free before you begin injecting with the pump (Figure 5).

b. Perform the pressure test near the maximum allowable pressure based on the components in the cable system as determined above.
   - **Pressure test = maximum of cable system**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:
   - Pressure test (psi) = 60psi

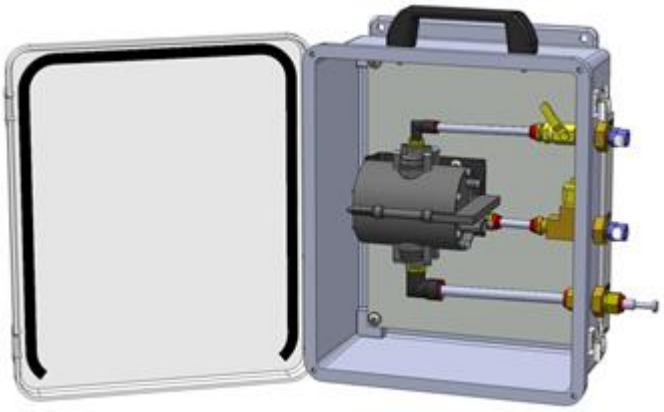

**Figure 5:** Determine pressures for testing and injecting large diameter cables.

## 2. Flow test.

a. Use the flow test to prove that an adequate flow path exists within the cable system.
   - **Flow Test (psi) = Pressure Test (psi)**

b. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:
   - Flow test (psi) = 60psi

## 3. Injection.

a. Use a 10% margin of safety to determine the injection pressure relative to the pressure test.

b. For all injections, select the injection pressure according to the equation below:
   - **Injection (psi) = .9 x Pressure Test (psi)**

c. For most polyethylene-insulated cables in flat terrain, the following pressures may be used:
   - Injection (psi) = 54psi