

Rehabilitation Instructions #412 – Fluid Systems – iUPR & SPR



This NRI convers the following:

- The common applications for each type of tank or bottle.
- How to fill feed tanks and mix fluid.
- Understand the tank factors for all feed tanks.
- How to secure all feed tanks on the jobsite
- How to daisy chain the UP1.5L tank.
- Understand the application for the liquid flow meter



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

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Tank Cable Length Injected

Use this table to find approximately how much footage can be injected with a given tank.

Approximate Injected Length for Each Tank								
Units	Stranding	AWG/Tank	50L Tank	9L Tank	3L Tank	2L Tank		
	Compressed	1000MCM	1,854	371	-	-		
		750MCM	2,472	494	-	-		
		500MCM	4,045	809	270	-		
		4/0	-	1,309	436	291		
		1/0	-	2,781	927	618		
		#2	-	-	2,967	1,978		
Feet	Compact	1000MCM	10,854	645	-	-		
		750MCM	5,494	1,099	-	-		
		500MCM	3,225	2,171	724	-		
		4/0	-	4,450	1,483	989		
		1/0	-	5,235	1,745	1,163		
		#2	-	-	5,933	3,956		
	Compact	1000MCM	3,289	195	-	-		
		750MCM	1,665	333	-	-		
		500MCM	977	658	219	-		
		4/0	-	1,348	449	300		
		1/0	-	1,586	529	352		
Motore		#2	-	-	1,798	1,199		
Meters	Compressed	1000MCM	562	112	-	-		
		750MCM	749	150	-	-		
		500MCM	1,226	245	82	-		
		4/0	-	397	132	88		
		1/0	-	843	281	187		
		#2	-	-	899	599		

Table 1: Approximate footage injected for each tank size.

iUPR Feed Tanks

1. UP1.5L Feed Tank – iUPR

The iUPR 1.5 liter tank is made almost entirely of non-conductive items and due to its compact design, allows the tank to be stored inside energized environments during the injection. The 1.5 liter tank can be used in iUPR injections for all cables up to 4/0 in size. For the average length of 1/0 cable, multiple injections can be carried out before a refill is required.

Tank Information

- Tank Factor: 7.42 cc/mm
- Maximum Capacity: 1.5 L (1500 cc)
- Maximum Read Height: 210 mm
- Minimum Read Height: 0 mm
- Maximum Pressure: 30 psi



Figure 1: UP1.5L feed tank.

2. Daisy Chain UP1.5L Feed Tanks

For longer length runs of cable or larger sized cables being injected with the iUPR process, multiple UP1.5L feed tanks can be connected together to increase the reservoir of fluid available.

- a. Designate the tank that will be directly connected to the cable as Tank 1.
- b. Designate the tank being connected to Tank 1 as Tank 2. Add as many additional tanks as needed.
- c. Attach tubing to the fittings of a JACO ball valve. Determine the length of tubing necessary.



Figure 2: Connect tubing with correct fittings to a JACO valve.

d. Attach one end of the ball valve assembly to the injection port fitting of Tank 2.



Figure 3: Connect to the JACO valve on Tank 2.



Figure 4: Connect the other end to the fill port on Tank 1.



Figure 5: Connect CO2 kit to Tank 2's gas port, and FIC to Tank 1's injection port.

- e. Connect the other end of the ball valve assembly to the fluid fill port of Tank 1.
- f. Repeat steps **a** through **e** for any additional tanks in the chain.

- g. Connect the Compact CO₂ kit to Tank 2's gas port.
- h. Connect the FIC to the injection port of Tank 1.

SPR Feed Tanks

1. Insulated 2.0L Feed Tank – SPR

The Insulated 2L Tank contains a flowmeter inside of a cover designed to prevent incidental contact with secondary voltage. A handle allows the tank to be placed in a transformer using a hot stick. The cover is clear, allowing the flowmeter to be read through it, while protecting it from damage. There is a small filter between the tank outlet and the flowmeter. This tank can be used for most of the small diameter cables, but may not have enough volume for long segments. Refer to Table 1 to find the length of common cable sizes that can be injected by a full 2 liter tank.

Tank Information

•	Tank Factor:	8.33 cc/mm

- Maximum Capacity: 2 L (2000 cc)
- Maximum Read Height: 240 mm
- Minimum Read Height: 10 mm

2. 3.0L Feed Tank – SPR

The silver 3 liter tank is the most commonly used tank for SPR injection. Refer to Table 1 to find the length of common cable sizes that can be injected by a full 3 liter tank.

Tank Information

- Tank Factor: 8.33 cc/mm
- Maximum Capacity: 3 L (3000 cc)
- Maximum Read Height: 360 mm
- Minimum Read Height: 10 mm
- Maximum Pressure: 450 psi

• Maximum Pressure: 400 psi



Figure 6: Insulated 2.0L feed tank.



Figure 7: SP3.0L feed tank.

3. Replacing the flowmeter on the Insulated 2.0L Tank

If necessary the flowmeter on the Insulated 2.0L Tank can be maintenance in the field. A hole in the top of the tank cover allows the flowmeter to be tightened if necessary. If the flowmeter needs to be replaced in the field, follow these steps to open the tank cover.

- a. Close the Outlet Valve.
- b. Remove the 4 screws surrounding the flowmeter (see image). Remove the Nylon Strip covering the joint in the cover.
- c. Unfold the cover to expose the flowmeter.
- d. Loosen the fitting closest to the Outlet Valve.
- e. Loosen the nuts on the back of the flowmeter ports if necessary and remove the flowmeter.



Figure 8: Removing the flowmeter on the Insulated 2.0L Tank

4. Suggestions for securing 3.0L tanks

During injection, the 3.0L feed tank should be secured to prevent it from tipping over. Bumping the tank or snagging the tubing attached to the tank, could lead to the tank tipping over.

A tank that tips over could become damaged and leak or spray fluid.

A few suggestions of safeguarding the tanks from tipping include:

- Constructing a wheeled cart carrying the feed tanks.
- Using magnets connected by rope, wire, or bar to hold the feed tank against the outside of the transformer enclosure.
- Adding a makeshift base to hold the tank.
- There is no prescribed way to secure tanks during injection as each job encounters its own unique situation.
- Observe all local requirements for securing pressure vessels.
- Refer to and follow the Compressed Gas Cylinder Safety section in Chapter 5 of the FOSH for requirements during transportation of pressure vessels.
- Develop the solution that best suits the crew's needs.



Figure 8: Two magnets tied together example



Figure 9: Injection Cart example



Figure 10: Example of a milk crate carrier for storing and moving tanks.

5. SP9.0L Feed Tank – SPR

The 9 liter tanks are typically needed on long cable runs or when injecting 4/0 and other small feeder-sized cables. Fluid measurement can only be done while the fluid is in the cylindrical section of the tank. In the cylindrical section, the displayed tank factor is valid. The tank factor constantly changes if injection is done while fluid is in the lower domed or reaches above the sight gauge into the upper domed section. This makes measuring the fluid usage extremely difficult.

Tank Information

- Tank Factor: 33.3 cc/mm
- Maximum Capacity: 9 L (9000 cc)
- Maximum Read Height: 265 mm
- Minimum Read Height: 0 mm
- Maximum Pressure: 200 psi



Figure 11: SP9.0L feed tank.

6. SP50.0L Feed Tank – SPR

The 50 liter tank is the largest available SPR injection tank. It is primarily used during large diameter cable injections or for extremely long cable lengths. As with the 9 liter tank, fluid measurement can only be done while fluid is in the cylindrical section of the tank. Otherwise, the tank factor will change constantly depending on the height, making it difficult to measure fluid usage.

Tank Information

- Tank Factor: 71.4 cc/mm
- Maximum Capacity: 50 L (50,000 cc)
- Maximum Read Height: 690 mm
- Minimum Read Height: 0 mm
- Maximum Pressure: 200 psi



Figure 12: SP50.0L feed tank.

Flush Tanks and Bottles

1. 140mL Square Tank – SPR

- The square 140mL tank can withstand the full pressure of SPR injection. This tank with a ball valve is required for unattended SPR injection.
- Fluid flushed into this tank must be measured with a graduated nylon bottle for accurate recording into the "Flush" field of Knomentous.

2. Insulated Receiver Tank – SPR

The Insulated Receiver Tank is designed to be placed in a transformer during injection. It is a 140mL SPR tank, placed in an insulating bag. The tank has two ball valves, one at the tank inlet and one at the outlet. The outlet valve should always be closed during an injection.

Any fluid remaining in the receiver tank following injection must be measured with a graduated nylon bottle for accurate recording into the "Flush" field of Knomentous.



Figure 13: 140mL square tank.



Figure 14: Insulated Receiver Tank.

3. UP Relief Bottle – iUPR

- After iUPR injection, the UP relief bottle is used to quickly bleed off the cable's internal pressure while containing any fluid that may come out.
- The fitting on the UP relief bottle needs to match that of the tubing connected to the fluid injection cap.



Figure 14: UP relief bottle.

4. Nylon Bottle: 1L, 0.5L, 0.25L, 0.125L – SPR

- The various sizes of nylon bottles come with a graduated scale on their side, making these bottles an excellent choice for measuring flushed water and fluids.
- The nylon bottles can also be used as a catch bottle for monitored SPR injections. This removes the need to transfer flushed fluid into a graduated container for accurately measuring the flush for Knomentous.



Figure 15: Nylon bottle.

Dip Tube Assembly

1. 1/4" and 3/8" Dip Tube Assemblies

- The 9L and 50L tanks require filling using the 3/8" dip tube assembly, while the ¼" dip tube assembly is needed for filling all other tanks.
- Using the larger tubed dip tubes fills the larger feed tanks at a faster rate.
- The dip tube assembly's cap can hold the dip upright on the spout of the fluid pail. However, it will only loosely thread onto the spout.
- After many uses, the filter of the dip tubes will become clogged as they filter the fluid from the pail. If flow drops significantly, it is suggested to contact Supply Chain for replacement dip tube assemblies.



Figure 16: Dip tube assemblies.

Filling Feed Tanks

- a. Fill the feed tanks by first drawing a vacuum inside to pull fluid directly from the fluid pail.
- b. Close all valves on the feed tank.
- c. Connect either the hand vacuum pump or the DC vacuum pump to the gas port of the feed tank, which is marked green.



Figure 17: Connect vacuum pump to gas port.

- d. Connect the dip tube assembly to the feed tank's fill port, which is marked purple.
- e. Open the gas port and begin pulling vacuum.
- f. When the tank has a full vacuum, close the gas port valve.
- g. Insert the dip tube assembly into the pail of fluid.
- h. Loosely thread the cap of the dip tube assembly onto the fluid can spout.
- i. Open the valve on the fill port to begin pulling in fluid.
- j. Monitor the fluid level in the tank.
- k. When the desired fluid level has been reached, pull the dip tube assembly from the fluid pail.
 - Pulling the dip tube assembly from the pail will pull all fluid inside the dip tube and tubing, minimizing drips and potential fluid cross-contamination.
- I. When finished filling the tank, disconnect lines and install a plug fitting on the fill port to prevent accidental fluid leaks.



Figure 18: Connect dip tube to fill port.

Mixing Fluid in Feed Tanks

Sometimes fluid needs to be mixed on site. If no mixing drums are available to mix large quantities, fluid can be mixed inside individual tanks. Fluid mixtures are described in parts (e.g., a 2:1 mix of 733 to 212).

- a. Calculate the amount of fluid needed for each fluid type.
- b. Fill the tank with the first type of fluid.
- c. Place the dip tube into the second type of fluid and fill the tank the rest of the way.
 - Filling the tank with the fluid of less parts first will allow more natural mixing time.
 - The second fluid, with more parts, naturally takes longer to draw into the tank.
- d. Purge the air from any partial cans with CO₂.
 - Novinium fluids will react with the water in the air. Removing air from the pail will stop this.
- e. Label and seal any partial cans for later use.
- f. Close all valves on the tank.
- g. Agitate the tank to mix the fluid further. Quickly moving the tank from vertical to horizontal 20 times should thoroughly blend the fluid.

Liquid Flow Meter – SPR

- The liquid flow meter is a necessary tool for the SPR injection. It allows visual confirmation of fluid flow and the end of the pressurization step in the injection of small diameter cables.
- The inlet of the liquid flow meter filters the fluid coming from the feed tank. This removes any debris picked up by the fluid inside the feed tank.
- The 3-way valve on the top of the liquid flow meter comes standard with two 1/8" NPT x 1/8" tubing fittings. These fittings can be swapped for 1/8" NPT x 1/4" tubing fittings.
- For any outlets that are not being used, place a cap to prevent accidental spills.
- The scales on the paper backing are used to determine the flow rate of the floats inside the glass tube. If the flow meter uses two floats, make sure the black float is on top of the silver float.



Figure 19: Liquid flow meter for SPR.