Entergy

Entergy Operations, Inc.
River Bend Station
5485 U. S. Highway 61N
St. Francisville, LA 70775
Tel 225 381 4374
Fax 225 381 4872
eolson@entergy.com

Eric W. Olson
Site Vice President

RBG-47553

March 30, 2015

U. S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Response to Request for Additional Information on License Amendment Request 2013-13
River Bend Station – Unit 1
Docket No. 50-458
License No. NPF-47

REFERENCES:

1. Entergy letter to NRC, dated July 29, 2013, License Amendment Request 2013-13, Heavy Load Movement Over Fuel Assemblies (Letter No. RBG-47382)

2. NRC letter to Entergy (via email), dated December 18, 2014, Request for Additional Information

RBF1-15-0048

Dear Sir or Madam:

On July 29, 2013, Entergy Operations, Inc. (Entergy) submitted a request to allow the movement of heavy loads over fuel assemblies (Reference 1). During their review, the NRC staff determined that additional information is needed to complete the processing and approval of Entergy's request. The request for that information was transmitted to Entergy per Reference 2. Attachments 1 and 2 to this letter contain the requested information. If you have any questions on this matter, please contact Joey Clark, Manager – Regulatory Assurance, at 225-381-4177.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 30, 2015.

Sincerely,

Eric W. Olson

EWO/dhw

Attachment 1: Response to Request for Additional Information
Attachment 2: Estimate of Potential Liner Leakage in a Gate Load Drop Scenario

A001
NRR

cc: U. S. Nuclear Regulatory Commission
Attn: Mr. Alan Wang
MS 8-G14
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
1600 E. Lamar Blvd.
Arlington, TX 76011-4511

NRC Senior Resident Inspector
River Bend Station

Department of Environmental Quality
Office of Environmental Compliance
Radiological Emergency Planning and Response Section
Ji Young Wiley
P.O. Box 4312
Baton Rouge, LA 70821-4312

Public Utility Commission of Texas
1701 N. Congress Ave.
Austin, TX 78711-3326

Attachment 1
RBG-47553

Response to Request for Additional Information

RAI No. 1:

Attachment 2 to the letter dated September 23, 2014, included a description of the methodology used to determine the strike velocity and penetration potential of the gate and associated handling equipment, if dropped through air and/or water. The methodology used was from Topical Report BC-TOP-9A, Revision 2, September 1974, "Topical Report, Design of Structures for Missile Impact" (ADAMS Accession No. ML14093A217). The NRC Topical Report Evaluation included in the document states that the evaluation of punching shear effects due to impact was not included as part of the structural response considerations in the report, but should be addressed in the safety analysis report. Describe the configuration of the spent fuel pool floor liner and address the susceptibility of the liner to punching shear effects.

Please note that NRC Information Notice 94-13, Supplement 2, "Control and Oversight of Contractors during Refueling Activities and Clarification of Applicability of Section 50.120 of Title 10 of the *Code of Federal Regulations* to Contractor Personnel," describes the drop of a core shroud bolt that punched through the liner of a spent fuel pool at a U.S. reactor.

RAI No. 2:

The analysis of the gate drop included in Attachment 2 to the letter dated September 23, 2014, treated the 2000 pound gate as a shallow box with dimensions of 24.39 feet in length, 4.771 feet in width, and 0.3958 feet in thickness. This treatment resulted in a determination that the gate density would be less than the density of water (see page 72 of Calculation G13.18.2.7-116 [Attachment 2 to the letter dated September 23, 2014]). Explain the actual construction of the gate and, considering the sensitivity of the liner damage analysis to effective impact area, address the accuracy of the modeled configuration in predicting the potential for liner penetration.

RESPONSE:

Clarification regarding the information needed to support the RBS Heavy Loads Amendment was provided by the NRC in a follow up email meeting notice and associated conference call between the NRC and River Bend personnel on March 4, 2015. The clarification was regarding information to demonstrate meeting the requirement of NUREG-0612, Section 5.1, Evaluation Criterion III which states:

> "Damage to the reactor vessel or the spent fuel pool based on calculations of damage following accidental dropping of a postulated heavy load is limited so as not to result in water leakage that could uncover the fuel, (makeup water provided to overcome leakage should be from a borated source of adequate concentration if the water being lost is borated)..."

In clarifying the methodology for demonstration that Criterion III was satisfied, the NRC stated that Entergy could use the second option of the acceptance criterion (i.e. leakage would be within the capacity of makeup) based on a simplified conservative estimate of liner damage. Alternatively, Entergy could respond to the specific RAIs which related to the specific methodology chosen to evaluate penetration capability based on the strain energy absorbed by a steel plate allowed to freely deform in response to missile impact. The first question involves the potential that the impact is near a point where the liner plate is supported by part of the concrete floor such that the plate shears. The second question involves the shape of the missile, which influences the inertial resistance of the plate (i.e., the mass of the plate directly in front of the missile that does not stretch). In both cases, if the plate is directly backed by the reinforced concrete floor, the floor would not yield to the small impact from the gate and there would be no need to calculate the strain energy absorbed by the steel plate.

A detailed review of the configuration of the RBS spent fuel pool floor and interface between the pool liner and reinforced concrete floor of the pool structure was performed. The configuration of the interface is summarized as follows:.

- The spent fuel pool floor liner is composed of 3/16 inch thick stainless steel plates welded to concrete embedded mounts. The top of the stainless steel mounting plates are flush with concrete pool floor. The typical embedded mounting plate dimensions in the gate movement path are 28" x 48" x 3". The liner plate overlaps the edge of the mounting plate by 1 ¼".

- The weld between the each embedded mounting plate and the connecting liner plate is covered with a leakage collection system channel. In the spent fuel pool gate movement path, the leak detection channel typically consists of 1" x 1" x 3/16" or 1 ½" x 1 ½" x 3/16" angle welded to the liner plate on one side and the embedded mounting plate on the other side. The leak detection channels are tubed to headers that are directed to the leakage zone header piping. The header piping is equipped with normally closed isolation valves.

- The spent fuel pool liner plates are in direct contact with the spent fuel pool concrete floor. The only portion of the liner system that is not in direct contact with the floor are the leakage monitoring channel covers. In the event of a load drop impacting the pool floor, a breach of the leakage monitoring channel covers would not result in external liner leakage as the weld between the liner plate and the embedded mounting plate is not affected, and the leakage collection system is isolated.

Because the liner plates are directly backed by the reinforced concrete floor, the floor will not yield to the impact from the gate and calculation of the strain energy absorbed by the plate is not required.

For the purpose of providing a comprehensive response, a simplified conservative estimate of liner damage was postulated, a corresponding estimate of the liner leakage rate determined, and the capability of the makeup to the spent fuel pool evaluated as follows:

- In order for liner leakage to occur, it would be necessary for the weld between the liner plate and the embedded mounting plate to fail, in addition to failure of the covering leakage monitoring channel. For evaluation purposes, a failure of the weld between the liner plate and embedded mounting plate was postulated and a leakage rate estimated as detailed in Attachment 2. The resultant estimated leakage rate is approximately 180 gallons/minute. Note that this estimated leakage rate is conservative, as no credit is taken for the leakage limiting capability of the concrete pool structure.

- The spent fuel pool cooling and cleanup system (SFC) includes two 100% capacity, safety-related, cooling pumps, each with a rated discharge flow of 2500 gallons per minute. The system also contains two 100% capacity, non-safety related cleanup pumps, each with a rated discharge flow of 600 gallons per minute. The normal makeup water source for the spent fuel pool is the condensate storage tank (CST). The CST is a non-safety related tank with a maximum operating capacity of 581,000 gallons, including 125,000 gallons reserved for high pressure core spray and reactor core isolation cooling.

- In addition to the normal makeup water supply from the CST, emergency makeup to the pool can be provided from either the makeup water system (MWS) or the standby service water system via interconnections with reactor plant component cooling water system (CCP). These sources are supplied via interconnections between the safety related SFC system piping and safety-related portion of the CCP system. The MWS system is non-safety related and contains two 350,000 capacity demineralized water storage tanks. The SSW system is safety-related with a nominal ultimate heat sink usable volume of 6,908,274 gallons.

- The normal makeup capability of the SFC system with suction from the CST exceeds the estimated leakage that would occur in the event that liner weld failure occurred. Thus the requirement of NUREG-0612, Section 5.1, Evaluation Criterion III, which requires that damage following dropping of a postulated heavy load is limited so as not to result in water leakage that would uncover the fuel, is met.

- Although the CST and SFC cooling pumps are not specifically required to be operable by RBS Technical Specifications, the SFC cooling pumps are safety-related and are periodically tested in accordance with the Inservice Testing Program as required by Technical Specification 5.5.6 and Technical Requirements Manual 5.5.6. The CST reserve water volume is one of two water sources that can be used to support operability of the HPCS system per Technical Specification Surveillance Requirement (SR) 3.5.2.2. The SSW system and ultimate heat sink are required to be operable per Technical Specification 3.7.1. The SFC cleanup pumps and the MWS system water supply, although not safety-related and not addressed in the Technical Specifications, provide additional means of providing makeup to the spent fuel pool.

With the exception of the SSW pumps and ultimate heat sink, the equipment that would be utilized to mitigate the consequences of a load drop in the spent fuel pool are not specifically required to be operable by the Technical Specifications, which is a deviation from the guidance provided in NUREG-0612 Appendix A. However, the SFC Cooling pumps and CST are indirectly addressed by Technical Specifications, as previously discussed. Because the spent fuel pool gate seals are replaced on a nominal 15-year frequency, there is no significant potential for a load drop to occur when the mitigating equipment is not capable of performing its function to provide makeup to the pool. Since highly reliable makeup capability exceeding the conservatively estimated leakage rate from the spent fuel pool liner is provided, Evaluation Criterion III of NUREG-0612 is met.

Attachment 2
RBG-47553

Estimate of Potential Liner Leakage in a Gate Load Drop Scenario

The purpose of this analysis is to estimate a conservative liner leakage rate resulting from a spent fuel pool gate load drop scenario.

Discussion

In a fuel pool gate load drop scenario, the gate will impact the pool floor liner. The liner plates rest directly on the concrete pool floor and are welded to embedment plates, with the top of the embedment plate flush with the concrete. The leakage detection channel covers are composed of 1" x 1" x 3/16" or 1 ½" x 1 ½" x 3/16"angle welded to the liner plate and embedment plate on either side of the weld between the liner plate and the embedment plate.

The impact of the gate on the pool floor liner could potentially damage the leakage detection channel covers, as the covers are not resting directly on the concrete pool floor. Because the leakage detection channels are routed to piping headers equipped with normally closed isolation valves, a failure of the channel covers will not result in leakage from the pool liner. As damage to the leakage detection channel covers will not result in liner leakage, it is necessary to postulate additional damage in order to estimate a liner leakage rate.

Liner Damage Scenario

The postulated liner damage scenario is as follows:

- The gate is dropped vertically during movement and impacts the spent fuel pool floor liner.
- The area of the gate impacting the floor is equal to the gate width times thickness.
- The leakage detection channel covers impacted by the gate fail, allowing pool water to be in direct contact with the underlying liner to embedment weld.
- The underlying liner to embedment weld cracks. A postulated gap between the liner plate and the embedment plate with a width of 1/32" is exposed due to the cracked weld providing a leakage path. The length of the cracked weld is equal to the length of damaged leakage detection channel.
- The ability of the concrete pool structure to limit leakage is not credited.

Inputs

Gate width = 4' 9 ¼"
Gate thickness = 4 ¾"
Embedment plate length and width = 28" x 48"
Embedment plate spacing (south edge to south edge) = 6' 9"
Maximum Spent Fuel Pool Level (Process Safety Limit) = 42' 8"

<u>Assumptions</u>

1. For the purposes of estimated leakage flow, the damaged area is treated as an orifice. This is reasonable as the postulated damage area is small relative to the floor liner area.

2. Due to the large area of pool floor surface relative to the damage area, the ratio of orifice diameter to pipe inlet diameter is assumed to be less than 0.3.

3. Based upon the general flow configuration between the liner plate and embedded plate, the orifice coefficient for a square edged orifice will be used.

4. The pressure differential across the orifice is equal to the static pressure of water above the spent fuel pool liner elevation at maximum spent fuel pool level. This is conservative as it does not credit the concrete pool structure as a leakage barrier.

5. Pool temperature effects on head pressure from standard conditions are neglected. This is conservative as the density of water at standard conditions is greater than that at normal or maximum pool temperatures and is thus conservative.

6. The width of gap between the liner plate and concrete exposed by a damaged weld is assumed to be 1/32". This value has been arbitrarily selected.

<u>Method</u>

1. Based on the spent fuel pool liner floor configuration in the gate movement area, determine the maximum length of leakage channel that can be damaged by a gate drop.
2. Determine the leakage flow area based on a length equal to the length of damaged channel and width of 1/32".
3. Convert the leakage flow area to an equivalent diameter.
4. Using the orifice formula from Reference 12, page 2-8 with the orifice diameter equal to the equivalent diameter, calculate a leakage flow rate with a differential pressure equal to the static head of water at maximum spent fuel pool water level.

$$Q = 19.636 * C * d_1^2 * (h)^{1/2}$$

Where: Q = flow, gpm
C = discharge coefficient = 0.61 (Assumption 3)
d_1 = orifice opening diameter, inches
h = differential head at orifice, feet of liquid

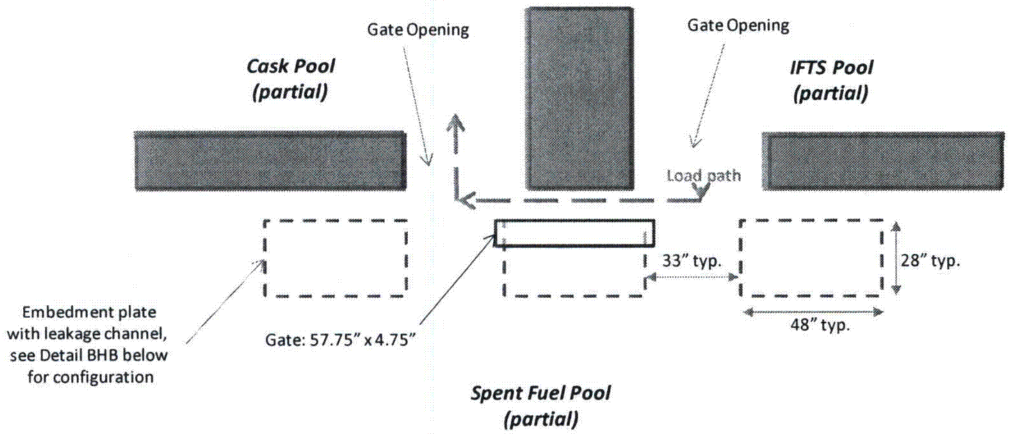
Calculation

1. Determine Damaged Channel Length

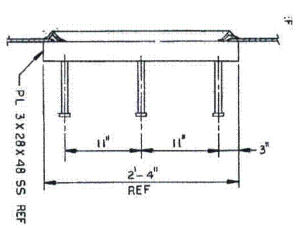
Width of Spent Fuel Pool Gate =4' 9 ¼"

Thickness of Spent Fuel Pool Gate = 4 ¾"

The embedment plates located on the pool floor in the gate load path area between the IFTS pool opening and the Cask pool opening are 28" x 48". The spacing between the edges of the plates is (6' 9" – 48") = 2' 9". A sketch showing the general plate location in the load paths and the detail of the leakage channel is provided below.



EV-003BH Detail BHB



Ref. EV-003A, EV-003AY, EV-003BH

As shown on the sketch above, the largest damage to the leakage channel area would result from a gate strike along one 48" side of the embedded plate. Damage to the short sides of the embedded plate channel would equal the thickness of the gate or 4 ¾" on each side.

Damaged channel length = 48" + (2 * 4.75") = 57.5"

2. Determine Leakage Flow Area

   Leakage Flow Area = Damaged channel length * Flow gap width

   Damaged channel length = 57.5"

   Width of flow gap = 1/32" (Assumption 6)

   Leakage Flow Area = Damaged channel length * Flow gap width
   = 57.5" * 1/32" = 1.797 in^2

3. Determine Equivalent Diameter

$A = \pi * r^2 = \pi * (d/2)^2 = \pi *(d^2/4)$

Where A = Area, in^2
r = radius, in
d = diameter, in

Rearranging

$d = (4A / \pi)^{1/2}$

$d = (4*1.797 / \pi)^{1/2} = 1.51$ in

4. Calculate Leakage Flow Rate

$Q = 19.636 * C * d_1^2 * (h)^{1/2}$

Where: Q = flow, gpm
C = discharge coefficient = 0.61 (Assumption 3)
d_1 = orifice opening diameter, inches
h = differential head at orifice, feet of liquid

$d_1 = 1.51$ in
$C = 0.61$
h = 42' 8" or 42.667'

$Q = 19.636 * 0.61 * (1.51)^2 * (42.667)^{1/2} = 178.4$ gpm