UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

August 19, 2005

EA-05-166
NMED Nos. 040585, 050105

Gregory M. Rueger, Senior Vice
President, Generation and Chief Nuclear Officer
Pacific Gas and Electric Company
Diablo Canyon Power Plant
P.O. Box 3
Avila Beach, CA 93424

SUBJECT: HUMBOLDT BAY POWER PLANT UNIT 3 - NRC SPECIAL INSPECTION FINAL REPORT 050-00133/05-002

Dear Mr. Rueger:

This refers to the special inspection initiated on November 2, 2004, at the Humboldt Bay Power Plant (HBPP) Unit 3 facility. The purpose of the special inspection was to review the circumstances of the reported loss of three approximately 18-inch long spent fuel rod segments, one intact incore detector, and parts of three other incore detectors all containing special nuclear material (SNM). An interim inspection report was issued on April 5, 2005, that described the inspection activities through March 31, 2005. On June 20-24, 2005, a team of inspectors visited HBPP to complete the inspection. Subsequent to this site visit inspectors interviewed personnel, and reviewed and evaluated licensee documents submitted after the visit. The inspection activities were concluded on August 2, 2005. On August 16, 2005, a telephonic exit interview was conducted with you and members of your staff to discuss the inspection results.

This report documents the NRC's assessment of: Pacific Gas and Electric's (PG&E) current control of SNM; accountability for the remainder of the SNM in the spent fuel pool; the adequacy of PG&E's investigation into the circumstances that led to the loss of accountability of the missing SNM; the potential radiological consequences of the postulated scenarios involving the missing SNM; and compliance with applicable regulations.

The NRC special inspection team determined that your investigation was thorough and complete, and the conclusions were reasonable and supportable. The NRC also found that once these matters were identified by PG&E, you promptly and accurately notified the NRC and kept it informed throughout the process of search and investigation.

The NRC staff concluded that the current material control and accounting program being implemented at the Humboldt Bay Power Plant meets regulatory requirements. In addition, the NRC team agreed with your conclusion that there is no evidence to support theft or diversion of the missing SNM, and this is not a plausible scenario. The NRC team's conclusions differed

from yours in one notable respect. The NRC team concluded that the most likely scenario for the missing SNM is that it was inadvertently shipped to a low level waste burial site. While your conclusions supported this as a possibility, your investigation concluded that the most likely scenario for the missing spent fuel rod segments was that they are still in your spent fuel pool in an altered condition.

Based on the results of this inspection, three apparent violations were identified and are being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC's Web site at www.nrc.gov; select **What We Do**, **Enforcement**, then **Enforcement Policy**. The apparent violations involved (1) the failure to keep records showing the inventory, transfer or disposal of the three 18-inch segments of irradiated fuel and one complete and three partial incore detectors; (2) the failure to establish, maintain, and follow adequate written material control and accounting procedures sufficient to account for the SNM; and (3) the failure to conduct an accurate physical inventory of all SNM in your possession at intervals not to exceed 12 months. The circumstances surrounding these apparent violations, the significance of the issues, and the need for lasting and effective corrective action were discussed with members of your staff at the inspection exit meeting on August 16, 2005. As a result, it may not be necessary to conduct a predecisional enforcement conference in order to enable the NRC to make an enforcement decision.

Before the NRC makes its enforcement decision, we are providing you an opportunity to either: (1) respond to the apparent violations addressed in this inspection report within 30 days of the date of this letter or (2) request a predecisional enforcement conference. If a conference is held, it will be open for public observation. The NRC will also issue a Meeting Notice to announce the conference. Please contact Dr. Blair Spiztberg, at (817) 860-8191 within 7 days of the date of this letter to notify the NRC of your intended response.

If you choose to provide a written response, it should be clearly marked as a "Response to Apparent Violations in Inspection Report No. 050-00133/05-002; EA-05-166," and should include for each apparent violation: (1) the reason for the apparent violation, or, if contested, the basis for disputing the apparent violation, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate response is not received within the time specified or an extension of time has not been granted by the NRC, the NRC will proceed with its enforcement decision.

In addition, please be advised that the number and characterization of apparent violations described in the enclosed inspection report may change as a result of further NRC review. You will be advised by separate correspondence of the results of our deliberations on this matter.

During a public meeting held in Eureka, California on September 29, 2004, to discuss the missing spent fuel rod segments, the NRC indicated its intent to hold another public meeting in the area at the conclusion of the special inspection to discuss the NRC findings. This public meeting has been scheduled for the evening of September 15, 2005. A separate meeting notice and agenda will be issued at least 10 days prior to this meeting.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response (if you choose to provide one) 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 should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction.

Sincerely,

/RA/

Leonard D. Wert Jr., Director
Division of Nuclear Materials Safety

Docket No.: 050-00133
License No.: DPR-7

Enclosure:
1. NRC Special Inspection Report
   050-00133/05-002
2. Special Inspection Charter (ML042990566)

cc w/enclosure:
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ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Docket No.:	050-00133
License No.:	DPR-7
Report No.:	050-00133/05-002
Licensee:	Pacific Gas and Electric Company (PG&E)
Facility:	Humboldt Bay Power Plant (HBPP), Unit 3
Location:	1000 King Salmon Avenue Eureka, California 95503
Dates:	November 2, 2004, through August 2, 2005
Inspectors:	Emilio M. Garcia, Health Physicist, Team Leader John B. Hickman, Project Manager, NMSS Ray L. Kellar, P.E., Health Physicist Thomas K. McLellan, Materials Inspector, NRR Glenn W. Tuttle, MC&A Physical Scientist, NSIR Wayne C. Sifre, Reactor Inspector Martha C. Williams, Sr. MC&A Physical Scientist, NSIR
Approved By:	D. Blair Spitzberg, Ph.D., Chief Fuel Cycle and Decommissioning Branch
Attachment:	Supplemental Inspection Information

ADAMS Entry: IR 05000133-05-02, on 11/02/2004-08/02/2005; Pacific Gas & Electric Co.; Humboldt Bay, Unit 3. Special Inspection Final Report. Three apparent violations.

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EXECUTIVE SUMMARY

Humboldt Bay Power Plant, Unit 3
NRC Inspection Report 050-00133/05-002

During the fall of 2003, staff from Pacific Gas and Electric (PG&E) Humboldt Bay Power Plant were conducting an examination of the contents of its spent fuel pool (SFP). This examination was in preparation for eventual removal of the fuel for placement into dry storage in an onsite Independent Spent Fuel Storage Installation (ISFSI). During the sorting of materials in a container in the SFP, licensee personnel discovered a fragment of a spent fuel rod approximately 4-inches long. Licensee personnel located additional fuel fragments ranging in length from 4 to 6 inches in subsequent sorting of materials in the SFP.

The discovery of fuel fragments indicated a potential problem with the Humboldt Bay material control and accounting (MC&A) practices. In January 2004, during an NRC inspection, the Plant Manager announced that due to the unexpected presence of the fuel fragments and other uncertainties in the special nuclear material (SNM) inventory, the licensee initiated a re-evaluation of the amount of SNM present in each assembly and in the SFP. The NRC periodically monitored the licensee's investigation. In addition, on March 25, 2004, the NRC conducted a review of practices of spent fuel MC&A at HBPP in accordance with guidance contained in Temporary Instruction 2515/154, Phases I and II. This Instruction was implemented to determine if the MC&A issues at Millstone 1 regarding the loss of two spent fuel rods, are applicable to other power reactors. Based on that review, the NRC decided that Humboldt Bay required a Phase III inspection under Temporary Instruction 2515/154. [Completion of Phase III of Temporary Instruction 2515/154 was documented in Inspection Report Number 50-133/2005-01].

In late June 2004, the licensee found documentation indicating that in 1968 a stainless steel clad fuel pin from assembly A-49 was segmented into three 18-inch sections. Other records indicated that the complete A-49 assembly was later shipped offsite for reprocessing. The licensee promptly informed the NRC of this discovery.

On July 16, 2004, the licensee made formal notification to the NRC pursuant to the requirements of 10 CFR 20.2201(a)(1)(ii) of the discrepancy between inventory records and the location of spent fuel pin segments. No records had been found indicating the location of the fuel segments in the SFP. During July and August 2004, licensee personnel searched the most likely and accessible locations within the SFP where the fuel segments could be. Region IV NRC inspectors observed part of the search activities. On August 16, 2004, PG&E issued a 30-day written followup report to its initial July 16, 2004, notification to the NRC, and the next day the licensee made a 1-hour notification to the NRC pursuant to 10 CFR 74.11(a) that the subject fuel pin segments were considered missing.

On September 29, 2004, the NRC held a meeting with licensee management and members of the public in Eureka, California, to discuss the missing fuel and the licensee's planned search activities. During the public meeting, the NRC Region IV Regional Administrator announced this special inspection and on October 25, 2004, Region IV established its charter (attached).

On February 22, 2005, the licensee issued their Special Nuclear Material Control and

Accountability Project Interim Reports (PG&E Interim Reports). On the same date, the licensee notified NRC (Event Report 41340) and issued License Event Report 2005-01. This notification and report informed NRC that PG&E was unable to locate one intact in-core detector and three partial in-core detectors, amounting to less than a gram of SNM.

After the licensee had completed its major search activities for the missing SNM on April 5, 2005, NRC issued Inspection Report Number 50-133/2005-01. This report was an interim report of the ongoing special inspection. The NRC interim report noted that the Material Control and Accounting (MC&A) program in place as of November 4, 2004, met regulatory requirements. However, the interim report also identified four apparent violations concerning past licensee practices connected with the missing SNM. Three of these apparent violations are discussed in Sections 3 and 11 of this report. The fourth apparent violation addressed the possession of SNM in the form of remnants of fuel fragments when neither the license nor the technical specifications authorized possession of SNM in this form. As noted in Section 11 of this report, this apparent violation has been resolved and is no longer considered an apparent violation. The NRC interim report also identified three unresolved items. The unresolved items are discussed in Section 11 of this report and are considered resolved.

On May 27, 2005, PG&E issued their Special Nuclear Material Control and Accountability Project Final Report. This report provided the results of the licensee's investigation into the location of the three 18-inch fuel rod segments and missing incore detectors, as well as the overall control and accountability of SNM at the HBPP. On June 10, 2005, the license submitted Revision 2 to LER 2004-01, regarding the three missing 18-inch fuel rod segments and Revision 1 to LER 2005-01, regarding the missing incore detectors.

On June 20-24, 2005, a team of inspectors from NRC Headquarters and Region IV conducted the final onsite portion of the special inspection to review the licensee's efforts to locate the missing SNM, the licensee's scenarios as to the possible locations of the SNM and to complete the review of current special nuclear material control and accounting practices.

Based on the findings of the special inspection, the inspection team concluded that:

- The licensee's current material control and accounting program meets regulatory requirements. The program had undergone significant changes from that program described in the interim special inspection report 05000133/2005-001. The changes made to, and the implementation of procedures for the control and accountability of SNM, physical inventory, and the use of tamper-indicating devices, had enhanced the licensee's MC&A program (Section 3).

- The licensee's SNM Control and Accountability Project which investigated the missing SNM and the overall control and accountability of SNM at the HBPP was complete and thorough in its search for the three 18-inch spent fuel segments and missing incore detectors. The searches included all areas that were reasonable and practical to search and that could accommodate the fuel segments. The licensee concluded, and the inspectors agreed, that it is very improbable that the missing SNM could be in an area not searched. The licensee expects that as the SFP contents are removed for dry fuel storage, and plant decommissioning progresses, additional fuel fragments may be found. However, it is very improbable that the intact missing 18-inch fuel segments

would be found. The inspectors agreed with this assessment (Section 2).

- Although the SNM Control and Accountability Project documentation did not always include the basis for their conclusions, no instances of erroneous or unreasonable conclusions were identified (Section 2).

- An Apparent Violation of 10 CFR 74.19(a)(1) was identified for PG&Es failure to keep records during the period from August 6, 1969, to July 16, 2004, showing the inventory, transfer or disposal of three approximately 18-inch segments of irradiated fuel containing approximately 22.5 grams of SNM. Also from June 25, 1973, to February 4, 2005, the licensee failed to keep records, including location and unique identity, showing the inventory, transfer or disposal of one complete and three partial incore detectors containing SNM (Sections 3, 11).

- An Apparent Violation of 10 CFR 74.19(b) was identified for PG&Es failure to establish, maintain, and follow written material control and accounting procedures sufficient to enable PG&E to account for the SNM in its possession. Specifically, PG&E failed to account for the SNM contained in three approximately 18-inch segments of irradiated fuel and one complete and three partial incore detectors (Sections 3, 11).

- An Apparent Violation of 10 CFR 74.19(c) was identified for PG&Es failure to conduct adequate physical inventories of all SNM in its possession at intervals not exceeding 12 months. Specifically, inventories performed by PG&E from June 4, 1971, to February 4, 2005, with the exception of periods when the sealed SFP cover was in place, did not include the three approximately 18-inch segments of irradiated fuel and one complete and three partial incore detectors (Sections 3, 11).

- The licensee evaluated 258 radioactive waste shipments made to low-level radioactive waste (LLRW) disposal sites. The inspectors reviewed the screening criteria used by the licensee and determined them to be reasonable. Of the 258 shipments, 249 were "screened out" as implausible leaving 9 potential shipments to be further investigated. Of the nine potential LLRW shipments, four had been made to Barnwell (South Carolina) Waste Management Facility and five had been made to US Ecology, Inc., (Hanford, Washington) (Section 4).

- The licensee's records of LLRW shipments were remarkably thorough, considering the lack of procedural guidance in effect at the time. The licensee's loading procedures for LLRW shipments lacked guidance for documentation and obtaining a dose rate of individual items included in the shipments (Section 4).

- The pipe container that had contained the fuel rod segments from assembly A-49 was never located or described in any LLRW shipment records. In addition, the container was unlikely to have completely dissolved in the SFP. The inspectors concluded that the container was more than likely shipped to a LLRW site as irradiated material during one of the spent fuel pool cleanup campaigns (Sections 4, 8).

- Using the licensee's terminology for the possibility of occurrence, the inspectors concluded that it was "Reasonably Possible" that the pipe container along with the fuel rod segments could have been inadvertently included in a LLRW shipment between 1968 and 1989. This conclusion differs from the licensee determination that it was "Possible, But Not Likely." The LLRW shipments to either Barnwell, South Carolina or US Ecology in Richland, Washington could have contained the fuel rod segments. However, the inspectors agreed with the licensee's conclusion that the shipments to Barnwell, South Carolina, that took place during 1983 and 1985, had the highest probability of containing the fuel rod segments (Section 4).

- The inspectors reviewed the screening criteria and process used by the licensee to review the Other Direct Shipments (ODS) and determined it was reasonable. The inspectors agreed with the licensee conclusion that it was "Possible, But Not Likely" that the fuel rod segments had been included in an ODS (Section 5).

- The licensee had located an extensive collection of records that documented the history of the incore detectors at HBPP. A number of shipments of cutup incore segments and intact incore detectors were documented. The inspectors agreed with the licensee's conclusions that the most likely locations for the missing full and three partial incore detectors were either the Barnwell or Hanford LLRW disposal facility (Section 6).

- The inspectors agreed with the licensee's conclusion that theft or diversion of the three 18-inch fuel rod segments and incore detectors was highly unlikely (Section 7).

- The inspectors concluded that the licensee's consultant report performed by ATI to evaluate the fuel fragments was based on sound engineering judgment and the consultants were methodical in the process of determining the conditions of the fuel rod fragments. However, the inspectors concluded that without substantial additional testing, they could not agree with the ATI consultants conclusion that there was reasonable evidence that the 18-inch segments maybe among the fragments found in the SFP (Section 8).

- The NRC team's conclusions differed from the licensee's in one notable respect. The NRC team concluded that the most likely scenario for the missing SNM was that it was inadvertently shipped to a low level waste burial site. The licensee's conclusions supported this as a possibility, however, its investigation concluded that the most likely scenario for the missing spent fuel rod segments was that they were still in the spent fuel pool in an altered condition. The table below compares the inspection team's conclusions with those of the licensee with respect to the possible scenarios regarding the missing fuel rod segments and incore detectors:

	Three 18 inch fuel rod segments		Incore detectors	
Scenario	Licensee	NRC	Licensee	NRC
Shipment to LLRW site	possible but not likely	reasonably possible	reasonably possible	reasonably possible
Other Direct shipment	possible but not likely	possible but not likely	highly unlikely	highly unlikely
Theft/Diversion	highly unlikely	highly unlikely	highly unlikely	highly unlikely
Still in SFP[1]	reasonably possible	possible but not likely	highly unlikely	highly unlikely

[1] This scenario includes fuel fragments or incore detectors in the spent fuel pool in either an altered configuration, or in a location that was not directly observable.

- The cause analysis performed by the licensee followed the applicable procedure and appeared to be through and adequate. Although the process used by the licensee was not a root-cause analysis, but a less stringent cause analysis, the inspectors concluded that the licensee considered all reasonable causes. The identified corrective actions were complete and comprehensive. The inspectors identified several missed opportunities to correct the MC&A program to address the three missing approximately 18-inch long fuel fragments and other SNM in its possession (Section 9).

- The inspectors concluded that regardless of whether the missing fuel segments were located in the SFP, had been shipped to NFS for reprocessing, or had been transferred to a LLRW disposal facility, the overall risk from the 18-inch fuel rods segments was minimal to the health and safety of the public, workers, or the environment. Based on the extremely low risk that the 18-inch fuel rods segments posed, if they were at Barnwell or Hanford, attempts to locate and retrieve the 18-inch fuel rods segments would not be justified by arguments concerning public health and safety. The overall risk from the missing incore detectors, if present (Section 10).

REPORT DETAILS

1. Introduction

Humboldt Bay Power Plant Unit 3 is currently in decommissioning SAFSTOR[1] status. Unit 3 received an operating license from the Atomic Energy Commission[2] on August 28, 1962. On July 2, 1976, Unit 3 was shutdown for annual refueling and seismic modifications. This work was suspended in December 1980, and in June 1983 PG&E announced its intention to decommission the unit based on economic analyses that showed that completing the necessary seismic upgrades would not be economical. Unit 3 has been essentially in SAFSTOR since July 1985. On July 19, 1988, NRC approved the licensee's SAFSTOR plan and amended the license to a possess-but-not-operate status. The license expires on November 9, 2015. The facility has undergone minimal decommissioning activity since shutdown.

During the fall of 2003, the licensee conducted an examination of the contents of its spent fuel pool (SFP) in preparation for eventual removal of the remaining fuel assemblies[3] to a dry storage Independent Spent Fuel Storage Installation (ISFSI). On December 15, 2003, PG&E applied for a license to build an onsite ISFSI.

On November 12, 2003, during sorting of materials in a container in the SFP, licensee personnel discovered a fragment of a spent fuel rod[4] approximately 4 inches long. During subsequent sorting of materials in the SFP, licensee personnel located an additional eight fuel fragments ranging in length from 4 to 6 inches. Through record reviews the licensee identified additional fuel fragments, ranging in length from 1 to 30 inches, that were stored in one container. These fuel fragments were in addition to those that had been found at that time.

On November 17, 2003, the licensee initially informed NRC personnel by telephone of these findings. The licensee kept the NRC staff informed of subsequent findings as they arose. In early December 2003, the licensee stopped additional work with containers in the SFP that could potentially contain fuel pin fragments until a criticality evaluation could be completed.

The initial fuel assemblies used in 1963 during the first fuel loading were clad with stainless steel. In 1965, cladding failure of stainless steel clad fuel was observed. In 1966, a "fuel washer" was built and used to remove accumulated corrosion on the surface of the fuel pins. During August through December 1966, fuel inspections identified at least three fuel

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[1] SAFSTOR is defined as a method of decommissioning in which the nuclear facility is placed and maintained in such condition that the nuclear facility can be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

[2] The Atomic Energy Commission was the predecessor to the Nuclear Regulatory Commission.

[3] A fuel assembly is a cluster of fuel rods. The HBPP Unit 3 first fuel assemblies were General Electric Type I fuel with stainless steel cladding and a 7 by 7 fuel rod array for 49 fuel rods per assembly. Forty-eight of the fuel rods had 79 inches active fuel length and one had an active fuel length of approximately 78.5 inches. The segmented rod in assembly A-49 had an active fuel length of 79 inches.

[4] A fuel pin or fuel rod is a long slender thin walled metal tube that holds fissionable materia (fuel) for nuclear reactor use. At HBPP Unit 3 the cladding was made of stainless steel or zirconium alloys. The terms pin and rod are used interchangeably.

assemblies with missing portions of pins. An undated Polaroid photograph of a video monitor shows an additional assembly, different from those previously identified, with a missing portion of a pin. Tests performed by licensee personnel demonstrated that all the spent fuel pin fragments found in the SFP were from stainless steel clad fuel pins. Fuel used after the first load was made with zirconium alloy. Zirconium alloy cladding was not subject to the same failures experienced by the stainless steel clad fuel.

During an NRC inspection conducted during January 5-9, 2004, the licensee informed the inspectors that it had found records that indicated that the stainless steel clad fuel assemblies were transferred to Nuclear Fuel Services Corporation in West Valley, New York, during the late 1960's and early 1970's. Based on the information found as of the time of the inspection, it was not clear to the inspectors that the reported transfer of special nuclear material (SNM) would have accounted for the missing portions of pins. Some assemblies were shipped years after being inspected and would have been inside containers that would have prevented the damage from being easily seen. The licensee's records indicated that a number of the assemblies in the pool had pins removed in the 1970's time frame for evaluations by the fuel vendor. It was not clear to the inspectors if the SNM inventory used by the licensee had accounted for the removed pins.

On January 9, 2004, during the inspection, the plant manager decided to initiate a re-evaluation of the amount of SNM present in each assembly and in the SFP. He took this action due to the many uncertainties in the base inventory. The inspectors opened inspection followup items (IFIs) 50-133/0304-01 and 50-133/0304-02 to track and review the licensee's investigation of the actions that were taken or should have been taken upon discovery of the fuel fragments; and re-assessment of the SNM possessed under the license, including the accuracy of special material status reports previously submitted. The discovery of fuel fragments indicated a potential problem with the Humboldt Bay material control and accounting (MC&A) practices, possibly extending as far back as the 1960 time-frame. However, the fuel fragments that were discovered were contained within the licensee's controlled area and did not constitute an imminent reportability concern due to theft or loss of licensed material in accordance with requirements of 10 CFR 20.2201 or 74.11.

On March 25, 2004, the NRC conducted a review of MC&A practices for spent fuel at Humboldt Bay. The review was conducted in accordance with guidance contained in Temporary Instruction 2515/154. This temporary instruction required the inspector to gather information in answer to a series of questions about the licensee's MC&A program. The questions covered the following programmatic areas: physical inventory, tracking of individual rods that had been separated from their assemblies, spent fuel pool practices, written procedures, accounting records, and visual verification. Based on the responses to the questions, the NRC determined that this site required additional inspection under the temporary instruction.

On June 29, 2004, the licensee informed NRC staff that it had recently found documentation indicating that in 1968 a fuel pin was segmented into three 18-inch sections and that other records indicated that the complete assembly was sent off site for reprocessing.

On June 30, 2004, the licensee convened a Technical Review Group to review the recently found records. The minutes of an Onsite Review Committee (OSRC) meeting conducted on October 2, 1968, noted that a fuel rod from assembly A-49 had been cut into three 18-inch long

segments. These three segments were intended to be sent to Battelle, Ohio, for an experiment. The minutes indicated that prior to shipment of the rod segments the licensee learned that the experiment had been canceled and the rod segments were placed in a container in the pool. Another document from the September - October 1968 time frame indicated that the rod that had been segmented had been previously damaged while in operation. This document described a 1.5-inch diameter schedule 40 steel pipe that was used as a container for the rod segments, which were to be shipped to Battelle. This document also stated that if possible, the remains of the rod were to be placed in the "garbage can" in the pool. The “garbage can” was an aluminum container originally intended for shipping damaged stainless steel clad assemblies for reprocessing. This container was used for collection of small irradiated components that were in the SFP. In more recent documents, PG&E has referred to this container as the “central storage container.” None of the fuel pin fragments found in November and December 2003 were 18 inches long.

Other records maintained by the licensee indicated that assembly A-49 was sent to Nuclear Fuel Services, West Valley, New York, on August 6, 1969, for reprocessing. The record indicated that the weight of the assembly shipped to Nuclear Fuel Services corresponded with the weight of the assembly when it was received. Since the OSRC records indicated a fuel pin had been removed from assembly A-49, the weight on receipt should not have agreed with the weight on shipment. The licensee decided that this apparent discrepancy constituted a quality problem related to their SNM records and issued a nonconformance report to address this matter.

On July 16, 2004, PG&E notified the NRC pursuant to the requirements of 10 CFR 20.2201(a)(1)(ii) of the discrepancy between inventory records and the location of spent fuel rod segments (Event Notification 40877). No records had been located indicating the location of the fuel segments in the SFP.

During July and August 2004, licensee personnel searched the most likely and accessible locations within the SFP where the fuel segments could be physically located. Region IV inspectors observed part of the search activities, including the opening and removal of contents from the assembly UD-006N box. On June 4, 1975, zirconium clad fuel assembly UD-006N was dropped by an operator while being moved from one SFP location to another. As a result, several rods became separated from the others in the fuel assembly. Subsequently, the licensee stored all the rods from assembly UD-006N in a box. Some stainless steel clad fuel fragments were also stored in the UD-006N box. The inspectors observed the search for assembly A-49 segments in the UD-006 box. Several fragments were found in these searches that at first appeared to have been cut as opposed to broken due to metal failure. A metallurgist and a specialist in non-destructive examinations, both employed by the licensee at their Diablo Canyon Nuclear Plant, examined video images of 12 fragments that initially appeared to have been cut. The metallurgist’s opinion was that the video images suggested that the fragments “all exhibit the appearance of a fracture surface and are dark in color as if oxidized to some degree. This appearance is more typical of inter-granular stress corrosion cracks that occurred at operating temperature.” The non-destructive examination specialist concurred.

The metallurgist also stated that the schedule 40 steel pipe described in the 1968 records as the “shipping container” for the 18-inch segments, could not have completely corroded away.

The metallurgist stated that even if the pipe container had been made from carbon steel, which he believed it probably was since the material of construction was referred to simply as "steel pipe," it would not have completely corroded away. He expected that if it was in the SFP it would show signs of significant rust and corrosion, possibly even through the wall in localized areas but it would still be easily recognizable.

On August 16, 2004, PG&E issued a 30-day written followup report to its initial July 16, 2004, notification to the NRC (Event Notification 40877). This report was made pursuant to 10 CFR 20.2201(b)(2)(ii). The licensee reported implementation of an action plan that included a detailed physical inspection of the SFP; documentation reviews of PG&E and vendor records; and interviews with both employees and contractors who had been associated with the Humboldt Bay SFP and radwaste operations.

On August 17, 2004, the Humboldt Bay Plant Staff Review Committee reviewed the results from searching the most likely and accessible locations within the SFP where the fuel segments could be located. During this phase of the search, the missing fuel was not located. Consequently, the licensee made a 1-hour notification to the NRC pursuant to 10 CFR 74.11(a) that the subject fuel rod segments were considered missing (Event Notification 40961).

On September 29, 2004, Region IV conducted a public meeting with the licensee in Eureka, California, to discuss the current and planned search activities. During the public meeting, the NRC Region IV Regional Administrator announced that a special inspection would be conducted of the licensee's material control and accountability program and that Region IV would also continue to follow the licensee's efforts to search for the missing fuel fragments. On October 25, 2004, Region IV chartered this special inspection.

On February 22, 2005, the licensee issued their Special Nuclear Material Control and Accountability Project Interim Reports (PG&E Interim Reports). On the same date the licensee notified NRC (Event Report 41340) and issued License Event Report 2005-01. This notification and report informed the NRC that PG&E was unable to locate one intact incore detector and three partial incore detectors, amounting to less than a gram of SNM.

On April 8, 2005, PG&E submitted the revised ATI report. This licensee consultant report was titled "Evaluation of Nuclear Fuel Rod Fragments and Inference to Fuel Rod A-49 at Humboldt Bay Power Plant." The executive summary to this report stated, in part, that it was the judgement of the consultants that there was reasonable evidence that fragments from the three missing 18-inch segments from assembly A-49 may be among the fuel fragments found in the SFP.

On May 27, 2005, PG&E issued their Special Nuclear Material Control and Accountability Project Final Report. This report provided the results of the investigation into the location of the three 18-inch fuel rod segments and the location of the missing incore detectors, as well as the overall control and accountability of SNM at HBPP.

On June 10, 2005, the license submitted Revision 2 to LER 2004-01, regarding the three missing 18-inch fuel rod segments and Revision 1 to LER 2005-01, regarding the missing incore detectors.

On June 20-24, 2005, a team of inspectors from NRC Headquarters and Region IV conducted the final onsite portion of the special inspection to review the licensee's efforts to locate the missing SNM, the licensee's scenarios as to the possible locations of the SNM and to complete the review of current special nuclear material control and accounting practices. This report documents that effort.

2. Review of PG&E's SNM Control and Accountability Project

2.1 Inspection Scope

The inspectors reviewed the licensee's SNM Control and Accountability Project (the Project) to evaluate the completeness and thoroughness of the search for the three 18-inch spent fuel segments. The review included the search in the SFP and surrounding areas, the search of historical records, documentation of interviews conducted with current and former employees and contractors, and the characterizations of fuel fragments found. This review included project control documents that consisted of the Project Plan and all Project Instructions, as well as applicable records generated by the project, video documentation of the search and fuel fragments characterizations, and the pertinent records obtained by the licensee from outside PG&E. The inspectors also interviewed the project manager, other key project personnel, and a former employee and a contractor who had been interviewed as part of the project.

2.2 Observations and Findings

a. Project Management

The project guidance documents provided adequate and effective guidance for the investigation process. The investigation method and approach was reasonable and effective. The investigation had a logical division of investigation paths, inspections, document reviews & interviews, coordinated with scenario and time line development. However, although the guidance for control and retention of documents was adequate, the guidance did not require specific documentation of the basis of decisions. Consequently, some portions in the report did not have adequate documentation for the basis of the licensee conclusions. This is discussed in more detail in paragraph f. of this report section.

b. Records Review

The inspectors reviewed the project control documents including the physical search data summary document (this document had no revision number or date). The inspectors also reviewed records obtained from Nuclear Fuel Services (West Valley), Battelle, and General Electric (GE). The licensee's search for and review of records was well organized, methodical and through. The licensee used a two step process (designating documents first as applicable, then as relevant) which provided an independent review. Additionally, the process included a second review audit of documents determined applicable but then not relevant. This provided a necessary independent verification of a key decision point. Searches and reviews were conducted

of both hard copy and electronic media. The documentation of the records review process was particularly through and complete, including areas that were searched without results. However, there were significant gaps in the documentation to be reviewed. This was due to the unavailability of the documents due to their age rather than a poor search process. Where inconsistencies were identified in the documents, the SNM project staff resolved them adequately.

The search of records outside the company was adequate given the age of the issue and the poor filing practices for documents during that time period. Although the licensee relied on the personnel at the outside facility to conduct the search, there is no indication the SNM project staff would have been more effective.

The inspectors also reviewed the training program and documentation for the document readers. The training appeared to be comprehensive, sufficient, and well documented. A training coordinator was designated and qualified personnel conducted the training on each project instruction.

c. Physical Search

Inspection Report 05000133/2005-001 describes the observations made by the inspectors during site visits in November and December 2004 and January 2005. During these visits the inspectors observed ongoing search activities, including opening of the UD006N assembly container and the vacuuming of the resin beds. The licensee had experienced a number of problems that resulted in delays during the search for the missing segments but the inspectors concluded that regardless of the difficulties experienced the licensee had conducted a thorough search of the SFP and other areas of the HBPP outside the SFP that could accommodate the fuel segments and were probable, e.g. shielded containers or water-filled areas capable of accommodating the fuel segments. These searches where conducted while maintaining effective personnel safety. The licensee referred to the systematic searches performed during Phase 2 of their project as Global Inspection Plan.

The searches did not find the three 18-inch fuel segments in their original form nor the pipe container in which they were originally stored in 1968. The searches of locations outside the SFP also did not locate the fuel rod segments, fuel fragments, or any other irradiated SNM. The searches in the SFP did find fuel fragments, and other irradiated SNM, including 175 fuel fragments amounting to 282.71 inches in length. The licensee defined a fuel fragment as “a clad or unclad portion of a fuel rod, including pellets or portions of pellets that have a measurable dimension nominally greater than ¼ inch. Cladding without fuel was considered irradiated hardware, not a fuel fragment. The fuel fragments contains SNM. The Global Inspection Plan also accounted for 50 incore detectors and identified that one complete and three partial incore detectors were missing.

The licensee searched all areas that were deemed practical to search and that could reasonably contain or accommodate the fuel segments. However, these searches did not include all areas of HBPP, for example the reactor vessel was not searched. The licensee concluded, and the inspectors agreed, that based on available information it

was very improbable that the fuel rod segments or fuel fragments could be in any of the locations not searched. It should be noted that the licensee expects that as the SFP contents are removed to implement dry fuel storage and plant decommissioning, additional fuel fragments maybe found. However, if this were to occur it is very improbable that the intact missing 18-inch fuel segments would be found. The areas that remain to be searched were too small to contain the intact 18-inch segments or were recently developed. The area below where the fuel channels were stacked is such a recently developed area. The channels were placed in their current location in the year 2000 and no fuel segments or containers were observed when the channels were stacked. The inspectors agreed that it is possible that additional fragments may be found but it is very improbable that the intact missing 18-inch fuel segments or the segments in their shipping container would be found.

d. Interviews

The inspectors reviewed applicable guidance documents including Project Instruction 04, “Interviewing,” and the results from the different interviews conducted by the licensee. Additionally, the inspectors interviewed key project personnel. The project instructions generally provided adequate guidance for an effective controlled interview process. Although the Phase I interviews were conducted informally, the documentation was adequate, allowing for the formal interviews to use the Phase I interviews as an effective starting point. The documentation of the Phase II interviews that were conducted was adequate. Documentation for why interviews had not been conducted were not always available or easily recognizable. However, the inspectors determined that the interviews that had not been conducted were generally not done for good reasons, i.e. candidate deceased or unable to be located. Additionally, most of the interviews were conducted by a single interviewer, which could have potentially reduced the effectiveness of the interview process.

The inspectors conducted two independent interviews with Phase II interview subjects. These interviews confirmed the records of the Phase II interview, although additional information was obtained.

e. Fuel Fragment Characterizations

The licensee had used two types of fuels during their operation. The initial fuel load consisted of fuel clad in stainless steel referred to as Type I. Subsequently, the licensee used fuel clad with zirconium alloy or Type II fuel. Assembly A-49 from which the segments were removed was Type I, stainless steel clad fuel. Differences in tube external diameters, tube wall thickness, and magnetic properties would allow differentiation between stainless steel and zirconium cladding. The licensee collected a series of measurements from the fuel fragments with cladding to establish the type of fuel involved, including external diameters, tube wall thickness, and magnetism. All clad fuel fragments found were stainless steel clad. The licensee also characterized each fragment found by measuring the length of fuel and the dose rates at nominal contact (approximately 1 cm from center of detector) and at 6 inches. The inspectors observed portions of the licensee’s activities to measure, identify, characterize, and store fuel fragments.

Using information known about the missing 18-inch segments, the licensee calculated the estimated dose rates and reported this information in Licensee Event Report (LER) 2004-001, revisions 0 and 1. The NRC's Special Inspection Interim report 05000133/2005-001 noted that the calculated dose rates were at least 10 times greater than the measured dose rates in fragments that had been found. The licensee agreed to review their calculation for possible errors.

Revision 2 to LER 2004-001, issued on June 10, 2005, revised the calculated dose rates. A footnote to Table 3, Calculated Dose Rates, of the revised LER stated that the dose rates in this table were corrected from the previous LER revision, as described in PG&E Calculation NX-289. Revision 3 to PG&E Calculation NX-289 noted that the initial calculations were performed using the power level that corresponded to the power generated in three segments (54 inches) of fuel rod. The revision used the power level for one 18-inch segment. These calculated dose rates were still at least twice the values measured.

To address this apparent discrepancy the licensee performed PG&E Calculation NX-293. This calculation evaluated the underwater dose rates postulated from the A-49 18-inch segments, at multiple distance from the segment, including 1 centimeter and 6 inches. This calculation also estimated dose rates from fragments of 1, 2, 3, 6, 9, and 12 inches in length. The calculation also estimated dose rates for various burnup rates of the fragments. The table below compares the measured dose rates for selected fragments to the calculated values at 1 centimeter and 6 inches using the burnup rate of 13,000 megawatt-day per metric ton uranium (MWD/MTU). The calculated values at 1 centimeter range from two to four times the measured values. At 6 inches the values are in better agreement ranging from comparable to three times the measured value. The inspectors concluded that when comparing the calculated dose rates for the A-49 segments to the measured dose rates on the fuel fragments in the SFP it is not reasonable to conclude that any of the fragments of interest originated from assembly A-49.

Table 1
Humboldt Bay Power Plant Unit 3
Measure vs Calculated Dose Rate for Fuel Fragments

Fragment	Fuel Length in Inches	Measured Rate in R/hr		Calculated Rate in R/hr[i] (NX-293)		Approximate Ratios Calc/Meas	
		1 cm	6"	1 cm	6"	1 cm	6"
FF013	2 5/8	230	9	701	10	3	1
FF021	13 3/8	198	10	776	29	4	3
FF026	10	209	7.5	774	25	4	3
FF027	6 3/8	303	15	762	18	3	1
FF029	1	101	1.3	431	3	4	2
FF030	4 ½	325	7	701	10	2	1
FF031	2 ¾	216	4.5	701	10	3	2
FF033	3.5	275	5	701	10	3	2
FFO34	3 1/8	271	4	701	10	3	3

[i] Calculation NX-293 calculated dose rates for fragments of 1, 2, 3, 6, 9, 12, and 18 inches in length. The recorded dose rates are for the nearest calculated value to the measured fuel length, and for a burnup rate of 13000 MWD/MTU.

f. Documentation of Investigation

The inspectors reviewed the project documentation in support of the final report. Although the documentation was generally adequate to support the conclusions of the final report, one notable exception was the basis for decisions. Although the inspectors were able to reconstruct the basis by examining supporting documentation, the basis for some decisions was not explicitly provided in the report. Examples include:

- No documentation was provided for the individuals listed on the proposed interview list who were not interviewed, other than for those individuals who were determined to be deceased. Although the basis could be determined by the inspectors, it had not been documented by the SNM Project.

- No documentation was provided for the basis of the Other Direct Shipments which were excluded from further consideration. Again, the inspectors were able to determine the basis and have no issues with the basis, but it was not provided in the SNM Project documents.

- Calculations were not performed to support the licensee's conclusion that the area radiation monitors (ARMs) would have alarmed if the rod segments had been removed from the spent fuel pool. Although these calculations were performed and provided during the course of the inspection, they were not provided in the SNM Project documents.

Although the SNM Project documentation did not always document the basis of the conclusions, no instances of erroneous or unreasonable conclusions were identified.

g. Adequacy of Interfaces with Government Agencies (NRC & States)

The inspectors reviewed the contact list for the fuel issue and interviewed key licensee personnel. The contact list of government contacts was maintained current and tracked for each notification. The notifications were timely. A weekly status call (subsequently changed to bi-weekly at the participants request) was conducted with key stakeholders. The contact list for significant updates was tracked by the licensee's public affairs staff. Additionally, the existing citizens advisory board, which includes local government officials, was kept informed of the progress of the investigation.

2.3 Conclusions

The licensee's SNM Control and Accountability Project was complete and thorough in its search for the three 18-inch spent fuel segments and missing incore detectors. The searches included all areas that were reasonable and practical to search and that could accommodate the fuel segments. The licensee concluded and the inspectors agreed that it is very improbable that the missing SNM could be in any of the locations not searched (e.g. the reactor vessel). The licensee expects that as the SFP contents are removed for fuel dry storage and plant decommissioning, additional fuel fragments may be found, but that it is very improbable that the intact missing 18-inch fuel segments would be found. The inspectors agreed with this assessment.

By comparing the measured dose rates on the fuel fragments in the spent fuel pool to the calculated dose rates for the A-49 segments, the inspectors could not associate any of the candidate fragments with those originating from assembly A-49.

Although the SNM Control and Accountability Project documentation did not always document the basis for their conclusions, no instances of erroneous or unreasonable conclusions were identified.

3. Material Control and Accounting

3.1 Inspection Scope

The inspectors reviewed changes made to the licensee's Material Control and Accounting (MC&A) program since the special inspection visit in November 2004 (see inspection report 05000133/2005001). The inspectors reviewed the licensee's written MC&A procedures, which addressed control and accountability of SNM, physical inventory, and the use of tamper-indicating devices. The inspectors interviewed personnel on procedure implementation and examined records generated by the procedures.

3.2 Observations and Findings

The over-arching material control and accounting procedure in force at the time of the

inspection was HBAP D-7, “Control and Accountability of Special Nuclear Material and Waste Shipment,” Volume 1, Revision 11, dated May 2, 2005. The procedure defined MC&A roles and responsibilities; provided instructions for identification, shipment, and transfer of SNM; provided instructions concerning the discovery of SNM-containing articles or SNM waste; and described the records and reports used to control and account for SNM.

Several definitions were added to the procedure to better classify the various forms of SNM in the SFP. New sections were added to provide more detail on SNM Accountability Records and the discovery of SNM-containing articles or SNM waste. The SNM Accountability Record form, SNM Movement Authorization form, and the SFP map were revised to provide more thorough entries on the forms, to enhance traceability, to provide better control of SNM moves, and to enhance the process of updating records.

The inspectors reviewed the recently created accountability records for the new SNM containers - SC1, FUEL FRAG, and UFFC. The forms included the serial number of the Tamper Indicating Device (TID) installed and a reference to the container contents as required by HBAP D-7. The inspectors also reviewed the accountability records for a sample of assemblies and verified that attachments were added describing the history of the assembly as specified in HBAP D-7.

The inspectors reviewed the licensee’s physical inventory procedure STP 3.6.6, “SNM Inventory,” Volume 6, Revision 20, dated May 2, 2005. Steps were added to verify that all SNM-containing items listed in the accountability records are found in the SFP and to visually inspect the TID tags installed on the SNM storage containers. The inspectors reviewed the SFP map from the most recent inventory conducted on May 5, 2005, and reviewed a sample of 30 assembly accountability records to verify that the locations of the assemblies as indicated on the SFP map matched the location in the accountability records. The new SFP map and all reviewed accountability records were completed according to procedure. The TID serial numbers for the SNM containers were verified as required during the inventory.

The inspectors reviewed procedure HBAP D-8, “SFP Cover Seals and SNM Container TIDs,” Volume 1, Revision 0, dated May 2, 2005. This new procedure included the requirements for installation and removal of the SNM storage container TIDs. The inspectors observed the new TIDs on the storage containers via underwater camera while inspecting the SFP, and viewed video and photographs of the installation of the TIDs. As mentioned above, the inspectors verified that the TID serial numbers were recorded on the accountability records for the storage containers, and were verified at the most recent inventory, as required.

On August 6, 1969, assembly A-49 was shipped off site for reprocessing, from that date forward, PG&E failed to maintain records indicating whether the three approximately 1-inch long segments of irradiated fuel were in their inventory, had been transferred or had been disposed. Calculations made by the licensee indicate the three segments contained approximately 22.5 grams of SNM.

Site records indicated that during the period of June 21 to 25, 1973, some incore strings were cut to remove the incore detectors . The incore detectors from three selected incore strings were then transferred to another licensee on June 25, 1973. An additional nine incore strings were presumed to have been cut and segmented during this same time frame, based on plant documentation. Evidence indicated that several segments from the incore cutup operations conducted during 1973 were approximately 30 inches in length. The three partial incore detectors were found in segments that were also approximately 30 inches long. June 1973 is the most likely period when control and accounting of the SNM in the incore detectors was lost, since the licensee did not know which lengths of incore string tubing contained SNM and which were just irradiated hardware. The inspectors concluded that this is when the licensee lost control of the accounting for the SNM in the incore detectors.

Records maintained by the licensee indicated that on June 4, 1971, the last shipment of fuel with stainless steel cladding, also known as Type 1 fuel, was made. At that point the licensee removed all the associated SNM contained in the Type 1 fuel from their inventory. However, as noted on the licensee's calculation NX-288, over the last year and half, the licensee has found 175 Type 1 fuel fragments. These fuel fragments are the equivalent to more than 280 inches of fuel or more than the equivalent of three fuel rods. In calculation NX-290, the licensee calculated that as of September 30, 2004, this amounted to 97 grams of uranium-235 and 22 grams of plutonium. Additionally, licensee's calculation NX-290 also estimated that there was 10 grams of uranium-235 and 5 grams of plutonium as SNM waste in the SFP. Regulations in effect during these time frames required that inventories account for all SNM, including the amount contained in the fuel fragments.

Even though the presence of Type 1 fuel fragments was noted during the 1976 and the mid-1980's pool clean up campaigns and the licensee conducted SNM inventories at the required intervals, these inventories failed to account for the SNM in the fuel fragments and SNM waste. Inventories of all SNM have been required by applicable regulations throughout this time.

These failures in the SNM control and accountability program were noted in the interim inspection report and are identified as apparent violations on Section 11 of this report.

3.3 Conclusions

The inspectors concluded that the licensee's current material control and accounting program meets regulatory requirements. The program has undergone significant changes from that program described in the special inspection report 05000133/2005-001. The changes made to, and the implementation of, procedures for the control and accountability of SNM, physical inventory, and the use of tamper-indicating devices, have enhanced the licensee's MC&A program.

4. Review of Scenario Involving Fuel Segments Shipped Offsite with Low Level Radioactive Waste (LLRW)

4.1 Inspection Scope

The inspectors reviewed the licensee screening process that was used to evaluate the potential inclusion of the three fuel rod segments in LLRW shipments. Supporting shipment records and plant procedures that were used for LLRW shipments were also reviewed.

4.2 Observations and Findings

This scenario evaluated the possibility that the three missing spent fuel rod segments were inadvertently included in a LLRW shipment, that would have originated from HBPP between September 1968 and July 1989. This scenario assumed that the three 18-inch fuel rod segments would not have been recognized as spent fuel and were either individually or collectively included with other radioactive waste and shipped offsite. Portions of the screening process used by the licensee for LLRW also evaluated the potential that the three fuel rod segments were included in what the licensee termed "Other Direct Shipments" (ODS). A separate scenario will be evaluated for ODS.

The licensee investigation for the both the LLRW and ODS scenarios started with a record review to locate all the radioactive material shipment records. After the radioactive material shipment records were located, they were screened for applicability and relevancy by the licensee using instructions contained in procedure "Special Nuclear Material (SNM) Inventory, Inspection & Control Project, Project Instruction Documentation Investigation SAP8065936 - PI - 03," Revision 5, dated March 18, 2005.

The licensee then evaluated all of the 490 radioactive material shipment records that had been determined to be applicable and relevant by using the "Screening Tool for Fuel Rod Segments in Offsite Shipments," approved May 24, 2005. This screening tool provided detailed criteria for evaluation of the potential inclusion of the spent fuel rod segment(s) in either LLRW shipments or in ODS.

The Screening Tool for Fuel Rod Segments included potential scenarios explaining how the fuel rod segments could have been inadvertently shipped from the site along with evaluation criteria to determine if the fuel rod segment(s) were contained within a shipment. Each shipment was conservatively evaluated using the radiological dose profile from a single fuel rod segment. Table 3.1-1 of the Screening Tool for Fuel Rod Segments provided a summary of the evaluation criteria that was used by the licensee to determine whether the shipment could contain the missing fuel segments. The criteria from Table 3.1-1 utilized to evaluate the shipping records consisted of:

5. The first screening criteria that was considered in the process determined if the shipment of radioactive material had been receipt inspected upon arrival at the final destination. The licensee evaluated the plausibility of a material recipient inspection occurring that would have recognized the presence of the fuel rod segments as an anomaly and contacted HBPP personnel. Material contained in

LLRW shipments were not individually receipt inspected and therefore received further consideration.

6. The second screening criteria considered the dose rate of the package. If the shipment had a high dose rate, the presence of the fuel rod segments were more plausible. A dose rate tool contained in "Humboldt Bay Power Plant Calculation No. NX-292," Revision 1, provided several dose rate versus decay time curves for different types and sizes of transportation packages. The package types evaluated by the curves included large Low Specific Activity (LSA) boxes, small LSA boxes, steel drums and cardboard boxes. The dose rate associated with a single 18-inch segment was conservatively applied in each of the curves. If the dose rate of the individual package was above the calculated dose rate curve from Calculation No. NX-292, the package would be further evaluated.

7. The third screening criteria determined if the shipment used a shielded cask. The shielding provided by the cask made it more plausible that the presence of a fuel rod segment would be undetected during radiation surveys. A package that was shielded would receive additional evaluation. Even if the package was not shielded, it was still evaluated utilizing the dose rate versus decay time curves from Calculation No. NX-292.

8. The forth screening criteria examined the contents and details of the shipping manifest. The shipping records were reviewed to determine if the description of the package contents described items with a similar appearance and/or configuration to the fuel rod segments or pipe container.

9. The fifth screening criteria determined if the material originated from the spent fuel pool. Due to the extremely high dose rates emitted from the fuel rod segments, their most probable storage location would be under water in the spent fuel pool, where they were initially placed in 1968. It was considered highly unlikely that the fuel rod segments would have been moved from the spent fuel pool during the course of normal operations, due to the extremely high dose rates involved with their movement. A planned movement of the fuel rod segments should have required additional documentation and procedures, which were not located during the record search.

10. The sixth screening criteria considered whether the package involved the solidification of an ion exchange resin or a concentrated liquid. Requirements for processing a liquid or a resin for waste shipment were considerably different than those associated with preparing a solid item for shipment, such as a pipe. Regulations also prohibited mixing waste forms and therefore, packages that contained resin or liquids were not evaluated further.

11. The seventh and final screening criteria confirmed that the date associated with the shipment record occurred after the segments had last been documented to be located in the spent fuel pool in 1968 and before the pool cover was installed in 1989. The segments could not have been shipped offsite prior to their initial

placement in the spent fuel pool in September 1968 and there were no shipments that originated from the spent fuel pool, exceeding the dose rate screening criteria contained in Calculation No. NX-292, after the pool cover had been installed in July 1989.

The licensee utilized the screening criteria listed above, although not necessarily in the order listed, to examine and evaluate if the fuel rod segments and/or the pipe container could have been removed and shipped from the site to a LLRW or ODS facility.

The inspectors concurred that the Screening Tool for Fuel Rod Segments and the screening process utilized by the licensee to evaluate LLRW shipments and ODS was appropriate.

The inspectors selected 30 of the ODS and LLRW shipments that had been screened by the licensee for an independent review. Selected records of shipments to General Electric Co. Vallecitos, CA; Nuclear Fuel Services; Nuclear Engineering Co., Richland, WA; Nuclear Engineering Co., Beatty, NV; Southwest Radiological Health Lab and US Ecology were compared to the screening results obtained by the licensee using the Screening Tool for Fuel Rod Segments in Offsite Shipments. No deficiencies of the licensee screening results were identified.

Utilizing the Screening Tool for Fuel Rod Segments, the licensee evaluated 258 radioactive shipments made to LLRW facilities. Of these 258 shipments, 249 were "screened out" as implausible based on the criteria mentioned above. There were nine potential LLRW shipments that were determined to be candidates for the inadvertent shipment of the fuel rod segments. The potential LLRW shipments included four to Barnwell Waste Management Facility located in Barnwell, South Carolina and five to US Ecology, Inc., located in Richland, Washington. The LLRW shipments were made in two phases. The initial phase consisted of three shipments to Barnwell Waste Management Facility during 1983. The second phase consisted of one shipment to Barnwell and five shipments to US Ecology, Inc., during 1985 and 1986.

The first three shipments to Barnwell Waste Management Facility occurred during October and November 1983. The first shipment record was dated October 11, 1983, and described the waste contents as "reactor control rods, control rod followers and poison curtains." **Normally smaller items or miscellaneous parts would be included with a shipment to prevent the larger material from movement during transport.** A description of small material or miscellaneous parts was not included with the first shipment record. This could mean that no additional material was necessary to stabilize the shipment or that a detailed list of the items had been omitted. The second shipment record dated October 24, 1983, and the third shipment record dated November 16, 1983, described the waste contents as "reactor control rods, control rod followers, poison curtains, fuel channels & misc. parts." Handwritten descriptions of the items included in the waste shipments as "shoring" or "misc. parts" along with sketches of the articles were located with the records for both the second and third shipments. None of the items that were described or sketched included with the second or third shipments resembled the fuel rod segment pipe container or the fuel rod segments. Dose rate surveys had not been performed on the individual items included as "shoring" in the

shipments. Dose rate readings were performed after all the waste had been placed in the liners for shipment, while still underwater in the spent fuel pool. Due to the highly radiated components that were included in the waste shipments, the dose rate readings measured underwater for the three Barnwell shipments varied from 600 to 2,200 Rem per hour. Therefore, final dose rate surveys performed for these shipment packages to Barnwell would have masked the presence of the fuel rod segments, if they had been present.

The loading of the radioactive material into the LLRW shipment casks for the 1983 Barnwell shipments was reported to have been performed by HBPP personnel. Chem-Nuclear Systems, Inc., personnel provided the personnel and equipment to ship the transportation packages from HBPP to the LLRW disposal site. Temporary Procedure No. 10/04/83, "Loading the Shipping Cask Liner," Revision 100-10/83, had been utilized to perform the loading operations for the cask liners. Procedure step number 10.f. stated, "Load any more items that will fit in the available space. Load items in the remaining space in the top of the liner as directed." Therefore, the temporary procedure directed the loading personnel to place as many items as possible into the available spaces in the transportation cask. The temporary procedure did not require individual items be listed or surveyed as they were incorporated into the waste shipments.

A major change to the regulations for radiological waste shipments occurred in December 1983. This was when the requirements of 10 CFR Part 61, Licensing Requirements for Land Disposal of Radioactive Waste became effective. 10 CFR Part 61 required, in part, that the waste be properly classified and packaged in such a manner to provide structural stability of the waste at the disposal site. Prior to implementation of this regulation, the requirements for classification of items included in a waste shipment were less stringent.

The second phase of LLRW shipments consisted of one shipment to Barnwell Waste Management during the last quarter of 1985 and five shipments to US Ecology during the first quarter of 1986. These shipments were all made after 10 CFR Part 61 regulations went into effect. In contrast to the earlier LLRW shipments made during 1983, Chem-Nuclear Systems, Inc., personnel loaded all the shipments.

The fourth LLRW shipment to Barnwell Waste Management Facility occurred on December 15, 1985. The radioactive waste shipment manifest described the waste as "activated metal." A handwritten spreadsheet included with the records listed the dimensions, weight and average dose rates for each individual item. The item descriptions did not resemble the fuel rod segment pipe container or the fuel rod segments. Dose rate information was provided for the individual items, but high dose rate readings would have masked the presence of the fuel rod segments. The radioactive waste shipment record reported that 1,520 linear inches of cutup incore tube string pieces or "processed incores" were included. The average radiological dose rates for the "processed incores" were recorded as 69.3, 218.83 and 145.36 Rem per hour. The "processed incores" were reported to consist of various lengths of incore pieces, that were composed of stainless steel tubes with a diameter of 0.75 inches. The missing fuel rod segments also consisted of stainless steel tubes, approximately 18 inches long and were 0.50 inches in diameter. It is not known whether the missing

fuel rod segments were ever removed from the pipe container. A HBPP Memorandum to File, dated February 24, 1986, stated that additional pieces of the cutup incore tubes had been located during "subsequent pool cleanup work." From this statement, it could be concluded that during previous incore tube cut-up campaigns, portions of the tubes had been misplaced in the spent fuel pool and later recovered. It is reasonable to assume that if the fuel rod segments had become separated from the pipe container, they could have been mistaken as previously cut-up incore tubes. The small difference in stainless steel tube diameters between the fuel rod segments and the incore tubes would have been difficult to differentiate underwater in the spent fuel pool. However, the inclusion of the fuel rod segments was believed to be highly unlikely due to documentation included in the HBPP Memorandum to File, dated February 24, 1986. Information in the memorandum indicated that only the incore segments that had been cut up during the year 1985 were included in the shipment. Therefore, only a small potential for the inclusion of miscellaneous incore pieces found on the bottom of the spent fuel pool would have existed.

The five shipments to US Ecology in Richland, Washington occurred on January 20, 1986; January 28, 1986; February 5, 1986; February 18, 1986 and March 4, 1986. Each of the five shipment manifest records described the waste as "metal oxides and plastic/cellulose filter media, stabilized/encapsulated in cement." A separate handwritten sheet of paper found with each of the 5 waste shipments provided a description for each item that had been included in the shipment. Additionally, the weights and average dose rates for each item were also included on the handwritten sheets of paper. The descriptions of the items included in the shipments did not resemble the fuel rod segment container nor the fuel rod segments, however some of the item descriptions were of 55 gallon drums that could have contained the missing items. An example of such a container would be the shipment that occurred on January 28, 1996, that included a drum containing "compacted spent fuel pool trash." Dose rate information was provided for the individual items in the radwaste shipment, but high dose rate readings of the packages varied from 13 to 30 Rem per hour and would have masked the presence of the fuel rod segments.

Instructions for loading the radioactive waste shipment liners during the 1985 and 1986 shipment campaigns were included in Temporary Procedure No. 12/26/85 No. 2, "Loading SFP Hardware into Chem-Nuclear Systems' CNS 8-120 Liner and Cask," Revision 146-12/85. Step 8 of the Temporary Procedure stated, "Liner is now ready to be loaded with hardware as approved by Chem-Nuclear personnel with the concurrence of the PGandE Chemical/Radiation Protection Engineer." The step is very vague by today's standards and does not preclude the undocumented introduction of additional items into the liner nor does the procedure require that each item receive a dose rate survey. However, a dose rate survey of each major item was located with the records for each shipment. Figure 1 of the Temporary Procedure contained the only procedurally required dose rate readings, that specified final dose rate readings be taken and recorded at 32 separate locations on the liner after loading operations had been completed.

The inspectors conducted a telephonic interview with an individual that had served in a supervisory capacity with Chem-Nuclear Systems, Inc., during the LLRW shipments

conducted during the years 1985 and 1986. The individual described the process of documenting and obtaining a dose rate survey for each item included in the LLRW shipment. The process details described by the individual closely aligned with the details contained in the LLRW shipment records, recovered by the licensee.

The licensee's records of LLRW shipments were remarkably thorough, considering the lack of procedural guidance and regulatory requirements. The licensee's loading procedures for LLRW shipments lacked guidance for documentation and obtaining a dose rate of individual items in the shipment. The licensee procedures did not require that a closed container, such as a pipe, be opened to evaluate the container contents. The licensee did not have a current procedure that could be used to ship LLRW in a shielded cask that originated from the spent fuel pool.

There were no items discovered during the licensee's review of LLRW shipment records that matched or resembled the pipe container that had contained the fuel rod segments. Unfortunately, the only record located by the licensee described the pipe container as 1 ½" schedule 40 steel pipe. Regardless of whether the pipe was made from carbon steel or stainless steel, a substantial portion of the pipe along with the pipe caps were expected to have remained intact in the spent fuel pool. Since the pipe container was not located in the spent fuel pool and no records exist that indicated a planned or procedural approved movement of the pipe container with the fuel rod segments ever occurred, it is possible that the pipe was disposed of as radwaste with or without the fuel rod segments inside.

4.3 Conclusions

The inspectors reviewed the screening criteria used by the licensee and determined that the process utilized to evaluate and screen the LLRW shipments was reasonable.

The licensee evaluated 258 radioactive waste shipments made to low-level radioactive waste (LLRW) disposal sites utilizing the Screening Tool for Fuel Rod Segments. Of these 258 shipments, 249 were "screened out" as implausible leaving 9 potential shipments to be further investigated. Of the nine potential LLRW shipments, four had been made to Barnwell (South Carolina) Waste Management Facility and five had been made to US Ecology, Inc., (Hanford, Washington).

The first three shipments to Barnwell had been loaded by Humboldt Bay personnel during 1983. Handwritten records provided descriptions of the small items included in the last two radwaste shipments, but a description was missing from the first radwaste shipment. Site procedures governing loading activities lacked instructions to describe and document items included in the radwaste shipment and specifically directed loading personnel to fill available spaces in the liner with waste items.

The fourth Barnwell shipment had been loaded by Chem-Nuclear personnel during the 1985 time frame. A handwritten record confirmed that the shipment contained "processed incores." The fuel rod segments could have been mistaken as cutup incore

string tubes and included in the shipment. However, this was believed to be highly unlikely. The high dose rates associated with the incore string tubes would have masked the missing fuel rod segments, if they had been present.

The five shipments to US Ecology in Richland, Washington were loaded and shipped by Chem-Nuclear personnel during the 1986 time frame. Handwritten records were available that provided descriptions of items included with the shipment together with dose rates for the individual items. The procedural instructions to document individual items placed in the radwaste shipments were vague.

The licensee's records of LLRW shipments were remarkably thorough, considering the lack of procedural guidance and regulatory requirements. The licensee's loading procedures for LLRW shipments lacked guidance for documentation and obtaining a dose rate of individual items included in the shipments.

The pipe that had contained the fuel rod segments was never located or described in any LLRW shipment records. Since the pipe container was never located, it was plausible that it had been shipped from the site as radwaste during one of the spent fuel pool cleanup campaigns.

Using the licensee's terminology for the possibility of occurrence, the inspectors concluded that it was "Reasonably Possible" that the pipe container along with the fuel rod segments could have been inadvertently included in a LLRW shipment between 1968 and 1989. This conclusion differs from the licensee determination that it was "Possible, But Not Likely." The LLRW shipments to either Barnwell, South Carolina or US Ecology in Richland, Washington, could have contained the fuel rod segments. However, the inspectors agreed with the licensee's conclusion that the shipments to Barnwell, South Carolina, that took place during 1983 and 1985 had the highest probability of containing the fuel rod segments.

5. Review of Scenario Involving Fuel Segments Shipped Offsite In Other Direct Shipments (ODS)

5.1 Inspection Scope

The inspectors reviewed the license screening process used to evaluate the potential inclusion of the three spent fuel rod segments in Other Direct Shipments (ODS) that contained radioactive material. Shipment records and other supporting documentation for the ODS were also reviewed.

5.2 Observations and Findings

This scenario evaluated the inadvertent inclusion of the three missing spent fuel rod segments in a shipment classified as ODS. An ODS is defined as a radioactive materials shipment that was made from HBPP to another licensee authorized to receive the shipment. The ODS shipments differed from LLRW shipments in that the radioactive material that was shipped was not waste. The radioactive material would be utilized or processed by the licensee, normally expected to include unpacking, receipt

inspection and handling of the material. This scenario assumed that the three 18-inch fuel rod segments would have been recognized as an anomaly and the licensee would have then contacted HBPP personnel.

The licensee used several of the same processes to evaluate this scenario that were used to determine if the segments were contained in a LLRW shipment. The radioactive shipment records were screened for applicability and relevancy. The licensee then applied the screening criteria from Table 3.1-1 of the Screening Tool for Fuel Rod Segments to evaluate the potential for inadvertent inclusion of the fuel rod segments into one of the ODS.

The inspectors selected and reviewed 30 of the ODS and LLRW shipments that had been screened by the licensee. No deficiencies of the licensee screening results were identified.

Utilizing the Screening Tool for Fuel Rod Segments, the licensee evaluated 232 radioactive ODS. Of these 232 shipments, 217 were "screened out" as implausible. The 15 ODS that were "screened in" as potential candidates for receipt of the fuel rod segments were the shipments of fuel for reprocessing to Nuclear Fuel Services (NFS) at West Valley, New York.

The 15 ODS shipments of irradiated spent fuel assemblies were made to NFS between May 14, 1969, and June 3, 1971. Each of the shipments were reported to contain 18 fuel assemblies. Interviews with plant personnel indicated that it would have been possible to include the fuel rod segments and pipe container in the fuel shipment cask. However, due to the level of difficulty necessary to accomplish this task, documentation would most likely have included in a plant record. A record that indicated the fuel rod segments had been placed in a shipping cask with the fuel assemblies was never located.

The spent fuel reprocessing activities at NFS were described in a report by Nuclear Audit and Testing Company entitled, "Surveillance of Humboldt Bay Spent Fuel During Reprocessing at the NFS Plant at West Valley, New York," dated October 25, 1971. The focus of the report was on accounting for the percentages of uranium and plutonium that had been recovered during fuel reprocessing. The radionuclides from the assemblies were reclaimed in batches of 11 fuel assemblies. The report specified that fuel assembly A-49 had been included in Dissolver Batch number 8 and Tank 3D-1 batch number 13. The report documented the variance between the recorded weights of the uranium and plutonium that were recovered from the batch of fuel assemblies that contained assembly A-49, as well as the other batches of fuel assemblies received from HBPP. The nuclide variances of the individual batches far exceeded the radionuclide weights reported in the three fuel rod segments by the licensee in Licensee Event Report 2004-001-002. Therefore, accounting records of reclaimed radionuclides, that could have indirectly substantiated the presence or absence of the missing fuel rod segments were inconclusive due to large variances.

The licensee requested three of the most likely ODS recipients to perform a search to determine if their records indicated receipt of the fuel rod segments or the pipe

container. Responses were received from New York State Energy Research and Development Authority (formerly NFS), dated September 10, 2004; Battelle, dated September 8, 2004; and General Electric, Vallecitos Nuclear Center, dated October 14, 2004. New York State Energy Research and Development Authority responded that a review of available records did not disclose any information of the receipt of a small shipping container with fuel rods or of the disposition of the three rod segments. Battelle reviewed its records and confirmed that the planned shipment of the three irradiated fuel rod segments from HBPP to Battelle's West Jefferson, Ohio facility did not take place. General Electric responded that after an extensive review of available General Electric records, they did not identify any information to support a finding that the three unaccounted for Humboldt Bay fuel rod segments were ever received at the GE Vallecitos Nuclear Center or the GE San Jose facilities.

The shipment records reviewed by the inspectors normally contained detailed descriptions of the individual items included in the shipments. Based on a review of the available information, the inspectors agreed with the licensee conclusion that it was "Possible, But Not Likely" that the fuel rod segments had been included in an ODS.

5.3 Conclusions

The inspectors reviewed the screening criteria used by the licensee and determined that the process utilized to evaluate and screen the Other Direct Shipments (ODS) was reasonable.

The licensee evaluated 232 radioactive ODS made to other licensees using the Screening Tool for Fuel Rod Segments. Of these 232 shipments, 217 were "screened out" as implausible leaving 15 potential shipments of irradiated fuel to NFS for reprocessing to be further investigated.

No conclusive or circumstantial evidence was found to support the premise that the fuel rod segments were included in an ODS.

The inspectors agreed with the licensee conclusion that it was "Possible, But Not Likely" that the fuel rod segments had been included in an ODS.

6. Review of Scenario Involving Incore Detectors Shipped Offsite with Low Level Radioactive Waste (LLRW)

6.1 Inspection Scope

The inspectors reviewed licensee documents consisting of incore accountability records, shipment records, procedures and miscellaneous correspondence to determine if the incore detectors had been shipped offsite with a LLRW shipment.

6.2 Observations and Findings

This scenario evaluated the possibility that the one full and three partial missing incore detectors, also called ion chambers, were included with a LLRW shipment. The

licensee reported their belief that the missing incore detectors had been erroneously included with irradiated hardware and shipped to a LLRW facility at Hanford or Barnwell, in Licensee Event Report 2005-001-01. The inspectors independently reviewed available documents to determine the most likely location of the missing incore detectors including the accounting of the incore detector string segments. This scenario concentrated on the incore detector strings that had been placed in the spent fuel pool and later cutup and was not concerned with the intact incore detector strings that have not been irradiated.

A brief description of the incore detector string composition and the process used to cutup the incore detector strings for shipment follows. Each incore detector string, hereafter referred to as simply an incore, consisted of a stainless steel tube approximately 16-feet long with three incore detectors, also called ion chambers. Each incore detector contained a small amount of Special Nuclear Material (SNM), which the licensee was required to account for. The incore detectors were located at regularly spaced intervals near one end of the incore detector string. When the incore detectors no longer functioned correctly, the entire incore detector string would be removed from the reactor and stored underwater in the spent fuel pool, due to the high radiation dose rates emanating from the irradiated incores. The incore detector strings would periodically be disposed of as waste to provide additional space in the spent fuel pool. To dispose of the incores, the personnel would remove sections from the incore that contained the incore detectors and store these sections separately. The remaining pieces of the incores, that did not contain the incore detectors, would be cut up into lengths that could be easily handled and were either stored in the spent fuel pool or shipped offsite.

The licensee had located an extensive collection of records that documented the history of the incores at HBPP. The Special Nuclear Material Accountability Record had been located for each incore that had been used at HBPP. The SNM Accountability Records documented the movements of each incore from the warehouse to disposal, along with associated dates. The inspectors reviewed the SNM Accountability Records along with records of radioactive material shipments, procedures used to cutup the incores and other miscellaneous correspondence that related to the missing incore detectors.

The first planned shipment of incore detectors and incores for disposal occurred on December 12, 1968. The HBPP On-site Review Committee Minutes of Regular Meeting, dated December 3, 1968, discussed a proposal to remove the incore detectors from the six defective incores that were located in the spent fuel pool and cutup the remaining sections into approximately four foot lengths to fit into an available cask for shipment offsite. The Radioactive Materials Shipment Record, dated December 12, 1968 and the SNM Material Accountability Records for incore detector serial numbers 5451136, 5451137, 5451138, 5451140, 5451141, 5451142 confirmed that both the incore detectors and the cutup incores had been shipped offsite to Nuclear Engineering Co., Beatty, Nevada, for disposal.

The second planned shipment consisted of nine incore detectors removed from three selected incores that were located in the spent fuel pool. Documentation indicated that the left over incore pieces had been stored in the spent fuel pool. A letter from General

Electric Co., San Jose, California, dated May 7, 1973, documented plans for GE personnel to remove the incore detectors from incore serial numbers 5451154, 5808867 and 5808868. The incore detectors or “elements” were then planned to be returned to General Electric Co., Vallecitos, California, for examination. HBPP Radioactive Materials Shipment Record No. 215, dated June 25, 1973, confirmed the shipment of the “nine incore fission chambers from strings, Serial Nos. 5451154, 5808867, & 5808868," which indicated that only the incore detectors had been shipped. A typed record of the events that occurred on June 21, 1973, documented that the incore detectors had been cutup into two foot sections and stored in a separate compartment of “GE’s cask liner” for shipment, while the other short pieces were to be placed in “one of the storage cans prepared for plant use.” This record also supported that only the nine incore detectors had been shipped leaving approximately 400 inches of incores in “one of the storage cans” presumably in the spent fuel pool.

At the time of the segmenting of the incore detectors for General Electric in 1973 there were nine additional incores in the spent fuel pool. Although detailed records or copies of the procedure used to cutup these nine incore detectors strings were never located, it appeared that this operation occurred at approximately the same time as the segmenting of the incore detectors for GE. A handwritten note from the April 1973 time frame indicated that “we might as well cut them all up while we are at it.” The incores were most likely cutup between June 22 and 25, 1973. A HBPP Memorandum to File, dated February 24, 1986, documented that the remnants of nine incores cutup in earlier years were located in the spent fuel pool.

In December 1985, HBPP Temporary Procedure 11/25/85 No. 2, Revision 146-12/85 was used to cut the incore detectors from nine intact incores located in the spent fuel pool. The procedure provided specific directions and diagrams for removing the incore detectors. Additionally, the presence of the incore detectors were determined by changes in dose rate readings as detailed in Supplement to T.P.11/25/85 No. 2. The HBPP Memorandum to File, dated February 24, 1986, documented that nine incores were cut and 27 incore detectors were removed. By procedure, the cutup sections that contained the incore detectors would be either 10 or 11 inches long. The remaining pieces of incores cutup by use of the procedure were reported to have been included in shipment number 473, to Barnwell, South Carolina that occurred on December 15, 1985. This shipment listed three barrels that contained a total length of 1520 inches of “processed incores,” corresponding to the expected amount of waste from the nine cutup incore pieces, minus the 27 incore detector segments.

Soon after the cutup and shipment of the nine incore waste pieces that occurred in December 1985, HBPP personnel attempted to account for all the incore detectors. They found cutup incore remnants that consisted of 49 pieces approximately 25 to 30 inches in length and 5 pieces approximately 18 inches in length. The total length of the incores evaluated by HBPP personnel (including the 27 incore detectors from the nine detector strings cutup in 1973) was estimated between 1315 to 1560 inches. This total did not include the incore detectors recently cutup in December 1985 of approximately 400 inches. A dose rate survey of the incore pieces was conducted to locate the missing incore detectors. The results of the dose rate surveys were inconclusive. The Memorandum noted that “due to variations in activation of the fission

chambers and decay times, positive identification of the fission chambers was not possible." However, based on the total length of the incores and the dose rate measurements, the licensee concluded that all fission chambers were accounted for.

As part of the effort to positively account for all SNM at HBPP, the licensee performed an inventory of all the incore detectors onsite. HBPP procedure TP 2004-10, "Incore Detector Evaluation and Container Loading," Revision 5 provided instructions to determine if the incore segments contained an incore detector. The procedure required measurement of the individual incore piece lengths and positive verification of the presence of an incore detector. The results of this inventory was reported to the NRC on February 22, 2005, which concluded that one full and three partial incore detectors were not in the spent fuel pool as previously believed. The three partial incore detectors, located by the licensee, were found in incore segments approximately 30 inches in length. The licensee reported that the total length of the incores (including incore detectors) that remained in the spent fuel pool was 2,046 inches. This reported length of incore detectors and incore pieces closely matched the total length of incores documented in the HBPP Memorandum to File, dated February 24, 1986. The single exception was an equivalent length of approximately 400 inches of cutup incore pieces from the 1973 time period.

The precise location of the missing segments from the full and partial length incore detectors can not be determined. Approximately 400 inches of incore segments, including the missing incore detectors, cannot be located or accurately accounted for. The missing incore detectors were most likely included in a LLRW shipment along with portions of other incore segments from the 1973 cutup campaign. Evidence exists that the 1973 cutup campaign produced segments of 25 to 30 inches in length. The inspectors concluded that the documented shipments of incores would not have included the missing full or partial incore detector segments for the following reasons:

- The shipment in 1968 included all the components (both strings and incore detectors) from the six incores that existed in the spent fuel pool. No incore detector pieces were reported to have been left in the spent fuel pool.

- According to available records the shipment to GE in 1973, only included the incore detectors. Evidence suggested that approximately 400 inches of cutup incores were stored from the campaign at HBPP. No shipment records or other documentation to account for the 400 inches of cutup incores from this shipment were located.

- The three partial incore detectors were located by the licensee in incore segments that were approximately 30 inches in length.

- Records related to the shipment made in 1985 indicated that only the recently cutup incore segments from the campaign conducted several weeks prior to the shipment were included. Documentation indicated that the incore detector segments stored in the HBPP spent fuel pool from the 1985 cutting operation

contained incore detectors between 10 and 11 inches long. Therefore, the probability that a 30-inch segment remained at HBPP from the cutting operation/shipment conducted in 1985 is very small.

- HBPP personnel noted that 49 incore pieces that were 25 to 30 inches in length were in the spent fuel pool in 1986, presumably from the 1973 cutup campaign.

- The licensee performed a comprehensive search that determined the number of incore detectors that are currently in the spent fuel pool. Based on the HBPP Memorandum to File, dated February 24, 1986, the amount of material that existed in the spent fuel pool in 1886 closely matched the amount recently reported by the licensee.

The licensee records were inconclusive as to the possible location for approximately 400 inches of incore detector strings, presumably cutup in 1973. Based on a review of the available information, the inspectors agreed with the licensee conclusion that the missing incore detectors were most likely located at a licensed LLRW disposal facility. Since the incore detectors would have been highly radioactive and therefore stored in the spent fuel pool, the most likely LLRW disposal sites were determined to be either Barnwell or Hanford. The suspect LLRW shipments mirror those considered for the missing fuel rod segments that would have occurred between 1983 and 1986.

6.3 Conclusions

The licensee had located an extensive collection of records that documented the history of the incore detectors at HBPP. A number of shipments of cutup incore segments and intact incore detectors were documented.

Records were inconclusive as to the whereabouts of approximately 400 inches of cutup incores, presumably from the campaign performed during June of 1973. Documentation indicated that the partial incore detectors found by the licensee had been cutup during this campaign.

The inspectors agreed with the licensee's conclusions that the most likely locations for the missing full and three partial incore detectors were either the Barnwell or Hanford LLRW disposal facility.

7. Review of Scenario Involving Fuel Segments Stolen or Diverted

7.1 Inspection Scope

The inspectors reviewed the licensee interim and final reports sections related to the theft and diversion scenario, interviewed personnel involved in the development of this portions of the licensee reports, examined supporting documentation and reviewed special evaluations and calculations.

7.2 Observations and Findings

The licensee identified three alternatives for this scenario:

7. Theft by an External Entity
8. Theft by an Insider
9. Unauthorized Disposal

The licensee analysis involved a "defense-in-depth" approach meaning that for a successful theft or diversion to have occurred, multiple barriers in place to prevent such an occurrence would have to have failed. In addition to the analysis performed by the licensee, the inspectors requested that the licensee conduct some additional evaluations not detailed in the licensee's report. The inspectors requested that the licensee perform a calculation to demonstrate that the plant radiological monitoring system could have detected and would have generated an alarm if one unshielded 18-inch segment would had been removed from the SFP. The inspectors also requested the licensee evaluate available records of unexpected alarms and determined if plant personnel had responded. The licensee evaluations demonstrated that a single unshielded 18-inch segment would have generated an alarm and that for unexpected alarms the licensee personnel responded to evaluate the cause. The licensee evaluations and the inspectors' independent review support the conclusions listed in Section 4.5.6 of the licensee's Final Report. These conclusions include:

- Few individuals knew of the existence of the three 18-inch fuel segments
- Theft of unshielded fuel segments in the 1968 through 1974 period would have presented significant health risks due to radiation exposure.
- Theft of fuel segments using a shielded container would have required knowledge of a large number of plant employees and the use and manipulation of major plant equipment that would not have gone on unobserved. No evidence of such use has been found.
- There is very limited economic or strategic value to the fuel rod segments or the incore detectors.
- No group or individuals have claimed to have stolen or diverted the fuel rod segments or incore detectors.

7.3 Conclusions

The inspectors agreed with the licensee's conclusion that theft or diversion of the three 18-inch fuel rod segments and incore detectors was highly unlikely.

8. Review of Scenario Involving Fuel Segments Remaining in the SFP in an Altered Condition

8.1 Inspection Scope

The inspectors reviewed the ATI Consulting report *Evaluation of Nuclear Fuel Rod Fragments and Inference to Fuel Rod A-49 at Humboldt Bay Power Plant* (ATI report) dated March 31, 2005, and other related documents and procedures, and reviewed video and still images of the fuel fragments found.

8.2 Observations and Findings

In a meeting held on September 17, 1968, by the HBPP On-site Review Committee (OSRC) led by W. A. Raymond (Acting Chairman), the committee decided that a fuel segment will be removed from a corner rod of bundle A-49. This fuel segment would then be cut in three 18 inch segments from this irradiated fuel rod and shipped to Battelle Memorial Institute in Columbus (BMI). The top and end pieces of the fuel rod were to remain in the SFP. The three rod segments were to be used in a study regarding Type 1 fuel rods and were to be shipped in a specially made shipping container. The study by BMI was canceled prior to shipment and the three 18-inch fuel rod segments and pipe container were placed back in the SFP.

During the fall of 2003, Pacific Gas and Electric (the licensee) conducted an examination of the contents of its SFP in preparation for removal of the fuel for placement into dry storage in an onsite Independent Spent Fuel Storage Installation. Subsequently, on June 23, 2004, the licensee discovered a discrepancy in the plant records related to the three 18-inch rod segments such that there was no accounting for the removed fuel rod or segments from Assembly A-49. The licensee contracted with ATI Consulting to review digital video and photographs of the inventoried fuel rod fragments to determine if they may be part of the remnants and cut segments from the fuel rod fragments of Assembly A-49.

The inspectors reviewed each section of the ATI report and repeated the visual assessment of each fuel fragment that the consultants performed in the ATI report. The inspectors also reviewed each document used by the consultants listed in the Sources of Data Evaluated Section of the ATI report. Each of the documents are listed in the attachment to this inspection report. The ATI report was divided into seven sections that included: 1) Executive Summary; 2) Background; 3) the Sources of Data Evaluated; 4) General Assessment; 5) Evaluation Criteria; 6) Data and Discussion; and 7) Conclusions.

In the General Assessment Section of the ATI report, the consultants discussed the history of the GE Type 1 fuel with Type 304 stainless steel cladding regarding failures due to intergranular stress corrosion cracking (IGSCC). The report also described the dimensions of a typical Type 1 fuel rod that is representative of the stainless steel clad fuel rods in Assembly A-49 and the cutting plan for the subject fuel rod.

The inspectors reviewed a paper by R. N. Duncan, et al, in titled “Stainless-Steel-Clad Fuel Rod Failures,” and General Electric Company (GE), Nuclear Applications Vol.1 (pp 413-418), dated October 1965 which discussed the failure of the Type-304 stainless steel fuel rods by IGSCC. The inspectors reviewed this paper in order to determine if the ATI consultants were accurate in explaining the cause of the fragmentation of the subject fuel rod. The inspectors were also aware of substantial efforts in research and development that had been sponsored by the BWR (Boiling Water Reactor) Owners Group for IGSCC Research. The results of this program, along with other related work by vendors, consulting firms, and confirmatory research sponsored by the NRC allowed the NRC staff to development positions regarding the IGSCC problems in BWRs. The technical bases for these positions were detailed in NUREG-0313, Revision. 2

"Technical Report on Material Selection and Process Guidelines for BWR Coolant Pressure Boundary Piping." Based on these studies, the inspectors determined that the ATI consultants were correct in their assessment that the subject rods fragmentation was caused by IGSCC.

The ATI consultants noted that the axial dimension, not including the endplug shanks at the top and bottom ends of the rod, was approximately 83 inches. The consultants further noted that the top endplug shank was slightly longer than one inch, while the bottom endplug shank was slightly longer than 0.5 inches. Additionally, each fuel rod had an identification stamp at the bottom end of the rod above the endplug shank. The inspectors reviewed General Electric Drawing Number 932C653, Titled “ASM Fuel Rod” and verified that the consultants were accurate in their description of the subject fuel rod in the ATI report.

The inspectors also reviewed the licensee’s cutting plan and the ATI consultant’s evaluation of the licensee’s cutting plan of the subject fuel rod. The cutting plan was contained in the OSRC meeting notes dated September 17, 1968, along with a sketch showing the A-49 corner rod and a second cutting plan that would require five cuts to produce the three 18-inch segments. The consultants in their report termed this drawing as the “alternate cutting plan.” The inspectors found that the ATI consultants were methodical and sound in their engineering judgement in determining the process the licensee used in the cutting plan of the subject fuel rod.

In the Evaluation Criteria Section of the ATI report, the consultants developed a basis for the assessment of the fuel rod segments that consisted of five criteria: (1) planarity/ perpendicularity of the end surfaces of the individual fuel rod fragments, relative to their axial orientation; (2) appearance of the separated surfaces of the cladding, when viewed normal to the separated surface; (3) flushness of the separated surfaces of the fuel pellets with the separated surfaces of the cladding; (4) appearance of the separated surfaces of the fuel pellets, when viewed normal to the separated surface; and (5) degree of associated intergranular stress corrosion cracking adjacent to the separated surface. The ATI consultants also developed criteria to identify the deference between ends of broken segments produced by cutting, verses ends of broken segments produced by other failure mechanisms, e.g, IGSCC or tearing. The inspectors found that when they repeated the visual assessment of each fuel rod fragment utilizing the five criteria developed by the ATI consultants, the criteria were of sound engineering judgement and provided a useful tool in determinating the end conditions of the subject fragments.

In the Data and Discussion Section of the ATI report, the consultants listed the fuel fragments and findings of their assessment for each fuel rod fragment. The inspectors repeated the visual assessment of each fuel fragment that the ATI consultants performed. These fragments are listed in Table 2 of this report along with the inspectors’ findings.

Prior to their visual assessment of the subject fragments, the inspectors reviewed the licencee's procedure TP 2400-08 "Fuel Fragment Evaluation and Container Loading," dated May 12, 2005. Procedure TP 2400-08 was used by the licensee to evaluate the fuel fragments and to determine their physical characteristics. It also provided instructions for loading fuel fragments into compartmental container trays or unclad fuel fragment container boxes. In TP 2400-08 the licensee characterized the different types of fuel fragments e.g., Type I (304 stainless steel clad), Type II (zircaloy clad), and Type III and Type IV (both are zircaloy clad and are of a larger diameter). According to the procedure, three tests were performed by the licensee on each of the fragments to determine their characteristics. For example, 1.) a go/no-go test was performed to determine if the fragment was of a smaller diameter Type 1 or Type II fuel rod verses the larger diameter Type III and IV fuel rods; 2.) a magnetic test was performed to distinguish the Type I and the other types of fuel rods (a stainless steel clad fuel rod is slightly magnetic whereas the zircaloy clad fuel is non-magnetic); and 3) an ultrasonic examination was performed on the fragments to determined the wall thickness of each fragments to distinguish the different fuel types since there is a difference in thickness for various fuel types. The licensee also measured the does rate of each fragment and the length of the fuel segment. The inspectors determined that the licensee's procedure TP 2400-08 was a sound engineering approach to distinguish the different types of fuel rods.

The licensee recorded and documented its data by video camera and on a fuel fragment evaluation data sheet. The video camera was a Remote Ocean Systems (ROS) CE-X Miniature Environmental Color Zoom Camera Serial Number 1090. The NRC had authorized alternatives to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components* allowing licensees to perform an enhanced VT-1 visual examination with a high resolution camera that can be calibrated to focus on a .001 inch wire in lieu of ASME Code surface nondestructive examinations e.g., dye-penetrans or magnetic particle examination.

The inspectors were able to visually identify the measurement line increments of the ruler used by the licensee to measure the fuel fragments. The inspectors judged the line increments of the ruler to be 1/64 inch or .016 inches wide. The inspectors compared the specifications of the licensee's camera to one that was evaluated in NRC's NUREG/CR-6860, "An Assessment of Visual Testing" and found that the licensees's camera was comparable to one listed in the NUREG. The inspectors were aware that the licensee did not calibrate its camera to focus on a .001 inch wire; however, the inspectors did determine that the licensee's camera imaging did have the capability to distinguish between a mechanical cut and fracture of a fuel fragment by IGSCC or other means.

The inspectors repeated the visual examinations described in the ATI report. Using the ATI consultant's five criteria basis for the assessment of the fuel rod fragments, the inspectors found that all the fragments as shown in Table 2 match the ATI report description. The inspectors also inspected two additional fragments FF-001 and FF-020. Fragment FF-001 was a top end fuel assembly segment with one end that appeared to have been fractured by IGSCC. Fragment FF-020 was identified as a

bottom end fuel assembly fragment with a serial number of PH-5177. Both FF-001 and FF-020 fragments were not considered part of fuel assembly A-49 in the ATI report.

Table 2
Humboldt Bay Power Plant Unit 3 - Fuel Rod Fragments Examined From ATI Report

Fuel Rod Fragment No.	Length (Inches)	Match ATI Report Description	End Fragment?	End Condition of Fragments	Rad Dose on Contact (R/hr)	Rad Dose 6 Inches From Fragment Surface (R/hr)	Remarks
FF009	30.25	Yes	Top End fuel rod fragment	One end is jagged and no sign of cutting	183	15	None
FF013	4	Yes	No	Fractures on both ends of fuel rod fragment	230	9	Partial cut mark on surface of fuel rod fragment and could be considered as part of A-49
FF021	14	Yes	Bottom End of fuel rod fragment	One end split and folded back across fuel rod	198	10	ID Pin Number PH-5155
FF026	11	Yes	Top End of fuel rod fragment	One end is cut	209	7.5	Fuel rod fragment meets 5 point ATI Report Criteria
FF027	6.25	Yes	No	One end of fuel fragment appears cut and the other end is bent	303	15	None
FF028	1	Yes	No	Fractures on both ends of the fuel rod fragment	136	1.5	None
FF029	1	Yes	No	Fractures on both ends of the fuel rod fragment	101	1.3	None
FF030	4.5	Yes	No	Fractures on both ends of the fuel rod fragment	325	7.0	None
FF031	2.75	Yes	No	Fractures on both ends of the fuel rod fragment	216	4.5	None
FF032	4.5	Yes	No	Fractures on both ends of the fuel rod fragment	328	5	None
FF033	3.625	Yes	No	One end appears cut and other end is fractured	275	5	None
FF034	3.25	Yes	No	Fractures on both ends of the fuel rod fragment	271	12	None
FF020	16.5	N/A	Bottom End of fuel rod fragment	Fractured on end of fuel rod fragment	225	12	This fragment was not considered as part of A-49 in the ATI Report. ID as PH 5177
FF001	52	N/A	Top End of fuel rod fragment	Fractured on end of fuel rod fragment	250	116	This fragment was not considered as part of A-49 in the ATI Report.

Fragment FF-021 was a bottom end fragment and had the serial number PH-5155 stamped on it. The ATI consultants considered this fragment as part of the A-49 fuel rod. Neither the licensee nor GE could produce records to confirm whether fuel rod Serial Number PH-5155 was part of fuel assembly A-49. The inspectors determined that for positive identification, the serial number for FF-021 needed to be confirmed. The opposite end of the pin end was spilt and folded back toward the pin end.

The ATI consultants also identified fragments FF-026, and FF-013 as potential portions of A-49. The inspectors found that fragment FF-026 was a top end and the opposite end appeared to have been cut by mechanical means. However, the inspectors did not agree with the ATI consultants that FF-026 may have been part of A-49, without additional examination either by chemical analysis or microscopic examination. However, the inspectors realized that it was not practical to perform these tests due to the high radiation doses that would be encountered. Furthermore, the individual fuel rod manufacturer specifications were not available and without these specifications the results of these tests would not produce meaningful data. The inspectors also found that for fragment FF-013, it was approximately 4 inches long and both ends were fragmented by what appeared to be IGSCC. The inspectors identified an aborted partial mechanical cut on fragment FF-013 as did the ATI consultants. The inspectors determined that fragment FF-013 could be a fragment of A-49. The inspectors' findings regarding all other fuel fragments were similar to the findings of the of the ATI consultants with the exception that the inspectors did not agree that FF-021 was part of A-49 without further testing.

The inspectors also identified that some of the fragments appeared to be bent as if a dynamic load had been placed on the rods. In discussions with the licensee, review of spent fuel pool handling procedures, and observation of the spent fuel pool, the inspectors determined that it was unlikely that dynamic loading caused the bending of the fragments. The inspectors determined that more than likely IGSCC weakened the fuel rod fragments and the weight of the fuel rod itself and the repositioning of the fuel assemblies in the spent fuel pool caused the bending of the fuel rod fragments.

The inspectors evaluated the possibility that the missing pipe container in which the licensee had placed the three A-49 18-inch long fuel segments could have dissolved in the SFP. The container was a carbon or stainless steel 1½ Schedule 40 pipe capped at both ends, with a welded hook on one end of the container. The outside diameter was 1.90 inches and wall thickness 0.145 inches. The licensee believed that the container was shipped with other contaminated waste material or it was on the bottom on the fuel pool in fragments. There had been discussion by the licensee that the pipe container had dissolved in the SFP. The inspectors reviewed SFP water quality data sheets and found that the chemistry of the SFP water was fairly constant and had only experienced a high acid content for a couple of short periods. The inspectors also reviewed the monthly spent fuel pool water quality check procedure and found it an acceptable procedure to insure he SFP water quality. The inspectors determined that if the container had corroded into fragments there should be remnants left in the SFP. The licensee did a search for the pipe container and did not find any remains in the SFP. Therefore, the inspectors determined that the container was not in the SFP and that it more than likely was shipped offsite as contaminated waste.

8.3 Conclusions

The inspectors concluded that the ATI report was based on sound engineering judgment and the ATI consultants were methodical in the process of determining the conditions of the fuel rod fragments. However, the inspectors concluded that without substantial additional test, they could not agree the ATI consultants conclusion that there was reasonable evidence that the 18-inch segments maybe among the fragments found in the SFP.

The inspectors concluded that the cause of the bent fragments was most likely Intergranular Stress Corrosion Cracking (IGSCC), that weakened the fuel rods with the weight of the fuel rod itself causing the bending. In addition, the inspectors concluded that the repositioning of the fuel assemblies in the spent fuel pool also may have contributed to the bending of the fuel rods.

The pipe container for the missing segments was unlikely to have dissolved in the SFP. If the pipe container corroded into fragments there would have been remnants of it in the SFP. The inspectors further concluded that the container was more than likely shipped to a LLRW site as irradiated material.

9. Cause Analysis

9.1 Inspection Scope

The inspectors reviewed licensee reports, records, procedures, and interviewed personnel to determine whether the cause analysis performed was thorough and well documented.

9.2 Observations and Findings

The inspectors reviewed HBPP Procedure Number HBAP C-12 #2, Revision 7, 2/14/05, “Technical Review Group and Nonconformances,” and Application of HBAP C-12 #2 “Cause Analysis Guidelines” to SNM Control and Accountability Issues at HBPP, dated 4/14/05, by Roger Johnson, and interviewed key licensee personnel.

The cause analysis was conducted by Project personnel who were contractors and independent from the organizations responsible for the activities evaluated. The cause analysis utilized a barrier analysis and an simplified event-cause tree analysis. These are two tools often used in root cause analysis. The licensee was not committed and was not required to perform a root-cause analysis. Although the process used by the licensee was not a root-cause analysis, but a less stringent cause analysis, the inspectors concluded that the licensee considered all reasonable causes. No alternative causes were identified by the inspectors.

As previously noted in Section 2.f, although the SNM Control and Accountability Project documentation did not always include the basis for the conclusions, no instances of erroneous or unreasonable conclusions were identified.

The licensee's process identified causes, characterized barriers, and recommended immediate corrective actions (ICA) and corrective actions to prevent recurrence (CAPR). Further, the licensee determined potential causes associated with the loss of control of fuel fragments, the missing fuel rod segments and the missing incore detectors. The causes, barrier analysis and ICA and CAPR are summarized in Section 6 the licensee's Final Report.

Once the licensee recognized that it was likely that SNM was missing, they promptly notified the NRC and initiated a search for the missing SNM and any other SNM fragments. The corrective actions included revising procedures, cataloging and characterization the fuel fragments and SNM waste found to ensure a complete and accurate accounting and tracking of all SNM in PG&E's possession at HBPP, down to the fragment level. The corrective actions also included developing a program to ensure that SNM Custodians are appropriately trained and qualified. The inspectors concluded that the corrective actions taken and proposed by the licensee where through, complete and comprehensive.

The licensee missed several opportunities to correct their MC&A program to address the three missing approximately 18-inch long fuel fragments and other SNM in its possession. Four of the more significant opportunities were:

6. On August 3, 1966, an internal memorandum directed plant staff to keep track of fuel rod pieces and to make entries on the control operator's log regarding fuel rod pieces that were found. The memorandum included the following statement: "In those cases where portions of fuel rods are broken off of the bundle, the inspector should estimate as accurately as possible, the total number of rods (or portions of rods) which are missing. **We are required to account for all of the uranium that we possess**, and so we will have to estimate as accurately as possible the amount of fuel which ends up in the pellet catcher." (Bold font added for emphasis). Although the licensee recognized the need to maintain control of SNM and to account for it accurately, no specific actions to maintain accounting and control appear to have been taken.

7. On October 22, 1974, ANSI Standard N15.8-1974 was approved and on June 1975 this standard was endorsed by NRC Regulatory Guide 5.29. In Section 6.1, "Internal Control," the ANSI Standard described the unit of control as follows: "The basic unit of control for nuclear material shall be the nuclear fuel assembly. Each nuclear fuel assembly shall be identified in the material control records by its serial number and location. **Nuclear material contained in fuel elements, not part of an assembly, shall be separately identified on all material control records**." (Bold font added for emphasis). In this statement, the standard and the endorsing regulatory guidance identified to all licensees the need to account for and control nuclear fuel that had become separated from its assembly, but no action appears to have been taken by the licensee.

8. The licensee's November 14, 2003, response to NRC Bulletin 2003-004, which requested that licensees perform a one-time reporting of SNM quantities of 1 gram or more of contained uranium-235, was based on the September 2003

inventory that did not include the fuel fragments present in the spent fuel pool. Opportunities to acknowledge and include fuel fragments in the SNM reported quantities included a recent discovery of a fuel fragment on November 12, 2003, only days before the licensee submitted their response to NRC Bulletin 2003-004. No action was taken by the licensee to adjust their accounting records to account for the found fragment or other fragments that existed in the spent fuel pool.

9. During the physical inventories performed annually from 1971 through 2003 (except for those years when the pool was covered and the licensee was given an exemption from the requirement to perform inventory), the presence of fuel fragments should have been identified and the SNM inventory records updated to account for them. The licensee missed multiple opportunities to identify that the segments were missing and to account for the rod pieces in the spent fuel pool. Comparison of the book inventory with the results of the physical inventory would have shown that the book inventory was incorrect, but the licensee did not appear to have made this comparison.

The licensee missed all of the opportunities described above and did not initiate a reevaluation of the SNM inventory until January 2004. This reevaluation was undertaken partially in response to concerns expressed by the inspectors about the accuracy of the existing book inventory in light of the six fuel fragments that were found in containers in the SFP during November and December 2003, and uncertainty about the inventory of zirconium clad assemblies from which rods had been removed.

9.3 Conclusions

The cause analysis performed by the licensee followed the applicable procedure and appeared to be through and adequate. Although the process used by the licensee was not a root-cause analysis, but a less stringent cause analysis, the inspectors concluded that the licensee considered all reasonable causes. The identified corrective actions were complete and comprehensive. The inspectors identified several missed opportunities to correct the MC&A program to address the three missing approximately 18-inch long fuel fragments and other SNM in its possession.

10. Health and Safety Consequences

10.1 Inspection Scope

The inspectors reviewed the licensee's evaluation of consequences to public health and safety as well as to the environment due the loss of the 18-inch fuel segments and incore detectors. The inspectors also evaluated the safety analysis performed for the Millstone missing fuel rods for its applicability to the missing SNM from HBPP.

10.2 Observations and Findings

Section 5.2 of the licensee's Final Report titled "Health and Safety," described the evaluation the licensee performed for the potential consequences to the public health

and safety or to the environment due the loss of the 18-inch long fuel segments. Section 3.3.1 of the Final Report addressed potential consequences to the public health and safety or to the environment due to the loss of the incore detectors.

The licensee evaluated three possible locations for the 18-inch long fuel rod segments:

- They were still in the SFP
- They were shipped to NFS for reprocessing, or
- They were shipped to Barnwell or Hanford LLRW sites

The licensee concluded that if the fuel rod segments are in the SFP, they are in a safe location and there is no increased risk to the health and safety of the public, workers, or the environment. If the fuel rod segments were shipped to NFS, the shipping and processing was in accordance with approved methods and there was no increased risk to the health and safety of the public, workers, or the environment.

The licensee also concluded that if the fuel rod segments were shipped to either Barnwell or Hanford, the shipment process did not pose a significantly increased risk to the health and safety of the public, the workers, or the environment. Also the potential burial of the fuel rod segments at either of these LLRW facilities would not increase the risk to the health and safety of the public, site workers, or the environment. Both of the LLRW facilities were designed and licensed to safely dispose of all radionuclides contained in the three fuel rod segments, and all of the radionuclides contained in the three fuel rod segments were already present in the inventories of those facilities at amounts that far exceeded the contents of fuel rod segments. The fuel rod segments would add only a very small amount to the radionuclide inventories at these LLRW disposal facilities.

On April 14, 2004, NRC released the safety analysis reports of the long-term hazard of Millstone Unit 1's missing spent fuel rods potentially disposed of at the Barnwell and Hanford commercial LLRW disposal facilities. These reports noted that the inventory in the Millstone Unit 1's two missing spent fuel rods was a very small fraction of the radionuclide inventories already present at these two LLRW disposal facilities. Millstone's two missing rods contained SNM in a quantity of 132 grams of uranium-235, 27 grams of plutonium, and a total of 518 curies of activity. The HBPP three 18-inch missing rods segments contained SNM in an approximate quantity of 17 grams of Uranium-235, 5 grams of plutonium, and a total of 80 curies of activity. The radionuclide contents of the three 18-inch missing rods segments were only a fraction of the inventory in the Millstone Unit 1's two missing spent fuel rods.

The NRC safety analyses concluded that although the LLRW sites are not licensed for disposal of nuclear fuel, the overall risk due to the potential presence of the Millstone fuel rods at either Barnwell or Hanford, was minimal to both the present workers and future generations of the public. The risks associated with locating and retrieving them would likely result in more actual dose being delivered to the workers than the potential dose future generations could receive if the rods were not retrieved. Based on the extremely low risk that the fuel rods posed, if they were at Barnwell or Hanford, retrieval of the rods would not be justified by arguments concerning public health and safety.

Considering that the radionuclide inventory for the HBPP missing fuel segments was a fraction of the inventory of Millstone's two missing spent fuel rods, the inspectors concluded that if 18-inch fuel rod segments were at either site, the risk is minimal to both the present workers and future generations of the public. Additional efforts to locate and retrieve the missing 18-inch fuel rod segments would not be warranted. The overall risk from 18-inch fuel rods segments, if present, would be minimal to the health and safety of the public, workers, or the environment.

Since the SNM inventory from the missing incore detectors was considerably less than the 18-inch fuel rod segments (estimated at 0.035 grams of uranium-235), it is evident that the overall risk from the missing incore detectors, if presence at either Barnwell or Hanford, would also be minimal to the health and safety of the public, workers, or the environment.

10.3 Conclusions

The inspectors concluded that regardless of whether the missing fuel segments were located in the SFP, had been shipped to NFS for reprocessing, or had been transferred to a LLRW disposal facility, the overall risk from the 18-inch fuel rods segments was minimal to the health and safety of the public, workers, or the environment. Based on the extremely low risk that the 18-inch fuel rods segments posed, if they were at Barnwell or Hanford, attempts to locate and retrieve the 18-inch fuel rods segments would not be justified by arguments concerning public health and safety. The overall risk from the missing incore detectors, if present at either Barnwell or Hanford, would also be minimal.

11. Discussion of Apparent Violations and Previously Identified Unresolved Items

11.1 Apparent Violations

In NRC Interim Inspection Report 05000133/2005001, the inspectors identified and documented four apparent violations and three unresolved items. As noted in the report, the licensee identified the missing 18-inch irradiated fuel segments and the missing one complete and three partial incore detectors; promptly notified the NRC when it determined that the material was missing and promptly initiated a search, evaluation of the problems and corrective actions. As a result of the Special Inspection chartered to review all information related to the missing SNM, the inspectors identified the following apparent violations:

A. 10 CFR 74.19(a)(1), formerly 10 CFR 70.51(a)(1), requires, in part, that the licensee shall keep records showing the receipt, inventory (including location and unique identity), acquisition, transfer, and disposal of all SNM in its possession regardless of its origin or method of acquisition.

   1. Contrary to the above from August 6, 1969 (date when assembly A-49 was shipped off site) to July 16, 2004 (date when PG&E determined that the segments were missing), PG&E, failed to keep records showing the

inventory, transfer or disposal of three approximately 18-inch segments of irradiated fuel containing approximately 22.5 grams of SNM.

2. Contrary to the above from June 25, 1973 to February 4, 2005, the licensee failed to keep records including location and unique identity showing the inventory, transfer or disposal of one complete and three partial incore detectors containing a total of approximately 0.035 grams of SNM.

These failures are an apparent violation of 10 CFR 74.19(a)(1) (APV 50-133/0501-03).

B. 10 CFR 74.19(b), formerly 10 CFR 70.51(b), requires that each licensee that is authorized to possess SNM in a quantity exceeding one effective kilogram at any one time shall establish, maintain, and follow written material control and accounting procedures that are sufficient to enable the licensee to account for the SNM in its possession under license. The licensee shall retain these procedures until the Commission terminates the license that authorizes possession of the material and retain any superceded portion of the procedures for 3 years after the portion is superceded.

Contrary to the above, from June 4, 1971 (date when last Type 1 fuel assembly was shipped off site) to July 16, 2004 (date when PG&E determined that the segments were missing), PG&E, a licensee authorized by NRC License DPR-7 to possess SNM in a quantity exceeding one effective kilogram, failed to establish, maintain, and follow written material control and accounting procedures sufficient to enable PG&E to account for the SNM in its possession under license DPR-7. Specifically, PG&E failed to account for SNM located in the HBPP SFP consisting of a quantity of 111 grams of uranium-235, 27 grams of plutonium contained in the remnants from Type 1 damaged fuel assemblies (fuel fragments and SNM waste), and incore detectors.

This failure is an apparent violation of 10 CFR 74.19(b) (APV 50-133/0501-04).

C. 10 CFR 74.19(c), formerly 10 CFR 70.51(c), requires each licensee who is authorized to possess SNM, at any one time and site location, in a quantity greater than 350 grams of contained uranium-235, uranium-233, or plutonium, or any combination thereof, shall conduct a physical inventory of all SNM in its possession under license at intervals not to exceed 12 months.

Contrary to the above, PG&E, a licensee authorized to possess SNM at the HBPP in quantities greater than 350 grams of contained uranium-235, uranium-233, or plutonium failed to conduct a physical inventory of all SNM in its possession at intervals not to exceed 12 months. Specifically, inventories performed by PG&E from June 4, 1971 (date when last Type 1 fuel assembly

was shipped off site), to February 4, 2005, with the exception of periods when the sealed SFP cover was in place, did not include fuel fragments and other SNM remnants from Type 1 damaged fuel assemblies and all incore detectors.

This failure is an apparent violation of 10 CFR 74.19(c) (APV 50-133/0501-05).

Based on information provided by the licensee and upon further evaluation, the inspectors concluded that the previously identified apparent violation related to the form that the licensee was authorized to possess SNM is controlled by the conditions of the license and not technical specification 4.2. License Condition B.2(d) states that the licensee is authorized to possessed 1000 kilograms of contained uranium-235 at any one time. This condition does not specify the form of the uranium, therefore this matter is no longer considered an apparent violation.

11.2 Unresolved Items

(Closed) URI 50-133/0501-01. As of January 31, 2005, the current location and reportability of an unspecified number of fuel pellets last accounted for on June 7, 1976, as stored in a vacuum bag hung from the side of SFP had not been determined.

The licensee determined based on interviews and other records reviewed that the June 1976 records of an unspecified number of fuel pellets that had been collected and stored in a vacuum cleaner bag in the SFP was incorrect and that fuel pellets were not stored in vacuum bags. After review of the licensee's evaluation and as a result of an independent interview conducted by the inspectors with the individual that lead the clean up campaign in 1976, the inspectors agree with the licensee's conclusion.

(Closed) URI 50-133/0501-02. As of January 31, 2005, the current location of the three 18-inch segments from irradiated fuel Assembly A-49, that was first reported missing by Pacific Gas & Electric on July 16, 2004, had not been determined.

The licensee has completed their investigation and concluded that the location of the missing 18-inch fuel segments can not be conclusively be determined. The licensee believes that the most likely possibilities is that the fuel segments remain in the SFP but in broken fragments or they were shipped to a low level waste site or NFS. The inspectors concluded that the most likely location is at a low level waste site, but since the actual location cannot be determined this matter is consider closed.

(Closed) URI 50-133/0501-06. The conditions that resulted in the loss of one complete incore detector and parts of three others, their fate, and the consequences associated with their loss has not been reviewed by the NRC.

The inspectors have concluded that the lost of the incore detectors constitute another example of the three apparent violations identified above and would be so noted, therefore this item is considered closed.

12. Licensee Briefings and Exit Interview

The inspectors conducted briefings of preliminary inspection findings with licensee senior plant managers at the conclusion of each site visit. On August 16, 2005, a telephonic exit interview was conducted with senior licensee managers at the conclusion of the NRC Special Inspection.

ATTACHMENT

SUPPLEMENTAL INSPECTION INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

J. Albers, Radiation Protection Manager
M. Anthony, Decontamination Specialist
W. Barkhuff, Metallurgist Diablo Canyon
G. Bierbaum, Engineer
J. Brimble, Supervisor of Maintenance
T. Carraher, Data Logger
J. Galle, Sr. Design Engineer Manager
S. Gardner, Former Supervisor, Chem Nuclear
J. Hill, Inservice Inspectors Diablo Canyon
R. Johnson,
V. Jensen, Nuclear Quality Services Supervisor
P. Kapus, Document Reader
C. Kudla, SNM Control and Accountability Project
G. McKinnon, Control Operator
P. Narbut, Nuclear Quality Services Inspectors
B. Norton, Project Manager SNM Control and Accountability Project
R. Parker, Senior Radiation Protection Engineer
J. Rasmussen, Senior Control Operator
D. Swanson, Shift Foreman
M. Smith, Engineering Manager
D. Sokolsky, Supervisor of Licensing
S. Stevens, Document Reader
I. Tsosie, Radiation Protection Dosimetry Analyst
R. Willis, Plant Manager

INSPECTION PROCEDURES USED

IP 93812	Special Inspection
TI 2515/154	Spent Fuel Material Control and Accounting at Nuclear Power Plants

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

None

Discussed

50-133/0501-03	APV	Contrary to the requirements of 10 CFR 74.19(a)(1), formerly 10 CFR 70.51(a)(1), from August 6, 1969 (date when assembly A-49 was shipped off site) to July 16, 2004 (date when PG&E determined that the segments were missing), PG&E, failed to keep records showing the inventory, transfer or disposal of three approximately 18-inch segments of irradiated fuel containing

		approximately 22.5 grams of SNM. Also from June 25, 1973 to February 4, 2005, the licensee failed to keep records including location and unique identity showing the inventory, transfer or disposal of one complete and three partial incore detectors containing a total of approximately 0.035 grams of SNM.
50-133/0501-04	APV	Contrary to the requirements of 10 CFR 74.19(b), formerly 10 CFR 70.51(b), from June 4, 1971 (date when last Type 1 fuel assembly was shipped off site) to July 16, 2004 (date when PG&E determined that the segments were missing), PG&E, a licensee authorized by NRC License DPR-7 to possess SNM in a quantity exceeding one effective kilogram, failed to establish, maintain, and follow written material control and accounting procedures sufficient to enable PG&E to account for the SNM in its possession under license DPR-7. Specifically, PG&E failed to account for SNM in a quantity of 111 grams of uranium-235, 27 grams of plutonium contained in remnants from Type 1 damaged fuel assemblies (fuel fragments and SNM waste), and incore detectors.
50-133/0501-05	APV	Contrary to the requirements of 10 CFR 74.19(c), formerly 10 CFR 70.51(c), Pacific Gas and Electric Company, failed to conduct a physical inventory of all SNM in its possession at intervals not to exceed 12 months. Specifically, inventories performed by PG&E from June 4, 1971 (date when last Type 1 fuel assembly was shipped off site), to February 4, 2005, with the exception of periods when the sealed SFP cover was in place, did not include fuel fragments and other SNM remnants from Type 1 damaged fuel assemblies and all incore detectors.

Closed

50-133/0501-01	URI	As of January 31, 2005, the current location and reportability of an unspecified number of fuel pellets last accounted for on June 7, 1976, as stored in a vacuum bag hung from the side of SFP had not been determined.
50-133/0501-02	URI	As of January 31, 2005, the current location of the three 18-inch segments from irradiated fuel Assembly A-49, that was first reported missing by Pacific Gas & Electric on July 16, 2004, had not been determined.
50-133/0501-06	URI	The conditions that resulted in the loss of one complete incore detector and parts of three others, their fate, and the consequences associated with their loss has not been reviewed by the NRC.

50-133/0501-07	APV	From November 18, 2002, through September 10, 2004, the licensee possessed SNM in the form of fuel fragments and was not authorized by the technical specifications in effect at that time to possess SNM in this form.

LIST OF ACRONYMS

BMI	Battelle Memorial Institute
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
GE	General Electric Company
HBPP	Humboldt Bay Power Plant
IFI	Inspection Followup Item
IP	Inspection Procedure
IGSCC	Intergranular Stress Corrosion Cracking
LER	Licensee Event Report
LLRW	Low Level Radioactive Waste
LSA	Low Specific Activity
MC&A	Material Control and Accounting
NRC	Nuclear Regulatory Commission
NFS	Nuclear Fuel Services
PG&E	Pacific Gas and Electric Company
ODS	Other Direct Shipment
R	Roentgen
SFP	Spent Fuel Pool
SNM	Special Nuclear Material
TI	Temporary Instruction
TID	Tamper Indicating Device
URI	Unresolved Item
APV	Apparent Violation

LIST OF SIGNIFICANT DOCUMENTS REVIEWED	
Document Title	Document Date
PG&E HBPP Visual Inspection Record of Type I (304 Stainless Clad) Nuclear Fuel	September 7, 1966
Minutes of HBPP On-Site Review Committee of Special Meeting of September 17, 1968. (PG&E Record Locator No. 0210-4610)	September 17, 1968
PG&E General Computation Sheet Subject: Inner Can for fuel shipping Cask Sample to Battelle Columbus (Undated)(PG&E Record Locator No. 3601-2912)	(Undated) Circa September 17, 1968
Minutes of HBPP On-Site Review Committee of Special Meeting of October 2, 1968. (PG&E Record Locator No. 0210-4607)	October 2, 1968
PG&E General Computation Sheet Subject: NFS Shipping Cask (PG&E Record Locator No. 3612-2856)	August 5, 1969
HBPP Calculation NX-265, Evaluate Fuel Criticality with Assemblies Removed from Boral Cans, Revision 1	July 1, 2004
Event Notification No. 40877, Report of Missing Special Nuclear Material (Three Missing Fuel Rod Segments)	July 16, 2004
Event Notification No. 40961, Report of Missing Special Nuclear Material (Three Missing Fuel Rod Segments)	August 16, 2004
PG&E Letter HBL-04-020, Licensee Event Report (LER) 2004-001-00, Three Missing Fuel Rod Segments	August 16, 2004
PG&E Letter HBL-04-026, LER 2004-001-01, Three Missing Fuel Rod Segments, Rev. 1	November 19, 2004
PG&E Letter HBL-05-001, Special Nuclear Material Control and Accountability Project Interim Reports	February 22, 2005
PG&E Letter HBL-05-002, LER 2005-001-01, Missing Incore Detectors	February 22, 2005
Event Notification No. 41430, Report of Missing Special Nuclear Material (Missing Incore Detectors)	February 22, 2005
HBPP Calculation NX-291, Estimation of SNM waste at HBPP, Revision 2	March 14, 2005
HBPP Calculation NX-287, SNM Re-verification, Revision 2	March 29, 2005
ATI Report “Evaluation of Nuclear Fuel Rod Fragments and Inference to Fuel Rod A-49 at Humboldt Bay Power Plant”	March 31, 2005
HBPP Calculation NX-288, Documentation of Spent Fuel Fragments and Debris, Rev. 6	April 21, 2005
HBPP Calculation NX-292, Develop Radioactive Waste Shipping Package Screening Tool for Possible Identification of Location of 18" Fuel Rod Segments from Fuel Assembly A-49, Revision 1	April 29, 2005
HBPP Calculation NX-293, Evaluation of Underwater Dose Rates Associated with A-49	April 30, 2005
HBPP Calculation NX-290, To calculate and record the SNM Inventory, Revision 3	May 3, 2005
HBPP Calculation NX-289, Evaluate 18" Fuel Rod Segments from Fuel Assembly A-49, Revision 4	May 11, 2005

LIST OF SIGNIFICANT DOCUMENTS REVIEWED	
PG&E Letter HBL-05-017, Special Nuclear Material Control and Accountability Project Final Report	May 27, 2005
PG&E Letter HBL-05-019, LER 2005-001-01, Missing Incore Detectors, Revision 1	June 10, 2005
PG&E Letter HBL-05-020, LER 2004-001-02, Three Missing Fuel Rod Segments, Rev. 2	June 10, 2005

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

October 25, 2004 Enclosure 2 (ML042990566)

MEMORANDUM TO: D. Blair Spitzberg, Ph.D., Chief
Fuel Cycle Decommissioning Branch

Emilio M. Garcia, Health Physicist
Fuel Cycle Decommissioning Branch

FROM: Mark A. Satorius, Director */RA/*
Division of Nuclear Materials Safety

SUBJECT: SPECIAL INSPECTION CHARTER - THREE SPENT FUEL ROD SEGMENTS MISSING IN THE HUMBOLDT BAY SPENT FUEL POOL

A NRC special inspection has been established in response to information received from PG&E that three spent fuel rod segments are missing in the Humboldt Bay spent fuel pool. On August 17, 2004, PG&E Humboldt Bay Power Plant informed the NRC Operations Center that three spent fuel rod segments (approximately 18 inches in length) could not be located within Humboldt Bay's spent fuel pool in accordance with 10 CFR 74.11. PG&E also issued a press release of the event on the same date. Personnel at Humboldt Bay Power Plant continue to search the spent fuel pool for the missing segments and the licensee has begun an investigation to determine what happened to them.

The NRC decided, based on a number of factors, that it is appropriate to charter a special inspection to assess the key elements of PG&E's investigation effort. Key factors in this NRC decision included the large scope and complexity of the licensee's investigation, the need for focused specialist oversight by NRC, and the need to evaluate potential generic implications. The NRC decision recognizes that it is highly unlikely that the material is in the public domain. The inspection will review the results of PG&E's investigation, assess PG&E's determination of the root cause, determine whether PG&E was in compliance with applicable regulations, complete Phase III of TI 2515/154, "Spent Fuel Material Control and Accounting at Nuclear Power Plants," and identify which findings or observations may have generic implications.

Focused oversight of the licensee's investigation and search efforts for the missing fuel fragments began on July 12, 2004. Additional inspector site visits occurred during the weeks of August 9 and September 13, 2004. Results of these focused inspection visits will be issued as a separate inspection report no later than early November 2004.

The special inspection is expected to be conducted during several weeks of onsite inspection to review focused areas within the overall scope of the inspection and to continue to observe licensee search activities. The special inspection will primarily consist of onsite activities but may include some in-office activities. Each week of onsite inspection should utilize only the inspector resources assigned to the areas to be reviewed during that week's inspection. The

overall duration of the inspection will depend on PG&E's schedule for completion of its investigation but it is currently anticipated that it could extend into 2005. For planning purposes, it is expected that the onsite portion of the special inspection will be completed 30 days after the issuance of PG&E's report documenting its investigation.

A draft of the inspection plan should be available for approval prior to the first onsite inspection activity. Major revisions of the inspection plan should be discussed with me prior to implementing the changes. An exit meeting, that is open for public observation, will be held after the onsite and in-office inspection activities are completed. An inspection report will be issued within 45 days following the exit meeting for the inspection.

The members of the special inspection team are:

Manager:	Blair Spitzberg, Chief, FCDB
Leader:	Emilio Garcia, Region IV
Members:	Ray Kellar, Region IV
	Martha Williams, NSIR
	Glenn Tuttle, NSIR
	Other members will be assigned as needed.

The charter for the special inspection and details of the inspection scope are attached. The special inspection shall be conducted in accordance with the applicable sections of Inspection Procedure 93812, "Special Inspection," and this memorandum.

Attachment: Special Inspection Charter

ATTACHMENT

CHARTER FOR HUMBOLDT BAY SPECIAL INSPECTION

BACKGROUND:

Humboldt Bay Power Plant Unit 3 is a shutdown 200-megawatt (thermal) (65-megawatt electric) General Electric designed boiling water commercial nuclear power reactor. This reactor is owned and was previously operated by Pacific Gas and Electric Company.

During the fall of 2003, Pacific Gas and Electric Company (PG&E) personnel at the Humboldt Bay Power Plant Unit 3, were conducting an examination of the contents of the spent fuel pool in preparation for dry storage operations. On November 12, 2003, Humboldt Bay personnel discovered a fragment of a spent fuel pin approximately 4 inches long. Subsequent detailed investigations identified additional fuel pin fragments in various spent fuel pool locations. Humboldt Bay personnel informed the NRC via telephone of the discovery of the fuel fragments.

In early December 2003, Humboldt Bay halted additional work in the spent fuel pool until a criticality evaluation could be completed. Based on an NRC inspection performed during January 2004, the Humboldt Bay Plant Manager initiated an evaluation of the amount of special nuclear material present in each assembly and in the spent fuel pool.

On June 29, 2004, the licensee informed NRC staff that it had recently found documentation indicating that in 1968, a fuel pin was segmented into three 18-inch sections intended to be sent offsite for an experiment. Documentation also indicated that the three segments had been placed into a 1.5-inch diameter pipe and subsequently returned to the spent fuel pool after the intended experiment had been canceled. Humboldt Bay personnel started a search of the spent fuel pool for the three fuel rod segments on July 9, 2004.

On July 16, 2004, PG&E notified the NRC of a discrepancy between inventory records and the location of the three missing spent fuel rod segments (Event Notification #40877). The licensee continued to perform a search for the fuel pin segments in the most likely and accessible locations in the spent fuel pool and perform a search of documents that could provide information as to the whereabouts of the fuel segments. Interviews were conducted with personnel that worked at the plant during the time frame when the fuel pin was segmented.

On August 16, 2004, PG&E issued a 30-day written followup report to the initial July 16, 2004, notification. This report was made pursuant to 10 CFR 20.2201(b)(2)(ii).

On August 17, 2004, the licensee Plant Staff Review Committee determined that the fuel segments were not in the most likely and accessible locations within the spent fuel pool. Consequently, PG&E made a 1-hour notification to the NRC pursuant to 10 CFR 74.11(a) that the missing fuel rod segments were considered lost.

PG&E personnel have entered into Phase II of the search for the missing fuel rod segments. The Phase II search includes additional searches of the spent fuel pool in less accessible locations, additional document searches and personnel interviews. NRC inspectors continue to provide periodic oversight of the investigation process. The licensee still believes that the most likely location of the missing fuel rod segments is in the spent fuel pool. The licensee's

investigation team will evaluate the potential for offsite disposal of the fuel segments and complete a root cause analysis including documentation of the team findings in a final report. PG&E expects to complete the search for the missing fuel rod segments and root cause investigation during the first quarter of 2005.

On September 29, 2004, a Category 1 Public Meeting was held with Pacific Gas and Electric Company. The purpose of this meeting was to discuss licensed radioactive material control and accountability at Humboldt Bay Power Plant.

SPECIAL INSPECTION CHARTER

A special inspection will evaluate PG&E's investigation and conclusions regarding the potential location of the missing fuel rod segments. The special inspection may consist of several inspections that occur during the course of PG&E's investigation. The special inspection should:

13. Conduct a thorough and systematic review of PG&E's investigation into the circumstances that led to the loss of accountability of the three missing fuel rod segments and other special nuclear material (SNM). Determine the adequacy of PG&E's investigation and conclusions regarding the location of the three missing fuel rod segments, based upon its completeness and thoroughness of fuel pool inspections, records reviews, and interviews.

14. Assess the adequacy of PG&E's control of SNM and non-SNM radiological materials.

15. Assess the determination of root cause performed by PG&E. Identify alternative causes if appropriate. Develop independent conclusions regarding the causes(s) of the loss of accountability of the special nuclear material.

16. Assess the adequacy of PG&E's investigation regarding its conclusion on the accuracy of the accountability for the remainder of the special nuclear material in the spent fuel pool.

17. Independently verify selected sets of records and interviews.

18. Determine whether PG&E was in compliance with applicable regulations.

19. Assess the adequacy of PG&E's radiological characterization of each missing fuel rod segment.

20. Complete Phase III of TI2515/154, "Spent Fuel Material Control and Accounting at Nuclear Power Plants."

21. Conduct regular briefings for NRC internal stakeholders to allow the appropriate NRC internal stakeholders to brief external stakeholders.

22. Identify those findings or observations that may have generic implications.

23. Document the inspection findings, observations and conclusions in a special inspection report in accordance with the applicable sections of IP 93812 within 45 days of the exit meeting.

24. Conduct an inspection exit that is open for public observations.