TRANSPORTATION
THE VITAL TENDONS OF THE NUCLEAR INDUSTRY

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INTRODUCTION

In all of the diagrams of the nuclear fuel cycle ever prepared, we see an array of facilities ranging from mining to ultimate disposal connected by arrows denoting movement. Until lately, hardly anyone has ever even stopped to think that those arrows involved an activity every bit as much of the nuclear fuel cycle as the boxes representing the power plant or the reprocessing plant. But, in the last few years there has been a growing awareness that, first, the nuclear fuel cycle cannot function without these "tendons" and, secondly, that many of the systems needed to provide these connective links are either non-existent, or in short supply. Let me start today by trying to give you some perspective on the general significance of transportation to our modern society and then compare this with nuclear materials transportation.

GENERAL BACKGROUND

In the United States each year, we transport from one point to another, some five hundred billion packages of a very broad range of commodities. On the basis of weight alone, roughly 57 percent of all of these packages are moved by the nation's motor carriers, either as common carriers or private haulers. Another 37.8 percent of the tonnage moved is carried by America's railroads. America's inland waterways handle 4.6 percent of these cargos. The remaining .6 percent is moved by the nation's air carriers. In addition to commodities, we also transport people in this country. Not surprisingly, most of the passenger service in the United States is provided by the private automobile; roughly 86 percent of the 1331 billion intercity passenger miles accumulated each year are provided by the private automobile. Furthermore, the influence of the transportation industry in our society is not limited to the mere movement of people and commodities. Roughly 6 percent of the total work force in this country is involved directly in the transportation industry, either through being employed in the actual movement of goods and people or in the original equipment manufacturing industries. These manufacturing industries have annual revenues on the order of $30 billion per year. In addition to these equipment costs the operating revenues of the nation's transportation industry approach $60 billion per year.

As we all know, in the transportation of goods and people, accidents sometimes occur. Again, refering to statistics, there are approximately 25 million accidents involved in the transportation activity every year. These involve injuries to about 5 million people and about 47,000 deaths. (It is important to note that these figures do not include deaths and injuries from private automobiles.) This accident experience adds another $40 billion per year to the costs of operating the total transportation activity within the United States. Taking all of the costs into account, we spend about $130 billion per year in the transportation industry, or roughly 14 percent of our gross national product.

Thus, transportation is an important factor in the fabric of our country, even if you don't consider the nuclear industry. And, transportation is equally important to the nuclear industry, even though the transportation needs of this industry are miniscule in comparison to the total transportation needs of the country.

HAZARDOUS MATERIALS

In order to grasp this relationship, let's go back to the beginning and break out the transportation activity of the nuclear industry from the overall transportation industry. Of the 500 billion packages shipped every year by all modes in this country, about 100 million of them contain hazardous materials. This encompasses a very broad range of materials, some of which you might consider hazardous and some of which you might not. The total list in the Code of Federal Regulations runs to 91 pages of fine print and includes such surprises as wet hair, hay, metal shavings, and scrap lead. It also includes those which you would normally consider to be hazardous, such as caustics and acids; toxic materials, such as pesticides and poisons; explosives, such as dynamite and munitions; flammables, such as gasoline and propane; corrosives; compressed gases; and radioactive materials.

But, of those 100 million packages of hazardous materials being shipped each year in our society, only about 2 million contain radioactive materials. Thus, the problem of shipping radioactive materials in our society constitutes only about 2 percent of all the hazardous materials currently being moved and only about 0.0004 percent of all of the cargos being carried. Therefore, the attention, by the transportation industry, given to the movement of radioactive materials is truely insignificant in comparison to the attention given to all other commodities.

So, instead of comparing the movement of nuclear materials to the total transportation picture, let's look at the 2 million packages of radioactive material in comparison to the 100 million packages of hazardous materials moved each year in our society. By using this comparison, we are at least drawing a parallel between one hazardous material and other hazardous materials. Data gathered by the U. S. Department of Transportation from hazardous material incident reports during the 1973-76 time frame reveal that during that four year period there were 113 persons killed as the result of transporting hazardous materials. Of these 113, 97 people were killed in accidents involving flammable materials, such as gasoline and propane. Five were killed in accidents involving the transportation of poisonous materials. Another five were killed in accidents involving corrosive materials, such as caustics and acids. Three persons were killed, during that four year period, by accidents involving the transportation of compressed gases. Another two were killed in activities involving the transportation of explosives. Only one person was killed in the movement of radioactive material. It is important to note that this one death involved the truck driver who died as a result of the accident and not as a result of any involvement with the radioactive nature of the cargo. Even so, it is interesting that, on the basis of the deaths involved, the movement of radioactive materials is roughly twice as safe as the movement of other hazardous materials. When compared on the basis of the total number of accidents involved, the radioactive material transportation activity is four times as safe as hazardous materials in general.

RADIOACTIVE MATERIALS

In order to more fully understand the perspective involved in the transportation of radioactive materials, let me give you some further information on the types of radioactive materials now being transported. Those 2 million packages of radioactive material vary widely in the level of radioactivity they contain and, thus, vary equally as widely in the amount of protection that is afforded to them by the packaging in which they are placed.

For instance, about 700,000 of the 2 million shipments each year involve the movement of materials of such low radioactive levels as to not require any specific federal regulation. These are called limited or exempt materials and include such items as luminous watch dials, exit signs that glow in the dark, smoke detectors, and other products of that nature. The radioactive level of these materials is so low that the regulations allow these to be shipped by the U. S. Post Office in packages that provide no protection against accidents.

About 910,000 of these 2 million annual shipments involve radiopharmaceuticals and other medical sources. The majority of these shipments involve radioisotopes intended for ingestion or injection into the human body. Other radioactive materials in this category are used in diagnostic and treatment techniques, such as radiotherapy sources for the treatment of cancer. It is interesting to note that the American Medical Association now estimates that there are over 1 million people in the United States alone who are alive today because of the use of radiopharmaceuticals and other medical applications of radiation. Most of these sources are shipped in cardboard boxes (Type A packages) while some are packaged in heavier containers.

Another 220,000 of the 2 million packages annually transported involve industrial radiation sources. These are the radiation sources which are used in the manufacturing processes common to our industrialized society. If you are a cigarette smoker, your cigarettes were manufactured using a radiation source to maintain uniformity in the density of the tobacco. Another radiation source was used to control the thickness of the paper which surrounds the tobacco in your cigarette. Almost all paper manufactured in this country is thickness controlled by radiation gauging. The same technique is used to control the thickness of steel, and glass, and plastics, and many other manufactured goods in our society. This category also includes the portable radiography sources used to maintain quality control through x-ray examination of such field fabricated items as pipelines, storage tanks, bridges, and high-rise buildings. Most of these sources are shipped in heavy, shielded packages.

Approximately, 200,000 additional shipments are made each year involving the nuclear fuel cycle, with the exception of its waste products. These shipments involve movement of fresh fuels, startup sources, and a very small quantity of spent fuels being moved between nuclear facilities.

The remaining 150,000 packages a year are involved in moving wastes from the nuclear industry to the points of their disposal. These wastes include not only the wastes from the nuclear power cycle but wastes from industrial activities and medical activities as well. Further, these materials include the entire spectrum of radioactive wastes from the almost totally non-radioactive by-products associated with radiopharmaceutical applications to the high-level residues resulting from the chemical extraction processes necessary to produce selected radioactive sources and specific fissile materials. In terms of today's movements, only about one-third of the current waste movements are attributable to the nuclear power industry. Yet, this is the single point at which the fears of the public and the pressure of the intervenors is applied.

A PERSPECTIVE ON NUCLEAR MATERIALS TRANSPORTATION

In spite of this perspective, the current political atmosphere surrounding nuclear power has resulted in identification of the transportation of nuclear wastes as the "soft underbelly" of the nuclear fuel cycle. This is manifested by the inordinate amount of attention given to the hazard of radioactive material transportation in various news accounts appearing in the media, in pronouncements from various concerned public interest groups, and from political postures taken by local, state, and national officials. This situation has developed to the point that even when persons questioning the safety of transportation are reminded that we have been moving radioactive materials in this country for 30 years without adverse impact upon the public, the immediate response is that the near term expansion of this activity will obviously produce an unacceptable consequence within our society. Such an attitude is based, in large measure, upon a lack of understanding of why the transportation of radioactive materials has been conducted successfully for the past 30 years. Let me repeat, the nuclear industry in this country, as well as the rest of the world, has been moving radioactive materials without serious impact upon the public for the past 30 years.

That success rests upon a series of philosophies developed back in the 1940's.

Following World War II, the National Academy of Sciences asked the National Research Council to initiate a study on the regulation for transportation of nuclear materials. The results of that study were a set of regulations subsequently adopted by the International Atomic Energy Agency and utilized throughout the world. But, even more important than the regulations were the foundations behind the regulations which were developed by that group. These foundations can be identified as three fundamental philosophies.

First, the protection afforded to the material being shipped should be proportional to the risk involved in shipping that material. Obviously you don't need to ship radiopharmaceuticals in the same kind of container that you use for the shipment of spent fuel. In more detail, the original philosophy concluded that there were four components of protection that should be considered in the design of packages or containers for radioactive material. These four factors include containment (to prevent the material from being released into the atmosphere), shielding (if material is radioactive enough to require shielding), heat management (if the material produces enough heat to require some sort of heat dissipation), and, finally, criticality management (if the material being shipped is a fissile material requiring consideration of criticality). Thus, in each case the material being shipped is considered in the design and manufacture of the container in which it is to be transported so that these four considerations are addressed as necessary.

The second philosophical point which grows out of the first one, is that the package used to ship radioactive material should provide <u>all</u> of the protection necessary to assure the safety of the public. Thus, the package incorporating, as necessary, the four previously stated criteria must apply these criteria in such a way as to assure public safety. This safety must be provided not only during normal transport, but even in the expected range of accident situations, the package must provide protection sufficient to assure the safety of the public. Historically, radioactive material has been the only hazardous material in which the package must provide for public safety under accident conditions. While recent modifications to the regulations covering propane tank cars call for a limited measure of accident protection, these regulations require some attempt be made to reduce the likelihood of low order explosions in accidents involving fires. But, there is essentially no attempt to apply the broad philosophy of public safety assurance as used in the design of nuclear packages to the design of containers for other hazardous materials.

The third philosophy important to the development of the regulations involves the utilization of engineering testing, or analysis, to evaluate the package before it is put into service. Thus, the designer of a package for the movement of radioactive material is required to analyze that package mathematically or submit it to a series of engineering tests to determine whether or not it would meet the stated requirements. These requirements, specified in the form of physical tests, are, as stated before, designed to be of an engineering nature. On that basis then, the tests or analysis could utilize standard engineering inputs such that the results are repeatable no matter who did the analysis or where the testing was accomplished. These requirements centered on tests that would produce damage to the package equivalent to what would be experienced in severe accidents. While the test criteria have been modified slightly since their initial inception in the late 1940's, they are basically the same as those set up in the beginning.

Let me reiterate, the tests are not intended to replicate the accident environment or to simulate the accident situation per se, but instead are intended to produce damage to the package equivalent to that which would be experienced in extra severe accidents. At this point the obvious question is "How successful is that approach?" As was stated earlier, nuclear material has been shipped around the United States and the rest of the world for about thirty years with minimal effect on the public. On the basis of this experience, one must conclude that the approach has been highly successful. This does not mean that there have not been accidents, but does mean that in spite of those accidents, there have been no disasters, there have been no major releases of radiation.

THE PUBLIC PERCEPTION

All these factors not withstanding, there still exists in the minds of the American public a great uneasiness about the transportation of radioactive materials. This uneasiness is intentionally aggravated by intervenors who view the transportation of radioactive materials as yet another battleground upon which the development of commerical nuclear power can be halted. In the public opinion arena, the transportation of nuclear wastes is ballyhooed as an activity fraught with unknowns. A recent anti-nuclear organization radio spot is a good example of this approach. That spot reads like this.

"If you live in New Mexico, federal officials have a surprise for you. At a site near Carlsbad, they plan to dump radioactive wastes brought in from other states. To get it there, trucks and trains will pass through Albuquerque, Santa Fe, Farmington, Carlsbad, and every major town in New Mexico. What happens if there's an accidental spill? Land and homes contaminated...Wide spread cancer...Whole towns abandoned forever...No insurance would be valid...All policies exempt nuclear accidents. Could such a disaster really happen. Well, 2000 truckloads and 1500 trainloads will run through this state every year. Would you guarantee there would never be an accident? We wouldn't."

Such scare tactics indicate to the public that the hazards of the nuclear industry and, more specifically, the risks of transporting nuclear materials are unknowns in our society. The fact is that there are few, if any technological activities currently being conducted by mankind about which more is known than the nuclear industry and the transportation activity associated with that industry. It would be difficult to find another activity in the history of mankind with a safety record even closely approximating that of the nuclear industry or the transportation of nuclear materials.

The facts indicate that the risk of transporting nuclear materials is considerably below that of other commonly accepted activities in our society. Even given that there will be accidents in the transportation of nuclear materials, and that it is conceivable that sometime there might be an accident so severe as to create a release of radioactive materials into the environment, the quantities of those releases have been evaluated and found to be small. Because of the years of effort devoted to studying the consequences of nuclear accidents, throughout the fuel cycle, we know more about the effects of a nuclear transportation accident than we know about the total effects of almost any of the hazardous materials we currently move in routine commerce throughout the world. We know the probability of accidents, the severity of accidents, the probable release which can be caused by accidents, and the consequences of such releases. So, in spite of the tactics employed by the segment of our society who would stop the transportation of nuclear materials on the basis of the unknowns involved, the actual situation is that we know more about this activity than about almost any other activity carried out within our society.