2244 University Ave
Sacramento CA 95825
June 3 2002

Nuclear Regulatory Commission
mail stop 07d3
One White Flint North
11555 Rockville Pike, Commission meeting room
Rockville Md. 28852

Att. Mr. Anthony Mendiola

Dear Mr. Mendiola,

It has come to my attention that the management of the Davis-Besse Nuclear Power Station at Oak Harbor, Ohio has purchased an unused RPV head to replace the existing damaged head. Given the record of stress corrosion degradation of alloy 600, the subsequent cracking of the nozzles made of this alloy and the uncertainties involved in the ability to discover major damage before a calamity occurs, it would be irresponsible to simply make this replacement without further modification.

The main reason I am writing to you is to point out what I believe to be a major design flaw in the RPV head assembly and to suggest a possible remedy.

In the present configuration the alloy 600 nozzle is welded directly to the RPV head. The radial deformation at the penetration due to the biaxial membrane stress in the head is transferred to the alloy 600 nozzle through the J weld resulting in a hoop stress of about 26000 psi and meridional bending stress of about 47000 psi. Given the susceptibility of alloy 600 to stress corrosion cracking these stress levels are much too high. Calculations leading to these stresses is shown on attachments A1 and A2.

What I propose, as shown in attachment A3, is that a ferritic steel nozzle extension be welded directly to the RPV head and the seal weld to the alloy 600 nozzle be located at the end of the ferritic nozzle about 4 inches away from the head. The membrane and bending stresses in the ferritic steel nozzle at its juncture with the head would be about the same as those existing now in the alloy 600 nozzle. However, by welding the alloy 600 nozzle to the ferritic steel nozzle away from the RPV head, these stesses would attenuate to about 1000 and 7000 psi respectively. The added ferritic steel nozzle could absorb the high stress levels since they are secondary stresses and there is little concern for stress corrosion cracking here. On the other hand, the decreased stress levels in the alloy 600 nozzle would increase the reliability against cracking, leaking and corrosion of the RPV head enormously.

If extension of the alloy 600 nozzle into an RPV head shrink fit is of any value then an alternative design is shown on attachment 4.

I would appreciate your giving these suggested design changes serious consideration and look forward to your reaction.

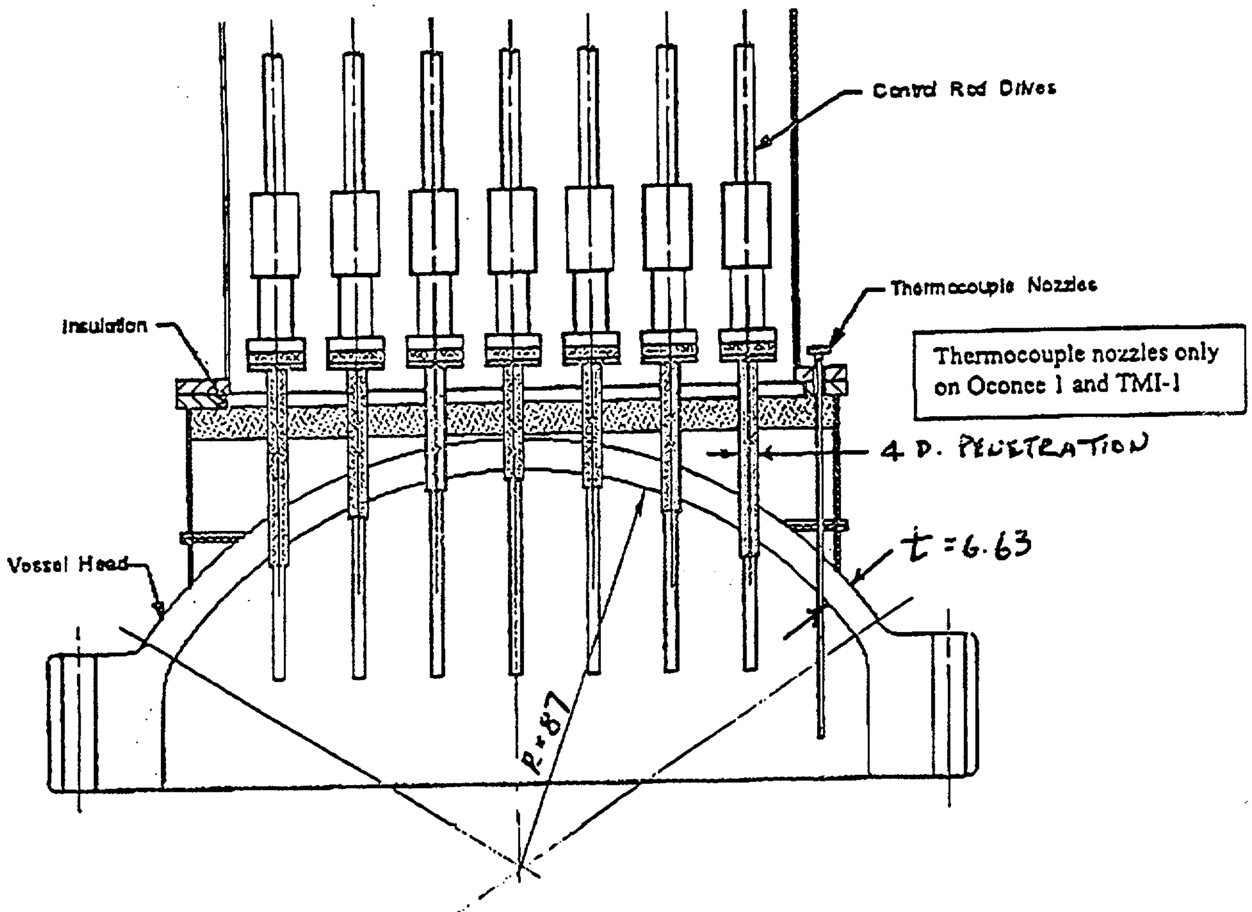
very truly yours,

Martin W. Schwartz

voice phone: 916-489-6672
fax: 916-483-8462
Email: schwartzmw@cs.com

PS I considered the calculation for the stresses at the junction of the ferritic steel and the alloy 600 nozzles a bit too lengthy to submit with this letter. To a practiced eye, however, the attentuation of the stress levels at this juncture would be obvious. Nevertheless, these calculations are available for your review if you so desire.

A1

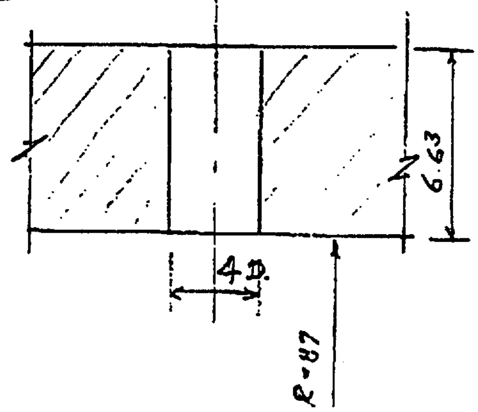



THE PRIMARY MEMBRANE STRESS IN THE RPV HEAD IS

$$\sigma = \frac{PR}{2t}.$$

WHERE: P IS THE INTERNAL PRESSURE OF 2250 PSI
R IS THE RADIUS = 87 IN.
t IS THE THICKNESS = 6.63 IN.

$$\sigma = \frac{2250 \times 87}{2 \times 6.63} = 14760 \ \#/in^2$$




THE TANGENTIAL STRESS AT THE EDGE OF THE 4" D PENETRATION IS TWICE THAT OF THE PRIMARY MEMBRANE STRESS OR 29500 psi

THE TANGENTIAL STRAIN AT THE EDGE OF THE 4" D. PENETRATION IS

$$\epsilon_\theta = \frac{\sigma_\theta}{E}$$

WHERE E IS THE MODULUS OF ELASTICITY $\approx 3 \times 10^7$ psi

$$\epsilon_\theta = \frac{29500}{3\times10^7} = 0.000983 \text{ in/in}$$

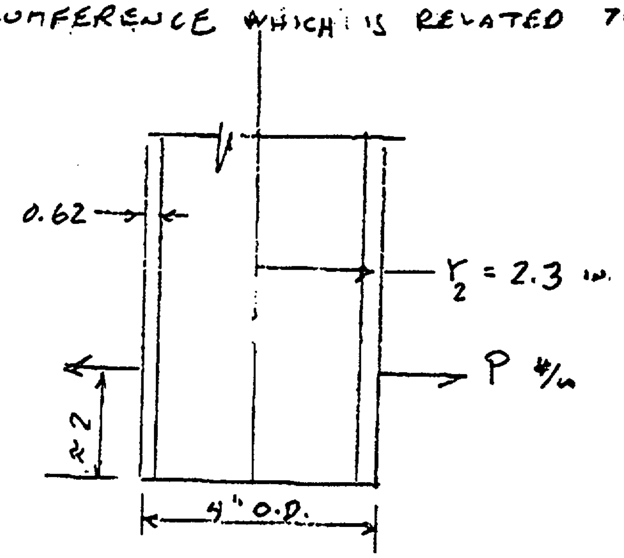
THE RADIAL DISPLACEMENT AT THE HOLE = $\Delta r = r\epsilon_\theta$

SINCE THE RADIUS IS 2", $\Delta r = 2 \times 0.000983 = 0.00197$ in.

THE ALLOY 600 NOZZLE AT THE J WELD WILL BE FORCED TO SUFFER ABOUT THE SAME RADIAL DISPLACEMENTS. AS A RESULT WE CAN IDEALIZE THE ALLOY 600 NOZZLE AS A CYLINDER SUBJECTED TO A RADIAL FORCE OF P #/in OF CIRCUMFERENCE WHICH IS RELATED TO $\Delta r$ BY

$$\Delta r = \frac{P r_2^2 \lambda}{2Et} \quad \text{(ROARK)}$$

OR $$P = \frac{2Et\Delta r}{r_2^2 \lambda}$$




WHERE: $$\lambda = \sqrt[4]{\frac{3(1-\nu^2)}{r_2^2 t^2}}$$

$\Delta r$ = RADIAL DISPLACEMENT = 0.00197
$r_2$ = MEAN RADIUS = 2.3 in
$t$ = THICKNESS = 0.62 in.
$\nu$ = POISSON'S RATIO ≈ 0.3

$$\lambda = \sqrt[4]{\frac{3(1-.3^2)}{2.3^2 \times .62^2}} = \sqrt[4]{\frac{3\times.91}{5.29\times.38}} = \sqrt[4]{1.168} = 1.08$$

$$P = \frac{2\times3\times10^7\times.62\times.00197}{2.3^2\times1.08} = 12,800 \text{ #/in}$$

THE MAXIMUM HOOP STRESS IN THE ALLOY 600 NOZZLE IS

$$\sigma_2 = \frac{P r_2 \lambda}{2t} = \frac{12800\times2.3\times1.08}{2\times.62} = \underline{\underline{25640}} \text{ #/in}^2$$

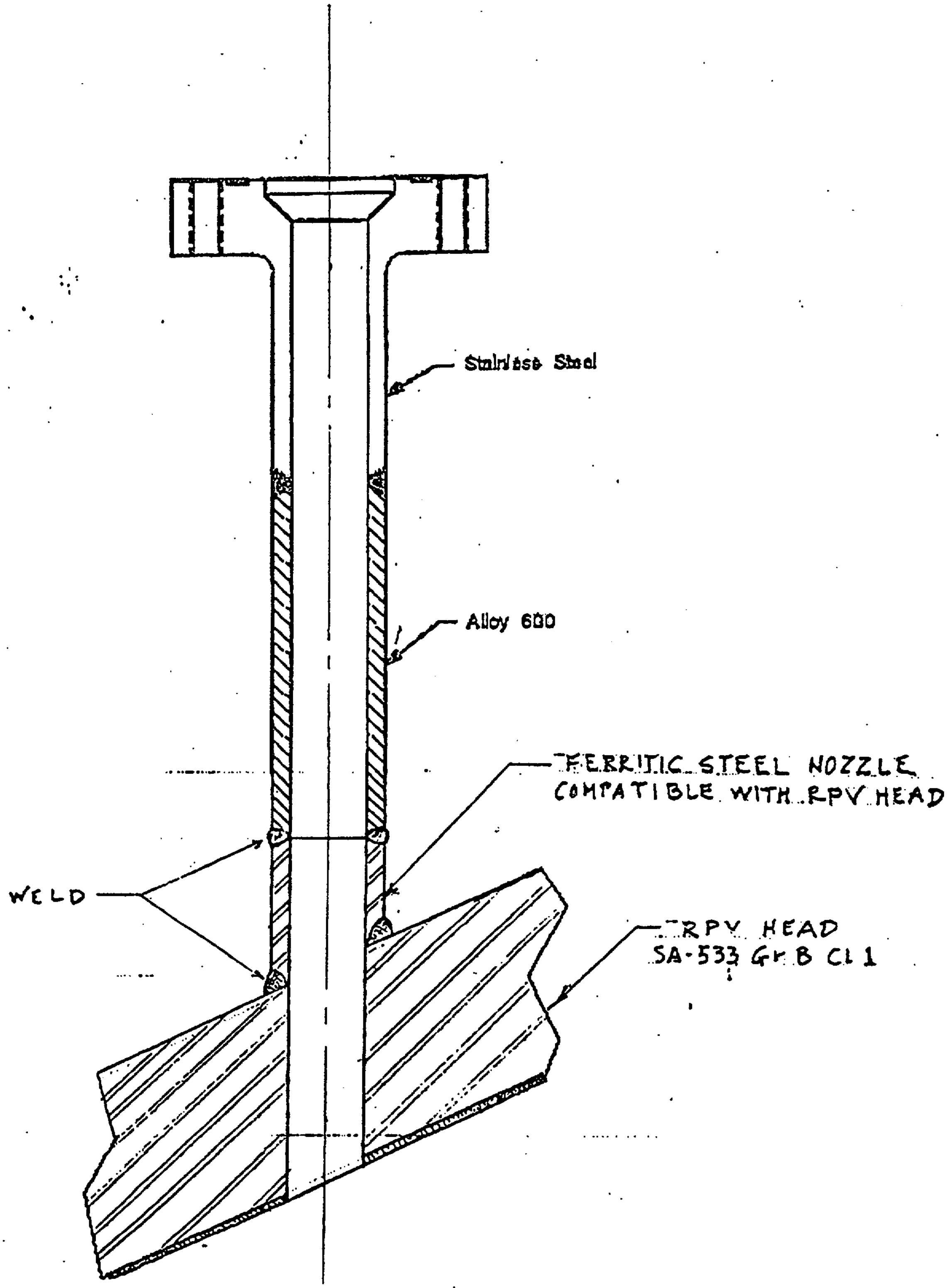
THE MAXIMUM MERIDIONAL BENDING STRESS IS

$$M_{max} = \frac{P}{4\lambda} = \frac{12800}{4\times1.08} = 2960 \text{ #in/in}$$

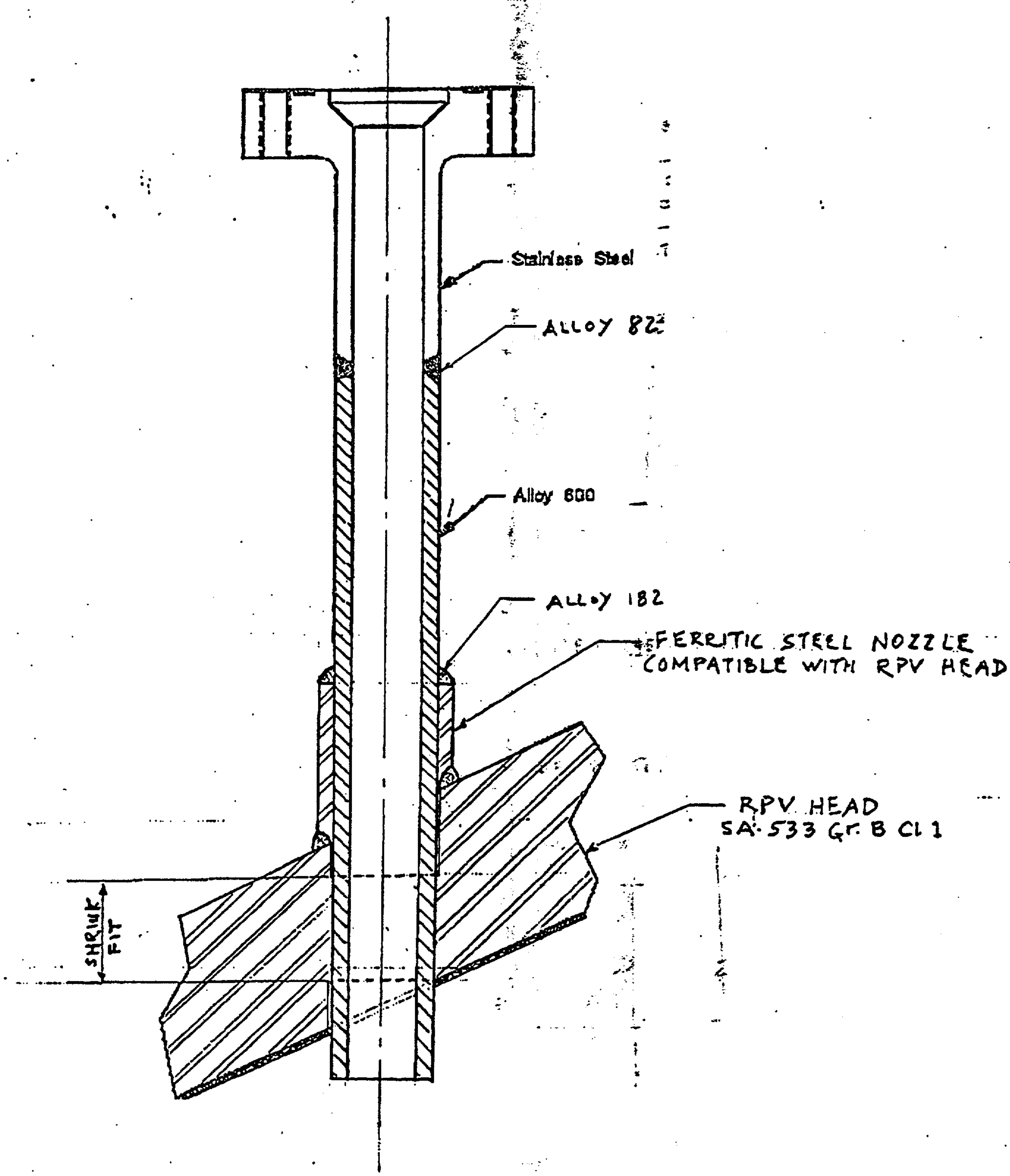
THE MERIDIONAL BENDING STRESS IS

$$\sigma_1 = \frac{6M}{t^2} = 6\times2960/.38 = 46700 \text{ #/in}^2$$

A


Stainless Steel
Alloy 600
FERRITIC STEEL NOZZLE
COMPATIBLE WITH RPV HEAD
WELD
RPV HEAD
SA-533 Gr B Cl 1

A7


Stainless Steel
ALLOY 82
Alloy 600
ALLOY 182
FERRITIC STEEL NOZZLE
COMPATIBLE WITH RPV HEAD
RPV HEAD
SA-533 Gr. B Cl 1
SHRINK FIT