



Illinois Spent Nuclear Fuel and High-Level Waste Inspection and Escort Program



Overview

Energy demands in the United States respond to population, lifestyle and business trends. Increasing energy consumption results in the need for corresponding power production. Nuclear energy is one of the available energy options used in the country. There are currently over 100 nuclear reactors licensed to operate in the United States. In 1998, these units supplied approximately 20 percent of the nation's electricity.

An inevitable by-product of nuclear energy production is nuclear waste because materials and equipment become contaminated with radioactivity during production. Nuclear waste is also generated through nuclear medical, industrial and agricultural research and application; uranium mining; and nuclear weapons production and testing.

Nuclear waste is classified according to:

- origin;
- isotopic content;
- amount and level of radioactivity; and
- strategic significance.

The laws, rules and regulations that apply to the management of nuclear waste are applied according to the specific classification. Much of the nuclear waste generated during nuclear power production is classified as high-level radioactive waste (HLW), meaning it contains a high enough concentration of certain radionuclides to require special handling, shipping, transportation and storage procedures.

The primary component of commercial HLW is spent nuclear fuel. Spent nuclear fuel is fuel that has been removed from a reactor core because it no longer contributes efficiently to a nuclear chain reaction. Spent fuel can be reprocessed and used again. The residues from the chemical extraction processes used in reprocessing are another example of HLW.



Transuranic wastes are another kind of radioactive waste that requires special controls over handling, shipping and disposal. Transuranic wastes contain alpha emitting radionuclides with an atomic number greater than uranium (92) and a half-life greater than 20 years. These materials are typically laboratory clothing, tools, glassware and other items that are contaminated with plutonium or americium as a result of activities related to research, nuclear weapon production or decommissioning of nuclear facilities.

The transportation and storage of radioactive wastes continues to be an issue across the United States. This brochure describes the Illinois Emergency Management Agency (IEMA)-Division of Nuclear Safety inspection and escort program for spent nuclear fuel, HLW and transuranic waste in the state of Illinois.

History

Illinois' central geographic location and extensive transportation infrastructure makes it one of the nation's major transportation hubs. In addition, Illinois is home to a large number of nuclear facilities, including six operating nuclear power stations; the nation's only operating commercial nuclear fuel storage facility; and a national laboratory.

Due to these factors, many truck and train shipments of spent fuel move into and out of the state, or pass through Illinois en route to out-of-state destinations for research or storage. Most of the shipments that have traveled through Illinois contained spent nuclear fuel.

The broad development of the nuclear industry in Illinois led to the establishment of the IDNS in 1980. To fulfill its responsibility for protecting the citizens of Illinois from potential radiation hazards, the IDNS developed one of the most advanced nuclear facility monitoring and emergency response systems in the world.

While these systems are state-of-the-art, they did not offer the immediate response capability necessary to ensure safety along an entire transportation route. Because of the large number of shipments that enter or traverse the state, IDNS created a comprehensive inspection and escort program that takes a preventative approach to ensuring public health and safety.

To enhance the safety of spent nuclear fuel shipments within Illinois, a legislatively mandated **Spent Nuclear Fuel and High-Level Waste Inspection and Escort Program** was established in early 1983 to:

- prevent accidents by allowing only transportation equipment and vehicles that pass rigorous inspections to travel in the state;
- provide immediate on-scene radiation expertise in the event of an accident during shipment; and
- ensure compliance with all U.S. Department of Transportation (U.S. DOT) and U.S. Nuclear Regulatory Commission (U.S. NRC) regulations governing shipment of these materials.

The program developed by IDNS is carried out in conjunction with several other Illinois state agencies.

Illinois has taken a preventative approach to spent nuclear fuel and HLW shipment safety by establishing a well-trained and well-equipped mobile team of experienced emergency response personnel. The program was originally designed to inspect and escort shipments of both HLW and spent nuclear fuel. However, with the recent opening of the U.S. Department of Energy's (U.S. DOE) Waste Isolation Pilot Plant (WIPP), legislation was passed that added transuranic waste shipments to the types of shipments requiring inspection and escort.

Through the cooperative effort of IEMA (Division of Nuclear Safety), the Illinois State Police (ISP) and the Illinois Commerce Commission (ICC), over 480 shipments of spent nuclear fuel have been transported safely through Illinois since 1983.

What is Spent Nuclear Fuel?

Spent nuclear fuel is a by-product of generating electricity with a nuclear reactor. Nuclear power reactors are fueled by pellets of enriched uranium oxide. Each pellet is about the size of a pencil eraser. Hundreds of pellets are placed into metal tubes one-half inch in diameter and 15 feet long. Once sealed, the metal tubes are referred to as fuel rods, and are bundled together to form nuclear fuel assemblies.

The assemblies are placed in the core of the nuclear reactor in fixed positions. Once the nuclear reaction begins, heat and radiation are produced. The heat resulting from the fission process produces steam, which drives a turbine, in turn generating electricity—much like a coal-fired or oil-fueled power station.

A fuel assembly will efficiently produce heat for approximately three years, and then needs to be replaced. During the reaction process, some of the uranium is used. However, the overall amount of radioactive material in the fuel is increased. Thus the term "spent nuclear fuel" is used when referring to this material.

The Inspection and Escort Process

Any high-level radioactive waste, spent nuclear fuel or transuranic waste shipment originating in Illinois or traveling through the state must follow the guidelines of the Illinois Spent Nuclear Fuel and High-Level Waste Inspection and Escort Program.

The process begins when IEMA-Division of Nuclear Safety officials receive notification of a planned shipment through Illinois. Information must be provided on the point of origin, route to be taken, shipment description, date of departure and the estimated time of arrival at the state border (if coming from out-of-state). These details are considered “safeguard information” by the U.S. NRC, and is distributed only on a “need to know” basis. For a shipment to be authorized, notification must be received from the shipper at least four days in advance of shipment.



After confirming plans with the shipper, IEMA-Division of Nuclear Safety inspectors from the Division of Environmental Monitoring are scheduled to inspect and escort the shipment. As the lead agency for the program, IEMA-Division of Nuclear Safety maintains primary responsibility during the inspection and escort. The IEMA-Division of Nuclear Safety dispatcher, on duty 24 hours a day, remains in constant contact with the team during shipment.

Once notification of a shipment is received, personnel from the IEMA-Division of Nuclear Safety Division of

Environmental Monitoring contact the following four Illinois state agencies with shipment information:

State Police

IEMA-Division of Nuclear Safety contacts the ISP district where the shipment will originate or enter the state. Hazardous materials and motor carrier inspection officers are scheduled to participate in the inspection and escort. In addition, ISP headquarters contacts all of the districts located along the shipment route, to arrange for continuous escort across the state. In the event of an incident, the officers would assist with emergency response and traffic control.





Packaging Spent Nuclear Fuel

Because spent nuclear fuel assemblies are thermally hot and highly radioactive, stringent packaging and transport procedures must be followed. After the assembly is removed from the reactor, it is placed in a large cooling pool. Prior to being shipped, the assembly must be placed in a special shipping cask approved by the U.S. Nuclear Regulatory Commission. The stainless steel casks are lined with a lead barrier and are designed to withstand severe accident conditions.

Using special hoists, the cask is submerged in the cooling pool and the spent fuel assembly is placed inside. Casks designed for rail transport typically hold 18 assemblies. The smaller truck casks typically hold nine assemblies. After the cask is sealed, the unit is removed from the pool and the water in the cask is drained back into the pool. Since the cask was submerged in radioactive water, the outside of the cask must be scrubbed to remove contaminants.

After the cask is appropriately decontaminated, examined, labeled and placarded, it is either stored on site or shipped off site for research or storage. If the material is shipped off site, it is loaded onto a truck or train flatcar. Additional safety precautions, such as personnel barriers or impact limiters, may be used. Because there are only a limited number of approved casks, most shipments of spent nuclear fuel are conducted as part of a shipping campaign – a large number of individual shipments are transported to a storage facility over a concentrated period of time.

Illinois Emergency Management Agency

The Illinois Emergency Management Agency (IEMA) is notified and serves as a backup for communications systems necessary to track shipment progress. In the event of an incident involving a shipment, IEMA would assist by coordinating with other state agencies and securing needed resources.

Illinois Department of Transportation (IDOT)

If it is a truck shipment, this agency is notified and appropriate personnel review conditions of the roads to be used during the shipment. This agency has several facilities available for use as inspection checkpoints. Personnel from this agency also issue overweight permits, if necessary. If the shipment travels along any toll roads, the route must be approved by the Illinois Toll Highway Authority.

Illinois Commerce Commission

If the shipment moves by rail, the ICC is notified. ICC track inspectors perform a physical inspection of the track within 24 hours prior to movement. In addition, the ICC provides a rail hazardous materials inspector to assist with inspection of the train and review of the shipping papers.

Every shipment of spent nuclear fuel, high-level waste or transuranic waste that enters, exits or traverses Illinois is inspected and escorted by IEMA-Division of Nuclear Safety. Whether by truck or by rail, these shipments are checked for compliance with all appropriate U.S. NRC and U.S. DOT requirements. Upon arrival at a predetermined location, the inspection to verify compliance with all requirements begins.



First, the shipping papers that accompany each hazardous materials shipment are reviewed for appropriate content and accuracy. These and the shipment bill of lading contain all of the specific information required by the U.S. DOT. In addition, the driver's operator credentials and training certificates are reviewed and confirmed to be up-to-date.

If the movement is by highway, the shipping papers are reviewed by an ISP hazardous materials officer. If the movement is by rail, the railroad waybills and consist are reviewed by a hazardous materials inspector from the ICC. The shipping papers contain important information that confirms the identity of the package and contents. They also contain information regarding the type and quantity of radioactivity in the package along with other information that would be beneficial to anyone responding to an incident or accident involving the package.

ISP hazardous materials inspectors perform motor-carrier inspections on trucks. These inspections include checks on the vehicle's lights, brakes, tires, emergency equipment, and other safety features. ICC inspectors perform similar checks of rail safety equipment.

IEMA-Division of Nuclear Safety inspectors conduct radiological surveys of the outside of each cask. Surveys are performed using a portable radiation detection instrument. Radiation levels are measured at the surface of the package (when accessible), at one meter from the package, at two meters from the package and at the nearest occupied position (usually the cab of the truck or caboose of the train). Because of the high degree of shielding provided by the casks, radiation exposures to inspection personnel and vehicle operators is minimal.

G.E. Spent Nuclear Fuel Storage Facility

The only commercial off-site spent nuclear fuel storage facility in the country is located 15 miles southwest of Joliet, Illinois. This facility, owned and operated by the General Electric Company (G.E.), received shipments of spent nuclear fuel from nuclear reactors across the nation during the 1970s and 1980s.

G.E. originally intended to reprocess spent nuclear fuel at this facility for reuse in the nuclear energy production cycle. However, in 1977 President Jimmy Carter put a moratorium on spent nuclear fuel reprocessing. Therefore, instead of recycling, the company chose to contract out storage space in the facility cooling pool. Because of this decision, some of the spent nuclear fuel shipments already delivered to the facility were returned to the reactors of origin. Shipments of spent nuclear fuel were sent to the facility until it reached capacity in 1989.

If the surface of the cask is accessible, IEMA-Division of Nuclear Safety inspectors conduct surface contamination tests. The surface of the cask is wiped with a special filter paper and checked with portable radiation detection equipment. Samples are later analyzed at the IEMA-Division of Nuclear Safety Radiochemistry Laboratory in Springfield, Illinois.

If motor carrier safety violations are identified during the inspection, the vehicle may be put out of service until necessary repairs can be made, or the vehicle may be escorted to the nearest repair facility. If a non-safety related violation is cited, a notice of apparent violation is issued. Vehicles are not routinely put out of service for non-safety related violations.

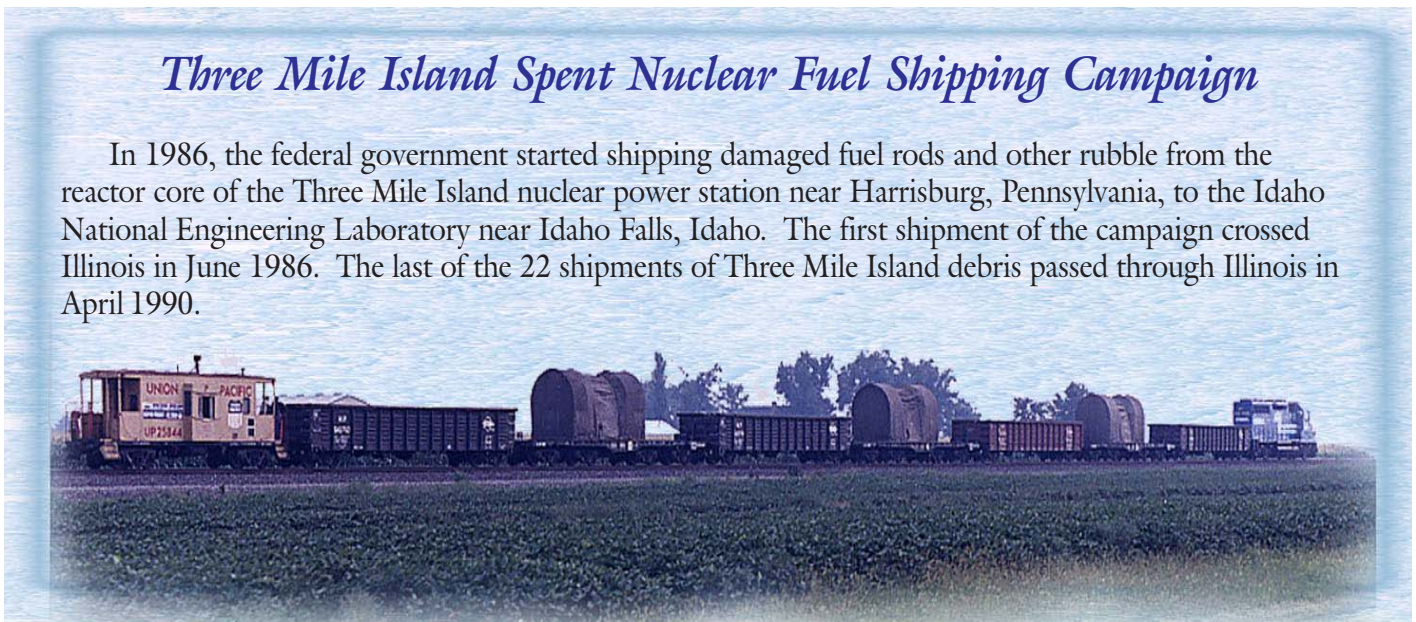
After the full inspection is satisfactorily completed, the escort begins. With truck shipments, the ISP officers lead the convoy by about one-fourth mile. The IEMA-Division of Nuclear Safety team follows the truck by approximately the same distance.

Train shipments typically include an engine, two to three cask cars, a caboose and buffer cars placed between the cask cars. The IEMA-Division of Nuclear Safety team, accompanied by the ICC inspector and ISP officers, escort the train along parallel roads. During the radiation inspection of the train cask, an IEMA-Division of Nuclear Safety inspector installs communication equipment necessary for tracking the shipment in the caboose and accompanies the shipment on the train, maintaining contact with the rest of the team via radio. At certain



Three Mile Island Spent Nuclear Fuel Shipping Campaign

In 1986, the federal government started shipping damaged fuel rods and other rubble from the reactor core of the Three Mile Island nuclear power station near Harrisburg, Pennsylvania, to the Idaho National Engineering Laboratory near Idaho Falls, Idaho. The first shipment of the campaign crossed Illinois in June 1986. The last of the 22 shipments of Three Mile Island debris passed through Illinois in April 1990.



checkpoints along the route, the escort team arrives ahead of the train so they have visual contact with the shipment.

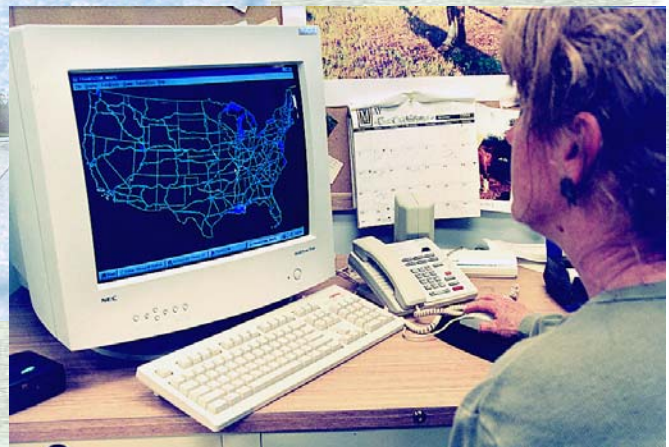
As the truck and train shipments pass checkpoints along the route, IEMA-Division of Nuclear Safety inspectors transmit progress reports to the dispatcher in Springfield and receive updates on weather, traffic and route conditions. The escort team accompanies the truck or train to its in-state destination or to the Illinois border.

In addition to tracking shipment progress through radio transmission from checkpoints, IEMA-Division of Nuclear Safety staff also uses TRANSCOM, the Department of Energy's satellite tracking system, to track movements of DOE materials. The TRANSCOM system allows IEMA-Division of Nuclear Safety to verify checkpoint information through position data generated from the truck's on-board satellite receiver/transmitter. The truck or train's position is updated approximately every five minutes and positions are accurate to within 500 feet.

Transportation of Trupact II

During March 1999, the first shipment of defense-generated transuranic waste arrived safely at the U.S. Department of Energy's (U.S. DOE) Waste Isolation Pilot Plant (WIPP), in Carlsbad, New Mexico. The WIPP site is a deep salt bed repository that was constructed by the U.S. DOE during the late 1980's. Transuranic wastes consist primarily of items such as laboratory clothing, tools, glove boxes, glassware and air filters contaminated with radioactive materials such as plutonium and americium. These items were generated as a result of activities related to research and materials production for national defense systems.

These materials are transported from the generator site to the WIPP in packages referred to as Trupact II. These Type B containers are required to meet hypothetical accident conditions and are certified by the U.S. Nuclear Regulatory Commission. Each Trupact will hold 14 drums of transuranic waste and a single truck can carry as many as 3 of the containers. U.S. DOE estimates the facility will receive approximately 37,000 shipments over the 35-year shipping campaign.



Results

Since the establishment of the program in 1983, over 480 highway and railroad shipments of spent nuclear fuel have been transported safely across Illinois. Of the 403 truck shipments and 81 train shipments, only eight were delayed. Delays were due to carrier violations discovered during the inspection, such as paperwork discrepancies or mechanical problems. All violations were rectified immediately, and shipments proceeded without prolonged delays. No transportation accidents have occurred.

To date, except for several instances when surface contamination measurements slightly exceeded statutory limits, no serious radiation-related violations were identified. This was due to small amounts of contamination leaking from microscopic pores in the metal cask surface. These minor incidents did not result in any measurable radiation dose or risk to the public.

While only five shipments passed through Illinois in 2000 and eight in 2001, IEMA-Division Nuclear Safety is already preparing for a time when there will be many more shipments each year. With the U. S. DOE's WIPP now open in New Mexico, shipments of transuranic waste will begin moving on Illinois highways, requiring the same inspection and escorting as spent fuel shipments. The future opening of a HLW disposal facility, proposed for Nevada, also would significantly increase the number of shipments through Illinois.

Surprisingly, Illinois' inspection and escort program is unique among states where spent fuel shipments travel. With the impending increase in transuranic waste and HLW shipments, many states are looking to Illinois for leadership as they attempt to establish similar programs.

Fees assessed on commercial shippers of spent nuclear fuel, HLW and transuranic waste help fund the inspection and escort program. The current fee is \$2,500 per cask for truck shipments and \$4,500 for the first cask and \$3,000 for each additional cask on train shipments.

The success of the Illinois inspection and escort program can be attributed to several factors:

- well-educated, properly trained and experienced personnel;
- proven state-of-the-art radiation detection and communication equipment; and
- a common-sense approach and cooperative interagency effort toward emergency prevention and response preparation.

Through the combination of these elements, the people of Illinois have been and will continue to be protected from the potential for radiation-related transportation incidents.

TRANSCOM

TRANSCOM is the U.S. Department of Energy (U.S. DOE)-sponsored satellite tracking system used for tracking its shipments of spent nuclear fuel, high level waste, transuranic waste and various other types of radioactive material shipments from U.S. DOE facilities. In recent years, the U.S. DOE has made the system available for use by certain state regulatory agencies and organizations responsible for emergency response to radioactive materials incidents and accidents.

The system is a "secure" system that meets the U.S. Nuclear Regulatory Commission requirements for transmitting "safeguards" information. U.S. DOE traffic managers, state regulatory officials and other organizations with access to the system are allowed to track the location and status of shipments as they progress along the route. Other data available through the TRANSCOM system includes screens showing the shipment specific bill of lading, shipping papers, emergency response guidance and an emergency contact list.



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