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Detroit Edison

A DTE Energy Company

November 21, 2000
NRC-00-0069

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington D C 20555-0001

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) Detroit Edison letter to NRC "Proposed Technical Specification Changes (License Amendment) – Design Features/ Fuel Storage (Technical Specification 4.3) And Programs and Manuals/High Density Spent Fuel Racks (Technical Specification 5.5.13)", dated November 19, 1999

3) Detroit Edison letter to NRC "Response to Request for Additional Information on Technical Specifications Change Request Related to Spent Fuel Pool Expansion at Fermi 2 (TAC No. MA7233)", dated October 19, 2000

Subject: Response to Request for Additional Clarifications on Technical Specifications Change Request Related to Spent Fuel Pool Expansion at Fermi 2 (TAC No. MA7233)

This letter confirms the teleconference between the Detroit Edison, Brookhaven National Laboratories and NRC staffs on November 7, 2000 to discuss Detroit Edison's response to the Request for Additional Information provided in Reference 3. In response to an NRC request, the following additional clarifications are provided for two questions.

A001

1) In response to Question 7, all members of the "Crane Crew" including crane operators, signalmen and spotters are trained to requirements of ANSI B30.2-1976.

2) In response to Question 15(a), it is reiterated that full core off load is not a normal practice during refueling. However, any unplanned full core off load capability is retained.

During the evaluation and review of the inputs for Reference 3, concerns were raised regarding the quality of the Holtec Licensing Report Submittal in Reference 2. An evaluation of the Holtec Analyses versus the Licensing Report was conducted. The results of the evaluation confirmed that the Holtec Analyses supported the Licensing Report. However, ten minor discrepancies were found in the Holtec Licensing Report. The minor discrepancies were discussed with the NRC Project Manager on October 31, 2000 and entered into the Detroit Edison corrective action program. Enclosed is the errata sheet and revised pages identifying the minor corrections.

Should you have any questions or require additional information, please contact Mr. Norman K. Peterson of my staff at (734) 586-4258.

Sincerely,

William D. O'Connor Jr.

Enclosure

cc: D. S. Hood
M. A. Ring
NRC Resident Office
Regional Administrator, Region III
Supervisor, Electric Operators,
Michigan Public Service Commission

I, WILLIAM T. O'CONNOR, JR., do hereby affirm that the foregoing statements are based on facts and circumstances which are true and accurate to the best of my knowledge and belief.

WILLIAM T. O'CONNOR, JR.
Vice President - Nuclear Generation

On this 21st day of November, 2000 before me personally appeared William T. O'Connor, Jr., being first duly sworn and says that he executed the foregoing as his free act and deed.

Notary Public

NORMAN K. PETERSON
Notary Public, Monroe County, MI
My Commission Expires July 24, 2002

ENCLOSURE TO
NRC-00-0069

ERRATA SHEET AND REVISED PAGES

COMPARISON OF HOLTEC LICENSING REPORT SUBMITTALWITH HOLTEC ANALYSES
ERRATA SHEET

NO.	Licensing Report HI-992154	Affected Areas of the Licensing Report	Remarks
1	Section 6.0	1. Table 6.3.1 incorrectly specifies E value of 27.6 x 10^6 psi. The correct value is 28.5 x 10^6 (page 6-40) 2. The synthetic time histories are mentioned in Sect. 6.4 and shown as Figures 6.4.1 to 6.4.6. The figures are taken from Holtec Report HI-982070 but the report is not listed in either References Sect. 6.14 or in Section 6.4 (pages 6-36 and 6-6) 3. In Sect. 6.7.2(i) e, the term kl/r is used but l is not defined. The similar term, kλ/r, is used in subsection c. The term, kl/r, is used in the report. (page 6-19) 4. Sect. 6.7.4 mentions Ref. 6.6.3. There is no Ref. 6.6.3 listed in Ref. Sect. 6.14. (page 6-21) 5. Last sentence in Sect. 6.8.2 has upper and lower limits of "0.2 and 0.8". It should state "0.8 and 0.2". (page 6-24)	1. Value is corrected in Table 6.3.1 of the submittal. This change has no effect on the analysis. 2. HI-982070 was added as a Reference in both sections of the submittal. 3. Symbol usage made uniform within submittal. 4. Reference number corrected. 5. Submittal has been corrected.
2	Section 2.0, 2.1.d	The last sentence of item d states no bulk boiling occurs during full core off load assuming a single active failure. (page 2-1)	The last sentence was removed to be consistent with the response to RAI 15a from the Plant Systems Branch.
3	Section 4.0, Table 4.4.1	The uncertainties in the MCNP column for fuel types GE 12 (T) down through GE 9B in Table 4.4.1 of the submittal are slightly different than their respective values in Table 4.1 of Holtec report HI-992248. (Page 4-23)	Although changes are insignificant, submittal Table 4.4.1 has been corrected. Conclusion of the analysis unaffected.
4	Section 3.0, Table 3.1.1	The cell wall thickness (nom.) was given as 0.75 inch. It should have been given as 0.075 inch. (page 3-9)	Typographical error. This has been corrected in the submittal. No effect on the analysis.
5	Section 3.0, Figure 3.1.3	The figure shows the poison panel extending to the end of the sheath (to include the inner sheathing spacer). It should not include the spacer in the depiction of the active poison length.	Figure 3.1.3 has been revised in the submittal to show correct location of poison material and spacer. No effect on the analysis
6	Section 3.0, 3.2.1.e	The bearing pads are listed as being 304 stainless steel when they should be listed as 304L stainless steel. (page 3-3)	Corrected in the licensing report. No effect on the analysis.

2.0 PRINCIPAL DESIGN CRITERIA AND GOVERNING CODES

In this chapter, a synopsis of the principal design criteria applicable to the design of the Holtec high density racks for the Enrico Fermi 2 Plant is presented. For convenience, the entire range of codes, industry standards, publications, and plant-specific documents utilized or consulted in the preparation of this licensing report is also provided. In general, the information provided in this chapter serves as the common reference material for the safety analyses documented in Chapters 4 through 9 herein.

2.1 Summary of Principal Design Criteria

The key design criteria for the new Fermi 2 spent fuel racks are set forth in the USNRC memorandum entitled "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications," April 14, 1978 as modified by amendment dated January 18, 1979. The individual chapters of this report address the specific design bases that are described in the above-mentioned "OT Position Paper." A brief summary of the design basis requirements for the Fermi 2 racks is provided below.

a. Disposition: All new rack modules are required to be free-standing.

b. Kinematic Stability: All free-standing modules must be kinematically stable (against overturning) when subjected to a seismic event. Factors of safety of 1.5 and 1.1 are required for OBE and SSE conditions, respectively.

c. Structural Compliance: All primary stresses in the rack modules must satisfy the limits postulated in Section III, Subsection NF of the 1995 ASME Boiler and Pressure Vessel Code. Also, the cumulative damage factor for fatigue life must be less than 1.0 when the rack is subjected to 1 SSE and 20 OBE events. The fatigue assessment of the fuel rack follows the applicable guidelines in Subsection NB, Paragraph NB-3222.4.

d. Thermal-Hydraulic Compliance: The spatial average bulk pool temperature is required to remain under 150°F following a normal refueling. ~~For a full core off-load, it is required to demonstrate that bulk pool boiling does not occur, with single active failure.~~

3.2 Material Considerations

3.2.1 Structural Materials

The following structural materials are utilized in the fabrication of the new spent fuel racks:

a. ASME SA240-304L for all sheet metal stock

b. Baseplate: ASME SA240-304L

c. Internally threaded support legs: ASME SA240-304L

d. Externally threaded support spindle: ASME SA564-630 precipitation hardened stainless steel (heat treated to 1100°F)

e. Bearing pads: ASME SA240-304L

f. Weld material - per the following ASME specification: SFA 5.9 ER308L

3.2.2 Neutron Absorber Materials

In addition to the structural and non-structural stainless material, the racks employ Boral, a patented product of AAR Manufacturing, as the neutron absorber material. A brief description of Boral and its pool experience list follows.

Boral is a thermal neutron poison material composed of boron carbide and 1100 alloy aluminum. Boron carbide is a compound having a high boron content in a physically stable and chemically inert form. The 1100 alloy aluminum is a lightweight metal with high tensile strength, which is protected from corrosion by a highly resistant oxide film. The two materials, boron carbide and aluminum, are chemically compatible and ideally suited for long-term use in the radiative, thermal, and chemical environment of a nuclear reactor or a spent fuel pool.

Boral's use in spent fuel pools as the neutron absorbing material can be attributed to its proven performance (over 150 pool years of experience) and the following unique characteristics:

Table 3.1.1 KEY DESIGN DATA FOR NEW FERMI-2 MODULES	
Cell wall thickness (nom.), inch	0.075
Cell height (nom.), inch	175
Cell I.D. (nom.), inch	6.035
^{10}B areal loading in Boral (min.), g/cm^2	0.020
Boral panel thickness, inch	0.075
External Sheathing thickness, inch	0.075
Internal Sheathing thickness, inch	0.035
Height of bottom of baseplate above liner (nom.), inch	7.5
Layout pitch (nom.), inch	6.23
Number of support pedestals (min.)	4

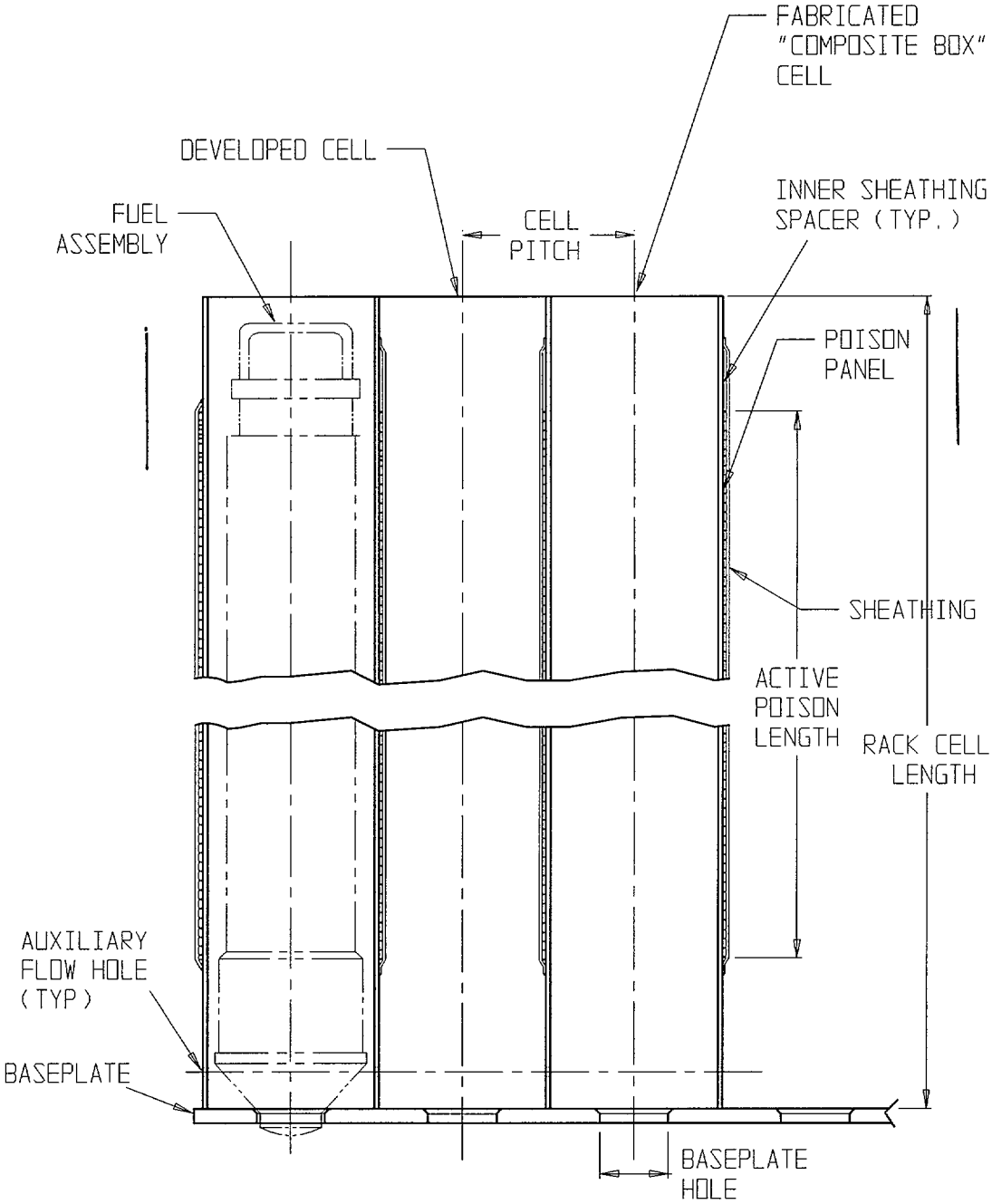

FIGURE 3.1.3

ELEVATION VIEW OF A TYPICAL BWR STORAGE RACK MODULE

HI-992154

Table 4.4.1
COMPARISON OF CALCULATIONAL METHODS @3.3% ENRICHMENT

	CASMO4	KENO5a	MCNP
GE 12 Fuel			
Calculated k_{inf}	0.9189	0.9142 ± 0.0003	0.9161 ± 0.0004
Corrected* k_{inf}		0.9172 ± 0.0013	0.9169 ± 0.0013
GE 12 Fuel (T)			
~~Calculated k_{inf}~~	~~0.9218~~	~~0.9171 ± 0.0003~~	~~0.9191 ± 0.0004~~
Calculated k_{inf}	0.9218	0.9171 ± 0.0003	0.9191 ± 0.0003
~~Corrected* k_{inf}~~		~~0.9201 ± 0.0013~~	~~0.9200 ± 0.0013~~
Corrected* k_{inf}		0.9201 ± 0.0013	0.9200 ± 0.0012
GE-6 8x8			
~~Calculated k_{inf}~~	~~0.9193~~	~~0.9114 ± 0.0003~~	~~0.9156 ± 0.0003~~
Calculated k_{inf}	0.9193	0.9114 ± 0.0003	0.9156 ± 0.0004
~~Corrected* k_{inf}~~		~~0.9144 ± 0.0013~~	~~0.9165 ± 0.0012~~
Corrected* k_{inf}		0.9144 ± 0.0013	0.9165 ± 0.0013
GE-8B 8x8			
~~Calculated k_{inf}~~	~~0.9189~~	~~0.9104 ± 0.0003~~	~~0.9145 ± 0.0004~~
Calculated k_{inf}	0.9189	0.9104 ± 0.0003	0.9145 ± 0.0003
~~Corrected* k_{inf}~~		~~0.9134 ± 0.0013~~	~~0.9154 ± 0.0013~~
Corrected* k_{inf}		0.9134 ± 0.0013	0.9154 ± 0.0012
GE-9B 9x9			
~~Calculated k_{inf}~~	~~0.9181~~	~~0.9121 ± 0.0003~~	~~0.9144 ± 0.0003~~
Calculated k_{inf}	0.9181	0.9121 ± 0.0003	0.9144 ± 0.0004
~~Corrected* k_{inf}~~		~~0.9151 ± 0.0013~~	~~0.9153 ± 0.0012~~
Corrected* k_{inf}		0.9151 ± 0.0013	0.9153 ± 0.0013
GE-11			
Calculated k_{inf}	0.9183	0.9121 ± 0.0003	0.9163 ± 0.0004
Corrected* k_{inf}		0.9151 ± 0.00103	0.9172 ± 0.0013
GE-11 (T)			
Calculated k_{inf}	0.9204	0.9141 ± 0.0003	0.9177 ± 0.0004
Corrected* k_{inf}		0.9171 ± 0.0013	0.9186 ± 0.0013
ABB SVEA-96			
Calculated k_{inf}	0.9232	0.9202 ± 0.0003	0.9233 ± 0.0004
Corrected* k_{inf}		0.9232 ± 0.0013	0.9242 ± 0.0013

* Includes Monte Carlo statistics and uncertainty in bias, at 95% probability, 95% confidence level (one-sided), where the k-factor is 1.70.

6.4 Synthetic Time-Histories

The synthetic time-histories in three orthogonal directions (N-S, E-W, and vertical) are generated in accordance with the provisions of SRP 3.7.1 [6.4.1]. In order to prepare an acceptable set of acceleration time-histories, Holtec International's proprietary code GENEQ [6.4.2] is utilized.

A preferred criterion for the synthetic time-histories in SRP 3.7.1 calls for both the response spectrum and the power spectral density corresponding to the generated acceleration time-history to envelope their target (design basis) counterparts with only finite enveloping infractions. The time-histories for the pools have been generated to satisfy this preferred (and more rigorous) criterion. The seismic files also satisfy the requirements of statistical independence mandated by SRP 3.7.1.

Figures 6.4.1 through 6.4.3 and 6.4.4 through 6.4.6 provide plots of the time-history accelerograms which were generated for a 20 second duration of OBE and SSE events, respectively. These artificial time-histories are used in all non-linear dynamic simulations of the racks.

Results of the correlation function of the three time-histories are given in Table 6.4.1. Absolute values of the correlation coefficients are shown to be less than 0.15, indicating that the desired statistical independence of the three data sets has been met. [6.4.3]

6.5 22-DOF Nonlinear Rack Model for Dynamic Analysis

6.5.1 General Remarks

The single rack 3-D model of the Fermi 2 racks has been prepared with due consideration of the following characteristics, which are typical of high-density modules designed by Holtec International.

i. As a continuous structure, the rack possesses an infinite number of degrees-of-freedom, of which the cantilever beam type modes are most pronounced under seismic excitation if the rack is of the honeycomb construction genre. (The Fermi 2 racks, like all prior Holtec designs, are of the honeycomb type.)

$D_x = 1 - (f_a/F'_{ex})$

$D_y = 1 - (f_a/F'_{ey})$

$F'_{ex,ey} = (\pi^2 E)/(2.15\ (\cancel{kl/r})^2\ \underline{(k\lambda/r)^2_{x,y}})$

E = Young's Modulus

and subscripts x,y reflect the particular bending plane.

f. Combined flexure and compression (or tension) on a net section:

$$\frac{f_a}{0.6\,S_y} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} < 1.0$$

The above requirements are to be met for both direct tension or compression.

g. Welds

Allowable maximum shear stress on the net section of a weld is given by:

$$F_w = 0.3\ S_u$$

where S_u is the weld material ultimate strength at temperature. For fillet weld legs in contact with base metal, the shear stress on the gross section is limited to $0.4S_y$, where S_y is the base material yield strength at temperature.

(ii) Level D Service Limits

Section F-1334 (ASME Section III, Appendix F) [6.7.2], states that the limits for the Level D condition are the minimum of 1.2 (S_y/F_t) or ($0.7S_u/F_t$) times the corresponding limits for the Level A condition. S_u is ultimate tensile stress at the specified rack design temperature. Examination of material properties for 304L stainless demonstrates that 1.2 times the yield strength is less than the 0.7 times the ultimate strength.

Exceptions to the above general multiplier are the following:

a) Stresses in shear shall not exceed the lesser of $0.72S_y$ or $0.42S_u$. In the case of the Austenitic Stainless material used here, $0.72S_y$ governs.

b) Axial Compression Loads shall be limited to 2/3 of the calculated buckling load.

c) Combined Axial Compression and Bending - The equations for Level A conditions shall apply except that:

6.7.4 Loads and Loading Combinations for Spent Fuel Racks

The applicable loads and their combinations which must be considered in the seismic analysis of rack modules is excerpted from Refs. [6.1.2] and [6.76.3]. The load combinations considered are identified below:

Loading Combination	Service Level
$D + L$ $D + L + T_o$ $D + L + T_o + E$	Level A
$D + L + T_a + E$ $D + L + T_o + P_f$	Level B
$D + L + T_a + E'$ $D + L + T_o + F_d$	Level D The functional capability of the fuel racks must be demonstrated.

Where:

D = Dead weight-induced loads (including fuel assembly weight)

L = Live Load (not applicable for the fuel rack, since there are no moving objects in the rack load path)

P_f = Upward force on the racks caused by postulated stuck fuel assembly

F_d = Impact force from accidental drop of the heaviest load from the maximum possible height.

E = Operating Basis Earthquake (OBE)

E' = Safe Shutdown Earthquake (SSE)

T_o = Differential temperature induced loads (normal operating or shutdown condition based on the most critical transient or steady state condition)

T_a = Differential temperature induced loads (the highest temperature associated with the postulated abnormal design conditions)

LIST OF RACK SIMULATIONS				
Run	**Model**	**Load Case**	**COF**	**Event**
19	Single Rack	Module A Fully Loaded	0.2	SSE
20	Single Rack	Module A Fully Loaded	0.8	SSE
21	Single Rack	Module A Fully Loaded	Random	SSE
22	Single Rack	Module A Half Loaded	0.2	SSE
23	Single Rack	Module A Half Loaded	0.8	SSE
24	Single Rack	Module A Half Loaded	Random	SSE
25	Single Rack	Module A Nearly Empty	0.2	SSE
26	Single Rack	Module A Nearly Empty	0.8	SSE
27	Single Rack	Module A Nearly Empty	Random	SSE
28	Single Rack	Module B (full)	0.8	SSE
29	Single Rack	Module B (full) with HOP	0.8	SSE
30	Single Rack	Module G (full)	0.8	SSE
31	Single Rack	Module G (full) with HOP	0.8	SSE
32	Single Rack Overturn Check	Full Rack Module D	0.8	SSE

Where:

Random = Gaussian distribution with a mean of 0.5 coefficient of friction (upper and lower limits of ~~0.2 and 0.8)~~ 0.8 and 0.2)

6.14 References for Chapter 6

[6.1.1] USNRC NUREG-0800, Standard Review Plan, June 1987.

[6.1.2] (USNRC Office of Technology) "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications", dated April 14, 1978, and January 18, 1979 amendment thereto.

[6.2.1] Soler, A.I. and Singh, K.P., "Seismic Responses of Free Standing Fuel Rack Constructions to 3-D Motions", Nuclear Engineering and Design, Vol. 80, pp. 315-329 (1984).

[6.2.2] Soler, A.I. and Singh, K.P., "Some Results from Simultaneous Seismic Simulations of All Racks in a Fuel Pool", INNM Spent Fuel Management Seminar X, January, 1993.

[6.2.3] Singh, K.P. and Soler, A.I., "Seismic Qualification of Free Standing Nuclear Fuel Storage Racks - the Chin Shan Experience", Nuclear Engineering International, UK (March 1991).

[6.2.4] Holtec Proprietary Report HI-961465 - WPMR Analysis User Manual for Pre&Post Processors & Solver, August, 1997.

[6.4.1] USNRC Standard Review Plan, NUREG-0800 (Section 3.7.1, Rev. 2, 1989).

[6.4.2] Holtec Proprietary Report HI-89364 - Verification and User's Manual for Computer Code GENEQ, January, 1990.

[6.4.3] Holtec Proprietary Report HI-982070, 3-D Seismic Time Histories for Enrico Fermi 2 Spent Fuel Pool, October, 1999.

[6.5.1] Rabinowicz, E., "Friction Coefficients of Water Lubricated Stainless Steels for a Spent Fuel Rack Facility," MIT, a report for Boston Edison Company, 1976.

[6.5.2] Singh, K.P. and Soler, A.I., "Dynamic Coupling in a Closely Spaced Two-Body System Vibrating in Liquid Medium: The Case of Fuel Racks," 3rd International Conference on Nuclear Power Safety, Keswick, England, May 1982.

[6.5.3] Fritz, R.J., "The Effects of Liquids on the Dynamic Motions of Immersed Solids," Journal of Engineering for Industry, Trans. of the ASME, February 1972, pp 167-172.

Table 6.3.1 RACK MATERIAL DATA (200°F) (ASME - Section II, Part D)			
Material	**Young's Modulus** **E** **(psi)**	**Yield Strength** **S_y** **(psi)**	**Ultimate Strength** **S_u** **(psi)**
SA240; 304L S.S.	27.6×10^6	21,300	66,200
SUPPORT MATERIAL DATA (200°F)			
SA240, Type 304L (upper part of support feet)	27.6×10^6	21,300	66,200
SA-564-630 (lower part of support feet; age hardened at 1100°F)	~~27.6×10^6~~ 28.5×10^6	106,300	140,000