33-991117-CLN-01

TO: *DISTRIBUTION*
FROM: *C NEUMEYER*
SUBJECT: *MINUTES OF MEETING TO DISCUSS UPCOMING OUTER VV BAKEOUT*

A meeting was held to discuss precautions to be taken prior to the upcoming bakeout of the outer vacuum vessel to 150C.

The attached figures were provided by the writer to introduce the issues.

In summary, it was concluded that there are no "show stoppers" and the bakeout operation can proceed, but a variety of measurements must be made prior to and during the rise of temperature in order to gain knowledge about how the system heats up and deflects.

Three main areas of concern were discussed, namely:

1. Circumferential thermal expansion of vacuum vessel body (estimated for an idealized, continuous axisymmetric situation to be ≈ 1", which translates to a radial growth of 0.16), and the resultant displacement, deflection, and stress, as follows:

a. Radial displacement of sliding joints, or lack thereof. Ideally, all sliding joints on the vessel legs would deflect 0.16", if there were no constraints such as that imposed by the vacuum pumping duct. Sliding joints on the umbrella structures and the outer PF coils should work OK since there are no unbalanced forces in these areas.

b. Transmission of force through bolts which presently connect across the vacuum pumping duct bellows, and resultant radial deflection of duct support structure, possible binding of NW and SE sliding joints which are aligned on an axis normal to that of the duct, and bending and deflection of the support legs

With respect the above, a discussion of the stresses on the vacuum vessel floor anchoring, the welds on the leg to vessel attachments, the welds on the ports to the vessel, and the bolts which connect across the pumping duct bellows led to the conclusion that there were no significant concerns. It was noted that, based on prior measurements during pumpdown, where the radially inward vacuum force on the pumping duct is of order 7000 lbs, a deflection of 0.07" was observed. This means that, prior to baking, the supports on the duct, which act like a spring, are preloaded to approximately 7000 lbs. So, when the vessel expands radially due to bakeout, it would initially unload the spring as it expanded outward by 0.07, and would then load the spring in the opposite direction such that a force of order 7000 lbs would develop at an expansion of 2*0.07=0.14", a bit more to move out to 0.16". This level of force did not lead to any serious concerns in terms of the floor anchors, welds, or bolts. In general it is thought that the vacuum pumping duct support structure, and the vacuum vessel body itself, are compliant enough such that high stresses will not develop.

The necessity of the additional leg supports (not installed at the moment) remains somewhat unclear. It was mentioned that they will provide additional restraint in case of a seismic event but that there are possibly other solutions to this problem which may be superior in that they do not take up so much space. On the other hand, the space taken up by the present support design must be reserved to allow for possible ceramic break replacement in the future, in any case. So, this area remains unresolved, but it seems that these supports are not critical to the subject operation.

2. Axial thermal expansion of vacuum vessel body from point of attachment to vacuum vessel legs to point where the vacuum pumping duct joints the vessel (estimated growth of 0.1"), and ability of duct/bellows/stops to allow for this motion.

Concerning this item, it was noted that the bolts which bridge the bellows have had their attachment nuts loosened on the outside, such that the configuration transmits a radial force but that the bellows action is more or less still effective in terms of allowing relative vertical motion of the two sections of the duct.

3. Differential temperatures on vessel body due to blockage of fluid heating circuits, inconsistent thermal contact with vacuum vessel, or incomplete application of thermal insulation, as well as temperatures of areas within umbrella.

Concerning this item, it was noted that:

- temperature on the heating fluid lines can and will be measured to ensure that there is no blockage and to check for uniformity of temperature

- the application of the thermal insulation is essentially complete on the main body of the vessel such that the heat leakage to the test cell should be more or less uniform.

- some concern exists with respect to the differential temperature along ports, as measured from the point where the port departs from the vessel body to the flange. It was noted that TFTR adopted a rule during bakeout that this differential should not exceed 11C for windowed ports, and 30C for others, although it was mentioned that this rule was not strictly followed. In any case it was judged prudent to take measurements along the ports.

- Some concern exists with respect to the fact that hot air rising into the upper umbrella area is trapped, and that this area will heat up. Although the most important parts in this area are water cooled and should therefore stay at safe temperatures, it is likely that the temperature stickers on all of the bus joints will “trip”. In any case it was judged prudent to measure the temperature in this area.

Following is a summary of the recommendations:

1. Measure all side gaps in the vacuum vessel leg sliding joints, prior to, and after, bakeout

2. Measure relative motion across vaccum vessel leg sliding joints during bakeout, as temperature is increased

3. Measure radial deflection of vacuum pumping duct relative to a nearby fixed structure during bakeout as temperature is increased

4. Measure temperature differential across selected examples of midplane and dome ports

5. Measure outlet temperature of all heating lines initially, and later as temperature is increased and reaches equilibrium, to ensure uniformity

6. Measure and record ex-vessel thermocouple signals as temperature is increased and reaches equilibrium to characterise uniformity. If possible, complete the installation of the cables so that the EPICS display is available.

7. Install a temporary thermocouple in the trapped area of the upper umbrella assembly and record temperature as the vessel temperature is increased and reached equilibrium.

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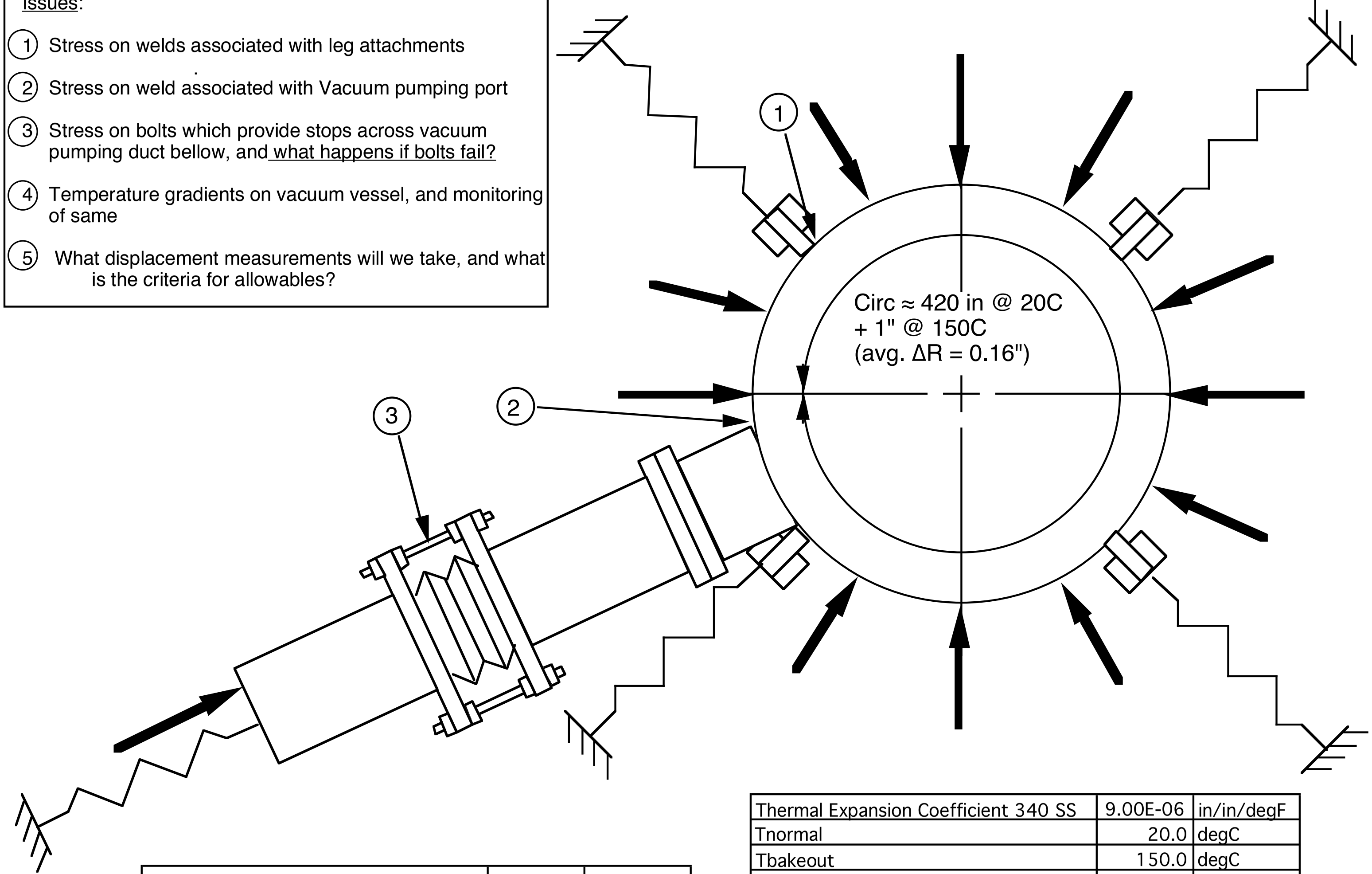
Issues:

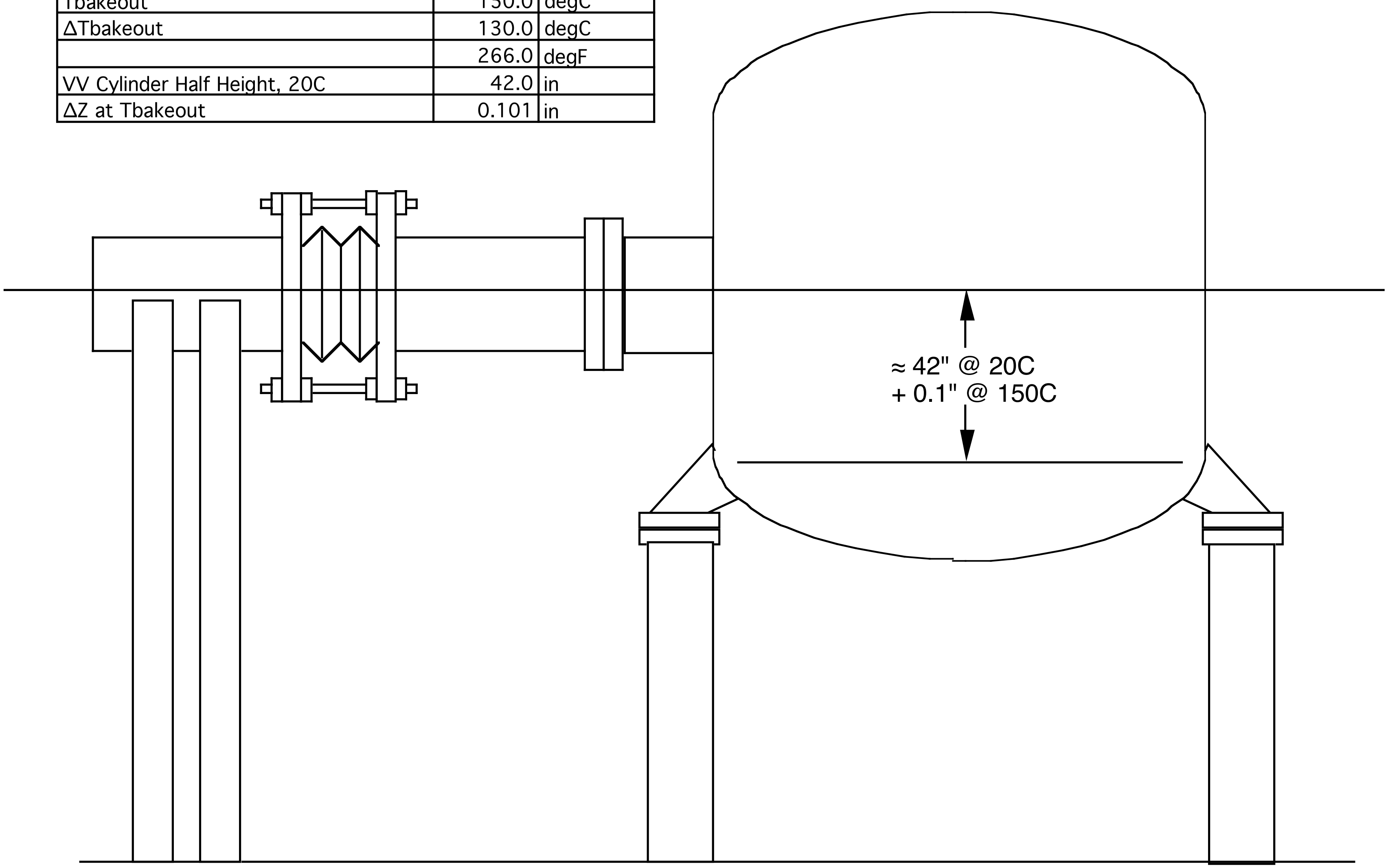
1. Stress on welds associated with leg attachments
2. Stress on weld associated with Vacuum pumping port
3. Stress on bolts which provide stops across vacuum pumping duct bellow, and what happens if bolts fail?
4. Temperature gradients on vacuum vessel, and monitoring of same
5. What displacement measurements will we take, and what is the criteria for allowables?



Port Diameter	24	in
Port Area	452.389	in^2
Atmospheric Pressure	14.7	lbs/in^2
Force on Port	6650.12	lbs

Thermal Expansion Coefficient 340 SS	9.00E-06	in/in/degF
Tnormal	20.0	degC
Tbakeout	150.0	degC
ΔTbakeout	130.0	degC
	266.0	degF
VV Cylinder Circumference, 20C	419.7	in
ΔCirc at Tbakeout	1.005	in
ΔR, average	0.15992	in

Thermal Expansion Coefficient 340 SS	9.00E-06	in/in/degF
Tnormal	20.0	degC
Tbakeout	150.0	degC
ΔTbakeout	130.0	degC
	266.0	degF
VV Cylinder Half Height, 20C	42.0	in
ΔZ at Tbakeout	0.101	in



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