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MDS Nordion
Science Advancing Health

July 23, 2004

Your file: 71-9290, 71-9310

Mr. Shawn A. Williams
Project Manager
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
Mail Stop: 13 D13
United States Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD
20852-2738

RE: Request for Additional Information Related to the Certificate of Compliance No. 9290 MDS Nordion's Model No. F-430 and Certificate of Compliance No. 9310, MDS Nordion's Model F-431

Dear Mr. Williams:

This letter is in response to the U.S. Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI) dated July 22, 2004. The additional information requested relates to the need for an analysis of the bolt stresses considering the gap in the tiedown collar joint. Please find attached a report, which analyses the bolt stresses in the tiedown collar joint.

Please note that the original design as submitted February 20, 2003 included a gap in the tie-down collar.

I trust this information will enable the staff to complete their review.

If you have any questions or require further information please feel free to contact me by telephone at (613) 592-3400 extension 2421 or by email at mcharette@mds.nordion.com.

Yours sincerely

Marc-André Charette

Marc-André Charette
International Transport & Nuclear Initiatives
Manager, Regulatory Affairs

Attached: ASSESSMENT OF F-430 TIE-DOWN COLLAR BOLTED CONNECTION

Copy to: Mike Krzaniak, Blair Menna, Luc Desgagne, MDS Nordion

NMSS01

ASSESSMENT OF F-430 TIE-DOWN COLLAR BOLTED CONNECTION

The stresses in the bolts that fasten together the two halves of the tie-down collar were considered.

The maximum load in the tie-down chains is 27,750 lb. The horizontal and vertical components of this force are 19,620 lb. each. Since the vertical component of the tie-down force is borne by the oblong bosses, there is no vertical force borne by the bolted connection. The horizontal tie-down force, however, can potentially exert tension, shear and bending stresses on the bolted connection. These stresses are considered as follows;

<u>Tension</u>

The component of the horizontal tie-down force acting in the direction of the axis of the bolts applies tension on the bolts. As a worst-case condition, the entire horizontal tie-down force is considered to act along the axis of the bolts (see Figure 1).

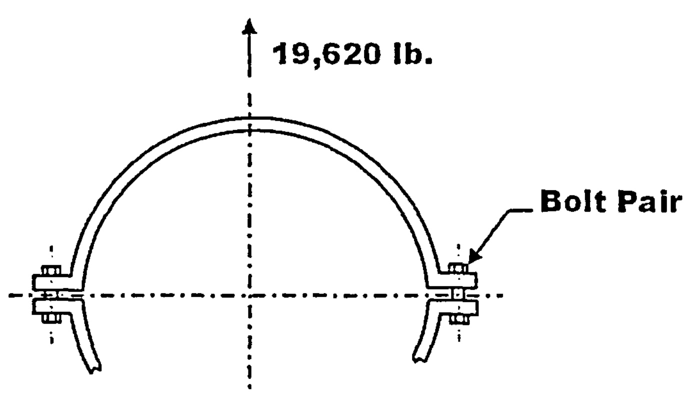

Figure 1: Tension on Tie-Down Collar

The tensile stress in the bolts, σ_t, is calculated from;

$$\sigma_t = F_t/A_t$$

Where,

F_t = the load on the bolts = 19,620 lb.
A_t = tensile stress area of the bolts, based on the root diameter (d = 0.741 in)
$= \pi d^2/4 * 4 \text{ bolts} = \pi(0.741)^2/4 * 4 \text{ bolts} = 1.725 \text{ in}^2$

Therefore,

$$\sigma_t = F_t/A_t = 19{,}620/1.725 = 11{,}374 \text{ psi}$$

The bolts (ASTM A193 Grade B8 Class2) have a yield strength, σ_y, of 80,000 psi. Therefore, the safety factor for the bolts in tension, SF_t, is;

$$SF_t = \sigma_y/\sigma_t = 80{,}000/11{,}374 = 7$$

Shear

The component of the horizontal tie-down force acting in the direction perpendicular to the axis of the bolts applies shear on the bolts. As a worst-case condition, the entire horizontal tie-down force is considered to act perpendicular to the axis of the bolts (see Figure 2).

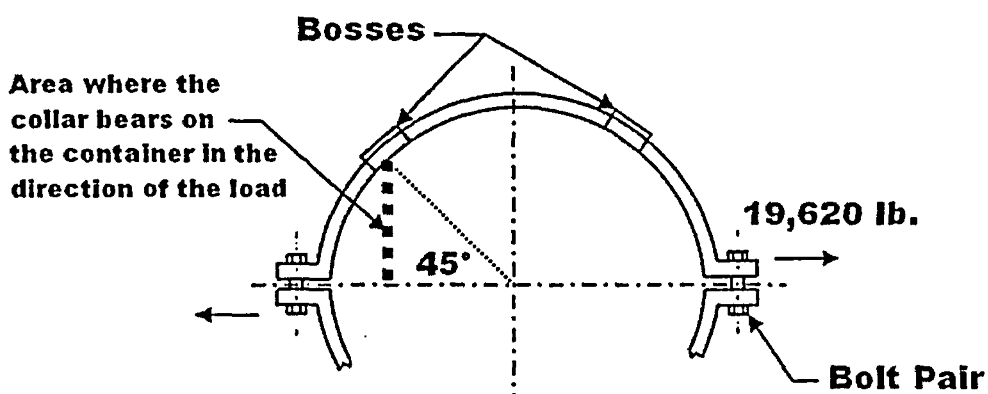

Figure 2: Shear on Tie-Down Collar

The shear is also borne by the oblong boss welds and by the tie-down collar bearing onto the container itself. The total area bearing the shear force, A_s, is calculated by;

$$A_s = A_{bolts} + A_{boss} + A_{container}$$

Where,

A_{bolts} = shear area of bolts = A_t = 1.725 in^2
A_{boss} = shear area of boss welds
= $(2.0*\pi*1.5 + 1.5*2.0)*(0.12)$weld size*2 bosses = 2.982 in^2

$A_{container}$ = area where the tie-down collar bears on the container, which is conservatively assumed to be over a 45° arc in a plane perpendicular to the load (see Figure 2), where the radius of the container is 25.14 in. and the height of the collar is 9.0 inches.

= $\sin(45°)*25.14*9.0 = 159.990\ in^2$

Therefore, the total shear area is,

$A_s = 1.725 + 2.982 + 159.99 = 164.697\ in^2$

The shear stress across the section, τ_s, is calculated from;

$$\tau_s = F_s/A_s$$

Where,

F_s = the shear load = 19,620 lb.

Thus,

$$\tau_s = F_s/A_s = 19{,}620/164.697 = 119\ psi$$

Note that almost all the shear load is borne by the tie-down collar bearing on the container. If it is conservatively assumed that the yield strength of the section to be the yield strength of the compressed foam, which has a yield strength, σ_{yf} of 198 psi, the safety factor for the section in compression, SF_{sc}, is calculated as;

$$SF_{sc} = \sigma_{yf}/\tau_s = 198/119 = 1.7$$

If one considers the yield strength of the shell, the safety factor will be higher.

The bolts have a yield strength, σ_y, of 80,000 psi. Therefore, the safety factor for the bolts under the shear stress, SF_s, is;

$$SF_s = \sigma_y*0.6/\tau_s = 80{,}000*0.6/119 = 403$$

Bending

As there is a gap at the bolted connection, the shear force calculated above applies a bending moment on the bolts.

Conservatively assuming the entire shear stress to act on a pair of bolts, the bending force, F_b, can be calculated as;

$$F_b = \tau_s * A_b$$

Where,

τ_s = 119 psi from the previous section
A_b = cross-sectional area of 2 bolts = = $\pi d^2/4 * 2 = \pi(0.741)^2/4 * 2 = 0.863\ in^2$

Therefore,

$$F_b = 119*0.863 = 103\ lb.$$

The bending stress in the bolts, σ_b, can then be calculated by,

$$\sigma_b = Mc/I$$

Where,

M = moment at the root of the bolts (see Figure 3)
= F_b* (maximum gap between bolts + thickness of bolt flanges)
= 103*(1.0+2.0) = 309 lb-in
c = radius of bolts = (0.741/2) = 0.371 in
I = section modulus of bolts = $\pi d^4/64*2 = \pi(0.741)^4/64*2 = 0.03\ in^4$

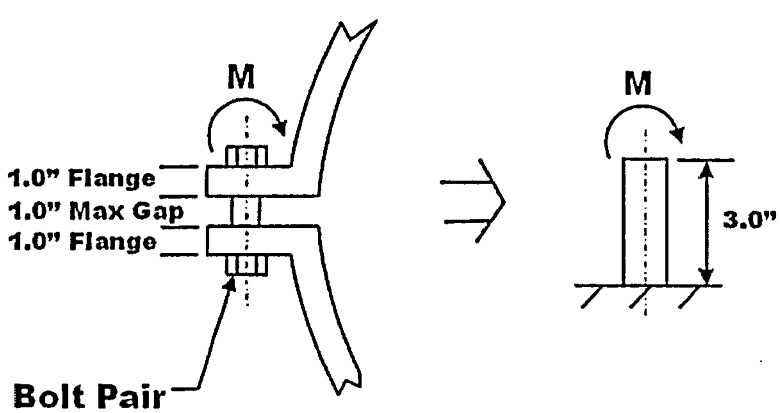

Figure 3: Bending on Tie-Down Collar Bolts

Thus, the bending stress in the bolts is;

$$\sigma_b = 309*0.371/0.03 = 3,821 \text{ psi}$$

The bolts have a yield strength of, σ_y of 80,000 psi. Therefore, the safety factor for the bolts in bending, SF_b, is;

$$SF_b = \sigma_y/\sigma_b = 80,000/3,821 = 21$$

Summary

The safety factors on the bolts in tension, shear and bending were conservatively calculated to be 7, 403, and 21, respectively. It should be noted that a large amount of conservatism was used in the calculation of the load imparted to the bolts in shear and in bending. The container would absorb most of the shear and bending forces and the bolts would be subjected mainly to tension load. The minimum safety factor for the tie-down collar and container under the tie-down force is governed by the compressive strength of the foam resisting the load.