Truck Accident Involving Unirradiated Nuclear Fuel

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Truck Accident Involving Unirradiated Nuclear Fuel

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ABSTRACT

In the early morning of Dec. 16, 1991, a severe accident occurred when a passenger vehicle traveling in the wrong direction collided with a tractor-trailer carrying 24 unirradiated nuclear fuel assemblies in 12 containers on Interstate 1-91 in Springfield, Massachusetts. This paper documents the mechanical circumstances of the accident and assesses the physical environment to which the containers were exposed and the response of the containers and their contents.

The accident involved four impacts where the truck was struck by the car, impacted on the center guardrail, impacted on the outer concrete barrier and came to rest against the center guardrail. The impacts were followed by a fire that began in the engine compartment, spread to the tractor and cab, and eventually spread to the trailer and payload. The fire lasted for about three hours and the packages were involved in the fire for about two hours. As a result of the fire, the tractor-trailer was completely destroyed and the packages were exposed to flames with temperatures between 1300 °F and 1800 °F. The fuel assemblies remained intact during the accident and there was no release of any radioactive material during the accident. This was a very severe accident; however, the injuries were minor and at no time was the public health and safety at risk.

INTRODUCTION

At approximately 3:15 a.m. on Dec. 16, 1991, a passenger vehicle traveling in the wrong direction collided with a flat-bed, tractor-trailer carrying 24 unirradiated nuclear fuel assemblies in V2 Model No. RA-2 and RA-3 containers from the GE fabrication plant in Wilmington, North Carolina, to the Vermont Yankee Nuclear Plant. The collision occurred on I-91 where it passes through downtown Springfield, Massachusetts.

The trip from Wilmington, North Carolina, to Vernon, Vermont, normally requires about 24 hours, allowing time for refueling stops. Travel is essentially continuous, requiring two drivers that alternate driving and sleeping. Less than one hour of travel remained for the truck to reach its destination.

The truck was reported to have stopped for refueling shortly before the accident. The truck carries two saddle tanks on either side of the cab of the tractor. Each tank is rated at 125 gal; however, the positioning of the fill necks on the tanks prevents each tank from carrying the rated capacity. Consequently, the inventory of diesel fuel on board the truck has been estimated at about 210 gal. As with any vehicle, the cab of the tractor has numerous combustible materials (seats, blankets, floor mats, maps, etc.). The engine also contains several flammable liquids (power steering fluid, engine oil, etc.).

The containers were secured to the trailer with nylon tie down straps on top of tarpaulins that provided weather protection for the payload. The nylon straps were preloaded when the load was prepared for shipment. The tarpaulins were secured to the bed of the trailer by wooden boards that were nailed to the trailer bed with the nails passing through the tarpaulin.

ENVIRONMENT

At the time of the accident, weather conditions were ideal for driving. Weather conditions were recorded by two stations in the general vicinity of the accident. Westover Air Force Base is located about six miles northeast of the site of the accident, while the Hartford Airport is about 15 miles southwest of the accident site. The weather conditions reported by both stations were essentially the same. At the time of the accident, both stations reported high scattered clouds with excellent visibility at ground level. The weather was not a factor in the accident. The only impact of the weather was the movement of the flames due to the wind. Based on photographs and videos of the fire, the wind direction at the scene of the accident was approximately parallel to, and in the direction of, the northbound lanes of the highway. This is consistent with the wind directions reported by Westover Air Force Base. The barometric pressure was dropping at the time of the accident. This resulted in a snowstorm in the Springfield area; however, the snow began later in the day and had no impact upon the accident and cleanup.

ACCIDENT SITE

The accident occurred on an interstate highway in downtown Springfield, Massachusetts. In this area the highway is elevated, has limited access, and is divided. The right hand side (outer edge) of the northbound lanes is bordered by a concrete (with steel-reinforcing bars) barrier that is approximately 3-ft tall. This barrier is designed to return any vehicles that impact it to the roadway. The small railing at the top of the barrier was torn away during the impact. This railing appears to be the highest object that was involved in any of the impacts on the tractor or trailer. The barrier incorporates a curb that is about 6-in. higher than the roadway. The left-hand side (adjoining the southbound lanes) of the northbound lanes is bordered by a steel-beam type barrier that is designed to prevent cross-over type accidents. The shoulder at this side of the roadway is elevated by about 6 in. The highway is three lanes wide (each lane is 12 ft wide) with a shoulder on the right side of the road that is equivalent to a narrow lane, and at the center of the roadway, the shoulder is about 2-ft wide. The road is crowned with the high point in the center of the center lane and

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slopes to both sides of the northbound lanes. Drains exist at both sides of the roadway to channel water off the roadway into the Connecticut River. The interstate highway at the accident site passes over parking garages and is adjacent to the Springfield Marriott and Springfield Sheraton Hotels.

ACCIDENT DESCRIPTION

In the following description of the accident, the terms north and south refer to the approximate travel directions of I-91 and are not compass directions. At the location of the accident, the northbound lanes of I-91 are directed approximately northwest. Similarly, the terms left and right refer to the driver's side and the passenger side of the truck, respectively.

An allegedly intoxicated motorist entered the northbound lanes : I-91 traveling in a southbound direction. After driving several miles without encountering any other traffic, this car collided with the tractor-trailer that was transporting unirradiated nuclear fuel assemblies. Both the car and the truck were reported to be traveling in the center lane. The driver of the truck veered left in an attempt to avoid the collision. The car appeared to continue in a straight path and struck the tractor at an angle causing damage to the passenger side of the car and the passenger side of the truck. The initial impact appeared to involve the fuel tank and/or storage compartment on the right side of the tractor.

Following the initial impact, the truck continued northbound veering toward the center of the interstate and impacting the small curb and guardrail that separates the northbound from the southbound lanes. The impact was a glancing blow that apparently dislodged the left front wheel of the tractor and probably damaged some of the air tanks and/or tubing that provide compressed air to operate the brakes, suspension, and several accessories. The co-driver (also an experienced driver) was sleeping in the sleeper portion of the tractor and reported hearing an explosion during this impact. The source of this explosion is speculative, but one possibility could be the failure of any one of several compressed air components. This could also explain the loss of air pressure in the braking system.

The driver and co-driver were the closest observers at the conclusion of the impact portion of the accident and at the start of the fire portion of the accident. Both reported that the entire payload remained intact on the trailer based on the tarpaulin and tie downs being intact and in place. One early witness reported that he could not identify the form of the contents of the truck which tends to corroborate the fact that the tarpaulin was intact.

The fire in the tractor was allowed to burn. About one hour after the impact, ignition of the tarpaulin lead to ignition of the wooden outer containers, the bed of the trailer, and ultimately the tires on the trailer. This fire was also allowed to burn until all of the combustible materials were consumed. Various accounts place the length of the fire between two and three hours with the principal differences arising from differing definitions of the end of the fire. The containers fell off the trailer at various times during the fire and were exposed to varying amounts of flames after falling from the trailer; therefore, some containers could have been exposed to fire for as little as one hour while others appear to have been exposed for over two hours.

The principal sources of combustion that impacted the containers were the following:

- Diesel fuel from the fuel tanks of the truck.
- Rubber from the tires on the truck.
- Asphalt from the roadway.
- Wood from the deck of the trailer.
- Wood from the outer containers of the containers.

Not all of the diesel fuel from the truck burned during the fire. The cleanup included distributing sand on the roadway to absorb the diesel fuel that remained on the roadway after the fire.

Local flame temperatures during the fire were about 1800 °F in the vicinity of the tires and about 1300 °F throughout the remainder of the portion of the fire that affected the containers and unirradiated nuclear fuel assemblies. Consequently, only portions of containers were exposed to
temperatures greater than 1300 °F. The fire burned for over three hours; however, the containers and the unirradiated nuclear fuel assemblies were exposed to the fire for about two hours. The damage to the metal inner containers ranged from minimal to very severe based upon the location of the container and the intensity of the flames during the fire. The fuel assemblies inside the container were designed to conform to the configuration of the metal inner container. In addition, some of the clad tubes had swollen due to the increases in pressure within the fuel rod as a result of the elevated temperatures during the accident. Analyses indicate that temperatures in excess of 1500 °F are required to cause this type of damage. Some cracks were observed in the clad tubes at the location of swelling; however, no uranium dioxide fuel exacted from the clad tubes.

**ACCIDENT CONSEQUENCES**

During and after the fire, several surveys of the accident scene were made to determine the amount of radioactive contamination. No measurable amounts of radioactivity were identified and it was determined that it was safe to remove the fuel assemblies from the accident site. The fuel assemblies were loaded onto trucks and transported to a temporary holding site. The damaged containers were subsequently returned to the GE plant.

All of the fuel assemblies remained in their inner containers and were maintained in a safe geometry throughout the entire accident. There were no serious injuries or fatalities, and the health and safety of the public and the personnel responding to the accident were never at risk.