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Memo

date: *May 21, 2001*

to: *S. Plate*

from: *J Cozzolino* JC

subject: *Pressure Test of the LHC D1 Dipole Heat Exchanger Bellows*

A pair of these bellows (P/N 14010334) is located inside the non-lead end volume of D1. They are welded between the heat exchanger tube assemblies (P/N 14010267) and the heat exchanger manifold (P/N 14010266). Their purpose is to allow axial movement due to the differing thermal contraction rates of the copper heat exchanger tubes and the stainless steel cold mass shell. Routine pressure testing of the bellows while installed in the cold mass resulted in moderate squirming starting as low as 40 psia internal pressure. It was, therefore, deemed prudent to perform a bench test of one such bellows to ascertain its behavior at higher pressures and under more controlled conditions.

For room temperature pneumatic internal pressure testing, a bellows was welded between two 1" dia. x .065" thick x 6" long stainless tubes. One tube end was capped while the other tube end was fitted with an appropriate quick-connect pressure fitting. The ends of the tubes were clamped into a fixture that provided a 0.1" lateral offset and an angle of approximately 1 deg. to the bellows. The resulting offsets applied to the bellows were intended to exceed the "worst case scenario" in actual service. In addition, the overall rigidity of the testing support structure (influenced by such factors as length and stiffness of unsupported tubing on either side of the bellows) approximated that of the actual cold mass structure.

The bellows was subjected first to three ten-minute pressure cycles from zero to 75 psia using dry nitrogen gas. Upon completing the third cycle, the pressure was increased in 25 psi increments to 350 psia, thus concluding the test. The bellows withstood the maximum internal pressure without excessive squirming or other ill effects. Not surprisingly, the bellows displayed moderate squirm at intermediate pressures, similar to earlier observations. However, at 300 psia the squirm corrected itself and the bellows straightened out as a result of the convolutions permanently "ballooning." This final "ballooned" configuration of the bellows whereby the outer diameter of the convolutions became more rounded, remained an acceptable condition.

It has been demonstrated that the heat exchanger bellows has the ability to resist excessive squirm at design and test pressures. Since it is intended to function at a pressure not exceeding 75 psia in the D1 dipole heat exchanger circuit, this test verifies that it will do so adequately and safely.

It deserves brief mention that the conclusions of this test refer only to the ability of the bellows to resist excessive squirm at the design and test pressures. Other issues such as the effects on its cycle life, especially at higher pressures, cannot be inferred from this test.

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