Revision 2 - 12/30/97

Solenoid Installation Procedures

Install the solenoid in the barrel

1. Align the beam 10 mm above the center of the coil
2. Remove the upper half of the transportation rings
3. Lift the forward end (opposite the chimney end) of the cryostat 10 - 20 mm
4. Turn out the trolley supports 10 mm (Place a 1 inch thick board between the trolley arm and the ID of the cryostat)
5. Lower the forward end of the cryostat onto the forward end of the trolley
6. Check to make sure all forward arms are touching the ID of the cryostat
7. Lift the chimney end (backward end) of the cryostat 10 - 20 mm
8. Turn out the trolley supports 10 mm (Place a 1 inch thick board between the trolley arm and the ID of the cryostat)
9. Lower the forward end of the cryostat onto the forward end of the trolley
10. Check to make sure all forward arms are touching the ID of the cryostat
11. Check the alignment of the coil on the trolley. The beam should be centered within the cryostat by 1-2 mm.
12. Repeat steps 3 through 11 until the beam is centered within the cryostat

13. Chain the trolley onto the beam to keep it from moving during transport.
14. Move the coil to the backward end of the flux return
15. Secure the beam on to the beam supports
16. Install the beam that passes through the flux return
17. Connect both beams with the pin
18. Measure the height of the beam from the floor
19. Remove the support stand located between the two beams
20. Measure the height of the beam from the floor to determine the beam deflection

21. Align the beam inside the flux return (centers aligned +/- 2 mm). The main purpose of this alignment is make sure that the cryostat does not touch the flux return or RPC's during the push-in. Final alignment will be done after the cryostat is inside the flux return.
22. Push the cryostat inside the flux return
23. Adjust the beam during the push-in if necessary
24. Align the cryostat inside the flux return.
25. Locate the cryostat axially 2 mm in the forward direction (This number needs to be checked again)

26. Shim the spherical washer assembly so that they engage in the center of the travel of the radial support slides
27. Engage the radial supports until they touch the OD of the cryostat
28. Transfer the load to the radial supports
    29. Option 1 is to retract the trolley arms by turning them.
    30. Option 2 is to only engage the 4 bottom radial supports and the 4 center radial supports. Leaving space between the 4 upper radial supports and the OD of the cryostat. Then using a jack at the forward end the coil (opposite the chimney end) jack up the cryostat 1-2 mm. Just enough to allow the arms of the trolley to be retracted. **Record the number of turns the trolley arms are retracted. This will make it easier if the coil has to go back onto the trolley.** Do the same to the backward end.
31. Check the alignment of the cryostat inside flux return. The cryostat and flux return centers should be aligned within 0.5 mm if possible. The axial location of the cryostat with respect to the flux return should be aligned within 0.5 mm if possible.

32. Install the z-support brackets onto the flux return.
33. Adjust the 2 bearing pads on each z-support until they touch the cryostat.
34. Apply the axial preload with the tie-rods.
    35. The preload should be applied in steps to make sure that the axial location of the coil does not change.
    36. The amount of the preload needs to be finalized
37. Check the radial and axial alignment of the cryostat inside the flux return.
38. Make adjustments to the cryostat location if necessary.

39. Install the intermediate beam support - this time install it so that the beam out side of the flux return can be remove first
40. Remove the pin between the two beams
41. Remove the beam out side of the flux return
42. Using the counter weight remove the beam from inside the ID of the cryostat.
43. Remove the beam supports
44. **START Forward Door assembly**

Install the valve box

45. Install the valve box: Lower the valve box onto the valve box supports attached to the barrel. The valve box will be set 2 inches its final location. The valve box supports has adjusting screws that allow the valve box to be carefully lowered to mate up with the triangle chimney attached to the cryostat.
46. Make the electrical and cryo connections: Make up the 2 bolted current lead connections. Connect the coil and thermal shield cryogenic tubes (2 inlet and 2 outlet). Connect the sensor cables.
47. Leak test new cryo connections: Leak test the new cryogenic connections by bagging off the welded areas and inject helium into the bag while helium circuit is under vacuum.
48. Global leak test the solenoid: Pump down the cryostat and pass helium gas through the coil and thermal shield cooling circuits. Using a mass spectrometer check for leaks.

Final Connections and Tests

49. Connect the DC cables: Cut and terminate the 20 DC cables to length between the current leads and the dump resistor / breakers.
50. Connect the transfer line: Connect the helium co-axial transfer line to the valve box.
51. Misc. cryo connections: Connect the 300 K gas line, quench and current lead return line to the lines plumed to as far as the current wall.
52. Final I&C connections: Connect the I/C cables strung as far as far as the control rack on top of the barrel flux return to the valve box.
53. Leak test the final cryo connections: Leak test the final cryogenic connections by bagging off the welded area and injecting helium. Check for a leak using a mass spectrometer connected to cryogenic pluming under vacuum.
54. Check the power supply system: Check to see that power supply and DC cables have been installed properly.
55. Final system checks: Check solenoid interlocks system, solenoid control system, quench protection system, power supply system, vacuum system.

Cooldown solenoid

56. Initial Cooldown: Cooldown the solenoid, carefully watch the preload in the tie-rods.
57. Solenoid testing
    a) High potential test between one current lead and the control dewar "ground" as specified in 5.4.4, with leakage current not to exceed 0.1 mA with full vacuum in the service

chimney at room temperature; (Comment: The voltage in 5.4.4 is 500 V. This value should be verified with ANSALDO)

b) Cool the system to operating temperature, logging coil temperatures vs. time; note that in this and all subsequent tests thru 16 below, the helium supply to the solenoid shall be at the temperature and flow rate as specified in Table 5.7. Check the operation of the thermo-siphon system.

c) Measure heat leak to the helium and nitrogen systems at zero current;

d) Operate power supply to small current and verify proper connection and operation of all potential taps, quench detector noise, and temperature instruments;

e) Charge the coil at a current 32% of the design current, monitoring the axial and radial loads. Compare the loads with the computed ones and eventually move axially the coil before going to the following point.

f) Charge the incrementally to at least six increasingly larger current values of 44%, 63%, 78%, 90%, and 100% of the design current at the specified charge rate appropriate to the current level with fast and slow discharges at he end of each current plateau. Operate dump switch and energize dump at 30% of maximum operating current of the solenoid. Log versus time the solenoid current and solenoid terminal voltages, coil and shield temperatures, and helium flow rate, temperature, and pressure in the coil , and temperature, voltage drop and helium flow rates in the vapor cooled current leads, and the temperature of the protective resistor, during this and all tests specified in 9, 10, 11, 12, 13, and 14 below. Logging rates for quantities recorded shall be sufficiently rapid to display he useful time-dependent detail in each parameter, especially during quenching;

g) Verify that the solenoid can be charged to the design current in the time specified, and measure inductance of the solenoid;

h) Operate the solenoid at the design current for a period of not less than 12 hours;

i) Charge magnet at a rate charge sufficient to reach design current in 15 minutes;

~~j) Measure the coil temperature, current, and terminal voltage vs. time following initiation of a quench from 71% design current with the protection resistor shorted;~~

~~k) Repeat items j) quenching from 87%, and 100% design current with the protection resistor shorted;~~

l) Operated the solenoid at the design current for a period of not less than 8 hours.

m) Measure the solenoid field using a Hall probe.

Solenoid commissioning complete: