Entergy

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RBG-46369

March 8, 2005

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

Subject: River Bend Station
Docket Nos. 50-458 and 72-49
License No. NPF-47
License Amendment Request (LAR) 2004-26, "Use of the Fuel Building Cask Handling Crane for Dry Spent Fuel Cask Loading Operations"

Reference: Entergy Operations letter to NRC, "Response to NRC Bulletin 96-02, 'Movement of Heavy Loads Over Spent Fuel, Fuel in the Reactor Core, or Over Safety Related Equipment,'" dated August 29, 1996

Dear Sir or Madam:

Pursuant to 10 CFR 50.90, Entergy Operations Incorporated (Entergy) hereby requests an operating license amendment for River Bend Station (RBS). The proposed license amendment seeks approval for the use of the Fuel Building Cask Handling Crane (FBCHC) for dry spent fuel cask handling operations. Specifically, consistent with the requirements of 10 CFR 50.59 and the guidance in NUREG-0612 and Bulletin 96-02, certain heavy load drop events have been postulated and analyzed, which Entergy has determined require NRC review and approval prior to implementing dry storage cask operations at RBS.

Entergy intends to construct and operate an Independent Spent Fuel Storage Installation (ISFSI) at RBS under the general license provisions of 10 CFR 72, Subpart K. Implementation of dry spent fuel storage at the RBS ISFSI under 10 CFR 72 requires the lifting and handling of heavy loads using the FBCHC inside the Part 50 facility and on the adjacent outdoor FBCHC superstructure. Based on a review of the necessary operations using the FBCHC for dry spent fuel cask loading activities and the associated postulated drop events, Entergy has determined that the change requires NRC review and approval as a Part 50 license amendment. Subsequent to amendment approval, cask loading operations in general, and these drop events in particular, will be in the RBS licensing basis and described in the RBS Updated Safety Analysis Report (USAR).

The proposed amendment has been evaluated in accordance with 10 CFR 50.90(a)(1) using criteria in 10 CFR 50.92(c) and it has been determined that this amendment involves no significant hazards considerations. The bases for these determinations are included in the attached submittal.

The proposed amendment includes new commitments. These new commitments are summarized in Attachment 3 to this letter. The NRC has recently reviewed and approved a similar license amendment request for the Diablo Canyon Power Plant, for which a license amendment was granted in September, 2003.

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Entergy requests approval of the proposed amendment by August 1, 2005 with an immediate effective date. Once approved, the amendment will be implemented prior to using the FBCHC for dry spent fuel cask operations.

If you have any questions or require additional information, please contact Mr. Bill Brice at 601-368-5076.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 8, 2005

Sincerely,

Rick J. King
Director, Nuclear Safety Assurance

RJK/BG

Attachments:
1. Analysis of RBS Spent Fuel Cask Handling in the Fuel Building
2. Figures
3. List of Regulatory Commitments

cc: U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

NRC Senior Resident Inspector
P.O. Box 1050
St. Francisville, LA 70775

U. S. Nuclear Regulatory Commission
Attn: Mr. Michael K. Webb
MS O-7D1
Washington, DC 20555-0001

Louisiana Department of Environmental Quality
Office of Environmental Compliance
Attention: Mr. Prosanta Chowdhury
P. O. Box 4312
Baton Rouge, LA 70821-4312

Attachment 1

RBG-46369

Analysis of Proposed License

Amendment

1.0 DESCRIPTION

This letter is a request to amend Operating License NPF-47, for Entergy Operations Incorporated's (Entergy's) River Bend Station (RBS) in support of dry spent fuel storage cask operations in the Fuel Building. As a result of a review recently performed, certain hypothetical heavy load drop events associated with dry spent fuel cask handling operations have been identified and evaluated. A preliminary evaluation of these drop events under 10 CFR 50.59 has resulted in a determination that a license amendment is required to implement the operating procedure changes associated with dry spent fuel storage cask operations at RBS.

2.0 PROPOSED CHANGES

The proposed amendment will require changes to the RBS Updated Safety Analysis Report (USAR) to reflect the use of the non-single-failure-proof Fuel Building Cask Handling Crane (FBCHC)[1] for dry spent fuel cask component lifting and handling operations. Specifically, lifting and handling of the spent fuel canister, canister lid, and transfer cask is required. The existing discussion pertaining to a shipping cask drop will be augmented to discuss the spent fuel storage component drops. A new USAR subsection will be added to summarize the activities in support of dry spent fuel storage that take place in the RBS Fuel Building. The existing discussion related to the spent fuel shipping cask drop will be modified to add a new discussion of spent fuel storage cask component drops.

This proposed amendment does not involve any changes to the RBS operating license or technical specifications. Further, Entergy is not requesting NRC approval of an upgrade in designation of the FBCHC from non-single-failure-proof to single-failure-proof or from non-safety-related to safety-related. Rather, this submittal demonstrates that the FBCHC is adequately designed and is operated, inspected, tested, and maintained in a manner that makes it acceptable for use in spent fuel transfer cask lifting and handling activities. NRC approval of this proposed amendment is requested based on the fact that, despite the lack of single-failure-proof design, FBCHC load drop events remain highly unlikely and the consequences of certain hypothetical load drop events have been analyzed and found to be acceptable.

3.0 BACKGROUND

3.1 Fuel Building Cask Handling Crane Design and Licensing History

The RBS FBCHC was designed, procured, and installed in the RBS Fuel Building in the late 1970s and early 1980s. It is a non-safety-related, commercial-grade crane originally designed and licensed to lift and handle a spent fuel shipping cask. The crane has been used from time to time since RBS commercial operation began in 1985 to move radwaste containers (e.g., high integrity containers) onto transportation vehicles for shipment to a disposal site. The FBCHC is a bridge-and-trolley design that is not single-failure-proof as defined in NUREG-0612 (Reference 6.1) or NUREG-0554 (Reference 6.2). However, the crane does meet many of the criteria in these documents. Entergy will submit a matrix comparing the RBS FBCHC to NUREG-0554 and NUREG-0612 criteria to support the NRC review.

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[1] The FBCHC is also referred to as the Spent Fuel Cask Trolley (SFCT) in the USAR and other design documents. The term FBCHC is used throughout this document for consistency.

The FBCHC main hoist has a rated load of 125 tons and the auxiliary hoist has a rated load of 15 tons. The subject of this amendment request is only the main hoist because only the main hoist is used to lift the heavy loads associated with dry spent fuel cask loading operations.

A review of the FBCHC design, maintenance and operational history was conducted. This review concluded that with additional analysis, modifications and inspections, spent fuel casks can be handled with a load drop being a very unlikely event. Analysis was performed to demonstrate the crane can handle the rated load under the appropriate loading conditions including seismic. Inspections of welds, bolting, structural steel and concrete were performed to provide reasonable assurance that the crane and supporting structure are installed in accordance with the applicable design drawings and specifications. Aside from routine preventive maintenance activities and installing the redundant rigging discussed latter in this section, no additional modifications, test or inspections are required to support cask handling operations.

The main hoist is capable of lifting its rated load and moving it in a north-south direction between the spent fuel cask pool inside the Fuel Building to an adjacent area outside the Fuel Building designated for the cask transport vehicle to receive the cask (hereafter referred to as the "truck bay"). See existing USAR Figure 9.1-9 and Figure 1 in Attachment 2 to this submittal for details. The FBCHC is not capable of moving in the east-west direction.

The current licensing basis for the FBCHC permits the lifting and movement of a spent fuel shipping cask inside the Fuel Building. A hypothetical drop of a 125-ton shipping cask was analyzed as discussed in the RBS USAR in support of the proposed licensing basis because the FBCHC is not single-failure-proof. No significant damage to any safety-related structures, systems, or components (SSCs) was predicted by this analysis. However, the current licensing basis does not provide a bounding scenario for all of the lifting and handling evolutions required for the spent fuel storage cask system chosen for use at the RBS Independent Spent Fuel Storage Installation (ISFSI) under a 10 CFR 72 general license. The system chosen for use is the Holtec International HI-STORM 100 System™, which includes the HI-TRAC 125D™ transfer cask and the multi-purpose canister (MPC) that, together with necessary rigging, comprise the heaviest load lifted by the FBCHC during dry storage loading operations in the Fuel Building.

The HI-TRAC 125D™ transfer cask and the MPC must be lifted and moved several times during fuel loading operations in the Fuel Building. At various points in the operation, the empty transfer cask, the empty MPC, the MPC lid, the fuel-loaded MPC, and the loaded transfer cask must be lifted and handled by the FBCHC. Because the FBCHC is not single-failure-proof and will not be upgraded to single-failure-proof, certain drops of the transfer cask, MPC, and MPC lid must be postulated. The locations where drops are postulated and evaluated were chosen to comply with applicable Part 50 licensing requirements, NUREG-0612, and NRC Bulletin 96-02 (Reference 6.3). Licensing basis information for the dry storage cask system was also incorporated in this evaluation, as appropriate, from the HI-STORM 100 System™ 10 CFR 72 Certificate of Compliance (CoC) (Reference 6.4) and associated Final Safety Analysis Report (FSAR) (Reference 6.5). A summary of the Fuel Building cask handling operational sequence and postulated drops germane to this amendment request is provided in Appendix A to this attachment.

To mitigate the consequences of two of these postulated drops, engineered design features (i.e., impact limiters) will be employed in locations over which the transfer cask must be moved in the vertical direction. In most cases, for locations where the load is moved only in the horizontal direction, redundant crane rigging is employed to provide temporary single-failure-proof drop protection and preclude the need to postulate drops in these locations. More detail is provided on these design features in Section 4.7.2 of this attachment.

3.2 Fuel Building Loading Operations Summary

The HI-STORM 100 System™ will be used for dry cask storage of nuclear fuel at the RBS ISFSI. The HI-STORM 100 System™ consists of a multi-purpose canister (MPC-68™), which is capable of holding up to 68 BWR fuel assemblies; a transfer cask (HI-TRAC 125D™), which contains the MPC during loading, unloading, and transfer operations; and a storage cask (HI-STORM 100S™ overpack), which provides shielding, heat removal capability, and structural protection for the MPC during storage operations at the ISFSI. The FBCHC is required to lift and handle the HI-TRAC transfer cask and MPC (both empty and loaded with spent nuclear fuel), and the MPC lid in support of dry storage cask loading. The combined maximum lifted weight, including rigging and lift yoke will not exceed 125 tons, which is the design rated (maximum critical) load of the FBCHC.

During each cask loading campaign, spent fuel assemblies are moved, one at a time, from the RBS spent fuel pool wet storage racks into the MPC, which is resting inside the HI-TRAC transfer cask in the cask pool on the lower shelf (Position 5 on USAR Figure 9.1-9). The cask pool will have been previously flooded with water to approximately the same elevation as the spent fuel pool and the gate separating the cask pool and spent fuel pool will have been opened. Once the desired number of fuel assemblies has been loaded into the MPC, the MPC lid is installed under water and the transfer cask is lifted by the FBCHC and placed on the cask pool upper shelf (Position 4 on USAR Figure 9.1-9) to allow changes in rigging equipment (see Figure 1 in Attachment 2 to this submittal). Then, the transfer cask is lifted out of the cask pool and moved northward to a dry cask washdown area (Position 3 on USAR Figure 9.1-9, hereafter referred to as the "cask pit").

In the cask pit, the MPC lid is seal welded and the canister is drained, dried and backfilled with helium in accordance with the 10 CFR 72 cask CoC and FSAR. The transfer cask containing the sealed MPC is decontaminated, lifted out of the cask pit, and moved by the FBCHC through the Fuel Building outer doors into the truck bay (Position 2 on USAR Figure 9.1-9) where it is placed on top of the empty storage overpack, which has previously been prepared to receive the transfer cask with a mating device. The FBCHC is disengaged from the transfer cask lifting trunnions and rigged to lift the MPC by its lift cleats. The MPC is lifted slightly to remove the weight from the transfer cask bottom (pool) lid. The pool lid is detached and lowered into the mating device, the mating device drawer is opened to provide a pathway through to the overpack, and the MPC is lowered into the overpack. After MPC transfer, the overpack lid is installed and the overpack is transported to the ISFSI using a cask crawler.

4.0 TECHNICAL ANALYSIS

4.1 General Basis

The River Bend Station FBCHC was designed and procured as a non-safety-related, non-single-failure-proof lifting system that would hold its suspended load in the event a safe shutdown earthquake occurred during load handling. This design and procurement process took place in the mid- to late-1970's and pre-dated the issuance of NUREG-0554, NUREG-0612, and associated NRC Generic Letters. The FBCHC design is in accordance with Crane Manufacturer's Association of America (CMAA) Standard 70 (1970); ANSI B30.2, "Overhead and Gantry Cranes" (1967); and Occupational Safety and Health Administration (OSHA) regulations (1973), as well as contemporaneous commercial structural, welding, and electrical design codes. The issues surrounding NUREG-0612 were addressed as part of the RBS license application review process, but the crane was not upgraded to single-failure-proof or safety-related.

A review of RBS historical records shows that, while the crane was not formally designated as safety-related with quality assurance controls under 10 CFR 50 Appendix B applied, there were appropriate inspections, tests, and documentation required by the procurement specification and performed at the time of construction to verify that the construction met the design requirements. As part of the RBS dry cask storage project, a comprehensive evaluation was undertaken by Entergy to review the original design and construction documents and compare them to what would be required of a safety-related design and installation today. From this review and the results of additional inspections and testing, it was concluded that the crane and superstructure were actually constructed in accordance with the design documents and are suitable for use in dry storage cask loading operations.

However, the crane does perform an important design function in lifting and handling the loaded transfer cask. Therefore, the classification of the FBCHC is being upgraded to "Quality Assurance Program Applicable" in the RBS configuration management and work control systems. With this upgrade in classification, all future modifications, inspections, testing, and maintenance of the FBCHC will be performed under the RBS 10 CFR 50 Appendix B Quality Assurance program (i.e., as if it *was* a safety-related component).

The outdoor portion of the FBCHC crane structure extends out from the Fuel Building doors in the north direction approximately 100 feet and is 27 feet wide, column line to column line (see Reference 6.6). There are a total of twelve vertical columns supporting the crane trolley. The structural members are carbon steel with cross-bracing for lateral stability. There are a number of bolted and welded joints that bear the dead load of the structure, including the crane bridge and trolley, and the live load of the suspended spent fuel transfer cask. Each element of the crane structure and certain key design criteria are addressed separately below.

4.2 Crane Foundations

Twelve reinforced concrete pedestals support the outdoor crane superstructure columns. All 12 of the crane columns are bolted to 5 ft. long by 3 ft. wide pedestals. The four southernmost pedestals are 3'-4½" high and rest atop a single 48 ft. long by 25 ft. wide by 3½ ft thick footing. Each of the center six pedestals rests atop individual 5ft. by 5 ft. by 2½ ft. high footings. The two northernmost pedestals rest atop a single 34 ft. long by 16 ft. wide by 3½ ft. thick footing. The pedestals protrude approximately one foot above grade. Finish concrete is provided between the column rows to form the truck bay.

Entergy engineering performed a review to document the inspections and tests performed to demonstrate that there is reasonable assurance that the crane foundation, including the concrete pours, base plates and anchor bolts, was constructed in accordance with the design. A ground-penetrating radar investigation of the crane foundation was also performed in May, 2004 during the ground excavation that was being performed in support of a modification to the truck bay concrete. The results of this investigation show that the crane pedestals and footings are in the locations and are of the dimensions specified on the design drawing. Evidence of reinforcing steel in the top mat of the foundation footings was also confirmed by the radar.

Additional excavation to expose more of the footings in an attempt to gain more information is not practical. The proximity of the footings to the RBS condensate storage tank (CST) precludes any significant additional excavation without the threat of undermining the CST foundation. No additional investigative work on the outdoor crane foundation is planned. No foundation modifications are required for the FBCHC to perform its design functions during dry spent fuel cask loading operations.

4.3 Crane Structural Steel

An engineering review was also performed to document the inspections and tests performed and to demonstrate that there is reasonable assurance that the crane steel structure, including materials used and the bolted and welded connections that bear load or provide structural rigidity, was constructed in accordance with the design. All inspections conducted under this review were satisfactory in confirming the integrity of the crane structure.

As part of the operational review for dry storage cask loading activities, it was discovered that a header beam in the outdoor crane structure needed to be raised to provide adequate clearance for the overpack and cask crawler. Upon removal of the beam from its existing location, its root weld was observed to have a lack of fusion in a number of areas. As a result, the affected weld was repaired and the weld inspection scope was increased to include ultrasonic inspection of all critical (load bearing) welds of a similar type that support the crane rails and a sampling of other welds not in the load path but which contribute to the rigidity of the structure. No other occurrence of degraded welds was found.

4.4 Crane Inspections and Tests

The FBCHC receives periodic inspections on a 6-month frequency, with additional inspections and preventive maintenance on an 18-month frequency. These inspections are performed as a good practice to ensure the crane is in good working order prior to use. Discrepancies that are encountered during the inspections are resolved as part of the inspection or entered into either the maintenance work control system or the corrective action program for resolution. The 6-

month inspection verifies that there are no loose parts on the trolley or bridge; the fire extinguisher is in working order; seals, gaskets, and lubricant levels are satisfactory; cab controls are undamaged, clean, and warning/caution signs are in place and legible; walkways, ladders, and handrails are in good condition; trolley wheels, brakes, couplings, sheaves, drum, wire rope, hooks, and bumpers are in good condition; and the crane bridge, trolley, and hoists (including travel limit instrumentation) operate satisfactorily throughout the entire range of travel.

The 18-month inspection is more detailed and, in addition to the items covered in the 6-month inspection, includes inspections of motors, electrical equipment, and gearboxes; lubricant chemistry check; gearbox oil change; structure inspection (e.g., cracks in steel, loose bolts); brake adjustment; chain drive inspection; coupling greasing; pillow block bearing inspection; and nondestructive examination of hooks. The 6-month and 18-month inspections are performed without a load on the hook(s).

Load testing of the entire travel range of outdoor portion of the FBCHC was performed in 2004 at 125% of the 125-ton rated load, which is consistent with the guidance in NUREG-0554. This test also included testing of the redundant rigging appurtenance design modification, which is relied upon to preclude having to postulate load drops during most lateral moves of the crane (see Section 4.7.2 and Appendix A to this attachment). Load testing of the indoor portion of the FBCHC was performed during initial construction. The crane procurement specification required a 125% rated load test, which was performed during plant pre-operational functional testing. Because the load-bearing components of the inside portion of the crane structure have not been modified since original installation, another 125% load test of the crane inside the Fuel Building in support of dry spent fuel cask loading operations is not required.

4.5 <u>Crane Seismic Qualification</u>

The FBCHC was designed and procured as a seismically qualified structure. During the review of design documents for the RBS dry cask storage project it was discovered that the seismic analysis was performed with no load on the crane hook. This is contrary to the RBS USAR, which states that the crane is qualified to maintain the load during a design basis seismic event. This issue was entered into the RBS corrective action system and a re-analysis was performed which concluded that, with the exception of two welds, the crane system is qualified to hold the maximum critical load during a design basis seismic event. The two affected welds – the main girt to the two end trucks – were recently upgraded under an RBS modification package. Therefore, the crane is considered fully seismically qualified for dry storage cask loading operations.

4.6 Tornado Wind and Missile Loads

RBS currently has administrative controls in place that prohibit fuel handling and the Fuel Building outer doors from being opened if severe weather is imminent (Reference 6.7). If fuel handling is in progress when severe weather is detected, current procedures require fuel handling and radioactive material transport activities to cease except as required to move the material to a safe location. In addition, Entergy will evaluate meteorological conditions using information available from the National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), or other appropriate source to confirm that weather conditions are not expected to be conducive to tornado development over the time period when cask handing in the outdoor crane structure is planned. Cask handling operations in the outdoor crane superstructure would not commence if atmospheric conditions exist that are conducive to tornado formation. Thus, no specific evaluation of tornado wind or missile loads on the crane superstructure while a cask is suspended above the truck bay has been performed.

If outdoor cask handling is underway and weather conditions unexpectedly deteriorate rapidly, sufficient time exists to move the suspended cask to a safe location in a controlled, deliberate manner. A "safe location" can mean anything from closing the outer doors and lowering the transfer cask onto the overpack or to the ground (where, in either case, it would then be in an analyzed condition), to returning the transfer cask to the Fuel Building and closing the outer doors. The actual actions taken would depend on the estimated time available before severe weather arrives. RBS's severe weather procedures will be reviewed and modified appropriately, as necessary, to address cask handling operations. RBS's cask loading operations procedures will contain a requirement to check meteorological conditions prior to opening the Fuel Building outer doors and commencing outdoor cask handling operations, and periodically thereafter during outdoor cask handling operations.

4.7 FBCHC Cask Handling and Postulated Drop Events

4.7.1 Cask Loading Operations and Related Design Features

By design, the FBCHC cannot physically move a heavy load over irradiated fuel in the RBS spent fuel pool. The load path of the FBCHC main hoist is centered between, and parallel to, column lines FAA and FBA in the Fuel Building (see Reference 6.6). This keeps the loaded cask strictly above the cask pool, cask pit, and outdoor truck bay during cask loading operations. The step-by-step operational activities and hypothetical load drop events involving the FBCHC and the MPC/transfer cask are provided in Appendix A to this attachment based on the guidance of NUREG-0612. The following criteria govern cask handling operations as they pertain to the postulation of potential cask drop events (see Figure 1 in Attachment 2 to this submittal):

a) During applicable load movements, impact limiters are installed on the floor at elevation 70 ft. in the cask pool (known as the "lower shelf") and at elevation 98'-1" in the cask pit. The impact limiters are made of a crushable material encased in sheet stainless steel (see Figure 2 in Attachment 2 to this submittal).

b) No impact limiters are used at elevation 93 ft. in the cask pool upper shelf or under the overpack in the truck bay beneath the outdoor cask handling crane structure.

c) During certain horizontal cask movements between the cask pool and the outdoor truck bay, redundant rigging is engaged to the cask lift yoke, which provides temporary single-failure-proof protection against load drops and eliminates the need to postulate a load drop during these movements (Figure 3 in Attachment 2 to this submittal).

d) Cask drops must be postulated for locations where loads are suspended from the FBCHC and the redundant rigging is not engaged.

e) Drops of a loaded cask provide a bounding case for drops of an unloaded cask or empty MPC for a given location, provided other elements of the drop scenario (e.g., drop height or impact energy) are the same or bounded by the loaded cask drop.

f) Relevant elevations of the cask handling area horizontal surfaces and dimensions of cask components are:

i. Cask pool lower shelf elevation: 70 ft.
ii. Cask pool upper shelf elevation: 93 ft.
iii. Wall elevation between upper cask pool shelf and cask pit: 113 ft.
iv. Cask pit pedestal elevation: 98.08 ft.
v. Truck bay elevation: 94.42'.
vi. Impact limiter height: 26.25 in.
vii. Spent fuel pool water level elevation: 111.75 ft.
viii. HI-TRAC 125D pool lid thickness: 5.5 in.
ix. MPC baseplate thickness: 2.5 in.
x. MPC-68 basket height: 14.67 ft.
xi. HI-STORM overpack height without lid:
100S(243): 18.5 ft.,
100S Version B (218): 16.625 ft.
xii. HI-STORM baseplate thickness plus pedestal:
100S(243): 19.25 in.,
100S Version B: 8 in.
xiii. HI-STORM mating device height: 10.75 in.

4.7.2 Redundant Crane Rigging

4.7.2.1 Operational Description and Design Criteria

The FBCHC has been modified to add upper "lift links," which are redundant, load-bearing structural connections to the crane main girt. These upper lift links include pins, around which fixed-length slings are looped. Lower lift links are attached to the bottom of the slings and connect to the lift yoke to create redundant rigging that is capable of holding the full 125-ton rated load of the crane in the event of a failure of the main hoist's ability to hold the load for any reason (Figure 3 in Attachment 2 to this submittal). The upper crane links are considered a crane modification and are designed with safety factors of three and five to yield and ultimate stress allowables, respectively. The slings are designed in accordance with ASME B30.9, "Slings." The lower crane links and lift yoke are designed as special lifting devices in accordance with the guidance in ANSI N14.6 (Reference 6.8). The RBS cask lift yoke is designed as shown in Figure 3 in Attachment 2 to this submittal to mate with the lower lift links as described below. The upper crane link modification has been successfully installed and load tested at 125% of the rated load. The lower crane links were also shop tested at 150% of the rated load in accordance with ANSI N14.6.

Referring to Figures 1 and 3 in Attachment 2 to this submittal, the redundant crane rigging is engaged whenever the cask is moved horizontally at its maximum suspended elevation. That is, when the bottom of the transfer cask is at about elevation 114'- 0". During these lifts, the main hook is attached to the cask lift yoke and the lift yoke is attached to the lifting trunnions of the transfer cask with ANSI N14.6-designed lift links. The cask is lifted vertically with the main hoist until the crane block and lift yoke are high enough that the lower lift links of the redundant rigging fit inside the lift yoke and the engagement mechanisms of both lower links are aligned with the holes in the lift yoke. Air actuators are used to engage the lower lift links with the lift yoke, providing a redundant load path through the slings and upper lift links into the crane support structure. Successful engagement of the redundant rigging is visually confirmed. After initial engagement with the lift yoke, the slings have some slack in them. To eliminate the slack, and therefore, minimize the dynamic loading in the event of a sudden load transfer, the load is lowered slightly to make the slings taut without placing any significant load on them.

After successful engagement of the redundant rigging, vertical movement of the load is not necessary and horizontal movement of the cask may proceed. When the cask reaches a point where vertical movement is again required, the redundant rigging is disengaged and the main hoist may be operated normally to lower and raise the load. The redundant rigging may be engaged and disengaged as many times as necessary during cask handling operations with the FBCHC. Load drops are not postulated during times when the redundant rigging is engaged.

4.7.2.2 Load Transfer during Postulated Failure Scenarios

As described above, operating administrative controls are used to ensure the slings in the redundant load path have a minimal amount of slack without carrying any significant portion of the load. The absence of significant load in the redundant load path under normal conditions eliminates having to evaluate some, or the entire load being suddenly shifted to the primary load path if a failure of the redundant load path is postulated.

In a postulated failure scenario where the load is suddenly shifted from the primary load path (the crane hook) to the redundant rigging, a dynamic load is applied to the slings and other members of the redundant load path. The magnitude of that dynamic load has been calculated to verify that the load is within the capacity of the redundant rigging system (Reference 6.9). The dynamic analysis code used is VisualNastran, a commercial dynamic simulation code that has been used by Holtec International in other dynamic analysis work reviewed and approved by the NRC. The acceptance criterion for this analysis is that, due to the shift of the load from the primary load path to the redundant load path, the design limits of all components must not be violated by the expected increase in stress or load level.

Key assumptions used in this analysis are:

1. The crane trolley is assumed to be positioned over a support when the event occurs. This is conservative because no structural dampening from the crane girders is available to reduce the dynamic amplification.

2. The redundant lift links are assumed to behave as non-linear elastic members. The crane hoist primary load is modeled as a rope element; no compression is permitted in the crane main load path member. These are realistic assumptions.

3. When the event occurs, the load is transmitted instantaneously to the redundant load path. This is conservative.

4. The crane ascent or descent speed is constant throughout the computer simulation. This is realistic and makes the solution independent of the speed.

5. The redundant load path slings are assumed to have no slack. This is realistic and control by operating procedures.

6. The redundant load path links are unloaded when the load transfer occurs. This is conservative because any initial tensile loading in the redundant links would serve to reduce the dynamic amplification.

7. The damping available in the redundant load path system is the same as the structural damping in steel from a safe-shutdown seismic event. This is conservative because the sling material and built-up woven construction increases internal friction and produces higher damping values.

Key input data used in this analysis are:

1. A spring constant for the redundant link system is calculated using data from the sling manufacturer to develop a non-linear load-stretch relation, $K = 2 \times 10^5$ lbf/in.

2. Redundant link damping = 7 percent.

3. Weight of lifted load = 250,000 lbs.

4. Weight of load block = 5,000 lbs.

5. Weight of trolley = 55,000 lbs.

The results of the analysis indicate that the peak dynamic load in the redundant load support system due to a sudden shift of the 125-ton load from the primary load path to the redundant load path is 492 kips or, stated differently, a dynamic amplifier of 1.97. Other load cases executed to determine the sensitivity of the results to higher damping (arbitrarily chosen to be 21%) and starting with some load in the redundant load path (28 kips and 127 kips) show that the 7% damping and zero load in the redundant load path provide a bounding set of results.

The crane girders, secondary load-bearing members, the trolley, and the crane hook and attachments are all qualified for a load of 596 kips based on the seismic analysis of the FBCHC. Because the supports for the redundant load support system transmit load to the trolley main girt directly, safety factors for the main girt were re-computed for the 492-kip maximum load calculated for the sudden load transfer event plus the girt self weight. The safety factor based on 90% of yield for the girt material and assuming a pin-ended connection for the main girt is 1.162. The safety factor for the weld group (defined as allowable load per unit length divided by the calculated load per unit length) assuming a one-inch weld and fixed-end connections at the ends of the main girt is 1.07.

The redundant load support system components have a safety factor of 1.06 for the normal 125-ton load condition (over and above the minimum requirements of 3.0 on yield and 5.0 on ultimate for members in tension or combined shear). The safety factor is for a bending stress in the top pin of the lift yoke load latch assembly. Under the peak dynamic load induced in the redundant load path by the load transfer event, the bending stress in the pin is 42.7 ksi, which is well below the yield strength of 95 ksi for the SA 193-B7 material.

The two slings in the redundant load support system are rated for a combined load of 300,000 lbs with a safety factor of 5.0 for a total sling capacity of 1,500 kips. For the peak dynamic load of 492 kips in the load transfer event, the safety factor is slightly more than 3.0.

In summary, all load-bearing members of the redundant load support system are qualified to support the dynamic load resulting from a hypothetical loss of the primary load support system during cask handling operations with the redundant rigging engaged.

4.7.3 MPC Lid Drop

The drop of the MPC lid during installation into the canister after fuel loading in the cask pool is addressed as a unique event. Due to its weight (10,000 lbs), the MPC lid is a heavy load as defined in NUREG-0612. The combined weight of the lid and rigging apparatus is approximately 15,600 lbs. The 125-ton rated load of the FBCHC is nearly 16 times the weight of the lifted load. Therefore, all crane safety factors calculated based on the rated load are 16 times higher for lid-only lifts, making a lid drop event extremely unlikely.

The slings and special lifting devices used to lift the MPC lid exceed all applicable NUREG-0612, Section 5.1.6 design guidance to preclude having to postulate a load drop due to a failure in a load-bearing component in the load path below the crane hook. However, as discussed above, the crane design does not meet all NUREG-0612 and NUREG-0554 guidance to be considered single-failure-proof (e.g., it does not have dual rope reeving). Absent a single-failure-proof crane design, a drop of the MPC lid needs to be evaluated.

Section 5.1.4 of NUREG-0612 specifically addresses handling heavy loads over irradiated fuel inside the reactor building of a BWR. While the MPC lid handling activity at RBS does not occur in the Reactor Building (it takes place in the Fuel Building), this guidance is deemed to be applicable because the lid is suspended over irradiated fuel in the canister located in the cask pool. The NUREG-0612 guidance recommends several alternative approaches for addressing heavy load handling over irradiated fuel, including:

- Upgrade the crane to single-failure-proof status in accordance with Section 5.1.6 of the guidance (which includes NUREG-0612, Appendix C for existing cranes), or

- Analyze the drop of the load in accordance with Appendix A of the guidance to ensure the acceptance criteria of NUREG-0612, Section 5.1 are met.

Entergy has chosen to evaluate the consequences of an MPC lid drop into the loaded spent fuel canister. A discussion of that evaluation is provided in Section 4.7.4 below.

4.7.4 MPC Lid Drop Evaluation

As discussed previously, the MPC lid and associated rigging weigh approximately 15,600 lbs and will be handled by the FBCHC, which has a rated load of 250,000 lbs, making the safety factors for the lid lift 16 times higher than those for the rated load. An NRC safety evaluation report for Zion Nuclear Power Station (Reference 6.10) provides a licensing precedent for considering a crane single failure proof based on high safety factors for the load being lifted. In the case described in the Zion SER, the crane is to be used to lift spent fuel racks, some of which would contain spent fuel assemblies during the lift. However, the racks would only be lifted six inches above the pool floor and would not be carried over irradiated fuel. Despite the high safety factor for the MPC lid lift with the FBCHC and this licensing precedent, Entergy determined that it would be prudent to evaluate the consequences of an MPC lid drop onto the loaded MPC in the cask pool as a conservative licensing approach.

4.7.4.1 Lid Drop into the MPC

After the spent fuel is loaded into the MPC, the MPC lid is installed using the FBCHC. The rigging, attached to four symmetrically located lift points in the lid, ensures that the lid is held in the horizontal position during lowering so that it will fit into the MPC, which has a very close shell-to-lid dimensional clearance. Because there is approximately 20 feet of water above the MPC during lid installation, if a failure of a crane mechanical component (rather than a wire rope) results in an uncontrolled lowering of the lid, the lid will initially remain horizontal.

If the lid is dropped from a significant height, the column of water below the falling lid will eventually cause the lid to drift laterally and not physically be able to enter the open MPC. Therefore, the first analysis of this event assumes the lid is three feet above the MPC and perfectly positioned for insertion when the failure occurs, allowing the lid to drop straight down into the MPC fuel cavity in the horizontal orientation. In this scenario, the lid will accelerate as it falls and impart an impact load on the four lift lugs welded to the inside of the MPC shell. (The lift lugs are designed to support the dead weight of the lid until the lid is welded to the canister shell.) The lift lugs are designed with very large safety factors to preclude failure and dropping of the lid onto the top of the fuel basket. The analysis evaluates the ability of the lift lugs to withstand the impact load of the lid drop using manual structural mechanics computational techniques (Reference 6.11).

The acceptance criterion for this analysis is no damage to the spent fuel assemblies in the MPC.

Key assumptions used in this analysis are:

1. The lid remains horizontal during the drop through the water and enters the MPC without obstruction. This is conservative for the 3 ft. drop height assumed because the lid would actually likely drift laterally to some extent and be prevented from entering the MPC without impacting the MPC shell or transfer cask upper flange.

2. The lid is considered as a rigid mass. This is realistic for this application.

3. The MPC shell is assumed to be instantaneously expanded out by the increase in internal pressure caused by the "piston" effect to the diameter where it contacts the

transfer cask inner shell. This is conservative because it provides the largest drop cross-sectional area and a smaller resisting force is applied to the dropped lid.

4. Fluid drag is considered in computing the lid velocity during the free fall. This is realistic.

5. The water is considered approximately incompressible in that the change in density is assumed to be proportional to the lid velocity. The proportionality constant affords a simple way to account for the expected reduction in the water velocity escaping through the lid-to-shell gap as the water density increases. This is a simplifying assumption.

Key input data used in the analysis are:

1. Drop height above MPC = 3 ft.

2. Distance from top of MPC to top of lift lugs = 9.5 inches

3. MPC lid weight = 10,000 lbs.

4. MPC lid diameter = 67.25 in.

5. MPC shell inner diameter = 67.75 in.

6. Other cask component dimensions and material properties are taken from the HI-STORM 100 FSAR.

The results of the analysis show that the lift lugs will withstand the impact force and prevent the lid from coming into contact with the fuel basket or fuel.

4.7.4.2 MPC Lid Drop onto the Transfer Cask Top Flange

A second MPC lid drop event was analyzed where the dropped lid lands on the transfer cask top flange, pivots, and falls into the MPC. This analysis (Reference 6.12) was performed using the LS-DYNA computer code, which has been used in previous NRC-reviewed and approved dynamic analysis work performed by the cask vendor. The acceptance criterion for this analysis is no unacceptable fuel damage and that the deformation of the fuel basket in the MPC, if any, must not extend to the top of the active fuel region, where the fixed neutron poison panels are located. This second criterion is chosen to ensure the licensing basis criticality analysis is preserved.

Key assumptions used in this analysis are:

1. The lid is dropped from the surface of the cask pool through the water to the upper flange of the transfer cask. This is a realistic assumption because the lid will only be carried high enough to avoid making contact with the cask pool prior to being lowered into the MPC. See Figure 1 in Attachment 2 to this submittal.

2. The MPC and the transfer cask structural components behave as bilinear elastic-plastic materials characterized by five material parameters (i.e., Young's modulus, yield strength, ultimate strength, failure strain, and Poisson's ratio). This is a reasonable assumption based on good engineering practice.

3. Material damping and water resistance during the impact are neglected. This is conservative since both damping and resistance will be non-zero.

4. The lid impacts the transfer cask flange at a 2-inch offset between the radial centers of the MPC/transfer cask and the lid such that the lid does not fall directly into the MPC in a horizontal orientation and a minimal amount of energy is dissipated in the first impact with the transfer cask prior to the lid falling into the MPC.

Key input data used in this analysis are:

1. Weight of MPC lid = 10,000 lb.

2. Thickness of MPC lid = 9.5 in.

3. Distance between top of the fuel basket and top of the active fuel region = 14.625 in.

4. Lid drop height = 319.25 in.

5. Other cask component dimensions and material properties are taken from the HI-STORM 100 FSAR.

The analysis shows that the lid hits the transfer cask top flange with a velocity of 212.6 in/sec. The impact does not cause any damage to the transfer cask because the maximum stress (10,300 psi) is well below the material yield stress. The subsequent impact between the MPC lid and the MPC shell does result in local plastic deformation; the maximum plastic strain (0.3123) is below the failure strain limit of the material (0.38). The fuel basket is also locally damaged with plastic deformation in four fuel cells, extending down two inches from the top of the basket. This damage is well above the active fuel region and the neutron absorber panels remain undamaged. Conservatively, up to four fuel assemblies could experience some damage, but major relocation of fuel material would not be expected.

4.7.4.3 Radiological Evaluation

The potential radiological consequences of an MPC lid drop onto irradiated fuel in the canister and subsequent damage to the fuel were compared to the existing RBS fuel handling accident analysis described in USAR Section 15.7.4 and with the data in Tables 2.1-1 and 2.1-2 of NUREG-0612. While the MPC lid drop has the potential to damage more fuel assemblies than the drop of a single fuel assembly (see Section 4.7.4.2), the fuel in the spent fuel storage canister will have decayed at least three years in order to be authorized for dry storage in the HI-STORM 100 System[2]. The decay time for the fuel considered in the fuel handling accident is 24 hours. A significant amount of decay of the radionuclides available for release will have taken place between 24 hours and three years. No significant iodine will be available for

[2] The limit in Amendment 1 (the current version) of the HI-STORM 100 CoC is five years minimum cooling time. This limit has tentatively been approved to be decreased to three years in Holtec HI-STORM 100 CoC Amendment 2, which is currently being prepared for rulemaking. Therefore, three years is used as a bounding value in this evaluation.

release after three years[3] and the key noble gas elements that contribute to the whole body dose, xenon and krypton, will have decayed to very low levels.

Table 2.1-1 of NUREG-0612 shows that, for 90 days of decay and no credit for halogen filtration, the calculated thyroid doses from damage to a single BWR fuel assembly at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) are 40 millirem and zero, respectively. The whole body doses at the EAB and LPZ are zero. No doses for the control room are estimated. Also from Table 2.1-1 of NUREG-0612, the number of fuel assemblies that would need to be damaged at 90-days decay to produce doses that are 25% of the 10 CFR 100 dose limits is 1,900. Based on the lid drop analysis described in Section 4.7.4.2 above, at most there may be four fuel assemblies damaged. A conservative evaluation has been performed, as described below, that bounds all four assemblies being damaged.

The generic NUREG-0612 analysis assumes a thermal power level of 3,000 Mwt and X/Q values for the EAB and LPZ of 1.0×10^{-3} sec/m^3 and 1.0×10^{-4} sec/m^3, respectively, as shown in Table 2.1-2 of that document. The power level used in the River Bend Station fuel handling accident is 3,100 Mwt and the X/Q values are: 8.58×10^{-4} sec/m^3 (EAB), 1.13×10^{-4} sec/m^3 (LPZ, 0-8 hour maximum), and 1.62×10^{-3} sec/m^3 (control room, 0-20 minute maximum). Other differences include peaking factor (1.2 in NUREG-0612 and 2.0 in the RBS fuel handling accident) and halogen decontamination factor (100 in NUREG-0612 and 200 in the RBS fuel handling accident).

To determine whether the RBS fuel handling accident radiological consequences provide a bounding case for an MPC lid drop into the canister, the number of fuel assemblies in the canister required to be damaged to reach 25% of the 10 CFR 100 dose limits[4] and the GDC 19 control room dose limits was estimated using the NUREG-0612 value (1,900) and the ratios of the differences in the generic NUREG-0612 and site-specific RBS fuel handling accident analysis inputs to see if the number of assemblies remains above four. The difference in dose due to the difference in halogen decontamination factor is ignored due to the three-year decay time. This is conservative because the RBS site-specific analysis uses a higher decontamination factor and would, therefore, reduce the dose. The difference in dose due to the lower source term produced by the longer decay time is not evaluated because it is not a linear relationship. This is conservative because the longer decay time would yield even lower doses.

Power Level: 3,000 / 3,100 = 0.968

X/Q: 1.0×10^{-3} sec/m^3 / 1.62×10^{-3} sec/m^3 = 0.617

Peaking Factor: 1.2 / 2.0 = 0.600

N = Minimum number of RBS fuel assemblies required to reach 25% of Part 100 dose limits in a fuel handling accident:

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[3] I-131 has a half-life of approximately eight days. All other isotopes of iodine except I-129 have half lives of 20 hours or less. The half-life of I-129 is 1.6×10^7 years but it emits a very low-energy gamma photon (0.04 MeV), making it an insignificant dose contributor for short duration exposures.

[4] The RBS licensing basis for offsite dose is the alternate source term limits specified in 10 CFR 50.67. The dose limits in 10 CFR 50.67 are equivalent to the GDC 19 control room limits and 25% of the 10 CFR 100 off-site limits.

N = (0.968)(0.617)(0.600) x 1,900 = 680 assemblies

This means that, assuming 90 hours decay time, at least 170 (680/4) times the number of fuel assemblies that could possibly be damaged in a lid drop event at RBS would need to be damaged to reach 25% of the 10 CFR 100 and GDC 19 dose limits (equivalent to the 10 CFR 50.67 dose limits) considering River Bend site–specific licensing basis inputs instead of the NUREG-0612 generic inputs. Accounting for the three years of minimum decay time required by the HI-STORM 100 CoC and the fact that the peak X/Q value for all dose locations and all times was used in the evaluation above, the number of fuel assemblies required to approach the Part 100 dose limits would actually be significantly higher. Therefore, the existing fuel handling analysis in USAR Section 15.7.4 (which assumed 24 hours decay time and more realistic, time-dependent X/Q values) provides a limiting case accident event that bounds the potential consequences from fuel damage due to an MPC lid drop.

4.7.4.4 Criticality Evaluation

Both of the analyses performed for the MPC lid drop and described in Section 4.7.4.1 and 4.7.4.2 confirm that no damage to the fuel basket occurs to the extent that the neutron absorber panels would be prevented from performing their criticality safety function. In addition, there would be no significant relocation of fuel material to create a critical geometry. Therefore the existing generic cask vendor licensing basis criticality analysis remains applicable and bounding and no additional analysis is necessary.

4.7.5 Storage Cask Component Load Drop Summary

4.7.5.1 Drops Inside the Fuel Building

Referring to Appendix A to this attachment, the unique and/or bounding load drops inside the Fuel Building that are required to be evaluated and analyzed, as appropriate, due to a lack of single-failure-proof crane design features (by operational step) are:

1. Step 4(a): 3.75 ft. empty MPC vertical drop[5] onto the cask pit north wall.

2. Step 27(a): <1 ft. loaded transfer cask drop onto cask pool upper shelf corner with cask top-to-side wall impact (no impact limiter). This evaluation bounds those drops specified in Steps 12(a), 18(a), and 32(a).

3. Step 27(b): <1 ft. loaded transfer cask vertical drop onto cask pool upper shelf (no impact limiter). This evaluation bounds those drops specified in Steps 12(b), 17, 27(b) and 31.

4. Step 33: 42.5 ft loaded transfer cask vertical drop onto cask pool lower shelf (with impact limiter). This evaluation bounds those drops specified in Steps 10, 11, 18(b), 26, and 32(b).

[5] Drop distances, where cited, are approximate and are measured from the bottom of the dropped load to the top of the target (i.e., the cask pool or cask pit floor, the impact limiter, the top of the HI-STORM mating device, or the top of the overpack pedestal). See the detailed analysis section for actual drop distances evaluated.

5. Step 36: 17.5 ft. loaded transfer cask vertical drop into cask pit (with impact limiter). This evaluation bounds those drops specified in Steps 4(b), 7, and 41.

4.7.5.2 Drops Outside the Fuel Building

When the cask moves from inside the Fuel Building to outdoors, the applicability of NUREG-0612 and the requirement to postulate load drops become less clear. As previously discussed, the focus of the guidance in NUREG-0612 is to ensure protection of operating plant equipment in general and safe shutdown equipment in particular, as well as irradiated fuel in the reactor and spent fuel pool. There is no safe shutdown equipment located under the outdoor crane truck bay. However, because the FBCHC is not single-failure-proof, a drop of the loaded transfer cask onto the top of the overpack and mating device is postulated in the truck bay when the redundant rigging is not engaged. For any drop in the truck bay, the concern is protection of the MPC, the transfer cask, and the contained spent fuel. Therefore, the dry storage system 10 CFR 72 licensing basis documents (FSAR and CoC) were consulted to determine the appropriate acceptance criteria for the drop evaluations.

The HI-STORM 100 CoC includes requirements for the design of a Cask Transfer Facility (CTF), which is used for cask lifting and handling using lift devices not governed by 10 CFR 50. This set of requirements was considered the most appropriate to use as a basis for determining the acceptance criteria for evaluating drops in the truck bay due to functional similarities between the CTF and the FBCHC outdoor crane structure. Section 3.5.2.1.4 of Appendix B to the HI-STORM 100 CoC states that "The CTF shall be designed, constructed, and evaluated to ensure that if the MPC is dropped [into the overpack] during inter-cask transfer operations, its confinement boundary would not be breached. *This requirement applies to either stationary or mobile lift devices* [emphasis added]." That is, notwithstanding the design features required of the device used to lower the MPC into the overpack (i.e., the CTF or a mobile crane), a drop of the MPC during transfer operations must be postulated, with maintenance of confinement boundary integrity as the acceptance criterion for the evaluation.

Based on the above assessment of truck bay operations, the following additional drops require evaluation:

6. Step 44: <1 ft. loaded transfer cask vertical drop onto HI-STORM mating device (no impact limiter).

7. Step 45: 18.5 ft. to 19.5 ft. loaded MPC vertical drop into HI-STORM overpack (no impact limiter)

It is appropriate, based on the CoC requirements for a CTF, to establish the acceptance criterion for Drop Number 7 as maintaining of confinement boundary integrity.

4.7.6 Transfer Cask Drop Evaluations

A description of the evaluation of each of the transfer cask drops is provided in the subsections below, along with the results of each evaluation. In general, the impact velocity of the dropped cask was calculated using an equation of motion that takes into account all applicable fluid effects, as applicable (e.g., cask pool water), and the height of the drop. The derivation of this equation of motion is based on Reference 6.13 and is described in Reference 6.14. After calculating the impact velocity, a dynamic simulation computer code, such as VisualNastran

(VN) or LSDYNA, was used to simulate the dynamic impact and resultant effects on the cask and/or building structure. The results from the dynamic simulation establish the peak g-force on the cask/fuel, the extent of crush of the impact limiter (as applicable), and the maximum deformation in the floor slab or wall. The VisualNastran and LSDYNA computer codes have been used in prior dynamic simulation work by Holtec International and reviewed by the NRC, as described in Sections 3.4 and 3.6 of the HI-STORM 100 System™ FSAR.

The general acceptance criteria for each drop analysis are (as applicable)[6]:

- Maintain deceleration of the cask to $\leq$ 60 g's to protect the fuel inside the cask and to ensure the MPC design basis deceleration limit is not exceeded. It should be noted that the design basis g-load deceleration limit for the HI-STORM 100 System™ is 45 g's. However, it has been demonstrated that the fuel assembly deceleration limit for a vertical drop is 64.8 g's (HI-STORM FSAR Section 3.5). The MPC is designed for 60 g's based on the HI-STAR 100 storage FSAR (Docket 72-1008). Therefore, 60 g's is chosen as the fuel assembly and MPC acceptance criterion for these evaluations to provide an additional margin of safety.

- Ensure primary stress levels in the HI-TRAC 125D™ transfer cask structure remain with ASME Code Level D limits,

- Ensure that any cask-to-pool wall impact does not cause a collapse of the pool wall.

The general assumptions used in the analyses are (as applicable):

- The cask and contents are modeled as rigid bodies with known geometry and weight. This is conservative because all energy loss associated with cask structural deformation is neglected, which imparts maximum energy into the drop target.

- At the interface between the dropped cask and the target (impact limiter or the floor slab), a contact force-crush relationship is specified. This represents the force-crush relationship of the impact limiter or the force-deformation behavior of the floor slab if no impact limiter is present. This is a realistic assumption that permits actual impact limiter test data to be used to represent impact limiter performance.

- If the cask is dropped through water, buoyancy effects, fluid virtual mass, and fluid hydrodynamic mass are included in the simulation after the cask breaks the surface of the water. This is a realistic assumption. The effect of "squeezing out" the fluid between the cask and the impact surface are neglected in calculating impact velocity. This is conservative because this effect, if included, would decrease the impact velocity.

- The energy lost by splashing of the cask as it enters the water is neglected. This is conservative because that energy is assumed to remain with the dropped cask.

- During the post-impact phase, all effects of the surrounding fluid (e.g., drag, added mass) are ignored. This is conservative because these effects tend to decelerate the cask as it falls.

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[6] The Fuel Building floor is already qualified for a 125-ton shipping cask drop under the current RBS licensing basis and is, therefore, not re-analyzed.

- For those drops occurring before the MPC lid is welded to the MPC shell, the MPC lid is treated as a separate body in order to determine the potential for separation of the lid from the MPC shell. The mass assigned to the MPC lid in the computer model represents the combined mass of the lid, the lift yoke, crane hook, and a portion of the hoist chain, which were assumed to have separated from the crane in the hypothetical failure that caused the load drop.

Appropriate cask component dimensions and masses, lift yoke and rigging component masses, and characteristics of the building structure were taken from the applicable design documents (e.g., drawings) and the HI-STORM 100 System FSAR. The design of the impact limiters was confirmed based on the analyses, which included the necessary crush strength for the devices, and manufacturer's data for the foam installed inside the impact limiters' steel housing.

Other assumptions and inputs unique to a particular drop analysis are included in the discussion of that particular analysis.

4.7.6.1 Drop 1 - Empty MPC Drop onto the Cask Pit North Wall

The effects of this drop on the adjacent floor slab at elevation 93'-0" are bounded by the current licensing basis analysis of an RBS shipping cask drop described in River Bend USAR Section 9.1.4.3. The drop of an empty MPC-68 (approximately 39,000 lbs) from 3.75 feet above the doorway opening results in significantly less kinetic energy when impacting the floor slab than the 125-ton analyzed drop of the shipping cask from 0.5 feet above the door opening. No significant damage to safety-related SSCs was predicted by the shipping cask drop analysis. Therefore, the empty MPC drop will not damage any safety-related SSCs. Because the MPC does not contain spent fuel during this postulated drop, there is no need to evaluate damage to the cask's contents.

4.7.6.2 Drop 2 - Loaded Transfer Cask Drop onto Cask Pool Upper Shelf Corner with Cask Top-to-Side Wall Impact

After the spent fuel and MPC lid are installed under water, the transfer cask containing the loaded MPC is lifted to an elevation just high enough to clear the elevation of the cask pool upper shelf. The cask is then moved horizontally toward a position over the upper shelf. The movement of the transfer cask to and from the cask pool lower shelf from and to the upper shelf, respectively, are the only horizontal movements of the transfer cask performed without the crane redundant rigging installed (see Section 4.7.2). This is because a lift yoke extension is used to place the cask on the cask pool lower shelf to avoid contaminating the crane block due to immersion in the pool water (see Figure 1 in Attachment 2 to this submittal).

The redundant rigging cannot be installed with the lift yoke extension in use. The lift yoke extension is installed and removed when the cask is on the cask pool upper shelf. Therefore, a drop of the loaded transfer cask is postulated when it is located over the edge of the cask pool upper shelf before the whole cask clears the corner of the shelf, as a bounding analysis. The cask is postulated to drop onto the shelf corner and pivot to the south, toward the lower shelf area, impacting the cask pool south wall. This drop analysis (Reference 6.15) evaluates the structural integrity of the cask pool south wall, including the steel liner.

Two drop orientations were analyzed to determine the worst case impact on the cask pool south wall. The first case assumes the impact of the outer edge of the transfer cask pool lid on the corner of the upper shelf with the resulting rotation of the cask about that point and impact with the wall. The second case assumes the central portion of the cask pool lid impacts the corner of the upper shelf and rotates toward the pool wall. Two drop heights, 1.37 inches and 4 inches, were evaluated for each drop scenario in order to determine sensitivity and identify a bounding case for further evaluation of the pool wall structural integrity. The limiting case (producing the peak force on the cask pool wall) is the 4-inch drop with impact at the edge of the cask pool lid. This limiting drop case was then re-analyzed to include the non-linear behavior and ductility of the concrete wall to more precisely evaluate the effect of the impact on the cask pool wall.

The results of the limiting case analysis are:

Peak Vertical Force on Upper Shelf: 14.258 kips

Peak Horizontal Local Impact Force on Pool Wall: 745.0 kips

Peak Force in Wall Spring: 1.07 kips

Vertical Cask Speed at Impact with Upper Shelf: 55.56 inches/sec

HI-TRAC Angular Velocity at Impact with Pool Wall: 53.57 degrees/sec

The ductility ratio of the pool wall is calculated to be 5.48. The maximum permitted ductility ratio for a concrete plate supported is 30 (Table 4-4 in Reference 6.16). Therefore, the cask pool wall will not collapse as a result of a hypothetical cask drop onto the upper shelf and rotation impact into the wall.

4.7.6.3 Drop 3 - Loaded Transfer Cask Vertical Drop onto Cask Pool Upper Shelf

A second hypothetical drop of the loaded transfer cask during horizontal movement without the redundant rigging engaged was analyzed (Reference 6.17) for when the cask clears the corner of the cask pool upper shelf. This is a vertical drop of the transfer cask onto the upper shelf from an arbitrarily chosen bounding carry height. This height limit, or less will be incorporated as an operating limit in the cask loading procedures. The dynamic analysis computer code LS-DYNA was used for this simulation.

The acceptance criteria for the analysis are as follows:

- No stress levels in the MPC may exceed the allowable limits established in the cask system FSAR for load handling accidents, and the fuel deceleration (Reference 6.5) shall not exceed 64.8 g's.

- The reduction in cask shielding, if any, shall be limited such that the dose emitted by the cask is less than any analyzed loss-of-shielding event in the cask FSAR.

- The MPC and transfer cask must not deform to the extent that prevents retrievability of the MPC and the fuel assemblies.

- The deformation of the fuel basket in the MPC, if any, must not lead to the loss of fuel cladding integrity such that reactivity of the system is increased compared to normal conditions.

- The deformation of the MPC, if any, shall not produce an internal helium flow configuration that stifles heat rejection.

Key assumptions used in this analysis are:

1. The transfer cask structural components behave as bilinear elastic-plastic materials characterized by five material parameters (i.e., Young's modulus, yield strength, ultimate strength, failure strain, and Poisson's ratio). This is a reasonable assumption based on good engineering practice.

2. Material damping is neglected. This is conservative because the energy absorption associated with damping is ignored.

3. The load block, crane wire rope, and cask lift yoke, weighing a total of approximately 10,000 lbs, are resting atop the transfer cask during the drop event. This is conservative because it increases the total mass of the dropped cask.

4. The drop height is 7 inches. Seven inches was assumed as a reasonable carry height necessary to ensure clearance over the upper shelf corner.

5. The dropped transfer cask remains stable after impacting the target. VisualNastran simulations demonstrate that a dropped transfer cask will not tip over under the conservatively postulated worst scenario.

6. The analysis was performed assuming a drop through air. This is conservative because the cask would actually be falling through water, which would create drag resistance on the cask body. A drop through water would result in a lower impact velocity of the cask and less severe consequences compared to a drop through air.

Key input data used in the analysis are:

1. Thickness of concrete drop target = 30 in.

2. Compressive strength of concrete target = 5,000 psi.

3. Concrete target Poisson's Ratio = 0.16

4. Rock subgrade Young's Modulus = 1.158×10^6 psi

5. Rock subgrade Poisson's Ration = 0.3

   The actual concrete target (the cask pool upper shelf) is essentially a 23 ft. tall concrete wall with a compressive strength of 3,000 psi. The flexibility of an impact target is proportional to the thickness and inversely proportional to the supporting area. Therefore, the cask pool upper shelf is relatively flexible compared to the target concrete slab used in the dynamic computer simulation.

6. Cask component dimensions and material properties are taken from the HI-STORM 100 FSAR.

The results of the dynamic simulation show that the cask velocity upon impact with the target after a 7-inch free-fall is 73.55 in/sec. The maximum deceleration of the MPC is 61.3 g's, which is below the fuel acceptance limit of 64.8 g's. Therefore, the drop would not cause fuel cladding damage or fuel relocation resulting in an unanalyzed criticality configuration.

The MPC enclosure experiences a maximum Von Mises stress of 22,278 psi at the MPC lid-to-shell weld, which is above the material yield stress of 20,050 but well below the failure stress of the material. Other than at the lid-to-shell weld, the MPC enclosure vessel does not experience any plastic deformation. The maximum Von Mises stress on the transfer cask inner shell is 10,289 psi, which is less than the material yield stress of 33,150 psi. Therefore, there is no deformation of the transfer cask inner shell. These results indicate that the MPC and transfer cask will retain their structural configurations sufficiently to permit retrieval of the MPC after the drop.

Because of the relatively low yield stress of the pure lead shielding material, some slumping will occur due to the drop. This slump is predicted by the computer simulation to be less than 0.5 inch. While this may allow a small amount of local radiation streaming, but does not have an offsite does consequence. Therefore, it is an acceptable consequence for an accident event.

4.7.6.4 Drop 4 - Loaded Transfer Cask Vertical Drop onto Cask Pool Lower Shelf

In this event, the loaded transfer cask is assumed to drop vertically 42'-6" onto the cask pool lower shelf with the impact limiter installed on the floor at elevation 70 ft. The first 2'-11¼" of the drop is through air and the remaining 39'-6¾" of the drop is through water (normal pool water elevation is assumed to be 111'-9"). The top of the impact limiter is at elevation 72'-2¼". In order to determine sensitivity, different impact limiter resistances were evaluated: 80%, 100%, 120%, and 140%. The 80-120% range covers the manufacturer's standard tolerance range for the foam material and the 140% resistance addresses the scenario where a larger impact area contributes to increased resistance. The analysis yielded the following results:

CASE	MAXIMUM CASK DECELERATION (g's)	IMPACT LIMITER CRUSH (inches)	MAXIMUM CRUSH STRAIN (%)
100% Resistance	48.0	12.84	55.24
80% Resistance	51.7	14.47	62.24
120% Resistance	45.9	11.46	49.30
140% Resistance	48.5	10.30	44.32

All cask deceleration values are less than 60 g's. Therefore, no fuel damage is predicted and all MPC stresses remain below allowable values established in the HI-STAR 100 System™ FSAR. The MPC lid shows no tendency to separate from the MPC shell. Therefore, no lid restraint system is required.

The following limiting Von-Mises Stresses were calculated for the transfer cask for a bounding deceleration value of 61.3 g's:

LOCATION	VON-MISES STRESS (ksi)
Inner Shell	10.3
Water Jacket End Plate	11.4
Outer Shell	9.22
Water Jacket Bottom Ring	22.1

As interpolated from the data in Table 3.1.12 of the HI-STORM 100 System™ FSAR, the allowable primary membrane stress intensity and primary membrane plus bending stress intensity at 350°F and are 39.75 ksi and 59.65 ksi, respectively. Von Mises stresses are closely related to stress intensity at a point. Therefore, the Level D stress allowables are met for all values of deceleration calculated for this drop event.

4.7.6.5 Drop 5 - Loaded Transfer Cask Vertical Drop into Cask Pit

This drop is postulated to occur while the loaded transfer cask is suspended 19'-9" above the cask pit floor. The cask pit is dry and has a 26.25 inch thick impact limiter located on the pedestal at elevation 98'-1". A cask drop height of 17.5 ft. through air onto the impact limiter was analyzed. The analysis was performed considering the pedestal elevation at 95' resulting in additional conservatism in the results. Like drop No. 4, cask deceleration and impact limiter performance are analyzed, except that the 80% resistance case was not run. The results are as follows:

CASE	MAXIMUM CASK DECELERATION (g's)	IMPACT LIMITER CRUSH (inches)	MAXIMUM CRUSH STRAIN (%)
100% Resistance	32.4	9.67	41.61
120% Resistance	34.2	8.45	36.34
140% Resistance	42.2	7.10	30.56

All cask deceleration values are less than 60 g's. Therefore, no fuel damage is predicted and all MPC stresses remain below allowable values established in the HI-STAR 100 System™ FSAR. The MPC lid shows no tendency to separate from the MPC shell. Therefore, no lid restraint system is required. Because the deceleration values are all less than 61.3 g's, the conclusions drawn under Drop 4 for transfer cask structural integrity are applicable and bounding for this drop.

4.7.6.6 Drop 6 - Loaded Transfer Cask Vertical Drop onto HI-STORM Mating Device

Once the loaded transfer cask is moved horizontally by the FBCHC into the truck bay through the Fuel Building doors and positioned directly over the overpack with the mating device installed, the redundant rigging is removed in preparation for lowering the transfer cask onto the mating device. A cask drop is postulated at this point and analyzed. The analysis (Reference 6.17) assumes a free vertical drop from a height of eight and one half inches. This height was assumed as a reasonable bounding value for the carry height necessary to ensure clearance over the mating device. This height limit, or less, will be incorporated as an operating limit in the cask loading procedures. The details of this analysis are described in Section 4.7.6.3.

In this scenario, the pool lid, which protrudes approximately 5.5 inches below the transfer cask bottom flange, would not experience an impact because it would fit into the open drawer of the mating device. The impact location, therefore, is the transfer cask bottom flange. This drop simulation results in the same deceleration loads on the MPC and fuel as that previously discussed in Section 4.7.6.3. However, unique to this drop scenario, the structural integrity of the transfer cask bottom flange and pool lid are evaluated to ensure that the MPC does not break through the pool lid and drop into (or through) the mating device drawer. This drop scenario also credits a flexible, spiral wound gasket mounted on the top of the mating device for limiting fuel deceleration to the limits described in Section 4.7.6.3.

The analysis results show that the 2-inch thick bottom flange has a safety factor of 1.51 against shear failure when the limiting deceleration of 64.8 g's is assumed. This result bounds the pool lid as well because the pool lid is 5.5 inches thick. Moreover, even if the pool lid bolts were to fail by tension, the disconnected pool lid would stay in the mating device due to the vertical support provided by the overpack.

4.7.6.7 Drop 7 - Loaded MPC Vertical Drop into HI-STORM Overpack

After the transfer cask pool lid has been unbolted and removed by the mating device, a path to transfer the MPC into the overpack exists. A drop of the MPC into the overpack has been analyzed for this scenario. The acceptance criterion for this event is no breach of the MPC enclosure vessel, as justified in Section 4.7.5.2. The drop analysis (Reference 6.18) is performed using the LS-DYNA dynamic simulation computer program.

Key assumptions used in the analysis are:

1. The stainless steel used to manufacture the MPC is a bilinear, elasto-plastic material with a failure strain of 0.38 in/in.

2. The contents of the MPC (fuel basket and fuel) are modeled as a rigid mass with no energy dissipation capability.

3. The MPC lid-to-shell weld is explicitly modeled with full recognition of the discontinuity stresses that are expected to develop at the weld location. The material behavior of the weld joint is conservatively assumed to be the same as the MPC shell material.

4. The impact target is modeled as an infinite half-space of steel using the bounding overpack baseplate material properties. This conservatively bounds the actual target, which is one of two overpack designs resting atop the cask staging pad. The cask staging pad is a 36-inch (maximum) thick concrete pad (compressive strength $\leq$ 4,200 psi at 28 days) founded upon a subgrade with a soil effective modulus of elasticity no greater than 28,000 psi. The HI-STORM 100S and HI-STORM 100S Version B

overpack pedestals are constructed using a combination of steel and/or concrete as shown on the drawings in the HI-STORM 100 System FSAR.

5. Yield and ultimate stresses for the target are taken at room temperature.

Key input data used in the analysis are:

1. The loaded MPC weighs 90,000 lbs. This is a conservative, bounding value from Reference 6.5.

2. The MPC drop height is 25 feet. This is conservative because the height of the taller overpack design plus the mating device is just under 20 feet.

3. The impact velocity of the MPC is $(2gh)^{1/2}$ = 481.5 in/sec.

The result of the dynamic simulation show that the maximum Von Mises stress in the MPC shell is 44,515 psi, indicating that the shell is plastically deformed. However, the calculated stress is well below the ultimate stress of the material (64,000 psi). The maximum plastic strain is less than 21.25%, which is below the failure strain of 38%. The MPC shell is deformed most at the bottom because of impact-induced local bending. Therefore, the "no breach" acceptance criterion is met and this hypothetical drop has acceptable consequences.

4.8 Summary

The FBCHC is adequately designed and has been appropriately maintained, inspected and tested to provide reasonable assurance that the cask handling loads can be safely handled with a load drop being a very unlikely event. Evaluations of hypothetical drop events during spent fuel storage cask component lifting and handling resulted in no unacceptable consequences for the plant, the MPC, the transfer cask, the cask contents, and the public.

5.0 REGULATORY ANALYSIS

The hypothetical load drops associated with using the FBCHC for dry spent fuel cask handling require the use of an impact limiter in certain locations to ensure the consequences of the drop are acceptable. As such, they create a malfunction of an SCC with a different result than previously evaluated in the USAR. Furthermore, the cask drop onto the cask pool upper shelf resulting in a secondary impact against the pool wall is an accident of a different type than previously evaluated in the USAR. Thus, a 10 CFR 50.59 evaluation for the procedure changes needed to implement dry spent fuel storage at RBS would result in the need for a license amendment. In addition, Entergy's response to NRC Bulletin 96-02 for River Bend Station includes a statement that a license amendment request would be submitted if an activity creates a potential load drop accident not previously evaluated in the FSAR. While its consequences are clearly bounded by a previously evaluated accident, the drop of an MPC lid has not previously been evaluated in the FSAR. For these reasons, NRC approval of this amendment request is requested to support implementation of dry storage cask loading activities inside the Part 50 facility at RBS.

5.1 Applicable Regulatory Requirements/Criteria

The USAR and plant procedure changes required to implement dry spent fuel storage at RBS have been evaluated to determine whether applicable requirements and regulations continue to be met.

Entergy has determined that the proposed amendment does not require any exemptions or relief from regulatory requirements and do not affect conformance with any 10 CFR 50, Appendix A General Design Criterion (GDC) differently than described in the USAR.

NRC regulatory guidance applicable to this proposed amendment includes NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" (Reference 6.1); associated Generic Letters 80-113, 81-07, 83-42, and 85-11; NUREG-0554, "Single Failure Proof Cranes" (Reference 6.2); and ANSI N14.6, "American National Standard for Radioactive Material - Lifting Devices for Shipping Containers Weighing 10,000 lbs (4500 kg) or More" (Reference 6.8). NUREG-0612 and its associated generic letters required Part 50 licensees and holders of construction permits to demonstrate to the NRC how the criteria in NUREG-0612 are met for the handling of heavy loads. NUREG-0612 was issued in July 1980 and GL 80-113 was issued in December 1980 as part of the resolution of Generic Technical Activity A-36, "Control of Heavy Loads near Spent Fuel."

Appendix I to the River Bend Station Supplemental Safety Evaluation Report (Reference 6.19) provides NRC's approval of River Bend's response to NUREG-0612 and the associated generic letters. At that time, the River Bend licensing basis for spent fuel cask handling addressed only a generic, 125-ton shipping cask. The presumption was that the shipping cask would be certified under 10 CFR 71 and, as such, would be qualified to withstand a 9 meter (30 ft.) drop without radioactive release or damage to the fuel. Therefore, no analysis of the consequences of a shipping cask drop on the cask or cask contents was performed as part of Part 50 licensing for RBS.

The Part 50 licensing basis includes qualification of the RBS Fuel Building for handling a 125-ton shipping cask in the area of the cask pool, cask pit, and outdoor crane structure. This licensing basis remains bounding for the handling of the 125-ton spent fuel transfer cask (HI-TRAC 125D™) as it relates to drop effects on the Part 50 structure. However, the HI-TRAC 125D™ transfer cask is not a 10 CFR 71-certified transport package. Therefore, because the FBCHC is not going to be upgraded to single-failure-proof, the spent fuel storage canister (MPC-68), the fuel inside, and the transfer cask require evaluation for certain hypothetical drops postulated based on the guidance in NUREG-0612.

NRC Bulletin 96-02 (Reference 6.3) was issued in April 1996 in response to a heavy load handling issue that arose in the industry pertaining to spent fuel cask handling. This Bulletin reiterated to licensees NRC's expectations regarding heavy load control established in NUREG-0612. Bulletin 96-02 states, in part: "For licensees planning to perform activities involving the handling of heavy loads over spent fuel, fuel in the reactor core, or safety-related equipment while the reactor is at power...and that involve a potential load drop accident that has not been previously evaluated in the FSAR, submit a license amendment request in advance..." RBS responded to Bulletin 96-02 in August 1996 (Reference 6.20) and the NRC approved that response in May 1998 (Reference 6.21).

Section 5.5 of Appendix A to the HI-STORM 100 System™ Certificate of Compliance (CoC) states: "For lifting of the loaded TRANSFER CASK or OVERPACK using devices which are integral to a structure governed by 10 CFR Part 50 regulations, 10 CFR 50 requirements apply." Because the FBCHC is integral to the RBS Fuel Building, this amendment request is governed by the regulations in 10 CFR 50, consistent with that CoC provision. However, the acceptance criteria for verifying the integrity of the spent fuel, the spent fuel transfer cask, and the multi-purpose canister are drawn from the 10 CFR 72 cask licensing basis documents. The cask system being used at RBS under a Part 72 general license is certified under 10 CFR 72, Subpart L. The CoC and FSAR for the HI-STORM 100 System™ provide the design criteria for verifying protection of the cask components and fuel, which have been previously approved by the NRC. Absent applicable acceptance criteria in 10 CFR 50 for these components and fuel, the acceptance criteria developed under 10 CFR 72 during cask licensing were chosen for use in evaluating the consequences of postulated load drops related to cask handling in the Fuel Building and the adjacent outdoor crane structure.

5.2 No Significant Hazards Consideration

The proposed amendment will revise the Updated Safety Analysis Report pertaining to spent fuel management, ISFSI operations, heavy load handling, and associated drop event analyses. The proposed amendment will add an overview of dry storage cask loading operations and a discussion of the transfer cask, MPC, and MPC lid drop events to augment the existing USAR discussion of the shipping cask drop event. The changes to the USAR will be made after approval of this amendment request.

This proposed amendment has been evaluated in accordance with 10 CFR 50.92(c). The amendment shall be deemed to involve a no significant hazards consideration if there is a positive finding in any of the following areas:

1. Will operation of the facility in accordance with this proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The proposed amendment introduces no new mode of plant operations and does not affect Structures, Systems, and Components (SSCs) associated with power production, accident mitigation, or safe plant shutdown. The SSCs affected by this proposed amendment are the Fuel Building Cask Handling Crane (FBCHC), the spent fuel storage canister, the spent fuel transfer cask, and the spent fuel inside the storage canister. A hypothetical 30 ft. drop of a loaded spent fuel shipping cask from the FBCHC is part of the River Bend Station (RBS) current licensing basis. With the proposed spent fuel transfer cask design and procedural changes implemented, the FCHC will be used to lift and handle a fuel-loaded spent fuel transfer cask of the same maximum weight and approximately the same dimensions as previously evaluated in the RBS USAR. The proposed amendment involves the use of redundant crane rigging during most lateral moves with a loaded spent fuel transfer cask, which provides temporary single-failure proof design features to provide protection against an uncontrolled lowering of the load or load drop. In those cases where the spent fuel transfer cask is not supported with redundant rigging, certain hypothetical, non-mechanistic load drops have been postulated and evaluated, with due consideration of the use of impact limiters in some locations.

With this amendment, the probability of a loaded spent fuel transfer cask drop is actually less likely than previously evaluated because the capacity of the spent fuel multi-purpose canister (68 fuel assemblies) is larger than the capacity of the shipping cask described in the current licensing basis (18 fuel assemblies), which means that fewer casks will be required to be loaded, lifted, and handled for a given population of spent fuel assemblies. The consequences of the hypothetical spent fuel transfer cask load drops on plant SSCs are bounded by those previously evaluated for a shipping cask. That is, there is no significant damage to the Fuel Building structure or any SSCs used for safe plant shutdown. New analyses of hypothetical drops of a loaded transfer cask or canister confirm that there is no release of radioactive material from the storage canister and no unacceptable damage to the fuel, MPC, or transfer cask.

The hypothetical drop of a spent fuel canister lid into an open, fuel-filled canister in the spent fuel pool during fuel loading has also been evaluated. Again, this hypothetical accident is no more likely to occur than previously considered due to the higher capacity of the spent fuel transfer cask over the spent fuel shipping cask (i.e., fewer casks will need to be loaded for a given number of fuel assemblies). The radiological consequences of this event due to the potential damage of spent fuel assemblies in the canister onto which the lid could be dropped have been evaluated. While more total fuel assemblies could potentially be damaged from a spent fuel canister lid drop compared to that assumed for the fuel handling accident described in the RBS current licensing basis, the significantly longer decay time of the spent fuel assemblies in the canister results in a much smaller source term, such that the existing fuel handling accident described in USAR Section 15.7.4 provides a bounding evaluation for the radiological consequences MPC lid drop. There is no rearrangement of the fuel or deformation of the fuel basket in the canister such that a critical geometry is created as a result of an MPC lid drop.

The likelihood of a spent fuel canister lid drop due to the failure of a crane component due to overload is very unlikely because the rated load of the crane (250,000 lbs) is approximately 16 times the weight of components lifted to install the canister lid.

2. Will operation of the facility in accordance with this proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   The proposed amendment introduces no new mode of plant operations and does not affect SSCs associated with power production, accident mitigation, or safe plant shutdown. The SSCs affected by this proposed amendment are the non-single-failure-proof FBCHC, the spent fuel canister, the spent fuel transfer cask, and the spent fuel inside the canister. The design function of the FBCHC is not changed. The proposed amendment does not create the possibility of a new or different kind of accident due to credible new failure mechanisms, malfunctions, or accident initiators. The proposed amendment creates a new initiator of two accidents previously evaluated and caused by the non-mechanistic single failure of a component in the FBCHC load path.

The current licensing basis accidents for which new initiators are created by this amendment are the spent fuel shipping cask drop and the fuel handling accident. The RBS current licensing basis includes evaluations of the consequences of a spent fuel shipping cask drop and the consequences of the drop of a spent fuel assembly into the reactor core shortly after shutdown and reactor head removal. The new initiators include the drop of a spent fuel transfer cask of the same maximum weight and approximately the same dimensions as the shipping cask, and the drop of a spent fuel canister lid into an open, fuel filled canister in the spent fuel pool. Both of these new initiators create hypothetical accidents that are comparable in consequences to those previously evaluated. For the drop of a spent fuel transfer cask, the consequences are bounded by the current licensing basis analysis of the spent fuel shipping cask drop. That is, there is no significant damage to the Fuel Building structure or any SSCs used for safe plant shutdown, and there is no release of radioactive material. New analyses of the drop of a loaded transfer cask confirm that there is no release of radioactive material from the storage canister and no unacceptable damage to the fuel, MPC, or transfer cask.

For the drop of the spent fuel canister lid, the significantly longer decay time of the spent fuel assemblies in the canister compared to a spent fuel assembly in a recently shutdown reactor results in doses to the public that are less than the previously analyzed fuel handling accident. There is no rearrangement of the fuel in the canister such that a critical geometry is created as a result of an MPC lid drop.

3. Will operation of the facility in accordance with this proposed amendment involve a significant reduction in a margin of safety?

   Response: No.

   The proposed amendment introduces no new mode of plant operations and does not affect SSCs associated with power production, accident mitigation, or safe plant shutdown. The SSCs affected by this proposed amendment are the non-single-failure-proof FBCHC, the spent fuel storage canister, the spent fuel transfer cask, and the spent fuel inside the canister. Therefore, this amendment does not affect the reactor or fuel during power operations, the reactor coolant pressure boundary, or primary or secondary containment. All activities associated with this amendment occur in the Fuel Building or in the adjacent outdoor truck bay area. The design function of the FBCHC is not changed. The proposed changes to plant operating procedures needed to implement dry spent fuel storage at RBS do not exceed or alter a design basis or safety limit associated with plant operation, accident mitigation, or safe shutdown. The FBCHC is used to lift and handle the spent fuel canister lid over spent fuel in the canister while in the spent fuel pool, and to lift and handle the spent fuel transfer cask, both when it is empty and after it is loaded with spent fuel in the spent fuel pool.

   This proposed amendment results in a net safety benefit because a larger capacity cask is being used to move spent fuel out of the spent fuel pool that was previously evaluated (68 fuel assemblies versus 18 fuel assemblies), while maintaining the same maximum analyzed cask weight described in the USAR. This yields fewer casks to be loaded, fewer heavy load lifts, and, as a result, fewer opportunities for events such as load drops. Because the maximum weight of the loaded spent fuel transfer cask is the same as that assumed for the shipping cask and for which the FBCHC was designed, all design safety margins for use of the FBCHC remain unchanged. The rated capacity of the FBCHC is approximately 16 times that of components lifted to place the spent fuel canister lid, yielding significant safety margins for that particular lift.

Based on the above review, it is concluded that: (1) the proposed amendment does not constitute a significant hazards consideration as defined by 10 CFR 50.92; and (2) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed amendment; and (3) this action will not result in a condition which significantly alters the impact of the station on the environment as described in the NRC Final Environmental Impact Statement.

5.3 Environmental Considerations

The proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or a significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 REFERENCES

6.1 NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," USNRC, July 1980.

6.2 NUREG-0554, "Single Failure Proof Cranes for Nuclear Power Plants," USNRC, May 1979.

6.3 USNRC Bulletin 96-02, "Movement of Heavy loads Over Spent Fuel, Over Fuel in the Reactor Core, or over Safety-Related Equipment," April 1996.

6.4 HI-STORM 100 10 CFR 72 Certificate of Compliance 72-1014, Amendment 1.

6.5 HI-STORM 100 System Final Safety Analysis Report, Revision 2.

6.6 Drawing EC-62-AM, "Foundation Plan & Details, Cask Handling Area, Fuel Building," Revision 2.

6.7 "Severe Weather Operation," RBS Abnormal Procedure AOP-0029, Rev. 14B.

6.8 ANSI N14.6, "American National Standards for Radioactive Material Lifting Devices for Shipping Containers Weighing 10,000 lbs (4500 kg) or More," 1993.

6.9 Holtec International Report No. HI-2043304, "Dynamic Analysis of Redundant Link System Subsequent to Loss of Primary Load Path in Cask Pit Crane," Revision 0.

6.10 U.S. NRC Safety Evaluation Report Related to License Amendments 142 and 139 for 10 CFR 50 Operating Licenses DPR-39 and DPR-48, respectively, Dockets 50-295 and 50-305, Zion Nuclear Power Station, Commonwealth Edison Company, February 23, 1993.

6.11 Holtec International Report No. HI-2043275, "Analysis of MPC Lid Drop during Cask Loading at River Bend," Revision 0.

6.12 Holtec International Report No. HI-2043312, "Analysis of a Postulated MPC Lid Drop Event over the HI-TRAC Transfer Cask Top Flange," Revision 0.

6.13 "The Effect of Liquids on the Dynamic Motion of Immersed Solids," R.J. Fritz, ASME Journal of Engineering for Industry, February 1972.

6.14 Holtec Position Paper DS-246, "Seismic Analysis of Submerged Bodies," Revision 1.

6.15 Holtec International Report No. HI-2022956, "HI-TRAC Impact Limiter Qualification at River Bend," Revision 1.

6.16 "Design of Structures for Missile Impact," Topical Report BC-TOP-9A, Bechtel Power Corporation, Revision 2.

6.17 Holtec International Report No. HI-2043278, "Evaluation of Postulated HI-TRAC 125D Transfer Cask Drop Accidents at the River Bend Station," Revision 2.

6.18 Holtec International Report No. HI-2043276, "Analysis of a Postulated MPC Drop Accident during MPC Transfer Operation," Revision 0.

6.19 Supplemental Safety Evaluation Report for River Bend Station, EG&G Idaho for USNRC, Appendix I, January 1985.

6.20 Entergy Operations' Response to NRC Bulletin 96-02 for River Bend Station, dated August 29, 1996.

6.21 USNRC letter to Mr. John R. McGaha, Jr., dated May 13, 1998, "Completion of Licensing Action for NRC Bulletin 96-02, "Movement of Heavy Loads over Fuel in the Reactor Core, or over Safety-Related Equipment, dated April 11, 1996, for River Bend Station, Unit 1."

Appendix A to

Attachment 1 to

RGB-46369

Cask Handling Operational Sequence

Refer to Figure 1 in Attachment 2 to this submittal for cask locations and Section 4.7 of this attachment for component dimensions and elevations. A cask bottom elevation of 114.0 ft. is assumed to permit engagement of redundant rigging with the lift yoke. "IL" means an impact limiter is in place to protect the dropped component and the target, and "no IL" means no impact limiter. "PD" means postulated drop(s). Drop distances, where cited, are approximate and measured from the bottom of the dropped load to the top of the target (i.e., the cask pool or cask pit floor, the impact limiter, the top of the HI-STORM mating device, or the top of the overpack pedestal). See the detailed analysis section for actual drop distances evaluated.

1. Empty multi-purpose canister (MPC) located outdoors
2. Open Fuel Building door (no fuel movement permitted inside)
3. Lift MPC to point where bottom of MPC is approx. 116.75 ft. elevation
4. Move MPC laterally through Fuel Building door to point above cask pit (impact limiter (IL) and empty transfer cask (HI-TRAC) previously installed in cask pit)
   PD -- a): 3.75 ft. empty MPC vertical drop onto cask pit north wall – no IL; and b: 16.5 ft. empty MPC vertical drop into empty HI-TRAC – IL
5. After closing fuel building door, lower MPC into HI-TRAC
6. Engage lift yoke to HI-TRAC
7. Lift cask to point where bottom of cask is approx. 114.0 ft. elevation
   PD -- 17.5 ft. empty HI-TRAC transfer cask drop into cask pit - IL
8. Engage redundant rigging
9. Move cask laterally to point above lower shelf in cask pool
10. Disengage redundant rigging
    PD -- 42.5 ft. empty cask drop onto cask pool lower shelf- IL
11. Lower cask to approx. 94 ft. elevation
    PD -- 22 ft. empty cask drop onto cask pool lower shelf – IL
12. Move cask laterally to point above upper shelf of cask pool
    PD -- a: <1 ft. empty cask drop onto corner of cask pool upper shelf and b: <1 ft. empty cask vertical drop onto cask pool upper shelf – no IL
13. Lower cask onto cask pool upper shelf
14. Disengage lift yoke from HI-TRAC
15. Attach lift yoke extension and lift yoke
16. Engage lift yoke to cask
17. Lift cask 1 ft. above cask pool upper shelf
    PD -- <1 ft. empty cask vertical drop onto cask pool upper shelf – no IL
18. Move cask laterally to a point above cask pool lower shelf
    PD -- a: <1 ft. empty cask drop onto corner of cask pool upper shelf and b: 22 ft. empty cask vertical drop onto cask pool lower shelf – IL
19. Lower cask onto lower shelf on impact limiter
20. Detach and stow lift yoke and extension
21. Load fuel into MPC
22. Rig MPC lid beneath lift yoke and lift yoke extension
23. Move MPC lid into place above cask
    PD -- 27 ft. drop of MPC lid onto MPC basket with fuel loaded
24. Lower MPC lid, install in MPC, and disengage lid rigging from lift yoke
25. Engage lift yoke with extension to HI-TRAC transfer cask
26. Lift cask to approx. 94 ft. elevation
    PD -- 22 ft. loaded cask vertical drop onto cask pool lower shelf - IL
27. Move cask laterally to point above cask pool upper shelf

PD -- a: <1 ft. loaded cask drop onto corner of cask pool upper shelf and b: <1 ft. loaded cask vertical drop onto cask pool upper shelf – no IL

28. Lower cask onto cask pool upper shelf
29. Disengage lift yoke and extension
30. Engage lift yoke without extension to cask
31. Lift cask to approx. 94 ft. elevation
    PD -- <1 ft. loaded cask drop onto cask pool upper shelf – no IL
32. Move cask laterally to a point above cask pool lower shelf
    PD -- a: <1ft. loaded cask drop onto corner of cask pool upper shelf (no IL) and b: 22 ft. loaded cask vertical drop onto cask pool lower shelf - IL
33. Raise cask to approx. elevation 114.0 ft.
    PD -- 42.5 ft. loaded cask vertical drop onto cask pool lower shelf – IL
34. Engage redundant rigging
35. Move cask laterally to point above cask pit
36. Disengage redundant rigging
    PD -- 17.5 ft. loaded cask vertical drop into cask pit – IL
37. Lower cask into cask pit onto IL
38. Disengage lift yoke from transfer cask
39. Finish MPC preparation and install HI-TRAC top lid
40. Engage lift yoke to transfer cask
41. Lift cask to approx. 114.5 elevation
    PD -- 17.5 ft. loaded cask vertical drop into cask pit – IL
42. Engage redundant rigging
43. Move cask laterally outdoors to point above empty HI-STORM with mating device installed
44. Disengage redundant rigging
    PD -- <1 ft. loaded cask vertical drop onto mating device – drop height varies with overpack model used and whether cribbing under 100S Version B overpack is used
45. Remove HI-TRAC pool lid
    PD -- 18.5 to 19.5 ft. loaded MPC drop into empty overpack – drop height varies with overpack model used and whether cribbing under 100S Version B overpack is used
46. Remove empty HI-TRAC and mating device
47. Install overpack lid and transport cask to ISFSI

Attachment 2

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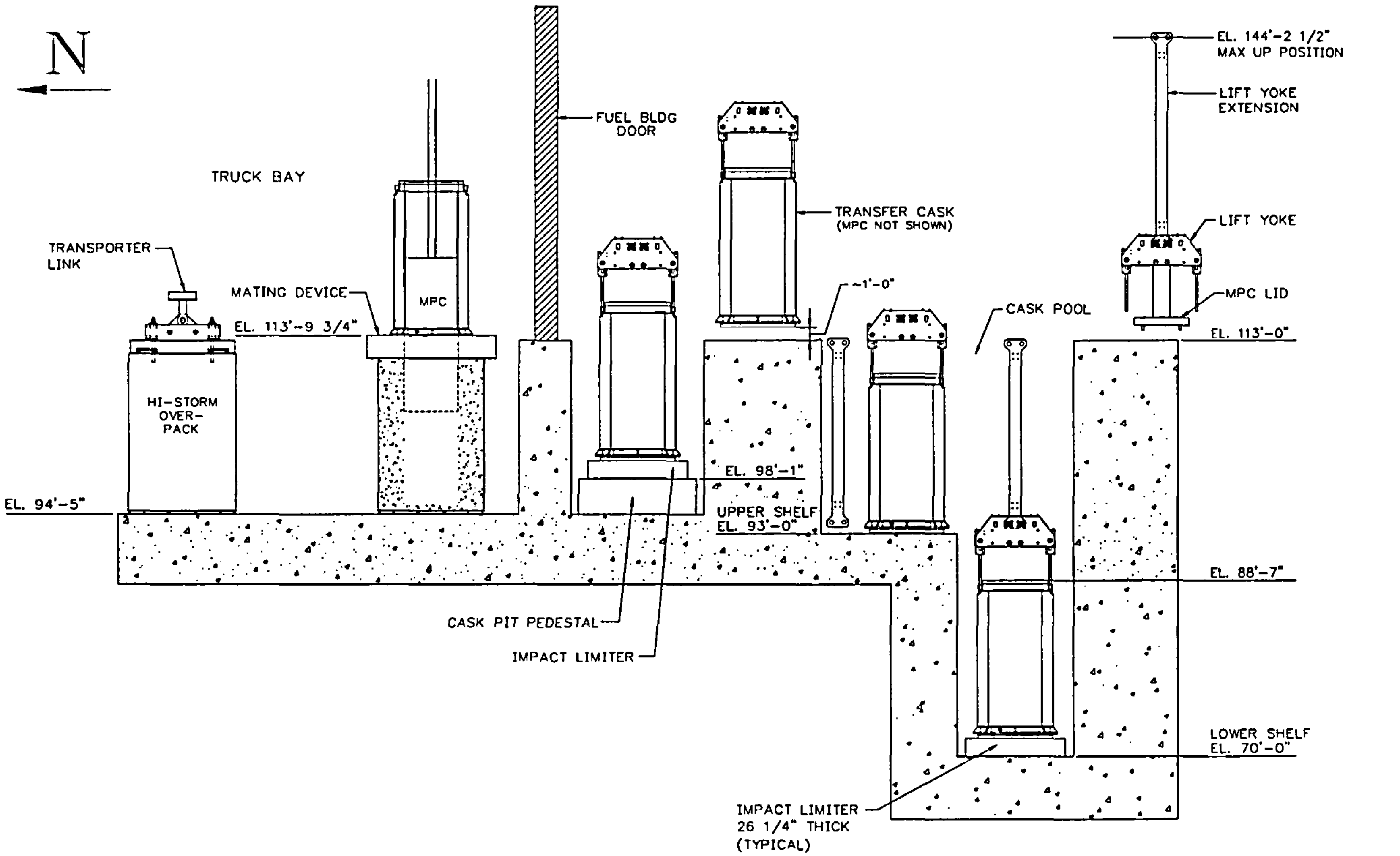
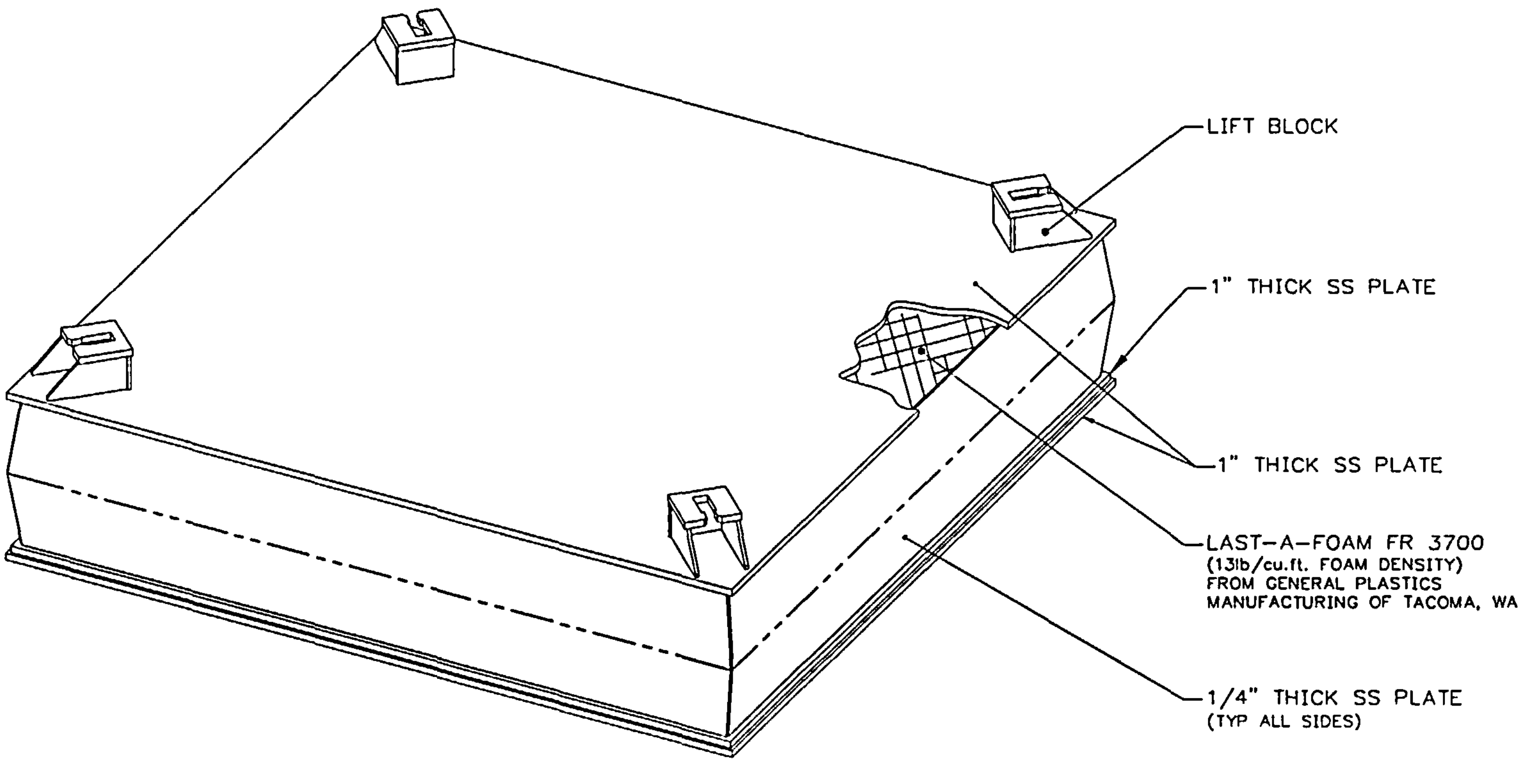
Figures

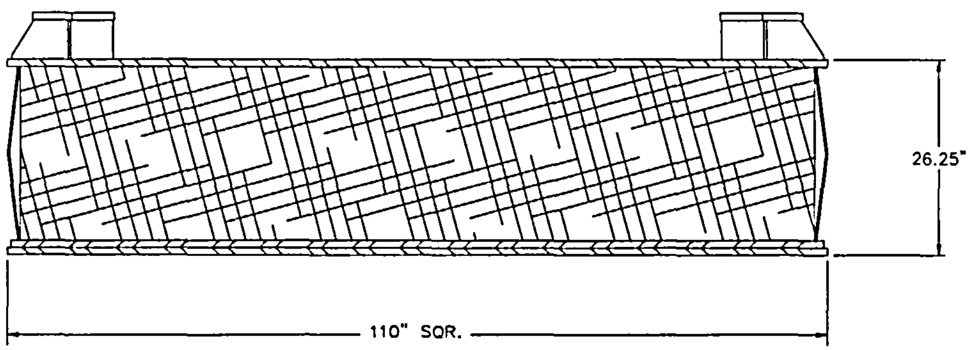


Entergy Operations, Inc.

FIGURE 1

ELEVATION OF RBS FUEL BUILDING AND TRUCK BAY FOR SPENT FUEL STORAGE CASK LOADING





SECTION VIEW

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FIGURE 2

DRY & WET
IMPACT LIMITER
ASSEMBLY

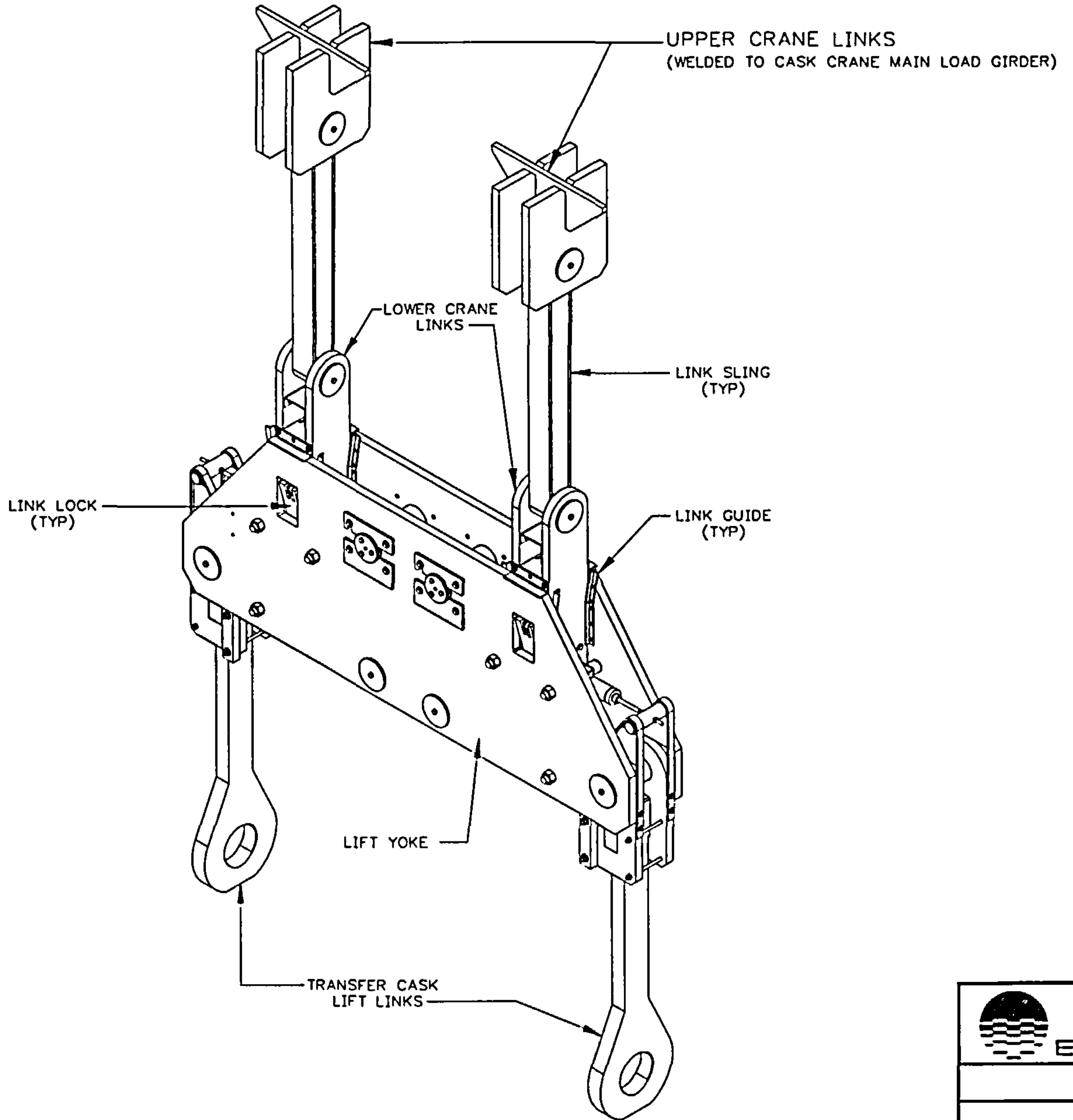

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FIGURE 3

REDUNDANT CRANE RIGGING AND LIFT YOKE ASSEMBLY

Attachment 3

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List of Regulatory Commitments

List of Regulatory Commitments

This table identifies actions discussed in this letter for which Entergy commits to perform. Any other actions discussed in this submittal are described for the NRC's information and are not commitments.

COMMITMENT	TYPE (Check One)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
Submit a matrix comparing the RBS FBCHC to NUREG-0554 and NUREG-0612 criteria to support NRC review.	X		4/1/05
Ensure cask loading procedures specify that only the FBCHC main hoist will be used for cask handling activities		X	Prior to first cask loading campaign
Ensure appropriately designed impact limiters are installed on the cask pool lower shelf and cask washdown area prior to cask lifts in these areas		X	Prior to first cask loading campaign
Ensure cask loading procedures match cask loading evolutions described in this LAR		X	Prior to first cask loading campaign
Upgrade FBCHC quality classification to "Quality Assurance Program Applicable"		X	3/31/05
Ensure cask loading procedures include instructions to check for severe weather prior to commencing outdoor cask handling operations. Evaluation and modify, as necessary, severe weather procedures to address cask handling operations per this LAR, particularly operations when the loaded cask is suspended from the outdoor cask handling crane superstructure		X	Prior to first cask loading campaign
Ensure cask loading procedures include visual confirmation that redundant rigging is properly engaged and slack is removed from redundant rigging slings prior to horizontal movement		X	Prior to first cask loading campaign
Ensure cask loading procedures restrict transfer cask lift height over cask pool lower shelf, cask pool upper shelf, cask washdown area, and mating device to values less than or equal to the values used in the drop analyses		X	Prior to first cask loading campaign
Provide appropriate personnel training to reflect operating procedures and limits per this LAR		X	Prior to first cask loading campaign