UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
612 EAST LAMAR BLVD, SUITE 400
ARLINGTON, TEXAS 76011-4125

March 17, 2011

Rafael Flores
Senior Vice President
and Chief Nuclear Officer
Luminant Generation Company LLC
Comanche Peak Nuclear Power Plant
P.O. Box 1002
Glen Rose, TX 76043

SUBJECT: NRC INSPECTION REPORT 05000445/2011008; 05000446/2011008; 07200074/2010001

Dear Mr. Flores:

Between December 7, 2010, and January 4, 2011, the U.S. Nuclear Regulatory Commission conducted an inspection at your Comanche Peak Nuclear facility. The inspection involved site visits on three separate occasions to your facility. The purpose of these combined inspections was to review the planning and construction of the Independent Spent Fuel Storage Installation (ISFSI) pad at Comanche Peak. On February 7, 2011, an exit briefing was conducted with members of your staff after receipt by the NRC of the 28-day concrete break test results for the first section of the pad. The enclosed report presents the scope and results of the inspections performed.

The inspections included a review of the ISFSI foundation subgrade, concrete mix design, inspection of the concrete batch plant, inspection of concrete forms and placement of the reinforcing steel, and observation of concrete mixing, delivery, sampling, and placement for the first of three sections of the ISFSI pad. The inspection determined that Comanche Peak's ISFSI pad construction was in conformance with the requirements of the Holtec Final Safety Analysis Report and the requirements and standards established by the American Concrete Institute (ACI) and the American Society for Testing and Materials (ASTM), as required by your general license. No violations were identified during the inspections.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/Adams.html. To the extent possible, your response, if any, should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction.

Should you have any questions concerning this inspection, please contact the undersigned at 817-860-8191 or Lee Brookhart at 817-276-6549.

Sincerely,

D. Blair Spitzberg, Ph.D., Chief
Repository and Spent Fuel Safety Branch

Docket: 050-445
050-446
072-074
License: NPF-87
NPF-89

Enclosures:
NRC Inspection Report 05000445/2011008; 05000446/2011008; 07200074/2010001
Attachments:
(1) Supplemental Inspection Information
(2) Comanche Peak ISFSI - Inspector Notes

cc w/enclosure:
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U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Docket:	050-445; 050-446; 072-074
License:	NPF-87; NPF-89
Report:	050-445/2011-08; 050-445/2011-08; 072-074/2010-01
Licensee:	Luminant Generation Company LLC Independent Spent Fuel Storage installation (ISFSI)
Facility:	Comanche Peak Nuclear Power Plant, Units 1 and 2
Location:	FM-56, Glen Rose, TX
Dates:	December 7, 2010; Onsite December 27, 2010; Onsite January 4, 2010; Onsite
Inspectors:	V. Everett, RIV/DNMS, L. Brookhart, RIV/DNMS M. Williams, RIV/DRS C. Denissen, RIV/DRS
Approved By:	D. B.Spitzberg, Ph.D., Chief Repository and Spent Fuel Safety Branch, Region IV
Attachments:	1. Supplemental Inspection Information 2. Inspector Notes

EXECUTIVE SUMMARY

Comanche Peak Independent Spent Fuel Storage Installation
NRC Inspection Report 05000445/2011008; 05000446/2011008; 07200074/2011001

The Comanche Peak Independent Spent Fuel Storage Installation (ISFSI) is under a general license from the U.S. Nuclear Regulatory Commission (NRC). The ISFSI has been designed to hold up to 84 storage casks on the ISFSI pad. The ISFSI pad was approximately 102 feet wide, 262 feet long, and 25 inches thick. The licensee had elected to use a Holtec dry cask storage system, Certificate of Compliance 1014, "HI-STORM 100," Amendment 7, and Revision 9 of the Final Safety Analysis Report (FSAR). The MPC-32 multi-purpose canister and Hi-Storm 100S Version B cask will be used.

The ISFSI concrete pad was designed and constructed in accordance with American Concrete Institute (ACI) 349, "Code Requirements for Nuclear Safety Related Concrete Structures." The inspection included a review of the concrete mix design, concrete material requirements, reinforcing bar specifications, and concrete batch plant facility along with direct observation of the concrete mixing, placement, and sampling of the north section of the pad.

The ISFSI pad was constructed in three sections, a north, a center, and a south section. During this inspection, the north section of the ISFSI pad was poured. The concrete volume was calculated at approximately 730 cubic yards per section. Seventy-two trucks, containing approximately 10 cubic yards of concrete each, were used in the north section. The concrete was provided by Ingram Enterprises from their batch plant in Glen Rose, TX. The concrete placement was performed by Osburn Contractors.

Details related to the activities observed are provided in Attachment 2, "Inspector Notes," to this report. The following provides a summary of the observations made during this inspection.

Cold Weather Requirements

- Adequate measures were taken by the licensee, during placement, to ensure the concrete was maintained above the 50°F requirement specified in the ACI (Attachment 2: Topic – Protection During Cold Weather).

Concrete Curing

- The ACI requirement for maintaining the concrete in the ISFSI pad in a moist condition and above 50°F for a minimum of 7 days after placement was met (Attachment 2: Topic – Concrete Temperature).

Concrete Mixing & Delivery

- The ready mix concrete batch plant and the concrete trucks used for mixing the concrete had been inspected by the licensee and found to meet the requirements of ASTM C 94 (Attachment 2: Topic – Ready Mix Concrete).

- The applicable ASTM standards for concrete mixing and delivery were met with respect to addition of water at the job site, maximum time, and drum revolutions between leaving the batch plant and discharging the concrete, and minimum drum revolutions for mixing (Attachment 2: Topics – Concrete Mixing; Addition of Job Site Water; Concrete Mixing Revolutions; Conveying; and Drum Rotation Discharge Limits).

Concrete Placement

- The concrete forms were constructed and prepared for concrete placement in accordance with ACI standards with respect to wetting of the interior surfaces prior to concrete placement, removing debris, controlling mortar leaks and deflection, applying release agents to the interior of forms, wetting of masonry units, and removing standing water (Attachment 2: Topics – Formwork; Formwork Coating; Masonry Units; Reinforcement Cleanliness; Reinforcement Condition; Removal of Debris; Standing Water Removal).

- The applicable ACI standards for concrete placement were met with respect to exclusion of foreign materials, placement rates, and minimizing course aggregate segregation (Attachment 2: Topic – Deposition to Avoid Segregation; Foreign Material in Concrete; Placement Rate).

Concrete Quality

- The concrete mix met the design specifications for air entrainment, slump and water/cement ratio (Attachment 2: Topics – Air Content; Water/Cement Ratio; and Slump Tolerances under Category: Concrete Testing).

- Fly ash was added to the concrete mix to compensate for the higher alkali levels in the local aggregate used in the concrete mix. Water soluble chlorides were tested and were within the ACI 349 limits (Attachment 2: Topics – Aggregate Specifications; Corrosion Protection; Fly Ash).

Concrete Reinforcement

- In general, rebar placement was constructed in accordance with ACI standards to establish a minimum concrete cover over the steel to protect the rebar from corrosion in accordance with the pad design. One small area did not meet the design requirement and was analyzed and found to be acceptable (Attachment 2: Topics – Reinforcement Cover for Rebar Exposed to Earth; Reinforcement Cover for Rebar on Top).

- Rebar tensile strength test reports were reviewed and all rebar used in the pad was found to meet the 60 thousand pounds per square inch (ksi) design requirement (Attachment 2: Topics – Reinforcement Tensile Tests).

Concrete Testing

- Both the ACI and ASTM standards for concrete sampling were met with respect to sampling locations, methods, frequencies, number of samples, and methods for molding and curing strength test cylinders (Attachment 2: Topic – Initial (Temporary) Sample Storage; Strength Test Minimum Samples; Strength Test Sample Locations; Strength Test Sampling Time Limit).

- The concrete sampling activities were performed in accordance with the requirements of ASTM C 172. The field technicians responsible for sampling and making the concrete test cylinders were certified as ACI Grade I Field Testing Technicians (Attachment 2: Topic – Field Technician Requirements; Making and Curing Strength Test Specimens).

Corrective Action Program

- Conditions adverse to quality, nonconforming conditions, failures, malfunctions, deficiencies, deviations, defects, adverse trends, lessons learned at other facilities, and work enhancements were examples of issues identified and resolved through Comanche Peak's Corrective Action Process (Attachment 2: Topic – Condition Reports).

Pad Design

- Documentation, calculations, and drawings of the ISFSI pad were consistent with the design requirements in the Holtec FSAR for thickness, reinforcing steel yield strength and configuration, and soil subgrade modulus of elasticity (Attachment 2: Topic – Design Specifications for Rebar; Pad Thickness; Placement of Rebar; Subgrade Effective Modulus of Elasticity).

- The 28-day concrete compressive strength test results for the first concrete placement activities were within the limits specified in the FSAR of less than 6,000 pounds per square inch (psi) (Attachment 2: Topic – Concrete Compressive Strength at 28 Days).

- Seismic analysis was performed for the pad to demonstrate adequate support for static and dynamic loads for the Comanche Peak site (Attachment 2: Topic – Seismic Analysis for Static and Dynamic Loads).

SUPPLEMENTAL INSPECTION INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel:

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B. Henley, Project Manager
D. Kross, Acting VP Engineering
C. Montgomery, Project Engineering Manager
J. Seawright, Consulting Engineer Licensing
R. Swanson, Senior Nuclear Auditor

Contract Personnel:

J. Fosdick, Adjunct Site Services Manager, Holtec International
S. Watson, Project Manager, Rone Engineering Services

INSPECTION PROCEDURES USED

60853	On-Site Fabrication of Components and Construction of an ISFSI

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened
None

Closed
None

Discussed
None

LIST OF ACRONYMS
(including Attachment 2)

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Material
CFR	Code of Federal Regulations
CMTR	Certified Mill Test Report
DNMS	Division of Nuclear Material Safety
DRS	Division of Reactor Safety
EDCR	Engineering Design Change Request
F	Fahrenheit
FNCR	Field Non-Conformance Report
FSAR	Final Safety Analysis Report
HPP	Holtec Project Procedure
ISFSI	Independent Spent Fuel Storage Installation
ITS	important to safety

ksf	thousand pounds per square foot
lb/cu. ft	pound per cubic foot
MPC	multi-purpose canister
NRC	Nuclear Regulatory Commission
psi	pounds per square Inch
QA	Quality Assurance
Rev	revision
RIV	NRC Region IV office
RSFS	Repository and Spent Fuel Safety
SFST	Spent Fuel Storage and Transportation
SSE	safe shutdown earthquake
TxDOT	Texas Department of Transportation

ATTACHMENT 2

COMANCHE PEAK ISFSI PAD INSPECTION

COMANCHE PEAK ISFSI PAD INSPECTION

Category: Cold Weather Requirements **Topic:** Frost

Reference: ACI 349, Section 5.12.2

Requirement: All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact shall be free from frost.

Finding: Visual inspection of the pour area within the forms conducted the morning of the actual pad pour, January 4, 2011, verified the subgrade was not frozen, and all reinforcement, forms, fillers, and ground was free from ice and frost.

Documents Reviewed: None

Category: Cold Weather Requirements **Topic:** Protection During Cold Weather

Reference: ACI 349, Section 5.12.1

Requirement: Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.

Finding: The licensee provided adequate equipment and kept the concrete above the required 50 degrees F during concrete pour, placement, and curing. The temperature the day of the pour was between 49 and 53 degrees F. Design Specification 03300, Section 3.4 C, required the temperature of the concrete, at the time of delivery at the point of placement, to be kept within the range of 50 to 90 degrees F unless otherwise approved by the construction manager. Design Specification 03300, Section 3.4 E, required, for placement of concrete in ambient temperatures below 40 degrees F, adequate protection of the concrete after placement shall be provided by covering, insulating, and/or heating, to maintain a minimum concrete temperature of 50 degrees F for 7 days after placing. The measured temperature of the concrete during the pour was between 53 and 66 degrees F. After the concrete placement was completed, blankets were used to keep the concrete above 50 degrees F and to protect the water, used for curing purposes, on top of the concrete from evaporating due to the wind.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0, "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0

Category: Concrete Curing **Topic:** Concrete Temperature

Reference: ACI 349, Section 5.11.1

Requirement: Concrete (other than high-early-strength) shall be maintained above 50 degrees F and in a moist condition for at least the first 7 days after placement, except when cured in accordance with 5.11.3 (Accelerated Curing).

Finding: The licensee regulated and maintained the concrete temperature above 50 degrees F and maintained the concrete in a moist condition for 7 days. Design Specification 03300, Section 3.7 C, required curing for 7 days by addition of water methods. Design Specification 03300, Section 3.4 E, required adequate protection of the concrete after placement shall be provided by covering, insulating, and/or heating, to maintain a minimum concrete temperature of 50 degrees F for 7 days after placing. The concrete was kept moist by keeping a layer of water over the concrete for the 7 days. Blankets were used by the licensee to keep the concrete above 50 degrees F and to protect the water on top of the concrete from evaporating due to wind.

Documents Reviewed: (a) Holtec Procedure HSP-186 "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 8; (b) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0, "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0

Category: Concrete Mix & Delivery **Topic:** Concrete Mixing Revolutions

Reference: ASTM C 94, Section 12.5

Requirement: Concrete that is completely mixed in a truck mixer will be mixed at 70 to 100 revolutions at the mixing speed designated by the manufacturer to produce the uniformity of concrete. Additional revolutions by the mixer beyond the number found to produce uniformity of concrete shall be at a designated agitating speed.

Finding: The concrete was being mixed properly and met the minimum 70 to 100 revolutions to produce uniform concrete. Holtec Procedure HSP-186, Step 6.2.3, incorporated the requirement for 70 to 100 revolutions after the introduction of all ingredients, including water, are in the drum at the batch plant at the mixing speed designated by the truck manufacturer. Several batch tickets were reviewed from the concrete trucks. The typical number of revolutions for the concrete being delivered was around 150 to 220 revolutions.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for (ITS) "B" Applications," Rev. 8

Category: Concrete Mixing & Delivery **Topic:** Addition of Job Site Water

Reference: ASTM C 94, Section 12.7

Requirement: When a truck mixer or agitator is approved for mixing or delivery of concrete, no water from the truck water system or elsewhere shall be added after the initial introduction of mixing water for the batch, except when on arrival at the job site the slump of the concrete is less than specified. When adding water, the drum or blades shall be turned an additional 30 revolutions or more, if necessary, at mixing speed until the uniformity of the concrete is within these limits.

Finding: Water was added to only two of the 72 trucks used during the pour for the first section of the concrete pad. Each time water was added the mixing drum was turned at least 30 revolutions. Holtec Procedure HSP-186, Step 6.3.3, allowed water to be added at the job site after initial mixing if directed by the Holtec Representative. Holtec Procedure HSP-186, Step 6.3.3.3, required a minimum of 30 revolutions of the mixing drum if water was added.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for (ITS) "B" Applications," Rev. 8

Category: Concrete Mixing & Delivery **Topic:** Conveying

Reference: ACI 349, Section 5.9.1

Requirement: Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent separation or loss of materials.

Finding: The conveyance of concrete during the placement of the ISFSI pad was performed in a method that prevented separation and loss of material. Concrete was discharged from the concrete trucks via chute, then conveyed 20 to 60 yards via conveyor belts (depending on the position of the conveyor in relation to the point of placement), then dropped via "elephant trunk" into place. Positioning of the conveyors and final drop was manipulated by an operator on the ground adjacent to the proximity of placement. No separation or loss of material during placement was observed.

Documents Reviewed: None

Category: Concrete Mixing & Delivery **Topic:** Drum Rotation Discharge Limits

Reference: ASTM C 94, Section 12.7

Requirement: Discharge of the concrete shall be completed within 1 1/2 hours or before the drum has made 300 revolutions, whichever comes first, after the introduction of mixing water into the cement and aggregates or the introduction of the cement to the aggregates. These limitations are permitted to be waived by the purchaser if the concrete is of such slump after the 1 1/2-hour time or 300-revolution limit has been reached that it can be placed, without the addition of water, to the batch.

Finding: Three trucks exceeded the 1 1/2-hour time limit. Two of those trucks were rejected and sent back, the other (which exceeded the time requirement by 22 minutes) was accepted by a Holtec Representative since the concrete passed all sampling requirements. Concrete deliveries were checked for the number of revolutions prior to arriving on-site, plus any additional revolutions completed prior to discharge. None of the trucks exceeded the 300-revolution limit. Holtec Procedure HSP-186, Step 6.3.4, directed the Holtec Supervisor to confirm the concrete was meeting the 300 revolutions and 1 1/2-hour time limit. Step 6.3.5 allowed the Holtec Representative to waive the limits by checking the batch to confirm the concrete still complied with temperature, slump, and wet unit weight requirements.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for (ITS) "B" Applications," Rev. 8

Category: Concrete Mixing & Delivery **Topic:** Ready Mixed Concrete

Reference: ACI 349, Section 5.8.2

Requirement: Ready-mixed concrete shall be mixed and delivered in accordance with the requirements of "Specification for Ready-Mixed Concrete" ASTM C 94 or "Specification for Concrete Made by Volumetric Batching and Continuous Mixing" ASTM C 685.

Finding: The concrete used for the Comanche Peak pad was mixed and delivered in accordance with ASTM C 94. The licensee's quality assurance group had inspected the batch plant and mixing trucks prior to the pad pour. Holtec Procedure HSP-186, Step 6.1.5, required that the batch plant be inspected prior to the pour and shall meet the requirements of

ASTM C 94. Procedure HSP-186, Step 6.1.6, required that all truck mixers and agitator units be inspected prior to concrete placement to the requirements of ASTM C 94. Additionally, Design Specification 03300, Step 2.3 E required that the delivery of concrete shall be in accordance with ASTM C 94.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0, "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0; (b) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 8

Category: Concrete Placement **Topic:** Deposition to Avoid Segregation

Reference: ACI 349, Section 5.10.1

Requirement: Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing.

Finding: The concrete was deposited as nearly as practical into its final position, thus avoiding segregation due to rehandling or flowing. Concrete was discharged from the concrete trucks via chute, then conveyed 20 to 60 yards via conveyor belts (depending on the position of the conveyor in relation to the point of pour), then dropped via "elephant trunk" into place. Positioning of the conveyors and final drop was manipulated by an operator on the ground adjacent to the proximity of placement, ensuring good deposit volumes and eliminating any need to "drag" concrete with vibrators.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Foreign Material in Concrete

Reference: ACI 349, Section 5.10.3

Requirement: Concrete that has partially hardened or been contaminated by foreign materials shall not be deposited in the structure.

Finding: On January 4, 2011, NRC inspectors observed the placement of concrete for the first of three sections of the pad. During the concrete pad pour, no observations were made of an attempt to place concrete that had already hardened or contained foreign material. Discussions with the construction managers confirmed that any concrete that had partially hardened or contained foreign material was not acceptable for use.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Formwork

Reference: ACI 349, Section 6.1.2

Requirement: Forms shall be substantial and sufficiently tight to prevent leakage of mortar.

Finding: Visual inspection of the form area on December 27, 2010, January 3, 2011, and January 4, 2011, verified that the forms were of substantial convention to prevent leakage of mortar. During the concrete pour on January 4, 2011, visual inspection validated that forms were sufficiently tight to prevent leakage of mortar.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Formwork Coating

Reference: ACI 349, Section 5.7.1 (c)

Requirement: Preparation before concrete placement shall include that forms be properly coated.

Finding: A form release agent and/or the use of waxed forms was verified to have been in place prior to concrete placement. The use of the release agent and/or waxed forms provided easy form removal once the concrete had set. Design Specification 03100 Section 3.4 required personnel to apply a form release agent to the formwork in accordance with the form release agent manufacturer's written recommendations.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C03100-0 "ISFSI Project Specification Concrete Formwork," Rev. 0

Category: Concrete Placement **Topic:** Laitance Removal/Cold Joint

Reference: ACI 349, Section 5.7.1 (g)

Requirement: Preparation before concrete placement shall include that all laitance and other unsound material be removed before additional concrete is placed against hardened concrete.

Finding: All laitance and unsound material was properly removed before additional concrete was placed against hardened concrete. The pad at Comanche Peak was poured in three sections. This requirement applied to only the second and third sections, which were joined to the other sections. The licensee followed Step 3.2 D of Design Specification 3300, requiring previous concrete work to be bush hammered and cleaned to present a suitable surface to cast new concrete against it. Once the concrete was cleaned, a bonding agent, Flex Con, was applied to the surface prior to casting the next section of concrete. The bonding agent was applied per manufacturer's recommendations as required by Step 3.2.E. of Design Specification 3300.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0, "ISFSI Project Specification Cast-in-place Concrete," Rev. 0

Category: Concrete Placement **Topic:** Masonry Units

Reference: ACI 349, Section 5.7.1 (d)

Requirement: Preparation before concrete placement shall include that masonry filler units that will be in contact with concrete be well drenched.

Finding: Before the concrete placement on January 4, 2011, the contractor was observed to be wetting the rebar and subgrade, including the masonry blocks used to support the horizontal reinforcement bars off the ground, with a garden-type hose. Visual observation also confirmed that no standing water remained on the subgrade before concrete placement. Holtec Procedure HSP-186, Step 6.1.11, required personnel to wet the engineered fill and exposed concrete surfaces prior to the pour in accordance with the site-specific construction specifications. Design Specification 03300, Step 3.3 I, required personnel to moisten the subgrade prior to placing concrete. The licensee elected to use masonry blocks in accordance with Design Specification 03200 Section 3.5 B to securely support the pad's rebar above the required distance from the ground.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 8; (b) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03100-0 "ISFSI Project Specification Concrete Formwork," Rev. 0; (c) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0, "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0

Category: Concrete Placement **Topic:** Placement Rate

Reference: ACI 349, Section 5.10.2

Requirement: Concreting shall be carried on at such a rate that concrete is at all times plastic and flows readily into spaces between reinforcement.

Finding: Concrete placement was observed to be completed in prompt succession and visually verified to be in a plastic state, easily worked by concrete operators and crews, and that it readily flowed into open spaces between the reinforcement bars.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Reinforcement Cleanliness

Reference: ACI 349, Section 5.7.1 (e)

Requirement: Preparation before concrete placement shall include that reinforcement be thoroughly clean of ice or other deleterious coatings.

Finding: Visual verification was made that the reinforcement was free of any ice, dirt, loose rust, or other contaminants. Visual inspection of the pour area within the forms was conducted on three occasions: the afternoon of December 27, 2010, the afternoon of January 3, 2011, and the morning of the actual pad pour, January 4, 2011.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Reinforcement Conditions

Reference: ACI 349, Section 7.4.1

Requirement: At the time concrete is placed, reinforcement shall be free from mud, oil, or other nonmetallic coatings that decrease bond.

Finding: Visual verification was made that the reinforcement was free of any mud, oil, grease, and other nonmetallic coatings. Visual inspection of the pour area within the forms was conducted on three occasions: the afternoon of December 27, 2010, the afternoon of January 3, 2011, and the morning of the actual pad pour, January 4, 2011.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Removal of Debris

Reference: ACI 349, Section 5.7.1 (b)

Requirement: Preparation before concrete placement shall include that all debris and ice be removed from spaces to be occupied by concrete.

Finding: Visual verification was made that all debris had been removed from the pour area, as well as confirmation that no ice was present on the forms or rebar. Visual inspection of the pour area within the forms was conducted on three occasions: the afternoon of December 27, 2010, the afternoon of January 3, 2011, and the morning of the actual pad pour January 4, 2011.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Retempered Concrete

Reference: ACI 349, Section 5.10.4

Requirement: Retempered concrete or concrete that has been remixed after the initial set shall not be used unless approved by the engineer.

Finding: On January 4, 2011, during the observation of the concrete pour for the first section of pad, no observations were made of an attempt to place retempered or remixed concrete.

Documents Reviewed: None

Category: Concrete Placement **Topic:** Standing Water Removal

Reference: ACI 349, Section 5.7.1 (f)

Requirement: Preparation before concrete placement shall include that water be removed from the place of deposit before concrete is placed.

Finding: Visual inspection of the pour area within the forms conducted on the morning of the actual pad pour of the first section of the pad, January 4, 2011, verified the absence of any standing water.

Documents Reviewed: None

Category: Concrete Quality **Topic:** Admixtures

Reference: ACI 349, Section 3.6.5

Requirement: Water-reducing admixtures, retarding admixtures, and accelerating admixtures shall conform to ASTM C 494, "Specification for Chemical Admixtures for Concrete."

Finding: The accelerating admixture and water reducing admixture were verified by the inspector as conforming to ASTM C 494. The licensee had elected to use an accelerating admixture, Chryso EnviroMix i40 and a water reducing admixture, Chryso Fluid Optima 256.

Documents Reviewed: (a) Chryso Enviro Mix i40 Technical Data Sheet from website www.chryso.com viewed on January 27, 2010 (b) Chryso Fluid Optima 256 Technical Data Sheet from website www.chryso.com viewed on January 27, 2010

Category: Concrete Quality **Topic:** Aggregates Specifications

Reference: ACI 349, Section 3.3.1

Requirement: Concrete aggregates shall conform to ASTM C 33, "Specification for Concrete Aggregates," or utilized by exception when shown by special test or actual service to produce concrete of adequate strength and durability and approved by the building official.

Finding: The aggregates utilized by the licensee did not fully conform to ASTM C 33. The only aggregates in the vicinity of Comanche Peak had a history of higher alkali levels. The licensee utilized the exemption option allowed in the ACI 349 requirements. The use of the procured aggregate was authorized by an engineer from both Holtec and Shaw. The use of Type "F" fly ash was added to the design mix to address the potential issue of alkali-silica reactivity. The aggregate that was used was from TxDOT approved sources.

Documents Reviewed: (a) Engineering Design Change Request EDCR-1937-FDA04-012, dated November 22, 2010

Category: Concrete Quality **Topic:** Air Content

Reference: ACI 349, Section 4.2.1

Requirement: Normal weight concrete exposed to freezing and thawing shall be air-entrained with air content indicated in Table 4.2.1. Tolerance on air content as delivered shall be +/- 1.5 percent. For specified compressive strength greater than 5000 psi, reduction of air content indicated in Table 4.2.1 by 1.0 % may be permitted.

Finding: The licensee's air content specification of 5% with use of 3/4" aggregate was in compliance with Table 4.2.1 of ACI 349. Air content sampling during the pad pour was verified to have been within +/- 1.5 percent (3.5 - 6.5%) of the design requirement of 5% air-entrainment. Inspectors verified that this requirement was met on all 14 truck samples that were witnessed by the inspectors. The data sample results ranged from 4.0 to 5.8% air content. Originally the air-entrainment design requirement was 5 - 8% and was specified in Design Specification 03300, Step 2.3, A. 2. The licensee changed the requirement to 3.5 - 6.5% through Engineer Design Change Request (EDCR) 1937-FDA04-021.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0, "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0; (b) EDCR 1937-FDA04-021, dated December 22, 2010

Category: Concrete Quality **Topic:** Air-Entraining Admixture

Reference: ACI 349, Section 3.6.4

Requirement: Air-entraining admixtures shall conform to ASTM C 260, "Specification for Air-entraining Admixtures for Concrete."

Finding: The air-entraining admixture used in the ISFSI pad's concrete mix conformed to ASTM C 260. The licensee chose to use Chryso Air 260, an air-entraining admixture, which was verified by the inspector as conforming to ASTM C 260.

Documents Reviewed: (a) Chryso Air 260 Technical Data Sheet from website www.chryso.com viewed on January 27, 2010

Category: Concrete Quality **Topic:** Cement Specification & Mill Test Report

Reference: ACI 349, Section 3.2.1, 3.2.3

Requirement: Cement shall conform to ASTM C 150, "Specification for Portland Cement." Every shipment of cement shall be accompanied by a certified mill test report stating the results of tests representing the cement in the shipment and the ASTM specification limits for each item of required chemical, physical, and optional characteristics. No cement shall be used in any structural concrete prior to receipt of the 7-day mill test strengths.

Finding: The cement used for construction of the ISFSI pad met the requirements of ASTM C150 cement. The TXI Midlothian Cement Mill Test Report, dated September 13, 2010, was reviewed and verified to meet the chemical and physical requirements of ASTM C150.

Documents Reviewed: (a) TXI Midlothian Cement Report, dated September 13, 2010

Category: Concrete Quality **Topic:** Clean Water Requirements

Reference: ACI 349, Section 3.4.1

Requirement: Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

Finding: The water used in the mixing of the concrete met the requirements. ACI 349, Section 5.8.2, required ready-mix concrete be mixed and delivered in accordance with the requirements of ASTM C 94, "Specification for Ready-Mix Concrete." Ingram provided documentation that stated their water met the requirements of ASTM C-94 (2009), Section 5.13.1, "The mixing water shall be clear and apparently clean. If it contains quantities of substances which discolor it or make it smell or taste unusual or objectionable or cause suspicion, it shall not be used unless service records of concrete made with it or other information indicates that it is not injurious to the quality of the concrete." The batch plant had been in place since 1987 with the same water source. Since that time, concrete with this batch water has been supplied to residential, commercial, TxDOT, and other Comanche Peak Power Plant projects without incident or issues.

Documents Reviewed: (a) Ingram Enterprises Letter, "ASTM C-94 and Mixing Water at Plant Glen Rose," dated December 7, 2010

Category: Concrete Quality **Topic:** Control of Purchased Material for Batch Plant

Reference: 10 CFR 72.154

Requirement: The licensee shall establish measures to ensure that purchased material, equipment, and services conform to procurement documents.

Finding: The licensee performed audits to ensure that purchased material, equipment, and services conformed to procurement documents. Selective audits pertaining to the batch plant trucks, batch plant equipment, batch plant materials, and concrete test lab services were reviewed by the NRC inspectors to confirm that audits were being conducted. No significant issues were identified.

Documents Reviewed: (a) Concrete Test Lab Surveillance Checklist, dated December 17, 2010; (b) Concrete Batch Plant Surveillance Checklist, dated November 18, 2010

Category: Concrete Quality **Topic:** Corrosion Protection

Reference: ACI 349, Section 4.4.1

Requirement: For corrosion protection of reinforcement in concrete, maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits of Table 4.4.1 of ACI 349 of 0.15 percent by weight of cement. The testing shall conform to ASTM C 1218.

Finding: A sample of the concrete mix design was tested to have a maximum chloride ion concentration of 0.0018% by weight of cement, which is far below the ACI limit of 0.15%. The lab results were documented in Ana-Lab Corp Results, Project # 512400 dated December 20, 2010.

Documents Reviewed: (a) Ana-Lab Corp Results, Project # 512400 dated December 20, 2010.

Category: Concrete Quality **Topic:** Fly Ash

Reference: ACI 349, Section 3.6.6

Requirement: Fly ash or other pozzolans used as admixtures shall conform to ASTM C 618, "Specification for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete."

Finding: The fly ash used in the concrete of the ISFSI pad met the requirements of ASTM C-618. The licensee elected to use Type "F" fly ash in the concrete mix of the ISFSI pad. The HeadWater's Report of Class "F" Fly Ash, dated October 1, 2010, was reviewed and the fly ash was verified to meet the requirements of ASTM C-618.

Documents Reviewed: (a) HeadWater Resources Report of Class "F" Fly Ash, dated October 1, 2010

Category: Concrete Quality **Topic:** Infrared Spectrum Trace

Reference: ACI 349, Section 3.6.10.2

Requirement: An infrared spectrum trace of the conformance test sample of air-entraining and water-reducing admixtures shall be furnished with the conformance test results.

Finding: An infrared spectrum trace for the air entraining admixture, Chryso Air 260, the water reducing admixture, Chryso Fluid Optima 256, and the accelerating admixture, Chryso Enviro Mix i40, were furnished to the inspectors for review.

Documents Reviewed: (a) Chryso Enviro Mix i40 Technical Data Sheet from website www.chryso.com viewed on January 27, 2010; (b) Chryso Fluid Optima 256 Technical Data Sheet from website www.chryso.com viewed on January 27, 2010; (c) Chryso Air 260 Technical Data Sheet from website www.chryso.com viewed on January 27, 2010

Category: Concrete Quality **Topic:** Water/Cement Ratio

Reference: ACI 349, Section 4.2.2, Table 4.2.2

Requirement: Concrete that will be subject to the exposures given in Table 4.2.2 of ACI 349 shall conform to the corresponding maximum water-cementitious materials ratios and minimum strength requirements of that table. The water/cementitious materials ratio shall be calculated using the weight of cement plus the weight of fly ash or other pozzolans.

Finding: The concrete utilized for the ISFSI pad at Comanche Peak conformed to Table 4.2.2 of the ACI 349 requirements. The Design Specification 03300, Step 2.3. A. 2, required a concrete mix that had a minimum compressive strength of 4,000 psi at 28 days and a water to cement ratio not to exceed 0.50. These values were consistent with ACI 349-01 Table 4.2.2 for concrete in the exposure condition "Concrete intended to have low permeability when exposed to water." The purchase order to the batch plant, Mix ID:2-151TX5EM, contained a water to cement ratio of 0.44. During the pour, the inspector verified a sample of the concrete batch tickets that stated the truck's water to cement ratio. The batch tickets reviewed by the inspector all had water to cement ratios less than 0.50 percent.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0 "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0; (b) Concrete Mix Design MIX-ID:2-151TX5EM, dated October 29, 2010

Category: Concrete Reinforcement **Topic:** Field Bending of Bars

Reference: ACI 349, Section 7.3.2

Requirement: Reinforcement partially embedded in concrete shall not be field bent, except as shown on the design drawings or permitted by the engineer.

Finding: During the concrete pad pour, January 4, 2011, no observations were made of an attempt to bend partially embedded reinforcement.

Documents Reviewed: None

Category: Concrete Reinforcement **Topic:** Mechanical/Welded Connections

Reference: ACI 349, Section 12.14.3

Requirement: If mechanical or welded splices are used, a minimum of six static tensile strength tests shall be conducted as part of the mechanical connection qualification. All of the test samples shall develop in tension or compression, as required, at least 125% of specified yield strength of the bar.

Finding: No mechanical or welded splices were used with the rebar for the Comanche Peak pad.

Documents Reviewed: (a) CMC Rebar North Texas Job #1025002293, Drawing R4; (b) CMC Steel Texas Certified Mill Test Reports for Heat Nos. 3020048, 3020224, 3020172, 3020202, 3020245, 3020633, 3019257, 3019853, 4005284 and 3019766; (c) CMC Rebar North Texas Bid No. J10210, dated July 19, 2010; (d) Holtec Construction Drawing 13769701-04000-C-CON-500-2, "ISFSI Storage Pad," Rev. 0

Category: Concrete Reinforcement **Topic:** Reinforcement Cover for Rebar Exposed to Earth

Reference: ACI 349, Section 7.7.1(a)

Requirement: For concrete cast against and permanently exposed to earth, a minimum concrete cover of 3 inches shall be provided for reinforcement.

Finding: The majority of the rebar placement in the ISFSI pad met the 3-inch criteria. However, one small section did not fully meet the 3-inch requirement for the cover between the outside edge of the concrete that was exposed to the ground and the reinforcing bars of the pad. Construction Drawing 13769701-04000-C-CON-500-2, Note 11, stated that clearance cover for rebar shall be 2 inches minimum at the top and 3 inches minimum on all other faces. Documented in EDCR-1937-FDA04-029, there was a 1-foot by 8-foot area of the pad where the bottom rebar cover measured only 2.5 inches. The rest of the pad was greater than 3 inches. In percentage terms, the non-conforming area (8 sq. ft.) represents only 0.031% of the total ISFSI pad area. This is less than 0.04% of the total ISFSI pad area and was deemed acceptable for two reasons. One: The bottom surface of the reinforced concrete ISFSI pad was casted against a 3-foot layer of compacted engineered fill (which was a crushed stone material). This subgrade mitigates the risk of corrosion to the steel reinforcement since the crushed stone material allows the ground water to drain away from the ISFSI pad much more effectively than a compacted soil foundation. Two: The engineered fill layer has a low electrical conductivity and is non-acidic which further reduces the risk of corrosion. The 1 foot x 8 foot discrepant area posed a negligible risk to the structural integrity and functional capability of the ISFSI pad; therefore, it was deemed acceptable by Holtec and Comanche Peak.

Documents Reviewed: (a) Holtec Construction Drawing 13769701-04000-C-CON-500-2 "ISFSI Storage Pad," Rev. 0; (b) EDCR-1937-FDA04-029, dated February 17, 2011

Category: Concrete Reinforcement **Topic:** Reinforcement Cover for Rebar on Top

Reference: ACI 349, Section 7.7.1 (b)

Requirement: For concrete permanently exposed to earth or weather (top), a minimum concrete cover of 2 inches shall be provided for number 6 through 18 reinforcement.

Finding: The concrete on the top of the ISFSI pad had at least 2 inches of cover between the outside edge of the concrete and the reinforcing bars of the pad. Construction Drawing 13769701-04000-C-CON-500-2, Note 11, stated that clearance cover for rebar shall be 2 inches minimum at the top and 3 inches minimum on all other faces.

Documents Reviewed: (a) Holtec Construction Drawing 13769701-04000-C-CON-500-2; "ISFSI Storage Pad," Rev. 0

Category: Concrete Reinforcement **Topic:** Reinforcement Tensile Tests

Reference: ACI 349, Section 3.5.3.1.1

Requirement: A minimum of one tensile test shall be required for each 50 tons of each bar size produced from each heat of steel.

Finding: Tensile tests, for the rebar used in the ISFSI pad, were performed as required. Approximately 705 tons of rebar was purchased from CMC Rebar of North Texas. Approximately 315 tons of rebar was used in the construction of the ISFSI pad. The ISFSI pad contained 18 different batches of rebar, with each batch of rebar having an assigned heat number. Twenty-six Certified Mill Test Reports were reviewed, one for each batch plus additional test reports for the larger batches. For the rebar used, an adequate number of tests were performed and all tests confirmed that the rebar met the design requirements of greater than 60 ksi.

Documents Reviewed: (a) CMC Steel Texas Certified Mill Test Reports for Heat Nos. 3019004, 3019091, 3019710, 3019711, 3020174, 3020214, 3020222, 3020224, 3020225, 3020234, 3020236, 3020238, 3020239, 3020240, 3020241, 3020242, 3020244, 3020245; (b) CMC Rebar North Texas Bid No. J10210, dated July 19, 2010

Category: Concrete Reinforcement **Topic:** Steel Reinforcement Requirements

Reference: ACI 349, Section 3.5.1, 3.5.3.1

Requirement: Reinforcement shall be deformed reinforcement, except that plain reinforcement may be used for spirals or tendons. Deformed reinforcing bars shall conform to ASTM A615, "Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement."

Finding: Deformed reinforcement conforming to ASTM A615 was used in the Comanche Peak ISFSI pad. Comanche Peak Project Specification No. 13769701.04-S-C-03200-0, Section 2.1.A, specified ASTM A615 Grade 60 billet for the reinforcing steel. CMC Steel Texas certified mill test reports documented that the steel purchased for the ISFSI pad was ASTM A615-09b Grade 420/60.

Documents Reviewed: (a) CMC Rebar North Texas Job #1025002293, Drawing R4; (b) CMC Steel Texas Certified Mill Test Reports for Heat Nos. 3019004, 3019091, 3019710, 3019711, 3020174, 3020214, 3020222, 3020224, 3020225, 3020234, 3020236, 3020238, 3020239, 3020240, 3020241, 3020242, 3020244, 3020245; (c) CMC Rebar North Texas Bid No. J10210, dated July 19, 2010

Category: Concrete Testing **Topic:** Field Technician Requirements

Reference: ASTM C 31, Section 6.3

Requirement: The field technicians making and curing specimens for acceptance testing shall be certified ACI Field Testing Technicians, Grade I or equivalent. Equivalent personnel certification programs shall include both written and performance examinations, as outlined in ACI CP-1.

Finding: The field technicians performing the sampling of the concrete for the ISFSI pad were all currently certified as ACI Concrete Field Testing Technician - Grade I. The five individuals' qualifications were reviewed and verified to be current.

Documents Reviewed: (a) American Concrete Institute Certifications "ACI Concrete Field Testing Technician - Grade I," dated November 18, 2006, October 11, 2008, May 3, 2008, December 20, 2008, May 3, 2008, and March 22, 2008

Category: Concrete Testing **Topic:** Initial (Temporary) Sample Storage

Reference: ASTM C 31, Section 10.1.1, 10.1.2

Requirement: If the test specimens cannot be molded at the place where they will receive curing, immediately after finishing, move the specimens to an initial curing place for storage. Lift and support the cylinders from the bottom of the molds. Immediately after molding and finishing, the specimens shall be stored for a period up to 48 hours in a temperature range from 60 to 80 degrees F and an environment that will prevent moisture loss.

Record the temperature using a maximum-minimum thermometer.

Finding: This requirement was not initially met. Holtec Procedure HSP-186, Step 6.4.3, required that the test cylinders shall be initially cured in curing boxes under conditions that maintain the temperature immediately adjacent to the specimens in the range of 60 to 80 degrees F and prevent loss of moisture from the specimens. The first set of samples taken was not maintained at the correct temperature for approximately 2.5 hours. The licensee was unable to set up heating units in the storage box where the samples were stored until about 10 a.m. on the day of the pour. The heated box was correctly set up and running by the time the second set of strength samples were procured. The rest of the concrete samples obtained during the pour were placed into the storage box where the temperature was monitored to have been in the range of 60 to 80 degrees F. The storage box protected the samples from wind and other environmental conditions in order to protect the samples from moisture loss. Field Nonconformance Report FNCR 1937-FDA04-F-004 was written to address the first set of samples not being maintained at 60 to 80 degrees F immediately. The disposition was to use as is. The result of the average 28-day strength test for the first set of samples was 4,730 psi. This was representative of the other sets of samples taken, ranging from 4,140 to 4,800 psi.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 8; (b) Rone Engineering Report Number 384858, "Report of Concrete Compressive Strength Test," dated February 1, 2011

Category: Concrete Testing **Topic:** Making & Curing Strength Test Specimens

Reference: ACI 349, Section 5.6.2.2

Requirement: Cylinders for strength tests shall be molded and laboratory-cured in accordance with "Practice for Making and Curing Concrete Test Specimens in the Field" (ASTM C 31).

Finding: The Testing Services Project Specification, Steps 3.3.C.2 and C.5, "Concrete Testing," required the taking and storage of samples of concrete to follow ASTM C31, "Practice for Making and Curing Concrete Test Specimens in the Field" and ASTM C172, "Standard Method for Sampling Fresh Concrete." Holtec Procedure HSP-186, Step 6.4.1.4, required the concrete cylinders to be prepared and cured in accordance with ASTM C31/C31M. Concrete cylinders were to be transported to the laboratory for testing in accordance with ASTM C31, per Step 3.3.C.2 of the Testing Services Project Specification. The 2010 versions of ASTM C31/C31M and ASTM C172 were used. Concrete samples taken during the pouring of the first portion (1/3) of the pad were from the point of placement at the end of the conveyer belt. The samples were collected by Rone Engineering personnel who were ACI Concrete Field Testing Certified Technicians - Grade 1 as specified by ASTM C31/C31M, Section 6.3. Samples were also being taken at the truck point-of-discharge by the concrete supplier (Ingram) to compare with the samples from the point- of-placement. The slump, air content, and temperature readings at the two sampling points compared favorably and were relatively consistent, with air content varying only slightly on several samples. The field technicians taking the samples were very familiar with the sampling techniques. The samples collected by Rone Engineering for the strength tests were placed in molds and stored in a box near the pad that was heated to 60 to 80 degrees F. The samples were moved the following day to the testing lab in Dallas, TX, where they were stored until the 7-day and 28-day strength tests were performed.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-O-01410-1, "Testing Services," Rev. 1; (b) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 8

Category: Concrete Testing **Topic:** Slump Tolerances

Reference: ASTM C 94, Section 7.1.2

Requirement: When the project specifications for slump are not written as a "maximum" or "not to exceed" requirement, the following tolerances shall apply: if the slump is 2 inches or less the slump tolerance is +/-0.5 inches. If the slump specified is more than 2 inches to 4 inches, the slump tolerance is +/- 1 inches. If the slump specified is more than 4 inches, the slump tolerance is +/- 1.5 inches.

Finding: Slump sampling during the pad pour was verified to have been within 2 to 4 inches, as required, during placement of the concrete pad. The slump design requirement of 2 to 4 inches was specified in Design Specification 03300, Step 2.3. A. 2. The inspectors verified this for the sampling of 14 different trucks. Only two trucks were found to be outside of the design requirement (4.25 and 4.5 inches) during the pour of the concrete pad. The construction manager approved the use of these trucks. The licensee followed Holtec Procedure HSP-186, Step 6.5.2.1, which stated, "If test results (slump, temperature, density, or air entrainment) of a truck do not meet the specification requirements, the following trucks shall be tested until two consecutive trucks are tested satisfactory." For each occurrence the next two trucks were tested and met the slump limits.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-03300-0 "ISFSI Project Specification Cast-In-Place Concrete," Rev. 0; (b) Holtec Procedure HSP-186 "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 8

Category: Concrete Testing **Topic:** Strength Test Minimum Samples

Reference: ACI 349, Section 5.6.1.1

Requirement: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day nor less than once for each 150 cubic yd of concrete, nor less than once for each 5000 square ft of surface area for slabs or walls.

Finding: The required number of strength test samples were taken during the pouring of the first section of the ISFSI pad on January 4, 2011. Holtec Procedure HSP-186, Step 6.4.1.1, established a sampling frequency of three (3) samples for the first 300 cubic yards, with one sample taken from the first batch and the other two samples at random. For each additional 100 cubic yards of concrete placement, one additional sample shall be taken. The first pour (of the planned three pours) for the ISFSI pad was expected to take 73 truck loads of concrete at 10 cubic yards per truck for a total of approximately 730 cubic yards. For this quantity, seven sets of samples would be expected. For each set, six test specimens were taken for strength testing plus two spares per Procedure HSP-186, Step 6.4.1.2. Slump, air content, density and temperature were checked during each sampling per Step 6.4.1.3. During the pouring of the first section of the ISFSI pad on January 4, 2011, seven concrete samples were collected.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for (ITS) "B" Applications," Rev. 8; (b) ISFSI Project Specification No. 13769701.04-S-O-01410-1, "Testing Services," approved October 25, 2010

Category: Concrete Testing **Topic:** Strength Test Sample Locations

Reference: ASTM C 172, Section 5.2.3

Requirement: The concrete shall be sampled by collecting two or more portions taken at regularly spaced intervals during discharge of the middle portion of the batch. Do not obtain samples until after all the water and any admixtures have been added to the mixer. Also do not obtain samples from the very first or last portions of the batch discharge.

Finding: Observation of sampling activities confirmed that, when strength test samples were collected, they were taken from the middle of the batch at the point of placement at the end of the conveyer. Holtec Procedure HSP-186, Section 6.4, provided guidance for concrete sampling and testing. The requirement to take the samples from the middle of the batch was not included in Procedure HSP-186. The requirement to take the samples from the point of placement was in a note to Step 6.3.5 of Holtec Procedure HSP-186. During the concrete pour, the NRC inspector observed several sampling and testing activities of the concrete and confirmed that the samples were being collected consistent with the ASTM C 172 requirement.

Documents Reviewed: (a) Holtec Procedure HSP-186 "Aggregate and Ready Mixed Concrete Testing Requirements for (ITS) "B" Applications," Rev. 8

Category: Concrete Testing **Topic:** Strength Test Sampling Time Limit

Reference: ASTM C 172, Section 4.1, 4.1.2

Requirement: The elapsed time shall not exceed 15 minutes between obtaining the first and final portions of the composite sample. Start tests for slump, temperature, and air content within 5 minutes after obtaining the final portion of the composite sample. Start molding specimens for strength tests within 15 minutes after fabricating the composite sample.

Finding: Observation of sampling activities confirmed that sampling was being performed within the required time frames. Composite samples were obtained within the 15-minute time requirement. Testing was started within the 5-minute time requirement and molding of the specimens for strength testing was started within the 15-minute time requirement. Holtec Procedure HSP-186, Step 6.4.1, specified that concrete sampling and testing is done in accordance with ASTM C172. The time requirements are specified in Section 4 of the ASTM C 172 standard. However, Holtec Procedure HSP-186 did not specifically state the time requirements. During the concrete pour, the NRC inspectors observed several sampling and testing activities of the concrete and confirmed that the various time criterias were met.

Documents Reviewed: (a) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for (ITS) "B" Applications," Rev. 8

Category: Concrete Testing **Topic:** Transport of Samples to Testing Lab

Reference: ASTM C 31, Section 11.1

Requirement: Concrete strength specimens shall not be transported until at least 8 hours after the final set. The transport time shall not exceed 4 hours. During transport, the specimen is to be protected with suitable cushioning material to prevent damage from jarring. During cold weather, prevent the sample from freezing with suitable insulation material. Prevent moisture loss by wrapping the specimen in wet burlap, by surrounding it with wet sand or using tight fitting plastic caps on plastic molds.

Finding: The lab samples were transported to the lab after 8 hours, and the transportation process took less than 4 hours. The lab samples were picked up by Rone Engineering approximately 30 hours after the first sample was molded and 19 hours after the last sample was molded. The total transportation time took approximately one hour. The Testing Service Project Specification 01410, Step 3.3.C.2, required the concrete test samples to be placed in a cylinder curing box as soon as practical, and no sooner than 16 hours and not more than 24 hours after casting, the cylinders shall be transported to the laboratory for controlled curing in accordance with ASTM C 31. Rone Engineering exceeded the 24-hour limit. Holtec issued FNCR-1937-FDA04-002 to document exceeding the Testing Service Project Specification 01410 time limit for picking up the samples for transportation. The FNCR identified that, even though the testing lab did not meet their time limits, they did meet the Holtec time limits in Procedure HSP-186, Step 6.4.4, that required the lab to pick up the samples by 24 hrs +/- 8 hours after molding. The lab also met ASTM C31 Step 10.1.2, criteria of retrieving the samples before 48 hours. Holtec then issued EDCR-1937-FDA04-031 to change the design specification to match Holtec Procedure HSP-186.

Documents Reviewed: (a) Comanche Peak ISFSI Project Specification No. 13769701.04-S-O-01410-1, "Testing Services," dated October 25, 2010; (b) Rone Engineering Report No. 384318, "Report of Cylinder Collection," dated January 6, 2011; (c) Holtec Procedure HSP-186, "Aggregate and Ready Mixed Concrete Testing Requirements for ITS "B" Applications," Rev. 7; (d) Field Nonconformance Report FNCR-1937-FDA04-002, dated January 26, 2011; (e) Engineering Design Change Request EDCR -1937-FDA04-031, dated January 26, 2011

Category: Corrective Action Program **Topic:** Condition Reports

Reference: 10 CFR 72.172

Requirement: Measures shall be established to ensure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions identified as adverse to quality, the measures must ensure that the cause of the condition is determined and corrective action is taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken must be documented and reported to appropriate levels of management.

Finding: Conditions adverse to quality, nonconforming conditions, failures, malfunctions, deficiencies, deviations, defects, adverse trends, lessons learned at other facilities, and work enhancements were examples of issues identified in Comanche Peak Procedure STA-422 for generating condition reports. For significant conditions adverse to quality, a root cause analysis was required. "Significant conditions adverse to quality" were classified as Level A condition reports. No Level A condition reports had been issued for the ISFSI pad activities. Conditions determined to be "adverse to quality" were categorized as Level B and were divided into two groups as "Upper Tier" or "Lower Tier." Upper tier Level B condition reports required an apparent cause analysis, whereas an apparent cause analysis was optional for lower tier Level B condition reports. Level C was identified as a condition with minimal impact on quality or safety and Level D was a nonconforming condition with no adverse effect on quality. Attachment 8A, "Determination of the Condition Level," of Procedure STA-422 provided criteria and examples for determining the correct level (A, B, C, or D) for classifying an issue or problem.

A listing of 54 condition reports was provided to the NRC inspectors related to the ISFSI project. Not all of the condition reports related to the pad activities. The condition reports addressed a range of issues with several related to lessons learned at other sites loading ISFSIs and relevant NRC information notices that would relate to the Comanche Peak ISFSI. A general review of the topical areas included in the condition reports indicated the licensee was effectively documenting, tracking, and fixing issues related to the ISFSI project. Several condition reports related to pad design and construction activities were reviewed in more detail. Condition Report CR-2010-007872 related to the pouring of the cask construction pad and issues that had occurred during its construction. The cask construction pad was not-important-safety and will be used during the construction of the concrete storage casks. Comanche Peak used the cask construction pad as a practice pour to prepare for the pouring of the ISFSI pad. Problems occurred with air content, high slump values, amount of plasticizer used, minimum drum rotations, and using too much water in the initial "front" end of the batch, which caused the concrete that initially came out of the truck to have too high of a slump, resulting in spilling of the concrete. The lessons learned during the pouring of the cask construction pad were incorporated into the work activities for the ISFSI pad and were good training for the work crews, testing technicians, and concrete supplier. In Condition Report CR-2010-008210, Comanche Peak addressed an issue that had been identified by the NRC during an inspection at the LaSalle Nuclear Plant. The issue related to the use of data from NUREG/CR-6865 in the design of their site-specific ISFSI pad. In the past, the NRC has viewed this NUREG as being of general applicability useful for NRC licensing reviews as opposed to use in pad designs. The NRC conducted a review of the use of NUREG/CR-6865 by Holtec for the LaSalle pad design. On January 20, 2010, E. Benner, NRC Licensing Branch Chief, Division of Spent Fuel Storage and Transportation, sent a memo to C. A. Lipa, Branch Chief, Region III discussing the use of the NUREG for pad design and identified several conditions which, if met, may allow the use of the NUREG as a design tool to predict the maximum sliding and rocking response of a cask on an ISFSI pad (see page 8). Condition Report CR-2010-008210 had been issued by Comanche Peak to ensure the NRC conditions for use were appropriately applied to the Comanche Peak ISFSI pad, which also used information from NUREG/CR-6865 as part of the pad design.

In Condition Report CR-2010-008211, the license discovered during the review of Holtec document HI-2094472, Rev. 0, that the seismic acceleration curves used for the ISFSI pad design were based on Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," instead of the Newmark, Blume and Kapur spectra from the Comanche Peak FSAR, Chapter 3.7B.1.1. Though the Regulatory Guide 1.60 spectra was similar to the Newmark, Blume and Kapur spectra, they were not identical. Revision 4 of HI-2094472, which was in effect at the time of this NRC inspection, continued to assume a Regulatory Guide 1.60 spectra, but had increased the values by 50%. As such, the Newmark, Blume and Kapur spectra was fully bounded.

In addition to the condition reporting system, Holtec used two other processes to capture issues. These were the field non-conformance report (FCNR) process controlled under Holtec Procedure HSP-35, "Procedure for Nonconformance Reports and Procedure Filed Change Notices for all Site Work," Rev. 1, and the EDCR process controlled under Holtec Procedure HPP-1937-2, "Processing Engineering Design Change Requests (EDCRs) at Comanche Peak," Rev. 0. Shaw Stone & Webster used Procedure PP 5-11, "Field Initiated Engineering Design Change Request Control," for processing EDCRs applicable to their work. These two processes tracked field changes and engineering changes that were identified during construction activities. During the pouring of the first 1/3 of the ISFSI pad on January 4, 2011, the NRC observed the use of the FNCR and EDCR process. FNCR 1937-FDA04-F-004 was issued to identify that the initial strength test concrete specimens collected had been left in ambient temperatures of approximately 40 degrees F for approximately 2 to 3 hours prior to being placed in a heated enclosure and maintained at 60 to 80 degrees F as required by ASTM C31 (2010), Section 10.1.2. Disposition was to use-as-is. Results from the 7-day break tests conducted by Rone Engineering produced strength test results for the affected set of concrete sample consistent with those of the other samples collected during the day, indicating that the short time in ambient temperature had not adversely effected the samples. FNCR 1937-FDA04-F-005 was issued to identify that the craft person operating the vibrator during the pad pour was not consistent with his techniques of vibrating the concrete while it was being placed. Disposition was to inspect the pad for voids when the forms were removed and to address the acceptability of the pad based on the findings of the inspection. EDCR-1937-FDA04-030 identified a discrepancy between the pad specifications and a Holtec procedure related to the minimum rebar temperature that was acceptable during the concrete pour. The specification referenced 40 degrees F but the procedure referenced 35 degrees F as a minimum acceptable temperature for the rebar prior to concrete placement. The EDCR requested the specification be changed to 35 degrees F to be consistent with the procedure and with the American Concrete Institutes (ACI) Standard 306R-08, Section 4.1, "Temperature of Surfaces in Contact with Fresh Concrete," which used the 35 degrees F value.

Documents Reviewed: (a) Comanche Peak Procedure STA-422, "Processing Condition Reports," Rev. 24; (b) Condition Report CR-2010-007872, "Problems Identified During Concrete Pour for Cask Construction Pad," dated August 19, 2010; (c) Condition Report CR-2010-008210, "Problems Identified During an NRC Inspection at the LaSalle Nuclear Station Related to NUREG/CR-6865," dated August 26, 2010; (d) Condition Report CR-2010-008211, "Vendor Report HI-2094472," Rev. 0, Used the Regulatory Guide 1.60 Design Spectra Curve Instead of the Newmark, Blume and Kapur Spectra Discussed in Comanche Peak

FSAR Chapter 3.7B.1.1," dated August 27, 2010; (e) Field Non-Conformance Report (FNCR) 1937-FDA04-F-004, "Concrete Strength Samples Not Immediately Placed in Heated Enclosure after Collection," dated January 5, 2011; (f) Field Non-Conformance Report (FNCR) 1937-FDA04-F-005, "Inconsistent Use of Concrete Vibrator," dated January 5, 2011; (g) Engineering Design Change Request EDCR-1937-FDA04-030 "Minimum Temperature of Surfaces Prior to Concrete Pour," dated January 3, 2011; (h) Internal NRC Memo from E. Benner to C. A. Lipa entitled "Revision to Response to RIII Technical Assistance Request - LaSalle Station ISFSI Pad -Seismic Design LaSalle Station RIII TAR dated 10/20/10," dated January 20, 2010 (ML100200515); (i) Holtec Report HI-2094472, "Dynamic Analysis of Comanche Peak ISFSI Pad," Rev. 4

Category: Heavy Haul Path **Topic:** Heavy Haul Path Analysis

Reference:

Requirement: The heavy haul path shall be designed and constructed to facilitate the total weight of the canister and transporter. Underground utilities, piping, cables, etc., shall be identified and evaluated to ensure no adverse impact during transport of the casks.

Finding: The haul road from the Comanche Peak fuel building to the ISFSI pad was adequately designed and constructed to facilitate the weight of the canister and transporter. Geophysical exploration was performed by Tolunay-Wong Engineers, Inc during February 21 through March 11, 2010, to identify the presence of underground utilities and other anomalies under the proposed new haul road and the ISFSI pad area. Three different technologies were used to locate underground utilities and interferences. These included ground penetrating radar, an electromagnetic meter, and a radio-detection transmitter/receiver. The results were reported in Report 13769701-570517-0004. Cables, wires, electrical conduit and water lines were identified under the proposed haul road. One class 1E electrical cable was identified which required analysis to determine the effect if a cask was dropped while passing over the cable.

The haul path was approximately 3560 feet in length and was built primarily on weathered limestone bedrock. The straight sections of the haul path were compacted gravel. Eight concrete turning pads were located along the path at areas where the transporter will need to change direction. The turning pads were designed to a 6,000 pounds/square inch (psi) concrete strength. Tolunay-Wong Engineers, Inc. drilled borings within the proposed ISFSI pad area (including the area for future expansion) and along the proposed haul path. The depths ranged from approximately 10 to 25 feet. Data from the test results of the borings were used to verify that the haul road and ISFSI pad were structurally capable of supporting the weight of the casks and hauling equipment.

Documents Reviewed: (a) Tolunay-Wong Engineers, Inc. Report 13769701-570517-0004, "Geophysical Report Test Boring Clearance and Utility Exploration for New Haul Road Alignment and ISFSI Pad Areas Comanche Peak Nuclear Power Plant Near Glen Rose, Texas," Rev. 0; (b) Tolunay-Wong Engineers, Inc. Report 3769701-570521-0001, "Geotechnical Data Report ISFSI Pad Comanche Peak Nuclear Power Plant Glen Rose, Texas," Rev. 0

Category: Pad Design **Topic:** Concrete Compressive Strength at 28 Days

Reference: HI-STORM FSAR Table 2.2.9

Requirement: Concrete compression strength shall be less than or equal to 6,000 psi at 28 days.

Finding: All 28-day average strength sample sets for the first section of the ISFSI pad were verified to be less than 6,000 psi. Seven sets of strength samples were taken during the pour of the first ISFSI pad's section. The average strength for each set ranged from 4,140 psi to 4,800 psi. The highest single concrete sample was 4,960 psi and the lowest single concrete sample was 3,920 psi.

Documents Reviewed: (a) Rone Engineering Report 384858, "Report of Concrete Compressive Strength Test," dated February 1, 2011

Category: Pad Design **Topic:** Design Specifications for Rebar

Reference: HI-STORM FSAR Table 2.2.9

Requirement: The reinforcing bars used in the pad shall be 60 ksi yield strength ASTM material.

Finding: The rebar used in the ISFSI pad was ASTM A615-09b Grade 420/60 and met the 60 ksi yield strength requirement. The design specifications for ASTM rebar material at 60 ksi yield strength was specified in the Holtec FSAR, Table 2.2.9, "Examples of Acceptable ISFSI Pad Design Parameters," for Parameter Set "B." CMC Steel Texas provided certified mill test reports for the rebar supplied to Comanche Peak that documented the rebar as ASTM A615-09b Grade 402/60. All yield strength tests showed values above the 60 ksi requirement.

Documents Reviewed: (a) CMC Rebar North Texas Job 1025002293, Drawing R4; (b) CMC Steel Texas Certified Mill Test Reports for Heat Nos. 3019004, 3019091, 3019710, 3019711, 3020174, 3020214, 3020222, 3020224, 3020225, 3020234, 3020236, 3020238, 3020239, 3020240, 3020241, 3020242, 3020244, 3020245; (c) CMC Rebar North Texas Bid No. J10210, dated July 19, 2010; (d) Comanche Peak ISFSI Project Specification No. 13769701.04-S-C-032000, "Concrete Reinforcement," dated May 13, 2010

Category: Pad Design **Topic:** Pad Thickness

Reference: HI-STORM FSAR Table 2.2.9

Requirement: Concrete thickness must be less than or equal to 28 inches.

Finding: The Comanche Peak ISFSI pad was designed to a thickness of 25". The construction of the pad resulted in a pad thickness varying from 24" to 28" documented in EDCR-1937-FDA04-029. The reinforced concrete pad was designed as Not Important to Safety (ITS) as stated in Section 2.0.4.1 of the Holtec FSAR. However, Comanche Peak classified the ISFSI pad as ITS-C, which is consistent with NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Important to Safety." Structures, systems, and components classified as ITS-C are defined in NUREG/CR-6407 as those that would not significantly reduce the packaging effectiveness and would not be likely to create a situation adversely affecting public health and safety during a failure or malfunction.

FSAR Table 2.2.9, "Examples of Acceptable ISFSI Pad Design Parameters," provided the parameters for two pad designs. Comanche Peak selected the Set "B" parameters with a pad thickness of less than or equal to 28". Construction Drawing 13769701-04000-C-CON-500-2 provided the dimensions of the pad showing the thickness as 24". Construction Drawing 13769701-04000-C-CON-500-1, Note 13.B, provided for a tolerance of +2", -0" for the thickness of the pad. The licensee had decided to construct the pad with a 25" thickness. EDCR-1938-FDA04-029 was generated to document the pad's resulting construction, which varied from 24" to 28". The EDCR stated that the pad was acceptable because the pad was not greater that 28" as required by the FSAR. Observations during the pad pouring activities on January 4, 2011, confirmed the pad thickness as not greater than 28".

Documents Reviewed: (a) Holtec Final Safety Analysis Report (FSAR) HI-2022444, Rev. 9; (b) Holtec Construction Drawing 13769701-04000-C-CON-500-1, "ISFSI Storage Pad," Rev. 0; (c) Holtec Construction Drawing 13769701-04000-C-CON-500-2, "ISFSI Storage Pad," Rev. 0; (d) EDCR-1937-FDA04-029 dated February 17, 2011

Category: Pad Design **Topic:** Placement of Rebar

Reference: 10 CFR 72.150

Requirement: Rebar placement shall be in accordance with the design drawings.

Finding: Rebar placement slightly deviated from the design drawings. While performing a 100% verification, Holtec QC identified that the distance between #10 rebar varied with a minimum of 7.5 inches to a maximum of 10.5 inches between bars. Design Drawing #13769701-04000-C-CON-500-2 Note 14(A) required the spacing to be 9 inches, +/- 1 inch between bars. An Engineering Design Change Report (EDCR) # 1937-FDA04-027 was generated to document a resolution. This deviation was deemed acceptable by Holtec Engineers because the calculated safety margin due to the deviation was still maintained well above the allowable limit.

Documents Reviewed: (a) Holtec Construction Drawing #13769701-04000-C-CON-500-2, "ISFSI Storage Pad Sheet 2", dated May 14, 2010 (b) Engineering Design Change Request (EDCR) # 1937-FDA04-027, dated December 29, 2010

Category: Pad Design **Topic:** Seismic Analysis for Static & Dynamic Loads

Reference: 10 CFR 72.212 (b)(2)(i)(B)

Requirement: Cask storage pads and areas have been designed to adequately support the static and dynamic loads of the stored casks, considering potential amplification of earthquakes through soil-structure interaction and soil liquefaction potential or other soil instability due to vibratory ground motion.

Finding: The ISFSI pad design was reviewed to make an initial determination that the pad was adequately designed to support the static and dynamic loads of the storage casks. This initial review was performed to verify that no significant deficiencies were evident with the design prior to the start of pad construction. The ISFSI pad is approximately 252 feet long, 102 feet wide, and 25 inches thick. The pad was constructed with three separate pad pours, each pour comprising 1/3 of the pad. The pad is sized to hold 84 casks. The structural fill under the pad was approximately 3 feet of engineered fill gravel, placed in 9 inch-thick lifts compacted to 95% of maximum dry density. Grade level of the ISFSI pad was approximately 830 feet. Grade level of the plant area, approximately 3,000 feet west of the ISFSI, was approximately 809 feet. The Holtec Hi-Storm 100S ventilated storage cask system with metal MPC-32 multi-purpose canisters will be used. Each canister will hold 32 PWR fuel assemblies. The weight of the Hi-Storm 100S Version B(218) cask with a loaded MPC-32 is approximately 360,000 pounds.

Numerous geotechnical evaluations of the ISFSI pad area were performed, including eight borings within the planned footprint of the ISFSI pad from 10 to 25 feet in depth, soil sampling, rock coring, observation well installation, laboratory testing of soil and rock samples, surface seismic velocity surveys, electrical resistivity surveys, and surveying of "as-built" boring locations. The subsurface under the ISFSI pad was underlain by a nominal thickness of relatively stiff clay, which provided a stiff foundation support component unlikely to create significant amplification during an earthquake. Very stiff to hard clay stone interblended with weathered limestone and sandstone was found in the first 6 feet. The next 6 feet was interblended limestone. The layer below this was primarily gray limestone locally imbedded with layers of clay stone. This extended to a thickness in excess of 200 feet. The top 12 feet under the ISFSI pad was found to be unsaturated and was expected to exhibit negligible primary consolidation settlement. The material was not expected to saturate when exposed to the load from the fully populated ISFSI pad. The majority of settlement of these materials was expected to be elastic in nature. These soils were cohesive in nature with fines contents greater than 30% and the fines classified as clay based on the Unified Soils Classification System. Therefore, these soils were not considered susceptible to liquefaction and no further analysis was required. Post-earthquake settlement of the ISFSI pad is expected to be negligible.

Shaw Nuclear performed calculations to determine the stability of the ISFSI pad during a seismic event in Calculation 13769701-G-0003. The minimum acceptable factor of safety for the pad was selected as three for loads normally acting on the pad and two for the worst case loading conditions. The factor of safety against bearing capacity failure was calculated as the ultimate bearing capacity divided by the actual bearing pressure. Dead and earthquake loads were considered. The fully loaded (84 casks) factor of safety was calculated to be 7.22. The unbalanced factor of safety was calculated to be 8.18. Because these values were larger than the minimum required factor of safety for both dynamic loads (factor of safety of 2) and static loads (factor of safety of 3), the ISFSI pad was determined to be stable with respect to bearing capacity for these loads.

According to the Comanche Peak FSAR, Section 2.5.2.1, "Seismicity," central and east Texas lie within the zone of least seismic activity in the U.S. The reactor plant seismic design safe shutdown earthquake (SSE), as discussed in FSAR Section 2.5.1, "Basic Geology and Seismic Information," and Section 3.7B.1, "Seismic Input," was based on a peak horizontal ground acceleration of 0.12g and a peak vertical ground acceleration of 0.08g. The free-field horizontal response spectrum assumed at Comanche Peak was a Newman, Blume and Kapur spectrum. Holtec performed a dynamic analysis of the Comanche Peak ISFSI pad in Report HI-2094472 to determine the maximum displacement of a HI-Storm cask, the maximum angle of rotation from the vertical, and the peak vertical load applied to the ISFSI pad when subject to the bounding Comanche Peak seismic response spectra. A comparison of the Comanche Peak seismic spectrum from FSAR Figure 3.7B-6, "Horizontal Response Spectra, Safe Shutdown Earthquake, 15% Damping," to the Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," free field horizontal spectrum found a close comparison between the two spectrum. The Regulatory Guide 1.60 seismic spectrum was used in NUREG/CR-6865, "Parametric Evaluation of Seismic Behavior of Freestanding Spent Fuel Dry Cask Storage Systems." For added conservatism, the Holtec analysis used the Regulatory Guide 1.60 shape and increased the horizontal and vertical ground components by 50% over the entire frequency range of the Regulatory Guide 1.60 seismic spectra. This resulted in a horizontal ground component of 0.18g and a vertical ground component of 0.12g used in the ISFSI pad calculations and fully encompassed the Newman, Blume and Kapur spectrum assumed for the Comanche Peak site. The Holtec analysis used the nomograms from NUREG/CR-6865 at the 95% confidence level. A coefficient of friction value of 0.53 was used in the calculations and an engineered fill, Young's Modulus of Elasticity of 12 ksi. Actual plate load tests reported November 22, 2010, using Holtec Procedure HPP-1937-103 determined the Young's Modulus of Elasticity to be 12,446 psi (12.446 ksi) for the engineered fill.

Soil profiles at Comanche Peak were cross compared to the profiles in NUREG/CR-6865. Comanche Peak FSAR Table 2.5.4-5, "Initially Selected Values of Preexcavation-Dynamic Foundation Design Parameters," Table 2.5.4-5B, "Representative Geophysical Data from Preexcavation Surveys at Station Location," and Table 2.5.4-5C, "Representative Geophysical Data from Safe Shutdown Impoundment Dam Location," were compared to NUREG/CR-6865, Table 3.5, "Soft Soil Foundation Material Properties," and Table 3.7, "Rock Foundation Material Properties." The soil profile in Table 2.5.4-5C had a shear wave velocity of 650 ft/sec. Using a Poisson's Ratio of 0.43 from the same table and a weight density of 144 lb/cu. ft. from Table 2.5.4-5 resulted in a computed Young's Modulus of 5408 ksf down to 10 feet. This was within the range of the Comanche Peak soft soil foundation (19.3 ksi = 2779 ksf from Table 3.5) and the rock foundation (44.8 ksi = 6451 ksf from Table 3.7). Holtec concluded that the substrate profile at Comanche Peak could be considered within the range of NUREG/CR-6865. Based on the conservative use of the Regulatory Guide 1.60 seismic spectrum increased by 50% and the similarity of the soil profiles, Holtec concluded that the nomograms in NUREG/CR-6865 were applicable to the Comanche Peak site. Calculations determined that the casks would rotate approximately 0.16 degree raising the cask less than 1 inch during an earthquake. If a very low coefficient of friction (0.2) was assumed in the calculations, the most the cask would slide would be approximately 1.1 inches.

Documents Reviewed: (a) Shaw Nuclear Calculation 13769701-G-0004, "ISFSI Pad Settlement," Rev. 0; (b) Shaw Stone & Webster, Inc. Technical Report 13769701-R-G-00001-2, "ISFSI Pad Geotechnical Report," Rev. 2; (c) Shaw Nuclear Calculation 13769701-G-0003, "ISFSI Pad Stability," Rev. 2; (d) Holtec Report HI-2094472, "Dynamic Analysis of Comanche Peak ISFSI Pad," Rev. 4; (e) Shaw Nuclear Calculation 13769701-G-0002, "ISFSI Pad One-Dimensional Site Response Analysis," Rev. 0; (f) Shaw Nuclear Calculation 13769701-G-0001, "ISFSI Pad Bases of Geotechnical Parameters Recommended for Design," Rev 0; (g) Comanche Peak FSAR, Amendment 102 [ML082321269]; (h) Holtec Procedure HPP-1937-103, "Procedure for Plate Test of the Engineered Fill for Comanche Peak," Rev. 1, and Plate Load Test Results dated Nov. 22, 2010; (i) Holtec

Report HI-2094473, "Structural Analysis of Comanche Peak ISFSI Pad," Rev. 2; (j) Internal NRC Letter from E. Benner to C. A. Lipa, entitled "Revision to Response to RIII Technical Assistance Request (TAR) - LaSalle Station ISFSI Pad Seismic Design, LaSalle Station RIII TAR dated 10/20/09," dated January 20, 2010 (ML100200515)

Category: Pad Design **Topic:** Site Specific Seismic Parameters - Tip Over

Reference: CoC 1014, Technical Specification 3.4.3 (a)

Requirement: The resultant horizontal and vertical site-specific seismic acceleration parameters shall be evaluated to ensure the cask will not tip over or undergo excessive sliding during the design basis earthquake.

Finding: The seismic acceleration parameters for the Comanche Peak ISFSI site were evaluated and found to be incapable of causing a cask to tip over or undergo excessive sliding. The reactor plant seismic design SSE was discussed in FSAR Section 2.5.1, "Basic Geology and Seismic Information," and Section 3.7B.1, "Seismic Input." The FSAR identified a peak horizontal ground acceleration of 0.12g and a peak vertical ground acceleration of 0.08g as the design basis earthquake (SSE) values for the site. Holtec performed a dynamic analysis of the Comanche Peak ISFSI pad in Report HI-2094472 to determine the maximum displacement of a Hi-Storm cask, the maximum angle of rotation from the vertical, and the peak vertical load applied to the ISFSI pad when subject to the bounding Comanche Peak seismic response spectra. The Holtec analysis increased the seismic spectra by 50%, using values of 0.18g horizontal and 0.12g vertical. A coefficient of friction value of 0.53 was used in the calculations and an engineered fill Young's Modulus of 12 ksi. Calculations determined that the casks would rotate approximately 0.16 degree, raising the cask less than 1 inch on its side during an earthquake. If a very low coefficient of friction (0.2) was assumed in the calculations, the most the cask would slide would be approximately 1.1 inches. The ISFSI pad was constructed with a broom finish on the surface and will provide a high coefficient of friction, significantly higher than the 0.2 assumed in the calculations.

Documents Reviewed: (a) Holtec Report HI-2094472, "Dynamic Analysis of Comanche Peak ISFSI Pad," Rev. 4; (b) Comanche Peak FSAR, Amendment 102 [ML082321269]

Category: Pad Design **Topic:** Static Coefficient of Friction

Reference: HI-STORM FSAR Table 2.2.9

Requirement: A static coefficient of friction of 0.53 between the ISFSI pad and the bottom of the overpack shall be used. If a higher value of the coefficient of friction is used, it shall be verified by test. The test shall follow the guidelines in FSAR Section 3.4.7.1.

Finding: A static coefficient of friction of 0.53 was used for the Comanche Peak ISFSI calculations. The FSAR, Table 2.2.9, specified the 0.53 value. Holtec Report HI-2094472, Section 4.0, "Assumptions," specified a value of 0.53 for the coefficient of friction for the Comanche Peak ISFSI pad calculations. The ISFSI pad was constructed with a broom finish on the surface, which should provide a higher coefficient of friction.

Documents Reviewed: (a) Comanche Peak Final Safety Analysis Report (FSAR), Amendment 102 [ML082321269]; (b) Holtec Report HI-2094472, "Dynamic Analysis of Comanche Peak ISFSI Pad," Rev. 4

Category:	Pad Design **Topic:** Subgrade Effective Modulus of Elasticity
Reference:	HI-STORM FSAR Table 2.2.9
Requirement:	Subgrade effective modulus of elasticity shall be less than or equal to 16,000 psi.
Finding:	Comanche Peak used a subgrade effective modulus of elasticity of 12 ksi. Holtec Report HI-2094472, Section 5.0, "Input Data," specified a value of 12 ksi. Holtec Report HI-2094473, Section 5.0, "Input Data," specified the minimum Young's modulus of Engineering Fill as 12,000 psi (12 ksi). Actual tests at the ISFSI pad site to determine the modulus of elasticity were performed using Holtec Procedure HPP-1937-103. Test results dated November 22, 2010, reported an elastic modulus of 12,446 psi (12.446 ksi).
Documents Reviewed:	(a) Holtec Procedure HPP-1937-103, "Procedure for Plate Test of the Engineered Fill for Comanche Peak," Rev. 1, and Plate Load Test Results dated Nov. 22, 2010; (b) Holtec Report HI-2094472, "Dynamic Analysis of Comanche Peak ISFSI Pad," Rev. 4; (c) Holtec Report HI-2094473, "Structural Analysis of Comanche Peak ISFSI Pad," Rev. 2

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