Pressure Test Procedure for CM2's 2-Phase Helium Line at NML

M. Wong

8 May 2012

Note1: Cavity beam-line is evacuated (0-bar), outside of the helium vessel is evacuated (0 bar). The purpose of the pressure test is to pressurize the helium system up to a 2.2-bar differential above the cavity beam line and the space outside of the helium system.
Note 2: Before the test, the tuner motors will compress the cavities so that the cavities are not damaged during the pressure test. After the test, the cavities will remain compressed until after cooldown of the cavities.
Note 3: The pressure test will also include an RF frequency measurement before, during, and after pressurization.
Note 4: The pressure testing permit will be written to follow this procedure.

MAWP = 2.0-bar at room temperature
Test pressure = 1.1*MAWP = 2.2 bar (31.9 psia, 17.2 psig)
Pneumatic per ASME code B31.1 Para. 345.5.5

Pressure Test Procedure:

1. Using tuner motors, compress each cavity
2. Evacuate cavity string
3. Evacuate insulating vacuum of cryomodule
4. First pressurize to 5-PSIG [19.7 psia]
5. Close valves on helium system to maintain for 2 minutes without loss of pressure.
6. Record frequency measurement.
7. Repeat at increased pressures, as listed in table 1
8. At 17.2-psig [31.9 psia], hold at test pressure for 5 minutes.
9. Reduce pressure to MAWP. Hold for 10 minutes. Record frequency
10. Reduce pressure and hold as listed in table 1
11. Record frequency.

Table 1 below shows the pressure levels for each pause and what should be done at that pressure.

Table 1 – Sequence of Events for Pressure Test

Pressure psig [psia]	Dwell time (minutes)	Activity at pressure
0 [14.7]	--	Baseline RF test for relaxed cavities
5 [19.7]	~2	RF check
8.6 [23.3]	~2	RF check
11 [25.7]	~2	RF check
13 [27.7]	~2	RF check
15 [29.7]	~2	RF check
17.2 [31.9]	5	Peak test pressure of 1.1 x MAWP
14.3 [29.0]	10	Pressure hold point at MAWP, RF check
11 [25.7]	~2	RF check
9 [23.7]	~2	RF check
0 [14.7]	--	RF check

Displacement and Temperature Limits of the Blade Tuner System

The limits of displacement that cause the slim blade tuner to change the length of the vessel are defined by deformation of the tuner assembly and thus the frequency of the cavity. During operation, the cavity's default position is in a stretched state. However, during pressure testing of the two-phase helium supply line, the cavity must be compressed to prevent damage to the cavity due to external pressure of helium. Table 2 lists the displacement limits of the blade tuner, where 0-mm is the relaxed position of the cavity, a positive number describes the cavity in the stretched position, and a negative number describes the cavity in a compressed position.

Table 2 – Displacement Limits of 1.3GHz Cavity

Cavity Temperature	Max. Allowed Displacement	0 mm = cavity relaxed + = cavity stretched - = cavity compressed
300K	-0.3 mm to +1.0 mm	
2K	-1.0 mm to +3.0 mm	

The temperature of the motor is monitored by a Cernox RTD that is installed on the body of the each stepper motor. At room temperature it is important to limit the operation of the tuner. The tuner temperature should not exceed 30°C. It is good practice to keep the motor temperature within a range of 20°C-50°C. After cooldown of the cryomodule, the typical temperature of the motor is ~40°K. During cooldown, it is good practice to keep the motor temperature less than 100°K.