M_E_M_O

DATE: September 27, 2002

TO: M. T. Kirk

FROM: P. T. Williams and B. R. Bass

SUBJECT: Status Report on Davis-Besse Analyses

The attached Figs. 1-5 provide a summary of the Davis-Besse analyses performed to date under the new Task 9 of JCN Y6533. In Fig. 1, the cladding properties used in the current study are presented: (a) true stress versus true strain and (b) thermal expansion coefficient versus temperature. The remaining figures address specific sub-task described in the workscope for Task 9.

Sub-task 9.1A calls for estimates of stress/strain induced from a thermal gradient of 600 °F to 250 °F across the cladding thickness. Sub-task 9.1B requires an estimate of cladding residual strains induced from residual stresses assuming a stress free temperature of 1100 °F and an operating temperature of 600 °F. This was done by performing finite element analyses of flat plates.

Figure 2 depicts profiles induced by a temperature gradient through the cladding: (a) thermal stresses and (b) thermal strains induced by a stress-free temperature of 1100 °F and cladding temperature of 605 °F. Figure 3 depicts residual stresses induced by stress-free temperature (= 1100 °F) with a cladding temperature (= 605 °F) compared to thermal stresses.

Sub-task 9.1D requires an estimate for crack driving forces as a function of flaw size and applied membrane stress in cladding.

Figure 4 depicts the first step carried out in preparation for the J-integral analyses, i.e., calculation of an updated estimate of the exposed cladding "footprint" based on the recent "dental mold" cast from the D-B cavity. That footprint area was estimated to be 28.23 in^2. Comparisons of the latest "footprint" statistics with previous ORNL interpretations are given in the table of Fig. 4(b).

The newly calculated "footprint" area was used to define a burst disk having the same cross-sectional area. Figure 5 depicts *J*-integrals produced by pressure loading of that burst disk containing the largest postulated flaw: (a) burst disk model with flaw located at center ($a/t = 0.5$, $2L/a = 16$) and (b) *J*-integrals at deepest point of flaw induced by lateral-pressure loading. These results will next be compared with J_R curves for the cladding material.

X-8

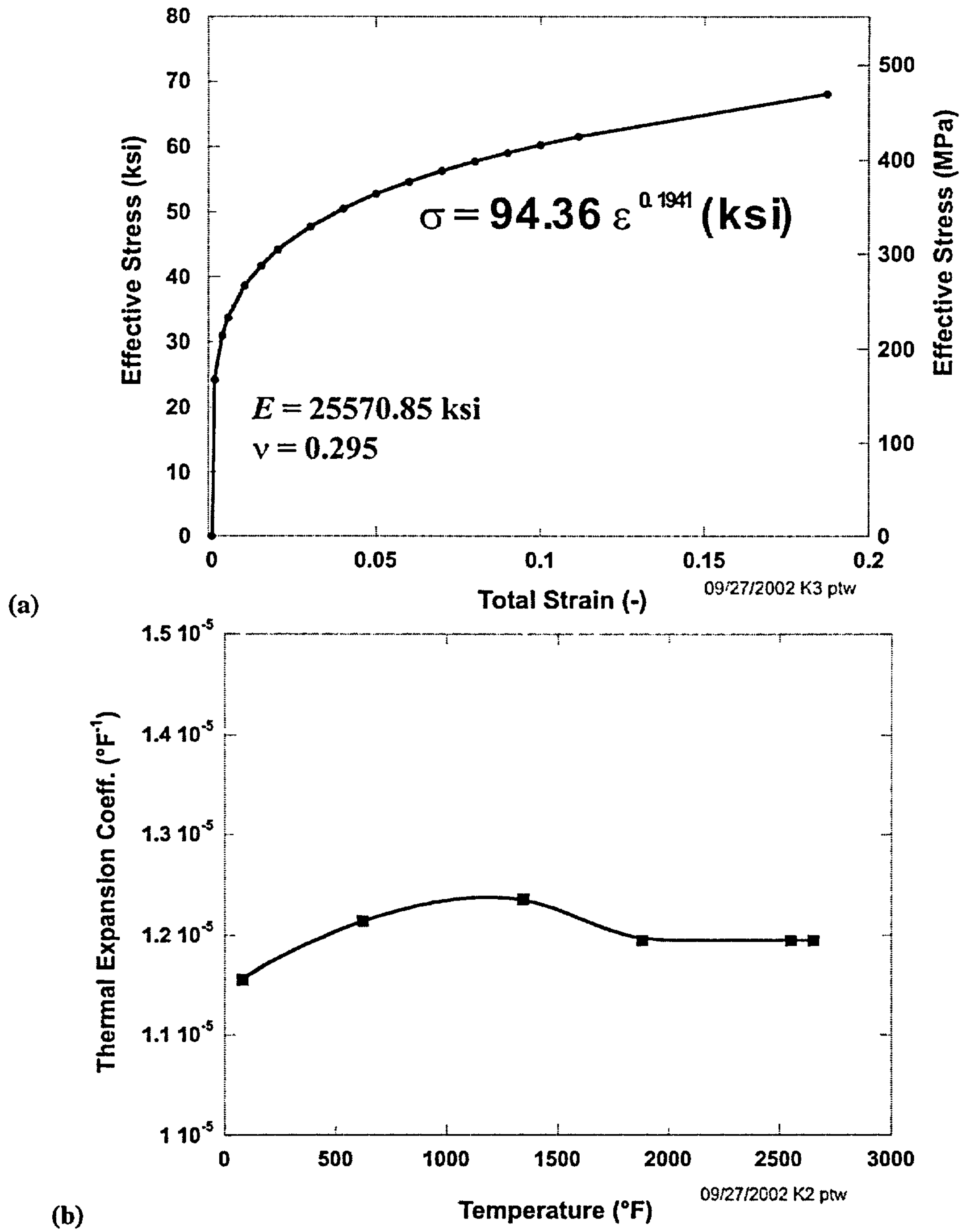


Fig. 1. Cladding properties used in the current study: (a) true stress vs true strain and (b) thermal expansion coefficient.

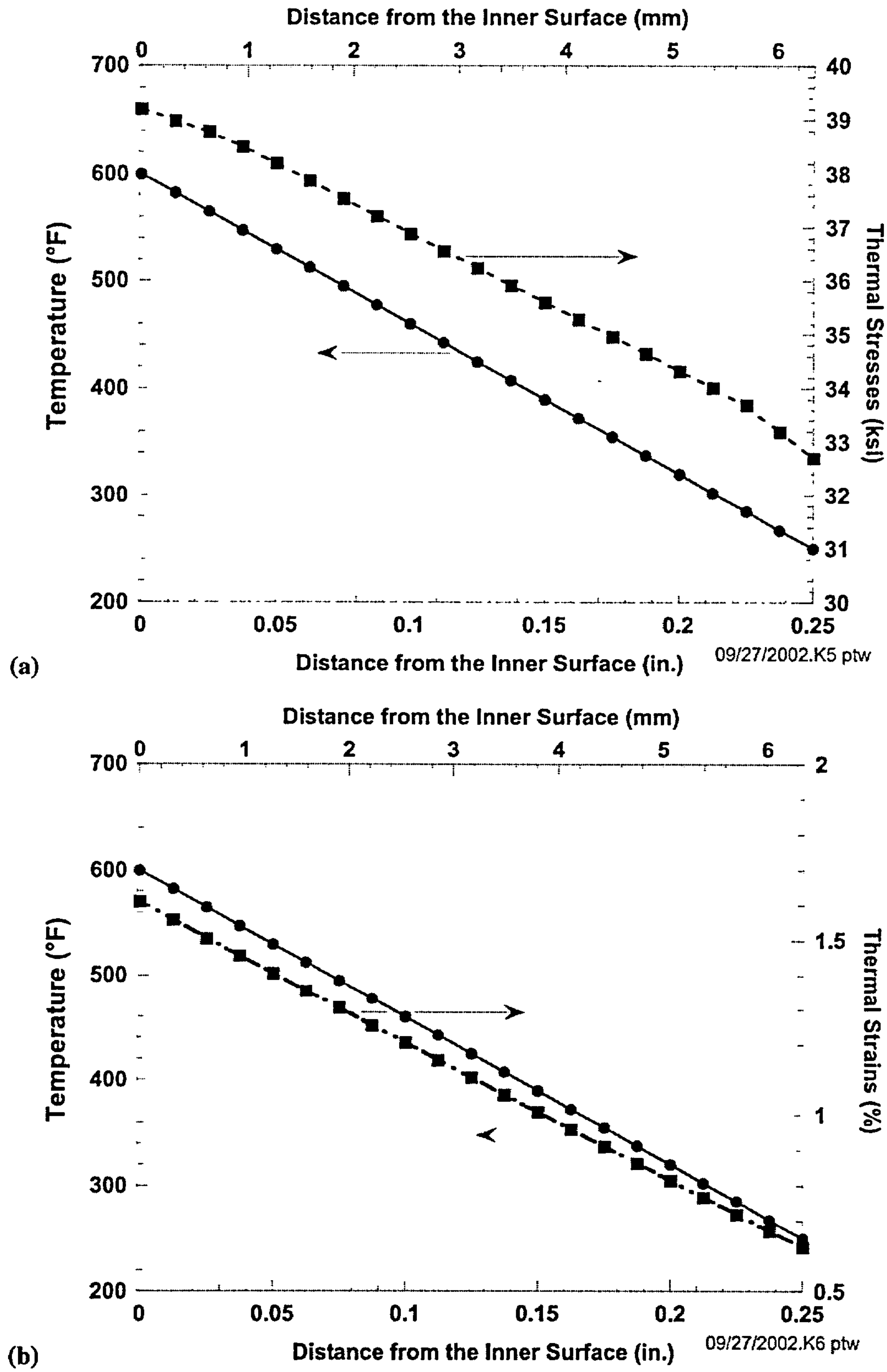


Fig. 2. Profiles induced by temperature gradient through the cladding and (a) thermal stresses and (b) thermal strains induced by a stress-free temperature of 1100 °F and cladding temperature of 605 °F. (Task 9.1A)

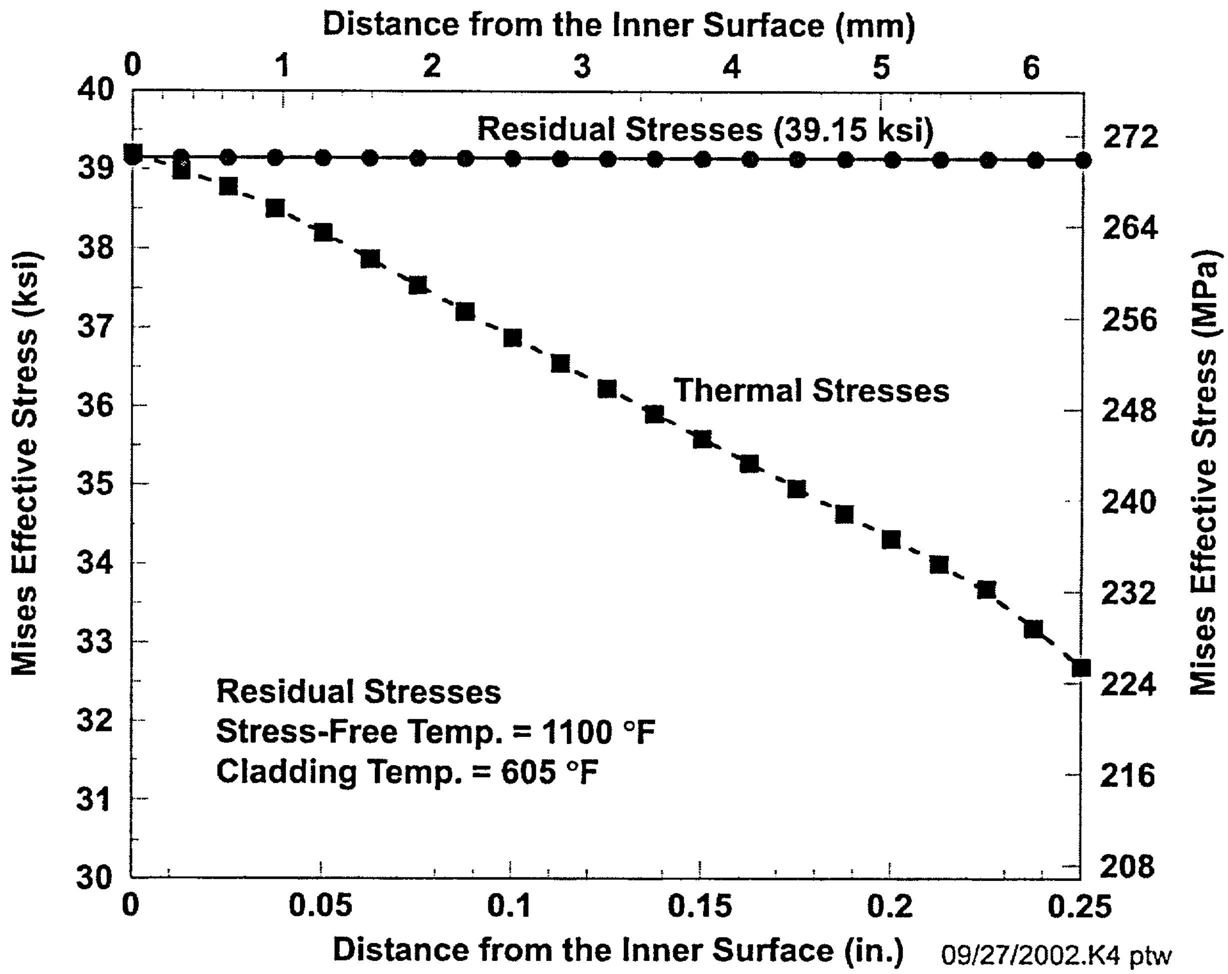
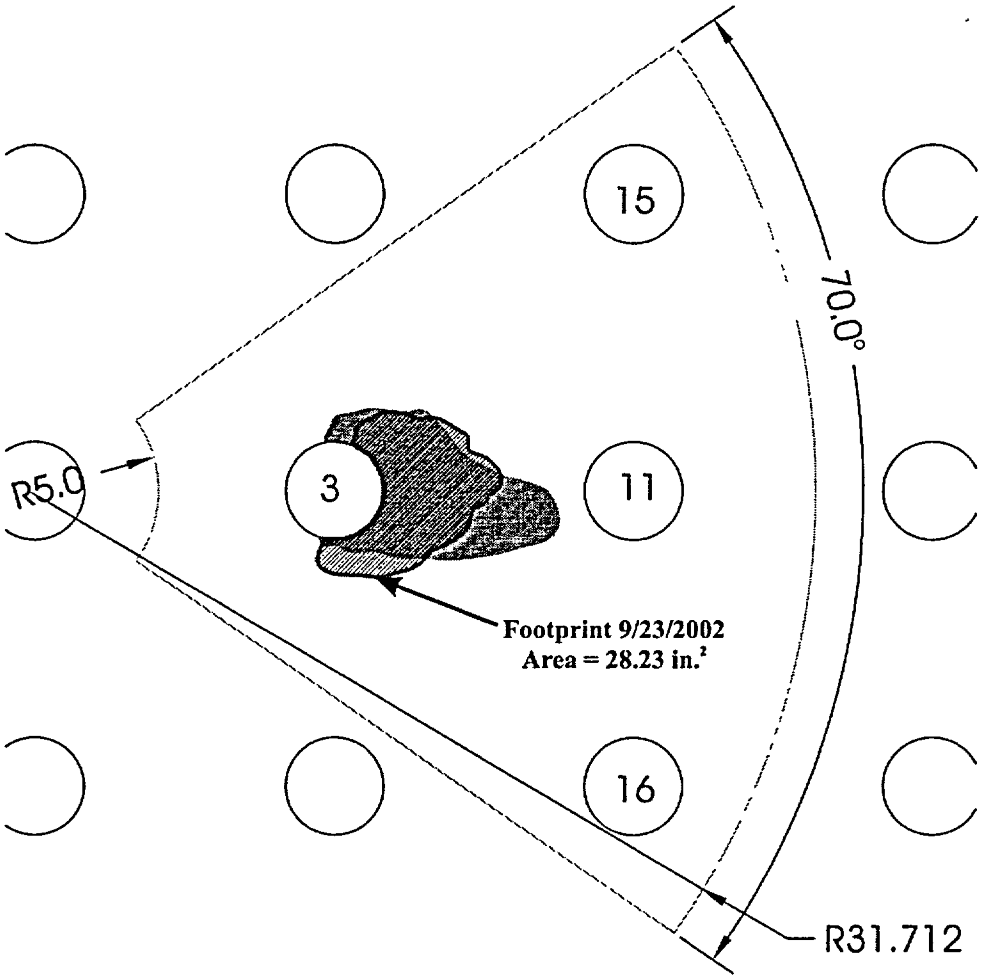


Fig. 3. Residual stresses induced by stress-free temperature (= 1100 °F) with a cladding temperature (= 605 °F) compared to thermal stresses. (Task 9.1B)



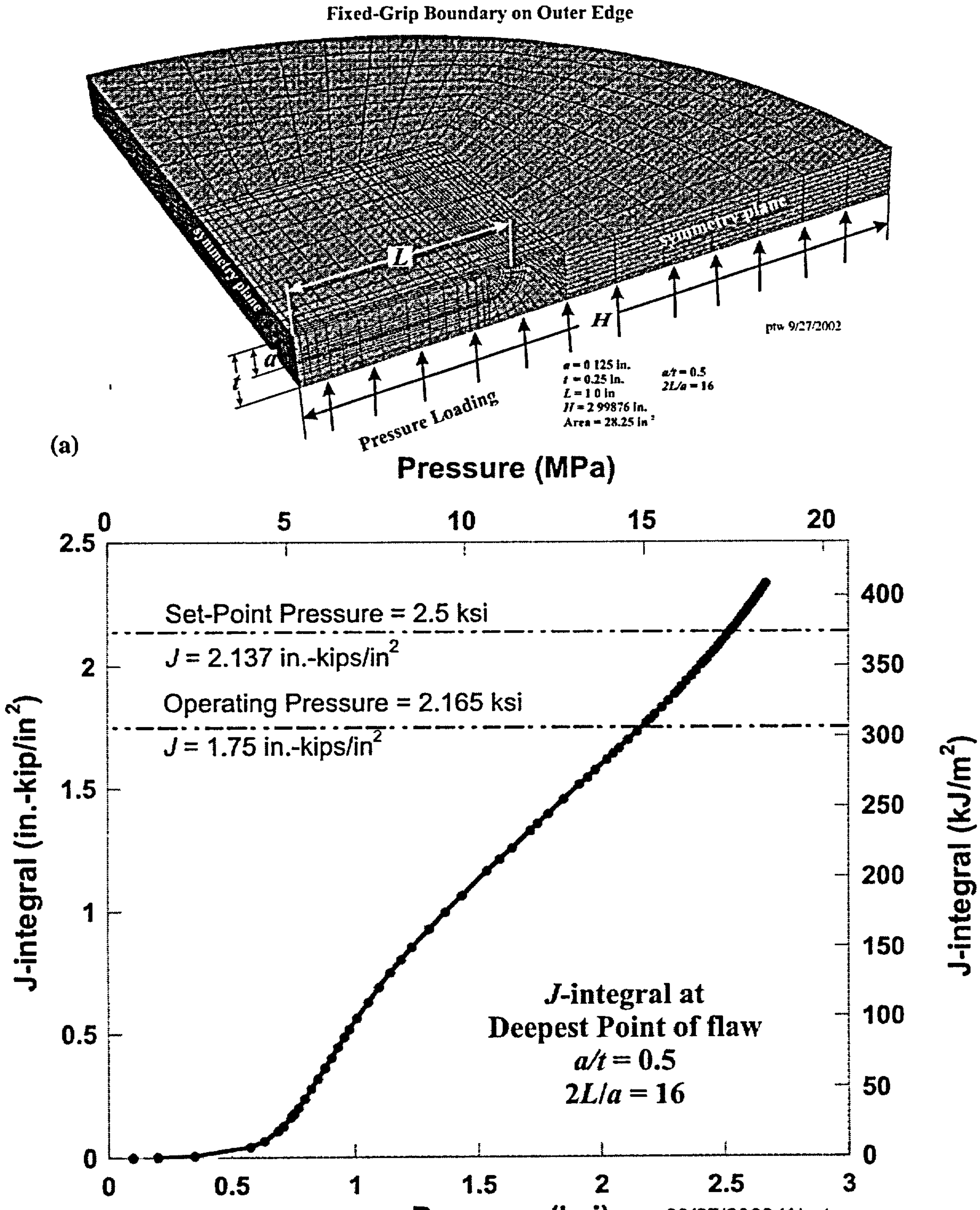
(a)

Description	Scaling Factor	Area	Perimeter	Centroid of Wastage Area Footprint		Moments of Interia About the Centroid			Eigenvalue Extraction for Prinicipal Moments and Directions			
				x_c	y_c	I_{xx}	I_{yy}	I_{xy}	Principal Moments I_1	I_2	Principal Directions I_1	I_2
		(in²)	(in.)	(in.)	(in.)	(in⁴)	(in⁴)	(in⁴)	(in⁴)	(in⁴)	$<n_x, n_y>$	$<n_x, n_y>$
As Found Footprint	1	35.36	30.36	16.4122	-0.1194	98.89	9699.33	-117.16	75.26	197.41	<0.9004, -0.4351>	<0.4351, 0.9004>
Adjusted Footprint for Bounding Calculation	0.25 in.	40.06	31.78	16.4301	-0.1255	129.02	11031.81	-141.35	99.00	245.71	<0.8943, -0.4476>	<0.4476, 0.8943>
As-Found Footprint 9/23/2002	1	28.23	24.55	15.332	-0.18	95.56	6708.63	-50.52	54.01	113.07	[0.558 0.830]	[-0.830 0.558]

Footprint centroid is in global coordinates.
Global coordinate system has its z-axis aligned with the vertical centerline of the vessel
The x-y plane of the global coordinate system is a horizontal plane
with the x-axis along the line between the centerlines of Nozzles 3 and 11

(b)

Fig. 4. Latest footprint estimated from “dental mold”.



(b)

Fig. 5. ***J*-integrals produced by pressure loading of burst disk: (a) burst disk model with flaw located at center ($a/t = 0.5$, $2L/a = 16$) and (b) *J*-integrals at deepest point of flaw induced by lateral-pressure loading. (Task 9.1D)**