

December 2, 2004

EA-04-174

Mr. Jay K. Thayer
Site Vice President
Entergy Nuclear Operations, Inc.
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Brattleboro, VT 05302-0500

SUBJECT: VERMONT YANKEE NUCLEAR POWER STATION - SPECIAL INSPECTION
REPORT NO. 05000271/2004007

Dear Mr. Thayer:

Between April 22 - August 27, 2004, the U.S. Nuclear Regulatory Commission completed a special inspection at your Vermont Yankee Nuclear Power Station. The enclosed inspection report documents the inspection findings which were discussed on August 12, September 8, and November 23, 2004, with you and other members of your staff.

This special inspection was in response to Entergy's April 21, 2004, report to the NRC that two spent fuel rod pieces were not in the location specified in its special nuclear material inventory records. The NRC conducted a thorough and systematic review in accordance with a charter developed for this special inspection. The charter is attached to the inspection report. The inspection included a review of Entergy's investigation and conclusions regarding the search for the two spent fuel rod pieces. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

This inspection report documents an apparent violation of 10 CFR 74.19 "Material Control and Accounting of Special Nuclear Material - Recordkeeping," that is being considered for escalated enforcement action. The disposition of the escalated enforcement action is still under NRC management review. We will advise you of the outcome of our review in separate correspondence for which you will have an opportunity to respond. Based on the information developed during the inspection, the NRC has determined that between January 1980 and July 13, 2004, Entergy and its predecessor did not keep adequate special nuclear material inventory records of two spent fuel rod pieces, did not follow its written procedures when the two spent fuel rod pieces were moved to a fuel storage liner, and did not conduct adequate periodic physical inventories of the two spent fuel rod pieces. Because the two spent fuel rod pieces remained in the Vermont Yankee spent fuel pool the entire time the apparent violation existed, there was no actual safety consequence of this apparent violation. Nevertheless, the NRC considers this apparent violation a potentially significant failure of your material control and accounting program. This failure could have resulted in these two spent fuel rod pieces

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being inappropriately included in a shipment of radioactive material to a low-level radioactive waste site.

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Sincerely,

/RA/

A. Randolph Blough, Director
Division of Reactor Projects

Docket No. 50-271
License Number: DPR-28

Enclosure: Inspection Report 05000271/2004007 w/Attachments

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U.S. NUCLEAR REGULATORY COMMISSION

REGION I

Docket No. 50-271

Licensee No. DPR-28

Report No. 05000271/2004007

Licensee: Entergy Nuclear Vermont Yankee, LLC

Facility: Vermont Yankee Nuclear Power Station

Location: 320 Governor Hunt Road
Vernon, Vermont 05354-9766

Dates: April 22 - August 27, 2004

Inspectors: Todd Jackson, CHP, Senior Health Physicist (Team Leader)
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Ray Kellar, P.E., Health Physicist, Region IV
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Observer: William Sherman, Vermont State Engineer

Approved by: A. Randolph Blough, Director
Division of Reactor Projects

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SUMMARY OF FINDINGS

Inspection Report 05000271/2004007; 4/22/04 - 8/27/04; Vermont Yankee Nuclear Power Station; Special Inspection regarding the loss of control of two spent fuel rod pieces; Other Activities.

The special inspection was conducted by two Region I inspectors, an NSIR material control and accounting (MC&A) inspector, and a Region IV inspector. The inspection identified one apparent violation. The disposition of the apparent violation is under NRC management review. The significance of most findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process" (SDP). Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. NRC-Identified and Self-Revealing Findings

Cornerstone: Safeguards

- TBD. The inspectors identified an apparent violation of 10 CFR 74.19 because Entergy and its predecessor did not keep adequate special nuclear material inventory records of two spent fuel rod pieces, did not follow its written procedures when two spent fuel rod pieces were moved to a fuel storage liner, and did not conduct adequate periodic physical inventories of the two spent fuel rod pieces.

Because the two spent fuel rod pieces remained in the Vermont Yankee spent fuel pool, the entire time the apparent violation existed, there was no actual safety consequence of this apparent violation. Nevertheless, the NRC considers this apparent violation a potentially significant failure of Entergy's material and control accounting program. This failure could have resulted in these two spent fuel rod pieces being inappropriately included in a shipment of radioactive material to a low-level radioactive waste site.

The disposition of this apparent violation is still under review by NRC management. (4OA5.1)

B. Licensee-Identified Violations

None

REPORT DETAILS

Background

On April 21, 2004, Entergy reported to the NRC that two spent fuel rod pieces were not in the storage location designated in the inventory records. On April 22, 2004, NRC Region I initiated a special inspection of the missing spent fuel rod pieces in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program," and NRC Inspection Procedure 93812, "Special Inspection." On July 13, 2004, Entergy discovered that the two spent fuel rod pieces were still in the spent fuel pool but in a different location. A chronology of significant events leading to and following the loss of accountability of the two spent fuel rod pieces is included in the Attachment to this report.

4. OTHER ACTIVITIES (OA)

4OA3 Event Followup

1. (Closed) LER 05000271/2004002-00 and 01, Special Nuclear Material not Accounted for at Vermont Yankee

On April 20, 2004, Entergy determined that two spent fuel rod pieces were not in the storage location designated in the inventory records. On April 21, 2004, Entergy notified the NRC Headquarters Operations Center in accordance with 10 CFR 50.72 (b)(2)(xi). Entergy submitted LER 2004-002-00 on June 17, 2004. On September 29, 2004, Entergy submitted LER 2004-002-01, which revised the original LER following the completion of Entergy's investigation and root cause determination. In the revised LER, Entergy provided the results of its investigation that located the two spent fuel rod pieces, described the root causes and contributing causes of the event, described the assessment of safety consequences, and described the corrective actions completed and in-progress.

NRC's special inspection identified an apparent violation that is documented in Section 4OA5.1 of this report. This LER is closed.

4OA5 Other Activities

1. Loss of Control of Special Nuclear Material (SNM)

- a. Inspection Scope

In accordance with the Special Inspection Charter (attached), the inspectors conducted a thorough and systematic review of Entergy's investigation into the circumstances that led to the loss of accountability for the two spent fuel rod pieces in the Vermont Yankee (VY) spent fuel pool (SFP). The inspection included a review of Entergy's investigation and conclusions regarding the location of the two spent fuel rod pieces. The inspectors: observed the initiation of physical searches in the SFP and the opening of

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the fuel storage liner determined to hold the two spent fuel rod pieces; reviewed selected videotaped records of the detailed searches, including verification of a sample of spent fuel assembly serial numbers; assessed Entergy's effort to identify, retrieve, and review pertinent documents; reviewed Entergy management's oversight of the investigation work in-progress; assessed Entergy's preparation for conducting personnel interviews; and reviewed the results of interviews that Entergy conducted. The inspectors also independently reviewed numerous documents related to material control and accounting (MC&A) of special nuclear material (SNM), independently evaluated the root causes of the event, and interviewed personnel involved in Entergy's investigation.

b. Findings and Conclusions

Introduction: The inspectors identified an apparent violation of 10 CFR 74.19 because Entergy and its predecessor did not keep adequate special nuclear material inventory records of two spent fuel rod pieces, did not follow its written procedures when two spent fuel rod pieces were moved to a fuel storage liner, and did not conduct adequate periodic physical inventories of the two spent fuel rod pieces.

Description: In 1979, two spent fuel rods broke into several pieces during inspection and reconstitution work in the SFP at VY. The longer pieces were reinserted into fuel assemblies because these pieces were long enough to be securely held in place. Station staff placed two smaller pieces, (9" piece from fuel rod in position D2 in fuel assembly LJ3949 and 17" piece from fuel rod in position D2 in fuel assembly LJ3915) into a specially fabricated container, that is referred to as a fuel storage bucket in VY's documentation, for temporary storage.

In January 1980, station staff transferred these two smaller spent fuel rod pieces from the fuel storage bucket to a fuel storage liner, but did not follow the instructions in Revision 15 of procedure OP-0400, "SNM Inventory and Accountability Procedure" (the revision used in 1980) to record the transfer. OP-0400 specified the use of four SNM accounting record keeping devices. They were: a) The SNM Card File and Notebook, b) The SNM Inventory Account, c) The SNM Inventory Summary, and d) The Fuel Location Boards. The accounting record keeping devices were to be revised based on information contained on an SNM Transfer Form (VYOPF 0400.02). SNM Transfer Form No. 822A documented that on January 21, 1980, the two spent fuel rod pieces were transferred from the fuel storage bucket to a fuel storage liner. The station staff did not record that transfer information in either the SNM Card File and Notebook, the SNM Inventory Account, the SNM Inventory Summary, or the Fuel Location Boards. This failure to follow the written procedure resulted in misidentification of the location of the two spent fuel rod pieces and loss of accountability.

From January 1980 through January 2004, SNM physical inventories at VY were not performed in accordance with procedure OP-0400. OP-0400 required the station staff to verify the presence of the two spent fuel rod pieces in the fuel storage bucket. A periodic physical inventory of SNM is performed in accordance with the current version

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(Rev. 32) of procedure OP-0400, using form VYOPF 0400.19, "Physical Inventory." Step 9 states, "Verify that the SFP contains the same number of fuel assemblies as the inventory records. Verify that fuel assemblies occupy the same locations in the SFP as on the inventory records." Instead of verifying the presence of the two spent fuel rod pieces in the fuel storage bucket, the practice of station staff was to ensure the fuel storage bucket remained upright and in place on the bottom of the SFP when performing their physical inventory. Operating Procedure OP-0400 allowed this type of physical inventory provided a container was sealed with a "tamper-safe" locking device. However, the fuel storage bucket had no tamper-safe or tamper-indicating device.

Analysis: The finding is a performance deficiency because station staff did not follow procedure OP-0400 in 1980 when station staff transferred the two spent fuel rod pieces from the fuel storage bucket to the fuel storage liner. Station staff did not properly record the transfer and also did not verify the two spent fuel rod pieces were in the location previously recorded during numerous periodic physical inventories from 1980 through January 2004. Entergy's and its predecessor's failure to follow procedure OP-0400 led to the loss of accountability, and therefore, loss of control of the two spent fuel rod pieces containing strategic SNM from January 1980 and continuing until July 13, 2004.

This finding did not have any actual safety consequences since the two spent fuel rod pieces remained in the VY SFP the entire time that the violation existed. Nonetheless, the two spent fuel rod pieces were misplaced in the SFP for over 24 years without the discrepancy being identified during any of the periodic inventories. The NRC considers this apparent violation a potentially significant failure of VY's material control and accounting program. This failure could have resulted in these two spent fuel rod pieces being inappropriately included in a shipment of radioactive material to a low-level radioactive waste site.

Enforcement: 10 CFR 74.19 requires the licensee to (a) keep records showing the inventory (including location and unique identity) of all SNM in its possession; (b) establish, maintain, and follow written procedures that are sufficient to account for the SNM in its possession; and (c) conduct periodic physical inventories of all SNM in its possession. Contrary to the above requirements, beginning in January 1980 and continuing until July 13, 2004, Entergy and its predecessor (a) failed to keep adequate records of the location of special nuclear material in two spent fuel rod pieces (9" piece from fuel rod in position D2 in fuel assembly LJ3949 and 17" piece from fuel rod in position D2 in fuel assembly LJ3915); (b) failed to follow its written procedures for accounting for the special nuclear material in its possession in that the instructions in procedure OP-0400, "Special Nuclear Material Inventory and Accountability" were not completed to record the transfer of two spent fuel rod pieces in the spent fuel pool from a fuel storage bucket to a fuel storage liner; and (c) failed to identify through physical inventory that the two spent fuel rod pieces were no longer in the location described in the inventory records.

Because this finding is a potentially significant failure of Entergy's and its predecessor's material control and accounting program designed to prevent or detect the theft, loss or diversion of SNM, it is being considered for escalated enforcement action pending further review by NRC management. **(AV 05000271/2004007-001, Did Not Keep Adequate Records, Follow Procedures, and Perform Physical Inventory of Special Nuclear Material).**

2. Entergy's Investigation into the Circumstances that Led to the Loss of Control of Special Nuclear Material (SNM)

a. Inspection Scope

The inspectors reviewed Entergy's investigation into the circumstances that led to the loss of control of SNM. The inspectors reviewed the SNM Investigation Team (SNM IT) Project Plan and the procedures listed in the Attachment to this report that were developed by Entergy to address specific investigation activities.

The inspectors reviewed the staffing and training of the SNM IT and observed SNM IT daily briefing meetings regularly during the course of the special inspection. The inspectors reviewed the results of Entergy's physical searches within the SFP, searches of historical plant documents for records that might contain pertinent information, and interviews of current and past employees and other individuals identified as having some role involved with spent fuel handling or activities associated with the SFP. The inspectors reviewed selected videotape samples of portions of Entergy's physical inspection of the SFP. Inspectors reviewed the results of personnel interviews and record searches performed at the General Electric (GE) Vallecitos Nuclear Center (VNC). The inspectors also reviewed the results of an Entergy Corporate assessment of the VY SNM control program, as well as the results of detailed examinations by Entergy of the contents of five spent fuel assemblies and two spent fuel rod storage assemblies.

b. Discussion

SNM Investigation Team Activities

Entergy initiated an SNM Investigation immediately after determining that two spent fuel rod pieces were not in the location within the VY SFP as documented in the most recent SNM inventory. The SNM Investigation Team Project Plan, Rev. 0, was approved by Entergy on April 26, 2004. The Project Plan assigned a project manager and established a structured management framework for the team. Procedures were developed by the team to address activities in the project areas, including physical searches in the SFP, interviews of key personnel, searches of plant records and review of documents, stakeholder communications, and regulatory oversight. Team members were required to complete training on the appropriate SNM IT procedures prior to beginning independent investigation activities. Staffing of the team included Entergy personnel from VY and from other Entergy office locations, supplemented by

contractors. Team members routinely met near the end of each day to discuss the evidence discovered during the day to ensure all investigators were aware of important information.

Initial Physical Search of the Spent Fuel Pool

The inspectors determined that SNM IT procedures provided appropriate guidance for the conduct and documentation of the physical inspections of the SFP, including identification of search areas, development of inspection techniques, and establishment of acceptance criteria. On April 27, 2004, the inspectors observed the initiation of in-pool searches under the spent fuel storage racks. Documented search plans covered all accessible areas of the pool. Visibility was excellent for the remote and manually manipulated cameras in the SFP. Searches were videotaped and catalogued for future reference, including audio descriptions of what was being viewed. While these initial physical searches were not successful in locating the two spent fuel rod pieces, the videotapes were used with other information to locate the misplaced pieces on July 13, 2004. Entergy initiated condition report CR-VTY-2004-02562 to evaluate why the in-pool searches were not initially successful and to identify potential lessons-learned for use in future investigation and troubleshooting efforts.

Inspection of Selected Assemblies

In addition to searching the SFP for the two spent fuel rod pieces, Entergy also performed inspections of five spent fuel assemblies and two spent fuel storage assemblies. Entergy determined that the contents were in accordance with Entergy's records. These assemblies were involved in past fuel reconstitution activities and contained the remnant sections of the spent fuel rods that were the source of the two spent fuel rod pieces. The inspectors reviewed portions of videotape SNM-028 that recorded these inspections. These inspections verified inventory records for the identification of individual spent fuel rods these assemblies contained. These inspections were also used to obtain accurate measurements of the length of the fuel rods within the assemblies.

In 1980, station staff did not place the two spent fuel rod pieces back into fuel assemblies because they were too short to be stored within the fuel assemblies. The remaining sections of the damaged spent fuel rods, which were the sources of the two spent fuel rod pieces, were long enough to be reinserted into other spent fuel assemblies for storage in the SFP. Entergy verified that these other sections of the damaged fuel rods remained in the spent fuel assemblies into which they had been inserted when the two spent fuel rod pieces broke apart. During Entergy's investigation, Entergy accurately re-measured the remnant sections of the fuel rods because of uncertainty in the original length estimates of the two spent fuel rod pieces. The investigation team determined that original measurements were made in 1979 by comparing the pieces with a tape measure or other reference item viewed through many feet of water, using either a periscope viewer or binoculars, resulting in original estimates that were likely crude and inaccurate. Based on a more accurate

measurement method, Entergy revised the estimated lengths of the two spent fuel rod pieces to 9 inches and 17 inches (instead of the 7 inches and 17¾ inches first reported). The revised length estimates were determined by measuring the remaining fuel rod remnants stored in the SFP and calculating the length equivalent missing from the whole length of these fuel rods.

Other Sources of Spent Fuel Rod Pieces

Entergy investigated the possibility that the two spent fuel rod pieces had been mistakenly shipped to the General Electric (GE) Vallecitos Nuclear Center (VNC) or GE VNC shipped fuel pieces to VY. A shipment of spent fuel rods was made from VY to GE VNC in March 1979. This shipment was the sole shipment of spent fuel from VY and was completed prior to April 1979, when the first piece broke from its parent fuel rod. This shipment therefore could not have included either of the two spent fuel rod pieces. In addition, GE VNC confirmed to Entergy that no spent fuel rods or spent fuel rod pieces were ever shipped to VY from GE VNC.

Search for Fuel Storage Liner

In June 2004, Entergy developed information from interviews and review of records at the GE VNC indicating that VY ordered a fuel storage liner from GE in 1979 specifically to contain pieces of broken spent fuel. Photos obtained of a typical fuel storage liner depicted an aluminum cylinder, 45 inches long by 5 inches diameter. Entergy subsequently re-examined the videotapes of the in-pool inspections and identified a cylindrical object that matched the GE fuel storage liner description. The cylinder was resting sideways on the top edge of the channel rack between the two fuel prep machines and fitting snugly against the south wall of the pool. In the videotape images, the cylinder appears to be part of the rack and is the same color as the wall and other rack metal around it. Entergy carefully planned the opening of the fuel storage liner to avoid damaging or losing control of its contents and documented the plan in work instruction SNM-WI-09, "Spent Fuel Pool GE Container Inspection." A special canister support fixture was fabricated to securely hold the fuel storage liner while it was opened in the SFP. When station staff opened the fuel storage liner on July 13, 2004, they discovered the two misplaced spent fuel rod pieces.

c. Findings and Conclusions

No significant findings were identified. Entergy's approach to planning and executing the process for physical inspections and examinations of spent fuel was thorough and comprehensive. While the initial in-pool searches did not identify the two spent fuel rod pieces, the detailed videotape records created during the searches were readily used when investigators developed new information and contributed to the eventual identification of the fuel storage liner holding the two spent fuel rod pieces.

3. Characterization of the Two Spent Fuel Rod Pieces

a. Inspection Scope

The inspectors reviewed Entergy's radiological and dimensional characterization of the two spent fuel rod pieces discovered to be stored in the fuel storage liner in the SFP. The inspectors observed the initial opening of the fuel storage liner and observed the presence of the two spent fuel rod pieces through a boroscope. The inspectors reviewed videotapes made using the boroscope that provided detailed views of the inside of the fuel storage liner, including the two spent fuel rod pieces. Using the videotape records, the inspectors independently estimated the lengths of the two spent fuel rod pieces within the fuel storage liner. The inspectors reviewed the results of radiation measurements taken by Entergy on the inside and outside of the fuel storage liner. The inspectors compared the radiation and dimensional data collected for the two spent fuel rod pieces in the fuel storage liner to the radiation and dimensional values as documented in Entergy Technical Evaluation (TE) No. 2004-057, "Radiological Evaluation of the VY Misplaced Fuel Rod Pieces." TE 2004-057 described the expected radiological characteristics of the two spent fuel rod pieces, based upon the known material content of the original fuel rods, the neutron flux exposure during power operations and radioactive decay time since discharge from the core, and also described the manufacturing specifications for the fuel. Finally, the inspectors interviewed Reactor Engineering department personnel.

b. Discussion

Following discovery of the two spent fuel rod pieces, the NRC inspection focused on understanding the basis for Entergy's conclusion that the two spent fuel rod pieces were, in fact, the same two spent fuel rod pieces which had been misplaced. Entergy verified that the two spent fuel rod pieces were the unaccounted spent fuel rod pieces by measuring radiation levels and making estimates of the length and diameter of the pieces. Entergy's conclusion was supported by the following:

- Lengths of the two found spent fuel rod pieces were consistent with the lengths of the two misplaced spent fuel rod pieces, based on visual comparison with items of known length.
- Radiation measurements inside and outside of the fuel storage liner were consistent with the expected radiation levels based upon Entergy's detailed radiological characterization of the two misplaced spent fuel rod pieces.
- Diameter of the two spent fuel rod pieces was consistent with the diameter of the original fuel rods based on boroscope observation.
- Only two spent fuel rod pieces were misplaced and two spent fuel rod pieces were recovered. No other record discrepancies were identified indicating any other unaccounted for SNM (See Section 4OA5.6).

- The fuel storage liner discovered on July 13, 2004, was consistent with the 1980 log entries and other documentation referring to a fuel storage liner.
- Entergy interviewed a former employee who had been involved in the transfer of the two spent fuel rod pieces from the fuel storage bucket to the fuel storage liner on January 21, 1980. While the individual did not specifically recall the transfer activity, his description of the fuel storage liner used to store broken spent fuel rod pieces matched the fuel storage liner discovered on July 13, 2004.
- A GE invoice dated August 9, 1979, indicated that a fuel storage liner was provided to VY to contain broken fuel pins. This invoice indicated the intent to use the fuel storage liner to contain broken spent fuel rod pieces, the first of which was broken on April 23, 1979. This invoice and documents provided by GE were consistent with the fuel storage liner found in the SFP by Entergy and the 1980 SNM Transfer Form.

Based on the review of videotape records, the inspectors compared the lengths of the two spent fuel rod pieces to the known distance between reference markings on a probe and independently confirmed the two spent fuel rod pieces in the fuel storage liner were 9 inches and 17 inches in length.

c. Findings and Conclusions

_____ No findings of significance were identified. The inspectors determined that Entergy's radiological characterization of the two spent fuel rod pieces was acceptable. The inspectors determined that Entergy had sufficient supporting information to conclude that the two spent fuel rod pieces found were the two misplaced spent fuel rod pieces. Entergy's characterization of the two spent fuel rod pieces supports the conclusion that the fuel storage liner opened in the SFP on July 13, 2004, contained the two spent fuel rod pieces described in the records.

4. Root Cause Determination and Corrective Action Plan

a. Inspection Scope

The inspectors reviewed Entergy's Root Cause Analysis Report Rev. 00, dated August 12, 2004, and an updated list of corrective actions provided in Licensee Event Report 2004-002-01 issued on September 29, 2004. The inspectors also reviewed condition reports documenting issues and corrective actions related to the two misplaced spent fuel pieces, including CR-VTY-2004-01339, which was initiated on April 20, 2004, and was updated during Entergy's investigation.

b. Discussion

As part of the SNM IT process, Entergy initiated a category A condition report (CR-VTY-2004-01339), which required performance of a formal root cause analysis. After the two spent fuel rod pieces were found on July 13, 2004, Entergy's focus shifted from the search for missing items to understanding what caused the pieces to be lost in the first place. The facts identified by the SNM IT were used by Entergy in evaluating the root cause of the problem. Entergy identified two specific root causes for the two misplaced spent fuel rod pieces:

1. The SNM accounting recordkeeping devices required by procedure OP-0400, "Special Nuclear Material Inventory and Accountability Procedure", were not properly maintained.
2. Procedure OP-0400 did not provide guidance for control of fuel pieces of SNM versus whole fuel assemblies.

Entergy defined numerous corrective actions with assigned completion dates to address specific issues identified during the misplaced SNM investigation and the Entergy Corporate SNM Assessment of VY. The inspectors noted that Entergy's plan for corrective actions did not directly address the failure to follow procedure OP-0400, either in the 1980 failure to record the transfer of the two spent fuel rod pieces from the fuel storage bucket to the fuel storage liner or in the failure to conduct adequate periodic physical inventories of the two spent fuel rod pieces. Following discussion with the inspector, Entergy revised its plan and defined an additional corrective action for the Reactor Engineering Manager to review the two cases in which procedures were not followed and address the issue of compliance with procedures. (CR-VTY-2004-01339, CA#23)

While Entergy identified in the second root cause that procedure OP-0400 did not provide guidance to handle spent fuel rod pieces versus bundles, the inspector noted that Entergy had not planned any specific corrective action to address the procedure changes necessary to prevent recurrence of the problem. Following discussion with the inspector, Entergy revised its plan and defined an additional corrective action to review accounting methods for individual fuel rods and fuel pellets. (CR-VTY-2004-01339, CA#24).

The corrective actions are scheduled for implementation by assigned due dates. In addition, Entergy's corrective action plan includes an effectiveness review of the corrective actions to be completed by June 30, 2005, which is prior to any additional planned movement of SNM in the SFP. (CR-VTYLO-2004-00329, CA#01)

c. Findings and Conclusions

No findings of significance were identified. Entergy's root cause analysis did identify appropriate root causes. Although Entergy's initial corrective action plan addressed

issues identified during its investigation, its initial corrective action plan did not fully address the identified root causes for the two misplaced spent fuel rod pieces. Entergy's subsequent corrective action plan was comprehensive.

5. Special Nuclear Material Control and Accounting (MC&A) Procedures

The inspectors reviewed Entergy's written MC&A procedures and their implementation. The review encompassed physical inventory, movement of SNM, record keeping, and data reporting. The inspectors examined records, reviewed procedures, and interviewed personnel. The procedures reviewed by the inspector are listed in the Attachment to this report. In addition to the procedures in force at the time of the inspection, the review covered historical versions of Procedure OP-0400, including Rev. 14, dated 1978 and Rev. 15, dated 9/14/79, which was in effect when the two spent fuel rod pieces were placed in the fuel storage liner.

b. Discussion

Entergy's methods for tracking inventory of SNM were contained in procedure OP-0400, (Rev. 32, dated 6/17/2003). Total SNM quantity by isotope was calculated and tracked using the computer application SNMtrac™. The procedure provided overall guidance and also relied significantly on individuals who were knowledgeable of the plant processes and data sources that interfaced with OP-0400 and SNMtrac™. SNMtrac™ tracked fuel assemblies as the physical unit of SNM. Adjustments to SNM inventory isotopic quantities were calculated by fuel assembly unit using SNMtrac™ to account for radioactive decay, fission loss, and other operational changes.

In addition to SNMtrac™, which was used for tracking SNM content, VY relied primarily on two accounting record keeping devices to track SNM items, namely, "notebook pages" and schematic layouts, including a SFP diagram. Both devices were prepared using a computer and maintained by the Reactor Engineering Department. A "notebook page" was prepared for each fuel assembly when it was received from the fuel manufacturer. Information entered into the computer included the fuel assembly serial number, date when it was received at VY, and location where it was placed. When a fuel assembly location was changed, the date of change was recorded along with the old and new locations, as well as any comments pertinent to the movement. Notebook pages were printed as necessary from the updated spreadsheet database. Each line of the notebook page represented a change to the fuel assembly or a re-location move, thus creating a complete history of the assembly. The SFP diagram was a color-coded map generated using a spreadsheet-type computer database, showing the physical location of each fuel assembly in the SFP. In addition to the overall SFP layout, the map also showed the relative location within the SFP of unique features and items such as the "prep machine," a "pin canister," and blade guides. The "pin canister" was the new designation for the fuel storage liner that held the two spent fuel rod pieces found on July 13, 2004. (Fuel "pin" is an alternate term used interchangeably with "rod" by Entergy.)

VY's method of tracking SNM physical inventory has changed very little since 1980 with the exception of its reliance on the computer. In 1980 VY relied on notebook pages, schematic layouts, and manually operated fuel location tag boards. The current practice was to use the computer to emulate these manual devices.

While the procedure was adequate, the inspector identified a number of examples of unclear and incomplete guidance in Procedure OP-0400. These examples involved: SNM movements within a single inventory control area (ICA), time limits to complete records of SNM movements, use of routine computer applications for isotope tracking and planning fuel assembly movements, cross-references with other procedures, and remnants of text or forms from past revisions. In general, Entergy's procedure relied on the procedure being implemented by knowledgeable individuals and as a result it did not provide detailed instructions in all cases.

Revision 15 of OP-0400 specified the requirement, "...the Reactor Engineering Supervisor will direct a member of the Reactor Engineering Department to perform a physical inventory of all SNM on site. The inventory consists of physically obtaining identification numbers of all units of SNM in accessible ICAs." OP-0400, Rev. 15, also instructed, "For the ICA's which are not physically accessible (such as the Reactor) during normal periods of operation, the identification numbers will be obtained from records," emphasizing that other identification numbers were to be obtained visually. The current revision of OP-0400 (Rev. 32) contained modified guidance to "Verify that the SFP contains the same number of fuel assemblies as the inventory records." Rev. 32 also stated that a "piece count" satisfied this requirement. These differences between revisions 15 and 32 of OP-0400 showed that the method for performing physical inventory at VY had evolved from verifying the serial numbers of all SNM units in 1980 into the current method of counting total units of SNM and confirming the total number of SNM units was consistent with the previous inventory ("piece count"). The omission of a visual verification of the two spent fuel rod pieces during inventories contributed to perpetuating the incorrect recorded location from 1980 to 2004. Entergy initiated a condition report to resolve the question of whether the current practice of performing a piece count, which replaced the verification of serial numbers and locations, is an acceptable method of performing a physical inventory of all SNM possessed. (CR-VTY-2004-01339, CA#25).

c. Findings and Conclusions

No findings of significance were identified. The inspectors concluded that conduct of the MC&A program relied heavily on individual knowledge. Although the written procedures contained adequate instructions, the level of detail of the instructions in the procedure could be enhanced. Entergy acknowledged the need for procedure enhancements and has included in its corrective action plan a review of MC&A practices and procedures.

6. Verification of Current SNM Inventory

a. Inspection Scope

The inspectors reviewed Entergy's inventory results for the most recent inventory to assure that Entergy accounted for all other SNM. The review included examination of videotapes documenting the inspection of fuel assembly serial numbers in the SFP storage racks and verification of selected non-fuel SNM materials. The inspectors also assessed Entergy's methods for tracking configuration changes caused by moving fuel assemblies, as well as moving individual fuel rods from one assembly to another assembly and within the SFP.

b. Discussion

Entergy fully verified the documented position of 100% of fuel assemblies in the SFP by comparing the serial numbers on the fuel assemblies to the serial numbers recorded on the SFP map for each rack position, with no discrepancies noted. The inspectors independently selected 219 of the rack positions shown on the SFP map and compared the serial numbers of fuel assemblies shown in those positions on the inspection videotapes with the expected serial numbers. The inspectors identified no discrepancies in the sample reviewed. The inspectors verified the location of selected non-fuel SNM (i.e. fission detectors) by comparing the actual serial number of the item to the inventory sheet. The inspectors also verified the balance of non-fuel SNM inventory by matching the tamper-evident seal number to the corresponding item shown on the inventory sheet. No discrepancies were found.

Procedure OP-1403, "Fuel Bundle Non-Destructive Testing and Reconstitution," Rev. 16, describes the methods used for examining fuel assemblies and individual rods, and it specifies that records be created for accountability of fuel rods moved. While discussed generally in procedure OP-1403, the inspectors interviewed Entergy personnel who also described in detail the method used to track configuration changes made to fuel assemblies through the movement of individual fuel rods, such as during reconstitutions. When a rod was removed from an assembly, the action was recorded on the notebook page for that assembly along with a note indicating where the rod was moved. Exchange of one rod for another was also recorded on the notebook page, creating the record that enabled tracking of the movements of individual fuel rods among assemblies. When all such changes to an assembly have been completed during a manipulation, the current SNM inventory of that reconstituted fuel assembly was adjusted to reflect the incremental additions and subtractions appropriate for the fuel rods added and removed. Entergy reviewed the records of all individual rod movements within the SFP as part of the SNM Investigation Team's work and identified no discrepancies. The inspectors reviewed a sample of these records and found that each rod movement in the sample reviewed was properly recorded in the affected fuel assembly records.

c. Findings and Conclusions

No findings of significance were identified. The inspectors concluded that as of July 13, 2004, Entergy was in full compliance with regulatory requirements to account for all SNM in its possession.

7. Control of Spent Fuel Pool Materials

a. Inspection Scope

The inspectors reviewed Entergy's radwaste shipping controls to determine whether vulnerabilities existed that could have allowed shipment of misidentified SNM located in a fuel storage liner to a low-level radwaste storage site. The inspectors reviewed the controls that would preclude station staff from inappropriately disposing irradiated material, such as the two spent fuel rod pieces, that were located in the SFP. The inspectors interviewed personnel participating in recent radwaste shipping campaigns. The focus of this review was restricted to radwaste generated within and shipped from the SFP.

b. Discussion

The records indicate that station staff made at least five SFP cleanup campaigns and subsequent shipments of radwaste materials between 1980 and 2000. These radwaste shipments were composed of various types of irradiated hardware and miscellaneous items. Plant personnel were knowledgeable of their individual responsibilities and indicated that controls had been implemented to assure categorization of materials that were intended to be placed into a radwaste liner for shipment to a low-level radwaste disposal site. The inspectors reviewed the material categorization report for one recent shipment of irradiated material from the SFP, Report WMG-9713, "Packing Hardware at VY During 1997," and found the categorization information provided sufficient detail of the items included in the radwaste shipment.

During interviews, station staff acknowledged that the procedure controlling the radwaste packaging and shipment did not require that a capped or closed container, such as the storage liner housing the spent fuel rod pieces, be opened and examined prior to placement into the radwaste liner for shipment. The inspectors reviewed the most current revision of the Entergy procedure utilized to control the packaging and shipment of radwaste, Operating Procedure OP-0044, "Volume Reduction, Packaging and Shipping of Irradiated Hardware from the Spent Fuel Pool", Revision 4. The inspectors confirmed that the procedure did not provide directions for opening a closed container prior to placement into the radwaste liner for shipment.

Additionally, the inspectors noted that while VY personnel indicated it was the station's practice to categorize all materials prior to packaging, the procedure did not prohibit placing other uncategorized hardware into a radwaste package. Completion of a dose

profile for waste items by radiation protection personnel was the only procedural requirement for including the miscellaneous hardware in any radwaste shipment.

The inspectors also reviewed historical procedures that provided controls of radwaste shipments originating from the SFP between 1983 and 1987. Revisions 0 and 1 to procedure OP-2203, "Procedure for Processing of Spent Control Rods Prior to Disposal," were also found to not prohibit disposal of irradiated materials other than the planned control rods, provided that a dose rate survey was completed and the liner surface dose rate did not exceed a specified limit.

c. Findings and Conclusions

No findings of significance were identified. The inspectors concluded that station staff were knowledgeable of correct radwaste shipment practices. The inspectors also concluded that although the radwaste procedural controls and the practices in use at the station for packaging and shipment of irradiated material originating from the SFP were adequate, the instructions and the administrative controls in the procedure could be enhanced to prohibit disposal of an unidentified piece of irradiated material. Entergy acknowledged the procedural weaknesses and revised the affected procedures before the on-site portion of the inspection ended on August 27, 2004.

8. (Closed) URI 05000271/2004002-02, Did not Adhere to Procedural Requirements for Performing an Annual Physical Inventory of Two Spent Fuel Rod Segments

This URI is considered closed based on the results of the inspector's review of the event as documented in Section 4OA5.1 of this report.

4OA6 Meetings, including Exit

The inspectors discussed the results of the on-site portion of the inspection with Entergy management at VY on August 12, 2004. The inspectors further discussed inspection results with Entergy on September 8, 2004, following completion of an in-office review of Entergy's Root Cause Analysis Report. On November 23, 2004, the inspectors conducted inspection closeout discussions with Entergy management in a telephone call.

ATTACHMENT 1
SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Entergy Personnel:

J. Thayer	Site Vice President
K. Bronson	General Plant Manager
J. Dreyfuss	Director of Engineering
J. Devincentis	Licensing Manager
J. Geyster	Radiation Protection Superintendent
M. Hamer	Licensing
R. Wanczyk	Director of Nuclear Safety
J. Hoffman	SNM IT Project Leader
T. White	SNM IT, Manager of Quality Assurance
D. Mannai	Reactor Engineering Superintendent
J. Card	SNM IT
R. Ramsdell	SNM IT

Others

W. Sherman Vermont Department of Public Safety

LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened

05000271/2004007-01	AV	Did Not Keep Adequate Records, Follow Procedures, and Perform Physical Inventory of Special Nuclear Material
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Closed

05000271/2004002-00, 01	LER	Special Nuclear Material not Accounted for at Vermont Yankee
05000271/2004002-02	URI	Did not Adhere to Procedural Requirements for Performing an Annual Physical Inventory of Two Spent Fuel Rod Segments

LIST OF SIGNIFICANT DOCUMENTS REVIEWED

OP-0400, "SNM Inventory and Accountability Procedure" (Rev. 32, dated 6/17/2003 and earlier revisions)
 OP-1400, "Fuel Receipt and Preliminary Handling," (Rev. 25, dated 01/06/04)
 OP-1401, "New Fuel Inspection and Channeling," (Rev. 29, dated 02/03/04)
 OP-1403, "Fuel Bundle Non-Destructive Testing and Reconstitution," (Rev. 16, dated 05/03/02)
 OP-1410, "Fuel Loading Schedule Generation," (Rev. 25, dated 04/09/01)
 OP-1411, "Core Verification," (Rev. 20, dated 11/04/03)
 OP-0044, "Volume Reduction, Packaging and Shipping of Irradiated Hardware from the Spent Fuel Pool", Revision 4
 OP-2203, "Procedure for Processing of Spent Control Rods Prior to Disposal", Rev's 0 and 1
 DP-0545, "Fuel Pool Storage Requirements", Rev's 11 and 0
 AP-0009, "Condition Reports", Rev 16

Material categorization report for one recent shipment of irradiated material from the SFP, Report WMG-9713, "Packing Hardware at Vermont Yankee During 1997"

SNM IT Project Plan, Rev 0
 SNM IT Procedure SNM-WI-01, "Communication Plan"
 SNM IT Procedure SNM-WI-02, "Regulatory Interface"
 SNM IT Procedure SNM-WI-03, "Conduct of Interviews"
 SNM IT Procedure SNM-WI-04, "Spent Fuel Pool Manual Camera Inspection"
 SNM IT Procedure SNM-WI-05, "Spent Fuel Pool Camera Inspection under Racks"
 SNM IT Procedure SNM-WI-07, "SNM Project Record Reviews"
 SNM IT Procedure SNM-WI-08, "Scenario Process"

<u>Condition Reports</u>	<u>Origination Date</u>	
CR-VTY-2004-01350	4/21/04	Revise AP-0156 to reflect changes in 10CFR reporting requirements
CR-VTY-2004-01389	4/22/04	Revise OP-0400 to reflect changes in 10CFR reporting requirements
CR-VTY-2004-02562	8/12/04	Understand why physical searches missed the GE liner
CR-VTY-2004-02440	8/2/04	Documentation of the transfer of fuel pieces in the SFP in 1980
CR-VTY-2004-00671	3/24/04	Plan to examine bucket to verify fuel pin pieces are present
CR-VTY-2004-01906	6/4/04	SNM container tamper-evident seal program not effective
CR-VTY-2004-01339	4/20/04	Investigate missing fuel pieces (all related issues)

Other Documents

Technical Evaluation No. TE-2004-057, "Radiological Evaluation of the VY Misplaced Fuel Rod Segments", Rev. 1

LIST OF ACRONYMS

AV	apparent violation
CFR	code of federal regulations
GE	General Electric
ICA	inventory control area
IMC	inspection manual chapter
LER	licensee event report
MC&A	material control and accounting
NSIR	Nuclear Security and Incident Response
NRC	Nuclear Regulatory Commission
SDP	significance determination process
SFP	spent fuel pool
SNM	special nuclear material
SNM IT	special nuclear material investigation team
TE	technical evaluation
URI	unresolved item
VNC	Vallecitos Nuclear Center
VY	Vermont Yankee

CHRONOLOGY OF SIGNIFICANT EVENTS

Date	Event
April 23, 1979	Two pieces of fuel rod D2 from fuel assembly LJ3949 were broken off during inspection handling. These two pieces were described as "two feet" and "six inches" in length. The remainder of rod D2 was described as "10 feet" long.
May 8, 1979	"Six inch" piece of LJ3949 rod D2 is placed into the fuel storage bucket.
August 14, 1979	One "17¾ inch" piece was broken off of rod D2, assembly LJ3915 during movement for a reconstitution campaign. The remaining longer piece was moved to position E7, LJ3912.
August 17, 1979	The "two foot" piece and remaining "ten feet" of rod D2, assembly LJ3949, are placed in position G7 of assembly LJ3891 (where they are still located as of August 12, 2004)
August 22, 1979	Log entry refers to the two spent fuel rod pieces in the fuel storage bucket as being "seven inches" from LJ3949 D2 and "17¾ inches" from LJ3915 D2.
March 10, 1980	Memo stated: "On ½1/80, two short pieces of broken fuel rods were transferred from the Fuel Storage Bucket to the Fuel Storage Liner. The status of all broken fuel rods in the Spent Fuel Pool is as follows: 1. 17.75" piece of fuel rod from D2-LJ3915 in Fuel Storage Liner. 2. 7" piece of fuel rod from D2-LJ3949 in Fuel Storage Liner. 3. 10' piece of fuel rod from D2-LJ3949 is stored in G7-LJ3891. 4. 2' piece of fuel rod from D2-LJ3949 is stored in G7-LJ3891."
March 1980 thru January 2004	Periodic SNM inventories keep track of the fuel storage bucket location in the SFP as method of implementing physical inventory of pieces.
March 2004	NRC resident inspectors perform Temporary Instruction 2515/154, "Spent Fuel Material Control and Accounting at Nuclear Power Plants", challenging Entergy performance of annual physical inventory.
March 26, 2004	Preliminary examination by Entergy personnel indicates two spent fuel rod pieces appear to be present in the fuel storage bucket, with confirmatory inspection planned.
April 20, 2004	Entergy informs NRC resident inspectors that boroscopic examination showed that two spent fuel rod pieces were not in the fuel storage bucket.
April 22, 2004	NRC initiates special inspection.
April 26, 2004	Entergy approves SNM Investigation Team (SNM IT) Project Plan
May 10-12, 2004	Entergy inspects sample of individual spent fuel rods in SFP, including remainder of those rods from which the two spent fuel rod pieces broke off. Precise measurements enable revised estimates for the length of the two missing spent fuel rod pieces as 9" and 17."

A1-5

Date	Event
July 7, 2004	Entergy SNM IT reviews new information from visit to Vallecitos Nuclear Center regarding fuel storage liner ordered by Vermont Yankee in August 1979.
July 8, 2004	SNM IT identifies on videotape record a container similar to that described by records as "liner for spent fuel pieces" and locates the liner in the SFP.
July 13, 2004	Entergy opens fuel storage liner in SFP and discovers two spent fuel rod pieces.

ATTACHMENT 2

CHARTER FOR VERMONT YANKEE SPECIAL INSPECTION

In March 2004, the resident inspectors performed inspections in accordance with TI 2515/154, "Spent Fuel Material Control and Accounting at Nuclear Power Plants." The inspectors determined that Entergy performed an annual inventory of items stored in the spent fuel pool. The inspectors identified that although Entergy and its predecessor had been performing an annual inventory of the spent fuel pool, the annual inventory did not verify that two fuel rod segments contained in a special container stored on the bottom of the pool were still present in the container.

Entergy's records indicate that the two fuel rod segments were inserted into the container for storage in 1980 after they had broken off from spent fuel rods during a fuel reconstitution effort. The fuel rod segments were approximately 17 inches and 7 inches in length. Instead of performing a "piece count" inventory to verify the fuel rod segments were in the container, Entergy personnel ensured the container remained upright and in place at the bottom of the spent fuel pool.

In response to questions from the NRC, Entergy performed an initial, cursory visual check in March 2004 and concluded that the fuel rod segments appeared to be in the container. On April 20, 2004, Entergy performed a more detailed, inspection, using better equipment, i.e., a boroscope, and determined that the initial inspection had been in error and neither of the fuel rod segments were in the container.

Entergy established a Special Nuclear Material Investigation Team. The mission statement for the Entergy investigation team is to: establish a high degree of confidence that the fuel rod segments are/are not likely to be in the spent fuel pool, identify other possible disposal locations and develop a working impact analysis for these potential offsite storage/disposal paths, complete a root cause analysis for this issue, support internal and external stakeholder needs, and document the findings of the team in a final report. Entergy expects to complete its investigation by the end of May 2004.

A special inspection will evaluate Entergy's investigation and conclusions regarding the possible disposition of the fuel rod segments. The special inspection should:

1. Conduct a thorough and systematic review of Entergy's investigation into the circumstances that led to the unaccountability of the two fuel rod segments in the Vermont Yankee spent fuel pool. Determine the adequacy of Entergy's investigation and conclusion regarding the location of the two fuel rod segments, based upon its completeness and thoroughness of fuel pool inspections, records reviews, and interviews.
2. Assess the determination of root cause assigned by Entergy. Identify alternative causes if appropriate. Develop independent conclusions regarding the cause(s) of the loss of accountability of the spent fuel rods.

3. Assess the adequacy of Entergy's investigation regarding its conclusion on the accuracy of the accountability for the remainder of the spent fuel material in the spent fuel pool.
4. Independently verify selected sets of records and interviews.
5. Determine whether Entergy was in compliance with applicable regulations.
6. Assess the adequacy of Entergy's radiological characterization of each fuel rod segment.
7. Conduct regular briefings for NRC internal stakeholders to allow the appropriate NRC internal stakeholders to brief external stakeholders.
8. Identify those findings or observations that may have generic implications.
9. Document the inspection findings, observations and conclusions in a special inspection report in accordance with IP 93812 within 30 days of the exit meeting.
10. Conduct an inspection exit that is open for public observation.