POLICY ISSUE
(Information)

September 20, 2001 SECY-01-0175

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: SPENT FUEL MISSING FROM MILLSTONE UNIT 1

PURPOSE:

To inform the Commission of licensee activities to date and NRC staff plans associated with the two fuel rods apparently missing from the spent fuel pool at Millstone Unit 1.

BACKGROUND:

In November 2000, the licensee for Millstone Unit 1 informed the NRC that the location of two spent fuel rods could not be determined.

In 1972 a once-burned spent fuel assembly with damaged fuel rods was disassembled to allow testing. During the disassembly, one of the fuel rods was bent and could not be reinserted into the assembly. Another fuel rod was displaced by the installation of a new tie rod in the fuel assembly. These two fuel rods were put into a fuel rod canister used to store individual fuel rods. Records dated 1979 and 1980 show the fuel rods stored in the canister in the northwest corner of the spent fuel pool. Records after 1980 do not identify the location of the spent fuel rods or canister in the fuel pool. Significant work, including two reracks and shipments of miscellaneous irradiated components from the spent fuel pool, took place from 1980 to 1990. In November 2000, a records reconciliation and verification effort, undertaken by the licensee (Northeast Utilities) to support the sale of the Millstone site to Dominion Resources, determined that the location of two full-length irradiated fuel rods was not properly reflected in special nuclear material records.

The licensee has formed a Fuel Rod Accountability Project with a dedicated investigative team. Additionally an independent oversight team is reviewing the overall investigative effort. Although the current licensee for Millstone Unit 1 is Dominion Nuclear Connecticut, the Fuel Rod Accountability Project is directed, staffed, and funded by Northeast Utilities, the former

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licensee for the Millstone units. The continued involvement of Northeast Utilities was a condition of the purchase of the Millstone units by Dominion. Licensee actions taken to locate the fuel rods and determine how they were misplaced include the following:

- physical inspections
- development of plausible scenarios to be investigated
- document reviews
- personnel interviews
- root cause analyses

The scenario investigation by the Fuel Rod Accountability Project has included review of documentation of the shipments from the site that could have contained the fuel rods. Due to the high contact radiation levels of the rods, only removal from the spent fuel pool in a shielded cask has been considered plausible. The project staff has looked primarily at the recorded dose rates from the packages but has also considered the dates of shipments and the sizes of packages. Although the package size has been an evaluation factor, a wide range of sizes is considered plausible. This is because some radioactive components in the pool, including local power range monitors, are routinely cut into smaller lengths before packaging, and the fuel rods, if mistaken for such components, could also have been cut into smaller lengths.

The NRC staff anticipates that the Fuel Rod Accountability Project will complete its investigation in September 2001. It appears increasingly likely that the fuel rods will not be found on site at Millstone, which leads to the possibility that the fuel rods may have been disposed of in the low-level waste disposal facilities at either Barnwell, South Carolina, or at Richland, Washington, or shipped to the GE-Vallecitos facility.

DISCUSSION:

STATUS

Health and Safety Issues

The current risk to human health from the missing fuel rods, based on the staff's knowledge to date, appears to be low. If the rods were in and are still in the spent fuel pool in an undetermined location (which appears highly unlikely based on the Fuel Rod Accountability Project's investigations to date), they would have been and are subject to all of the controls for protecting workers and the public that are in place for handling spent fuel in that area. If the rods were mistaken for some other non-fuel component, such as a local power range monitor and were inadvertently shipped offsite, they would have been packaged in shielded shipping containers due to their high radiation levels, and would therefore have met the requirements for external exposure limits. This is because the licensee's radiation monitoring program would have detected the high radiation levels from the rods, an easily identifiable characteristic of the hazard if they were unshielded. Furthermore, the radiation detection instruments at the potential offsite locations would also have detected unshielded spent fuel. If the rods were shipped offsite, there are only three plausible locations – transferred to the GE-Vallecitos facility, where

they would be safely stored in a manner similar to the spent fuel rods at the Millstone site, or a low-level waste (LLW) disposal site, either the Barnwell, South Carolina facility, or the Richland, Washington facility.

At an LLW disposal site, there are two potential risks to members of the public associated with unintended disposal of spent fuel rods. The first is a possible exposure to an inadvertent intruder into a disposal cell. The Commission's regulations in 10 CFR Part 61 (and the compatible regulations of the States of Washington and South Carolina) rely on a combination of 100 years of active institutional controls (to control the use of the disposal facility land), government ownership of the land, siting, waste form, and engineered barriers or depth of burial to protect against inadvertent intrusion. Thus, there is no present hazard from the possible disposal of the fuel rods at an LLW site because inadvertent intrusion is not possible until after the sites are closed. After closure, there is some residual risk from the disposal of LLW (which also has long-lived radionuclides in activated metals), and the staff intends to work with the States of Washington or South Carolina to review and evaluate the incremental risk if the rods are determined to be disposed of at an LLW site.

Another potential hazard at an LLW site is the long term release of radionuclides from the fuel rods. Northeast Utilities estimates the amount of radioactivity in the fuel rods to be approximately 300 curies. (Although the staff has not independently verified that estimate, it appears to be reasonable.) This amount of radioactivity is a small part of the total inventory of several million curies at either disposal site that must already be isolated to protect public health and safety. The specific hazard would depend on such factors as the amounts of specific radionuclides in the spent fuel rods, and site characteristics, such as the rate of potential groundwater transport of radionuclides to offsite locations. The staff also plans to review and evaluate in more detail the risk from offsite releases. Results from the ongoing environmental monitoring and radiation protection programs at the sites have demonstrated that there is no significant risk to the public or workers at this time from operations at each site.

A final consideration in the risk evaluation is the potential dose to workers from finding and exhuming the rods, if they are determined to be buried at a disposal site and if recovery of the rods is deemed necessary. The staff will also review and evaluate the potential doses from these efforts as well as whatever longer term risks might result from leaving the rods in place.

Nuclear Proliferation Issues

The very high radiation level of the material (contact radiation level of approximately 1600 R/hr in 1980) makes theft difficult, dangerous, and very unlikely. The radiation levels also make the material of limited or no economic value. Moreover, the amount and chemical form of the fissile material contained in the two spent fuel rods make it unlikely that the rods could be used to manufacture a weapon. The uranium in the fuel rods is low-enriched uranium (2.44 percent U-235, 97.56 percent U-238). The amount of U-235 in each rod is about 50 grams. The plutonium created in each rod during its time in the reactor core is estimated to be approximately 20 grams. The 40 grams of plutonium and 100 grams of U-235 contained in the rods would result in the missing material being considered special nuclear material (SNM) of low strategic significance (10 CFR 73.2, "Special nuclear material of low strategic significance").

Staff Monitoring and Inspection of Licensee's Investigation

Routine inspections have been conducted by Region I inspectors and by the Unit 2 resident inspector, who was formerly the resident inspector at Unit 1. Regional inspectors were on site during January, February, May, June, and August for routine inspections, including oversight of the Fuel Rod Accountability Project's spent fuel investigation. On December 19, 2000, Region I management, in a conference call with the licensee, discussed the investigation status and requested a written update, which the licensee provided to NRC and, during the conference call, NRC offered to conduct weekly conference calls. The calls began on January 2, 2001, and are expected to continue through the end of the Fuel Rod Accountability Project's investigation. The Office of Nuclear Reactor Regulation (NRR), the Office of Nuclear Material Safety and Safeguards (NMSS), and Region I staff have regularly participated in these teleconferences. Dominion Nuclear Connecticut, Inc. (DNC) visited Region I on April 23, 2001, to present a status report.

State Interactions

NRC staff has closely coordinated with the States of Connecticut, Washington, and South Carolina on this matter. Connecticut, Washington, and South Carolina staff participate in the weekly status calls with Northeast Utilities, during which they have an opportunity not only to understand the status of the Fuel Rod Accountability Project's activities but also to ask questions and request assistance. Washington, for example, has requested assistance from Northeast Utilities in a number of areas such as identifying possible shipments to Hanford and the type of disposal container that could have been used. Washington and South Carolina staff have also closely coordinated with NRC staff on their preparatory activities and have informed their respective Governor's Offices of the possibility that the fuel rods may have been shipped to the Hanford or Barnwell sites for disposal. Connecticut staff has continued to closely monitor the Fuel Rod Accountability Project's investigation and is preparing to brief the Governor's office. The Washington Governor's Office asked the State Department of Health staff to take the lead in the State and to complete a number of preparatory activities. The preparatory activities have included briefing key State management, developing background materials, including a set of questions and answers, reviewing disposal facility records and coordinating with U.S. Ecology, the operator of the Hanford LLW site. The Washington State Department of Health staff has requested assistance from NRC staff in several areas, particularly in the development of responses to questions in its set of questions and answers.

NRC staff has also initiated periodic (approximately monthly) conference calls between South Carolina and Washington staff and key NRC staff to discuss the status of the investigation and to coordinate and share information on actions being considered or planned. During a recent call, Department of Energy (DOE) Hanford staff also participated. DOE will help Washington determine whether it is possible to "verify" the placement of the fuel rods at Hanford if shipment to Hanford as LLW is finally identified as a credible scenario by Northeast Utilities. DOE staff will also assist in answering a question from Washington on whether the placement of the fuel rods at Hanford would affect DOE's ability to assume title for the land in 2063, when State of Washington lease of the U.S. Ecology LLW disposal facility from DOE ends.

Northeast Utilities has met with key State staff, including the Governor's Office staff, to discuss the investigation at Millstone.

The staff has not actively engaged in discussions with the State of California regarding this issue since the Fuel Rod Accountability Project's only plausible scenario involving California proposes that the fuel rods were shipped to the General Electric fuel examination facility at Vallecitos. Since the General Electric facility at Vallecitos is licensed by NRC to receive and store spent nuclear fuel, among other activities, this scenario would not involve any State licensing issues. In addition, radiation protection and safeguards programs at Vallecitos would be sufficient to ensure adequate protection of the public if the fuel had been inadvertently transferred there.

Press and Local Interest in Event

The local newspaper for the Millstone area (The Day) has reported on the missing spent fuel rods since 3 weeks after the licensee identified the issue. Copies of several recent articles are attached. (Attachment 1).

On February 1, 2001, NRC staff from Region I and from NRR made presentations on the status of NRC activities related to the missing spent fuel to the Millstone 1 Decommissioning Advisory Committee (M1DAC), a subcommittee of the Connecticut State Nuclear Energy Advisory Committee (NEAC). Region I presented an update to the M1DAC on May 3, 2001, and met with the NEAC on May 17, 2001.

Congressional Interest

Congressional interest expressed to NRC involved a request from Congressman Markey dated December 20, 2000, for answers to multiple questions on the situation. Chairman Meserve responded to Congressman Markey on February 1, 2001. Copies of both letters are attached. (Attachments 2 and 3).

Material Control and Accounting (MC&A) Inspections

The inspection of MC&A at power reactors was a regional responsibility until 1988, when resources for MC&A inspections were deleted from the regions' budgets. After 1988 the regions performed MC&A inspections at reactors only in response to events. NRR has oversight responsibility for the regions' safeguards programs at reactors.

The Inspection Procedure (IP 85102, "Material Control and Accounting - Reactors") that the regions followed has objectives to (1) determine whether the licensee has limited its possession and use of SNM to the locations and purposes authorized under license, and (2) determine whether the licensee has implemented an adequate and effective program to account for and control the SNM in its possession. The procedure's inspection requirements include the following: "Conduct a random spot-check of new fuel, irradiated fuel in spent fuel pool, sources, test specimens, etc., by comparing actual location with that indicated on loading diagrams, transfer forms, or other accounting records, as applicable. Check ten assemblies or bundles of new and irradiated fuel, and one source, test specimen...." The inspection procedure does not specifically address individual fuel rods.

Discussions with some NRC staff who had experience conducting MC&A inspections at reactors 10 years ago indicated that the inspectors would have taken random samples from each of the distinct populations, such as fuel elements, fuel assemblies, and sources. Therefore, unless the inspectors were made aware that fuel elements were stored separately from the assemblies, a sample for inspection would be drawn from the total spent fuel pool's population of fuel elements whether in assemblies or separated from assemblies, rather than a portion from the population in assemblies and a portion from the population separated from assemblies. It is not likely that an inspector following IP 85102 would have discovered the discrepancy in the records. The version of IP 85102 discussed here was issued on March 29, 1985. NRC staff was unable to locate records of the MC&A inspections conducted at Millstone Unit 1.

An ANSI standard (ANSI N15.8-1974 , "Nuclear Material Control Systems for Nuclear Power Plants," endorsed by Regulatory Guide 5.29) that was in effect in 1979-1980 reads:

> "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 numbers and location. Nuclear material contained in fuel elements, not part of an assembly, shall be separately identified in all material control records."

Under 10 CFR 70.51 and 70.58, a reactor licensee is required to keep records showing the receipt, inventory (including location), disposal, acquisition, and transfer of all SNM. Each record of receipt, acquisition, or physical inventory of SNM must be retained as long as the licensee retains possession of the material and for three years following transfer of such material. Physical inventories of SNM must be performed annually.

Nuclear power reactors are required to report to the NRC:

1. Semiannual material balance reports concerning SNM received, produced, possessed, transferred, consumed, disposed of, or lost.
2. Semiannual statements of the composition of the ending inventory .
3. A Nuclear Material Transaction Report whenever the licensee transfers or receives SNM, or when it makes corrections to its material balance.

Reports submitted to the NRC under these provisions did not indicate that the two fuel rods were no longer in the licensee's inventory, because the licensee did not apparently recognize at the time that it may have transferred the rods to another licensee.

<u>Discrepancy in NUREG-0725</u>

A representative from Millstone called the Spent Fuel Project Office staff in mid-May 2001 to ask why the NRC revised the spent fuel shipment data for shipments of spent fuel from Millstone to the GE-Vallecitos facility in the 1991 issuance of "Public Information Circular for Shipments of Irradiated Reactor Fuel," NUREG-0725, Revision 7. The earlier issuances of NUREG-0725 beginning with the first issuance in 1980 (Revision 0) through the 1989 issuance (Revision 6) reported the total spent fuel shipped in three shipments from 1980 - 1983 to be 36 kgs of combined element net weight of uranium and plutonium. The 1991 Revision 7 of NUREG-0725 changed that total to 43 kgs.

Based on the staff's review of the files, the staff concluded that the 1991 revision to the NUREG-0725 report changing the total shipped from 36 kgs to 43 kgs was an error by the staff. The correct total for the 1980 - 1983 shipments should be 36 kgs.

Agency Obligations/Regulatory Authority

NRC and Washington State or South Carolina share regulatory authority if the missing fuel rods are determined to be located in the LLW sites in Washington State or South Carolina (storage at GE-Vallecitos would be authorized under existing NRC license).

As a general rule, NRC retains regulatory authority over spent nuclear fuel and greater-than-Class C material associated with reactor operations. As provided in Section 111(b)(2) of the Nuclear Waste Policy Act of 1982 (NWPA), the disposal of spent fuel is a Federal responsibility. The NRC has not relinquished, in any agreement with an Agreement State, regulatory authority for spent fuel stored at a reactor site. In this case, if it is determined that the NRC licensee transferred spent fuel to an LLW site, it was an unauthorized transfer, since it was not authorized by the Commission's regulations or Millstone's license. In addition, NRC could determine that the recipient is in unauthorized possession of the material. Thus, if the spent fuel is determined to be at the LLW site in Washington State or South Carolina, NRC has the regulatory authority to require appropriate remedial action to be taken by its licensee and, if warranted, to require the spent fuel to be returned to an entity authorized to possess it. The exercise of that authority would depend on the circumstances, with the health and safety impacts of recovering the fuel and returning it to an entity authorized to possess it balanced against the impacts of leaving it at the burial site.

Washington and South Carolina, as Agreement States, regulate disposal of LLW at the Hanford and Barnwell sites respectively. The States' license includes authorization to dispose of limited quantities of SNM in accordance with Section 274 of the Atomic Energy Act of 1954, as amended. If the spent fuel is determined to be at the LLW site in Washington State or South Carolina, even though the fuel may be within the SNM limits in the license, Washington or South Carolina will likely determine that it was not an authorized disposal, since the State's license did not authorize its licensee to dispose of spent fuel. Spent fuel is explicitly excluded from the definition of low-level waste in 10 CFR 61.2 and compatible State regulations. Thus, if the spent fuel is found at the LLW site in Washington State or South Carolina, the States have the complementary regulatory authority to require remedial action to be taken and, if warranted, to require the spent fuel to be returned to an entity authorized to possess it.

PLANNED STAFF ACTIONS

Communication Plan

A communication plan has been developed to ensure that the appropriate staff personnel and stakeholders are informed of new developments in the Fuel Rod Accountability Project's investigation and NRC's follow up. A copy of the plan is attached. (Attachment 4).

Notifications

Once the licensee determines the spent fuel rods are lost, it will have to make a notification to the Operations Center within one hour under the provisions of 10 CFR 70.52. When this notification is received, the staff will inform other Federal agencies that could receive press inquiries such as the Department of Energy, the Federal Emergency Management Agency, and the Environmental Protection Agency and the State agencies. The purpose of this notification will be to ensure that the other agencies have a clear and common understanding of the situation and that there is no present hazard based on NRC's present understanding of the situation.

Follow-up Inspection

As discussed above, routine inspections have been conducted by Region I inspectors and by the Unit 2 resident inspector, who was formerly the resident inspector at Unit 1. Following up on these routine inspections performed at Millstone 1, the NRC staff is planning a special inspection to be conducted after the Fuel Rod Accountability Project's final investigative report is submitted. This inspection, to be led by Region I with assistance from NRR, NMSS, and OSTP, will enable the staff to independently assess actions taken by the licensee and Northeast Utilities.

The general objectives of this inspection are to:

1. Conduct a thorough and systematic review of the Fuel Rod Accountability Project's investigation into the circumstances of spent nuclear fuel missing from the Millstone 1 spent fuel pool. Determine the adequacy of the Fuel Rod Accountability Project's investigation, based upon its completeness and the thoroughness of records reviews and interviews.

2. Assess the Fuel Rod Accountability Project's determination of root cause. Identify alternative causes if appropriate. Develop independent conclusions regarding what caused the loss of the spent fuel rods, if it is determined that the rods are, in fact, lost.

3. Independently verify selected Fuel Rod Accountability Project records and interviews.

Potential Enforcement

If the NRC staff determines that regulatory requirements concerning accountability, possession, packaging, and transportation have been violated, the staff will consider whether enforcement action should be taken.

Options for Addressing Potential Disposal of Fuel Rods at an LLW Disposal Site

Although the location of the fuel rods, or portions of the fuel rods, is still unknown at this time, Northeast Utilities is nearing the completion of its inspection of the spent fuel pool, and may soon conclude that the rods are not on site. The focus of the investigation will then turn to their possible disposal at an LLW site, either the U.S. Ecology facility in Richland, Washington, or the Duratek facility in Barnwell, South Carolina. As noted in an earlier section of this paper, the

NRC staff has been coordinating with these States on the possibility of such disposal of the fuel rods, and the NRC staff has thus far generally addressed safety and jurisdictional issues. With a conclusion that the rods are not on site, however, specific actions will need to be taken to address disposal at an LLW site.

The fundamental issues associated with disposal are whether the rods, or portions of rods, can be located in a disposal trench and whether they should be exhumed. The NRC staff is taking a number of steps to obtain the information needed to address these issues. First, the NRC staff plans to perform its own scoping analysis of the potential safety impacts from the possible disposal of the fuel rods in either LLW site. The NRC staff will examine the potential impact on an inadvertent intruder, using assumptions similar to those used in the development of 10 CFR Part 61 and in Washington State's approval of the disposal of the Trojan reactor vessel at the U.S. Ecology LLW facility in Richland, Washington. The NRC staff will also evaluate the potential long-term dose impacts to an offsite individual from potential leaching of the radionuclides in the fuel rods into groundwater. Although the inventory of radioactivity is low (300 curies) compared to the total inventory at the sites (millions of curies), some longer lived radionuclides in spent fuel need to be considered.

The NRC staff is evaluating with the States of Washington and South Carolina plans to obtain more in-depth evaluations of the impact of the potential disposals of the fuel rods. Any organization that conducts such studies would need to have the special expertise required for this work, have access to the extensive site and waste characterization data and assumptions used in computer modeling of radiation exposures to members of the public, and be acceptable to all of the principal stakeholders. In addition, arrangements for funding of such a study by the utility would need to be worked out. To determine potential safety impacts, the NRC staff, in coordination with the States, has begun initial planning for determining if the rods can be located and exhumed. The NRC staff will evaluate the feasibility of such investigations, if exhumation is necessary, and will use this information for generally defining the work that may be required. Some of the issues being examined are whether radiation detection equipment is capable of locating fuel rods in the trenches, whether boreholes or larger scale removal of trench covers might be needed for detection, and what the potential dose impacts would be to workers involved in these efforts. An important consideration will be the risks associated with leaving the material in place over the long term, as compared with the risks (i.e., dose to workers) associated with removing it. The principal objectives at this time are to investigate feasibility, obtain consensus with State officials on approaches, and develop information for defining what work may have to be performed by the utility or its contractor in locating the rods on site.

Long-Term Actions

The staff is considering the following long-term actions:

1. Issue generic correspondence as appropriate for root cause determination.

2. Determine if the current NRC requirements for tracking and reporting SNM transactions provide information adequate for complete accounting of spent nuclear fuel.

3. Identify and recommend changes to NRC regulations and NRC oversight concerning special nuclear material control and accounting at power reactors that may be necessary to prevent similar incidents from occurring. Ensure affected states, other NRC and state licensees, and other stakeholders are kept informed of the NRC activities.

4. The Commission will be informed of significant developments pertaining to this issue.

Unless otherwise directed by the Commission, this paper will be made public 5 days after issuance.

/RA/

William D. Travers
Executive Director
for Operations

Attachments: 1. Selected Newspaper Articles
2. Letter from Congressman Markey dated December 20, 2000
3. Reply to Congressman Markey dated February 1, 2001
4. Communication Plan

3. Identify and recommend changes to NRC regulations and NRC oversight concerning special nuclear material control and accounting at power reactors that may be necessary to prevent similar incidents from occurring. Ensure affected states, other NRC and state licensees, and other stakeholders are kept informed of the NRC activities.

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Package: ML012110209/Attachment 1: ML012120002/Attachment 2: ML003780238
Attachment 3: ML010090267/Memo to Comm.ML012080223 SECY-012
***See previous concurrences **Concurred by telecon**

OFFICE	PM:PDIV-2	LA:PDIV	SC PDIV-2	D:PDIV	TECH EDIT
NAME	JHickman*	MMcAllister*	SDembek*	SRichards*	PKleene*
DATE	7/31/2001	7/24/2001	7/24/2001	7/25/2001	7/26/2001
D:DLPM	OPA	OGC (NLO)	D:RGN-I	D:OSP	D:IRO
JZwolinski*	WBeacher*	JLieberman*	HMiller**	PLohaus*	RWessman*
7/31/2001	8/02/2001	8/07/2001	8/20/2001	8/07/2001	8/03/2001
ADPT:NRR	D:OE	D:NMSS	D:NRR	DEDR:EDO	EDO
BSheron*	FCongel*	MVirgilio*	SCollins*	WKane	WDTravers
8/09/2001	8/14/2001	8/24/2001	8/09/2001	09/18/01	09/20/01

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COMMUNICATION PLAN

Significant Status Updates

NRR will assure that key staff personnel and outside stakeholders (see attached list) are notified promptly.

OSP will assure that involved States are notified.

Q&As (continually being revised as new info/issues emerge) will have been provided to OPA and other NRC liaison offices to respond to outside inquires.

70.52 Report

Same as above plus:

IRO notifications will made. Recipients will have been pre-briefed that this is a known event which the NRC has been following for nine months.

Final Investigation Report (Note: these actions will begin when the results of the investigation are provided to the NRC and other stakeholders not necessarily when the report is issued)

Same as Significant Status Updates plus:

If investigation concludes that fuel rods are at an LLW site, initiate detailed discussions with involved State(s) on appropriate course of action. (Alternatives, considerations, cost benefit analysis including examinations and testing possible and/or required, licensing requirements and options) Preliminary discussion have already taken place.

Final Root Cause Report (Note: these actions will begin when the results of the Fuel Rod Accountability Project's investigation are provided to the NRC and other stakeholders not necessarily when the report is issued)

Initiate generic communications as appropriate.

Attachment 4

Millstone Missing Fuel Contact List

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