COMPLIANCE INSPECTIONS BY USNRC OF RECENT SPENT FUEL SHIPMENTS

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ABSTRACT

During the past four years NRC inspectors have been routinely engaged in the inspection of a considerable number of the shipments of spent fuel by NRC licensees. During this time, a number of shipment campaigns by highway have been completed, and several rail shipment campaigns are currently on-going. The specifics of each shipment campaign are described. The items covered during each type of inspection; e.g., prior to start of a campaign, prior to each shipment at origin, and upon completion of the shipment at its destination; are also described. The overall safety experience, as well as regulatory compliance, have been noted to be excellent. The recurring technical problem of surface contamination; i. e., cask "weeping" and methods being taken to reduce its occurrences, are discussed.

BACKGROUND

Following many years during which a relatively low volume of shipments ofcommercial spent nuclear fuel had taken place, the past four years have seen a substantial increase of such transportation. This recent increase is not generally believed to be a forecast of the volumes expected over the next decade. It is, however, quite likely to be more representative of the greatly increased volumes which are expected to be commonplace after the turn of this century. That increase will be in conjunction with the operation of a nuclear waste repository and a monitored-retrievable-storage (MRS) facility, if the latter is built, pursuant to the Nuclear Waste Policy Act of 1982.

This recent increased volume of shipments began in July 1983 and has involved a series of nine specific campaigns. Upon their completion, the shippers will have accomplished the transfer of over 3600 long-cooled spent fuel assemblies between different storage basin (pools). There have, of course, been a number of other shipments of commercial spent nuclear fuel, however, these have been relatively few in number, involving mainly specific shipments of test assemblies in support of research and development programs and transfers of spent fuel by several utilities between the storage basins of different power stations operated by the same utility.

All of these recent shipments have been made in spent fuel casks which have been certified by the U.S. Nuclear Regulatory Commission (NRC) pursuant to its regulations in § 10 CFR 71. In seven of the campaigns, the consignor (shipper) has been an NRC licensed nuclear utility, whereas two of the campaigns involve shipments by the U.S. Government (DOE) in NRC-certified casks. Inspections have been performed by NRC inspectors from its regional inspection staff on the shipments made by NRC licensees.

In general, these inspections have indicated a very high degree of safety experience as well as compliance with requirements. No vehicular accidents have occurred. All of the problems experienced have been relatively minor, and equipment-related or related to ancillary equipment.

The only technical problem experienced has been a periodic recurrence of cask "weeping" episodes. Over the years, this has been a chronic problem for most spent fuel casks. Removable surface contamination is sometimes found to exceed limits after shipment, even though limits were not exceeded at the time of shipment. This problem is discussed in detail in the paper, along with some of the methods being used to alleviate the problem. These methods include typically, better cleaning of the casks after removal from the pool, and the determination and use of a higher efficiency for the wipe sampling.

Numerous institutional problems have also been experienced, particularly prior to the start of each shipment campaign. These problems are not addressed in this paper, as they are the subject of many papers at various other symposia over the past several years.

SHIPMENT CAMPAIGNS

Figure 1 is a schematic flow diagram of the relative geographical locations for the shipping campaigns. These involved:

- Completed campaigns of highway shipments of spent fuel from West Valley, New York back to the following power stations where the fuel had been originally generated:

- Wisconsin Electric Co., (Point Beach), Two Rivers, Wisconsin
- Commonwealth Edison, (Dresden), Morris, Illinois
- General Public Utilities Co., (Oyster Creek), Forked River, New Jersey
- Rochester Gas and Electric, (Ginna), Ontario, New York

West Valley, New York is the site of the formerly licensed commercial spent fuel reprocessing center (NFS) which is being decommissioned by the U.S. Department of Energy, as required by the West Valley Demonstration Project Act of 1980. As part of the decommissioning process, about 750 spent fuel assemblies, all of which are at least 10 years old, are being removed from the storage basin at West Valley.

- Other shipping campaigns include:
  - A planned campaign of two rail shipments by DOE of 125 NFS-owned assemblies remaining at West Valley to the Idaho Falls, Idaho (INEL) facility as part of a demonstration, dry-storage program.
  - A completed campaign of highway shipments from the General Electric Company away-from-reactor (AFR) licensed storage facility in Morris, Illinois (GE:MO) back to the generating location of the spent fuel at Two Rivers, Wisconsin (Point Beach).
  - On-going campaigns of rail shipments from two nuclear utilities; the Nebraska Public Power Company's Cooper Station, Nemaha County, Nebraska and Northern States Power Company's Monticello Station, Minnesota, to the GE:MO facility.
  - An on-going campaign of highway shipments by the DOE from the Virginia Power Company's Surry, Virginia station to the DOE Idaho (INEL) facility as part of a dry storage demonstration project.

Relevant shipment and inspection data on each campaign is summarized below:

HIGHWAY SHIPMENTS

- West Valley to Point Beach, WI (Oct. 1983 to Nov. 1984) 1213 Kilometers (754 miles)
  - One NLI-1/2 cask in each highway shipment.
  - One PWR Fuel Assembly per cask [C-O-C, USA/9010/B( ) F]
  - 114 shipments completed - 114 assemblies
  - 56 shipments inspected by NRC at West Valley
  - 21 shipments inspected by NRC at Point Beach
- West Valley to Oyster Creek, NJ (Nov. 1984 to July 1985), 854 Kilometers (531 miles)
  - 1 TN-9 cask in each highway shipment
  - 7 BWR fuel assemblies per cask (C-O-C, USA/9016/B ( )F)
  - 33 shipments completed - 224 assemblies total
  - 4 shipments inspected by NRC at West Valley
  - 33 shipments inspected by NRC at Oyster Creek
- West Valley to Dresden, IL (Dec. 1983 - Nov. 1984), 941 Kilometers (584 miles)
  - 1 TN-9 Cask in each highway shipment
  - 7 BWR fuel assemblies per cask (C-O-C, USA/9016/B ( )F]
  - 31 shipments completed - 217 assemblies
  - 25 shipments inspected by NRC at West Valley
  - 26 shipments inspected by NRC at Dresden
- West Valley to Rochester, NY (Ginna) (June 1985 - May 1986) (Present), 249 Kilometers (155 miles)
  - 1 NLI-1/2 cask in each highway shipment
  - 1 PWR fuel assembly per case, (C-O-C, USA/9010/B ( ) F]
  - 75 shipments completed (75 assemblies)
  - 8 shipments inspected by NRC at West Valley
  - 14 shipments inspected by NRC at Ginna
- Morris, IL to Point Beach, WI (July 1983 - Oct. 1984) 402 Kilometers (250 miles)
  - 1 NLI-1/2 cask in each highway shipment
  - 1 PWR fuel assembly per cask [C-O-C,USA/9010/B ( )F]
  - 109 shipments completed, 109 assemblies
  - 61 shipments inspected by NRC at Morris
  - 60 shipments inspected by NRC at Point Beach

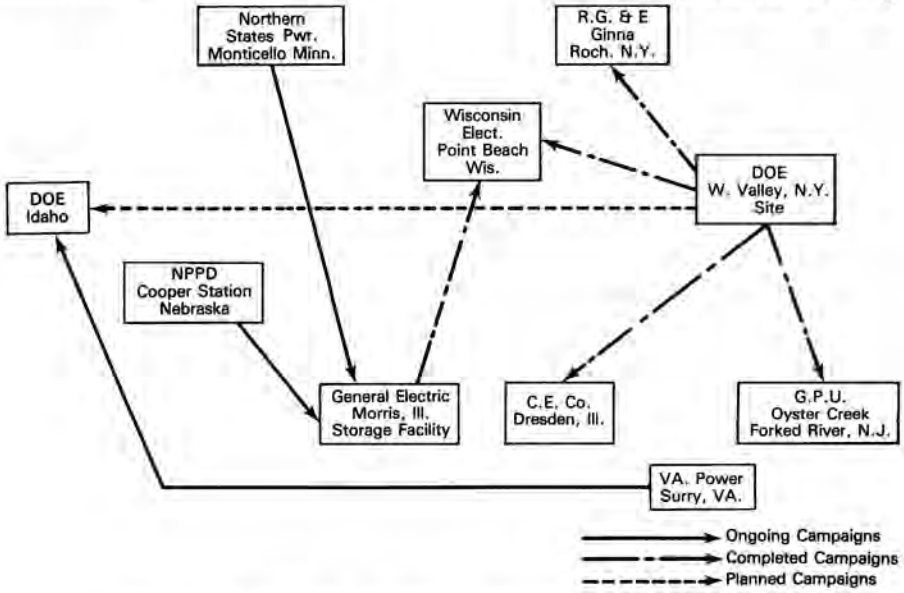

Fig. 1. Spent Fuel Shipment Campaigns 1983 to Present.

- Surry Station, VA to Idaho Falls, ID (1985 to present)
  - 1 TN-8L cask in each highway shipment
  - 3 PWR assemblies per cask [C-O-C, USA/ 9015/B( )F]
  - Approximately 100 fuel assemblies to be transferred
  - 45 assemblies transferred as of January 1986 (15 shipments)
  - DOE shipments - not inspected by NRC

RAIL SHIPMENTS

- Cooper Station, NE to GE:MO, IL (Aug. 1983 to present), 986 Kilometers (615 miles)
  - 30 shipments planned - approximately 1,100 BWR assemblies
  - 2-3 IF-300 casks in each special train shipment
  - BWR assemblies per cask. [C-O-C, USA/ 9001B( )F]
  - 13 shipments (27 casks) completed as of Dec. 31, 1986
  - 13 shipments inspected by NRC at Cooper
  - 11 shipments inspected by NRC at GE:MO

- Monticello Station, MN to GE:MO, IL (Nov. 1984 to present) 769 Kilometers (478 miles)
  - 30 shipments planned
  - 2 IF-300 casks in each special train shipment
  - 18 BWR assemblies per cask. [C-O-C, USA/ 9001B( )F]
  - 19 shipments (38 casks, 683 assemblies) completed as of March 1986
  - 12 shipments inspected by NRC at Monticello
  - 13 shipments inspected by NRC at GE:MO

- West Valley, NY to DOE, Idaho Falls, ID (INEL) (Planned)
  - 2 shipments planned (125 total assemblies) 3460 Kilometers
  - 1 shipment of 85 BWR assemblies in TN-BRP cask (new)
  - 1 shipment of 40 PWR assemblies in TN-REG Cask (new)
  - NRC will inspect shipments at departure from West Valley
  - Casks to be certified by NRC

SHIPMENT INSPECTIONS BY NRC

The NRC has been conducting compliance assurance inspections of many of the individual shipments in the recent campaigns. These inspections are made prior to initiation of a campaign, at the time of a shipment departure and upon its arrival at destination. As a general practice, NRC does not attempt to perform inspections of all of the individual shipments of nuclear materials by its licensees. Routinely, the major focus of inspection efforts is directed to inspection of the adequacy of a licensee's program for packaging and transportation compliance assurance.

During a routine inspection of a licensees' radiological safety program, the adequacy of the licensees' training of personnel, quality assurance program, written procedures, and records of past shipments are examined. Individual shipments will, however, be inspected, including independent measurements of radiation/contamination, if a shipment is being made during the course of any routine inspection.

Prior to the start of the recent campaigns in 1983, NRC elected, however, to perform individual inspections at departure and destination locations, as well as inspection of the licensee's preparations for the shipments prior to the start of any campaign. At the start of each campaign, inspection frequencies approached 100 percent. Subsequently, as each campaign progresses, this high frequency is then scaled down so as to cover a statistically significant number of shipments, but never less than 25 percent.

These inspections are routinely made by health physics inspectors who have been provided with training on transportation requirements. Inspectors may be based in any of the NRCs five regional offices. Upon becoming aware of a planned shipment, the inspector must travel at the appropriate time to the origin and/or destination locations. In several of the campaigns, the NRC inspector who is resident at the origin or destination power station has been provided with training in the use of survey instruments and survey techniques, thus enabling him to perform the required shipment inspections. This has been effective in eliminating the need for travel to the origin or destination location by a region-based inspector.

The inspections are directed at verifying the adequacy of the licensee-shipper's compliance with both safety (packaging) and safeguards (security) requirements.

PRESHIPMENT INSPECTIONS

Prior to the start of any campaign, preshipment inspections are made to verify the adequacy of the licensee's program and preparations for the forthcoming shipments. The following safety items include verification of:

- Cask adequacy with respect to NRC Certificate of Compliance requirements;
- Adequacy of procedures established to load spent fuel into the cask and prepare the cask for transport;
- Adequacy of training and instruction of personnel involved in cask loading and preparation;
- Adequacy of load testing of cask handling devices.

The shipment safeguards items include:

- Review of the previously approved routes (prior route approval by NRC for safeguards purposes is required)
- Review of proposed shipping schedules
- Review of procedures for advanced notifications of shipments
- Verification of procedures for advanced contracts with local law enforcement agencies
- Verification that armed escorts will be provided as or when required
- Assurance that armed escorts are trained and equipped as required
- Assurance that casks and vehicles are provided with approved seals/locks
- Review of adequacy of the transport vehicle communications and immobilization equipment
- Assurance that the licensee has made provisions for a continuously manned center for communicating with the transport vehicle

SHIPMENT INSPECTIONS AT ORIGIN

For each shipment selected for inspection, the NRC inspector verifies that at least a minimum approved number of properly trained drivers and/or escorts are available for the shipment, that the cask seals are applied and are intact, that the vehicle is equipped

with operable redundant communications equipment and that the vehicle is equipped with immobilization devices. The inspector also assures that the shipping paper documentation is properly completed, that the required testing and maintenance of the cask has been completed, that the cask is properly labeled and the transport vehicle placarded, and that no uncorrected problems remain from cask loading. In addition, the inspector performs independent predeparture radiation/contamination surveys of the cask and transport vehicle to verify the licensee's measurements.

SHIPMENT INSPECTIONS AT DESTINATION

At the destination, the NRC inspector verifies that seals are intact, and that placards on the vehicle are present. The inspector also conducts independent radiation/contamination surveys on the cask/vehicle to verify the licensee's measurements and to assure that regulatory limits were not exceeded during transportation. The inspector verifies that security provisions had been followed through examination of driver/escort's logbooks and by discussions with escort personnel.

In conducting the preshipment inspection, as well as shipment inspections at departure/destination, written checklist sign-off survey forms are used. Each checklist contains cask/vehicle-specific diagrams for recording the radiation/contamination survey data obtained.

GENERAL OBSERVATIONS

The safety experience during the shipment campaigns has been excellent. No vehicle accidents have occurred to date. Some relatively minor equipment-related and cask handling problems have been experienced, all of which were corrected. Typically, these have included such matters as:

- Cracking of a landing gear support structure and nonsupport structural area of a highway trailer
- Cracking of structural support members on several highway trailers
- Uncoupling of the intermediary axle assembly (known as a "Joe-Dog") i.e., a part of the trailer system, from its tractor at a very slow speed during a highway shipment. No accident occurred, and the trailer systems was replaced with a new system no longer utilizing the intermediary assembly
- Leakage of contamination from a vent fitting during unloading of a cask prior to insertion into the pool. Leakage was due to a missing gasket in the vent fitting assembly. No personnel exposure exceeding regulatory limits occurred
- A positioning pin on the upper impact limiter of a cask was bent as a result of cask shifting during transport due to improper positioning of the shims on the lower trunnion support structure
- On an early shipment, an inconspicuously marked cask nameplate was observed. A new nameplate was fabricated and attached before the next shipment
- An impact limiter hold-down bolt had not been adequately secured prior to departure on one shipment
- Bent lifting handles were observed on several fuel assemblies, apparently due to contact with the fuel cask lid
- One of six trunnion impact limiters was missing on a shipment, due to inadequate bolt torquing.

All of these problems were corrected prior to the next shipment of the cask, and actions were taken to prevent their recurrence.

CASK SURFACE CONTAMINATION PROBLEM

These recent shipment campaigns of spent fuel have focused renewed attention on a chronic problem identified as cask "weeping." This is a phenomena whereby certain spent fuel casks, after their removal from underwater storage pools and decontamination, subsequently exhibit a substantial increase, during transport, in the level of removable surface contamination, even though the levels were well within regulatory limits at the start of transport.

This buildup of contamination, generally referred to as "weeping," is apparently the result of release of entrapped activity from surface pores and fissures. Its occurrence and magnitude appear to depend on such variables as the cask cleaning methods, pool activity level, types of detergents used, cask surface treatment history, and the period of time which elapses between completion of transport and conduct of the contamination survey.

There have been perhaps several dozen cask "weeping" episodes, through these recent campaigns. Most of these episodes occurred during earlier shipments. A number of actions have been taken not only to decrease their frequency and magnitude, but also to clarify the application of the regulatory limits for measurement of surface contamination.

Removable surface contamination as limited by DOT regulations (§49 CFR 173,443) is based on wipe sampling techniques, wherein an assumption is made that a wipe sample is 10 percent efficient. The wipe sample limit is therefore set at 10 percent of the limit stated in the IAEA Regulations Safety Series No. 6. DOT regulations also allow for the use of wipe sampling methods at an efficiency greater than 10 percent, provided that such wiping efficiency has been demonstrated on a cask-specific basis.

These have been somewhat effective in decreasing their frequency and magnitude, and include:

- use of improved steam cleaning techniques and detergents
- use of a rubber-like "sleeve" to surround a certain cask (which has many small cooling fins) during its insertion into the pool, thereby preventing direct contact of the cask surface with the basin water
- Upon detection of weeping, immediate performance of a cask-specific survey to determine the actual wiping efficiency, i.e., to "demonstrate" that the application of an efficiency greater than 10 percent is justified.

The technique which has been acceptable to NRC for demonstrating a higher wiping efficiency involves the repetitive wiping of a portion of the cask surface. The demonstrated wipe efficiency is then the ratio of the initial smear activity to the summation of the activity on all the wipes obtained on the designated portion of the package surface. For these purposes, an assumption is made that all of the activity has been removed upon completion of ten wipes on the designated portion of the package surface. Use of this technique obviously requires that the receiver of the cask delay unloading of the cask upon its arrival until after the efficiency determination has been made and evaluated. Through the use of this technique a number of the "weeping" episodes identified during the past several years, initially observed values which exceeded limits using the "de facto" 10 percent efficiency, have been determined to be within limits by application of demonstrated high

efficiency. In some cases, this higher efficiency has been shown to be a high as about 50 percent.

The NRC Office of Inspection and Enforcement issued IE Information Notice No. 85-46 on this subject on June 10, 1985. In this Notice, discussion and guidance are provided on the cask "weeping" problem and on the application of high efficiency wipe sampling methods.

SHIPMENT INSPECTIONS BY OTHER AGENCIES

In addition to the inspection of shipments by NRC as described in this paper, spent fuel shipments area also inspected by other Federal and State agencies. In general, these inspections by the other agencies are directed toward compliance assurance requirements applicable to the carriers and the safety conditions of the transport vehicle. However, in some States, such inspections also include additional independent surveys of the radiation and contamination levels of the cask/vehicle. As most shipments transverse a number of different States, each with differing practices, the number and types of inspections vary considerably. In a few States, no inspections are made; in other States, an inspection is made at the point of entry only. In the State of Illinois, each shipment is met at the point of entry and inspections are performed. A State Police Hazardous Materials Officer inspects the vehicle safety, whereas a health physics inspector from the State Department of Nuclear Safety inspects the radiation/contamination levels. Shipments originating in that State are inspected by the State at the origin location. Once the shipment commences travel through Illinois, it is escorted to its destination or exit from the State by escorts in separate vehicles, from the same two State agencies; the Department of Nuclear Safety and the Hazardous Materials State Police.

In all cases, the shipper is required to provide an advance notification to each State, advising of times of shipment and routes to be taken.

CONCLUSION

During the seven shipment campaigns to date in which NRC has conducted inspections, some 394 of a planned total of 424 shipments had been completed successfully as of September 1, 1986. Through that date, compliance inspections were made were made by NRC of 45 percent (179 shipments) at the point of departure and 45 percent (179 shipments) at the point of destination. Safety experience has been excellent. No transport accidents have occurred. Minor handling equipment and vehicle problems were noted on several occasions. Overall compliance by the shippers with transportation and packaging requirements has also been noted to be very good. The major technical problem noted was the occurrence of cask "weeping," e.g., excessive removable surface contamination on cask surfaces upon arrival at destination. More recent shipments have noted a decrease of such occurrences. This problem, however, should be given consideration in the future designs of spent fuel casks, so as to provide cask surfaces and cleaning methods which will minimize the occurrence and magnitude of the "weeping" phenomena.

REFERENCES

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