

August 1987

# NUCLEAR WASTE

## Shipping Damaged Fuel From Three Mile Island to Idaho



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United States  
General Accounting Office  
Washington, D.C. 20548

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**Resources, Community, and  
Economic Development Division**

B-227551

August 10, 1987

The Honorable William L. Clay  
House of Representatives

The Honorable Richard A. Gephardt  
House of Representatives

The Honorable Alan Wheat  
House of Representatives

As requested in your letters of June and July 1986 and as agreed in subsequent meetings with your staffs, we have examined into the Department of Energy's program to ship damaged nuclear fuel from the Three Mile Island nuclear power plant, near Harrisburg, Pennsylvania, to the Idaho National Engineering Laboratory. This report presents the results of our examination.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to appropriate congressional committees; the Secretary of Energy; other federal, state, and private agencies and organizations involved with the Department's program; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

This work was performed under the direction of Keith O. Fultz, Associate Director, Resources, Community, and Economic Development Division. Other major contributors are listed in appendix VII.

A handwritten signature in black ink, reading 'J. Dexter Peach'. The signature is written in a cursive style with a large initial 'J' and 'P'.

J. Dexter Peach  
Assistant Comptroller General

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# Executive Summary

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## Purpose

The March 1979 accident at Three Mile Island (TMI) severely damaged the reactor's nuclear fuel and produced about 150 tons of highly radioactive debris. Efforts are underway to remove and transport this material to a government research facility in Idaho for further study.

Representatives William Clay, Richard Gephardt, Alan Wheat, and Robert Young requested GAO to report on the

- reasons why the debris is being shipped to Idaho;
- safety standards used for the shipments;
- testing of the transportation containers;
- criteria used to select the shipping route, because of concerns from the July 1986 rail accident in Miamisburg, Ohio, involving fire and hazardous cargo; and
- emergency planning along the route.

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## Background

One year after the accident, the Department of Energy (DOE); the Nuclear Regulatory Commission (NRC); the General Public Utilities Company (GPU), which owns and operates TMI; and the Electric Power Research Institute agreed to conduct research on the damaged fuel. The research objective is to obtain information that could improve the operation and safety of all commercial reactors. In March 1981 NRC issued an environmental impact statement which stated that the debris from the accident and subsequent cleanup should be removed from TMI because the site is not geologically suitable for the long-term storage of radioactive materials. A March 1982 memorandum of understanding between NRC and DOE stipulated that the debris would be shipped to DOE's Idaho National Engineering Laboratory for research and temporary storage.

According to DOE, between 20 and 40 train shipments over a 2-1 2 year period will be required to transport the material to Idaho. The first shipment was made on July 20, 1986. After the second shipment, a series of reactor defueling problems, such as clogged debris containers, occurred which temporarily halted the shipments. Corrective modifications were made and shipments resumed on December 14, 1986.

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## Results in Brief

DOE's program is designed to remove the damaged nuclear fuel from TMI and to perform research that may benefit all commercial nuclear power plants. GAO found that:

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- DOE decided to ship the damaged nuclear fuel to Idaho Falls because of its facilities and radiological research expertise;
  - the shipping containers were designed and tested, and independently reviewed by NRC, to ensure that radioactivity would not escape during any credible accident;
  - the criteria for route selection was the best quality track, shortest distance, and avoidance of large population centers; and
  - the emergency plans for the TMI shipments are the same as other hazardous cargo, with modifications to accommodate damaged nuclear fuel.

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## Principal Findings

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### Program Purpose

According to DOE, its Idaho facility is best suited, due to its unique equipment and personnel expertise, to perform research on the highly radioactive debris that was produced by the TMI accident. The research will provide insight into methods for large-scale decontamination of plant systems and equipment, processing and disposing of the radioactive wastes produced by an accident, and assessing the effects of an accident on the reactor vessel and other important components.

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### Equipment Design

The transportation equipment was designed and manufactured to safely accommodate the unique characteristics of the damaged fuel. The shipping program has been coordinated among DOE, NRC, GPU, the Federal Railroad Administration (FRA), affected states, and the railroads. Efforts have been taken to assure that appropriate margins of safety exist in all aspects of the program such as engineering and construction standards for the transportation equipment and repeated inspections of the trains and railbeds.

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### Container Testing

Prior to certification of the damaged fuel containers, NRC and the contractors worked over a 3-year period to develop the shipping package. When compared with containers used to transport undamaged spent nuclear fuel, the TMI containers are designed to provide greater protection against the escape of radioactivity. Destructive tests were performed on scale- and full-size models of the containers, and the results were measured against computer predictions. The containers met the predicted results and passed the tests. In addition, NRC performed an independent safety review which considered the shipping cask design

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and test results. DOE and NRC are satisfied that the containers will protect against the escape of radioactivity and were not able to identify any credible accident that would breach them.

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**Route Selection**

The route for the shipments was selected by DOE following consultation with FRA, NRC, and the railroads; route study assistance was provided by Oak Ridge National Laboratory and a private consultant. The criteria governing route selection was high quality track, avoidance of population densities, and the shortest, most direct route.

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**Miamisburg Accident**

In July 1986 a rail accident involving hazardous materials and fire occurred in Miamisburg, Ohio. Some residents had to evacuate the area. The accident, however, did not occur on the route used for the TMI shipments. According to DOE officials, the Miamisburg accident did not demonstrate the need to change the route used for the TMI shipments because, in their opinion, the shipping cask would have successfully withstood the accident.

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**Emergency Planning**

In the event of a hazardous materials accident, the rail carrier, local affected community, and the state are primarily responsible for initiating and monitoring recovery operations. The federal government plans to supplement local efforts, if needed, with assistance and support. The emergency plans for the TMI shipments are the same as those used for accidents involving other hazardous cargo, with modifications such as special emergency response teams to accommodate the unique characteristics of the damaged nuclear fuel.

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**Recommendations**

Because the objective of this report was to provide information on the TMI shipments, GAO is making no recommendations.

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**Agency Comments**

GAO obtained comments on a draft of this report from DOE and other federal, state, and private agencies and organizations involved with the damaged fuel shipping program. Although various suggestions were made for improving technical aspects of the report, commentors generally agreed that the report is an accurate and comprehensive account of the program.



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**Abbreviations**

ASME	American Society of Mechanical Engineers
DOE	Department of Energy
DPM	disintegrations per minute
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
GPU	General Public Utilities, Inc.
INEL	Idaho National Engineering Laboratory
mph	miles per hour
mr	millirems
NRC	Nuclear Regulatory Commission
NUPAC	Nuclear Packaging, Incorporated
SEMA	State Emergency Management Agency
TMI	Three Mile Island

# Introduction

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On March 28, 1979, the most severe accident in the nation's history of commercial nuclear power occurred at the Three Mile Island (TMI) nuclear power plant, which is located on an island in the Susquehanna River about 10 miles south of Harrisburg, Pennsylvania. The accident extensively damaged the nuclear fuel core of one of the two reactors on the site and produced about 150 tons of highly radioactive core debris, including melted fuel. The accident also resulted in minor releases of radiation into the atmosphere from the plant. Subsequent government accident investigations showed that the accident was caused by equipment malfunctions and inadequate operator response due to insufficient training. The TMI accident and the resulting damage to the reactor core presented the nuclear industry with its first large-scale cleanup and recovery operation.

In March 1980 a coordination agreement outlining common nuclear research interests and objectives was signed by the Department of Energy (DOE); the Electric Power Research Institute; the General Public Utilities Company (GPU), which owns and operates the facility; and the Nuclear Regulatory Commission (NRC). Since the TMI accident presented unique opportunities to enhance nuclear power plant safety and reliability, as well as advance accident cleanup technology, these organizations wanted to assure that the research was beneficial to the nuclear industry.

One year later, NRC prepared an environmental statement which concluded that TMI is not geologically suited for the long-term storage of the damaged nuclear fuel. The statement also addressed the effects of the accident and outlined the federal government's strategy in assisting the utility in its efforts to clean up the damaged reactor and dispose of the core debris.

In March 1982 NRC and DOE signed a memorandum of understanding regarding the removal and disposition of the core debris from the TMI site. The memorandum outlined NRC's and DOE's responsibilities in assuring that TMI is not used for long-term storage of the radioactive material produced by the accident and their roles related to cleanup operations. DOE is responsible for coordinating research on the damaged core debris. To carry out its responsibilities, DOE is conducting an accident evaluation program. The program includes shipping the core debris from TMI to DOE's Idaho National Engineering Laboratory (INEL) located in Idaho Falls, Idaho, where it will remain for research and temporary storage until the radioactive wastes are emplaced in a repository. The shipments are expected to cost over \$17 million, extend over a 2-1/2 year period,

and, depending on whether the two specially designed shipping casks are shipped separately or sent on the same train, require 20 to 40 shipments to move all of the core debris.

The reactor core debris consists of approximately 150 tons of radioactive fuel and internal pieces of the reactor that blended with the fuel during the accident's partial meltdown. The core debris is being removed from the reactor vessel and, depending on the size of the debris, put into one of three types of canisters. The canisters are then loaded into a reusable shipping cask which is placed on a flat-bed railcar. Due to the size and weight of the cask, the railcar carries no other cargo. Each cask is designed to hold core debris contained in seven canisters and inserted into reinforced tubes inside the cask. The program will require the use of about 250 canisters because they will not be reused; the shipping casks, however, will be in continuous reuse.

The shipping casks and railcars were specially designed and manufactured for the program at a cost of about \$4 million. Each cask has an empty weight of about 80 tons and, when loaded with the damaged fuel, will have a shipping weight of about 90 tons.

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## Objectives, Scope, and Methodology

Representatives William L. Clay, Richard A. Gephardt, Alan Wheat, and former Representative Robert A. Young requested that we provide information on the following aspects of DOE's program for transporting the radioactive waste from TMI to INEL:

- Reasons why the core debris is being shipped from TMI to INEL (see ch. 2);
- Safety standards used for shipping and testing the containers developed to transport the material (see ch.3);
- Criteria used to select the shipping route and the impact on the route selection of the July 1986 rail accident in Miamisburg, Ohio, involving fire and hazardous cargo (see ch. 4); and,
- Emergency response planning if an accident occurred along the route (see ch. 5).

Additional information relating to operational problems encountered during the program, such as clogged debris containers and differences in the use of dedicated trains, is discussed in chapter 6.

To attain our objectives, we interviewed DOE, GPU, and EG&G Idaho (DOE's contractor that operates INEL) officials at the TMI site and at DOE headquarters in Washington, D.C., to learn why DOE is shipping the core

debris, the safety precautions being exercised, the criteria used for selecting the train route, and why the debris is being shipped by dedicated trains.

We also interviewed NRC officials in Silver Spring, Maryland, who are responsible for licensing the shipping containers, to obtain information on container design standards and the process used to certify that the shipping containers meet the standards. At TMI we interviewed GPU and NRC officials who are performing and monitoring the loading of the debris; we also toured the facility and were provided an explanation of the radioactive waste processing and loading procedures.

We also interviewed representatives of the Consolidated Rail Corporation (Conrail) in Philadelphia, Pennsylvania, and officials of the Union Pacific Railroad to obtain their views on route selection, safety measures being used, and reasons why dedicated trains are being used.

Since it was not feasible for us to visit all of the communities along the shipping route, we visited the state emergency management agencies in Pennsylvania and Missouri to determine how state and local authorities have planned to respond to an emergency. Pennsylvania was selected because the shipments originate from TMI, and Missouri was selected because the shipments change rail carriers in the St. Louis, Missouri, metropolitan area.

To obtain information for our review, we reviewed various technical reports, regulatory directives, operating policies, internal agency correspondence and memoranda, and other related documentation. Our audit work was conducted between August and November 1986 and was performed in accordance with generally accepted government auditing standards.

We provided a draft of this report for comment to the government agencies and organizations mentioned above and other agencies and organizations involved with the damaged fuel shipping program. Agencies' comments and our analysis are discussed in chapter 6 (app. I through VI present agencies' written comments).

# Why the Damaged Fuel Is Being Transported

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DOE's decision to transport TMI's damaged fuel to Idaho was outlined in agreements reached soon after the accident regarding the federal government's role in the cleanup of the reactor site. The debris from the reactor core is being transported to INEL for research which could enhance the safety of other reactors and for long-term storage until the radioactive wastes are emplaced in a permanent repository. DOE and NRC agree that TMI should not be the site for long-term storage of spent nuclear fuel or the core debris produced by the accident. DOE believes that INEL is the most suitable location for the research work because of its unique facilities and proven historical experience in conducting research for NRC and the nuclear industry on severe accidents and damaged nuclear fuel.

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## Background of Transport Decision

Shortly after the accident, several research agreements were initiated in conjunction with the facility's cleanup operations. The following summarizes the activities authorized under these agreements.

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## The Four-Party Coordination Agreement

In March 1980 DOE, NRC, GPU, and the Electric Power Research Institute agreed to collect data and conduct research on the accident. The objectives of this agreement were to (1) develop information that would improve plant safety, reliability, and operation, (2) provide guidance in developing more effective regulations for nuclear facilities, and (3) integrate data gained from the accident into other ongoing reactor research and development programs. The data collected identified technical areas in need of additional research, including the development and testing of new methods to remove, package, transport, store, and dispose of damaged nuclear fuel. According to DOE, information gained from these efforts could enhance the safety of other reactors.

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## NRC's Environmental Statement

In March 1981 NRC published an environmental statement outlining the cleanup strategy for the damaged reactor and the disposal of the core debris. NRC identified the following key factors that led to DOE's role in the cleanup program and the decision to remove the core debris from TMI:

- TMI is geologically unsuited for long-term storage and disposal of the radioactive wastes produced by the accident and cleanup operations.
- Special facilities and equipment are required to handle and process the wastes, but TMI does not have this equipment. Since DOE's INEL contractor

already has these facilities, DOE did not consider it necessary or feasible to purchase this equipment for the cleanup program.

- Radioactive wastes should be packaged and transported to a federal facility for temporary storage until they can be repackaged for permanent disposal in a repository.
- The recovery and development of technical information should be maximized because the nuclear industry and scientific community had never experienced an accident with consequences of this magnitude. Information gathered from TMI would (1) add to the understanding of reactor operation and safety, (2) assist in developing better regulations governing nuclear facilities, (3) improve reactor hardware, and (4) establish recovery procedures in the event of another severe accident.
- When compared with shipment by truck, rail transportation would result in fewer shipments and less accident risk to the public.

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## Memorandum of Understanding

In March 1982 NRC and DOE reached an agreement on the implementation of the waste disposal procedures outlined in NRC's environmental statement. To carry out its agreement, DOE developed an accident evaluation program. DOE is responsible for (1) shipping the core debris to INEL for research, (2) coordinating research on the core debris at its facilities, and (3) providing temporary storage until the wastes can be repackaged and emplaced in a permanent repository. NRC agreed to work closely with DOE to provide regulatory oversight of these activities. The following summarizes the accident evaluation program's objectives:

- Increase the understanding of the accident. It was the first large-scale U.S. reactor incident that resulted in major damage to components and equipment. This research activity was also considered beneficial because the damage to TMI's nuclear fuel was more severe than the results previously obtained from experiments involving damaged nuclear fuel.
- Apply the results of the research in resolving generic issues pertaining to severe accidents and learn more about the consequences of an accident and its effect on the population.
- Ensure the participation and coordination of the nuclear industry in conducting the research program.

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## DOE's Decision to Ship the Radioactive Waste From TMI to INEL

DOE's cleanup role consists of two major activities—conducting research and providing temporary storage for the waste material. DOE determined that its facility at INEL was best qualified to perform these functions because it has (1) unique shielded facilities, or "hot cells," needed to

handle and store nuclear wastes and (2) a staff with the expertise required to conduct nuclear research. The following describes the activities to be performed at INEL.

## Research

DOE and its predecessor agencies have been involved in research related to the safe operation of nuclear reactors for more than 3 decades. Much of this effort has been conducted at INEL where 52 nuclear research and development reactors have been built, operated, and subjected to various experiments. To learn more about accident consequences, some of these reactors have been tested to failure. As a result of this work, INEL has developed:

- expertise on the behavior of nuclear fuel during loss-of-coolant incidents similar to what occurred at TMI;
- a library of failed fuel samples obtained from these loss-of-coolant experiments that could be valuable in comparative analysis; and
- computer programs for predicting reactor behavior during normal and abnormal events.

Based on these factors, DOE concluded that the facilities available at INEL make it the most qualified in the nation to perform research and to temporarily store the core debris.

## Storage

NRC has concluded that TMI is not geologically suited for the permanent storage of nuclear material. Although a federal repository is being planned for the permanent disposal of radioactive wastes from commercial nuclear reactors, it will not be available for use for about 15 years. DOE has therefore concluded that the 150 tons of damaged fuel and related radioactive wastes from TMI should be stored at one of its own facilities until the repository is available for permanent disposal.

All 150 tons of TMI's core debris are to be transported to INEL and stored there temporarily. DOE believes that if additional damaged fuel samples are needed during the examination process, quick access will be provided by having all the core debris material at INEL.

# Shipping Container Development

The shipping containers used to transport the core debris have been designed and built especially for TMI's wastes in accordance with NRC standards. The two primary considerations in developing the containers are their ability to withstand severe accidents and to protect the public from radiological exposure. The reusable shipping casks have double-walled containment barriers consisting of 8 inches of stainless steel and lead shielding. The casks' interior consists of reinforced stainless steel tubes into which canisters containing the core debris are inserted. The containers have features that are designed to prevent a nuclear reaction or the release of radioactive material if an accident occurs.

NRC standards and criteria were used as guidance in constructing the shipping containers. The NRC certification process included tests and analyses to assure that the casks and canisters would prevent the escape of radioactivity if they were subjected to severe impacts or fire.

NRC conducted inspections during the construction of the casks and canisters. Although some problems were observed, NRC took measures to ensure that the equipment meets regulatory standards and will protect the public against the escape of radioactivity.

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## Shipping Container Designed to Accommodate Damaged Fuel

Under normal conditions, intact spent fuel is contained in hollow metal rods known as cladding. The TMI fuel, however, is not in the normal condition. As a result of the damage from the accident, much of the fuel is no longer contained in the cladding; the debris produced during the accident consists of large pieces of reactor fuel components, smaller gravel-like pieces of radioactive material, and powdered fine particles suspended in the reactor cooling water.

Because of the unique condition of the damaged fuel, early in the planning stages of the shipment program EG&G Idaho decided that, instead of modifying and relicensing existing spent fuel shipping casks, new casks should be designed, fabricated, and certified by NRC. EG&G Idaho also determined that rail transport offered the following advantages over shipment by truck:

- A rail cask holds seven canisters, whereas a truck cask only holds one.
- Rail transport would require between 20 and 40 rail shipments, compared with about 250 by truck.
- Fewer shipments reduce the chance of an accident.
- Rail casks are considered to be more efficient and less costly.



The decision to transport the core debris by train led to the development of the Nuclear Packaging, Incorporated (NUPAC) 125-B rail cask. In addition to the reusable cask, three types of canisters were developed to hold the various types of debris removed from the reactor. After seven canisters are loaded with debris, they are inserted in the cask. The entire package has been designed as an integrated unit.

### NRC Standards Used for Container Design

NRC has established standards that shipping containers must meet before they are certified to transport radioactive waste. The standards require that under both normal and accident conditions, the container shall

- prevent the loss or dispersion of the radioactive contents,
- provide adequate shielding and heat dissipation, and
- prevent a nuclear reaction, or criticality.

Under normal transport conditions, a cask must withstand hot and cold environments, pressure differentials, vibration, water spray, and impact, puncture, and compression tests. For accident conditions, casks must withstand fire, more severe impact and puncture conditions, and immersion in water.

DOE believes that neither the Atomic Energy Act of 1954, as amended, nor the Nuclear Waste Policy Act of 1982 requires it to comply with NRC regulations for the TMI nuclear waste shipments. However, in previous projects involving commercial facilities licensed by NRC, DOE has used NRC-licensed casks. Since TMI is a facility licensed by NRC, DOE decided to follow the same policy.

For the manufacture of the shipping cask, DOE also decided to adopt the American Society of Mechanical Engineers (ASME) welding code that governs the construction of nuclear reactors. Although this welding code pertains to vessels such as reactors that contain a great amount of pressure, its requirements were used in the construction of the shipping casks which contain little or no pressure.

According to NRC officials, the general standards for transporting radioactive material and cask design were evaluated in an environmental impact statement published in 1977. On the basis of the information developed for this statement and the safety record associated with the

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transportation of radioactive material, NRC concluded that (1) the standards provide a reasonable degree of safety and (2) no immediate changes were needed to improve safety.

In February 1987 NRC published a study assessing the protection provided by current standards in extremely severe accidents. The study evaluated all types of severe non-nuclear accidents that have recently occurred in the country, the probability of a radioactive material shipment being involved in such an accident, and whether the shipping cask would prevent the escape of radioactivity during the accident. The study found nothing to indicate that the regulations are inadequate and should be changed.

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### Factors Affecting the Design of the Shipping Container

According to DOE, the condition of TMI's fuel required that several unique features be incorporated into the cask design:

- Two containment barriers, required by NRC, were incorporated into the cask design because the damaged fuel does not have the cladding that normally surrounds intact spent fuel. Since the cask has double-walled construction, this requirement is met by the cask; an additional barrier beyond NRC's requirements is therefore provided by the canisters.
- A "leaktight design" was incorporated into the casks to prevent the release of radioactive particles even after a series of severe impacts or fire; however, since the cask is not leak proof, a small gas bubble about the size of a ping pong ball could escape over a year.
- A system to control hydrogen and oxygen gases produced in the canisters was included in their design so these gases will not form a mixture of flammable gas.
- Materials that control nuclear reactions were incorporated into the canisters and the cask to ensure that the damaged fuel would not, under any condition, begin a nuclear reaction. These materials ensure that a nuclear reaction will not be initiated by absorbing the neutrons needed to achieve and sustain a chain reaction. This means that the self-sustaining splitting of atoms that normally occurs in an operating nuclear reactor cannot be duplicated in the cask.

The following describes in detail the design features incorporated in the casks and canisters.

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## Cask Design

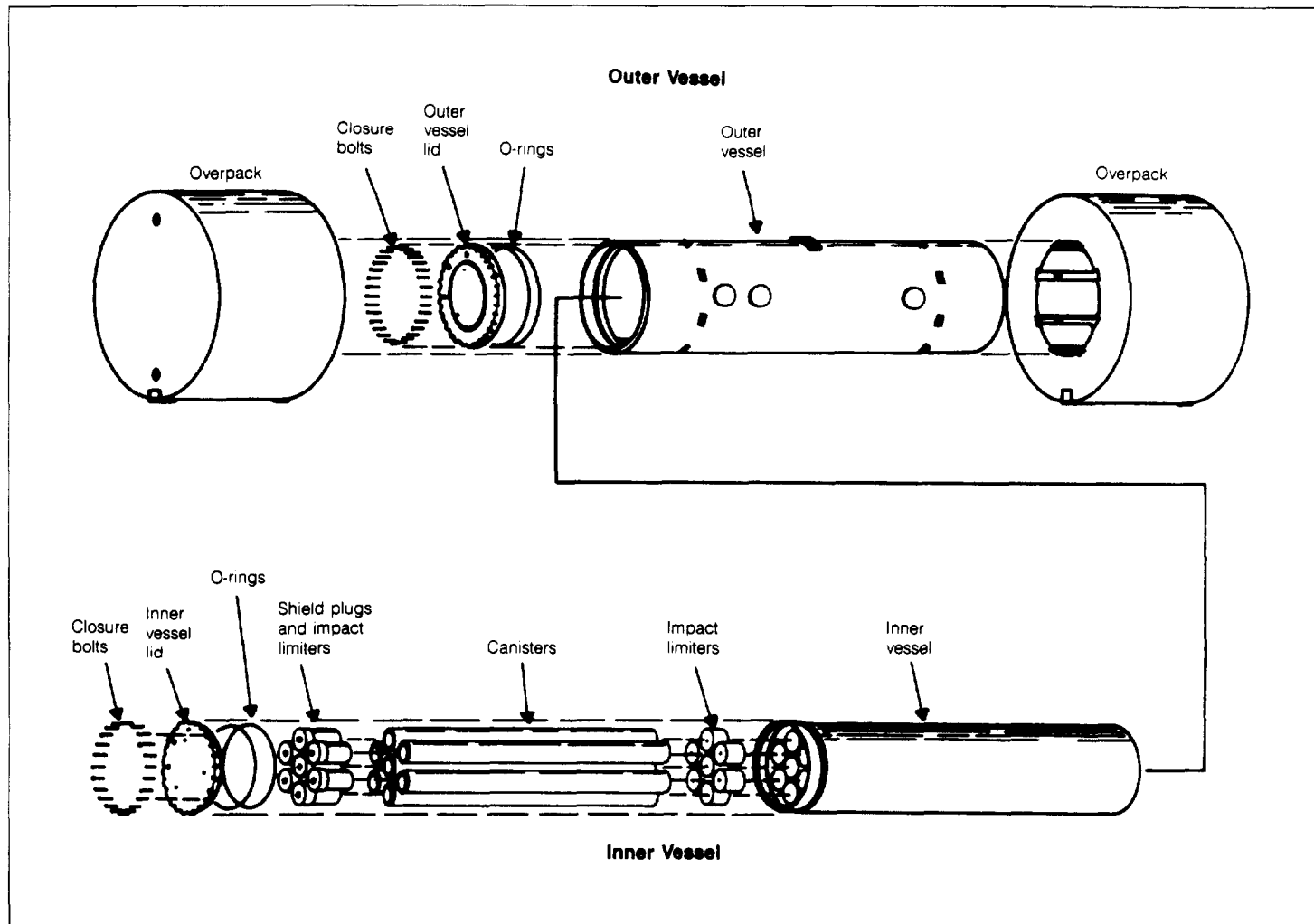
As illustrated in figure 3.1, the reusable shipping cask consists of an inner and outer vessel designed to contain radioactivity. The inner containment vessel was manufactured using a stainless steel hub-and-spoke structure that is welded to forgings at each end of the cask. According to DOE, this structure is designed to prevent the seven canisters and their supports from crushing each other in the event of a severe impact. The canisters that contain the core debris are inserted into stainless steel tubes that are welded to a thick plate. The radiation containment boundary is completed by a forging that is welded to the cask, and a 5-inch-thick lid is bolted to the forging. Two O-ring gaskets are installed around the lid to form a seal. These seals are inspected and tested for leaks before each shipment.

In addition to the stainless steel spokes that separate the canister tubes, one-inch-thick stainless steel plates are welded to the inner vessel. These plates provide structural stiffness and form voids between the canister tubes. The voids have been filled with a neutron-absorbing material that solidified like concrete. According to DOE, the strength of this material and the plates protect the tubes from impacts and ensure that the debris contained in the canisters cannot initiate a nuclear reaction. For added safety, energy absorbers, called impact limiters, are placed at each end of the canister tubes to absorb the shock of an impact and protect the canisters from crushing.

The outer containment vessel, which is a composite of three layers of metal, also has many safety features incorporated into its design. Two stainless steel shells, 2 inches thick and 1 inch thick, respectively, are placed one inside the other, with a gap of nearly 4 inches between them. Molten lead was poured into the gap. The lead cooled and solidified and became the primary material used to shield the radiation emitted by the debris. The effectiveness of the lead shielding was checked to ensure that there were no voids. The containment shell is welded to a bottom base plate and upper stainless steel forging. A 7.5-inch thick stainless steel lid is bolted in place using 32 bolts. A seal between the lid and the shell is formed by two O-ring gaskets installed around the edge of the lid. These seals are inspected and tested for leaks before each shipment.

Attached to the outer shell are short stainless steel cylinders, called trunions, which are used to lift the cask during loading and to hold it down during shipment. The trunions are designed and tested to support several times the weight of the loaded cask. Also attached to the exterior of the shell is a shear block that is designed to absorb motion that could jolt the cask forward or backward during transport. The shear block acts to

Figure 3.1: Shipping Cask and Canisters



protect the trunions from high inertia loads that may be encountered during shipment.

The cask is covered by a thermal shield which, according to DOE officials, provides an additional margin of fire-related safety beyond NRC's regulatory requirements. This thermal shield consists of wire surrounding the outer surface of the cask. The wire is covered by a thin sheet of stainless steel. An air space exists between the steel sheet and the cask which reduces the amount of heat that is transferred into the cask. This heat reduction occurs because air is a poor conductor of heat energy.

To complete the package, large energy absorbers, called overpacks, are attached to each end of the cask. Each overpack is made of a thin plate of stainless steel and filled with foam. The overpack is designed to crush and absorb the energy of an impact, thereby protecting the cask. These overpacks give the cask the dumbbell-like shape illustrated in figure 3.2.

Figure 3.2: Nuclear Packaging, Incorporated 125-B Rail Cask



### Canister Design

Three types of nonreusable canisters are being used to hold the reactor debris. Each type of canister is 14 inches in diameter, 150 inches long, constructed of stainless steel, and has the same general external appearance. The following three types of canisters are used to accommodate the various forms of debris:

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- The fuel canister has a removable upper lid that can accept a damaged fuel assembly. This canister is used to ship large pieces of fuel debris.
  - A knockout canister is used in conjunction with a hydraulic vacuum system. Water and smaller pieces of debris are vacuumed from the damaged reactor core and pumped into the canister. As the velocity of the water decreases in the large diameter of the canister, the pieces of debris settle out of the water. The water and residual fine pieces of debris then enter the third type of canister.
  - The filter canister captures fine powder-like debris on pleated stainless steel filters.

Neutron absorbers are built into each type of canister to prevent a nuclear reaction. In addition, catalytic material is installed on each end of the canister to recombine any hydrogen and oxygen gases that may form. This recombination prevents the formation of combustible gas mixtures and pressure buildup.

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### Safety Issues Affecting Canister Design

According to DOE officials, experience gained from earlier waste shipments from TMI was factored into the design of the canisters. As part of the effort to remove the contaminated water from the containment building in the aftermath of the accident, it was determined that special measures were needed to prevent (1) the debris from igniting spontaneously in the air, (2) the generation of hydrogen and oxygen through radiological decomposition, and (3) the generation of steam in the canisters during an accidental fire. DOE and EG&G Idaho requested assistance from Rockwell Hanford Operations (Rockwell) and GPU Nuclear in resolving these safety concerns. In a report issued in June 1985, Rockwell made several recommendations regarding how these issues should be handled. According to the TMI project manager for EG&G Idaho, after review and approval by NRC, the recommended design changes were incorporated into the shipping container and core debris loading procedures.

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### NRC Certification Process for Licensing the Containers

According to NRC officials responsible for certifying TMI's shipping containers, an applicant requesting to use equipment not yet certified by NRC must demonstrate that the product meets NRC's applicable requirements. The applicant is normally required to provide engineering analyses and mathematical models confirming that the components meet NRC's requirements. Mathematical models allow more comprehensive analysis of a greater number of variables than demonstrations and tests using actual hardware.

When NRC receives an application, it performs a pre-acceptance review to decide whether the application is sufficiently complete to proceed to the technical review. If not, the application is returned for further development. If NRC determines that an application is sufficiently complete, it conducts a technical review covering issues such as the structural integrity of the equipment; its ability to contain radiation and withstand heat damage; the prevention of a nuclear reaction; and the operating procedures, maintenance, and quality assurance programs associated with the equipment. After the technical review is complete, NRC decides whether to approve or deny a "certificate of compliance," or to request additional information to complete its review.

During the certification process for the TMI containers, a series of seven meetings were held between NRC and DOE from June 1983 to March 1985 to discuss the design of the damaged fuel shipping casks. The cask manufacturer, NUPAC, on behalf of DOE, filed an application to NRC on June 14, 1985, requesting a license to use the Model 125-B shipping container. According to NRC officials responsible for certifying the containers, these meetings resulted in a more complete application. NRC gave the application high priority due to the nature of the project. NRC officials believe the priority review, coupled with the series of prior meetings, resulted in a shorter than normal certification process.

During its technical review, NRC made two requests for additional information that was supplied by NUPAC. Six meetings were also held between NRC and NUPAC to clarify various technical aspects of the application. Although it is not formally required, NRC encouraged NUPAC to conduct scale-model testing in addition to its mathematical analysis. NRC officials told us that the scale-model tests confirmed the mathematical model analysis. At the conclusion of its technical review, NRC prepared a safety evaluation report that concluded the Model 125-B cask design meets the applicable requirements. A certificate of compliance was issued to DOE on April 11, 1986. The certificate of compliance has subsequently been revised based on changes submitted by DOE and reviewed and approved by NRC. The changes include:

- a change in the fuel canister seal design and an increase in the torque of the closure bolts,
- provisions for additional nonfuel contents,
- modifications to the gas used to detect radiation leakage,
- a modified procedure to allow an additional leak test to verify proper cask assembly,
- a modified procedure for drying radioactive wastes in containers.

- revised acceptance criteria for neutron absorbers, and
- an authorization to use a tarpaulin to cover the cask during transport.

DOE officials told us that additional modifications could be incorporated over the life of the program.

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## Problems Detected by NRC's Quality Assurance Program

NRC's certification process includes requirements for applicants to have procedures to assure that equipment is manufactured in accordance with approved design specifications. Normally, NRC requires the manufacturer to (1) certify that equipment was manufactured in accordance with the NRC-approved design specifications and (2) conduct an ongoing quality assurance program during manufacture. NRC regulations only require its approval of the manufacturer's quality assurance program. For the TMI program, however, NRC conducted several quality assurance inspections, such as inspecting welds, at the manufacturer's plants.

On the basis of these inspections, NRC questioned (1) the integrity of a weld on one of the reusable casks and (2) the documentation for the material used to manufacture a canister. For the weld integrity issue, NRC convened a panel of experts to review the data and determine whether the applicable construction standards were being met. In another instance, a contract to construct waste containers was withdrawn from the manufacturer after it was unable to document the source of the material used to build the containers. The following discusses these issues in greater detail.

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## Weld Integrity

During an inspection at NUPAC, an NRC inspector reviewed radiographs (X-rays) of welds made on the inner and outer containment shells of both casks. On the basis of this review, the inspector questioned whether one of the welds met design specifications. At issue was whether a 1/2-inch line on the radiograph was acceptable slag (waste produced by the welding process) or an incomplete weld that would not meet the cask design specifications and the ASME code. The ASME welding code prescribes the corrective action that should be taken in these situations.

In order to resolve the question, NRC established a panel of three independent radiographic experts to examine the radiographs and render an opinion. Computer enhancements were made of the radiographs and reviewed separately by each panel member who rendered an independent opinion. The panel then discussed what each member had seen and



a group consensus was formed. As a result of the evaluation process, the panel concluded that the indication on the radiograph was slag and not an incomplete weld.

According to NRC officials involved in the review of the weld, no single element of the data developed on the weld integrity question was conclusive. The panel's opinion that the indication did not present a safety problem was based on the weight of all the evidence developed for the panel's evaluation. The panel's conclusion was based on the following:

- The indication is located approximately 1/4-inch off the center of the weld and is not parallel to the center line of the weld.
- The indication has varying width and is not sharp on each end.
- The density appears to be even across the indication.

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## Canister Manufacturer Change

Quality assurance inspections were conducted by NRC at the canister manufacturer's factory. A problem was encountered in documenting the source of the material used to manufacture the canister. As a result of this and other delivery and schedule problems, the contract was withdrawn from the manufacturer and awarded to two other companies. NRC officials told us that no adverse effects have occurred as a result of the change in canister manufacturers.

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## Testing of the Casks and Canisters

DOE tested the casks and canisters using a scale model of the shipping cask and a full-size model of the core debris canister. The results of these tests were supplemented by mathematical model analyses. These testing procedures are complementary because the test results of actual models are used as a baseline to verify mathematical predictions. Mathematical modeling allows the testing of multiple situations or variables without having to construct and test hardware.

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## Cask Tests

NRC encouraged DOE to use scale-model tests of the NUPAC 125-B shipping cask to supplement its mathematical model analyses. The cask manufacturer fabricated a one-quarter-scale model of the shipping cask for the tests. According to DOE program officials responsible for shipping cask development, scale-model testing is used extensively to solve engineering problems in a wide range of technical industries such as civil and mechanical engineering, aerospace, and nuclear power. The use of scale models is widely accepted and provides a cost-effective method of demonstrating the adequacy of a wide range of designs. According to NRC

officials who participated in evaluating the test results, the scale-model tests confirmed the results predicted by the mathematical model analysis.

Several drop tests were conducted at the Sandia National Laboratory using different cask positions. Three drops were made from 30 feet onto an unyielding hard surface. According to DOE, the impact of a 30-foot drop onto an unyielding hard surface produces about the same impact as a 90-mile-per-hour crash into 2 feet of reinforced concrete. The following summarizes the test results.

- First drop - To determine how well the cask walls, lids, and closure bolts perform in an impact, the cask was chilled to minus 20 degrees Fahrenheit and dropped bottom first onto an unyielding surface. The test demonstrated that the impact limiters within the cask adequately protected the canisters.
- Second drop - To maximize the stress on the cask body, the cask was dropped at an oblique angle of 62 degrees from horizontal onto its lid. This drop was also at a temperature of minus 20 degrees Fahrenheit.
- Third drop - To produce maximum loads on the inner vessel, the cask was dropped on its side at ambient temperature.

In addition to the 30-foot drop tests, to produce maximum puncture damage to the cask, it was dropped twice from a height of 40 inches onto the end of a steel rod. Both puncture tests were designed to determine how well the cask could absorb the impact of a protruding object without the protection provided by the foam overpacks.

- First drop - The cask was dropped on its side to demonstrate the ability of the cask wall to absorb the impact of a protruding object to an area not protected by the foam overpack.
- Second drop - The cask was dropped onto the lid to show how it would resist puncture without the protection of the foam overpack.

Before and after the drops, tests for leaks were conducted which, according to DOE officials, indicated no detectable leakage from either the cask's primary or secondary containment vessels. Except for an indentation of the cask's outer shell as a result of the side puncture test, damage was limited, as anticipated, to the internal and external impact limiters. (The impact limiters are illustrated in figure 3.1.) The impact limiters remained attached, and no buckling of the shells or internal structures was observed. The cask was examined by X-ray which indicated no detectable displacement of the lead shielding. The drop test

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results were consistent with the damage predicted by the mathematical model analyses. DOE program officials stated that the tests demonstrated the safety of the cask even in accidents involving severe impacts.

Although the scale-model testing of the NUPAC 125-B shipping cask did not include fire or thermal tests, the manufacturer prepared a safety analysis report that contained an analysis of the cask behavior under heat stress. NUPAC evaluated the cask's thermal behavior by using a computer program that analyzes heat transfer in three dimensions. Four principal analyses were performed which demonstrated that the cask had adequate structural integrity to safely withstand NRC's standard fire test. These analyses were reviewed and approved by NRC and DOE.

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## Canister Tests

In addition to the cask scale-model tests, DOE performed a series of drop tests on full size fuel and knockout canisters. The following is a summary of the test for each type of canister.

- Fuel canister - A full size canister was dropped bottom end first from a height of 18 feet onto an unyielding surface. The canister was dropped "bare," and was not protected by the cask and its impact limiters. A shorter canister was also dropped on its side from 30 feet. Both tests showed that the internal structure designed to ensure against a nuclear reaction of the damaged nuclear fuel remained in place and maintained its basic shape.
- Knockout canister - A full size canister was subjected to four 30-foot drop tests in the following sequence: bottom end drop, side drop, top end drop, and side drop. During these tests, the canister was placed inside a steel pipe to simulate the interior of the cask. Each end of the pipe was fitted with impact limiters to absorb shock. According to DOE officials, the impact loads experienced in the tests exceeded the loads that the canisters would encounter if the canisters had been dropped while they were inside the cask. The tests showed that (1) the canisters contained their contents throughout each test, (2) the internal configuration of the canisters remained within the design parameters established to prevent a nuclear reaction, and (3) the tubes containing neutron absorbers experienced no damage beyond that projected by computer analysis.

Although no drop tests were performed on the filter canister, bench tests were conducted on individual filter elements to determine their crush strength. DOE also performed tests on the catalysts installed in each end of the canisters to demonstrate that the catalyst material

would recombine the hydrogen and oxygen gases generated by the radiolysis of the water. The performance of the catalyst was measured at a hydrogen/oxygen generation rate that is about three times what is expected to occur in the canister. The testing programs helped determine the size and shape of the catalyst placed in each canister. According to DOE officials, the catalyst tests also provided conclusive evidence that the catalyst would perform satisfactorily and would ensure safe transport of the fuel debris. These tests were reviewed by NRC as part of its certification process.

# Development of the Shipping Route and Implementation of the Shipment Inspection Program

The shipment of the core debris has required a cooperative effort between the rail carriers and various federal and state organizations. The rail carriers were responsible for initially selecting the route used to ship the damaged nuclear fuel. Once identified, the route was reviewed by DOE and evaluated by transportation consultants to assure that it offered optimum safety. Numerous precautions have been adopted to protect the health and safety of the population along the shipping route. The entire route was inspected prior to the first shipment of core debris and will continue to be inspected periodically.

In July 1986 a rail accident involving hazardous materials occurred in Miamisburg, Ohio. The accident did not occur on the route used for the TMI shipments. According to DOE officials, the Miamisburg accident did not demonstrate the need to change the route used for the TMI shipments because in their opinion, the shipping cask would have successfully withstood the accident.

Each shipment is inspected by the railroads and appropriate federal and state agencies at various stages during the shipping process.

## Route Selection Limited by Available Rail Carriers

DOE's route selection process was limited because Conrail is the only rail carrier serving TMI, and Union Pacific is the only rail carrier serving INEL. When the two rail carriers' most direct route and best quality track between these two locations is being considered, the major junction for these railroads is located in East St. Louis, Illinois.

According to DOE officials responsible for selecting the shipping route, both carriers have a good safety record and experience in transporting hazardous cargoes. Each rail carrier provided DOE with several potential routes within their service areas that could be used for the shipments. DOE then used the following criteria to evaluate each of the routing options:

- the quality of the railroad track;
- avoidance of high population areas; and
- the quickest, shortest, and most direct route.

Of primary importance to DOE was the quality of the railroad track. According to DOE officials, however, this attribute often conflicts with the avoidance of high population areas because the highest quality railroad track usually traverses areas with high population density. To

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Inspection Program**

avoid areas with high population, the shipments would have to use lesser quality railroad track.

According to DOE officials, it may be safer for the shipments to use the best quality railroad track and travel through some highly populated areas. They also noted that since the cask was designed to provide adequate protection against the escape of radioactivity, it was not a critical factor in selecting a route. Therefore, in their view, it is safe to ship the cask through some high population areas.

After working with the railroads to identify available shipping routes, DOE requested that transportation consultants at the Oak Ridge National Laboratory (Oak Ridge) and ALK Associates, Inc., evaluate them. Both organizations were requested to use DOE's selection criteria in reviewing the various proposed routes from TMI to Idaho. Oak Ridge used a railroad routing model known as INTERLINE to evaluate the rail routes identified in table 4.1.

**Table 4.1: Rail Routes Evaluated by Oak Ridge**

Distance in miles			
Route	Distance	Number of interchanges	Population <sup>a</sup>
Primary	2,383	2 <sup>b</sup>	1 179,583
Alternate 1	2,292	2	1 690,988
Alternate 2	2,322	2	1 591,208
Short Line	2,286	6 <sup>c</sup>	1 591,126
"Hot Potato"	2,389	4 <sup>c</sup>	783,338

<sup>a</sup>Number of people residing within 1 kilometer of the route.

<sup>b</sup>Interchange between the Missouri Pacific and Union Pacific is not considered a full interchange because these railroads are part of the same company.

<sup>c</sup>Includes a transfer with a terminal railroad.

Of the five routes evaluated by Oak Ridge, two—the Primary and "Hot Potato"—traverse the East St. Louis, Illinois, area, while the others go through Chicago, Illinois. The routes that intersect Chicago have higher population densities than those that go through East St. Louis. Although the Hot Potato route affects the least amount of population, it also has less high-quality track (81 percent) than the Primary route (96 percent). The Hot Potato route was not recommended by Oak Ridge because it (1) consists of lower grade track and (2) requires more transfers of the shipments between rail carriers. On the basis of its analysis, Oak Ridge recommended that DOE use the Primary route.

ALK Associates used a railroad computer model for routing hazardous materials to analyze the potential accident rates that may be expected along the proposed routes. The most favorable route evaluated by ALK Associates intersects East St. Louis, has about 96 percent high-quality track, and has the lowest overall potential accident rate of all the routes proposed. The EG&G Idaho traffic manager responsible for the TMI shipments informed us that with the exception of a 38-mile segment that uses Conrail's main line in Ohio, this route is the same as the Oak Ridge Primary route. ALK Associates did not recommend a specific route but provided the information to DOE to assist in making a final route selection.

### Route Selected by DOE Reflects Safety Criteria

The shipping route selected by DOE is the same as the most favorable routes analyzed by Oak Ridge and ALK Associates. DOE's decision was influenced by the fact that 96 percent of the railroad track along the route is of high quality; in addition, based on the results of ALK Associates' computer analyses, there is a low predicted accident rate along the route. As shown by table 4.2 and figure 4.1, the route selected by DOE is 2,383 miles and traverses 10 states.

**Table 4.2: Selected Railroad Route for Core Debris Shipments**

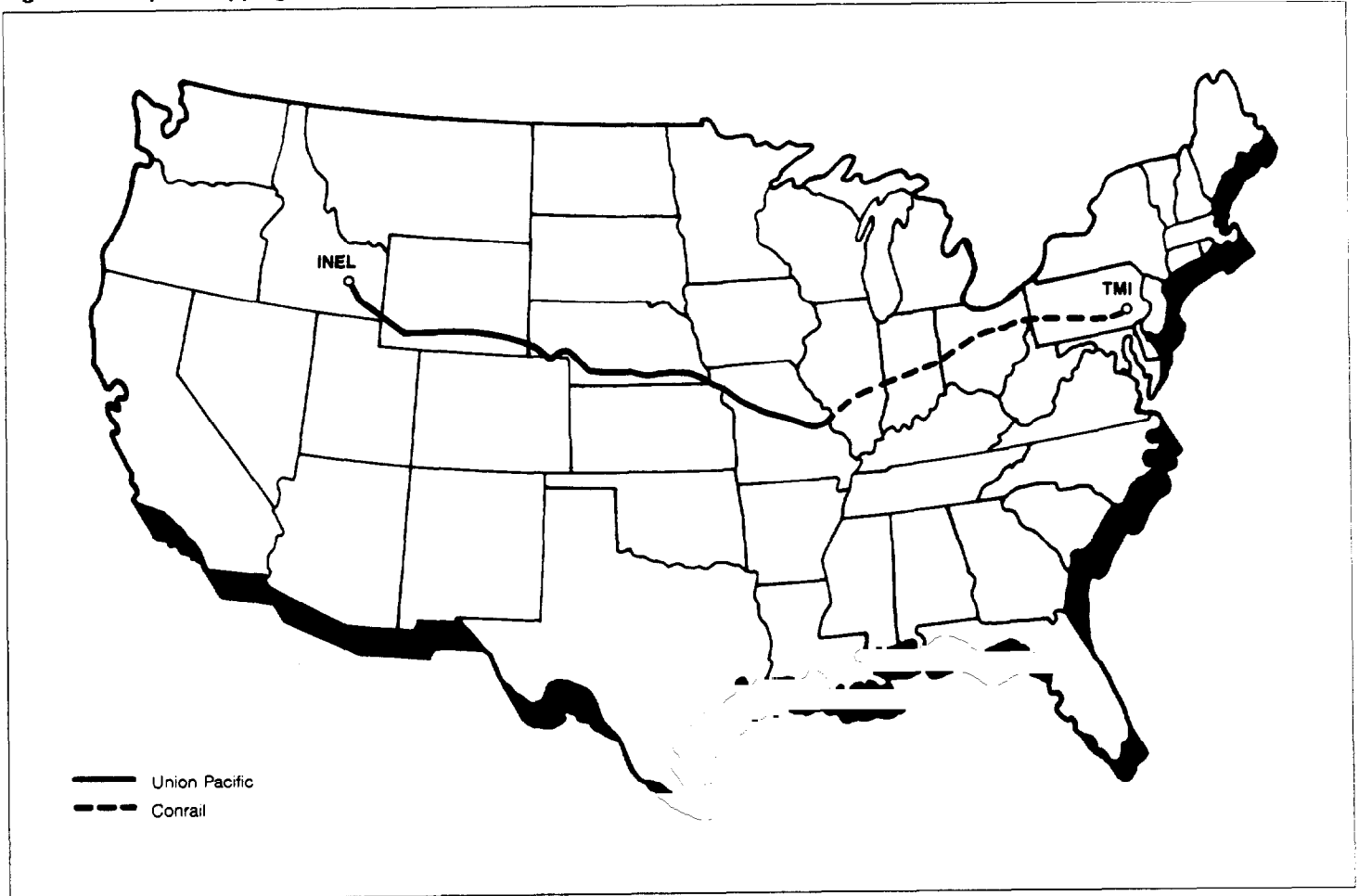
Railroad	From/To	Mileage
Conrail	TMI/East St. Louis, Illinois	880
Missouri Pacific	East St. Louis/Kansas City, Kansas	278
Union Pacific	Kansas City/INEL	1,225
<b>Total</b>		<b>2,383</b>

### Impact of Miamisburg Accident on Route Selection

In July 1986 a rail accident involving hazardous materials occurred in Miamisburg, Ohio. The accident resulted in a fire that burned for 5 days and required the evacuation of several thousand people. Although the Miamisburg accident is not directly related to the TMI shipments, some concerns have been expressed that the accident may indicate the need to alter the route for the shipments.

According to DOE officials responsible for coordinating the shipping program, this accident did not demonstrate the need to change the route used for the damaged fuel shipments. One factor considered by DOE in planning the shipments was the potential need to evacuate; consequently, where possible, the route avoids high population areas. In addition, the cask was designed to prevent the escape of radioactivity during any credible accident. DOE officials believe that the shipping cask and its

Figure 4.1: Map of Shipping Route



contents would have successfully withstood the Miamisburg accident. Finally, the incident occurred on another railroad and was not on the route being used for the shipments.

## Shipment Inspections

In order to ensure the safety of the TMI shipping program, various federal and state agencies have conducted inspections before, during, and after each shipment. NRC is responsible for approving and monitoring the procedures used to load the damaged fuel. Before the first shipment was made, the Federal Railroad Administration (FRA) conducted an extensive inspection of the railroad track; it will continue to perform periodic reinspections throughout the entire program.



DOE is responsible for monitoring the radiological aspects of each shipment, as well as the maintenance on the railcars carrying the casks. These inspections will continue for the duration of the shipping program.

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**NRC**

In its regulatory oversight capacity, NRC is responsible for (1) reviewing and approving the procedures used to remove the damaged fuel from the reactor and (2) monitoring the loading of the debris into the canisters for shipment. All applicable procedures must be reviewed and approved by NRC before their use. NRC also periodically conducts unannounced inspections of the loading process to ensure that the proper procedures are being used.

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**FRA**

Before the first shipment was made, FRA inspected the entire railroad route from TMI to Idaho and rode trains to determine if the crews were complying with the proper operating rules and procedures. The inspection was performed by FRA track and signal inspectors and included rail sidings, yards, and signal systems. FRA intends to conduct followup inspections of these components every 6 months for the duration of the shipping program. In addition to these route inspections, FRA plans to conduct the following inspections for each shipment:

- Prior to shipment, FRA equipment inspectors will inspect the railcars to ensure that they are in compliance with all appropriate FRA requirements.
- Before each shipment, hazardous materials inspectors will ensure that (1) the railcars have the proper radiation warning placards, (2) the train crews receive the required safety notification regarding their cargo, and (3) the railcars are placed in their appropriate location within the train.
- Before departure from TMI, the hazardous materials inspector will be accompanied by a representative of the Department of Transportation's Office of Hazardous Materials Transportation to monitor the levels of radiation from each cask. A similar inspection will be made when the train arrives in Idaho to determine if there has been any change in the radiation levels while the cask has been in transit.

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**DOE**

For the first three shipments, a DOE representative with radiological expertise accompanied each shipment to perform radiological monitoring during the trip. Each time the train stopped, radiological readings were taken at the surface of the cask and at a distance of 10 meters

According to DOE officials, this practice has been determined to be unnecessary, and was suspended, because the radiological readings for all the shipments have remained constant. DOE officials also stated that unless the need is demonstrated, persons with radiological expertise will not accompany future shipments.

As part of its contract with DOE, the Union Pacific Railroad is inspecting and performing any required maintenance on the cask railcars. The inspection provides a quality control check to ensure that the equipment is performing as designed. Since the railcars were new, had been built specifically for the shipping casks, and had not yet developed a maintenance history, the decision was made to inspect them on the return trip for each of the first three shipments to determine how they would respond to the transportation loads.

On the basis of the results of the first three shipments, it was decided that before departure from INEL, the railcars will be inspected by Union Pacific. The inspection consists of checking to ensure that all mechanical components are functioning properly, as well as determining whether any cracks have developed in the railcar or cask support structures. If problems are observed, the railcar will be sent to the Union Pacific facility in Pocatello, Idaho, for inspection and/or repairs before being used again. It has also been decided that on the return trip of every third shipment, the railcars will be sent to Pocatello for a more comprehensive inspection. The distance for each round trip is about 5,000 miles. Under normal loads, long-service railcars typically travel 100,000 to 200,000 miles between maintenance checks. According to an EG&G Idaho official, as a point of comparison, similar cask railcars used by the Department of Defense for defense-related shipments are serviced about every 20,000 miles.

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## State Agencies

DOE has encouraged the railroads to allow state agencies to conduct their own inspections of the train as it travels through their jurisdictions. Some states have availed themselves of this opportunity. For example, when the train arrives in East St. Louis, Illinois, the state of Missouri's Bureau of Radiological Health, in conjunction with the Illinois Department of Nuclear Safety, conducts an inspection of the cask. Prior to its departure from Kansas City, Missouri, the Bureau of Radiological Health inspects the cask again.

# Emergency Response Preparedness Along the Route

If an accident, such as a derailment, occurs the rail carrier and the affected state and local government are primarily responsible for initiating and monitoring the recovery operations. These recovery actions are supplemented by a wide range of federal programs. Training and assistance in emergency response planning has been provided to state and local governments by several federal agencies. These actions have been augmented by an emergency response team established by INEL specifically for the TMI shipments.

In addition to federal and state emergency response initiatives, the TMI debris is being shipped on trains dedicated solely to this cargo. Other restrictions, such as reduced speed, have also been instituted for the trains and their crews.

## Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA) has developed an Integrated Emergency Management System to guide the emergency response actions of state and local governments. These guidelines recognize that similar functions or actions may be required to mitigate many different types of emergencies. The guidelines provide information on the broad policies to be used during an emergency and assist in the development of emergency coordination groups. An objective of FEMA's guidelines is to develop a communication network at the state and local government level—before an emergency occurs—to bring together the needed actions and expertise required to successfully manage an emergency, including radiological transport accidents.

## DOE

In advance of each shipment, DOE has agreed to notify the affected states that radiological material will be passing through their jurisdictions. For each shipment, the train crews have radio equipment on board. Union Pacific stated that its train crews have been instructed to report any incident to the railroad, which will then notify DOE's Warning Communication Center. This report would trigger a series of contacts through a pre-established communication network which includes notifying DOE emergency management personnel, the state in which the incident has occurred, and adjacent states.

DOE has eight regional offices throughout the nation with 26 Radiological Assistance Teams. DOE's emergency response plans require that these teams be capable of mobilizing within 2 hours and arriving at the accident site within 6 to 8 hours. At INEL, DOE has also established a TMI shipment response team which, according to DOE officials, is capable of

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managing all foreseeable contingencies involving the shipments. This team could also be dispatched to the accident site, serve in an advisory capacity during the recovery operations, and provide a communications link to emergency management personnel at INEL.

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## Department of Transportation

The Department of Transportation has developed and distributed a handbook on hazardous materials. The handbook contains basic information to be used by firefighters, police, and other public safety personnel who are usually the first to arrive at the scene of an accident. All the hazardous materials transported in this country are listed in the handbook and have an identification number. Hazardous material may be identified either by placards and identification numbers on the exterior of packaging or by information contained in documents accompanying each shipment. If an accident occurs, emergency personnel are instructed to use the placards with the handbook to identify what hazardous material is being transported. If the shipment is not placarded, emergency personnel are to use the shipping document, in conjunction with the handbook, to identify the material. For each hazardous material listed, the handbook also contains instructions on what actions should be taken to prevent harm to personnel in the area. According to the Union Pacific Railroad, the identification numbers for radioactive materials are not displayed on placards.

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## State Emergency Plans

The Pennsylvania and Missouri state emergency response plans are an adaptation of the FEMA Integrated Emergency Management System. The plans outline the primary response functions to be used during an emergency; they also designate who will be responsible for communications and public information; evacuation and mass care; and emergency services such as police, fire, and medical attention.

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## Pennsylvania Emergency Management Agency

There are 67 counties and 2,572 political subdivisions within the state of Pennsylvania. By state law, every political subdivision is responsible for protecting the health and welfare of the public. The law also encourages the establishment of mutual aid agreements between subdivisions and provides that requests for assistance from political subdivisions will be referred to the county level. According to the Planning Supervisor for the Office of Plans and Preparedness, within the past 2 years, every county emergency management agency has conducted an analysis of the hazards that threaten persons or property within the county.

Most county emergency agencies have implemented a basic emergency response plan that addresses most of the potential hazards. Of the 13 significant hazards that have been determined to be applicable to the counties in Pennsylvania, 9 have been identified by every county. Heading the list of potential hazards are transportation accidents; also included are storms, fire hazards, energy emergencies, and hazardous materials.

A system of emergency assistance has been established between the state and local levels of government. Emergency exercises are conducted to test the feasibility of emergency plans, response capabilities, and the training of local and county emergency workers. Pennsylvania has also developed a network of public and private organizations with expertise in the handling of hazardous materials. These assistance groups are located throughout the state to provide a quick response to an accident.

## Missouri Emergency Management Agency

The State Emergency Operations Plan for Missouri includes a special appendix for dealing with nuclear-related emergencies. The plan outlines procedures to be followed during a radiological incident by the State Emergency Management Agency (SEMA) and the Missouri Nuclear Emergency Team. The Nuclear Emergency Team consists of 50 professional personnel drawn from SEMA, the State Bureau of Radiological Health, academic institutions, private industry, and various local civil preparedness and emergency response organizations. These representatives have been selected, based on their occupation, training, and technical expertise, to assist local authorities in responding to a radiological incident.

Should a radiological incident occur, local authorities are supposed to contact SEMA, who will coordinate the emergency response action with the Nuclear Emergency Team. The local authorities will be responsible for isolating the affected area from the general public and providing medical attention where needed. No recovery action will be taken until radiation safety experts arrive at the accident scene.

## Dedicated Trains and Emergency Response Capability of the Crews

As discussed further in chapter 6, the decision has been made to use dedicated trains to transport the shipments from TMI to INEL. As a result of this decision:

- The only freight on the train is the damaged nuclear fuel and core debris.

- Buffer cars are placed on either side of the railcar holding the shipping cask.
- Each train has personnel on board to provide security and observe the shipment while in transit.
- The speed of the train is restricted to 35 mph for the Conrail portion of each shipment. Union Pacific has a higher speed restriction of 50 mph in the open portions of its route.
- According to Union Pacific, when the train transporting the damaged fuel encounters another train, the other train enters a rail siding while the train carrying the damaged fuel passes at a speed no greater than 50 mph.
- For the Union Pacific portion of the trip, certain states, such as Nebraska, request state police to follow the train as closely as possible by vehicles on highways adjacent to the railroad track.

# Status of the Shipping Program

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The first shipment of core debris departed TMI on July 20, 1986, and arrived at INEL on July 24, 1986. It consisted of one cask that contained seven canisters. A train dedicated solely to the TMI cargo was used for the shipment.

Due to a series of operational problems, such as clogged and contaminated canisters, shipments were temporarily suspended after the second shipment in August 1986 until December 1986. Although shipments have resumed, the entire program will probably take longer than initially planned due to these unanticipated problems.

DOE and other federal government officials do not believe it is necessary to use dedicated trains to transport radioactive material. According to DOE, however, dedicated trains are being used at higher cost because the alternative offered by Conrail was not acceptable to DOE.

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## Operational Problems Affecting the Shipping Schedule

The process of removing the damaged nuclear fuel from the reactor and loading the debris into the canisters has been slowed by various operational problems such as (1) clogged filter canisters, (2) removal of sufficient water from the canisters, and (3) surface contamination on the canisters. As a result, shipments were temporarily suspended while solutions were developed. DOE had previously planned to ship one cask every 3 weeks and complete the program in about 2-1/2 years. Although the second shipment, consisting of two casks, arrived at INEL on September 4, 1986, no additional shipments were made during September, October, or November 1986.

On December 14, 1986, the program resumed when both casks were shipped to Idaho. Additional shipments were made on January 11, and February 1, 1987. GPU officials estimate that as of February 1, 1987, approximately 25 tons, or about 17 percent of damaged nuclear fuel, has been transported to INEL. The following summarizes the operational problems.

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## Clogged Filter Canisters

Filter canisters are one of three types of canisters used to contain the material removed from the reactor. As the smallest pieces of core debris flow out of the knockout canister, the filter canister is designed to capture these particles on pleated stainless steel filters. Because of the large quantities of small particles suspended in the reactor vessel water, the filters have become clogged before the canisters are sufficiently filled with core debris.

Twenty-seven filter canisters have become clogged. According to GPU officials, because each canister costs \$60,000, it is important to unclog and fully fill (reclaim) the canisters rather than ship them partially loaded with core debris. If the canisters were not reclaimed, additional canisters would have to be purchased in order to complete the program.

Although GPU has attempted to reclaim the canisters, they have become clogged again. GPU officials told us there appears to be a limited number of times that attempts can be made to reclaim the clogged filter canisters. According to the officials, some canisters may therefore have to be shipped with less core debris than they were designed to hold. To date, none of these clogged filter canisters have been shipped from TMI.

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### Removal of Water From the Canisters

Recombiner catalysts have been installed at both ends of each canister. These components recombine into water the hydrogen and oxygen gases that are generated as a result of interaction between water and the radioactive material from the reactor. If these gases were not recombined, the pressure inside the canister would increase.

Sufficient catalyst must be exposed to the atmosphere within the canister, regardless of the position of the canister. The catalyst will not function properly if submerged in water. To ensure that an adequate amount of catalyst is available to recombine the gases within each canister, NRC required that no more than 50 percent water be contained in each canister. According to GPU officials, if 50 percent of the water is removed from each canister, the amount of catalyst that would be exposed is about 12 times more than needed to effectively recombine the gases.

When empty, each canister is capable of holding 422 pounds of water. NRC therefore required GPU to remove 211 pounds of water from each canister to ensure that 50 percent of the water had been removed. GPU officials contended, however, that this approach does not consider the fact that a canister may contain core debris that may displace water. Therefore, if a canister is more than 50 percent filled with core debris, there would not be sufficient water in the canister to remove the required 211 pounds of water.

GPU requested permission from NRC to ship canisters even if 211 pounds of water has not been removed. On January 7, 1987, NRC approved GPU's request and reduced the amount of water that must be removed to 25 percent. According to GPU officials, with 25 percent of the water



removed from each canister, there is still 3 times more catalyst exposed than is needed to effectively recombine the gases.

GPU officials pointed out that each canister is monitored before shipment to ensure that the catalyst is functioning properly. The officials also stated that based on the results of tests and monitoring performed to date, it would take from 3 to 5 years to generate enough gas within each canister to reach the amount of pressure that the canisters were designed to accommodate.

## Contaminated Canisters

GPU has developed a process to remove radioactive contamination from the exterior of each canister before it is loaded into the shipping cask. The canisters are stored in the fuel pool until they are to be shipped. As they are removed from the fuel pool, the canisters pass through a ring that sprays a hot water/boric acid solution. This spray is supposed to remove loose surface contamination from the canisters.

The process has not been entirely successful, however, because 15 canisters have arrived at INEL with more surface contamination than anticipated. This increased surface contamination has resulted in additional cleanup work required at INEL. GPU and EG&G Idaho officials pointed out that this situation presents a housekeeping problem at INEL because additional measures have to be taken to prevent the spread of the contamination at the INEL facilities. Surface contamination of the canisters could also result in increased contamination levels in the interior of the shipping cask; this could also require additional cleanup work before returning the cask to service.

GPU and EG&G Idaho officials said that this situation does not present a threat to public safety because the public has not been exposed to the contamination; it has been contained, as designed, within the shipping cask. GPU officials stated that they are currently gathering data to determine the cause for the high contamination levels. They also stressed that the contamination on the surface of the canisters does not present a danger to the public because the canisters are contained within the shipping casks.

## Relationship of Surface Contamination to Other Types of Radiation

When the core debris loading program was initiated, DOE and EG&G Idaho established a surface radiation contamination goal of less than 10,000 disintegrations (radioactive decay) per minute (DPM) per 100 square centimeters of canister surface area. According to DOE and EG&G

Idaho officials, this contamination level is relatively clean considering the type of facility and its operations and was adopted because:

- Loose surface contamination could become airborne and endanger workers through inhalation.
- DOE did not want to contaminate the waste storage pool or waste handling facilities at INEL. Since it is very costly to decontaminate these facilities, it was decided to take special precautions to minimize the level of contamination before shipments depart TMI.

In order to obtain a perspective on the relationship between the canister DPM levels and other types of radiation, we asked EG&G Idaho officials to compare the radiation associated with the contaminated canisters and another form of radiation such as a chest X-ray. The officials stated that the canister contamination levels are almost insignificant when compared with chest X-rays.

EG&G Idaho officials also stated that there is no direct conversion from DPMs to millirems (mr), the unit commonly used to measure radiation. They did estimate, however, that 200,000 DPM per 100 square centimeters roughly equates to a dose rate of about 1 mr per hour. The officials also estimated that depending on the type, the dose rate from a chest X-ray could range from 30 to 100 mr per hour at a distance of 1 inch. As a point of comparison, the officials said a canister contamination level of 200,000 DPM would be about 3 percent of a chest X-ray which has a dose rate of about 30 mr per hour.

According to the EG&G Idaho officials, although 15 canisters are contaminated in excess of the 10,000 DPM level, the radiation exposure levels for all the contaminated canisters are less than a chest X-ray: 10 canisters have a radiation exposure level less than 200,000 DPM, or 1 mr per hour.

### Extent of Canister Contamination

As of December 8, 1986, 21 canisters had been shipped to Idaho. Of these, 15 canisters had contamination levels above the 10,000 DPM goal. Only 1 of the 7 canisters transported in the first shipment was contaminated, while all 14 canisters in the second shipment was found to be contaminated. Contamination levels have ranged from about 13,300 DPM to about 6,000,000 DPM, or about 30 mr per hour.

## Canister Status

As of November 1986, 230 empty canisters had been delivered to TMI, and 190 had been inspected and accepted to load core debris. The status of these canisters is summarized in table 6.1.

**Table 6.1: Status of the Canisters Available for Loading Debris as of November 18, 1986**

Status of canisters	Number
Shipped to Idaho	21
Loading not started	103
Loaded and ready for shipment	8
Loading in process but not ready for shipment	58
<b>Total</b>	<b>190</b>

## The Use of Dedicated Trains to Ship Spent Nuclear Fuel

Until recently, the use of dedicated trains to transport radioactive material had been an unsettled issue between shippers and the railroads. The hazardous material shipping regulations promulgated by the Department of Transportation do not require the use of dedicated trains. According to the Association of American Railroads, however, many rail carriers believe that dedicated trains should be used for the shipment of spent nuclear fuel. The Association recommends the following operating practice for transportation of spent nuclear fuel:

“Shipments of casks containing irradiated spent fuel cores should move in special trains containing no other freight, not faster than 35 mph. When a train handling these shipments passes or is passed by another train, one train should stand while the other moves past not faster than 35 mph.”

The use of dedicated trains has been contested before the Interstate Commerce Commission. In a 1980 ruling on a transportation case not related to the TMI damaged fuel, the Commission stated:

“Based on the evidence of record and Department of Transportation and Nuclear Regulatory Commission safety rules, the [Interstate Commerce] Commission again determined that special train service would yield no greater safety benefits than regular train service, and determined that it would not allow the railroads to require a service that would be several times as costly as regular service without commensurate safety benefits. Accordingly, the Commission found that the special train requirement was wasteful transportation and constituted an unreasonable practice . . .”

The government and electric utility companies subsequently challenged the reasonableness of the rates charged for dedicated train service. In a June 1986 ruling, the Commission found that railroads are (1) avoiding

their common carrier obligation to transport radioactive material in regular freight service and (2) engaging in an unreasonable practice by charging rates for dedicated train service that are several times the cost of regular train service. The Commission determined that spent nuclear fuel has been regularly transported in regular train service, and mandatory dedicated train service has not been shown to produce greater safety than regular train service. The Commission determination that the use of dedicated train service is not mandatory has been upheld by the U.S. Court of Appeals for the District of Columbia.

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### Dedicated Trains Used for TMI Shipments

NRC's cask design requirements incorporate standards that allow shipping casks, including the casks used for the damaged TMI fuel, to be used in regular train service. DOE officials responsible for the shipping program also informed us that they do not believe it is necessary to use dedicated trains to transport the damaged fuel and radioactive debris from TMI. They believe that dedicated train service does not provide any added safety in comparison with regular train service. They also stated that the dedicated train option was selected for the TMI shipments only because the other alternative offered was a poor second choice.

Conrail offered two options to DOE for shipping radioactive wastes and debris—local freight service and dedicated trains. Conrail believes that if a shipper declines to use dedicated train service, the only other alternative is to use local freight service. Conrail also believes that all nuclear materials should be shipped on dedicated trains for the following reasons:

- the route can use the best quality track, and can be planned to avoid population centers;
- the train can be scheduled to avoid other rail traffic;
- the train can be monitored enroute;
- the speed of the train can be controlled;
- the movement of other trains encountered along the route can be controlled;
- emergency response can be provided in the event of an incident;
- escorts can be provided; and
- maximum public confidence in the safety of nuclear movements through sensitive areas can be instilled, while at the same time minimizing the potential for terrorist intervention.

According to DOE officials, the local freight service was not a viable alternative because each shipment would have taken 8 days to travel

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between TMI and East St. Louis instead of 2 days for dedicated train service. This would have meant that the railcar and shipping cask would spend most of the travel time sitting idle on a rail siding and subjected to reduced surveillance. Because these were not favorable conditions, DOE program officials selected the dedicated service option.

According to Union Pacific, it initially concurred with DOE's plan to move the damaged fuel shipments in regular train service. Upon learning that Conrail would be providing dedicated train service over its segment of the route, however, Union Pacific concluded that dedicated train service should also be used for its portion of the journey.

Union Pacific also stated that it negotiated a shipping contract with EG&G Idaho that allowed DOE to replace dedicated train service with regular train service after the first three shipments. The company now believes, however, that DOE has not adequately educated the public on the safety of the shipments and the type of train service that is sufficient for the shipments. Union Pacific has concluded that public insistence on dedicated train service seems to have increased; therefore, dedicated train service should be continued for the balance of the shipments.

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### Dedicated Train Service Increases the Cost of Shipping TMI Wastes and Debris

In providing dedicated train service, the railroads currently charge about \$50,000 per trip over and above the normal tariff charge for shipping radioactive waste. If all 40 shipments are made by dedicated train, the cost of the shipping program could be increased by about \$2 million. This cost could fluctuate depending on whether the two casks are shipped separately or on the same train.

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### Agency Comments and Our Analysis

We requested comments on a draft of this report from the Departments of Energy and Transportation, NRC, FEMA, FRA, and the Interstate Commerce Commission. In addition, we requested comments from GPU, Consolidated Rail Corporation, Union Pacific Railroad, the Association of American Railroads, and DOE's Oak Ridge National Laboratory. Finally, we requested comments from the Missouri Emergency Management Agency and the Pennsylvania Emergency Management Agency. We received written comments from DOE, NRC, FEMA, the Missouri Emergency Management Agency, Union Pacific, and Oak Ridge National Laboratory. Appendixes I through VI contain the full text of the comments we received from these agencies and organizations.

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DOE

In its comments, DOE stated that our report presents a comprehensive review of its program and concludes that DOE has

- acted prudently in conducting the shipments and meeting all applicable federal requirements;
- taken extensive steps to protect public health, safety, and the environment; and
- cooperated with states beyond regulatory requirements to assure the safety of TMI shipments.

In addition, DOE suggested that we replace the discussion of dedicated trains in this chapter with text prepared by its Office of General Counsel and enclosed with its comments. Although we did not follow DOE's suggestion entirely, we have added relevant portions of the information to our discussion of dedicated train service. DOE also noted that a recent NRC report concludes that risks from spent fuel under severe transportation accident conditions are less than previously estimated.

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NRC

In its comments, NRC stated that our draft report provided a comprehensive and generally accurate review of the ongoing program to ship damaged fuel from TMI to INEL. It also provided seven comments intended to clarify specific factual matters discussed in the report. We have revised our report as appropriate to reflect these comments.

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FEMA

FEMA commented only on our discussion, in chapter 5, of emergency response preparedness along the shipping route. FEMA stated that while our discussion of its Integrated Emergency Management System is generally correct, more precision is needed to describe the system and its use. The agency added that we did not refer to its federal coordination role in assisting states enhance their capabilities to respond to radiological transportation accidents. FEMA suggested that we substitute alternative language contained in its comments (see app. III).

FEMA's suggested change addresses its general role in emergency planning and response, but does not address the DOE program to ship damaged TMI spent fuel. For this reason, we did not substitute the language suggested by FEMA. We did, however, add language referring to FEMA's emergency functions, including radiological transportation accidents.

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**Missouri Emergency  
Management Agency**

The Missouri Emergency Management Agency commented that our draft report was a positive document. The agency suggested that, in reference to the discussion of canister testing in chapter 2, we identify what damage occurred to tubes containing neutron absorbers when a canister was subjected to a 30-foot drop test. The document that we obtained during our audit did not describe the specific damage to the tubes, consequently, we could not provide this information.

The agency also said that it has no knowledge of any vehicles that follow the TMI spent fuel shipment train through Missouri. We have deleted the statement contained in our draft report that, for the Union Pacific portion of the trip (including Missouri), the train carrying TMI damaged fuel is followed by vehicles on highways adjacent to the railroad track.

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**Union Pacific Railroad**

Union Pacific's principal comment on a draft of our report relates to the discussion in chapter 6 of the dedicated train issue. The railroad did not disagree with what was contained in our draft report; rather, it took the opportunity to present its views on the issue. The railroad's basic position is that DOE has not adequately educated the affected public on the safety of TMI damaged fuel shipments and the type of train service that is sufficient for the shipments. Therefore, Union Pacific's view is that dedicated train service should be continued for the rest of the shipments.

Union Pacific also made several other comments intended to clarify matters discussed in our draft report or to correct factual errors. We have revised our report to reflect these comments.

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**Oak Ridge National  
Laboratory**

Oak Ridge provided editorial comments and comments intended to improve the technical accuracy of our draft report. We revised our report as appropriate to reflect these comments.

# Comments From the Department of Energy



Department of Energy  
Washington, DC 20585

MAY 15 1987

Mr. J. Dexter Peach  
Assistant Comptroller General  
Resources, Community, and  
Economic Development Division  
U.S. General Accounting Office  
Washington, DC 20548

Dear Mr. Peach:

The Department of Energy (DOE) appreciates the opportunity to review and comment on the General Accounting Office (GAO) draft report entitled "Damaged Nuclear Fuel Shipments from Three-Mile Island to Idaho Falls."

The report is a comprehensive review of the Department's program to ship damaged core material from the Three-Mile Island (TMI) reactor to the Idaho National Engineering Laboratory. We have reviewed the report and have the following comments:

1. The report title could be misleading (i.e., "damaged nuclear fuel shipments"). No shipments were damaged. A more precise title would be "Shipments of the Damaged Nuclear Fuel Core from Three-Mile Island to the Idaho National Engineering Laboratory."
2. The discussion of dedicated trains beginning on page 64 should be replaced by the enclosed material prepared by our Office of General Counsel.
3. We believe the GAO findings (with no findings to the contrary) lead to the following recommended conclusions:
  - a. DOE has acted in a prudent manner in conducting the TMI shipments and in meeting all applicable Federal regulations and requirements.
  - b. DOE has taken extensive steps, both regulatory and institutional, to protect the health and safety of the public and to protect the environment.
  - c. DOE has cooperated with States beyond regulatory requirements to assure the safety of TMI shipments. This includes prenotification of shipments, allowing for inspections and escorts if requested, and providing extensive information.
4. Environmental review and analysis completed since the GAO study was started continue to demonstrate the intrinsic safety of such shipments. The Nuclear Regulatory Commission (NRC) has just published NUREG/CR-4829, "Shipping Container Response to Severe Highway and Railway Accident Conditions." This document concludes, "... the radiological risks from spent fuel under severe highway and railway



accident conditions as derived in this study are less than risks previously estimated in the NUREG-0170 document." NUREG-0170 is the NRC's baseline environmental document supporting the shipment of radioactive materials by all modes.

We believe the TMI shipments are safe, secure, and well-monitored. They pose no significant health or safety risk to the public due to the extreme care we take and, more importantly, the extraordinary packaging used. DOE hopes these comments will be helpful to GAO in their preparation of the final report.

Sincerely,



Lawrence F. Davenport  
Assistant Secretary  
Management and Administration

Enclosure

THE DEDICATED TRAIN ISSUE

The use of dedicated train service versus regular train service for the transportation of spent nuclear fuel is a long-standing point of contention between the railroads and shippers of nuclear materials. In 1976, the Department of Energy (DOE) and a number of private shippers instituted proceedings before the Interstate Commerce Commission (ICC) to compel the railroads to handle spent nuclear fuel. Following a decision by the ICC that the railroads had a common carrier obligation to move the spent nuclear fuel, the railroads imposed a mandatory special train requirement. DOE and the private shippers instituted another proceeding before the ICC challenging the railroads' mandatory imposition of special trains as well as the exceedingly high rate charged for the special train service. Again, DOE and private shippers prevailed and the ICC held that the mandatory imposition of special train service was unreasonable transportation practice. This decision was upheld on appeal and the Supreme Court denied certiorari. The western and southern railroads filed tariffs for regular train service, but the eastern railroads refused to comply with the decision and, instead, published a tariff which again contained a mandatory special train requirement. Once again, DOE and the private shippers instituted proceedings before the ICC against the eastern railroads and, again, the shippers prevailed. The eastern railroads were found to be in contempt of the ICC order. As a result, the ICC prescribed a rate level for the eastern railroads for regular train service. This decision was upheld by the U.S. Court of Appeals for the District of Columbia and the Supreme Court denied certiorari. The issue of special or dedicated trains has been fully and completely resolved by the ICC and upheld by the courts. Special trains are a wasteful transportation practice and are not warranted as a safety precaution. In spite of the rulings of the two U.S. Courts of Appeal and the ICC, the Association of American Railroads (AAR) persists in recommending that special trains be used on a routine basis. Conrail continues to follow the AAR recommendations on the TMI shipments.

# Comments From the Nuclear Regulatory Commission



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

May 13, 1987

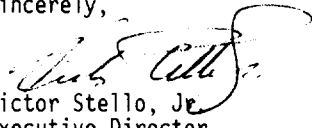
Mr. J. Dexter Peach  
Assistant Comptroller General  
U.S. General Accounting Office  
441 G Street, N.W.  
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review and comment on the draft GAO report "Damaged Nuclear Fuel Shipments from Three Mile Island to Idaho Falls." The draft report, which makes no recommendation, provides a comprehensive and generally accurate review of the ongoing program to ship damaged nuclear core material from Three Mile Island Unit 2 to the Idaho National Engineering Laboratory.

Specific comments on the report are enclosed.

Sincerely,

  
Victor Stello, Jr.  
Executive Director  
for Operations

Enclosure:  
Comments on Draft GAO Report

ENCLOSURE

Comments on Draft GAO Report:  
"Damaged Nuclear Fuel Shipments from Three Mile Island to Idaho Falls"

1. Page 2, last sentence

This statement should be revised to clarify that operational problems associated with defueling the reactor, rather than problems with the transportation program, led to a temporary suspension of shipments to Idaho.

2. Page 3, "Results in Brief," second finding

This section should be revised to clarify NRC's role in the certification of the NUPAC-125B cask. The NRC did not actually participate in the design or testing of the cask except to offer advice when solicited. The NRC performed an independent safety review of the NUPAC-125B cask which considered the cask design and test results. In addition, this section should be revised to reflect the fact that the cask is designed to provide shielding against the "radiation" emitted by the cask contents and to provide "leaktight containment" which prevents the leakage of "radioactive material" from the cask.

3. Page 4, "Container testing"

This section should be clarified to indicate that the NRC performed an independent safety review of the NUPAC-125B shipping cask. The paragraph should also be revised to indicate that the design provides for both

containment of "radioactive materials" as well as shielding against "radiation" emitted by the contents of the cask.

4. Page 4, "Route selection"

This section should be corrected to indicate that the shipping route was selected by DOE, after consultation with the railroads, federal officials, and private contractors.

5. Page 4, "Emergency planning"

This section should be revised to indicate that the affected state and the carrier, in addition to the local affected community, are primarily responsible for initiating and monitoring the recovery operations.

6. Page 34, last sentence

This statement should be revised to clarify that NRC staff performed an independent evaluation of reported test results but did not "monitor" the actual testing.

7. Page 22, second paragraph

The referenced study has subsequently been completed. The reference is Shipping Container Response to Severe Highway and Railway Accident Conditions - NUREG/CR-4829, February 1987.

# Comments From the Federal Emergency Management Agency



## Federal Emergency Management Agency

Washington, D.C. 20472

MAY 13 1987

Mr. J. Dexter Peach  
Assistant Comptroller General  
United States General Accounting Office  
Washington, DC 20548

Dear Mr. Peach:

This responds to your letter of April 13, 1987, to Mr. John Thiede, Inspector General of the Federal Emergency Management Agency (FEMA) concerning the Agency's review of a General Accounting Office (GAO) draft report: Damaged Fuel Shipments from Three Mile Island to Idaho Falls (GAO/RCED-87-123). We have reviewed this draft report and have the following comments:

Page 49: Reference is made to the use of FEMA's Integrated Emergency Management System (IEMS) to guide the emergency response actions of state and local governments. While the language in the report is generally correct, more precision is needed to describe IEMS and its use. Also, no reference is made to FEMA's Federal coordination role in assisting states in enhancing their capabilities to respond to radiological transport accidents. We recommend this alternative language:

The Federal Emergency Management Agency (FEMA) has an Integrated Emergency Management System (IEMS) to assist state and local governments in developing and enhancing integrated emergency planning, preparedness and response capabilities. Through the implementation of IEMS, recognition is given to the principle that similar emergency functions are required for all types of emergencies, including radiological transport accidents.

Through guidance issued by FEMA to support the implementation of IEMS by state and local governments, emphasis is placed on developing preparedness and response capabilities based on core functions such as communications, protective action decisionmaking, evacuation and medical services. For example, a primary objective of FEMA is to establish a national emergency management system through which local, state and Federal emergency operating facilities are linked with compatible communications capabilities. Through such a national emergency infrastructure, the resources of emergency personnel and equipment can be more effectively tapped and used for any type of emergency, regardless of its magnitude and impact.

Appendix III  
Comments From the Federal Emergency  
Management Agency

2

FEMA also coordinates the activities of 10 Federal agencies, under its regulation 44 CFR 351, to provide radiological emergency planning and preparedness assistance to state and local governments at the national level through the Federal Radiological Preparedness Coordinating Committee (FRPCC) and at the Regional level through the Regional Assistance Committees (RAC). Through the FRPCC, FEMA has developed and issued a guidance document in March 1983 for state and local governments to assist them in developing emergency planning and preparedness for radiological transport accidents. This document is entitled: Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness for Transportation Accidents. This guidance is being revised based on comments and experience in using it during the past four years. The revised version should be ready for distribution by October 1987. FEMA is providing technical assistance to state and local governments through the Agency's Regional Offices and RAC's to assist them in developing and enhancing their capabilities to prepare for and respond to radiological transport accidents.

We appreciate the opportunity to review and comment on this document.

Sincerely,



Julius W. Becton, Jr.  
Director

# Comments From the Missouri Emergency Management Agency

John Ashcroft  
Governor



STATE OF MISSOURI  
DEPARTMENT OF PUBLIC SAFETY  
OFFICE OF THE ADJUTANT GENERAL

Richard D. Ross  
Director

## EMERGENCY MANAGEMENT AGENCY

P. O. Box 116  
Jefferson City, Missouri 65102  
Phone 314 - 751-9500



may 6, 1987

J. Dexter Peach  
Assistant Comptroller General  
U.S. General Accounting Office  
Washington, DC 20548

Re: Comments to Draft - GAO/RCED-87-123

Dear Mr. Peach:

My staff and I have read the Draft of your report "Damaged Nuclear Fuel Shipments from Three Mile Island to Idaho Falls (GAO/RCED-87-123)" and found it to be a positive document. We have only a few comments.

On page 38, the report states that "(3) the tubes containing neutron absorbers experienced no damage beyond that projected by computer analysis." (emphasis mine) This raises the immediate thought, "Then there was some damage. What was it?" In my opinion it is better to admit what damage occurred than to leave it to the imagination. As you may know, there are folks in Missouri who are trying to stop the train and the question of criticality is one of their strong concerns.

On page 54, the statement is made that "... for the Union Pacific portion of the trip, the train is followed by vehicles on highways adjacent to the railroad track." This is news to us. The State Highway Patrol accompanied the first couple of shipments by air, at least part of the way, and some Patrol cars observed the train's passage at certain troublesome crossings. We have no knowledge of any vehicles, official or otherwise, following the train through Missouri. Therefore, we could not very well confirm this should we be asked by the news media. If your audit disclosed such a fact, please inform me as to who is following the train.



**Appendix IV  
Comments From the Missouri Emergency  
Management Agency**

Page 2

In essence, it is a good report and I would hope it might lay to rest the concerns of the public and interested legislators.

Thank you for giving us an opportunity to preview the Draft Report. If you or any of your staff have questions about this response, please contact Wm. K. Johnson, Chief of our Technological Hazards Branch, 314/751-9770.

Sincerely,



Richard D. Ross  
Director

WKJ:sb

# Comments From the Union Pacific Railroad

UNION PACIFIC RAILROAD COMPANY

R. K. DAVIDSON  
VICE PRESIDENT-OPERATION



1416 DODGE STREET  
OMAHA, NEBRASKA 68179

May 18, 1987

Mr. J. Dexter Peach  
Assistant Comptroller General  
Resources, Community and Economic  
Development Division  
U.S. General Accounting Office  
441 G Street, N.W.  
Washington, D.C.

Re: Draft Report Damaged Nuclear Fuel  
Shipments From Three Mile Island;  
GAO/RCED-87-123

Dear Mr. Peach:

I am in receipt of your letter dated April 13, 1987, enclosing the draft report on damaged nuclear fuel shipments from Three Mile Island to Idaho Falls. Union Pacific appreciates the opportunity to comment on the draft report. We would ask that the General Accounting Office consider our comments even though they are a few days late.

Our primary comment is addressed to the discussion of dedicated train service in Chapter 6. The draft indicates that there is a dispute between the railroads and the Department of Energy over the use of dedicated trains to transport the damaged fuel from Three Mile Island. The report sets forth Conrail's and the AAR's views (pp. 61-62). You should be aware of Union Pacific's view.

As you probably are aware, Union Pacific entered into a rail transportation contract with DOE's Contractor, EG&G of Idaho. That contract provided that expedited or dedicated train service would be provided from East St. Louis to Idaho Falls for at least the first three movements. Union Pacific preliminarily concurred in DOE's plans to move the Three Mile Island shipments in regular train service until it was learned that Conrail would be providing special train service from Middletown, Pennsylvania to East St. Louis. In our opinion, if special train service is to be provided under DOE arrangement over the eastern portion of the routing, the same level of transportation should be provided for the western portion of the movement.

In order to reach agreement with DOE on a rail contract, we subscribed to a condition that after the first three movements of damaged nuclear fuel the DOE could request that the dedicated train service be ended and regular service utilized. Public interest, however, has not abated. Instead, public insistence on at least special train service seems to have increased. Union Pacific has encouraged DOE to advise the public, as well as state and local officials, that dedicated train service might be replaced with more conventional train service. Our experience has been, however, that the DOE has failed to educate the public not only on the safety of the move, but also on the type of train service that is sufficient for this purpose. Union Pacific has concluded, therefore, that dedicated train service should be continued for the balance of the TMI shipping campaign.

We have the following comments concerning other portions of the draft report:

At page 47 in the last paragraph, the word "Pocotello" is misspelled.

On page 50, in the first paragraph, the draft notes that train crews have radio equipment on board and that they have been instructed to report to DOE's Warning Communications Center. It is correct that the crews have radios. However, Union Pacific train crews have been instructed to report any incident to the Train Dispatcher who then will communicate the report to Union Pacific's Operations Center for further notification to the DOE Center.

On page 51, the statement that hazardous cargo containers are required to have placards with the four digit identification number printed thereon is incorrect. Identification number markings are required to be shown only on portable tanks, cargo tanks and tank cars. The identification

Appendix V  
Comments From the Union Pacific Railroad

numbers for poison gases, radioactive materials and explosives cannot be displayed on the placard regardless of the type of conveyance.

On page 53, at the bottom of the page, Union Pacific has placed a speed restriction of 50 mph, rather than 55 mph on the movement of the cask cars whether loaded or empty. Also on the bottom of that page and carrying over to the top of page 54, Union Pacific's practice is that the train transporting the spent nuclear fuel holds the mainline while the other train being passed or met enters a rail siding. The train bearing the spent fuel then passes at a speed no greater than 50 mph, not 35 mph.

On the same page, the third item relating to the decision to use dedicated trains should be revised to delete mention of cabooses. Cabooses are provided for operating convenience or as a result of labor agreements between the railroad and the labor organization representing trainmen. Surveillance of the shipment can be made as easily from the cab of the second unit in the locomotive consist. The fifth item relating to train meets applies only to single track territory. Opposing trains are slowed in double track territory between St. Louis and Jefferson City, MO, Kansas City, MO and Menoken, KS; and Gibbon, NE and Granger, WY.

On page 54, it is noted that Union Pacific trains are followed by vehicles on highways adjacent to the railroad track. This is incorrect. Certain states, such as the State of Nebraska, request the State Highway Patrol to monitor the progress of the train by driving on the roads as closely parallel to the rail route as possible. These highways are not always adjacent to the railroad track. The draft report leaves the erroneous impression that Union Pacific is providing a motor vehicle escort for the entire portion of the journey on Union Pacific. That is not the case. That is occurring only in those states which require the additional escort. Union Pacific does have an Operating Department officer on board each train.

The last paragraph on page 54 indicates that train crews have been provided the phone numbers of DOE's Warning Communication Center. Again, the train crews have been instructed to notify the Train Dispatcher who in turn will make the necessary notifications in the event of an incident.

**Appendix V**  
**Comments From the Union Pacific Railroad**

We appreciate the opportunity to comment on the draft report. Please contact Mr. C. E. Dettmann at (402) 271-4440 if you have any further questions.

Sincerely,



R. K. Davidson

# Comments From the Oak Ridge National Laboratory

**OAK RIDGE NATIONAL LABORATORY**  
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX X  
OAK RIDGE, TENNESSEE 37831

May 5, 1987

Mr. J. Dexter Peach  
Assistant Comptroller General  
U.S. General Accounting Office  
Washington, DC 20548

Dear Mr. Peach:

In accordance with your letter of April 13, I have reviewed the draft report, Damaged Nuclear Fuel Shipments from Three Mile Island to Idaho Falls (GAO/RCED-87-123). Comments may be found written on the draft document itself.

Most of the comments are editorial. Two are probably worth mentioning. The author notes in many places that the cask is designed to "contain radiation." In fact, the cask will contain the activity associated with the fuel bearing parts that will be carried by the cask. Some small fraction of the gamma radiation emanating from the radioactive debris carried by the cask will pass through the wall of the cask. Thus, radiation is not contained; it is shielded.

Finally, Fig. 3.1 identifies the impact limiters or energy absorbers as "overpacks." Since the author was consistent with his nomenclature in that section, I chose not to suggest the change. However, in the latter parts of the report (see p. 36), the device is frequently called an impact limiter. This is better terminology, and I would suggest it be used in place of the term "overpack."

If you have any questions on my comments, please do not hesitate to call.

Sincerely,

  
L. B. Shappert  
Chemical Technology Division

LBS:cap

Enclosure

cc: A. G. Croff  
V. C. A. Vaughen  
File

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# Major Contributors to This Report

---

**Resources,  
Community, and  
Economic  
Development Division,  
Washington, D.C.**

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