DFBX-G Acceptance Criteria Summary

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A. Inspections during DFBX Fabrication

1. Helium tank assembly welding
   - 1.1 Manufactured and welded in accordance with ASME Pressure Vessel Code, Sec. 8with the exception of final close out weld of excess panel.
   - 1.2 Longitudinal welds radiographed and interpreted.
   - 1.3 4K Charpy impact test: minimum absorbed energy 22 ft-lb (144 J)

2. Each piping assembly, after the final weld
   - 2.1 Free of obstructions
     - 2.1.1 Large diameter pipes inspected with bore scope
     - 2.1.2 Small diameter pipes verified by passing a flexible wire or cable
   - 2.2 Two cold shocks to T ≤ 80 K, warmed to T ≥ 5C between.
   - 2.3 Pressure test.
   - 2.4 Leak rate < 1 x 10^{-9} atm cc/sec.

3 At completion of helium tank and top plate assembly
   - 3.1 All lead chimney straightness errors < 1 mm.
   - 3.2 All lead chimney bellows offsets < 0.5 mm.

4. After the installation of power leads and busses
   - 4.1 Resistance of all leads.
   - 4.2 Each bus labeled with lead designation
   - 4.3 Hi-pot of individual leads in air
     - o 7500 A leads: 5 kV, I < 50 μA
     - o 600 A leads: 2.0 kV, I < 20 μA
     - o 120 A leads: 2.0 kV, I < 20 μA
   - 4.4 Resistance of all HTS lead heaters and temperature sensors.
   - 4.5 Hi-pot of HTS lead heaters and temperature sensors in air
     - o 300 V, I < 3μV
   - 4.6 Continuity of power lead voltage taps
   - 4.7 Resistance check of He tank instrumentation (LL sensors, temperature sensors, tank heaters)
   - 4.8 Hi-pot of He tank instrumentation (LL sensors, temperature sensors, tank heaters)
     - o 600 V, I < 6 μA

5. Pressure and vacuum leak checks after the helium tank has been closed
   - 5.1 Two cold shocks of He tank to T ≤ 80 K, warmed to T ≥ 5C between.
   - 5.2 Lambda plug leak rate (ΔP = 0.1 MPa) and compared to value measured at LBL
   - 5.3 Pressure test bus ducts to 2.5 MPa ($P_{He\ tank}$ = 0.1 MPa) for 600 sec

5.4 Pressure test He tank and bus ducts together to 0.54 MPa for 600 sec
5.5 He tank and bus duct vacuum leak rate < 4 x 10^{-9} atm cc/sec
5.6 All lead chimney bellows offsets
5.7 Hi-pot leads and busses, temperature sensors, and helium tank instrumentation in room temperature, 1 bar helium
5.7.1 7500 A leads: 1.4 kV, I < 15 μA
5.7.2 600 A leads: 0.65 kV, I < 7 μA
5.7.3 120 A leads: 0.65 kV, I < 7 μA
5.7.4 HTS lead temperature sensors: 120 V, I < 1 μA
5.7.5 He tank instrumentation: 200 V, I < 2 μA

6. Electrical tests after instrumentation ducts have been installed
6.1 Continuity check from connectors at magnet end to DFBX feedthrough Hi-pot tests in air
6.1.1 Voltage tap leads: 5 kV, 50 μA
6.1.2 Quench protection heater leads: 5 kV, 50 μA
6.1.3 Warm-up heater leads: 2.0 kV, 20 μA
6.1.4 Temperature sensor leads: 0.6 kV, 7 μA

7. Leak Checks after the instrumentation ducts have been installed
7.1 Pressure test of MQX2 and MBX2 lines:
7.2 Leak check MQX2 and MBX2 lines
7.3 Leak rate < 1 x 10^{-7} atm cc/sec

8. Hi-pot instrumentation leads with helium in the instrumentation ducts
8.1 Hipot performed in 1 atm room temperature helium.
8.2 Hipot voltages and current limits
8.2.1 Voltage tap leads: 1.4 kV, I < 15 μA
8.2.2 Quench heater leads: 1.4 kV, I < 15 μA
8.2.3 Warm-up heater leads: 650 V, I < 7 μA
8.2.4 Temperature sensor leads: 200 V, I < 2 μA

9. Electrical tests of DFBX cryogenic instrumentation leads
9.1 Includes passive heater temperature sensors from LBX
9.2 Resistance of I+ to I- and V+ to V- leads on each temperature sensor
9.3 Hipot: 200 V, I < 2 μA.

10. Inspection of pipe clearances after assembly into the DFBX
10.1 Minimum clearance from any pipe to any other pipe ≥ 12 mm

11. Top plate distortion during end plate welding
11.1 Maximum movement of center of top plate < 0.75 mm.

12. Top and bottom plate distortion during side plate welding
12.1 Distortion measured at three locations on the top plate longitudinal centerline.

13. Vacuum flanges, pipe position and fiducial system measurements after the box has been fabricated.
    - 13.1 Verify that vacuum flange centers are in the correct position.
    - 13.2 Verify that the piping is in the correct position.
    - 13.3 Measurement of fiducial system
        - 13.1 Positions (x,y,z) of two Taylor Hobson spheres must be measured and recorded
        - 13.2 Roll angle (with respect to y-axis) must be measured and recorded

14. Vacuum vessel pressure test
    - 14.1 Hold P = 0.14 MPa for 600 sec
    - 14.2 No leaks found with "bubble check"

15. Vacuum vessel vacuum leak check
    - 15.1 Must be able to pump to $P < 10^{-3}$ Torr
    - 15.2 Leak rate $< 10^{-8}$ atm cc/sec

16. Helium tank and bus duct vacuum leak check in complete assembly
    - 16.1 Leak rate to insulating vacuum $< 1 \times 10^{-8}$ atm cc/s

17. Piping pressure and vacuum leak tests in complete assembly
    - 17.1 Pressurize with helium and leak rate to insulating vacuum $< 3 \times 10^{-9}$ atm

18. Pressurize the vacuum vessel, helium tank, and piping for shipment
    - 18.1 Helium tank warmed to room temperature
    - 18.2 All circuits (vacuum vessel, helium vessel, all pipes) backfilled with dry nitrogen at 0.12 MPa and sealed
    - 18.3 Ambient temperature and pressure at time of feedbox pressurization must be recorded

B. **Inspections before and after Shipping the DFBX to CERN**

1. Inspections before DFBX shipment to CERN
    - 1.1 Visual inspection of shipping crate
    - 1.2 Shock indicators must be zeroed
    - 1.3 Ambient temperature and pressure at time of feedbox packing must be recorded

C. Inspections and tests upon DFBX arrival at CERN

1. Visual inspection of shipping container prior to unloading from truck
2. Visual inspection of shipping crate after unloading from shipping container
3. Maximum acceleration recorded during shipment less than maxima specified in Shipping Specification
4. Vacuum vessel leak check: leak rate $< 10^{-8}$ atm cc/sec
5. Helium tank and bus duct vacuum leak check with helium tank at 80 K: leak rate to insulating vacuum $< 1 \times 10^{-8}$ atm cc/s

6. Helium vessel and bus duct pressure tests
7. Pipe and instrumentation conduits pressure and vacuum leak tests to insulating vacuum
8. Pipe positions with respect to WQX flange
   8.1 All pipe positions within tolerances specified in interface specification
9. Pipe positions with respect to WBX flange
   9.1 All pipe positions within tolerances specified in interface specification
10. Pipe positions with respect to JC1 and JC2 flanges
    10.1 All pipe positions within tolerances specified in interface specification