SAFETY EVALUATION BY THE MECHANICAL AND CIVIL ENGINEERING BRANCH

AND THE BALANCE OF PLANT BRANCH

OF THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING THE LICENSE AMENDMENT REQUEST FOR

UPGRADING THE FUEL HANDLING BUILDING CRANE SYSTEM

ZIONSOLUTION, LLC, ZION NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-295 and 50-304

1.0 INTRODUCTION

By letters dated May 31, 2012 (Reference 1), and October 25, 2012 (Reference 2), as supplemented by letters dated December 20, 2012 (Reference 3), January 17, 2013 (Reference 4), February 21, 2013 (Reference 5), March 4, 2013 (Reference 6), April 4, 2013 (Reference 7), and May 16, 2013 (Reference 8), ZionSolutions, LLC (the licensee), submitted a License Amendment Request (LAR) to the U.S. Nuclear Regulatory Commission (NRC). The LAR was applicable to the decommissioning Facility Operating License Nos. DPR-39 and DPR-48 for the Zion Nuclear Power Station (ZNPS), Units 1 and 2. The licensee requested approval for the upgrade of the Fuel Handling Building (FHB) crane. This crane upgrade conforms with the American Society of Mechanical Engineers NOG-1, “Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder),” (ASME NOG-1), 2004 Edition (Reference 12), as an acceptable means of meeting the criteria in NUREG-0554, “Single-Failure-Proof Cranes for Nuclear Power Plants” (Reference 11). The upgrade also conforms with any applicable criteria listed in NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36” (Reference 10), Appendix C.

2.0 REGULATORY EVALUATION

The licensee requested a change to the Facility Operating Licensee for ZNPS, Units 1 and 2 in accordance with sections 50.90, “Applications for amendment of license or construction permit,” and 50.59, “Changes, tests, and experiments,” of Title 10 of the Code of Federal Regulations (10 CFR)." The proposed changes would revise the Defueled Safety Analysis Report (DSAR) to include a description of the new single-failure-proof Fuel Handling Building (FHB) lifting system and methodology associated with that design. Additionally, the NRC staff reviewed the proposed method of analysis in accordance with General Design Criterion (GDC) 2, “Design Bases for Protection against Natural Phenomena,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50. Criterion 2 states, in part, that, “Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.” The Criterion also specifies that the design bases for the structures, systems, and components important to safety shall reflect:
(1) appropriate consideration of the most severe of the natural phenomena that have been

historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated; (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and (3) the importance of the safety functions to be performed.

Single-Failure-Proof Crane Guidelines

The licensee described the NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36," (Reference 10) program commitments in the revised DSAR. In Reference 10, the NRC staff provided regulatory guidelines for control of heavy load lifts to assure safe handling of heavy loads in areas where a load drop could impact stored spent fuel, fuel in the reactor core, or equipment that might be required to achieve safe shutdown or permit continued decay heat removal. Section 5.1.1 of Reference 10 provides guidelines for reducing the likelihood of dropping heavy loads and provides criteria for establishing safe load paths; procedures for load-handling operations; training of crane operators; design, testing, inspection, and maintenance of cranes and lifting devices; and analyses of the impact of heavy load drops. The guidelines in Section 5.1.6 address measures to further reduce the probability of a load-handling accident through installation and operation of highly reliable load-handling systems. These measures include use of a single-failure-proof crane to improve reliability through increased factors of safety and through redundancy or duality in certain active components. Criteria for the design of single-failure-proof cranes are included in NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants," (Reference 11).

In RIS 2005-25 Supplement 1, "Clarification of NRC Guidelines for Control Of Heavy Loads," (Reference 15), the NRC staff announced the availability of revised guidance on handling systems and design of single-failure-proof cranes. The staff presented this revised guidance in Revision 1 to Section 9.1.5, "Overhead Heavy Load Handling System" (Accession No. ML062260190), of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (Reference 17)(referred to hereafter as the Standard Review Plan (SRP)). This revised guidance endorsed the criteria for Type 1 cranes from American Society of Mechanical Engineers, NOG-1, "Rules for Construction of Overhead and Gantry Cranes," Reference 12 for the design of new overhead heavy load-handling systems as an acceptable method for satisfying the guidelines of Reference 11. The NRC staff considered the application of Reference 12 criteria to the design of single-failure-proof handling systems, to be an enhancement to Reference 11 guidelines.

3.0 TECHNICAL EVALUATION

Fuel Handling Building and Overhead Crane Design Basis

The FHB is located between the Unit 1 and Unit 2 reactor containment buildings. The FHB, as described in the DSAR, is a Seismic Class I structure and is characterized as important to the defueled condition. The seismic qualification of this structure ensures that a structural failure in the building will not result in an increase in the severity of any accident postulated to occur in the defueled condition, so the entire structure is classified as Seismic Class I. As such, the FHB is consistent with Section C.2 of Regulatory Guide (RG) 1.29, "Seismic Design Classification," and Section 3.7.2, "Seismic System Analysis," of Paragraph II.3 of the SRP.

Paragraph II.3 of SRP Section 3.7.2 states, “If the operating basis earthquake (OBE) is set at one-third or less of the safe shutdown earthquake (SSE), an explicit response or design analysis is not required. If the OBE is set at a value greater than one-third of the SSE, an analysis and design must be performed to demonstrate that the applicable stress, strain, and deformation limits are satisfied.”

Spent fuel is currently stored in the ZNPS spent fuel pool (SFP). The ZNPS does not have a single-failure-proof crane at this time; however, the licensee is not currently loading spent fuel casks. Before lifting the first spent fuel cask, the licensee plans to make modifications to the Zion FHB crane and its supporting structures to comply with single-failure-proof criteria.

The overhead crane consists of a bridge frame comprising two girders that are connected by two end trucks mounted on wheels that roll in the transverse direction on the building runway girders. A wheel-mounted trolley on this frame rolls in the axial direction of the crane. Harnischfeger/P&H manufactured the existing FHB overhead bridge crane as original plant equipment. It has a 125-ton rated main hoist and a 15-ton rated auxiliary hoist, both of which operate from the same trolley. The licensee will replace the existing trolley on the overhead crane with a new trolley with a single-failure-proof main hoist and upgraded crane controls in accordance with the guidance in NUREG-0554, ASME NOG- 1, and NUREG-0612 as applicable. In addition, the licensee will make modifications to the clip arrangement for the runway rails. Associated lifting devices and interfacing lift points will meet the guidance in NUREG-0612, Section 5.1.6 in order to ensure that the entire Fuel Handling Building lift system is single-failure proof.

The overhead crane is initially assumed to be parked on the FHB runway girders. The drive wheels are assumed to be locked in place by a brake torque that is transmitted from the crane brake through the gear box and the drive wheel axles. The crane brakes are preloaded spring brakes that are set when an earthquake occurs or when the crane is not in service, and they are rated for certain static torque ratings. If the building is undergoing seismic motion, the crane will move in its transverse direction with the runway girders without rolling or sliding, as long as the drive wheel brake torque is not exceeded or, equivalently, as long as the traction between the drive wheels and the runway rails does not exceed the critical traction corresponding to the brake torque. Once the wheel traction exceeds the critical traction or, equivalently, once the torque on the drive wheels exceeds the brake torque, the crane is assumed to roll without slipping on the runway girders until a reversal of girder motion occurs. The crane will continue to roll until the girder motion is reversed. At this point, the brake torque reverses, and motion in the reverse direction will occur when the critical traction is again exceeded. The same effect occurs when the trolley is parked in place and the seismic motion occurs in the axial direction of the crane, perpendicular to the runway girders.

The ZNPS DSAR revisions describe fuel handling operations using the FHB crane. Section 3.2.2, “Seismic Class I Structures,” of the DSAR, identifies the FHB and the SFP in the FHB as Seismic Class I structures. Section 3.3, “Wind Loading Design”, of the DSAR specifies the loads used in the design of Class I structures, which include tornado wind loads, tornado missiles, and the maximum hypothetical earthquake. Section 3.9.3.2.3 of the DSAR also identifies the FHB crane as a Class I system, though it was not designed as a single-failure-proof handling system during initial plant licensing.

As described by the licensee, the FHB at the ZNPS consists of a lower, reinforced concrete structure and a steel structure supporting the FHB overhead crane and the FHB roof. The reinforced concrete portion extends from the FHB foundation mat to the top of the SFP structure at the elevation of 617 feet and 4 inches. The FHB contains an SFP and a cask loading pit that is separated from the remainder of the pool by walls. The FHB houses a cask decontamination pit located west of the cask loading pit. An elevated floor opening at the elevation of 617 feet and 4 inches, which allows access to the cask loading bay at the 592-foot elevation, is located at the extreme west end of the FHB. The crane runway was arranged to support movement of fuel transportation casks in the FHB between the cask loading pit, the cask decontamination pit, and downward through the elevated floor opening to a cask transport vehicle in the cask loading bay. Thus, the crane runway extends along an east–west axis from above the SFP to the elevated floor opening over the cask loading bay.

In this LAR, the licensee described the configuration of the FHB steel structure. The top of the structural steel for the steel roof support structure is at about the 663-foot elevation. The SFP cask handling (overhead) crane runway is supported by the steel crane and roof support structure for the FHB. The crane rails are located at the 643-foot elevation. The crane rails are supported on steel crane girders, which are in turn supported by vertical structural steel columns. The steel building columns are anchored to the concrete structure at the 617-foot elevation and the steel columns for the cask loading bay are anchored at the 592-foot elevation.

3.1 Seismic Evaluation of the FHB

3.1.1 Licensee's Basis for Acceptance of Seismic for FHB

In a letter dated December 18, 2012, (Reference 18), the NRC staff asked the licensee to confirm that ZNPS has met the guidance stipulated by SRP 3.7.2, Paragraph II.3, and to provide the results and the references confirming that this condition has been satisfied. Alternatively, if ZNPS did not consider the aforementioned SRP criteria, the licensee was to provide the OBE results that were omitted from the analysis.

In Reference 5, the licensee stated that ZNPS DSAR defines only a design-basis earthquake (DBE) for the facility that is currently undergoing decommissioning and that the seismic response curves for the facility provided in the DSAR are equivalent to the SSE response used as the original design basis for the facility. No OBE or SSE is identified. This position was accepted by the NRC in its safety evaluation report (SER), (Amendments 180 and 167, respectively, for Units 1 and 2 dated December 30, 1999 (Reference 19)). The SER states, "The specification also notes that other SSCs [structures, systems, and components] are designed to withstand an operational basis earthquake or per applicable codes, and are defined as Seismic Class 2 or 3. These descriptions are not included in the PDTS [permanently defueled technical specification] since safe shutdown, post-accident containment isolation, LOCAs [loss-of-coolant accidents], and the ability of the reactor to withstand an earthquake and keep operating are no longer of concern."

The licensee also stated that, although only one seismic calculation was needed per the criteria in the DSAR, for the FHB structure, the contractor for ZNPS used the SSE and OBE responses from the updated final safety analysis report when analyzing the seismic qualification of the FHB, and in most cases, the SSE and OBE were analyzed in accordance with the SRP. However, in some cases, the SSE and OBE calculations were not performed; instead, the SSE loads were evaluated against the OBE working stress allowable. If the interaction ratio (IR) for this case was 1.0 or less, no further analysis was performed. If the IR of the SSE loads versus the OBE working stress allowable was greater than 1.0, the SSE and OBE cases were both evaluated. The IR is defined as the stress or load induced in a component divided by the allowable stress or load for the component as prescribed by the applicable design “Code of Record” for that component. Accordingly, an IR that is less than 1.0 demonstrates the design code provisions applicable to the structural evaluation of the component have been satisfied.

3.1.2 NRC Staff Evaluation for Acceptance of Seismic for FHB

The NRC staff reviewed the licensee responses for the seismic evaluation of the FHB and found them acceptable because the safe shutdown, post-accident containment isolation, LOCAs, and the ability of the reactor to withstand an earthquake and keep operating are no longer of concern. In Reference 12, Section 4140, both the OBE and the SSE are defined as extreme environment conditions and for this reason they have the same allowable values. Because the OBE response spectra are enveloped by the SSE response spectra and both events have the same allowable values, the OBE event is enveloped by the SSE event and no further evaluation was carried out for an OBE event. However, in some cases, both calculations were not performed; instead, the SSE loads were evaluated against the OBE working stress allowable. If the IR for this case was 1.0 or less, no further analysis was performed. If the IR of the SSE loads vs. OBE working stress allowable was greater than 1.0, the SSE and OBE cases were both evaluated by the licensee. The NRC staff found the licensee’s approach for evaluating the SSE loads and the OBE working stress acceptable because, the OBE response spectra are enveloped by the SSE response spectra and both events have the same allowable values.

3.2 Crane Supporting Structure Evaluation

3.2.1 Licensee’s Basis for Acceptance of Crane Supporting Structure

In Reference 3, the licensee stated that calculations performed in Calculation Note ZION001-002, Appendix B, demonstrated that the original design of the runway rail and rail clip was not adequate for the new design-basis load case for a seismic event with a load on the hook. The licensee proposed to modify the rail clips to address the new design-basis load case. Calculation ZION001-CALC-034, evaluated the proposed rail clip modification and the runway rail with the proposed modification installed. The licensee also stated that the majority of the existing clips have center-to-center spacing of 2 feet. The new rail clips will be installed between two existing rail clips, providing generally the same center-to-center spacing (2 feet) as the existing design. The new clips are designed for full wheel forces to be applied to a single rail clip without relying on the distribution of forces to the adjacent existing clips providing unanalyzed margin.

During the review of the crane supporting structures, the NRC staff noticed that, on page 17 of the Reference 2, the licensee stated:

(1) All of these members pass the code check except for the girder on Column Line P for two load cases. The interaction ratios for shear capacity in these two cases were 1.038 and 1.048. This girder has gusset plates that were not included in the model.

(2) In the "Beam Member" table shows an IR equal to 1.016 (156.39 kips (actual) versus 154 kips (allowable)) for the maximum resultant connection load under OBE loading. This interaction ratio was not acceptable, because the loads in all directions must act simultaneously during OBE and SSE loading conditions.

In a letter dated December 18, 2012, the NRC staff asked the licensee to provide the results of the analysis with: (1) the subject gusset plates included in the model for the girder on column line P, and (2) for the beam with IR greater than 1.0, provide a modification (method) that could bring the interaction ratio below unity for the staff to review.

In Reference 5, the licensee stated that Calculation ZION001-CALC-002 had been revised to calculate an IR based on the additional shear capacity. (1) The revised IR is 0.204 for the worst case (previously 1.048), with the other case (previously 1.038) determined to be less than 0.204 by comparison for the girder on column line P. (2) Calculation ZION001-CALC-002, Revision 2 was developed from the maximum enveloped axial end forces from cross braces HB4 and HB5 that are framed into the beam. The IR for the beam was therefore, reduced to 0.319.

The licensee also stated that during the preparation of Revision 2 of ZION001-CALC-002, the contractor determined that four other code checks produced IRs greater than 1.0. This resulted in the total number of load case/member combinations with IRs above 1.0 to equal six. The additional cases are for two W14x43 bracing members along column line 23 at the crane girder elevation as shown on FHB's drawings B-402 and B-403. In two load cases, the code check of these two members resulted in IRs of 1.041, 1.108, 1.197, and 1.274. The two load cases are for OBE forces. The ZNPS DSAR requires allowable stresses for the OBE to be in accordance with the American Institute of Steel Construction (AISC) specification. Therefore, an allowable stress increase was applied in the calculation and the resultants IRs were reduced to 0.78, 0.83, 0.90, and 0.96, respectively. An independent review by the licensee's contractor review of the output was performed and no other members, beyond those described above, were determined to have IRs greater than 1.0.

3.2.2 NRC Staff Evaluation of the Crane Supporting Structure

The NRC staff reviewed the licensee submittal (assuming that an existing 175-pound (lb) crane rail is 50 kips per square inch (ksi) material (as opposed to the controlled crane rail range from 65 ksi to 90 ksi) and information in the Reference 8. The staff found the information in Table 1 acceptable because the highest loads and stress values are less than the ASME Code allowable values as shown in the table. (In Table 1, "Clip 1" is the standard clip; "Clip 2" is located at column tie-backs). The staff also found that the weld stresses in Table 2 are within ASME Code allowable values.

The NRC staff also reviewed the licensee responses to the girder on column line P and the cases where the load case/member combinations initially had IRs greater than 1.0 and found all of them to be acceptable. The girder on column line P was acceptable based on the additional shear identified in the reanalysis of Calculation ZION001-CALC-002, Revision 2. The load case/member combinations were acceptable based on the licensee's use of the AISC Code allowables. For the beam with an initial IR greater than 1.0, the NRC staff reviewed the licensee responses and found that the Reanalysis was appropriate and resulted in the maximum resultant load at connection, was less than the code allowables. Additionally, the staff noted that there were no other members, beyond those described above, that were determined to have IRs greater than 1.0.

Table 1

Component/Load Description	Load/Stress	American Concrete Institute's (ACI) Code Allowable
Bending in clip because of uplift (Clip 2)	34.516 ksi	37.5 ksi
Shear in clip because of uplift at reduced section (Clip 1)	7.055 ksi	20 ksi
Bearing in clip at bolt location (Clip 1)	23.383 ksi	45 ksi
Block shear in clip (Clip 1)	72.34 kip	122.891 kip
Bolt tension (Clip 1)	17.515 kip	53.7 kip
Bolt shear (Clip 1)	36.17 kip	39.8 kip
Girder flange local bending because of tension in clip	5.015 ksi	27 ksi
Girder flange local bending because of compression	25.973 ksi	27 ksi
Girder flange local bearing	14.289 ksi	32.4 ksi
Girder flange local block shear	72.34 kip	299.334 kip
Crane rail local web shear	9.114 ksi	20 ksi
Crane rail local web bending	32.427 ksi	37.5 ksi
Crane rail minor axis bending	31.325 ksi	37.5 ksi
Crane rail bottom flange local bending	20.094 ksi	37. 5 ksi

Table 2

Case	Maximum Weld Stress	ACI Code Allowable Weld Stress
Operating Load Case	12.47 ksi	15.79 ksi
Seismic Load Case	21.696 ksi	23.69 ksi

3.3 FHB Structure Evaluation

3.3.1 Licensee's Basis for Acceptance of FHB Structure

Anchor Bolts

The capacity of the anchor bolts was evaluated for tension and shear as identified in the first two columns of Table 3 below. Reactions were calculated at the column baseplates for both

OBE and SSE loads using both working stress and ultimate strength load combinations. The anchor bolts were evaluated against the resulting worst-case tension and shear loads.

Table 3

Values for Anchor Bolts		**Calculated**	**ACI Code Allowable**
Tension	Max. Tension in Single Anchor OBE (Type R Base Plate Configuration)	89.45 kips	129.41 kips
	Max. Tension in Single Anchor SSE (Type R)	104.70 kips	129.41 kips
	Max. Tension in Group of Anchors OBE (Type R)	178.81 kips	229.11 kips
	Max. Tension in Group of Anchors SSE (Type R)	209.28 kips	229.11 kips
Shear	Max. Shear in Single Anchor OBE (Type R)	7.99 kips	68.45 kips
	Max. Shear in Single Anchor SSE (Type T)	51.95 kips	68.45 kips
	Max. Shear in Group of Anchors OBE (Type R)	15.93 kips	161.20 kips
	Max. Shear in Group of Anchors SSE (Type T)	100.41 kips	161.20 kips
Maximum Interaction, Combined Tension and Shear OBE (Type R)		0.897	1.0
Maximum Interaction, Combined Tension and Shear SSE (Type R)		0.95	1.0

<u>Concrete Columns</u>

The capacity of the concrete columns was evaluated in accordance with the original “Code of Design,” the American Concrete Institute’s (ACI) 318-63, “Building Code Requirements for Structural Concrete.” Enveloped forces from the SSE load combinations were used and verified using working stress design (OBE allowable forces and stresses) as opposed to ultimate strength (SSE allowable forces and stresses). The results are considered bounding for the OBE case. Axial and moment interaction diagrams from the ACI Publication SP-3, “Reinforced Concrete Design Handbook, Working Stress Method,” Third Edition, were used to compare forces to capacity.

Table 4

Values for Concrete Columns	Calculated	ACI Code Allowable
Max. Axial Load	711.49 kips	3,617 kips
Max. Shear Stress	21.9 psi	70 psi
Max. Bearing Stress	207.3 psi	1,000 psi
Max. Moment	18,351 kip-in.	18,951 kip-in.

Shear Walls

The capacity of the concrete shear walls was evaluated for shear, moment, and axial loads as identified in the first column of the Table 5. The second and third columns in Table 5 identify the most limiting cases of evaluations of SSE Loads and the allowable working stress, respectively. The working stress method of ACI 318-63 was used to evaluate the walls for the enveloped SSE loads. Where acceptable, this bounded the OBE load case. In isolated cases, SSE loads were evaluated using ultimate strength design allowable. In all but one case, for which SSE loads are evaluated using ultimate strength allowable, OBE loads were evaluated using working stress allowable.

Table 5

Values for Shear Walls	Calculated	ACI Code Allowable
Maximum Shear Stress (out-of-plane load)	70 psi	70 psi
Maximum Out-of-Plane Moment (per 1" width)	28.578 kip-in.	34 kip-in.
Maximum In-Plane Shear	68 psi	70 psi
Maximum In-Plane Moment	1,073,150 kip-in.	1,097,317 kip-in.
Maximum Axial Load (per foot of length)	512 kips*	508 kips

* The loads identified in the "Shear Walls" table are very close to the allowable loads. In particular, the "Maximum Axial Load" is greater than the allowable load (512 kips versus 508 kips) and the subsequent interaction ratio of 1.008 was unacceptable.

In a letter dated December 18, 2012, the NRC staff asked the licensee to provide an analysis that could bring the interaction ratio for the maximum axial load listed in Table 5 to below 1.0.

In Reference 5, the licensee stated that the loads shown in Table 5 were developed in Revision 1 of ZION001-CALC-002. The values were based on the SSE design loads compared to the OBE allowable stress capacities. A bounding evaluation was performed in lieu of performing two separate evaluations for OBE and SSE for the maximum axial load. In accordance with the ZNPS DSAR, the capacity of concrete members under SSE load combinations is based on Ultimate Strength Design. A reanalysis was performed by the licensee in Revision 2 of ZION001-CALC-002 comparing an OBE load against the 508 kips allowable and using Ultimate

Strength Design to evaluate the SSE load of 512 kips. The resulting IRs are 354 / 508 = 0.698 and 512 / 1406 = 0.364 respectively.

In Reference 8, the licensee stated that the capacity of the concrete shear walls shown in Table 6 below was evaluated for shear, moment, and axial loads, as identified in the first column. The most limiting cases of the evaluations of the SSE loads compared to the working stress allowable are identified in the second and third columns in Table 6. The working stress method of ACI 318-63 was used to evaluate the walls for the enveloped SSE loads. Where acceptable, this bounds the OBE load case. Isolated cases exist where SSE loads were evaluated using ultimate strength design allowable identified in the fourth and fifth columns. In all but one case (described in the note in Table 6 below where SSE loads are evaluated using ultimate strength allowable), OBE loads were evaluated using the working stress allowable identified in the sixth and seventh columns.

Table 6

Shear Walls						
Item	**SSE**	**OBE ACI Code Allowable** (Working stress)	**SSE**	**SSE ACI Code Allowable** (Ultimate Strength)	**OBE**	**OBE ACI Code Allowable** (Working stress)
Maximum out of plane shear stress	70 psi shear wall P7	70 psi	77 psi shear wall P4	108 psi	64.8 psi shear wall P4	70 psi
Maximum out of plane moment per 1” width	28.578 K-in shear wall P8A	34 K-in	30 K-in shear wall P3	66.15 K-in	Shear wall P3*	27 K-in
Maximum in plane shear stress	68 psi shear wall P10C	70 psi	SSE vs. SSE enveloped by SSE vs OBE		OBE vs OBE enveloped by SSE vs OBE	
Maximum in plane moment	1.073,105 k-in shear wall P3	1.097,317 k-in	SSE vs. SSE enveloped by SSE vs OBE		OBE vs OBE enveloped by SSE vs OBE	
Maximum axial load per ft. of wall	68.86 kips shear wall P4	96 kips	314 kips shear wall P11	345 kips	230 kips shear wall P11	255.36 kips

*SSE Maximum Moment - 30 k-in per in./OBE Working Stress Allowable Moment - 27 k-in. per in. (IR= 1.111). The SSE load case was subsequently evaluated independently and the satisfactory results are tabulated above. Based on the analysis and the results tabulated in Attachment 51 of the ZIONOO1-CALC-002, SSE forces and stresses are larger than OBE; therefore by comparison, the wall is acceptable under OBE conditions.

(1) Revision 2 of Calculation ZION001-CALC-002 refers to particular shear wall sections as P2 through P11 and is provided in Table 6 to aid in validating against the referenced calculation. These shear wall sections are not directly related to column lines and can only be interpreted using the referenced calculation.

(2) For the values shown (Maximum In-Plane Shear Stress and Maximum In-Plane Moment), all shear walls in the SSE calculated values were less than the OBE allowable. Since this represents a bounding case, the individual SSE and OBE calculations were not required.

(3) The original bounding load case of the SSE moment versus the OBE allowable had the IR of 1.111 for shear wall P3. The licensee recalculated the SSE load case using the SSE allowables and the resulting IR for the SSE load case was 0.45. The licensee thus judged that the OBE calculation was not required based on the relationship between the SSE and the OBE loads.

3.3.2 NRC Staff Evaluation of FHB Structures

The NRC staff reviewed the licensee responses and reanalysis (ZION001-CALC-002, Revision 2), as described in Section 3.3.1 above, and found that the reanalysis was acceptable based on the ACI Code Allowables. For the anchor bolts, concrete columns, and shear walls, calculated loads were all within the allowable values of the codes, as provided in Tables 3, 4, 5 respectively, and therefore, are acceptable. For shear wall P3, use of engineering judgment was considered to be acceptable since the OBE calculations were not required.

3.4 Tornado Wind Load Evaluation

3.4.1 Licensee's Basis for Acceptance of Tornado Wind Load

The licensee noted in the LAR that the seismic analysis was performed in accordance with Reference 12. However, on page 23 of the Reference 2, under "Crane operational load cases in Section 4140 of the ASME NOG-1" and under "Crane seismic event loads in Section 4140 of the ASME NOG-1," the operating, design, and tornado wind loads were omitted by the licensee.

In a letter dated December 18, 2012, the NRC staff asked the licensee to provide a technical justification for why the operating, design, and tornado wind loads were not included in the analysis.

In Reference 7, the licensee stated that the design bases for the FHB described in the ZNPS DSAR does not require (nor provide for) combining operating or design wind loads or tornado wind loads with the earthquake loads or crane live loads. However, the building design was analyzed for the combination of dead load, live load, thermal loading, and design wind loads, as well as the combination of dead load, thermal loading, and tornado wind loads. In no case does the required analysis include the design-basis earthquake combined with design or tornado wind loads.

Section 4140 of Reference 12 identifies the loads and load combinations applicable to the analysis performed for a Type 1 crane (which includes the proposed FHB crane modification). The Operating Wind Load (designated “P_{wo}” in Reference 12 and not included in the ZNPS DSAR Table 3-5), Design Wind Load (designated “P_{wd}” in Reference 12 and “W” in the ZNPS DSAR Table 3-5), and Tornado Wind Load (designated as “P_{wt}” in Reference 12 and “W” in the ZNPS DSAR Table 3-5) are not combined with earthquake loads or crane live loads in the ZNPS DSAR Table 3-5 or in the proposed Table 3-5A load cases, which reflect the design basis of the ZNPS.

The licensee also stated that the calculations performed for the proposed crane modification are consistent with the above stated station load combinations. However, as noted in the load combinations above, the “Operating Wind Load” was not considered in the original design basis for the FHB. Therefore, because the calculations provided to demonstrate the acceptability of the crane, in accordance with the standards in Reference 12, do not contain the full set of load combinations prescribed by Reference 12, ZNPS requested an exception to Reference 12, Section 4140. Although the original design basis of the building includes design and tornado wind loads as described above, this exception does not affect the analysis of the crane itself because it is an indoor crane.

ZNPS has proposed administrative controls to limit the likelihood of having a load suspended from the FHB crane hook during a tornado. These commitments to administrative controls are as follows in the LAR:

- In the “List of Regulatory Commitments,” a continuing compliance commitment states:

  Heavy load movements using the FHB Overhead Bridge Crane (OBC) are not permitted if a tornado watch or warning has been declared for the site by the National Weather Service. If heavy load handling with the OBC is in progress when any of these criteria are met, the load will be placed in a safe location as soon as possible and the crane secured.;

- In the proposed update to the ZNPS DSAR, Section 3.9.5.4.2, “Load Handling Procedures,” states:

  Because the maximum credible tornado and the fully loaded crane have not been analyzed together, heavy load movements using the Fuel Building overhead bridge crane are not permitted if a tornado watch or warning has been declared for the site;” and

- In the “Heavy Loads Program,” ZAP-510-19, Section 6.3.12 states:

  Procedures for heavy load handling operations shall include the following Precaution/Limitation:

  Heavy load movements using the FHB Overhead Bridge Crane (OBC) are not permitted if a tornado watch or warning has been declared for the site by the National Weather Service. If heavy load handling with the OBC is in progress when any of these criteria are met, then the load will be immediately lowered to a safe location and the crane secured.

3.4.2 NRC Staff Evaluation of Tornado Wind Load

The NRC staff reviewed the licensee responses and commitments and found them acceptable because the requested exception to Reference 12 pertains to the application of tornado wind and tornado-generated missile loading to the new single-failure-proof crane and its support structure. To support this request, the licensee has committed to update its DSAR to prohibit the movement of heavy loads using the FHB overhead bridge crane when high-wind conditions, such as tornadoes, hurricanes, or tropical storms, are forecast.

3.5 Bridge Crane Evaluation

3.5.1 Bridge Modifications

The licensee uses ASME NOG-I- 2004 (NOG-I) as the design and construction standard to satisfy NUREG-0554 requirements. In order to satisfy NUREG-0544 the licensee will make the following modifications to the bridge:

- Replacement of control panels: To facilitate the upgrade to single-failure proof and to conform to the guidance in NUREG-0544, Section 6.6, the licensee will replace the control panels. Upgrades include emergency stop buttons and interlock to prevent operation from multiple control stations.

- Load cell readouts: Per NOG-1, Paragraphs 6445.1 and 6466, the licensee will install new hoist controller furnished with overload limiting device. The overload limiting device includes a digital readout display for the cab, bridge, and radio controls.

- Isolation transformer: Per NOG-1, Paragraph 6417, the licensee will use AC variable frequency drives. To facilitate the use of the variable frequency drives, the licensee will install an isolation transformer for the new flux vector and frequency controls.

- Radio controls: As permitted by NUREG-0544, Section 6.6, the licensee will install radio controls. In conformance with Section 6.6, the radio controls will have the same functions as the cab master control switches. In addition, the controls will have electrical interlocks that permit operation of one control station at a time to preclude the possibility of operating multiple control stations at the same time.

- Festoon electrification and conductor bar: In accordance with NOG-1, Paragraph 6483, the licensee will install a ridged ground conductor bar for the main line runway system and a flexible continuous conductor suspended in a festooned arrangement for the bridge system.

- Modification to main disconnect: In accordance with NOG-1, Paragraph 6433, the licensee will make modification to the crane’s main disconnect to allow it to interface with and disconnect the auxiliary systems including the crane lighting and warning systems.

- Safe Shutdown Earthquake cutoff: In accordance with NOG-1, Paragraph 6120, the licensee will install an automatic system to de-energize the crane power supply in the event of either a Safe Shutdown or an Operational Basis Earthquake.

- Limit switches: In accordance with NOG-1, Paragraph 5459, the licensee will modify the bridge limit switch arrangement so that the bridge stops and the brakes set so that the bridge does not contact the bumpers.

- Runway rail clips: The licensee will modify the clip arrangement to assure that an SSE will not overstress the clips with the crane loaded to its maximum with the hook up (see seismic evaluation).

The licensee's proposed modifications to the bridge are in accordance with the applicable criteria and guidance in NUREG-0544 and ASME NOG-1-2004. Therefore, when implemented, the licensee's proposed modifications to the bridge will meet or exceed criteria listed in NUREG-0554, NUREG-0612 Appendix C, and ASME NOG-1-2004. Based on the above, the staff finds the proposed modifications ,when implemented as described in the LAR as supplemented, acceptable.

3.5.2 Trolley and Hoist Replacement

The licensee will replace the existing trolley and hoists with a new trolley and hoists manufactured by Morris Material Handling/P&H. As described by the licensee, the main hoist and trolley unit is a NOG Type I design, with a new 125-ton rated single-failure proof main hoist. The auxiliary hoist is a 15-ton rated non-single-failure proof NOG Type III design. The ASME NOG-1 Type I main hoist unit with Type I main hoist components is designed and arranged to prevent a "two-blocked" condition consistent with the NRC and industry guidance as specified below. Included in the upgrade are new hoist hooks, new carbon steel wire rope, lower block and other components affixed to the trolley. The 125-ton hook will attach directly to the specially designed yoke for the MAGNASTOR Transfer Cask (MTC). In addition, the upgraded trolley will have means and equipment for manually positioning the trolley in case of loss of all external AC power.

Travel Length

NUREG-0612, Section 5.1.1(1) states that safe load paths be defined for the movement of heave loads to minimize the potential of heavy loads, if dropped, irradiated fuel. The north/south (N/S) and east/west (E/W) end of travel limits of the 125-ton hook are the same as the existing end of travel limits and lift lengths are the same or greater than those for the existing hoist. However, the licensee will reduce the size of the existing load path restricted zone to exclude the new fuel vault. In accordance with NUREG-0612, the revised restricted zone will incorporate the spent fuel pool and transfer canal with added margin to prevent the MTC from travelling over those areas.

Reeving

ASME NOG-1, Paragraph 5420 (a), states that the design of the rope reeving system shall be such that a single rope failure will not result in the loss of the lifted load, a load balance shall be provided on each rope system, and the reeving system shall be divided into two separate load paths so that either path will support the load and maintain vertical alignment in the event of rope breakage or failure in the rope. In accordance with NOG-1, the licensee's main hoist has a balanced redundant reeving system such that no single rope failure results in the loss of the lifted load. Each rope system has equalizer sheaves or bars to ensure equal rope load and each system is capable of supporting the entire load. In addition, the main hoist system is such that the load block does not twist in the un-loaded or loaded condition and the hoist drums have a monitoring system that shuts down the main hoist crane drive if a wire rope becomes dislodged from its proper groove.

In accordance with ASME NOG-1, Paragraph 5420 (b)(2), the auxiliary hoist is double-reeved with both ends of the rope attached to the drum. The drum is grooved with left and right grooves beginning at both ends of the drum, then grooving toward the center of the drum. The load follows a true vertical path as the ropes wind toward or away from each other onto or off the drum.

In accordance with ASME NOG-1, Paragraph 5425.1, the main hoist wire ropes have a 10-to-1 design factor when supporting the maximum critical load (MCL) plus the weight of the load block, including a 5% increase to accommodate for degradation from wear. To accommodate the possible upending of the dry cask storage system components, the main hoist reeving and arrangement of mechanical components permit lifting at an angle of three (3) degrees in either direction along the centerline of the hoist, parallel with the girders. The arrangement ensures that the hoisting ropes do not rub against the trolley frame when lifting at this angle. In addition the main hoist fleet angles do not exceed 3½ degrees except for the last three feet of maximum lift elevation as required by ASME NOG-1, Paragraph 5426.1.

Hooks

In accordance with ASME NOG-1, Paragraph 5428.1, the main hoist is a dual prong hook with has a safety factor of 10-to-1, static plus dynamic; including margin for wear (design margin is maintained when lifting from either the hook prongs or center pin hole). The hook is made of forged alloy steel and has safety latches bridge the two hook prong openings. To ensure hook mating with the fuel transfer lifting devices, all latch components are narrower than the hook width and do not interfere with pins sized to rest in the valley of the hook prongs. The auxiliary hoist is a single-prong hook made of forged carbon steel with a safety latch to bridge the hook prong opening. All hooks rotate 360 degrees and have punch marks to measure the hook prong throat openings. All safety latch components are of a non-corrosive material.

Load Blocks

In accordance with ASME NOG-1, Paragraphs 5420 and 5421, critical components of the main hoist upper and lower blocks have a safety factor of 10-to-1, static plus dynamic loading. In accordance with ASME NOG-1, Paragraph 1145m the design of the main hoist load block allows for immersion into the SFP.

Drip Pans and Lubricants

In accordance with ASME NOG-1, Paragraph 5461, all oil-lubricated components of the main hoist, auxiliary hoist, and trolley have drip pans. Grease-lubricated components that do not have a structure beneath them (such as the trolley deck) have drip pans to retain any excess lubricant. Drip pans will hold 1.1 times the total quantity of lubricant that could leak.

In accordance with ASME-NOG-1, Paragraph 1145 (b), lubricants for components immersed in the SFP are non-water-soluble and free of halogenated compounds, halogens, mercury, and other harmful materials to ensure compatibility with the pool chemistry.

Controllers

In accordance with ASME-NOG-1, Paragraph 6417, the licensee will use AC variable frequency drive (VFD controllers. VFDs have protective features including output phase loss, under voltage, over voltage, motor thermal overload, and VFD overheat. The VFDs provide dynamic control braking and have a minimum of 150% overload capability for 1 min. In addition, the licensee will use line reactors, isolation transformers, and shielded cables, to prevent detrimental effects due to harmonic and EMI/RFI emissions produced by inverters as required by ASME NOG-1, Paragraph 6417.

Motors

The hoist motors are 460v, 3-phase, 60 Hz AC vector duty induction motors and are sized in accordance with ASME NOG-1, Paragraph 6472.1. The bridge and trolley drive motors are 460v, 3-phase, 60 Hz AC inverter duty motors and are sized in accordance with ASME NOG-1, Paragraph 6472.2. The maximum motor revolutions per minute (RPM) for any motor is 1800, with bridge motors being selected to interface with the existing bridge drive gear case and shafting. Each new motor has an automatic resetting 3-phase bi-metallic thermal overload relay for external motor branch-circuit overload protection. Each new motion controller has a separate 3-pole molded case thermal magnetic (inverse-time) circuit breaker for motor branch-circuit short-circuit protection. All motors meet the criteria in NEMA MG1, Part 31 as applicable for specified duty.

Hoist Holding and Emergency Brakes

In accordance with ASME NOG-1, Paragraph 6422.1, he main hoist has two (2) shoe-type holding brakes, one on each of the redundant gear trains, which can each hold 150% of the rated load hoisting torque. In accordance with ASME NOG-1, Paragraph 6422.2, the auxiliary hoist has two (2) holding brakes, which can each hold 100% of the rated load hoisting torque. All holding brakes for normal operating modes engage upon returning the motion controller to the neutral ("off") position, upon opening the mainline magnetic contactor, or upon loss of power. The main hoist brake, in accordance with ASME NOG-1, Paragraph 6422.1(b), is capable of stopping and holding the credible critical load during an SSE or OBE event. An emergency brake and, as appropriate, the normal operating brakes engage upon the predetermined emergency conditions (e.g. rope failure loss of AC power). The common motor drive has an eddy current brake (Magnetorque), which allows the operator to lower the load at a controlled speed in emergency conditions and has a means for manual releasing to provide emergency lowering of the load controlled in case of loss of all external AC power in accordance with ASME NOG-1, Paragraph 6422.1(c).

Bridge and Trolley Brakes

Each traverse motion controller motor has a motor mounted disc brake. In accordance with ASME NOG-1, Paragraph 6423.1, the brakes can hold 100% of the drive torque developed at the point of application and are field adjustable to be capable of stopping the drive within the distances specified in NOG-1. The disc brake of each traverse motor serves as the emergency brake and holding brake. The brake engages upon returning the motion controller to the neutral ("off") position, upon opening the mainline magnetic contactor, upon loss of power, or upon any emergency or faulted condition as detected by the traverse motion controller. The AC variable frequency control provides the controlled braking for each traverse motion. In addition, each brake has a means for manual brake release.

Hoist Limit Switches

In accordance with ASME NOG-1, Paragraph 6440, each hoist has an upper and lower geared limit switch wired to the hoist control circuit. Each hoist has a block-actuated back-up upper limit switch and a slack rope actuated back-up lower limit switch. Upon tripping an initial hoist limit switch, the control system will only allow motion in the reverse direction. Actuation of a second limit switch requires operator action to reset the control system before the control system will allow further motion.

Overload Limiting Device and Load Cell Readout

Each hoist controller has a field adjustable overload limiting device, which senses the lifted load (independent of any electronic sensing features of a flux vector hoist control) to prevent lifting overloads that could cause permanent damage. When an overload condition is detected the load cell sends a signal to the hoist motor control circuit and immediately disables hoisting, providing two-block and load hang-up protection as required by NUREG-0544, Section 4.5. The set point is adjustable, with the high setting approximately 120% of the heaviest lifted load (i.e., loaded and flooded transportable storage canister (TSC) with a lid inside a Transfer Cask and including the Lifting Yoke) to provide a margin for acceleration of the lifted load. The hoist controller has a means for bypassing the overload limiting device in order to perform the field load tests. The crane cab has a digital readout and the large readout on the bridge will be visible from the refueling floor. The display permits load readout of either the main or the auxiliary hoist. In addition, the radio control system will have a readout as well.

Radio Controls

NUREG-0544, Section 6.6 allows for the use of radio controls given that the controls for any of the motions should be identical to those provided on the bridge cab control panel and have electrical interlocks that permit only one control station to be operable at any one time. The bridge mounted control enclosure contains a selector switch for selecting either radio or cab operation. The cab master switches have the same control functions as the radio control and have electrical interlocks that permit only one control station to be operable at any one time The Magnatek/Telemotive radio system has Electromagnetic Compatibility (EMC) such that it does not produce electromagnetic emissions that will interfere with other devices and other devices' electromagnetic emissions will not interfere with it. The radio system has a receiver within its own RFI shielded NEMA 12 enclosure, Magnetek SLTX lever type belly box transmitter, receiving antenna, three rechargeable NiCad battery packs, and 120v AC battery charger. The system is digitally encoded and is failsafe upon loss of power or low battery. The licensee claims the system meets Federal Communications Commission (FCC) regulations for a Part 90 licensed system.

Load Testing

The manufacturer load tested the trolley at the factory. After installation, the licensee will perform all functional and "cold proof" load testing as applicable in accordance with NOG-1 and NUREG-0554 prior to placing the crane in service as a single-failure proof crane. Travel restrictions will be in place during the interim period consistent with the 10 CFR 50.59 screening for the modification. This will limit operations of the crane to be consistent with the exiting DSAR requirements until the licensee completes the required testing in accordance with NOG-1 and NUREG-0554.

Attachments 5 and 6 of the license's LAR provide a compliance matrix for ASME NOG-1 and NUREG-0544, respectively. The matrices outline the guidance in NOG-1 and NUREG-0544 and list how the licensee complies with the specific guidance. Through the use of the matrices the license has shown that they comply with the applicable guidance. The proposed modifications to the FHB crane at the Zion Nuclear Power Station, when implemented as described in the LAR as supplemented, will enable the crane to meet the criteria contained in NUREG-0554 and ASME NOG-1, as applicable, for single-failure proof designation. Therefore, the staff finds that the proposed modifications are acceptable.

3.5.3 Heavy Loads Program

In NUREG-0612, the NRC staff provided regulatory guidelines for control of heavy load lifts. Based on the permanently defueled state of the ZNPS, and the length of time the spent fuel has been stored in the SFP, the licensee explained that the areas applicable to NUREG-0612 guidelines are in or around the SFP, or in or around a cask loaded with spent fuel, or a lift of a cask loaded with spent fuel. The heavy loads program will prohibit travel with a heavy load over the SFP, exclusive of the cask loading area, without the appropriate administrative controls. To reduce the probability of a load handling accident, ZS will use a single-failure proof crane for activities near the fuel pool and the handling of spent fuel casks.

Required Load Lifts

An operator will use a transfer cask to place and remove each TSC from the SFP. Once a crane operator has loaded and processed a TSC, the operator will lower the TSC into a vertical concrete cask (VCC) for transport to the independent spent fuel storage installation (ISFSI). The licensee's general steps to fill and process each TSC inside the FHB are as follows:

1. Place an empty MTC in the FHB Truck Bay or Cask Decontamination Pit (CDP).

2. Place an empty TSC inside the MTC.

3. Transfer the empty MTC/TSC to a staging area on the north side of the SFP.

4. Fill the TSC with water.

5. Lift the flooded MTC/TSC assembly from the staging area to the cask loading pit in the SFP.

6. Fill the TSC with spent fuel.

7. Place the TSC lid on the loaded TSC.

8. Lift the loaded MTC/TSC assembly from the SFP to the CDP.

9. The TSC's internal volume is dewatered, vacuum-dried, lid closure-welded, and filled with inert gas.

10. Lift the MTC/TSC assembly over to the Truck Bay.

11. Place the loaded MTC/TSC assembly on top of an associated VCC/Transfer Adaptor.

12. Lower the loaded TSC from the MTC into the VCC.

13. Remove the empty MTC from the top of the VCC and place it in the FHB Truck Bay or CDP.

14. Remove the Transfer Adaptor from the VCC and install the VCC Lid.

The transfer cask weighs 108,500 lbs. and a fully loaded TSC with a lid weighs 102,000 lbs. The combined weight of the loaded and flooded TSC with a lid inside a transfer cask and including the lifting yoke is 228,000 lbs (114 tons). The Fuel Building Crane is rated at 125 tons. The licensee outlines the safe load path for handling the loaded cask in revised DSAR Figure 3-34. The licensee will handle the MTC using a specially designed yoke as specified by NAC and described in the MAGNASTOR Safety Analysis Report. The licensee will control safe load paths for other lifts listed above by the licensee's Heavy Loads Program. The licensee will perform the sequence of cask lifts/movements during both dry run and normal spent fuel transfer operations until the licensee removes all spent fuel assemblies from the SFP, places it into TSCs lowered into their associated VCCs and transports them to the ISFSI. The licensee will use the FHB overhead crane lift/move auxiliary equipment and components (e.g., welding system, vacuum drying system, shielding devices, lifting yokes, etc.) throughout the FHB in preparation for and during spent fuel transfer operations.

Attachment 4 of the licensee's LAR provides a compliance matrix for NUREG-0612. The matrix outlines the guidance in NUREG-0612 and lists how the licensee complies with the specific guidance. With the matrix, the licensee has shown that they comply with the applicable guidance in NUREG-0612. The licensee's heavy proposed loads program, when implemented as described in the LAR as supplemented, and the revised DSAR, will meet the criteria in NUREG-0612. Therefore, the staff finds that the proposed heavy loads program is acceptable.

4.0 ENVIRONMENTAL CONSIDERATION

This amendment involves changes to the ZNPS License that change a requirement with respect to installation or use of a facility component located within the restricted area. The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. NRC has previously issued a proposed finding that the amendment involves no significant hazards consideration (77 FR 47123; August 7, 2012), and there has been no public comment on such finding. NRC staff has made a final determination that the proposed amendment does not involve a significant hazards consideration. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.

5.0 CONCLUSION

The NRC staff determined that the licensee provided an adequate technical justification for approval of the upgrade of the FHB crane as a single-failure-proof crane. The crane upgrade conforms to the American Society of Mechanical Engineers, Rules for Construction of Overhead and Gantry Cranes (ASME NOG-1), 2004 Edition (Reference 12), as an acceptable means of meeting the criteria in Reference 11 and to any applicable criteria listed in Reference 10, Appendix C. The licensee will perform modifications as required to upgrade the crane rail clips from the original design basis to the proposed SSE seismic design basis, taking an exception to the Reference 12 criteria pertaining to the application of tornado wind and tornado-generated missile loading for a single-failure-proof crane and its supporting structure. To support this request, the licensee has committed to update its DSAR to prohibit the movement of heavy loads using the FHB overhead bridge crane when high-wind conditions, such as tornadoes, hurricanes, or tropical storms, are forecast. The licensee has provided reasonable assurance that the FHB overhead crane can operate safely in support of future dry-shielded canister and transfer cask loading operations, subject to the commitments noted above and in this SER. Therefore, the NRC staff concluded that the licensee's LAR, related to upgrading the FHB overhead bridge crane to single-failure-proof crane, subject to the commitment related to updating its DSAR noted in this conclusion, is acceptable.

6.0 REFERENCES

1. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment Request ZS-2012-0212), "Request for Amendment To Approve Methods of Analysis, use of the Upgraded Fuel Handling Building Crane System as a Single-Failure Proof Crane and Approval of a NUREG 0612 Compliant Heavy Loads Handling Program," May 31, 2012, Agencywide Document Access and Management System (ADAMS) Accession No. ML12160A394.

2. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's NRC Document Control Desk (License Amendment Request ZS-2012-0448), "Request for Amendment to Approve Methods of Analysis, use of the Upgraded Fuel Handling Building Crane System as a Single-Failure Proof Crane and Approval of a NUREG 0612 Compliant Heavy Loads Handling Program," October 25, 2012, ADAMS Accession No. ML12307A361.

3. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment

Request ZS-2012-0519), Additional Information Supplementing the Request for Amendment to Approve Methods of Analysis, use of the Upgraded Fuel Handling Building Crane System as a Single-Failure Proof Crane and Approval of a NUREG 0612 Compliant Heavy Loads Handling Program," December 20, 2012, ADAMS Accession No. ML12359A020.

4. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment Request ZS-2013-0023), "Update to the Supplement for the Request for Amendment to Approve Methods of Analysis, use of the Upgraded Fuel Handling Building Crane System as a Single-Failure Proof Crane and Approval of a NUREG 0612 Compliant Heavy Loads Handling Program," January 17, 2013, TAC Nos. J00433 and J00434, ADAMS Accession No. ML13022A412.

5. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment Request ZS-2013-0083), "Response to Requests for Additional Information for Questions 1, 2, 4, and 5," February 21, 2013 (document itself is misdated "February 21, 2012"), TAC Nos. J00433 and J00434, ADAMS Accession No. ML13056A011.

6. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment Request ZS-2013-0092), "Update to the Rail Clip Analysis Supplementing the Request for Amendment to Approve Methods of Analysis, use of the Upgraded Fuel Handling Building Crane System as a Single-Failure Proof Crane and Approval of a NUREG 0612 Compliant Heavy Loads Handling Program," March 4, 2013, TAC Nos. J00433 and J00434, ADAMS Accession No. ML13087A347.

7. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment Request ZS-2013-0121), "Apparent Cause Evaluation for Analysis Errors Associated with the Request for License Amendment for an Upgraded Fuel Handling Building Crane System," April 4, 2013, TAC Nos. J00433 and J00434, ADAMS Accession No. ML13100A130.

8. Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, letter to the U.S. Nuclear Regulatory Commission's Document Control Desk (License Amendment Request ZS-2013-0194), "Updated Request for Amendment to Approve Methods of Analysis, use of the Upgraded Fuel Handling Building Crane System as a Single-Failure Proof Crane and Approval of a NUREG 0612 Compliant Heavy Loads Handling Program ," May 16, 2013, TAC Nos. J00433 and J00434, ADAMS Accession No. ML13148A007.

9. *U.S. Code of Federal Regulations*, "Domestic Licensing of Production and Utilization Facilities," Part 50, Chapter I, Title 10, "Energy."

10. U.S. Nuclear Regulatory Commission, "Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36," NUREG-0612, July 1980, ADAMS Accession No. ML070250180.

11. U.S. Nuclear Regulatory Commission, “Single-Failure-Proof Cranes for Nuclear Power Plants,” NUREG-0554, May 1979, ADAMS Accession No. ML110450636.

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14. U.S. Nuclear Regulatory Commission, “Clarification of NRC Guidelines for Control of Heavy Loads,” NRC Regulatory Information Summary (RIS) 2005-25, October 31, 2005.

15. U.S. Nuclear Regulatory Commission, “Clarification of NRC Guidelines for Control Of Heavy Loads,” NRC Regulatory Information Summary (RIS) 2005-25 Supplement 1, May 29, 2007, ADAMS Accession No. ML071210434.

16. U.S. Nuclear Regulatory Commission, “Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment,” NRC Bulletin 96-02, April 11, 1996.

17. U.S. Nuclear Regulatory Commission, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” NUREG-0800, Revision 1 to Section 9.1.5, “Overhead Heavy Load Handling System” January 31, 2007

18 U.S. Nuclear Regulatory Commission Letter to Patrick Daly, Senior Vice President, Zion*Solutions*, LLC, regarding Request for Additional Information on the Upgraded Fuel Handling System for Zion Units 1 and 2, ADAMS Accession No. ML12352A298.

19 U.S. Nuclear Regulatory Commission, Issuance of Amendment No. 180 to Facility Operating License No. DPR-39 and Amendment No. 167 to Facility Operating License No. DPR-48 for the Zion Nuclear Power Station, Units 1 and 2, dated December 30, 1999, ADAMS Accession No. ML003672706.

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Dated: September 19, 2013