UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

May 18, 2000

Craig Anderson, Vice President-Operations
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S.R. 333
Russellville, Arkansas 72801-0967

SUBJECT: NRC INSPECTION REPORT 50-313/00-005; 50-368/00-005; 72-13/00-001

Dear Mr. Anderson:

This refers to the inspection conducted on April 17-20, 2000, at the Arkansas Nuclear One, Units 1 and 2, facility. The enclosed report presents the results of this inspection.

This inspection included a review of the current status of the casks loaded at your Independent Spent Fuel Storage Installation (ISFSI), including verification of compliance with technical specifications and license requirements for the operation of the ISFSI. During this inspection, loading of the 14th cask was completed. Activities related to movement of the cask to the ISFSI were observed by the NRC inspector. No violations of NRC regulations were identified.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be placed in the NRC Public Document Room (PDR).

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

/RA/

Dwight D. Chamberlain, Director
Division of Nuclear Materials Safety

Docket Nos.: 50-313
50-368
72-13
License Nos.: DPR-51
NPF-6

Enclosure:
NRC Inspection Report
50-313/00-05; 50-368/00-05; 72-13/00-01

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ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Docket Nos.:	50-313; 50-368; 72-13
License Nos.:	DPR-51; NPF-6
Report No.:	50-313/00-05, 50-368/00-05; 72-13/00-01
Licensee:	Entergy Operations, Inc.
Facility:	Arkansas Nuclear One, Units 1 and 2 Arkansas Nuclear One, Independent Spent Fuel Storage Installation
Location:	1448 S. R. 333 Russellville, Arkansas 72801
Dates:	April 17-20, 2000
Inspector:	J. V. Everett, Senior Health Physicist
Approved by:	D. Blair Spitzberg, Ph. D., Chief Fuel Cycle & Decommissioning Branch
Attachments:	1) Supplemental Information 2) List of Loaded VSC-24 Casks at ANO

EXECUTIVE SUMMARY

Arkansas Nuclear One, Units 1 and 2
NRC Inspection Report 50-313/00-05; 50-368/00-05; 72-13/00-01

This routine announced inspection included the annual review of activities associated with the Independent Spent Fuel Storage Installation (ISFSI) and the observation of activities associated with the loading of the 14th concrete storage cask and movement of the concrete storage cask from the train bay to the ISFSI. Work activities observed were conducted safely. Personnel were experienced and knowledgeable of procedural requirements and the requirements of the VSC-24 Certificate of Compliance. The ANO management team responsible for cask loading operations conducted activities in accordance with procedures and re-enforced worker responsibilities toward safe work practices and reporting safety concerns. There was a positive attitude by the workers interviewed during this inspection towards compliance and safety. The knowledge gained by the licensee during the loading of the first 14 casks had been substantial. Numerous lessons learned since loading the first cask in 1996 had been implemented by the licensee to improve work efficiency and safety.

During 1997, weld integrity issues were identified concerning the potential for weld cracking on the first four casks loaded at Arkansas Nuclear One (ANO). In response to this issue, the licensee had committed to evaluate the structural lid welds of the four casks. The licensee completed this evaluation and notified the NRC on September 27, 1999, of the results of the evaluation. The basis supporting the adequacy of the welds was reviewed during this inspection. The licensee's testing and analyses confirmed that the welds were acceptable.

Operation of an ISFSI

- Radiological surveys of the cask loaded during this inspection were performed in accordance with approved procedures and documented compliance with radiation limits and removable contamination limits specified in technical specifications (Section 1).

- The annual radiological effluent report submitted to the NRC reported that no effluents were released from the ISFSI. Radiological monitors on the fence around the ISFSI measured area radiation levels of approximately 250 mrem/quarter during the second half of 1999. This represented 13 casks placed on the ISFSI pad (Section 1).

- Thermal performance of the casks stored at the ISFSI were within the limits established by technical specifications. Temperature readings were collected twice daily and inlet/outlet screens were checked to ensure no blockage existed (Section 1).

Design Control

- The licensee was conducting safety screenings and safety evaluations in accordance with established procedures. Four safety evaluations related to the ISFSI were conducted during 1999 and reported to the NRC in the annual report (Section 2).

Report Details

Summary of Plant Status

The licensee completed the loading of the 14th cask during this inspection. Four additional casks were under construction with more casks to be ordered. Continued cask loading will be necessary to maintain full core offload capability in the spent fuel pools for the two reactors. With the continuation of cask loading, additional pad space will be required in the near future.

Seven casks were loaded with Unit 1 (Babcock and Wilcox) spent fuel and seven were loaded with Unit 2 (Combustion Engineering) spent fuel. The highest heat loading of any of the casks was 12.3 kW. The average heat load for the Unit 1 casks was 8.7 kW. The average heat load for the Unit 2 casks was 8.3 kW. The average collective dose to load the Unit 1 casks has been 0.246 person-rem. The Unit 2 casks average collective dose have been 0.552 person-rem. The higher Unit 2 doses were due to the Unit 2 fuel being 18 inches longer than the Unit 1 fuel, resulting in the fuel assembly extending closer to the lid.

1 Operation of an ISFSI (60855)

1.1 Inspection Scope

The annual inspection of the ISFSI included a review for compliance with technical specifications and an assessment of radiological conditions at the ISFSI pad. During this inspection, work activities were observed related to the movement of the 14th cask to the ISFSI pad.

1.2 Observation and Findings

Thirteen casks had been placed on the ISFSI pad. During this inspection, the 14th cask was loaded with Unit 2 fuel and moved to the ISFSI pad. The 14th cask was designated as Cask #10. This cask had originally been selected for Unit 1 fuel. However, during the loading of the Unit 1 fuel on May 21, 1999, a fuel assembly became stuck. Unit 1 fuel assemblies are approximately 0.1 inches larger in width than Unit 2 fuel. The licensee successfully removed the Unit 1 fuel assembly and evaluated the cause of the problem, which was determined to be due to a slight bowing in two locations in the channel on opposite sides and at different heights. This caused binding as the fuel assembly was inserted into the channel. The licensee documented the problem in corrective action CR ANO-1-1999-0140 on May 24, 1999. Actions taken in response to the incident included visual inspection of the fuel and the cask, inspection of the next two casks to be loaded, measurement of the tolerances in the channel, and verification that Unit 2 fuel would fit into the channel where the Unit 1 fuel had become stuck.

Cask #10 was placed onto the ISFSI pad on April 20, 2000. The radiological surveys of the cask while in the train bay and the movement of the cask onto the ISFSI pad were observed during this inspection. The ANO project team responsible for dry cask storage operations continued to demonstrate a strong adherence to regulatory and procedural requirements for cask loading activities. Personnel were very knowledgeable of the

requirements related to loading and moving a VSC-24 cask. Many of the personnel had been working on the dry cask storage project team since the first cask was loaded in 1996.

The radiological surveys conducted on Cask #10 while in the train bay included the surveys required by Technical Specification 1.2.4 "Maximum External Surface Dose Rate" and Technical Specification 1.2.5 "Maximum Multi-Assembly Sealed Basket (MSB) Removable Surface Contamination." The licensee conducted the radiological surveys per Procedure 1601.303 "Radiation Monitoring Requirements for Loading and Storage of the VSC," Revision 5. The radiological surveys found no removable contamination above detectable levels of 1,000 disintegrations per minute beta-gamma and 20 disintegrations per minute alpha. The highest contact dose rates measured were 1.2 mrem/hr on the sides, 2.4 mrem/hr at the air outlets, 18.6 mrem/hr at the air inlets and 23 mrem/hr on the lid. The measurements included both gamma and neutron dose rates. The neutron dose rate component ranged from 3-25 percent for the measurements taken on the sides and at the air vents. For the lid, the neutron component on the edges of the lid ranged from 20-50 percent and at the centerline, the neutron component was 70 percent of the dose. The licensee reported that neutron doses were typically not detected for casks with heat loads below 9.5 kw, but as the heat load increased, the neutron component would increase. The heat load for Cask #10 was 12.3 kw. All readings taken demonstrated compliance with Technical Specification 1.2.4, which limited the radiation levels to 20 mrem/hr on the sides and 50 mrem/hr on the lid and at the air vents. Cask #10 had been fitted with a modified shield ring that provided better shielding for the radiation streaming along the gap between the steel basket and the storage cask. By doing this, the licensee reduced the lid dose rates to levels further below the limit of 50 mrem/hr specified in Technical Specification 1.2.4. Surveys of several previous casks had used an average radiation reading for the lid to demonstrate compliance with Technical Specification 1.2.4. This was necessary because locations were found that exceeded the 50 mrem/hr value. Averaging was determined acceptable based on Section 2.11 "Radiation Shielding," in the VSC-24 Safety Evaluation Report issued by the NRC in April 1993. The Safety Evaluation Report established an average external dose rate limit of 20 mrem/hr on the sides and 50 mrem/hr on the top and at the air vents.

In addition to the radiological surveys conducted for compliance with the technical specifications, the licensee also placed a grid on the lid which matched the locations of the fuel assemblies loaded in the cask. Radiological data over each fuel assembly was recorded. Both gamma and neutron doses were measured. Though this data was not used to verify correct placement of the fuel assemblies in the cask, the data did demonstrate that readings could be taken to assess the relative location of the fuel assemblies loaded in the cask.

To assist in monitoring radiation levels of the basket containing the fuel during lowering from the transfer cask into the storage cask, the licensee had positioned a radiation detector at a work area where radiation levels were expected to be elevated. The doors on the bottom of the transfer cask are open when the transfer cask is sitting on top of the concrete cask and the basket is being lowered into the concrete cask. A radiation detector was placed approximately 10-feet from the door opening. The radiation

detector was not in the direct beam, but slightly off-center. Readings approached 1 R/hr. The licensee had designated the area around the door as a high radiation area and had removed unnecessary personnel from the area prior to opening the doors.

The licensee had performed a number of "as low as reasonably achievable (ALARA)" evaluations from data collected during previous cask loading activities. The data included a breakdown of radiation doses received by the various disciplines associated with cask loading activities to determine which work groups were receiving the highest doses. This would allow additional ALARA efforts to be directed towards the work activities with the most to gain from the dose reduction effort. The higher doses were received during the welding operations and the support activities. Radiological surveying was considered part of the support activities. Some of the lowest doses were received during the movement of the fuel in the spent fuel pool. Tracking of the person-rem dose and man-hours to load the first 14 casks found that for Unit 1 fuel, the average collective dose was 0.028 person-rem/kw. For Unit 2 fuel it was 0.067 person-rem/kw. Attachment 2 to this inspection report provides a table of data for each of the 14 casks loaded at ANO related to man-hours required to complete the loading, total doses received, and heat load for each of the casks.

The doses recorded for cask loading activities included both neutron and gamma components. The neutron component was based on neutron surveys and tracking of time that individuals were in neutron fields. The calculated neutron dose was then added to the individual's gamma dose. Thermoluminescent dosimeters (TLD) worn by workers included special neutron dosimetry calibrated for the spectrum that would be encountered around the casks. In 1999, no actual neutron doses were recorded by any individuals on their TLDs. The TLDs had a minimum detectable neutron dose of 10 mrem. Typically calculations for workers, based on neutron surveys, had resulted in 15-20 percent of the worker's dose being assigned from neutrons for the casks with higher heat loads.

The licensee monitored environmental radiation levels around the ISFSI pad with two TLDs located on the ISFSI fence. The TLDs were approximately 45-feet from the ISFSI pad. For the 3rd and 4th quarters of 1999, TLD #34 measured 273 mrem/quarter and 280 mrem/quarter, respectively. On the opposite fence was TLD #35, which measured 228 mrem for the 3rd quarter and 295 mrem for the 4th quarter. Based on this data for the second half of 1999, the integrated exposure at the fence of the ISFSI will be approximately 1-rem for the year with the current number of casks located at the ISFSI. Prior to placing the two TLDs on the ISFSI fence, the licensee had maintained one TLD adjacent to the pad within 3-feet of the nearest cask. This TLD had measured 1.6 rem for the first half of 1999. The ISFSI pad and fence are located away from normally occupied work areas and have not presented an exposure problem to workers. However, as more casks are loaded and placed in the ISFSI, an increase in background radiation levels to nearby work areas may require the addition of engineering features to the ISFSI to maintain acceptable ALARA dose rates to workers.

The licensee is required by 10 CFR 72.44(d)(3) to submit an annual report to the NRC within 60 days of January 1 of each year concerning effluent releases from the ISFSI. ANO submitted their annual report to the NRC on February 28, 2000. The report stated that no effluent releases had occurred from the ISFSI.

The technical specifications for the ISFSI required thermal performance monitoring of the casks. A review of records was completed to verify the licensee was performing the required thermal performance surveillances. To ensure proper air flow around the casks in order to maintain good thermal performance, Technical Specification 1.3.1 "Visual Inspection of Air Inlets and Outlets," required daily verification that the wire mesh screens covering the air inlets and air outlets were clear of any blockage. Technical Specifications 1.2.3 "Maximum Permissible Air Outlet Temperature" and Technical Specification 1.3.4 "Cask Thermal Performance," established criteria for thermal performance monitoring of the casks on a daily basis. Technical Specification 1.2.3 established a limit for the maximum air outlet temperature of a fully loaded (24 kw) cask to not exceed ambient temperature by more than 110°F. For casks with lower heat loads below the 24 kw limit, the licensee was required to calculate an acceptable temperature differential based on methodology provided in the safety evaluation report.

The licensee conducted thermal performance surveillances of the casks every 12 hours per ANO Procedure 1015.003B "Unit Two Operations Logs." The thermal performance data for Cask #6 was reviewed for the period of January 1 through April 14, 2000. The licensee's thermal performance data for Cask #6 included documentation of the required outlet and inlet screen inspections, ambient temperature readings, average outlet temperature readings, and the calculated maximum outlet temperature readings. The data documented compliance with Technical Specifications 1.2.3, 1.3.1 and 1.3.4. Outlet temperature data for the first half of 1999 was reviewed for Cask #5. The outlet temperature data for Cask #5 was reviewed in graph form to determine if any unusual temperature patterns existed. The outlet temperature followed the pattern for the ambient temperature during the period.

The thermal performance of Cask #10 was evaluated while the cask was in the train bay. The ambient temperature was 72°F. Based on the 12.3 kw heat load of the fuel, the maximum acceptable outlet temperature was calculated to be 139.6°F. The actual measured values ranged from 100.8°F to 110.6°F. The average was 106.6°F, which was less than the maximum limit of 139.6°F.

Technical Specification 1.2.11 "Placement of the Ventilated Storage Cask (VSC) on the Storage Pad," required the casks to be placed in a storage array 15-feet ± 1-foot apart, center-to-center. The licensee ensured the spacing by measuring the proper storage location for each cask prior to placement and marking the location on the ISFSI pad. During the tour of the ISFSI, the casks were observed to be properly placed on the pad.

1.3 Conclusions

Radiological surveys of the cask loaded during this inspection were performed in accordance with approved procedures and documented compliance with radiation limits and removable contamination limits specified in technical specifications.

The annual radiological effluent report submitted to the NRC reported that no effluents were released from the ISFSI. Radiological monitors on the fence around the ISFSI measured area radiation levels of approximately 250 mrem/quarter during the second half of 1999. This represented 13 casks placed on the ISFSI pad.

Thermal performance of the casks stored at the ISFSI were within the limits established by technical specifications. Temperature readings were collected twice daily and inlet/outlet screens were checked to ensure no blockage existed.

02 Design Control (60851)

2.1 Inspection Scope

Safety screenings and safety evaluations performed by the licensee were reviewed to verify compliance with the requirements in 10 CFR 72.48. The annual 10 CFR 72.48 summary report submitted to the NRC was also reviewed.

2.2 Observation and Findings

The licensee conducted safety evaluations of any changes which could affect the dry cask storage activities in accordance with procedure 1000.132 “10 CFR 72.48 Review Program,” dated April 13, 2000. The licensee conducted four safety evaluations during 1999. These were:

- Ventilated Concrete Cask Liner Tile Installation Adhesive
- Ventilated Concrete Cask Cover Plate Bolts
- Multi-Assembly Storage Basket Material Repair Non-Destructive Examination Nonconformance Accepted as “Use As Is”
- Multi-Assembly Storage Basket #13 Drain Line “Use As Is”

All four safety evaluations determined that the issues could be resolved within the criteria established in 10 CFR 72.48 without an amendment to the VSC-24 Certificate of Compliance. The safety evaluations were submitted to the NRC in the licensee’s annual report on 10 CFR 72.48 safety evaluations dated December 15, 1999.

A number of screenings were reviewed. This included the topics related to changes to procedures for equipment preparation, NRC reporting, training, ultrasonic testing examination of the structural lid, fuel selection criteria and software changes. Screenings were conducted of each issue to determine whether a safety evaluation was required. None of the screenings reviewed were found to require safety evaluations.

2.3 Conclusions

The licensee was conducting safety screenings and safety evaluations in accordance with established procedures. Four safety evaluations related to the ISFSI were conducted during 1999 and reported to the NRC in the annual report.

03 Follow-up on Open Items (92701)

3.1 (Closed) Unresolved Item (URI) 50-368/9712-05: Potential Hydrogen Cracking on Previously Loaded Casks: Inspection Report 50-368/97-12 dated May 21, 1997, reviewed the weld cracking problem that had occurred on two of the first three casks loaded at ANO. The potential for hydrogen cracking, as the weld failure mechanism on the two casks, was identified as a concern by the NRC. On August 28, 1998, the licensee committed to complete an ultrasonic examination of the structural lids of the four casks that had been loaded. Using a time-of-flight diffraction ultrasonic testing technique, the licensee determined that the welds on three of the casks met the screening criteria and required no further action. This was documented in Inspection Report 50-368/99-10 dated July 8, 1999. The 4th cask, Cask #6, however, was found to have a possible weld defect in the form of a group of small, closely spaced flaws, that exceeded the screening criteria related to the design basis for a horizontal drop.

The licensee performed a re-analysis of the weld defects using the more detailed method of elastic-plastic fracture mechanics (EFPM). Use of this method is difficult because the materials properties required for the analysis are not tabulated. Instead they must be derived from tests of the specific materials of construction, in this case the deposited weld metal. The licensee was able to perform the necessary laboratory tests on weld coupons that were made from the same lot of filler metal as was used for the cask weld.

During this inspection, the analysis performed to qualify the weld on Cask #6 was reviewed. Support for the review was provided by a materials specialist in NRC headquarters who reviewed selected data and conducted a phone interview with the licensee and the contractor hired to perform the analysis. Structural Integrity Associates was the contractor hired by the licensee to perform the analysis and coordinate the testing of several weld coupons prepared by the licensee. The material testing was conducted at Westmoreland Mechanical Testing and Research, Inc., to determine the material properties for use in the EPFM analysis.

Based on the analysis, a non-through-wall flaw length of up to 12 inches was found to be acceptable. The longest flaw on Cask #6 was 10.3 inches. The actual data for Cask #6 indicated the flaw was less than half the thickness of the weld wall.

Structural Integrity Associates, Inc., issued a letter to the licensee on September 27, 1999, reporting that the weld flaws on Cask #6 did not require further action and were acceptable. On September 27, 1999, Entergy notified the NRC by letter that all tests had been completed and the welds on the structural lids for the first four casks loaded were acceptable.

04 Exit Meeting

The inspector presented the inspection results to members of the licensee management at the conclusion of the inspection on April 20, 2000. The licensee acknowledged the findings presented. The licensee did not identify as proprietary any information provided to, or reviewed by, the inspector.

ATTACHMENT 1

PARTIAL LIST OF PERSONS CONTACTED

Licensee

D. Binkley, Shift Manager for Dry Cask Storage
P. Butler, Engineering
J. Dosa, Licensing Specialist
M. Eisenhower, Lead Welder
D. Grace, Radiation Protection
M. Harris, Dry Fuel Project Manager
T. Nickels, Radiation Protection Supervisor
R. Starkey, Radiation Protection Supervisor
G. Stephenson, Chemistry
J. Wellwood, Unit 2 Operations
D. Williams, Engineer

NRC Headquarters

J. Hornseth, Spent Fuel Project Office

INSPECTION PROCEDURES USED

60851	Design Control
60855	Operation of an ISFSI

LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

None

Closed

50-368/9712-05	URI	Potential Hydrogen Cracking of Previously Loaded Casks

Discussed

None

LIST OF ACRONYMS

ALARA	As Low As Reasonably Achievable
ANO	Arkansas Nuclear One
CFR	Code of Federal Regulations
EFPM	Elastic-Plastic Fracture Mechanics
ISFSI	Independent Spent Fuel Storage Installation
kw	killowatts
mR/hr	milliRoentgen/hour
mrem/hr	millirem/hour
NRC	Nuclear Regulatory Commission
TLD	Thermoluminescent Dosimeter
URI	Unresolved Item
VSC	Ventilated Storage Cask

ATTACHMENT 2

LOADED VSC-24 CASKS AT THE ANO ISFSI

LOADING ORDER	CASK #	UNIT	DATE PLACED ON PAD	HEAT LOAD (kw)	MANHOURS TO LOAD	Person-Rem DOSE
1	1	Unit 1	12/96	5.2	not tracked	0.185
2	3	Unit 1	1/97	10.7	1750	0.384
3	5	Unit 2	4/97	4.	1852	0.291
4	6	Unit 2	4/97	6.2	1463	0.469
5	12	Unit 2	9/98	10.8	2479	0.900
6	11	Unit 2	10/98	8.0	1416	0.553
7	7	Unit 2	10/98	8.0	1844	0.567
8	2	Unit 2	11/98	8.1	1542	0.483
9	4	Unit 1	4/99	9.1	2036	0.236
10	8	Unit 1	4/99	9.2	1186	0.231
11	9	Unit 1	5/99	9.1	1324	0.189
12	13	Unit 1	5/99	7.3	1380	0.112
13	14	Unit 1	6/99	10.7	1130	0.383
14	10	Unit 2	4/00	12.3	1700	0.602

Unit 1: 7 casks loaded, average heat load = 8.7 kw; average man-hours to load = 1468 hrs; average dose = 0.246 person-rem
Unit 2: 7 casks loaded, average heat load = 8.3 kw; average man-hours to load = 1757 hrs; average dose = 0.552 person-rem
Note: Unit 2 fuel is 18 inches longer than Unit 1 fuel