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SUBJECT: Informs that util performed insp of core shroud repair following installation,per GL 94-03.

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TITLE: GL 94-03 Intergranular Stress Corrosion Cracking of Core Shrouds in B

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CARL D. TERRY
Vice President
Nuclear Engineering

March 23, 1995
NMP1L 0927

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

RE: Nine Mile Point Unit 1
Docket No. 50-220
DPR-63

Subject: *Generic Letter 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors" (TAC No. M90102)*

Gentlemen:

Niagara Mohawk Power Corporation performed an inspection of the Nine Mile Point Unit 1 (NMP1) core shroud repair following installation. Three deviations were identified which required evaluations. Niagara Mohawk reviewed the results of the inspection with the Commission in a telephone conference on March 22, 1995. At that time, we indicated that two of these deviations would require Commission review and acceptance. These items are provided in Attachments 1 and 2 to this letter. Niagara Mohawk discussed the third deviation which we indicated would not require a submittal. However, since the Commission requested a copy of the applicable General Electric analysis, we have included a discussion of this deviation as Attachment 3.

First, Niagara Mohawk's original seismic analysis indicated that the design clearance between the tie rod mid-support and the shroud is 0.75 inch. However, the gap between the shroud and mid-support was found to be less than 0.75 inch at each tie rod location. An analysis of this condition indicates that the original seismic analysis remains valid, but that there is possible contact between the shroud and mid-support during faulted events. The analysis found that the stresses in the shroud, hardware and reactor pressure vessel were acceptable. Details of the evaluation are provided in Attachment 1.

Second, the inspections showed that the lower spring contact was not contacting the shroud barrel between the H5 and H6A welds at any of the four tie rod locations. As a result, the barrel section between the H5 and H6A welds is not captured as was originally intended. The normal, upset, emergency and faulted events were reviewed to evaluate the effects of this condition. This evaluation indicated that all design basis load combinations are met. The steam line LOCA combined with a seismic event, which is outside the NMP1 design basis, required additional evaluation. The evaluation of the main steam line LOCA plus seismic confirmed that the horizontal displacement of the core plate during this event will remain less than the allowable permanent core plate displacement. Details of the evaluation are provided in Attachment 2. Niagara Mohawk believes this analysis justifies continued

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operation through the next cycle. Niagara Mohawk will evaluate appropriate actions for implementation by the end of the next refuel outage. This evaluation will be submitted to the Commission for review and approval.

The third deviation which was identified concerns the lower spring wedge which bears against a recirculation nozzle weld at the 270 degree location. The inspection indicated that the contact area between the lower wedge and the reactor pressure vessel wall is approximately 2/3 of the wedge area. This condition was evaluated for resistance to twisting and possible contact movement, hydraulic asymmetric loads, and the loads on the nozzle. As a result of this evaluation, all existing analyses remain valid. The flow velocity in this close proximity to the nozzle is less than the velocity directly in front of the nozzle as was used to calculate the 7 Hz vortex shedding frequency. The existing flow-induced vibration analysis remains valid. A diagram of the position of the lower wedge and additional details of the evaluation are found in Attachment 3.

Very truly yours,

C. D. Terry
Vice President - Nuclear Engineering

CDT/JMT/kab
Attachments

xc: Regional Administrator, Region I
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Mr. G. E. Edison, Senior Project Manager, NRR
Mr. B. S. Norris, Senior Resident Inspector
Records Management

ATTACHMENT 1

SEISMIC ASSESSMENT OF THE REDUCED CLEARANCE BETWEEN THE MID-SUPPORT AND THE SHROUD

Statement of the Problem:

The design clearance between the tie rod mid-support and the shroud is 0.75 inch. However, the as-installed clearances between the mid-supports and the shroud are as follows:

Azimuth:	90°	170°	270°	350°
Clearance:	0.625"	0.56"	0.375"	0.5"

Assessment:

The design clearance between the mid-support and the shroud is 0.75 inch. Therefore, the mid-support was not modeled as a restraint in the linear seismic model. The maximum unrestrained displacement occurs when the weld H6A is modeled as a "roller" in the seismic model. The "H6A roller" condition occurs when the H6A weld separates in the vertical direction. The weld separation could occur only during the main steam line break LOCA event. Thus, the seismic lateral displacement due to "H6A roller" is a faulted condition response, when the seismic load occurs simultaneously with main steam LOCA. The plant design basis does not include a combined seismic and LOCA event, but was part of the proposed design basis for the shroud repair. This combination is evaluated below to demonstrate that the shroud repair remains acceptable even for this highly unlikely event.

The maximum unrestrained lateral seismic displacement of the shroud at the mid-support elevation is 0.562 inch ("H6A Roller" case). The minimum clearance actually available is 0.375 inch. Therefore, the shroud lateral displacement is restricted by an amount of 0.562-0.375 = 0.187 inch, after the shroud travels freely for 0.375 inch. The impact of this non-linear behavior was evaluated by calculating the stiffness offered by the mid-support in combination with the local stiffness of the shroud in restraining the motion. The resulting additional loads on the shroud, mid-support hardware, and the RPV were determined and evaluated. The impact of this restraint on the design loads of the other shroud repair hardware was also evaluated. The following is a summary of the evaluation.

Summary:

1. The shroud, mid-support hardware, and the RPV are within their allowable faulted condition stress limits, with the inclusion of the above described additional loads.

2. The seismic loads in the other shroud repair hardware, namely, upper spring, lower spring, and the tie rod are less than their design seismic loads.

3. There is no change in the function of the mid-support.

Conclusion:

The subject deviation in the clearance between the mid-support and the shroud is acceptable.

ATTACHMENT 2

EVALUATION OF CONSEQUENCES OF LOWER SPRING NOT CONTACTING THE SHROUD SHELL BETWEEN H5 AND H6A. REFER TO THE ATTACHED SKETCH FOR DETAILS OF THIS AS-BUILT CONDITION

Statement of the Problem

The lower spring was not contacting the shroud barrel between the H5 and H6A welds at any of the four tie rod locations.

ASSUMPTIONS

1. Core plate wedges are installed (original design basis).

2. Cracked shroud welds act as hinges unless there is a vertical separation. This assumption is explicitly part of the original design basis.

3. There is no effect below weld H6A, because the design is per the original configuration.

LOAD CASES

Upset:

There is no upset event which causes a vertical separation at any weld at or above H6A. Therefore, the shroud welds will carry the shear loads from the seismic event. There is no consequence and no possibility of loose shells and attendant leakage. The design basis is unchanged.

Emergency:

A main steam line LOCA will cause vertical separation, but the core plate wedges will maintain the alignment. There are no horizontal loads applied to the shroud by this event. There is no consequence and no possibility of loose shells and attendant leakage. The design basis is unchanged.

A recirculation line LOCA will not cause vertical separation. Therefore, the shroud welds will carry the shear loads from the LOCA. There is no consequence and no possibility of loose shells and attendant leakage. The design basis is unchanged.

Faulted:

The plant design basis does not include a combined seismic and LOCA event, but this combination was included in the stabilizer design. This combination is evaluated below to demonstrate that the shroud repair can safely perform its function for this highly unlikely event.

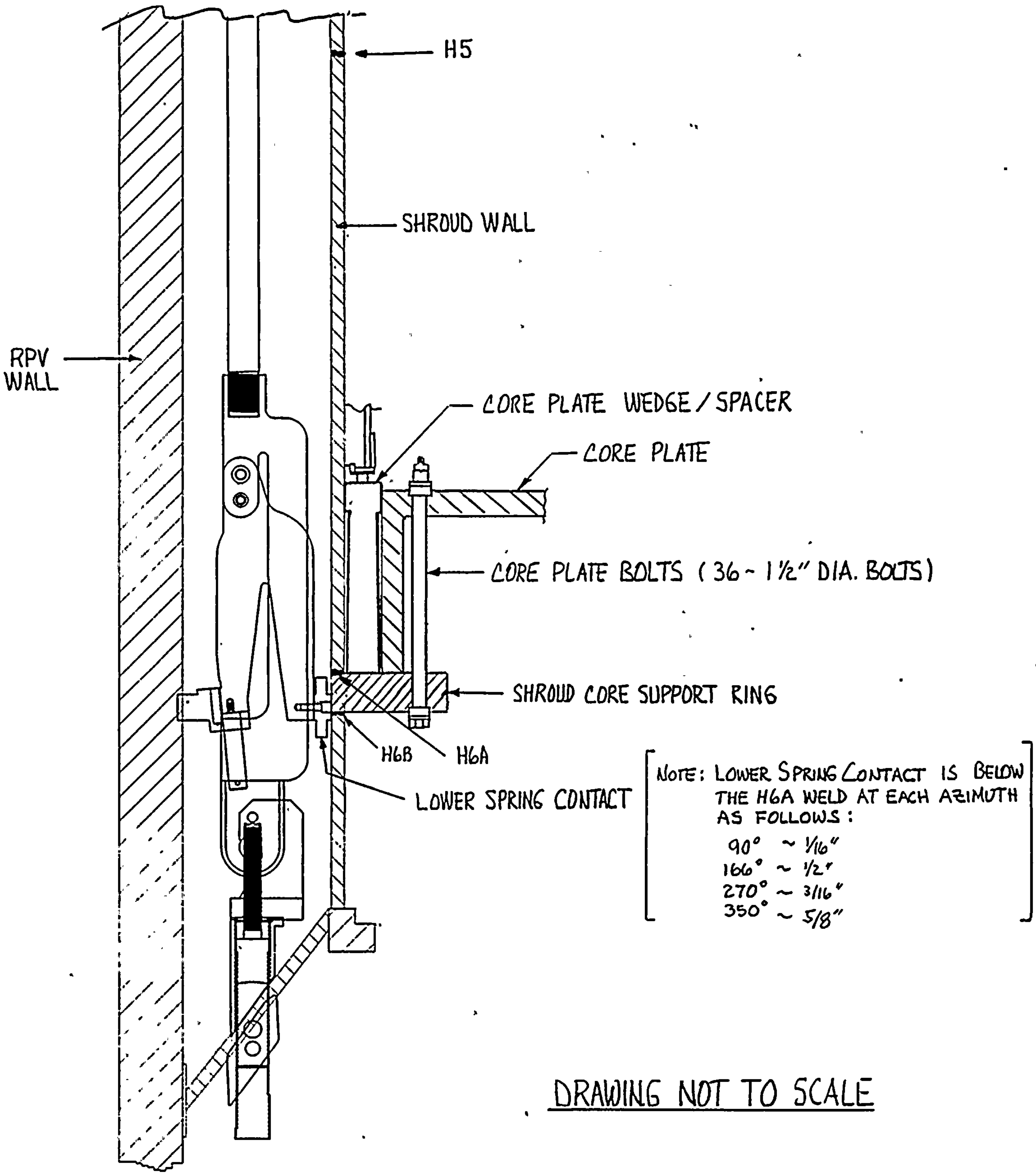
A recirculation line LOCA plus seismic event will not cause vertical separation. Therefore, the shroud welds will carry the shear loads from the LOCA plus seismic. There is no consequence and no possibility of loose shells and attendant leakage. The design basis is unchanged.

A main steam line LOCA plus seismic will cause vertical separation of cracked shroud welds. The shear from the bottom of the fuel assemblies cannot be transferred directly into the shroud shell between H5 and H6A (assuming they are cracked). This shear must first go through the core plate bolts into the shroud ring between H6A and H6B and then into the lower spring. Also, the shear from the shroud above weld H6A must be transferred through the wedges into the bolts and then into the lower spring. The core plate wedges will maintain the proper alignment of the shroud shell above H6A.

The core plate bolts were fabricated without welding from 304 stainless steel. They were installed with a preload of 16,000 pounds, which resulted in a preload stress of 9 KSI. The installation was secured with a keeper and tack welds between the bolt and the nuts. Since they were not sensitized and have low stresses, they are expected to be able to carry the additional loads. General Electric does not know of any failures of core plate bolts. Inspections conducted during the current refuel outage confirmed that the bolts are in place.

The preload stress will reduce due to both thermal creep and irradiation relaxation. The installed preload is below the proportional limit of 304 stainless steel at operating conditions. Thus, the preload reduction is small. The total reduction due to 40 years of operation was calculated to be 19%. Thus, the preload after 40 years will be 7.3 KSI. With a coefficient of friction of 0.2, the preload is not sufficient to react the seismic load. The core plate could shift horizontally until the bolts elongate sufficiently to stop the horizontal motion. There are spherical washers on these bolts, which prevent high bending stresses. After the core plate bolts have elongated by 0.0048 inch, the clamping force using a coefficient of friction of 0.2 is sufficient to react the seismic loads. The additional membrane stress in the bolts is approximately 5 KSI. The horizontal displacement of the core plate, equivalent to the 0.0048 inch bolt elongation, is 0.5 inch. The allowable permanent core plate displacement per the original design basis is 0.67 inch. Since this is a faulted condition, the potential loss of bolt preload due to the stress cycle is not relevant.

SKETCH SHOWS ASBUILT CONDITION OF LOWER SPRING CONTACT LOCATED BELOW WELD H6A



ATTACHMENT 3

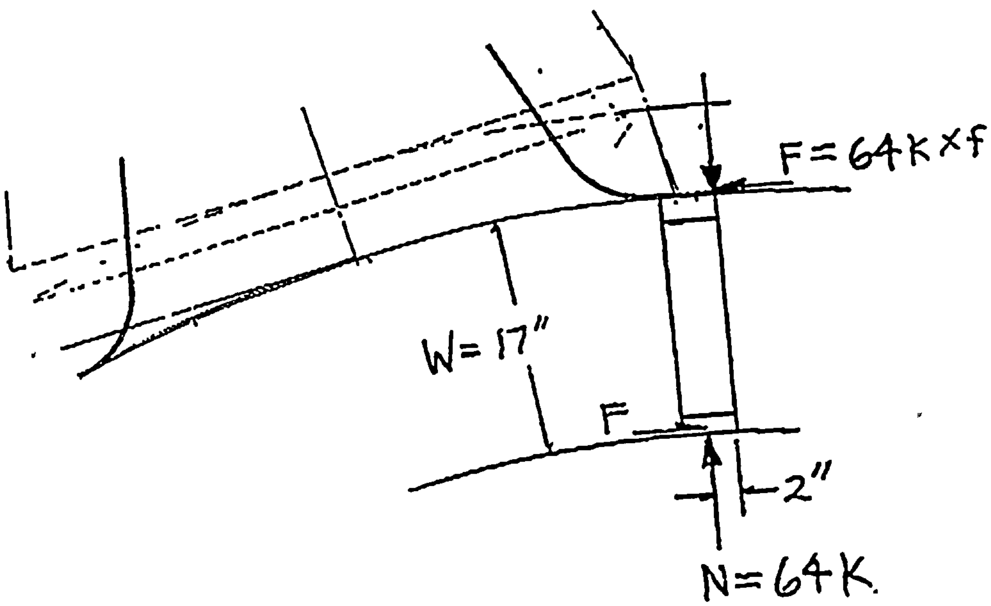
EVALUATION OF THE LOWER WEDGE AT THE 270 DEGREE LOCATION WHICH BEARS AGAINST THE RECIRCULATION NOZZLE WELD

Niagara Mohawk has evaluated four areas of concern relative to the lower wedge bearing against the recirculation nozzle weld. The evaluations for each concern is provided below:

CONCERN 1: *Adequacy of offset wedge contact seating on the 270 degree azimuth recirculation nozzle weld.*

EVALUATION:

If it is conservatively assumed that the reaction location for the seismic load on the lower wedge is offset by 2.0 inches to the edge of the contact surface, the eccentric load will produce a moment reaction of M = 2 x 64 = 128 in-K. This can be reacted by a force couple from frictional shear reactions on the vessel and shroud surfaces. For a 17.0 inch annulus width, the couple is W x N x f = 17 x 64 x f. Equating this to the offset load moment, the required friction coefficient is f = 128/(17 x 64) = 0.12, to prevent sliding. Since we can reasonably expect a friction coefficient of at least 0.20, the spring will not be twisted by the offset contact loading, and will react the seismic load as intended. Also, the wedge itself is prevented from rotating by the full width flat contact face of the mating lower spring. Further, the spring will be held in place for other operating conditions as follows. If the seismic motion unloads the spring, its position remains fixed by its bolted and pinned connections to the C-spring and clevis assembly which are fixed to the shroud support. The clevis pinned joint is held in place by the intimate contact maintained by the tie rod axial preload. If friction is ignored, the maximum azimuthal shifting of the assembly is limited by the 0.10 inch clearance in the fitup between the clevis hook and plate.



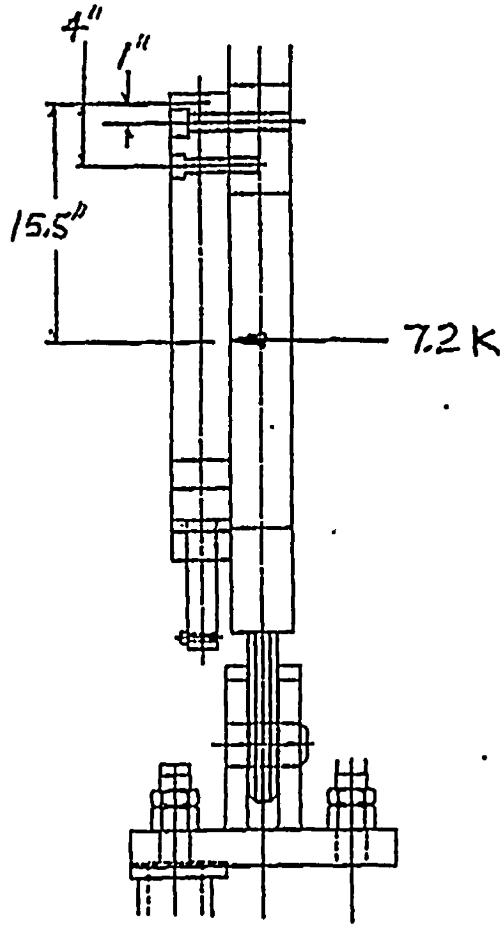
CONCERN 2: *LOCA transverse load on spring.*

EVALUATION:

If a LOCA occurs in the 270 degree recirculation line, the lower spring will have a pressure load of about 40 psid on its projected area in the flow field. The projected area is about 180 sq. in., giving an azimuthal load of 7.2K. The centroid of the area is about 15.5 inches from the spring's bolted attachment to the C-spring, producing a prying moment of 15.5 x 7.2 = 112 in.-K. The two mounting bolts have stress areas of 0.60 and 0.97 sq. in., respectively, and are located 4.0 inches and 1.0 inch, respectively, from the prying arm reaction area. The emergency condition allowable membrane stress in the Inconel X-750 bolts in 1.5Sm, or 71 ksi, giving maximum bolt forces of .6 x 71 = 43K and .97 x 71 = 69K, respectively. The resultant total allowable moment load on the bolted joint is then,

$$M = F \times d = (43 \times 4) + (69 \times 1) = \underline{241 \text{ in.-K}}$$

which is adequate as it is more than twice the applied prying moment.



CONCERN 3: *Wedge bearing contact adequacy.*

EVALUATION:

The minimum lower spring operating preload against the vessel is about 6K. If it is assumed the wedge is bearing on local areas of the nozzle 7 inch blend radius, the bearing stress available to support this load is at least the 2.7 x yield stress specified in Code paragraph NG 3232 for average bearing under a bolt head. For the stainless steel wedge and vessel clad, the resultant required area to support this load is A = P/S = 6000/2.7 x 19000 = 0.12 sq. in. As this is only 1% of the 12 sq. in. wedge contact area, bearing on the nozzle blend area is adequate to support the preload without significant surface deformation which could reduce the installed spring interference. This conclusion remains valid for the seismic event which applies a load of 64K, as the required bearing area is still only 10% of the wedge contact area.

CONCERN 4: *Stress Impact of lower spring contact near the nozzle-vessel wall weld.*

EVALUATION:

The original analysis of the effect of the lower spring loads on the vessel considered contact in the area of the cylindrical portion of the vessel rather than near the nozzle. This analysis considers the effect of this change on acceptability from the stress viewpoint. Two changes can occur as a result of the change in the contact location.

1. Change in the local stress due to the different load location.

2. Overall stress at the new location.

Item 1 was addressed using a local stress approach as described in WRC Bulletin 107. If a Bijlaard type analysis is performed using WRC Bulletin 107, one finds that the local stress in the shell is a factor of the contact area and the vessel thickness. When the contact area is relatively small, β (contact length/mean radius) is a small number. The bending stress is essentially constant at small contact areas. The bending stress varies inversely with the square of the thickness. The membrane stress tends to decrease with smaller contact areas and decreases linearly with increased thickness.

Therefore, the local stress due to the lower restraint is expected to remain the same or decrease with decreased contact area and increased shell thickness.

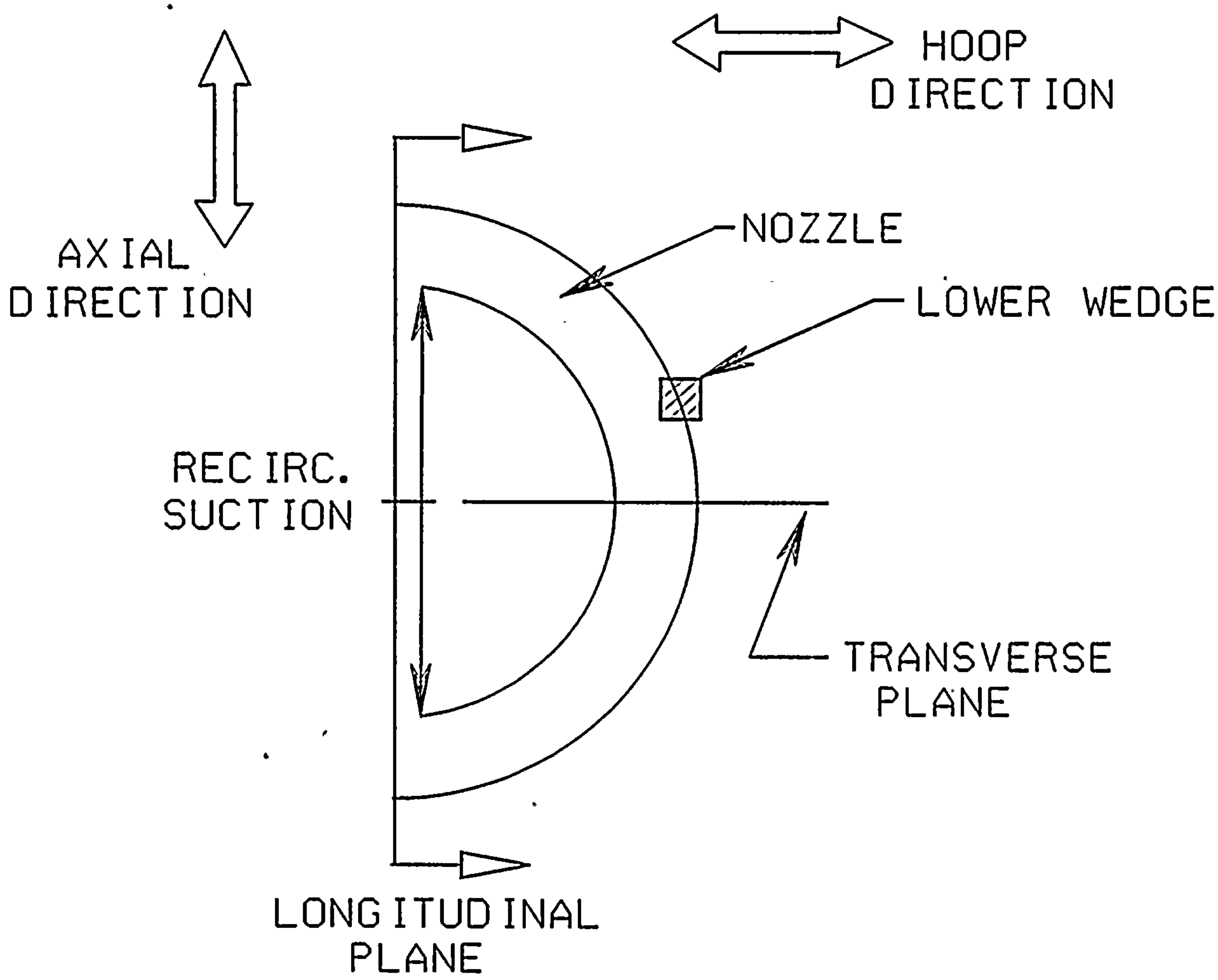
To address Item 2, consider the location of the lower spring contact shown in Figure 1. It is seen that the loading is close to the transverse plane. The high stress locations are at the 12 or 6 o'clock locations in the longitudinal plane. The NMP1 RPV stress report shows that the stress on the inside surface is, in fact, compressive on the transverse plane. In terms of local impact, the load point is in a region where the stresses are compressive compared to the cylindrical section. Therefore, any increment in stress is in an area where the overall stresses are <u>lower</u> than that at other azimuths.

Considering both the local stress increment or the overall stress at the contact point, the nozzle location is less limiting than that in the cylindrical portion of the vessel. Thus, the change in the spring contact location has no impact on vessel stresses.

CONCLUSION:

The above evaluations for the lower wedge at the 270 degree location provide the justification to disposition the condition as "accept-as-is." This condition was evaluated for resistance to twisting and possible contact movement, hydraulic asymmetric loads, and the increased loads on the nozzle. The flow velocity in this close proximity to the nozzle is less than the velocity directly in front of the nozzle as was used to calculate the 7 Hz vortex shedding frequency. The existing flow-induced vibration analysis remains valid.

FIGURE 1



HOOP
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AXIAL
DIRECTION
NOZZLE
LOWER WEDGE
RECIRC.
SUCTION
TRANSVERSE
PLANE
LONGITUDINAL
PLANE