NRC FAILURE TO ADEQUATELY REGULATE - MILLSTONE UNIT 1

CASE NO.95-77I 12/21/95

OFFICE OF THE INSPECTOR GENERAL
EVENT INQUIRY

NRC FAILURE TO ADEQUATELY REGULATE -

MILLSTONE UNIT 1

CASE NO. 95-77I

Rossana Raspa,
Special Agent

George A. Mulley, Team Leader

Robert A. Watkins
Acting Assistant Inspector
General for Investigations

Table of Contents

CHRONOLOGY OF SIGNIFICANT EVENTS

Date	Event
1966	Millstone Unit 1 Construction Permit issued by NRC
1968	Millstone Unit 1 Final Safety Analysis Report (FSAR) submitted to NRC. Spent fuel pool storage capacity is 870 fuel assemblies; normal refueling is 25 percent of core; identifies 25 percent core discharge and emergency full core discharge.
10/07/70	Millstone Unit 1 provisional operating license approved by NRC.
09/01/72- 03/04/73	Refueling Outage #1 (100 percent offload)
08/30/74- 11/04/74	Refueling Outage #2 (100 percent offload) 65 hrs - 192 hrs
09/12/75- 10/20/75	Refueling Outage #3 (100 percent offload) 130 hrs - 284 hrs
07/15/76	NU proposes License Amendment No. 39 to modify spent fuel pool to increase storage capacity to 2184 assemblies.
10/01/76- 12/01/76	Refueling Outage #4 (100 percent offload) 117 hrs - 213 hrs
06/30/77	License Amendment No. 39 is approved by NRC to increase spent fuel pool to 2184 assemblies.
03/10/78- 04/15/78	Refueling Outage #5 (25 percent offload) 116 hrs
04/28/79- 06/27/79	Refueling Outage #6 (25 percent offload) 164 hrs
10/04/80- 04/19/81	Refueling Outage #7 (100 percent offload) 136 hrs - 256 hrs
08/31/81	NU's Safety Assessment Report Re: Systematic Evaluation Program Topic IX-1, Fuel Storage for Millstone Unit 1 reflecting that the maximum heat loads of spent fuel pool were recalculated; revised heat loads are reported to be within design conditions.
03/09/82	NRC final evaluation of SEP Topic IX-1 stating spent fuel storage system is

acceptable with Standard Review Plan requirements.

09/11/82- 11/17/82	Refueling Outage #8 (100 percent offload) 110 hrs - 282 hrs
04/14/84- 06/28/84	Refueling Outage #9 (100 percent offload) 67 hrs - 179 hrs
10/01/85	NRC Safety Evaluation Report Related to Millstone Unit 1 Full-Term Operating License. NRC staff concludes spent fuel pool is acceptable with Standard Review Plan requirements.
10/26/85- 12/23/85	Refueling Outage #10 (100 percent offload) 109 hrs - 243 hrs
10/31/86	Millstone Unit 1 Full-term operating license approved by NRC
03/27/87	NU revision to FSAR stating maximum normal heat load is 25 percent core load decayed 150 hrs; emergency heat load is 100 percent core load decayed 250 hrs.
06/05/87- 08/18/87	Refueling Outage #11 (100 percent offload) 87 hrs - 193 hrs
05/05/88	NU provides NRC initial information on proposal to increase spent fuel pool to 3229 assemblies.
06/24/88	NU proposes License Amendment No. 40 to modify spent fuel pool storage capacity to 3229 assemblies. Normal refueling involves replacement of 33 percent of fuel assemblies. Normal discharge is 33 percent of core; abnormal discharge is 100 percent of core.
04/07/89- 05/26/89	Refueling Outage #12 (100 percent offload) 188 hrs - 314 hrs
11/27/89	License Amendment No. 40 is approved by NRC to increase spent fuel pool to 3229 assemblies.
04/09/91- 08/15/91	Refueling Outage #13 (100 percent offload) 146 hrs - 228 hrs
9/17/93	NU reported License Event Report 93-11 re: Millstone Unit 1 may have operated outside the plant's design basis.
06/30/93	NU revision to FSAR to reflect License Amendment No. 40. Normal discharge is 33 percent of core; abnormal discharge is 100 percent of

core.

01/24/94- 05/21/94	Refueling Outage #14 initial 1/3 core offload, followed by 2/3 core offload.
06/30/94	NU revision to FSAR discussing full core offload used in refueling outage #14.
06/30/95	NU revision to stating normal refueling involves full core offload.
07/28 95	NU proposes License Amendment No. 89 to allow full core offload as a normal end-of-cycle event.
11/09/95	License Amendment No. 89 is approved by NRC to allow full core offload as a normal end-of-cycle event during refueling operations.

EXECUTIVE SUMMARY

The Office of Inspector General (OIG), U.S. Nuclear Regulatory Commission (NRC), initiated this investigation based on information submitted to the NRC pursuant to a 10 Code of Federal Regulations (CFR) 2.206 petition filed on August 21, 1995, on behalf of George Galatis, a senior engineer with Northeast Utilities Services Company (NU), and We the People, Inc. The petition alleged that the NRC knowingly allowed NU to operate the Millstone Unit 1 Nuclear Power Station for 20 years in violation of its operating license and beyond its design basis. The petitioners maintained that during normal refueling outages at Millstone Unit 1, NU offloaded the entire fuel core. However, in the Final Safety Analysis Report and other documents submitted to the NRC in support of license amendments, NU described a normal discharge initially as a quarter then as a third of the core. The petitioners contended that the NU practice of offloading the full core during normal refueling outages resulted in Millstone Unit 1 operating beyond its design basis, with the result that NU violated its operating license. The petitioners asserted that NRC personnel were, or should have been, aware that the licensee's practice of offloading the full core during normal refueling outages violated the Millstone Unit 1 operating license.

The OIG investigation addressed the principal allegation of whether the NRC staff allowed NU to offload the entire core knowing that this practice was outside of Millstone Unit 1's design basis and in violation of its operating license. In addressing this issue, we developed and considered evidence relevant to whether NU had violated the Unit 1 license or operated outside the plant's design basis. However, OIG did not specifically investigate licensee wrongdoing matters.

The OIG investigation determined that generally the NRC Region I resident inspectors were aware of NU's practice of offloading the entire core at Millstone Unit 1 during refueling outages; however, resident inspectors did not realize that this practice was inconsistent with the normal discharge scenario outlined in the Final Safety Analysis Report.

The investigation determined that the NRC headquarter's staff had several opportunities to review the Millstone Unit 1 refueling practices and the heat removal capability of the spent fuel pool cooling system; however, the staff did not conduct an adequate evaluation related to the capabilities of the spent fuel pool cooling system.

The OIG investigation developed evidence that NU operated Millstone Unit 1 outside of its design basis. OIG found that the NU practice of offloading the entire core at 150 hours or less during normal refueling outages and their ability to meet the NRC single failure criteria under these conditions had not been analyzed.

The OIG investigation also determined that the licensee may have violated the operating license for Millstone Unit 1 because of a failure to operate in accordance with its technical specification. One procedure required by the technical specifications is for the operation of the spent fuel cooling system. OIG uncovered information which indicates that for approximately 10 years, in order to handle the heat load from a full core offload, reactor operators at Millstone Unit 1 operated the spent fuel pool cooling system in a configuration that was not covered by a plant

operating procedure.

BASIS

The Office of the Inspector General (OIG) initiated this investigation based on information submitted to the NRC pursuant to a 10 Code of Federal Regulations (CFR) 2.206 petition filed on August 21, 1995, on behalf of George Galatis, a senior engineer at Northeast Utilities Services Company (NU), and We the People, Inc., a public interest group. The petition alleged that the U.S. Nuclear Regulatory Commission (NRC) knowingly allowed NU to operate the Millstone Unit 1 Nuclear Power Station for 20 years in violation of its operating license and beyond its design basis.

In the 10 CFR 2.206 petition, Galatis and We the People related that during normal refueling outages at Millstone Unit 1, NU offloaded the full core. However, in Safety Assessment Reports submitted to the NRC for review and acceptance, NU described a normal discharge initially as a quarter, then as a third of the core. The petitioners contended that the NU practice of offloading the full core during normal refueling outages resulted in Millstone Unit 1 operating beyond its design basis, with the result that NU violated its operating license. Among other contentions, the petitioners asserted that the NRC, specifically the NRC resident inspectors, were, or should have been, aware that the NU practice of offloading the full core during normal refueling outages violated the Millstone Unit 1 operating license.

In support of their assertion that NU had violated its operating license for Millstone Unit 1, the petitioners stated that in the Final Safety Analysis Report (FSAR) submitted by NU with the application for an NRC Operating License and in subsequent Safety Assessment Reports submitted in conjunction with the NRC Systematic Evaluation Program (SEP) and License Amendment No. 39 (1977) and License Amendment No. 40 (1989), NU told the NRC that its normal reactor core offload was a quarter of the core (prior to 1989), then a third of the core. The Safety Assessment Reports were incorporated into the Millstone Unit 1 FSAR. The petitioners contended that the FSAR was part of the NU operating license, and, by its review and acceptance of the FSAR, the NRC gave NU permission to offload a quarter core then a third core. Consequently, NU violated its license by offloading the entire core during most refueling outages.

With respect to the allegation that NU operated Millstone Unit 1 beyond its design basis during normal refueling outages, the petitioners explained that the spent fuel pool heat load that had been reviewed and approved by the NRC for a third core offload was about 8 million BTU/hour. At this heat load, Millstone Unit 1 could sustain a single failure of equipment important to safety and still meet the NRC criteria for the maximum temperature of the spent fuel pool. This ability is required by the NRC Standard Review Plan (SRP) for normal fuel core offload scenario. However, the petitioners contended that the heat load generated by offloading the entire core as a normal refueling practice was about 23 million BTU/hour. The Millstone Unit 1 spent fuel pool had never been analyzed or approved for such a heat load. Consequently, the petitioners argued, Millstone Unit 1 operated outside its design basis when it conducted a full core offload during normal refueling outages.

On October 11 and 12, 1995, OIG interviewed George Galatis, in the presence of his attorney,

Ernest Hadley. During the interview, Galatis essentially recounted the information contained in the 10 CFR 2.206 petition and the basis for his contention that NU had violated its operating license. Specifically, Galatis maintained that NU had offloaded the full core as a routine refueling operation even though the FSAR and Safety Assessment Reports submitted by NU in connection with License Amendments No. 39 and No. 40 described a normal offload as only a quarter of the core and then one third of the core. According to Galatis, NU's practice had exposed the public to unnecessary risk since the spent fuel pool was never designed to handle the heat load generated from a full core offload during a normal refueling outage. Also, NU could not meet the single failure criteria for a full core offload.

Galatis also maintained that because 10 CFR 50.34 required that applications for an NRC operating license include an FSAR, then the FSAR became part of the operating license. Additionally, paragraph 1.c. of the Millstone facility operating license, dated October 31, 1986, required that the facility operate in conformity with its application. Therefore, Galatis maintained that the practice of offloading the entire core during normal refueling violated its operating license.

During the interview, Galatis raised other issues reg arding the NRC staff's handling of the spent fuel pooling cooling system allegations that he had reported to the NRC Region 1 staff in April 1994. The OIG has initiated a separate investigation of potential staff wrongdoing regarding the staff's review of allegations reported by Galatis.

SCOPE

The OIG investigation reviewed allegations regarding whether the NRC staff allowed Northeast Utilities Service Company (NU) to offload the entire fuel core at Millstone Unit 1 during refueling outages knowing that NU's practice was outside of the design basis and in violation of its operating license. To address this issue, OIG considered evidence relevant to whether the NU practice of conducting a full core offload may have violated the Millstone Unit 1 operating license and may have been outside the Millstone Unit 1 design basis. However, OIG did not specifically investigate allegations of licensee misconduct. The OIG coordinated its investigation with the NRC Office of Nuclear Reactor Regulation (NRR) and the NRC Office of Investigations (OI) which is investigating allegations of licensee misconduct. OIG has provided information to the NRC staff bearing on possible licensee violations.

The OIG reviewed the following Millstone Unit 1 documents:

-- The provisional operating license and full term operating license;

-- Relevant technical specifications regarding the spent fuel pool;

-- The Final Safety Analysis Report (FSAR) and revisions to the FSAR;

-- License Amendment No. 39 and License Amendment No. 40 and supporting documents for each amendment;

-- Over 250 NRC Inspection Reports covering the period of 1972 to 1995;

-- The NRC Region I Allegation File regarding allegations made by George Galatis, a senior engineer at NU in April 1994;

-- Documents provided by NU;

-- The file for Millstone Unit 1 License Amendment No. 40 maintained by the NRC Program Manager.

The OIG interviewed the alleger, as well as past and present NRC Resident Inspectors; Region I managers and the Regional Administrator; former NRR Project Managers; and the NRR Director and managers. OIG also interviewed the NU Vice President of Engineering, and the NU Director of Nuclear Planning, Licensing & Budgeting.

HISTORY

The Millstone Nuclear Generating Station, Unit 1, located in New London County, Connecticut, is a boiling-water reactor (BWR) designed by General Electric. The licensee is Northeast Nuclear Energy Company. The application for a construction permit was filed in November 1965. The construction permit was issued by the NRC in May 1966.

The initial submittal of the Millstone Unit 1, Final Safety Analysis Report (FSAR) was in 1968, and the provisional operating license was issued by the NRC on October 7, 1970. In the FSAR that supported the provisional operating license, NU described the Millstone Unit 1 spent fuel pool cooling system. NU analyzed the heat load being placed in the spent fuel pool that was generated during normal reactor refueling. NU defined the normal heat load as that from removal of a quarter of the core at 150 hours after reactor shutdown plus a quarter of the core decayed in the spent fuel pool for 12 months. In the FSAR an emergency heat load was also evaluated by NU. This heat load was defined by NU as the heat generated from removal of the full core at 250 hours after reactor shutdown plus a quarter core decayed in the spent fuel pool for three months and a quarter core decayed for 15 months. On September 1, 1972, NU applied for a full-term operating license.

On June 30, 1977, the NRC approved License Amendment No. 39 which permitted NU to make certain changes in the design of the Millstone Unit 1 spent fuel storage racks in order to increase the capacity of the spent fuel pool. The amendment allowed NU to change the Millstone Unit 1 technical specifications to increase the capability of the spent fuel storage pool. In the Safety Evaluation and Environmental Impact Appraisal that supported this amendment request, NU described a normal core offload as 25 percent of the core at 150 hours after reactor shutdown and an emergency core offload as a full core at 250 hours after reactor shutdown. This analysis also accounted for the heat being generated from fuel assemblies already in the pool as well as the heat to be generated in future refueling outages when the spent fuel pool would reach its storage capacity. This NU evaluation contained a single active failure analysis for normal and emergency heat loads.

The Systematic Evaluation Program (SEP) was initiated in February 1977 by the NRC to review the designs of older operating nuclear plants to reconfirm and document their safety. As required by the SEP, NU provided Safety Assessment Reports to the NRC on specific topics. On March 9, 1982, NRC issued a Safety Evaluation Report (SER) for SEP Topic IX-1, Fuel Storage. The SEP Topic IX-1, Fuel Storage for Millstone Unit 1 was reviewed in accordance with the NRC Standard Review Plan (SRP) and Regulatory Guides. However, the staff stated that because the NRC had reviewed the spent fuel pool cooling system design during their 1977 review of Amendment No. 39, they did not review this system as part of the SEP.

On October 31, 1986, the NRC issued a full-term operating license to Millstone Unit 1. The facility had operated since October 7, 1970, under the provisional operating license. However, the staff stated that because the staff had reviewed the Millstone Unit 1 spent fuel pool cooling system during its 1977 review of Amendment No. 39, they did not review this system in their October 1985 SER.

On June 24, 1988, NU submitted an application to the NRC to grant License Amendment No. 40. In its application NU sought a change in the Millstone Unit 1 technical specifications to specify the maximum storage capacity of the spent fuel pool and to increase the spent fuel storage for Millstone Unit 1. NU submitted an Safety Analysis Report (SAR) which analyzed a normal reactor core offload which NU described as one-third of the reactor core at 150 hours after reactor shutdown and an abnormal core offload which was described as full core offload at 250 hours after reactor shutdown. Residual heat from fuel assemblies already in the spent fuel pool was considered in the analysis as well as heat to be generated in future refueling outages when the pool would reach its storage capacity. On November 27, 1989, the NRC approved License Amendment No. 40. During the NRC review of the NU application, Millstone Unit 1 completed refueling outage (RFO) number 12, between April 7 and May 26, 1989, during which the full core was offloaded following 188 hours after reactor shutdown.

On September 17, 1993, NU notified the NRC of Licensee Event Report (LER) 93-11 concerning Millstone Unit 1. NU had just completed an engineering evaluation of concerns brought to NU management by a senior NU engineer about the ability of the spent fuel pool to maintain temperature within NRC limits when a full core was offloaded during refueling outages. The LER reported that the analysis determined that conditions may exist where during a full core offload the spent fuel pool cooling system may have been incapable of maintaining pool temperature below the 150 °Fahrenheit (F) design limit in the event of a single failure. This information was reported by NU as a condition that was outside the design basis of the plant.

In January 1994, following the issuance of LER 93-11, NU conducted RFO 14 at Millstone Unit 1. NU informed the NRC that it had conducted a 10 CFR 50.59 safety evaluation and used administrative controls during the refueling to ensure the spent fuel pool temperature remained within the 150 °F design limit temperature identified in the FSAR. During RFO 14, NU initially discharged a third of the core into the spent fuel pool. After waiting a period of time to allow the decay heat to dissipate, the remaining two thirds of the core were discharged into the fuel pool. The waiting period was calculated by NU to ensure that the fuel pool temperature remained below the 150 °F design limit, even in the event of a single failure.

By letter to the NRC dated July 28, 1995, and supplemented by a September 12, 1995, letter, NU proposed a Millstone Unit 1 license amendment which would add technical specifications relating to refueling activities at Millstone Unit 1. The amendment proposed changes to the operating license that would permit Millstone Unit 1 to perform a full core discharge as a normal refueling outage event.

On November 9, 1995, the NRC approved the amendment request submitted by NU regarding Millstone Unit 1. The new license amendment authorized NU to transfer the entire fuel core from the reactor core to the spent fuel pool during normal refueling. The amendment included provisions that refueling operations cannot begin until at least 100 hours after the reactor has been shut down and that the temperature of the spent fuel pool must be maintained no higher than 140 °F. As part of the amendment request, NU completed physical modifications to the spent fuel cooling system to allow the system to sustain a single failure with a full core offload.

DETAILS OF INVESTIGATION

I. NRC Region I Activities

Millstone Unit 1 has completed 14 refueling outages (RFO) since the first outage in September 1972. According to NU, Millstone Unit 1 conducted a full core offload for all refueling outages, with the exception of RFO 5 and RFO 6 which entailed the replacement of one quarter of the core while the core was in the reactor.

OIG reviewed over 250 inspections conducted by the NRC Region I at Millstone Unit 1 from 1972 to 1995. The NRC typically conducted inspections during refueling outages. Therefore, in many of these reports, inspectors documented their review of refueling records and procedures and their observations of the reactor fuel assemblies being unloaded. Further, there were several instances, (i.e., Region I Inspection Reports (IRs) 50-245/72-06, 50-245/75-17, and 50-245/76-22) where inspectors specifically noted that NU was conducting a full core offload during the outage. Also, several of these inspections were conducted while Millstone Unit 1 License Amendments No. 39 and No. 40 were being reviewed by the NRC headquarters. For example, while Amendment No. 39 was being reviewed by the Office of Nuclear Reactor Regulation (NRR) staff, Region I inspectors observed that the licensee was conducting a full core offload. After the amendment was approved, inspectors audited the shutdown cooling system and fuel pool cooling system procedures and again observed a full core offload being conducted (IRs 50-245/75-17, 50-245/76-21, and 50-245/76-22). Additionally, from 1987 to 1991, inspectors consistently reported that NU was conducting a full core offload during refueling outages.

OIG reviewed Millstone Unit 1 Shift Supervisor's Logs which documented refueling activities during outages. Shift Supervisor's Logs for RFO 2 through RFO 13 indicated that in almost all cases, except RFO 5, 6, and 12, NU began offloading fuel assemblies before 150 hours after reactor shutdown and concluded the entire fuel core offload in less than 250 hours. For example, in RFO 2, NU began removing fuel assemblies after 65 hours of decay and completed the full core offload at 192 hours; and in RFO 9, NU began removing fuel assemblies after 67 hours of decay and completed the full core offload after 179 hours. Also, in RFO 11, full core offload began at 87 hours and finished at 193 hours after reactor shutdown. RFO 5 and 6 entailed the removal of one quarter of the fuel core, and RFO 12 was a full core offload beginning at 188 hours after reactor shutdown.

OIG interviewed 13 current and former NRC resident inspectors and senior resident inspectors assigned to Millstone Unit 1. OIG also interviewed NRC Region I Division of Reactor Projects (DRP) managers and the Regional Administrator.

OIG found that once assigned to Millstone Unit 1, resident inspectors did not receive guidance or briefings specific to that facility. The resident inspectors stated they generally reviewed the Millstone Unit 1 operating license, technical specifications and in some instances, the FSAR. Also, resident inspectors typically attended licensee meetings and reviewed refueling procedures during outages. Resident inspectors generally stated that they recalled observing one or two refueling outages; however, many did not specifically recall observing a full core offload. In

those instances where inspectors recalled observing a full core offload, some resident inspectors said they believed that NU routinely conducted full core offloads, while others said they were not aware if NU routinely conducted full core offloads. Several resident inspectors said that Region I knew in advance that NU planned to perform a full core offload. One inspector stated that resident inspectors worked closely with the Region I staff and there were daily briefings between the two groups before an outage. This resident inspector stated that he would have discussed the details of an outage with his Region I section chief, and he did not recall there being a concern about NU conducting a full core offload.

Resident inspectors advised OIG that they never questioned NU's practice of offloading the entire core during refueling outages. In addition, some resident inspectors stated the practice of conducting full core offloads was routine in the industry, and there were health and safety benefits to doing so. Also, they were not aware of any conditions that would have restricted the number of fuel assemblies that could be offloaded during an outage. Resident inspectors also stated that they did not know if NU's practice of offloading the full reactor core was consistent with the Millstone Unit 1 FSAR.

A former senior resident inspector stated that he did not specifically recall whether Millstone Unit 1 offloaded a partial or full core during refueling outages. However, he supposed that NU conducted full core offloads. He was not aware of any technical problems or issues that developed with respect to NU's practice being inconsistent with the Millstone Unit 1 spent fuel pool design basis. The senior resident inspector stated that during his tenure at Millstone Unit 1, resident inspectors conducted performance-based inspections of refueling activities. He added that technical specifications would normally indicate if there was a need to delay moving fuel assemblies to the spent fuel pool for a certain time after shutdown to lower the heat load. NRC would have inspected against this requirement. Both the current and former senior resident inspectors stated that NU's practice of offloading the entire core during refueling outages was consistent with industry practice.

Several Region I Division Reactor Projects (DRP) managers, including two former section chiefs and former branch chief, stated that they were not aware of NU's practice of offloading the entire core during refueling at Millstone Unit 1. However, they stated that if NU's practice had been brought to their attention, they would not have considered it significant because the practice was not unusual. One manager speculated that resident inspectors knew that NU had conducted full core offloads on a routine basis at Millstone Unit 1; however, he questioned whether resident inspectors would have viewed the practice as unusual. The DRP managers also stated that they expected resident inspectors to be familiar with the licensee's operating procedures, FSAR, and any limitations in the FSAR. However, several managers noted that resident inspectors could not be expected to know the entire FSAR because it is voluminous. Unless inspectors researched technical specifications, the FSAR, and other

supporting documents, they would not know if NU's practice was inconsistent with their FSAR.

The current DRP Branch Chief advised OIG that before being assigned to Millstone Unit 1, some inspectors were assigned to plants that typically performed full core offloads. When they later transferred to Millstone Unit 1 and observed that plant conducting a full core offload, they would

not have considered the practice unusual. According to the Branch Chief, NU's practice would not have triggered a concern which would have prompted inspectors to refer to the Millstone Unit 1 FSAR. Nevertheless, he said he would expect inspectors to be reasonably familiar with the FSAR.

The former Deputy Director of DRP advised that he was not aware of NU's practice of conducting full core offloads; however, had he become aware of the practice he would not have considered it unusual. He stated that resident inspectors should be familiar with the licensee's FSAR, but cautioned that they would not be familiar with some portions until an event or unusual incident arose that caused them to consult the FSAR. He added that NU should not have implemented a practice of offloading the full core that was inconsistent with their licensing basis. Also, the NRC Project Manager should have had a better understanding of NU's practice and coordinated this understanding with the region.

The Director of DRP told OIG that past inspections at NU were performance based rather than compliance oriented. Therefore, he would not say conclusively whether resident inspectors should have been familiar with NU's design basis as described in the FSAR. Inspectors generally have different expertise and experiences at other plants, consequently, they may not have viewed NU's practice of offloading the entire core as unusual since other plants conduct full core offloads. In addition, he noted that while refueling is an important activity during an outage, inspectors would not necessarily scrutinize refueling activities. They would concentrate more on the surveillance aspects of the procedure. In the past, Region I stressed that inspectors closely review refueling activities. However, after reviewing these activities for a number of years, Region I concluded that there were no real safety concerns; therefore, inspectors have placed less emphasis on these activities.

The Regional Administrator, Region I, stated that he was not aware that NU had routinely conducted full core offloads during refueling outages. However, he was aware that NU had conducted a full core offload during the last four refueling outages. He stated that he hoped that if NRC inspectors became aware of anomalies in the refueling process, they would refer to the FSAR. While inspectors receive generic training in the area of spent fuel pool operations, there are 32 facilities in Region I and each FSAR is specific to each plant. Unless management has directed inspectors to review the FSAR as part of the inspection process, he would not expect them to be familiar with the FSAR. He noted that inspections are conducted by both Region I based inspectors and the resident inspectors. The region-based inspectors would not have the same level of knowledge of a particular facility as the resident inspectors who were more likely to have a comprehensive knowledge of the FSAR, procedures, and specific hardware at a particular facility. He added that the resident inspectors and the branch section chiefs would be expected to provide specific plant particularities to the region-based inspectors prior to their conducting inspections.

The Regional Administrator was reluctant to acknowledge that the NRC Region I staff and the resident inspectors should have recognized that NU's practice of offloading the entire fuel core was inconsistent with the discharge scenarios described in their FSAR. He said he had not reviewed the information that was available to the staff. Also, he noted that while the staff may have observed NU conducting full core offloads, this would not have triggered any concern

unless they had reviewed and understood the Millstone Unit 1 FSAR design basis. He explained that inspectors would need to understand that while the design basis articulated two discharge scenarios, NU had to stay within those heat load limitations. He added that NU could have conducted a full core offload and still remained within the Millstone Unit 1 design basis as long as they did not exceed the temperature and heat load design limits of the spent fuel pool cooling system. He stated that he hoped inspectors would have reviewed and confirmed that NU had conducted evaluations showing that they would not exceed the temperature limits prior to conducting refueling operations that differed from the FSAR.

II. NRR License Reviews

Background

The July 1981, NRC Standard Review Plan (SRP), 9.1.3 "Spent Fuel Pool Cooling And Cleanup System", revision 1, states that while the cooling methods for removing decay heat from stored fuel assemblies vary from plant to plant, the safety function to be performed by the system remains the same. Specifically, in all cases the spent fuel assemblies must be cooled and must remain covered with water during all storage conditions. The SRP states that two scenarios must be considered in evaluating the heat load imposed on the spent fuel pool cooling system. One scenario involves conditions for the normal maximum heat load which is described as one refueling offload after 150 hours of decay and one refueling offload after one year decay. The other scenario involves a full core offload after 150 hours decay and one refueling offload after 36 days decay. Also, for spent fuel pools with greater than 1-1/3 core capacity an additional one refueling offload after 400 days decay has to be evaluated under both scenarios. For the maximum normal heat load with single failure, the temperature of the pool should be kept at 140 °F; for the abnormal heat load (full core unload) the temperature of the pool water should be kept below boiling. A single active failure need not be considered for the abnormal case. The SRP was published in December 1975 as NUREG-75/087.

In 1968, as a basis for the Millstone Unit 1 operating license, NU submitted Section X, Auxiliary and Emergency Systems, of the Millstone Unit 1 FSAR to the NRC. The FSAR portions on fuel storage and handling described the Millstone Unit 1 design basis for storing new fuel in the storage vault; transferring new fuel to the spent fuel pool during refueling operations; and storing spent fuel assemblies in the spent fuel pool. The FSAR stated that normal reactor refueling involved replacement of approximately a quarter of the core. Further, the objectives of the spent fuel pool cooling and cleanup system were to handle the spent fuel cooling load and maintain pool water clarity. The spent fuel pool cooling and
cleanup system consisted of two circulating pumps and heat exchangers which were responsible for continuously filtering and cooling the pool.

To assess the heat removal capacity of the spent fuel pool cooling system, NU analyzed the heat load from a normal reactor refueling which was described as a quarter of the core at 150 hours after reactor shutdown and 25 percent of the core load decayed 12 months. Also, NU analyzed an emergency heat load which was described as 100 percent of the core at 250 hours after reactor shutdown, 25 percent core load decayed 3 months and 25 percent core load decayed 15 months. This analysis showed that the spent fuel pool cooling system design would handle the maximum

normal heat load of approximately 8 million BTU/hour. Also, the analysis showed that the combined capabilities of the spent fuel pool cooling system and the reactor shutdown cooling system could handle an emergency heat load of approximately 24 million BTU/hour. In addition, the analysis determined that under normal heat load conditions, the spent fuel pool temperature was 125 °F or less, and under emergency heat load conditions the temperature was 140 °F or less.

Office of Nuclear Reactor Regulation (NRR) Review of License Amendment No. 39

On July 15, 1976, NU submitted to NRR a license amendment request to modify the Millstone Unit 1 spent fuel storage pool to increase its storage capacity. In support of the proposed license amendment, NU submitted a safety evaluation. The safety evaluation indicated that after the 1977 refueling outage, the Millstone Unit 1 spent fuel pool would no longer have the capability to store a full core offload. The safety evaluation stated, "It is prudent to reserve storage space in the spent fuel pool to receive an entire reactor core, i.e., a full core offload, should unloading of the core be necessary or desirable because of operational considerations."

In addition, the NU safety evaluation stated that the existing spent fuel pool cooling system could accommodate the increase in heat load that would result from the greater number of spent fuel assemblies to be stored. Accordingly, NU did not propose any modifications to the spent fuel pool cooling system. NU analyzed the heat removal capability of the spent fuel pool cooling system given the increased heat generated by the additional fuel assemblies to be stored in the spent fuel pool. NU's analysis was based on both the normal refueling and full core offload conditions. NU determined that the fuel pool cooling system was designed to maintain a maximum pool temperature of 125 °F under a normal heat load condition. NU defined the normal heat load as that from the storage of 25 percent core load decayed 150 hours. For a emergency heat load, the temperature limit was 140 °F. An emergency heat load was defined as 100 percent core load decayed 250 hours. NU's analysis for both heat load conditions also calculated the residual heat load present as well as heat to be generated in future refueling outages when the spent fuel pool would reach its storage capacity. The calculations determined that the heat load under a normal offload condition was 7 million BTU/hour; and the heat load under an emergency offload condition was 18 million BTU/hour. NU stated that the emergency heat load was to be cooled through the combined use of the spent fuel pool cooling system and the shutdown cooling system. In addition, NU analyzed for a single failure of a loss of a spent fuel pool cooling pump under normal heat load and emergency heat load conditions. However, the failure of a spent fuel pool cooling pump was not the most critical failure for the emergency heat load. In an emergency heat load condition, the most critical failure would be the loss of the shutdown cooling system, which played a much more significant role in cooling the full core offload.

On June 30, 1977, NRR approved License Amendment No. 39. The Safety Evaluation And Environmental Impact Appraisal by the NRR staff concluded that the spent fuel pool cooling system was adequate to accommodate the increased number of fuel assemblies. The staff stated that they had compared NU's analysis to those contained in the SRP and the "Technical Position APCSB 9-2." However, the NRR evaluation did not comment on the fact that the single failure analysis by NU did not consider the most limiting failure for the emergency heat load condition.

Also, OIG did not find any indication that NU either sought or obtained exemption from the acceptance criteria prescribed in the SRP.

NRR Review of Systematic Evaluation Program (SEP) Topic IX-1, Fuel Storage for Millstone Unit 1.

Millstone Unit 1 was one of 10 older plants selected for review under the SEP which was initiated by the NRC in February 1977. The SEP review process was initiated to assess significant differences between then current technical positions on safety issues and those that existed when a particular plant was licensed. The program's goal was to document how each plant met the current criteria contained in the SRP or to provide a rationale for "acceptable departures from these criteria."

In accordance with the program, NU provided several Safety Assessment Reports (SARs) to the NRC on specific topics. On August 31, 1981, NU submitted an Safety Assessment Report regarding SEP Topic IX-1, Fuel Storage for Millstone Unit 1, which described the capability of the spent fuel pool cooling system. The Safety Assessment Report stated that the heat loads were 7 million Btu/hour under normal conditions and 18 million Btu/hour for the emergency core offload. While this report did not specifically discuss the single failure criteria, the pool temperatures given were those reflected in NU's safety evaluation for License Amendment No. 39. NU advised the NRC that these heat loads were well within the original design conditions of the pool cooling system.

In February 1982, the NRR Auxiliary Systems Branch completed its review of SEP Topic IX-1, Fuel Storage for Millstone Unit 1. The Safety Evaluation Report (SER) prepared by NRR indicated that certain systems recently reviewed were not re-evaluated; therefore, the heat removal capability of the spent fuel pool cooling system was not reviewed because it had been reviewed in connection with the issuance of License Amendment No. 39 in June 1977.

In a March 9, 1982, letter to NU, the NRC issued its final evaluation of SEP Topic IX-1. The evaluation identified the review guidance used by the NRC staff, including SRP Section 9.1.1 New Fuel Storage; SRP Section 9.1.2 Spent Fuel Storage Section; and SRP Section 9.1.3 Spent Fuel Pool Cooling and Cleanup System. The evaluation stated that NU's SAR demonstrated compliance with the requirements of SRP Sections 9.1.2. and 9.1.3. and that the staff had reviewed NU's submittal with respect to the current requirements for spent fuel storage. Although NU had received a provisional operating license in October 1970, OIG did not find any indication in NU's response to the SEP that NU either sought or obtained exemption from the acceptance criteria prescribed in the SRP.

NRR Safety Evaluation for the Full-term Operating License for Millstone Unit 1.

In October 1985, NRR issued an SER in support of granting a full-term operating license for Millstone Unit 1. The SER stated, in part, that since NRC had reviewed and approved License Amendment No. 39 in June 1977, the staff conclusions regarding the heat removal capability of the spent fuel pool remained valid. The SER further concluded that the spent fuel storage facility at Millstone Unit 1 was acceptable with respect to the requirements of SRP Sections 9.1.2 and

9.1.3. On October 31, 1986, the NRC issued a full-term operating license to Millstone Unit 1.

NRR Review of License Amendment No. 40

On June 24, 1988, NU submitted an application to the NRC requesting to amend its license. The proposed amendment requested a revision to the Millstone Unit 1 technical specifications to increase the capacity of the spent fuel pool and to specify the maximum number of spent fuel assemblies authorized to be stored in the pool. In support of the amendment, NU submitted an Safety Analysis Report (SAR) which analyzed the decay heat load and bulk pool temperature for the spent fuel pool cooling system. This analysis was based on two discharge scenarios, a normal discharge which was described as one-third of the reactor core following 150 hours after reactor shutdown and an abnormal discharge which was described as a full core offload following 250 hours after reactor shutdown.

The SAR stated that the spent fuel pool cooling system relied on two spent fuel pool pumps during normal discharge, and one shutdown cooling pump in addition to the spent fuel pool pumps during a full core discharge. NU analyzed the bulk pool temperature with single failure for both the normal discharge and the full core offload. Again, the single failure evaluated by NU was the loss of one spent fuel pool pump for both discharge scenarios. The NU single failure analysis showed that the maximum spent fuel pool temperature for the normal discharge was 140.4 °F; and for a full core offload, with single failure, the pool temperature was 125 °F. In addition, the SAR noted that given the single failure for both the normal discharge and the full core discharge, the fuel pool water temperature remained below the American Concrete Institute (ACI) limit of 150 °F for a concrete structure.

On November 27, 1989, NRR issued License Amendment No. 40 granting approval to NU to increase the capacity of the spent fuel pool. The staff's SER noted that NU had not proposed any modifications to the spent fuel pool cooling system. The SER stated that NU had analyzed two scenarios of fuel offload to the spent fuel pool: the normal discharge and the abnormal discharge. The SER concluded that the staff had reviewed the licensee's analysis regarding the adequacy of the spent fuel pool to cool the increased number of fuel assemblies and found that the cooling system met the criteria in the SRP and was therefore acceptable.

OIG learned that according to the SRP, 9.1.3 "Spent Fuel Pool Cooling and Cleanup System", revision 1, July 1981, the Auxiliary Systems Branch (currently the Plant Systems Branch) had primary responsibility for reviewing SARs regarding the spent fuel pool cooling and cleanup system. Several NRR branches were involved in reviewing and approving different aspects of the license amendments including seismic, structural, and criticality aspects of the new spent fuel racks; and chemical stability of the fuel racks and spent fuel pool.

OIG reviewed the NRR Project Manager's file for License Amendment No. 40. OIG determined that several NRR branches including the Chemical Engineering Branch and the Structural and Geosciences Branch each prepared an SER. However, OIG determined that the Plant Systems Branch did not prepare a branch SER for the spent fuel pool cooling system. While the final SER issued by NRR identified the principal contributors, it did not include staff from the Plant Systems Branch.

The Project Manager's file contained a memorandum dated July 27, 1988, in which the NRR Millstone Unit 1 Project Manager documented a meeting between the NRR staff and NU regarding the proposed license amendment. The memorandum stated, "It had been the practice of the licensee to offload the entire core during refuelings." In addition, in a letter written by the NRR staff, dated April 6, 1989, while the amendment was still pending, NRC gave NU approval to temporarily increase the spent fuel pool storage capacity during the next refueling operation (RFO 12) to allow the temporary storage of the fuel from a full core offload in the spent fuel pool.

The NRR Project Manager for Millstone Unit 1 during Amendment No. 40 advised the OIG that he was responsible for ensuring that the amendment was provided to the appropriate technical staff for review. He served as a facilitator for meetings between the licensee and the NRR technical staff. According to the Project Manager, after the technical staff in the various NRR branches reviewed issues in their areas of expertise, each branch prepared an SER, which he consolidated into a SER that was issued by NRR. The SER was then provided to the relevant branch chiefs for their concurrence.

The Project Manager told OIG that when he reviewed amendment No. 40, he knew that NU conducted a full core offload as a normal practice during refueling. He did not recall when he first became aware of NU's practice; however, he knew they had been conducting full core offloads for some time. According to the Project Manager, it was clear to the staff that NU was performing full core offloads. Further, the NRC staff never questioned NU's practice, which, according to the Project Manager, was consistent with other BWR plants. The Project Manager said he was not aware that the SRP required licensees to sustain a single failure during a normal reactor refueling. Regarding the April 1989 letter, the Project Manager stated that NRR gave NU a temporary waiver to conduct a full core offload after evaluating the safety issue.

The current Plant Systems Branch Chief, who was the Chemical Branch Chief during the NRR review of Amendment No. 40, stated that the Plant Systems Branch staff and the prior branch chief did not recall reviewing NU's SAR pertaining to Amendment No. 40. The current Plant Systems Branch Chief stated that he was familiar with the quality of work that would typically be completed by staff who would have reviewed the spent fuel pool cooling system. It was obvious to the Branch Chief that the level of detail contained in the SER was inconsistent with the results of a typical NRR staff review. In addition, he said that because Millstone Unit 1 was licensed in 1970, prior to the SRP requirement for a single failure analysis, if he had reviewed the spent fuel pool cooling system for amendment No. 40 and had known that NU was conducting a full core offload as a routine refueling operation, he would have ensured that the staff addressed whether NU had to meet the single failure criteria for a full core offload. According to the Plant Systems Branch Chief, it appeared that the staff did not consider this issue.

The Branch Chief agreed that the single failure analyzed by NU in their SAR for a full core offload, i.e., a failure of the spent fuel pool pump, was not the most limiting. He commented that if NU had to consider a single failure, then they should have analyzed the consequences of a failure of the shutdown cooling system. The Branch Chief acknowledged that Millstone Unit 1 could not remain within the SRP acceptance criteria for spent fuel pool temperature during a full core offload, assuming a failure of the shutdown cooling system. In addition, he stated that NU

should have advised the NRC that their normal practice was to offload the entire fuel core during refueling.

The former Director, Project Directorate I-4, NRR, advised that he was not aware that NU was conducting a full core offload during refueling outages. However, he said that if the NRR staff was aware of NU's practice, they should have questioned this practice and determined whether NU had to meet the single failure criteria. He added that if NU was conducting a full core offload during refueling outages, NU should have analyzed a full core offload as a normal refueling operation. He stated this analysis should have been reflected in documents in support of their license amendment as well as their FSAR.

The Associate Director for Projects, NRR, stated that if the NRR project manager was associated with a utility for a reasonable period of time, he would expect the project manager to be familiar with whether the utility conducted full core offloads during refueling. He noted that he would expect the project manager to be familiar with significant activities planned during an outage. However, he would not expect the project manager to be familiar with the FSAR or whether a licensee's practice was consistent with their FSAR.

Regarding the July 1988 memorandum in which the NRR Project Manager documented NU's practice of offloading the entire core during refueling outages, the Associate Director for Projects stated that this raised a question in his mind regarding the adequacy of NU's safety analysis as well as the adequacy of the staff's safety evaluation. He noted that neither NU's analysis nor the staff's evaluation reflected that NU was conducting a full core offload during refueling outages.

OIG found no record to show that the Plant Systems Branch reviewed the heat removal capability of the spent fuel pool prior to approving Millstone Unit 1 License Amendment No. 40. In addition, OIG noted several issues that should have been considered by the NRR staff regarding whether NU's analysis for a full core offload was consistent with the SRP guidance. Specifically, NU's evaluation was based on the full core offload occurring three months after the last refueling and that fuel assemblies would be transferred at 250 hours after reactor shutdown. However, according to the SRP, the calculation for the maximum amount of heat to be removed by the spent fuel pool cooling system should be under the condition when the full core offload occurs 36 days after the last refueling and transfer of fuel assemblies begins 150 hours after reactor shutdown.

In addition, while NU analyzed a full core offload with single failure of the spent fuel pool cooling pump, NU did not evaluate the most critical single failure which was loss of the shutdown cooling system. NRR did not question this analysis. Also, NU's analysis noted that the pool water temperature, assuming single failure for both normal discharge and full core offload, would remain "below the ACI recommended limit of 150 °F for a concrete structure." OIG noted that the staff's SER concluded that the water temperature for normal discharge with no single failure and with a single failure were "both below the acceptance criteria limit of 150 °F." NRR erroneously agreed with NU that the acceptance criteria for the pool temperature was 150 °F rather than the 140 °F acceptance criteria cited in the SRP.

III. NU Millstone Unit 1 Design Basis Issue

OIG determined that the initial Millstone Unit 1 FSAR submitted to the NRC in 1968, and License Amendments No. 39 and No. 40, each evaluated the capability of the spent fuel pool cooling system to remove heat generated by two discharge scenarios. These two scenarios involved a partial core offload- initially a quarter of the core, and later a third of the fuel core- and an emergency or abnormal offload which was described as a full core offload. NU's evaluations in support of both amendments analyzed a single failure for the partial offload as well as the full core offload. However, NU's analysis for the full core offload did not consider the most critical single failure, i.e., loss of the shutdown cooling system.

On September 17, 1993, NU notified the NRC of LER 93-11 concerning Millstone Unit 1. NU reported that an engineering analysis had been conducted which concluded that conditions may have existed where the spent fuel pool cooling system may have been incapable of maintaining the pool temperature at the design maximum temperature for the spent fuel pool. The analysis determined that during a full core offload beginning at 150 hours after reactor shutdown, the pool temperature would exceed 150 °F in the event of a failure of the shutdown cooling system. NU reported this as a condition that was outside the design basis of the plant. NU also reported that the Millstone Unit 1 FSAR and the NRC SER for License Amendment No. 40 described the "normal" refueling sequence as one third of the reactor core; however, "in practice, Millstone 1 typically performs a full core offload."

OIG reviewed a February 3, 1993, report by an NU consultant which documented the engineering analysis prepared on behalf of NU. The analysis was conducted as a result of concerns raised by Galatis. The analysis reviewed the spent fuel pool and the capability of the spent fuel pool cooling system and the shutdown cooling system to remove heat generated under various scenarios. This analysis determined that only one scenario would cause the spent fuel pool to exceed 150 °F. This scenario was identified as a normal full core offload beginning at 150 hours after reactor shutdown with a single failure loss of the shutdown cooling system. Under this scenario the spent fuel pool temperature reached 216 °F. However, it should be noted that OIG's review of the Shift Supervisor's Logs determined that in almost all refueling outages, NU began transferring fuel assemblies before 150 hours after reactor shutdown and on one occasion, the transfer began at 67 hours after reactor shutdown. OIG did not find any indication that NU conducted a safety evaluation prior to these refueling outages to calculate the heat loads generated by offloading the entire fuel core before 150 hours of decay.

In September 1995, Region I NRC issued Inspection Report 50-245/95-28 which concluded that NU's practice of performing a full core offload during refueling operations, including the sequential process used in RFO 14, was contrary to the design basis identified in their FSAR. This report also noted that "License Amendments 39 and 40 did not completely and accurately describe the refueling activities as they were actually conducted" by NU.

The NU Director of Nuclear Planning, Licensing & Budgeting advised OIG that the Millstone Unit 1 license and technical specifications were silent on whether it is permissible to offload the entire reactor fuel core. Also, the Millstone Unit 1 FSAR analyzed heat load assumptions for two discharge scenarios, but the FSAR did not explicitly identify what constituted the abnormal or emergency discharge scenario. The Director maintained that NU conducted full core offloads because it made the most sense from a safety standpoint and the procedure was consistent with

industry practice. He added that the NRC staff and resident inspectors were aware of NU's practice since NU frequently briefed the staff on planned outage activities and the resident inspectors attended daily outage meetings. Also, resident inspectors were able to observe the full core being offloaded during refueling outages.

The NU Vice President of Engineering advised OIG that NU's practice of offloading the entire core during refueling outages did not violate their operating license because technical specifications did not address procedures for offloading fuel. However, the NU Vice President stated that in support of the plant licensing process NU was required to analyze the heat removal capability of the spent fuel pool. This analysis described two cases, a partial core offload and a full core offload. According to the Vice President, the language used to describe the two cases was causing great difficulties. He explained that whether the two cases were called normal or abnormal, or case one or case two, or a partial core or a full core, did not matter because they were just two analytical cases which did not impose any operational restrictions. Additionally, the Vice President claimed that the specific operating practice used during refueling outages was their choice. According to this Vice President, NU's practice of conducting a full core offload was within the bounds of the analysis and therefore was acceptable.

The NRC staff advised OIG that they have not yet reviewed the historical aspects of NU's practice of offloading the entire core during refueling outages. On November 9, 1995, after NU completed certain plant modifications, the staff approved an amendment which allowed NU to conduct a full core offload as a normal end of cycle event during refueling. Regarding past practices, there appeared to be some disagreement within the NRC staff as to whether NU's practice was outside the Millstone Unit 1 design basis. However, the staff believed that NU's practice of offloading the entire core did not violate their operating license because their technical specifications did not contain procedures for refueling. Also, according to the staff, the FSAR was not a part of NU's operating license.

Regarding NU's past practice of offloading the entire core during refueling outages, the Plant Systems Branch Chief, NRR, stated that he had not conducted a review of the historical licensing documents submitted by NU with respect to the Millstone Unit 1 spent fuel pool. With that caveat, he said that the analysis performed by NU for the two discharge scenarios, i.e., a partial core offload under normal refueling conditions and full core offload under abnormal or emergency conditions, may have bounded their actual practice of routinely discharging the entire core. He noted that NU would have to operate the plant within the bounds of the heat loads generated by these two discharge scenarios. The Branch Chief acknowledged, however, that Millstone Unit 1 could not sustain a failure of the shutdown cooling system under a full core offload and maintain the temperature of the spent fuel pool below 140 °F. He noted that the NRC SRP is a guidance document that was issued after Millstone Unit 1 was licensed. Therefore, he speculated that if NU did not have to assume a single failure, they would not have exceeded the design basis of the spent fuel pool with respect to not having the capability of sustaining the loss of the shutdown cooling system during a normal refueling offload of the full core.

The Region I Regional Administrator stated that he did not know whether NU's practice of offloading the entire core during refueling outages was outside of the Millstone Unit 1 design

basis. He did not have a clear understanding of the Millstone Unit 1 design basis and of NU's commitment to a signal failure criteria. After briefly reviewing the SAR submitted by NU in support of license Amendment No. 40, he stated that NU apparently articulated two discharge scenarios to demonstrate to the NRC that the Millstone Unit 1 spent fuel pool cooling system met the NRC SRP acceptance criteria. Accordingly, since NU's normal discharge was a full core offload and not a third core as described in the SAR, NU should have conducted a 10 CFR 50.59 safety evaluation, using the single failure criteria and the temperature criteria to determine whether they met the SRP acceptance criteria. He added that if NU determined that they could not meet the SRP criteria, they should then have concluded that they were outside their design basis. The Regional Administrator stated that

NU then had a choice of either changing their method of operation during refueling or modifying their plant.

The Associate Director for Projects, NRR told OIG that if a licensee operates in a manner which differs from their FSAR, they should first perform a 10 CFR 50.59 safety evaluation. NU should have conducted such a safety evaluation to determine whether a full core offload was bound by the two discharge scenarios previously analyzed in the Millstone Unit 1 FSAR. The Associate Director added that he would expect NU to carefully review whether their analysis for a partial and full core offload bound their actual practice. Further, he said he would not assume that the full core offload previously analyzed was sufficiently
conservative to bound their actual practice of conducting a full core offload as a normal refueling event.

The Director of NRR advised OIG that he was the Regional Administrator, Region I between April 1987 and April 1990. He stated that as the Region I Administrator, he was aware of NU's practice of offloading the entire core during normal refueling outages. However, he was not aware that this practice was not the normal refueling scenario reflected in the Millstone Unit 1 FSAR.

The Director of NRR noted that for reason of safety, the NRC has for some time encouraged licensees to offload the entire core during refueling outages. Nevertheless, plants should have an FSAR that supports the practices and procedures used during the fuel core offload. He related that in the case of Millstone Unit 1, it appeared that the design basis scenario outlined and reviewed by the NRC in the Millstone Unit 1 FSAR for a normal discharge did not conform to the practice followed by NU during refueling outages. The Director of NRR stated that based on information he has reviewed thus far, Millstone Unit 1 has routinely conducted full core offloads during refueling outages without analyzing and documenting in their FSAR the acceptability of this practice. Further, this information coupled with recent plant modifications that NU was required to make to meet single failure criteria for a normal full core offload indicate that in the past Millstone Unit 1 operated outside of its design basis.

IV. NU Millstone Unit 1 License Violation Issue

OIG reviewed the Millstone Unit 1 operating license, dated October 31, 1986, which

incorporated the technical specifications as part of the license. The license required NU to operate Millstone Unit 1 in accordance with the technical specifications. Chapter 6 of the Millstone Unit 1 Technical Specifications listed the administrative controls required of NU for the operation of the plant. Section 6.8.1 of that chapter required that written procedures be established, implemented and maintained covering refueling operations. Two required procedures were for the operation of the fuel pool cooling system and for the operation of the shutdown cooling system.

OIG developed information indicating that for approximately 10 years, in order in handle the heat load from a full core offload, reactor operators at Millstone Unit 1 operated the spent fuel pool cooling system in a configuration that was not covered by plant operating procedures.

NU Operations Procedure No. 305 concerning operation of the shutdown cooling system and Operations Procedure No. 310 which detailed operating of the fuel pool cooling system were required by technical specifications. These procedures contained steps to be followed by the control room to operate the appropriate pumps, filter, valves, etc. to ensure these systems were operated properly and functioned as designed.

Operations Procedure No. 310 contained instructions for the operation of the spent fuel pool cooling system to cool a normal offload of a third of the core. Additionally, the procedure contained instructions on how to align the spent fuel pool cooling system during emergency operations. This procedure was to be used in conjunction with Operating Procedure No. 305 when NU offloaded the full core during refueling outages.

OIG learned that the operation of the fuel pool cooling system in conjunction with the shutdown cooling system during full core offload had been in a configuration not described in either operating procedure. The shutdown cooling system was aligned with the spent fuel pool cooling system by directing water through pipes and valves that differed from those proscribed by the operating procedures. This procedure had been used by NU without first being analyzed.

In December 1992, NU revised Operations Procedure No. 305 to include the alignment that had been used to operate the system at Millstone Unit 1 for approximately 10 years.

OIG FINDINGS

1. OIG determined that generally, the NRC regional staff was aware of NU's practice of offloading the entire core at Millstone Unit 1 during refueling outages; however, the NRC staff did not realize that this practice was inconsistent with the normal discharge scenario outlined in the Millstone Unit 1 FSAR. OIG found that many NRC resident inspectors were not familiar with the Millstone Unit 1 FSAR. Resident inspectors typically observed one or two refueling outages, and they did not question the licensee's practice of offloading the entire core.

2. The OIG investigation determined that the NRC headquarter's staff had several opportunities to review the Millstone Unit 1 refueling practices and the heat removal capability of the spent fuel pool cooling system; however, the staff did not conduct a fully

adequate evaluation related to the capabilities of the spent fuel pool cooling system.

3. The OIG investigation developed evidence that NU operated Millstone Unit 1 outside of its design basis due to its actual practice of offloading the entire core in less time than was analyzed in its FSAR. In SARs submitted to the NRC, NU had analyzed a full core offload at 250 hours after reactor shutdown; however, their actual practice of offloading the entire core at 150 hours or less during normal refueling outages and their ability to meet the NRC single failure criteria under these conditions had not been analyzed. A 1993 engineering evaluation conducted on behalf of NU concluded that the design of the Millstone Unit 1 spent fuel pool was incapable of meeting the single failure criteria following a full core offload after 150 hours of reactor shutdown.

4. The OIG investigation determined that the licensee may have violated the operating license for Millstone Unit 1 because of a failure to operate in accordance with its technical specifications. The Millstone Unit 1 operating license, incorporates the technical specifications as part of the license and also requires that the plant will be operated in accordance with the technical specifications. One procedure required by the technical specifications is for the operation of the spent fuel pool cooling system. OIG uncovered information which indicates that for approximately 10 years, in order to handle the heat load from a full core offload, reactor operators at Millstone Unit 1 operated the spent fuel pool cooling system in a configuration that was not covered by a plant operating procedure.

GLOSSARY

Normal Condition - As described in ANS 57.2, a general design condition that includes those occurrences during plant operations that are expected frequently or regularly during the course of routine storage, refueling, maintenance or preparation for shipment. Also included are those occurrences which may occur during a calendar year.

Abnormal Condition - As described in American National Standard (ANS) 57.2, a general design condition that includes faults that are not expected to occur but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material.

Technical Specifications - portion of NRC licenses that includes safety limits, limiting conditions for operation, surveillance requirements, design features, administrative controls, initial notification, and written reports. These are included in 10 CFR Part 50 and have legal force and effect. They are based on the SARs submitted by the applicant.

Operating License - To obtain an operating license applicants must show that the finished plant meets all of the construction requirements and that the applicant is capable of operating the plant safely, this is, that procedures, training programs, etc., have been established that will meet all of the NRC operating requirements. An operating license includes technical specifications as a license condition that must be completed by licensees.

Design Basis - that body of plant-specific design information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as a reference bounds for design.

Final Safety Analysis Report (FSAR) - report written by applicants for an NRC operating licensee which describes the plant and its equipment and states that the plant is safe to operate. It includes information that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the structures, systems, and components of the facility as a whole. The FSAR is updated by SARs as modifications to the plant are approved by the NRC.

Licensee Event Report (LER) - reports submitted by licensees in accordance with 10 CFR 50.73 to notify the NRC within 30 days of the occurrence of any event described in 10 CFR 50.73.

Nonconforming Condition - anything in an operating nuclear facility that does not conform with a license condition.

Unreviewed Safety Question - a proposed change will involve an unreviewed safety question (1) if the probability of occurrence or the consequences of an accident or malfunction of equipment

important to safety previously identified in the safety analysis report may be increased; or (2) if a possibility for an accident or malfunction of a different type than evaluated previously in the safety analysis report may be created; or (3) if the margin of safety as defined in the basis for any technical specification is reduced.

Safety Analysis Report (SAR) - report submitted by licensees that documents proposed changes to the nuclear plant showing that the modification was designed and analyzed in sufficient detail to conclude that the plant can be operated safely. As SARs are approved by the NRC, they are incorporated into the FSAR.

Safety Evaluation Report (SER) - the NRC staff evaluation of the SARs submitted by the licensee, then used by NRC to determine whether to issue a construction permit or license, or to issue a license amendment for a major modification to the plant.

Single Failure - an occurrence which results in the loss of capability of a component to perform its intended safety functions. Multiple failures resulting from a single occurrence are considered to be a single failure. A design deficiency in which capability to withstand a single failure is lost should be evaluated and treated as a degraded and nonconforming condition, and a prompt determination of operability is required.

Standard Review Plan (SRP) - NRC review outline that provides guidance for review of operating license applications for power plants. Its purpose is to improve the uniformity of the NRC staff review process and to improve the communication and understanding of the review process to interested members of the public and the nuclear power industry.

Systematic Evaluation Program (SEP) - NRC program initiated in 1977 to review the designs of older operating nuclear plants to reconfirm and document their safety as compared to newer plants.

10 CFR 50.59 Review - a review conducted by a licensee of a proposed change in the facility or procedures as described in the safety analysis report to determine if the proposed change involves a change in the license technical specifications or an unreviewed safety question. If the review determines that the proposed change does not involve either a change in technical specifications or an unreviewed safety question, the licensee must make a record of the review; however, it can proceed with the change and notify the NRC annually or with its FSAR update. If the proposed change involves an unreviewed safety question or a change in the plant technical specifications, the licensee must submit an application for a license amendment.