Maine Yankee
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October 2, 2003
MN-03-060 RA-03-147

UNITED STATES NUCLEAR REGULATORY COMMISSION
Attn: Document Control Desk
Washington, DC 20555

Reference: Maine Yankee letter dated September 18, 2003 (MN-03-057, RA-03-142)

Subject: License No. DPR-36 (Docket 50-309, ISFSI Docket 72-030) Request for Exemption from NRC Certificate of Compliance No. 1015, Amendment 2, Technical Specification B3.4.3.6

Gentlemen:

By the referenced letter, Maine Yankee indicated its intent to submit an exemption request to Technical Specification B3.4.3.6 of Certificate of Compliance No. 1015, Amendment 2. Attached is the exemption request.

The request would exempt Maine Yankee from the requirement for a specific coefficient of friction (COF) between the vertical concrete canisters (VCCs) and the pads upon which they reside at the ISFSI. Diverse assessments of VCC movement under seismic conditions, discussed in the attachment, demonstrate that VCC movement is restricted to several inches. As a result, such movement can have no affect on public health and safety, and a specific COF value is unnecessary.

By the referenced letter, Maine Yankee also indicated its intent to submit a corresponding amendment to the certificate of compliance to eliminate Technical Specification B3.4.3.6. Upon subsequent consideration, we believe granting the exemption achieves the same purpose. Submitting a similar amendment request would achieve no benefit while leading to additional administrative burden on Maine Yankee and NRC staff.

Finally, in the referenced letter, we noted that the probability of occurrence of a beyond-design-basis seismic event (which formed the basis for Technical Specification B3.4.3.6) was approximately 1E-4/year. The actual value based upon NRC and industry sponsored research is 8E-5/year (LLNL) or 5E-5/year (EPRI). These values reduce the likelihood of a 0.25g seismic event coinciding with a VCC/pad COF less than 0.5 from that reported in the referenced letter.

We look forward to your timely approval of this exemption request. Please feel free to contact us should you require additional information.

NMSS01

Sincerely,

Thomas L. Williamson, Director
Nuclear Safety & Regulatory Affairs

c: Dr. R. R. Bellamy, NRC Region I
Mr. J. T. Buckley, NRC Project Manager, NMSS
Mr. F. J. Congel, NRC Director, Office of Enforcement
Ms P. Craighead, Esq., State of Maine Nuclear Safety Advisor
Mr. P. J. Dostie, State of Maine, Division of Health Engineering
Mr. H. J. Miller, NRC Regional Administrator, Region I
Mr. S. O'Connor, NRC Project Manager, SFPO
Mr. R. Shadis, Friends of the Coast

REQUEST FOR EXEMPTION FROM NRC CERTIFICATE OF COMPLIANCE NO. 1015, AMENDMENT 2, TECHNICAL SPECIFICATION B3.4.3.6

I. REQUEST FOR EXEMPTION

Maine Yankee hereby requests exemption, in accordance with 10CFR72.7 (Specific exemptions), from Technical Specification B3.4.3.6 contained in NRC's Certificate of Compliance No. 1015, Amendment 2, for the NAC UMS dry fuel storage system.

II. BACKGROUND

Current License Basis

Technical Specification B3.4.3.6 states:

> Physical testing shall be conducted to demonstrate that the coefficient of friction between the CONCRETE CASK and ISFSI pad surface is at least 0.5.

This Technical Specification is associated with an analysis discussed in the UMS FSAR Section 11.2.15.1.4[1]. The analysis, which employed a beyond-design-basis earthquake loading of 0.25g peak ground acceleration resulting in a top-of-pad 0.38g horizontal acceleration, was a bounding analysis for earthquakes east of the Rocky Mountains. The coefficient of friction (COF) necessary to prevent sliding between the vertical concrete cask (VCC) and the ISFSI pad was calculated to be 0.45.

The UMS FSAR, in Section 11.2.8, also contains the same analysis for a seismic acceleration of 0.26g horizontal, much closer to Maine Yankee's design basis. For this case, a 0.31 COF was sufficient to prevent sliding.

Using the actual seismic design basis for Maine Yankee[2], a peak ground acceleration of 0.18g (0.231g horizontal, 0.155g vertical), yields a "non-sliding" COF of 0.266.

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[1] Maine Yankee is unaware of any other NAC users who have analyzed a beyond-design-basis seismic event. Nor are we aware of any other NAC users who have a coefficient of friction in their Technical Specifications.

[2] See NRC's SER for the seismic margin program transmitted by letter dated March 16, 1987 (NMY87-48).

Icing

During the winter of 2002-2003 it became apparent that ice was forming between the VCC and the ISFSI pad. As the winter progressed, a ridge of ice formed on the pad around the outer perimeter of the VCC. During minor melting periods, the ice ridge trapped water, directing it between the VCC and the rough pad surface which later re-froze.

While the ice ridge around the VCCs led to ice buildup between the VCC and the pad, Maine Yankee engineers concluded that the ice ridge coupled with the frozen bond between the VCC and the pad would provide at least equivalent resistance to movement as provided by any of the friction coefficients discussed above. Only after the ice ridge finally melted in the spring, and the ice between the VCC and pad started melting, was the VCC susceptible to some sliding due to a reduced COF between the VCC, the ice and the pad.

Because some sliding may occur during a seismic event that coincides with sufficient melting (resulting in an effective COF less than the values discussed above), Maine Yankee has evaluated the degree of sliding in such circumstances and found it acceptable. Since NRC has interpreted Technical Specification B3.4.2.6 to not allow ice between the VCC and the ISFSI pad[3] Maine Yankee has decided to request exemption from the Technical Specification.

III. GENERAL JUSTIFICATION FOR GRANTING THE EXEMPTION REQUEST

Introduction

Following spring melt of the ice ridge around the VCCs, there will be a short period of time when the effective friction factor between the VCC and ISFSI pad may vary from the license basis calculations.

> If the remaining ice beneath the VCC melts to a point of having an effective COF of zero, we have a perfect seismic base isolation system and the seismic movement of the pad and soil will not be transmitted to the VCC.
>
> If the effective COF remains above the license basis values there will be no movement.
>
> For coefficients between the license basis values and zero some movement of the VCC would be expected.

In other words, if the effective COF is zero, the pad is free to move back-and-forth beneath the VCC and the result is no inertial forces being transmitted to the VCC and no sliding between the VCC and the pad. As the effective COF increases, some seismic inertia will be transmitted to the VCC but once again this will be limited for small COFs. The ice surface will once again act as a base isolation system but not as a perfect one. It will essentially limit the seismic inertial

[3] See NRC Region I letter dated August 25, 2003 (EA 03-148).

forces to less than those anticipated during a design basis event and thus tend to reduce the effective seismic driving forces. As the effective COF increases, the magnitude of the seismic inertial forces being transmitted also increases, however, the effective COF also acts as a translation brake such that, the counter-acting pad movements will tend to slow, stop or reverse relative VCC movements. This phenomenon is analogous to a VCC supported on dry (i.e. non-iced condition) concrete being subjected to a larger than design basis seismic event where the seismic driving forces exceed the effective COF between the pad and the VCCs

To determine the magnitude of VCC movement at lower friction factors, Maine Yankee utilized three different approaches: 1) application of the Seismic Qualifications Utility Group (SQUG) seismic experience database and processes, 2) application of the Sandia study on the Private Fuel Storage facility, and 3) a practical, intuitive evaluation.

SQUG Approach[4]

In December, 1980, NRC published Unresolved Safety Issue A-46 to, in part, establish criteria to judge seismic adequacy of active equipment in older operating facilities. In January, 1982 the SQUG was formed, with Maine Yankee as a charter member, to address USI A-46.

Central to the SQUG approach is an extensive seismic experience database which covers actual equipment response at a broad number of locations in the world to a broad range of seismic events. This information includes displacement effects (e.g., sliding) for unanchored equipment relevant to VCCs. Engineers (five years experience in earthquake engineering applicable to nuclear power plants, degreed in structural or mechanical engineering) were put through a rigorous training program and qualified to apply the database to detailed seismic walkdowns intended to identify seismic vulnerabilities.[5] Maine Yankee retains two such engineers who were responsible for applying the SQUG approach to VCC movement under seismic conditions and a reduced effective COF.

The SQUG training and underlying technical information indicates that maximum movements for large, rigid masses like VCCs subjected to seismic inertial forces comparable to Maine Yankee s analyzed events would be in the 6"-12" range. This is due to the vibratory nature of the seismic loading. Classical seismic analysis of structures often use an artificial time history approach which mathematically moves the base of the structure back-and-forth such that the response of the structure can be determined based upon the structure s mass and stiffness. For a relatively squat rigid body, such as a vertical concrete storage cask, the structure response

[4] In their August 25, 2003 letter, NRC Region I noted "... the presence of ice was not factored into the studies used to generate the industry [i.e., SQUG] data that you cited...". In fact, the only effect of ice, under the right conditions, is to vary the COF. The same effect is achieved by increasing the magnitude of the seismic event such that even a 0.5 COF is insufficient to prevent motion, such as Sandia did (see next section). The presence of ice, itself, is irrelevant. What is relevant is the degree of motion identified in the seismic experience database when seismic events defeat the ability of a COF to prevent motion.

[5] The SQUG developed the "Generic Implementation Procedure (GIP) For Seismic Verification Of Nuclear Plant Equipment". NRC issued an initial SER to the GIP in July, 1988 and a second revision in March, 1992.

is simply reduced to VCC sliding relative to the storage pad if the inertial forces exceed the effective COF between the casks and the pad. The counter-cycles of the pad movement tend to often restrict and/or reverse any initially induced movement, thereby explaining the small relative movements noted in the SQUG seismic experience database.

Sandia Study for Private Fuel Storage

On March 31, 2002, Sandia National Laboratories provided a report to the NRC entitled "NRC Project on Seismic Behavior of Spent Fuel Storage Cask Systems, Seismic Analysis Report on HISTORM-100 Casks at Private Fuel Storage Facility, Rev. 1". NRC had contracted for the study to support the Spent Fuel Project Office's review of the Private Fuel Storage (PFS) ISFSI license application.

The purpose of the Sandia study was to determine the magnitude of cask movement under seismic conditions that were sufficiently large to exceed the ability of a COF to prevent motion. Unlike the "expert judgment" approach utilized by SQUG, Sandia developed three-dimensional coupled finite element models and performed seismic analyses.

In these analyses, a conservatively low COF of 0.2 was used along with three large earthquake ground motion simulations. The best estimate movements of the VCCs under these scenarios are included in Table 1.

Table 2 compares a number of significant design variable inputs between the Maine Yankee ISFSI and those used in the PFS analyses.

Based upon a review of Table 2, we can conclude that, other than the variations in the local soil conditions, the two ISFSIs are quite similar (from an analytical modeling viewpoint). The differences in soil depth will have some effect on the earthquake deconvolution process but for the purposes of this benchmark comparison the differences are not significant. The broad variation of dynamic soil properties employed in both the PFS and Maine Yankee analyses, coupled with the rigid nature of the casks is adequate to assure that all ground motion frequencies of interest will be considered.

Figure 1 provides a plot of various displacement data obtained from the PFS analyses for a COF of 0.2. Given the high seismic design inputs and the conservatively low COF used in the analysis (0.2), cask sliding is anticipated. As one would expect, the calculated cask movements are indeed related to the magnitude of the input accelerations, i.e., larger displacements are associated with larger input accelerations.

Particularly striking from the Sandia analysis is the very small cask displacements even for quite large seismic inputs – seismic accelerations well in excess of anything contained in the Maine Yankee license basis. Sandia's use of a 0.2 COF is well chosen for the Maine Yankee situation, in that we are interested in displacements resulting from COFs less than 0.45 (FSAR 11.2.15.1.4 calculated value) and greater than zero. The Sandia results cover the midpoint of this range.

Figure 1 has been shaded to reflect the area of interest for Maine Yankee up to 0.38g horizontal acceleration used in the FSAR Section 11.2.15.1.4 analysis. Extension of the Sandia analysis downward to Maine Yankee's seismic accelerations suggests maximum VCC displacement on the order of one inch for a 0.2 COF. Certainly, there are not sufficient differences in the analysis inputs to support VCC displacement at Maine Yankee greater than two inches.

A Practical, Intuitive Approach

A third, non-analytic yet practical, way to evaluate this issue is to apply common sense and observation to determine where the subject cask will tend to move and what are the results of that movement. The detailed inspections of the VCCs performed when the icing condition was discovered found both a circumferential constraining ridge of ice and a thin lens of ice that was working its way from the cask outer diameter toward the center of the VCC. With the onset of spring (the inspections were performed in mid-March) it was apparent that the ice ridge was melting on the south-facing sides of the VCCs. Additionally, any ice on the pad adjacent to a VCC was melting except in areas where the VCCs were shielding the pad surface from the sun. Based upon these observations, Maine Yankee s investigating engineers concluded that the VCCs would tend to move along the path of least resistance, that is, toward the free, non-ice ridge direction and onto the clear, non-iced roughened concrete surface. As the VCC slowly translated off of the ice and onto the rough concrete surface the previously verified greater than 0.5 COF would quickly act as a brake and rapidly end further sliding. Displacements on the order of 5-6 inches would be sufficient to "brake" the VCC.

Effects of VCC Movement

The three approaches to determining the magnitude of VCC sliding during a seismic event are in quite good agreement. The SQUG evaluation determined a range of 6-12 inches. At the opposite end, Sandia analyses show movement of no more than 1-2 inches at a reduced COF. A practical view suggests values in the middle.

The potential concerns with VCC sliding - impacting another VCC, or sliding over the edge of a pad sufficient to tip over the VCC - are thus resolved:

> In excess of 7 feet of movement is necessary to translate the center of gravity of a loaded VCC over the free edge of a storage pad, resulting in a tip-over event.
>
> VCCs are on a center-to-center spacing of 15 feet. Given the 11'-4" VCC outer diameter the resulting spacing between VCCs is 3'-8".

The VCC spacing is the limiting case. Even if two VCCs were to move in opposite directions towards each other[6], under any of the analysis results discussed above, a significant margin in spacing remains.

Therefore, VCC movements under seismic conditions at a reduced COF due to icing will not result in either a tip-over event or VCC interactions. Consequently, exempting Maine Yankee from Technical Specification B3.4.2.6 will have no adverse impact on public health and safety.

IV. SPECIFIC JUSTIFICATIONS FOR EXEMPTION

The Commission may grant exemptions under 10CFR72.7 as it determines are authorized by law, will not endanger life, property or the common defense and security, and are otherwise in the public interest.

Granting the exemption to Technical Specification B3.4.3.6 is authorized by law. Since the VCC movements under seismic loadings are so small, as demonstrated above, they cannot endanger life or property, and have no bearing on security or the common defense.

Approving the exemption is in the public interest by properly balancing safety benefit against public cost. Maine Yankee's decommissioning and long-term fuel storage is funded through FERC rate-making cases that ultimately result in public funding of the activities. Incurring unnecessary costs to members of the public is imprudent and clearly against the best interests of the public when, as in this case, no safety benefit is achieved through the expense.

Short of providing a heated enclosure over the ISFSI to prevent ice formation, Maine Yankee is unaware of any reliable means to prevent such ice buildup. Obvious methods such as applying

[6] Highly unlikely given the preferential directional melting of the ice on a pad and surrounding a VCC

localized heating to melt ice actually degrade the VCC through thermal expansion cracking and chipping of the concrete material.

The cost of a heated ISFSI enclosure is enormous and unjustified to prevent a highly improbable seismic event coincident with a reduced COF that only results in VCC movement of a few inches with no discernible effect on public health and safety. Maine Yankee would be irresponsible in its stewardship of public funds to not pursue this exemption request. Likewise, for the public interest, NRC should grant the request.

Table 1: Summary of Cask Displacements for PFS

PFS Analysis Earthquake	Maximum Horiz. Acceleration (g)	Assumed COF between cask and pad	Maximum Displacement[7]
10,000 year return [8]	1.25	0.2	11.9 inches
"2,000 year return"	0.78	0.2	5.6 inches
1971 San Fernando	0.64	0.2	3.4 inches

[7] Square-root-sum-of-the-squares (SRSS) of two orthogonal horizontal dimensions.

[8] This corresponds to less than a 1.0 E-06/yr event at Maine Yankee.

Table 2: Comparison of PFS and Maine Yankee

	PFS	Maine Yankee
Cask Description	HOLTEC HI-STORM	NAC UMS
Cask Diameter	132.5 inches	136 inches
Cask height	231.25"	218.28"
Cask CG height	118.38 inches	111.7 inches
Cask weight	360,000 pounds	303,300 pounds
Soil profile	140' depth[9]	34' and 53' depths analyzed[10]
Pad dimensions	30' x 67' x 3'	31' x 31' 3'
Number of casks per pad	8	4
Other	Embedded in 3' of aggregate + soil/cement on 2' of soil/cement	Embedded 6" and supported on 4.5' of densely compacted structural fill

[9] Basic state-of-the-art soil modeling techniques were used to determine strain compatible properties.

[10] Basic state-of-the-art soil modeling techniques were used to determine strain compatible properties. The deepest and most shallow soil depths occurring at the Maine Yankee ISFSI were modeled and the soil properties were varied to develop best estimate, upper and lower bound values.

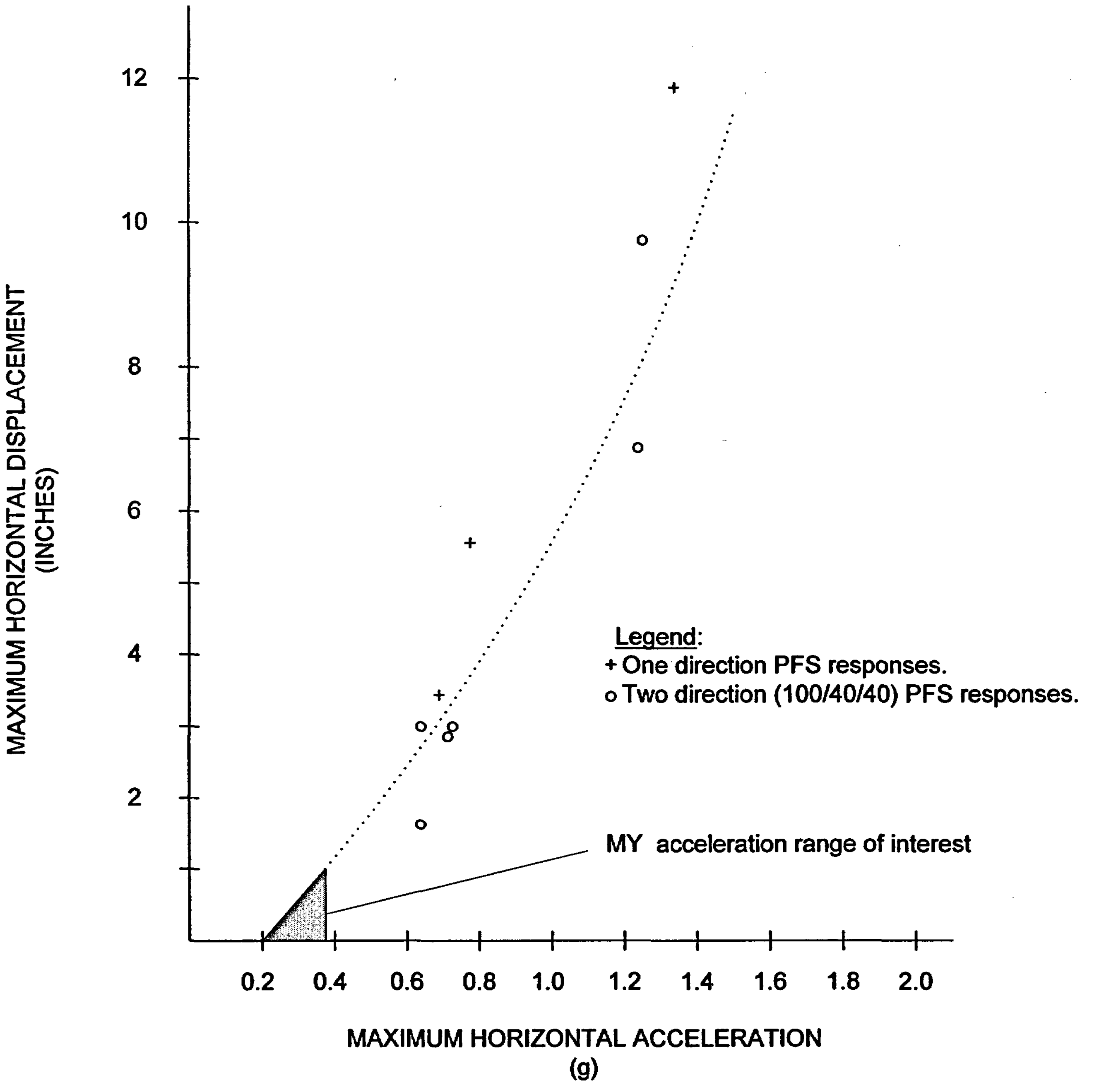
MAXIMUM HORIZONTAL DISPLACEMENT (INCHES)
2
4
6
8
10
12
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
MAXIMUM HORIZONTAL ACCELERATION (g)
Legend:
+ One direction PFS responses.
o Two direction (100/40/40) PFS responses.
MY acceleration range of interest

FIGURE 1