Recharging the Vacuum Insulation in LNG Tank

Purpose:
The purpose of this work instruction is to outline the steps necessary to recharge the vacuum insulation in an LNG tank. It is recommended that this procedure be performed only if the LNG tank vacuum pressure is greater than 20 milliTorr.

NOTE
The indicated vacuum threshold pressure of 20 milliTorr assumes a cold tank. If the tank has been empty for an extended period of time, please contact Westport HD service for assistance.

Tools and Materials Required:
- Westport Service Work Instruction INS-10011728 Draining the High Pressure Gas System
- Westport Service Work Instruction INS-10011871 Draining the LNG Tank
- Westport Service Work Instruction INS-10017715 Replacing LNG Tank Hydraulic Lines
- Westport Service Work Instruction INS-10020817 Vacuum Cart Maintenance Manual
- Westport LNG tank vacuum cart. Contact Westport service to request cart
- Teledyne® HPM4/6 vacuum gauge (or equivalent)
- Dow Corning® High Vacuum Grease (Westport p/n 10011673S)
- Dow Corning® High Vacuum Grease Material Safety Data Sheet (MSDS) - available on the Dow Corning® website
- Replacement vacuum port dust cap (Westport p/n 10015756S) may be required
- Replacement vacuum port plug (Westport p/n 10024439S)
- JIC-10 female caps (x2)
- JIC-8 female caps (x2)
- Appropriate personal protection equipment (PPE)

Stage 1: Preparation the Vehicle
1. Before beginning work, ensure the vehicle is parked in an outdoor shop area or approved natural gas vehicle shop (see local regulations), with parking brake on and engine off.
2. Review the Dow Corning® vacuum grease MSDS.
3. Open the LNG tank shroud lid and turn the red LNG pump shut-off valve (if equipped) to the CLOSED position.
4. Remove the service cover from the top of the tank shroud.
5. Drain the LNG tank following Westport Service Work Instruction INS-10011871 Draining the LNG Tank.
6. Drain the high pressure gas system following Westport Service Work Instruction INS-10011728 Draining the High Pressure Gas System.
7. On some tanks, it may be necessary to remove the LNG pump hydraulic lines to access the vacuum port. Follow the Removal section of Westport Service Work Instruction INS-10017715 Replacing LNG Tank Hydraulic Lines to remove the hydraulic lines from the pump. Cap the
LNG pump fittings with the JIC-10 female caps, and the hydraulic manifold with the JIC-8 female caps.

Stage 2: Preparing the Vacuum Cart

8. Remove the 5500 psi LNG pump pressure relief valve (PRV), if equipped, so the vacuum port may be accessed, as seen in Figure 1.

**WARNING**
The PRV may trap up to 5500 psi in the LNG pump internal plumbing. Before removing the PRV, if equipped, ensure that the LNG pump shut-off valve is in the OPEN position and the high pressure gas system is drained, in accordance with INS-10011728 Draining the High Pressure Gas System.

9. If the brass slip nut is not already attached to the vacuum tool, spin the slip nut onto the nozzle (Figure 2), but do not tighten. The o-ring should not be compressed.
10. Clear all debris on the inner walls and slip nut of the vacuum tool.

**CAUTION**
The inner wall and slip nut of the vacuum tool must be cleaned prior to performing the vacuum procedure to prevent contamination to the LNG tank vacuum and ensure a proper seal.

11. Remove the blank off plate from the vacuum intake line Figure 3.

**NOTE**
There is a centering o-ring between all mating surfaces of the vacuum cart connections. Clean all debris from the o-ring and mating surface. Apply a thin layer of Dow Corning® high-vacuum grease to the mating surface.

12. Clean all debris from the centering o-ring and mating surfaces. Apply a thin layer of Dow Corning® high-vacuum grease to the mating surface of the vacuum cart hose and vacuum tool.

13. Install the vacuum tool onto the vacuum inlet line.

14. Clean all debris from the vacuum tool nozzle o-ring and apply a thin layer of Dow Corning® high-vacuum grease to it.
Stage 3: Vacuuming the LNG Tank

15. Clean the LNG tank vacuum port and surrounding area.

16. Remove the dust cap from the vacuum port (Figure 4). Remove and discard the vacuum port cap (if installed) using a plastic pick or small flat-blade screwdriver, being sure not to damage the vacuum port surface.

![Figure 4: Vacuum port and dust cap](image)

17. Clean excess vacuum grease from the vacuum port plug surface and threads.

18. Push the vacuum tool nozzle onto the LNG vacuum port (Figure 5) until firm metal-to-metal contact is felt. Tighten the slip nut hand tight plus 1/8 turn. The tool may feel loose, but is sufficiently tight.

![Figure 5: Vacuum tool attached to port](image)

19. Pull the plunger out and actuate the vacuum tool valve to ensure there is sufficient clearance for valve operation.

20. With the vacuum tool valve open, open the manual shut-off valve on the vacuum cart and turn the vacuum pump on to evacuate the vacuum cart plumbing.
21. Measure the vacuum pressure at the vacuum cart and ensure it is less than or equal to 5 milliTorr.

**NOTE**
If the vacuum cart hosing is unable to reach 5 milliTorr or below, there may be a leak in the system. Follow the Troubleshooting section of INS-10020817 Vacuum Cart Maintenance Manual to troubleshoot vacuum cart issues.

22. Slowly actuate the vacuum tool valve twice to ensure air trapped in the valve body is evacuated.

23. Measure the vacuum pressure at the vacuum cart again to ensure that it is less than or equal to 5 milliTorr.

24. Ease in and thread the plunger to engage the vacuum port plug inside the port.

25. Pull the knob and check for resistance to ensure that the plug is engage.

26. Pull the knob out 6 inches to release the tank vacuum port plug.

**CAUTION**
The tank vacuum is now connected to the pump. DO NOT remove the hose or the entire vacuum in the tank will be lost, possibly damaging the LNG tank.

27. Plug the vacuum meter into the LNG tank vacuum sensor and monitor until it has reached a vacuum of 5 milliTorr. Once at 5 milliTorr, allow the vacuum cart to continue pulling vacuum for 1 hour minimum.

**NOTE**
One hour is the minimum required vacuum time. Where possible, allow the cart to continue vacuuming until all other repairs are complete, and the truck is ready for release to the customer.
28. Pull the plunger out completely, and close the vacuum tool valve (Figure 6). The valve actuates towards the left and should clear in between the LNG pump and the fill manifold.

**CAUTION**
Ensure the valve is completely closed as any leakage can cause contamination to the LNG tank vacuum.

![Figure 6: Vacuum tool valve closed](image)

29. Close the shutoff valve on the vacuum cart, turn off the vacuum pump, and monitor that the LNG tank vacuum remains constant.

**CAUTION**
If the vacuum starts to increase, immediately turn on the vacuum cart, reopen the vacuum tool valve, and reseat the vacuum port plug. Determine and repair the source of the leakage on the vacuum tool valve.

30. Loosen the wing nut on the clamp and remove the clamp, o-ring, and plunger fitting from the vacuum tool (Figure 7).

![Figure 7: Remove plunger fitting](image)
31. Discard the removed vacuum port plug.

**NOTE**
The vacuum port plug is one time use only and shall be replaced during every vacuum procedure.

32. Remove the new vacuum port plug from packaging (Figure 8) and inspect for damage to the wrap material, and debris on the o-ring. The plug may not be exactly as shown in the figures below.

**CAUTION**
A damaged plug (Figure 9) shall NOT be used as it could affect its ability to create an effective seal, leading to premature vacuum loss of an LNG tank.

33. Clean off any debris from the vacuum port plug o-rings and apply Dow Corning® high-vacuum grease.
34. Install the replacement onto the plunger and **finger tighten** (Figure 10). The plug may not be exactly as shown in the figure below.

![Figure 10: Vacuum port plug](image)

35. Reassemble the o-ring, plunger fitting, and clamp to the vacuum tool. Tighten the wing nut to **hand tight**.

36. Turn on the vacuum pump.

37. Monitor the pressure in the vacuum cart plumbing to ensure it is equal to or less than 5 milliTorr.

38. Open the vacuum tool valve and gently push the knob in to reseat the vacuum plug.

39. Turn the knob counter-clockwise to disengage the plug from the vacuum tool.

40. Pull the plunger out, close the vacuum tool valve and turn off the vacuum cart.

41. Remove the plunger fitting to confirm the vacuum port plug has been installed.

42. Remove the vacuum tool from the LNG tank and measure the LNG tank final vacuum to confirm repair.
Stage 4: Completion

43. Liberally apply Dow Corning® vacuum grease to the inside of the vacuum port and reinstall the dust cap (Figure 11). Replace the dust cap with a new one if the old one is missing, cracked, or otherwise damaged.

![Figure 11: Plug with grease (L) and caps replaced (R)](image)

44. Reinstall the 5500 psi PRV, if equipped. Tighten fittings to hand tight plus ¼ turn.

45. Follow the Installation section of Westport Service Work Instruction INS-10017715 Replacing LNG Tank Hydraulic Lines to reinstall the hydraulic lines if they were removed.

46. Ensure that the Fuel Conditioning Module (FCM) manual vent valve is CLOSED.

47. If equipped, turn the red LNG pump shut-off valve to the OPEN position.

48. Reinstall the service cover onto the LNG tank shroud.

49. Reinstall the plunger fitting to the vacuum tool.

50. Remove the vacuum tool from the vacuum hose, reinstall the blank-off plate, and store the vacuum tool in the drawer of the vacuum cart.