

17 April 2007

To: Director's Office and ES&H Office

From: Tom Peterson, Technical Division, SRF Department

Subject: **Request for exceptional vessel approval for dressed cavity DESY-MKS3 (C22)**

Mayling Wong has written the pressure vessel engineering note for the dressed cavity C22, and it has been reviewed and approved by Mike McGee per the requirements of FESHM chapter 5031. The engineering note documents the safety of the dressed, 1.3 GHz, 9-cell niobium SRF cavity for 2-Kelvin operation in the horizontal test cryostat at ILCTA-Meson Lab.

However, the dressed cavity cannot meet the requirements of FESHM 5031 in two ways. See page 12 of the engineering note for more details. Here is a summary of the issues:

1. Niobium is not an ASME Boiler and Pressure Vessel – approved code material.
2. A titanium bellows in the helium vessel which allows tuning of the cavity will experience stresses at the Maximum Allowable Working Pressure (MAWP) which we have designated for the system (1.8 bar, 26 psia in vacuum) above the ASME allowable for the material but well below the material yield stress. Yield stress for titanium is 25,000 psi. Predicted stress in the titanium bellows at 1.8 bar differential pressure, room temperature, is 12,300 psi. ASME allowable stress is 9,400 psi.

We believe that the helium vessel is nevertheless safe for operation for the following reasons:

1. Pure niobium as used here has been extensively tested; its mechanical properties and the properties of these RF cavities are well-known.
2. Forces on the helium vessel are carried around the bellows by the tuner. Thus, bellows crack or rupture would result in a leak of helium to insulating vacuum but not a failure of the vessel structure.
3. The engineering note documents safe venting of the helium vessel at its internal limit of 2 bar.
4. Cavity C22 was safely operated at DESY in its similar horizontal test cryostat.
5. There is no personnel hazard since the dressed cavity is contained in the horizontal test cryostat which in turn has a large relief vent to protect against internal helium leaks.

In the longer term, Fermilab will operate many similar dressed cavities which will also qualify as exceptional vessels for at least reason 1 above. (Item 2, bellows stress, may not be a factor since designs will differ from this older one in C22.) As we prepare for testing of the more up-to-date, standard helium vessel designs, we plan to draft a general

engineering note for the dressed cavities and request approval of the design rather than seek approval signatures for each individual dressed cavity.